Canonical LXD

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LXD (`[lks'di:]`) is a modern, secure and powerful system container and virtual machine manager.

It provides a unified experience for running and managing full Linux systems inside containers or virtual machines. LXD supports images for a large number of Linux distributions (official Ubuntu images and images provided by the community) and is built around a very powerful, yet pretty simple, REST API. LXD scales from one instance on a single machine to a cluster in a full data center rack, making it suitable for running workloads both for development and in production.

LXD allows you to easily set up a system that feels like a small private cloud. You can run any type of workload in an efficient way while keeping your resources optimized.

You should consider using LXD if you want to containerize different environments or run virtual machines, or in general run and manage your infrastructure in a cost-effective way.

CHAPTER

ONE

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CHAPTER

TWO

PROJECT AND COMMUNITY

LXD is free software and released under AGPL-3.0-only (it may contain some contributions that are licensed under the Apache-2.0 license, see *License and copyright*). It's an open source project that warmly welcomes community projects, contributions, suggestions, fixes and constructive feedback.

The LXD project is sponsored by Canonical Ltd.

- Code of Conduct
- *Contribute to the project*
- Release announcements
- Release tarballs
- *Get support*
- Watch tutorials and announcements on YouTube
- Discuss on IRC (see Getting started with IRC if needed)
- Ask and answer questions on the forum

2.1 First steps with LXD

This tutorial guides you through the first steps with LXD. It covers installing and initializing LXD, creating and configuring some instances, interacting with the instances, and creating snapshots.

After going through these steps, you will have a general idea of how to use LXD, and you can start exploring more advanced use cases!

Note: Ensure that you have 20 GiB free disk space before starting this tutorial.

2.1.1 Install and initialize LXD

The easiest way to install LXD is to install the snap package. If you prefer a different installation method, or use a Linux distribution that is not supported by the snap package, see *How to install LXD*.

1. Install `snapd`:
    1. Run `snap version` to find out if snap is installed on your system:

       `user@host:~$ snap version  snap 2.59.4snapd 2.59.4series 16ubuntu 22.04kernel 5.15.0-73-generic` If you see a table of version numbers, snap is installed and you can continue with the next step of installing LXD.

2. If the command returns an error, run the following commands to install the latest version of `snapd` on Ubuntu:

```
sudo apt update
sudo apt install snapd
```

Note: For other Linux distributions, see the installation instructions in the Snapcraft documentation.

2. Enter the following command to install LXD:

```
sudo snap install lxd
```

If you get an error message that the snap is already installed, run the following command to refresh it and ensure that you are running an up-to-date version:

```
sudo snap refresh lxd
```

3. Enter the following command to add the current user to the `lxd` group (the group was automatically created during the previous step):

```
getent group lxd | grep -qwF "$USER" || sudo usermod -aG lxd "$USER"
```

This is needed to be granted permission to interact with LXD.

4. Enter the following command to initialize LXD:

```
lxd init --minimal
```

This will create a minimal setup with default options. If you want to tune the initialization options, see *How to initialize LXD* for more information.

2.1.2 Launch and inspect instances

LXD is image based and can load images from different image servers. In this tutorial, we will use the official `ubuntu:` image server.

You can list all images (long list) that are available on this image server with:

```
lxc image list ubuntu:
```

You can list the images used in this tutorial with:

```
lxc image list ubuntu: 24.04 architecture=$(uname -m)
```

See *Images* for more information about the images that LXD uses.

Now, let's start by launching a few instances. With *instance*, we mean either a container or a virtual machine. See *About containers and VMs* for information about the difference between the two instance types.

For managing instances, we use the LXD command line client `lxc`. See *About `lxd` and `lxc`* if you are confused about when to use the `lxc` command and when to use the `lxd` command.

1. Launch a container called `first` using the Ubuntu 24.04 image:

```
lxc launch ubuntu:24.04 first
```

Note: Launching this container takes a few seconds, because the image must be downloaded and unpacked first.

2. Launch a container called `second` using the same image:

```
lxc launch ubuntu:24.04 second
```

Note: Launching this container is quicker than launching the first, because the image is already available.

3. Copy the first container into a container called `third`:

```
lxc copy first third
```

4. Launch a VM called `ubuntu-vm` using the Ubuntu 24.04 image:

```
lxc launch ubuntu:24.04 ubuntu-vm --vm
```

Note: Even though you are using the same image name to launch the instance, LXD downloads a slightly different image that is compatible with VMs.

5. Check the list of instances that you launched:

```
lxc list
```

You will see that all but the third container are running. This is because you created the third container by copying the first, but you didn't start it.

You can start the third container with:

```
lxc start third
```

6. Query more information about each instance with:

```
lxc info first
lxc info second
lxc info third
lxc info ubuntu-vm
```

7. We don't need all of these instances for the remainder of the tutorial, so let's clean some of them up:

   1. Stop the second container:

      ```
      lxc stop second
      ```

   2. Delete the second container:

      ```
      lxc delete second
      ```

   3. Delete the third container:

      ```
      lxc delete third
      ```

      Since this container is running, you get an error message that you must stop it first. Alternatively, you can force-delete it:

```
lxc delete third --force
```

See *How to create instances* and *How to manage instances* for more information.

2.1.3 Configure instances

There are several limits and configuration options that you can set for your instances. See *Instance options* for an overview.

Let's create another container with some resource limits:

1. Launch a container and limit it to one vCPU and 192 MiB of RAM:

```
lxc launch ubuntu:24.04 limited --config limits.cpu=1 --config limits.memory=192MiB
```

2. Check the current configuration and compare it to the configuration of the first (unlimited) container:

```
lxc config show limited
lxc config show first
```

3. Check the amount of free and used memory on the parent system and on the two containers:

```
free -m
lxc exec first -- free -m
lxc exec limited -- free -m
```

Note: The total amount of memory is identical for the parent system and the first container, because by default, the container inherits the resources from its parent environment. The limited container, on the other hand, has only 192 MiB available.

---

4. Check the number of CPUs available on the parent system and on the two containers:

```
nproc
lxc exec first -- nproc
lxc exec limited -- nproc
```

Note: Again, the number is identical for the parent system and the first container, but reduced for the limited container.

---

5. You can also update the configuration while your container is running:

    1. Configure a memory limit for your container:

    ```
    lxc config set limited limits.memory=128MiB
    ```

    2. Check that the configuration has been applied:

    ```
    lxc config show limited
    ```

    3. Check the amount of memory that is available to the container:

```
lxc exec limited -- free -m
```

Note that the number has changed.

6. Depending on the instance type and the storage drivers that you use, there are more configuration options that you can specify. For example, you can configure the size of the root disk device for a VM:

   1. Check the current size of the root disk device of the Ubuntu VM:

      ```
      user@host:~$ lxc exec ubuntu-vm -- df -h  Filesystem Size Used Avail Use% Mounted on/dev/root 9.6G 1.4G 8.2G 15% /tmpfs 483M 0 483M 0% /dev/shmtmpfs 193M 604K 193M 1% /runtmpfs 5.0M 0 5.0M 0% /run/locktmpfs 50M 14M 37M 27% /run/lxd_agent/ dev/sda15 105M 6.1M 99M 6% /boot/efi
      ```

   2. Override the size of the root disk device:

      ```
      lxc config device override ubuntu-vm root size=30GiB
      ```

   3. Restart the VM:

      ```
      lxc restart ubuntu-vm
      ```

   4. Check the size of the root disk device again:

      ```
      user@host:~$ lxc exec ubuntu-vm -- df -h  Filesystem Size Used Avail Use% Mounted on/dev/root 29G 1.4G 28G 5% /tmpfs 483M 0 483M 0% /dev/shmtmpfs 193M 588K 193M 1% /runtmpfs 5.0M 0 5.0M 0% /run/locktmpfs 50M 14M 37M 27% /run/lxd_agent/dev/ sda15 105M 6.1M 99M 6% /boot/efi
      ```

See *How to configure instances* and *Instance configuration* for more information.

2.1.4 Interact with instances

You can interact with your instances by running commands in them (including an interactive shell) or accessing the files in the instance.

Start by launching an interactive shell in your instance:

1. Run the `bash` command in your container:

   ```
   lxc exec first -- bash
   ```

2. Enter some commands, for example, display information about the operating system:

   ```
   cat /etc/*release
   ```

3. Exit the interactive shell:

   ```
   exit
   ```

Instead of logging on to the instance and running commands there, you can run commands directly from the host.

For example, you can install a command line tool on the instance and run it:

```
lxc exec first -- apt-get update
lxc exec first -- apt-get install sl -y
lxc exec first -- /usr/games/sl
```

See *How to run commands in an instance* for more information.

You can also access the files from your instance and interact with them:

1. Pull a file from the container:

```
lxc file pull first/etc/hosts .
```

2. Add an entry to the file:

```
echo "1.2.3.4 my-example" >> hosts
```

3. Push the file back to the container:

```
lxc file push hosts first/etc/hosts
```

4. Use the same mechanism to access log files:

```
lxc file pull first/var/log/syslog - | less
```

Note: Press `q` to exit the `less` command.

See *How to access files in an instance* for more information.

2.1.5 Manage snapshots

You can create a snapshot of your instance, which makes it easy to restore the instance to a previous state.

1. Create a snapshot called "clean":

```
lxc snapshot first clean
```

2. Confirm that the snapshot has been created:

```
lxc list first
lxc info first
```

Note: `lxc list` shows the number of snapshots. `lxc info` displays information about each snapshot.

3. Break the container:

```
lxc exec first -- rm /usr/bin/bash
```

4. Confirm the breakage:

```
lxc exec first -- bash
```

Note: You do not get a shell, because you deleted the `bash` command.

5. Restore the container to the state of the snapshot:

```
lxc restore first clean
```

6. Confirm that everything is back to normal:

```
lxc exec first -- bash
exit
```

7. Delete the snapshot:

```
lxc delete first/clean
```

See *Use snapshots for instance backup* for more information.

2.1.6 Next steps

Now that you've done your first experiments with LXD, check out the information in the *Getting started* section!

2.2 How-to guides

These how-to guides cover key operations and processes in LXD.

2.2.1 Get started

To get started with LXD, install and initialize it. Then do some basic configuration of the server and the command-line client.

Getting started

To get started with LXD, see the documentation in this section.

How to install and initialize LXD:

How to install LXD

The easiest way to install LXD is to *install one of the available packages*, but you can also *install LXD from the sources*.

After installing LXD, make sure you have a `lxd` group on your system. Users in this group can interact with LXD. See *Manage access to LXD* for instructions.

Choose your release

LXD maintains different release branches in parallel.

Long term support (LTS) releases
: The current LTS releases are LXD 5.21.x (snap channel `5.21/stable` - this is the default channel), LXD 5.0.x (snap channel `5.0/stable`) and LXD 4.0.x (snap channel `4.0/stable`).

  The LTS releases follow the Ubuntu release schedule and are released every two years:

- LXD 5.21 is supported until June 2029. It gets frequent bugfix and security updates, but does not receive any feature additions. Updates to this release happen approximately every six months, but this schedule should be seen as a rough estimation that can change based on priorities and discovered bugs.
- LXD 5.0 is supported until June 2027.
- LXD 4.0 is supported until June 2025.

Feature releases
: After LXD 5.21 is released, the next feature release will be LXD 6.x (starting with 6.1). It is available through the snap channels `latest/stable`, `latest/candidate`, and `latest/edge`, in addition to channels for the most recent specific releases (for example, `6.1/stable`). See `snap info lxd` for a full list of available channels.

  Feature releases are pushed out about every month and contain new features as well as bugfixes. The normal support length for those releases is until the next release comes out. Some Linux distributions might offer longer support for particular feature releases that they decided to ship.

LTS releases are recommended for production environments, because they benefit from regular bugfix and security updates. However, there are no new features added to an LTS release, nor any kind of behavioral change.

To get all the latest features and monthly updates to LXD, use the feature release branch instead.

Install LXD from a package

The LXD daemon only works on Linux. The client tool (*`lxc`*) is available on most platforms.

Linux

The easiest way to install LXD on Linux is to install the *Snap package*, which is available for different Linux distributions.

If this option does not work for you, see the *Other installation options*.

Snap package

LXD publishes and tests snap packages that work for a number of Linux distributions (for example, Ubuntu, Arch Linux, Debian, Fedora, and OpenSUSE).

Complete the following steps to install the snap:

1. Check the LXD snap page on Snapcraft to see if a snap is available for your Linux distribution. If it is not, use one of the *Other installation options*.
2. Install `snapd`. See the installation instructions in the Snapcraft documentation.
3. Install the snap package. For the latest feature release, use:

   ```
   sudo snap install lxd --channel=latest/stable
   ```

   For the LXD 5.21 LTS release, use:

   ```
   sudo snap install lxd --channel=5.21/stable
   ```

   For the LXD 5.0 LTS release, use:

   ```
   sudo snap install lxd --channel=5.0/stable
   ```

For more information about LXD snap packages (regarding more versions, update management etc.), see Managing the LXD snap.

Note: On Ubuntu 18.04, if you previously had the LXD deb package installed, you can migrate all your existing data over by installing the 5.0 snap and running the following commands:

```
sudo install lxd --channel=5.0/stable
sudo lxd.migrate
```

After successfully running the `lxd.migrate` command, you can then switch to a newer snap channel if desired, like the latest one:

```
sudo refresh lxd --channel=latest/stable
```

If you want the current user to be able to interact with the LXD daemon, add it to the `lxd` group as the installation process does not add it for you:

```
getent group lxd | grep -qwF "$USER" || sudo usermod -aG lxd "$USER"
```

Other installation options

Some Linux distributions provide installation options other than the snap package.

Alpine Linux

Arch Linux

Fedora

Gentoo

To install the feature branch of LXD on Alpine Linux, run:

```
apk add lxd
```

To install the feature branch of LXD on Arch Linux, run:

```
pacman -S lxd
```

Fedora RPM packages for LXC/LXD are available in the COPR repository.

To install the LXD package for the feature branch, run:

```
dnf copr enable ganto/lxc4
dnf install lxd
```

See the Installation Guide for more detailed installation instructions.

To install the feature branch of LXD on Gentoo, run:

```
emerge --ask lxd
```

Other operating systems

Important: The builds for other operating systems include only the client, not the server.

macOS

Windows

LXD publishes builds of the LXD client for macOS through Homebrew.

To install the feature branch of LXD, run:

```
brew install lxc
```

The LXD client on Windows is provided as a Chocolatey package. To install it:

1. Install Chocolatey by following the installation instructions.
2. Install the LXD client:

   ```
   choco install lxc
   ```

You can also find native builds of the LXD client on GitHub:

- LXD client for Linux: `bin.linux.lxc.aarch64`, `bin.linux.lxc.x86_64`
- LXD client for Windows: `bin.windows.lxc.aarch64.exe`, `bin.windows.lxc.x86_64.exe`
- LXD client for macOS: `bin.macos.lxc.aarch64`, `bin.macos.lxc.x86_64`

To download a specific build:

1. Make sure that you are logged into your GitHub account.
2. Filter for the branch or tag that you are interested in (for example, the latest release tag or `main`).
3. Select the latest build and download the suitable artifact.

Install LXD from source

Follow these instructions if you want to build and install LXD from the source code.

We recommend having the latest versions of `liblxc` (see *LXC requirements*) available for LXD development. Additionally, LXD requires a modern Golang (see *Go*) version to work. On Ubuntu, you can get those with:

```
sudo apt update
sudo apt install acl attr autoconf automake dnsmasq-base git libacl1-dev libcap-dev␣
↪liblxc1 liblxc-dev libsqlite3-dev libtool libudev-dev liblz4-dev libuv1-dev make pkg-
↪config rsync squashfs-tools tar tcl xz-utils ebtables
command -v snap >/dev/null || sudo apt-get install snapd
sudo snap install --classic go
```

Note: If you use the `liblxc-dev` package and get compile time errors when building the `go-lxc` module, ensure that the value for `LXC_DEVEL` is `0` for your `liblxc` build. To check that, look at `/usr/include/lxc/version.h`. If the `LXC_DEVEL` value is `1`, replace it with `0` to work around the problem. It's a packaging bug that is now fixed, see LP: #2039873.

There are a few storage drivers for LXD besides the default `dir` driver. Installing these tools adds a bit to initramfs and may slow down your host boot, but are needed if you'd like to use a particular driver:

```
sudo apt install lvm2 thin-provisioning-tools
sudo apt install btrfs-progs
```

To run the test suite, you'll also need:

```
sudo apt install busybox-static curl gettext jq sqlite3 socat bind9-dnsutils
```

From source: Build the latest version

These instructions for building from source are suitable for individual developers who want to build the latest version of LXD, or build a specific release of LXD which may not be offered by their Linux distribution. Source builds for integration into Linux distributions are not covered here and may be covered in detail in a separate document in the future.

```
git clone https://github.com/canonical/lxd
cd lxd
```

This will download the current development tree of LXD and place you in the source tree. Then proceed to the instructions below to actually build and install LXD.

From source: Build a release

The LXD release tarballs bundle a complete dependency tree as well as a local copy `libdqlite` for LXD's database setup.

```
tar zxvf lxd-4.18.tar.gz
cd lxd-4.18
```

This will unpack the release tarball and place you inside of the source tree. Then proceed to the instructions below to actually build and install LXD.

Start the build

The actual building is done by two separate invocations of the Makefile: `make deps` – which builds libraries required by LXD – and `make`, which builds LXD itself. At the end of `make deps`, a message will be displayed which will specify environment variables that should be set prior to invoking `make`. As new versions of LXD are released, these environment variable settings may change, so be sure to use the ones displayed at the end of the `make deps` process, as the ones below (shown for example purposes) may not exactly match what your version of LXD requires:

We recommend having at least 2GiB of RAM to allow the build to complete.

```
user@host:~$ make deps              ...make[1]:  Leaving directory '/root/go/deps/dqlite'#
environment Please set the following in your environment (possibly ~/.bashrc)#
export CGO_CFLAGS="${CGO_CFLAGS} -I$(go env GOPATH)/deps/dqlite/include/"# export
CGO_LDFLAGS="${CGO_LDFLAGS} -L$(go env GOPATH)/deps/dqlite/.libs/"# export
LD_LIBRARY_PATH="$(go env GOPATH)/deps/dqlite/.libs/${LD_LIBRARY_PATH}"# export
CGO_LDFLAGS_ALLOW="(-Wl,-wrap,pthread_create)|(-Wl,-z,now)" user@host:~$ make
```

From source: Install

Once the build completes, you simply keep the source tree, add the directory referenced by `$(go env GOPATH)/bin` to your shell path, and set the `LD_LIBRARY_PATH` variable printed by `make deps` to your environment. This might look something like this for a `~/.bashrc` file:

```
export PATH="${PATH}:$(go env GOPATH)/bin"
export LD_LIBRARY_PATH="$(go env GOPATH)/deps/dqlite/.libs/:${LD_LIBRARY_PATH}"
```

Now, the `lxd` and `lxc` binaries will be available to you and can be used to set up LXD. The binaries will automatically find and use the dependencies built in `$(go env GOPATH)/deps` thanks to the `LD_LIBRARY_PATH` environment variable.

Machine setup

You'll need sub{u,g}ids for root, so that LXD can create the unprivileged containers:

```
echo "root:1000000:1000000000" | sudo tee -a /etc/subuid /etc/subgid
```

By default, only users added to the `lxd` group can interact with the LXD daemon. Installing from source doesn't guarantee that the `lxd` group exists in the system. If you want the current user (or any other user) to be able to interact with the LXD daemon, add it to the `lxd` group:

```
getent group lxd >/dev/null || sudo groupadd --system lxd # create the group if needed
getent group lxd | grep -qwF "$USER" || sudo usermod -aG lxd "$USER"
```

Now you can run the daemon (the `--group sudo` bit allows everyone in the `sudo` group to talk to LXD; you can create your own group if you want):

```
sudo -E PATH=${PATH} LD_LIBRARY_PATH=${LD_LIBRARY_PATH} $(go env GOPATH)/bin/lxd --group␣
↪sudo
```

Note: If `newuidmap/newgidmap` tools are present on your system and `/etc/subuid`, `etc/subgid` exist, they must be configured to allow the root user a contiguous range of at least 10M UID/GID.

Manage access to LXD

Access control for LXD is based on group membership. The root user and all members of the `lxd` group can interact with the local daemon. See *Access to the LXD daemon* for more information.

On Ubuntu images, the `lxd` group already exists and the main user is automatically added to it. The group is also created during installation if you *installed LXD from the snap*. If the `lxd` group is missing on your system (as might be the case if you *installed LXD from the sources*), create it and restart the LXD daemon:

```
getent group lxd >/dev/null || sudo groupadd --system lxd
```

No users are added to the group on installation. You must add trusted users to the group so they can use LXD:

```
getent group lxd | grep -qwF "$USER" || sudo usermod -aG lxd "$USER" # adding current␣
↪user as an example
```

Anyone added to this group will have full control over LXD. See *Access to the LXD daemon* to better understand access control for LXD.

Because group membership is normally only applied at login, you might need to either re-open your user session or use the `newgrp lxd` command in the shell you're using to talk to LXD.

Important: Local access to LXD through the Unix socket always grants full access to LXD. This includes the ability to attach file system paths or devices to any instance as well as tweak the security features on any instance.

Therefore, you should only give such access to users who you'd trust with root access to your system.

Upgrade LXD

After upgrading LXD to a newer version, LXD might need to update its database to a new schema. This update happens automatically when the daemon starts up after a LXD upgrade. A backup of the database before the update is stored in the same location as the active database (for example, at `/var/snap/lxd/common/lxd/database` for the snap installation).

Important: After a schema update, older versions of LXD might regard the database as invalid. That means that downgrading LXD might render your LXD installation unusable.

In that case, if you need to downgrade, restore the database backup before starting the downgrade.

How to initialize LXD

Before you can create a LXD instance, you must configure and initialize LXD.

Interactive configuration

Run the following command to start the interactive configuration process:

```
lxd init
```

Note: For simple configurations, you can run this command as a normal user. However, some more advanced operations during the initialization process (for example, joining an existing cluster) require root privileges. In this case, run the command with `sudo` or as root.

The tool asks a series of questions to determine the required configuration. The questions are dynamically adapted to the answers that you give. They cover the following areas:

Clustering (see *About clustering* and *How to form a cluster*)
: A cluster combines several LXD servers. The cluster members share the same distributed database and can be managed uniformly using the LXD client (`lxc`) or the REST API.

  The default answer is `no`, which means clustering is not enabled. If you answer `yes`, you can either connect to an existing cluster or create one.

MAAS support (see `maas.io` and MAAS - Setting up LXD for VMs)
: MAAS is an open-source tool that lets you build a data center from bare-metal servers.

The default answer is `no`, which means MAAS support is not enabled. If you answer `yes`, you can connect to an existing MAAS server and specify the `name`, `URL` and `API key`.

Networking (see *About networking* and *Network devices*)
Provides network access for the instances.

You can let LXD create a new bridge (recommended) or use an existing network bridge or interface.

You can create additional bridges and assign them to instances later.

Storage pools (see *About storage pools, volumes and buckets* and *Storage drivers*)
Instances (and other data) are stored in storage pools.

For testing purposes, you can create a loop-backed storage pool. For production use, however, you should use an empty partition (or full disk) instead of loop-backed storage (because loop-backed pools are slower and their size can't be reduced).

The recommended backends are `zfs` and `btrfs`.

You can create additional storage pools later.

Remote access (see *Access to the remote API* and *Remote API authentication*)
Allows remote access to the server over the network.

The default answer is `no`, which means remote access is not allowed. If you answer `yes`, you can connect to the server over the network.

You can choose to add client certificates to the server (manually or through tokens, the recommended way) or set a trust password.

Automatic image update (see *About images*)
You can download images from image servers. In this case, images can be updated automatically.

The default answer is `yes`, which means that LXD will update the downloaded images regularly.

YAML `lxd init` preseed (see *Non-interactive configuration*)
If you answer `yes`, the command displays a summary of your chosen configuration options in the terminal.

Minimal setup

To create a minimal setup with default options, you can skip the configuration steps by adding the `--minimal` flag to the `lxd init` command:

```
lxd init --minimal
```

Note: The minimal setup provides a basic configuration, but the configuration is not optimized for speed or functionality. Especially the *`dir` storage driver*, which is used by default, is slower than other drivers and doesn't provide fast snapshots, fast copy/launch, quotas and optimized backups.

If you want to use an optimized setup, go through the interactive configuration process instead.

Non-interactive configuration

The `lxd init` command supports a `--preseed` command line flag that makes it possible to fully configure the LXD daemon settings, storage pools, network devices and profiles, in a non-interactive way through a preseed YAML file.

For example, starting from a brand new LXD installation, you could configure LXD with the following command:

```
    cat <<EOF | lxd init --preseed
config:
  core.https_address: 192.0.2.1:9999
  images.auto_update_interval: 15
networks:
- name: lxdbr0
  type: bridge
  config:
    ipv4.address: auto
    ipv6.address: none
EOF
```

This preseed configuration initializes the LXD daemon to listen for HTTPS connections on port 9999 of the 192.0.2.1 address, to automatically update images every 15 hours and to create a network bridge device named `lxdbr0`, which gets assigned an IPv4 address automatically.

Re-configuring an existing LXD installation

If you are configuring a new LXD installation, the preseed command applies the configuration as specified (as long as the given YAML contains valid keys and values). There is no existing state that might conflict with the specified configuration.

However, if you are re-configuring an existing LXD installation using the preseed command, the provided YAML configuration might conflict with the existing configuration. To avoid such conflicts, the following rules are in place:

- The provided YAML configuration overwrites existing entities. This means that if you are re-configuring an existing entity, you must provide the full configuration for the entity and not just the different keys.
- If the provided YAML configuration contains entities that do not exist, they are created.

This is the same behavior as for a `PUT` request in the *REST API*.

Rollback

If some parts of the new configuration conflict with the existing state (for example, they try to change the driver of a storage pool from `dir` to `zfs`), the preseed command fails and automatically attempts to roll back any changes that were applied so far.

For example, it deletes entities that were created by the new configuration and reverts overwritten entities back to their original state.

Failure modes when overwriting entities are the same as for the `PUT` requests in the *REST API*.

Note: The rollback process might potentially fail, although rarely (typically due to backend bugs or limitations). You should therefore be careful when trying to reconfigure a LXD daemon via preseed.

Default profile

Unlike the interactive initialization mode, the `lxd init --preseed` command does not modify the default profile, unless you explicitly express that in the provided YAML payload.

For instance, you will typically want to attach a root disk device and a network interface to your default profile. See the following section for an example.

Configuration format

The supported keys and values of the various entities are the same as the ones documented in the *REST API*, but converted to YAML for convenience. However, you can also use JSON, since YAML is a superset of JSON.

The following snippet gives an example of a preseed payload that contains most of the possible configurations. You can use it as a template for your own preseed file and add, change or remove what you need:

```
# Daemon settings
config:
  core.https_address: 192.0.2.1:9999
  core.trust_password: sekret
  images.auto_update_interval: 6

# Storage pools
storage_pools:
- name: data
  driver: zfs
  config:
    source: my-zfs-pool/my-zfs-dataset

# Storage volumes
storage_volumes:
- name: my-vol
  pool: data

# Network devices
networks:
- name: lxd-my-bridge
  type: bridge
  config:
    ipv4.address: auto
    ipv6.address: none

# Profiles
profiles:
- name: default
  devices:
    root:
      path: /
      pool: data
      type: disk
- name: test-profile
  description: "Test profile"
  config:
```

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```
    limits.memory: 2GiB
  devices:
    test0:
      name: test0
      nictype: bridged
      parent: lxd-my-bridge
      type: nic
```

See *Preseed YAML file fields* for the complete fields of the preseed YAML file.

How to manage the LXD snap

Among *other options*, LXD is distributed as a snap. The benefit of packaging LXD as a snap is that it makes it possible to include all of LXD's dependencies in one package, and that it allows LXD to be installed on many different Linux distributions. The snap ensures that LXD runs in a consistent environment.

Control updates of the snap

When running LXD in a production environment, you must make sure to have a suitable version of the snap installed on all machines of your LXD cluster.

Choose the right channel and track

Snaps come with different channels that define which release of a snap is installed and tracked for updates. See Channels and tracks in the snap documentation for detailed information.

Feature releases of LXD are available on the `latest` track. In addition, LXD provides tracks for the supported feature releases. See *Choose your release* for more information.

On all tracks, the `stable` risk level contains all fixes and features for the respective track, but it is only updated when the LXD team decides that a feature is ready and no issues have been revealed by users running the same revision on higher risk levels (`edge` and `candidate`).

When installing a snap, specify the channel as follows:

```
sudo snap install <snap_name> --channel=<channel>
```

For example:

```
sudo snap install lxd --channel=latest/stable
```

If you do not specify a channel, snap will choose the default channel (the latest LTS release).

To see all available channels of the LXD snap, run the following command:

```
snap info lxd
```

Hold and schedule updates

By default, snaps are updated automatically. In the case of LXD, this can be problematic because all machines of a cluster must use the same version of the LXD snap.

Therefore, you should schedule your updates and make sure that all cluster members are in sync regarding the snap version that they use.

Schedule updates

There are two methods for scheduling when your snaps should be updated:

- You can hold snap updates for a specific time, either for specific snaps or for all snaps on your system. After the duration of the hold, or when you remove the hold, your snaps are automatically refreshed.
- You can specify a system-wide refresh window, so that snaps are automatically refreshed only within this time frame. Such a refresh window applies to all snaps.

Hold updates

You can hold snap updates for a specific time or forever, for all snaps or only for the LXD snap. If you want to fully control updates to your LXD deployment, you should put a hold on the LXD snap until you decide to update it.

Enter the following command to indefinitely hold all updates for the LXD snap:

```
sudo snap refresh --hold lxd
```

When you choose to update your installation, use the following commands to remove the hold, update the snap, and hold the updates again:

```
sudo snap refresh --unhold lxd
sudo snap refresh lxd --cohort="+"
sudo snap refresh --hold lxd
```

See Hold refreshes in the snap documentation for detailed information about holding snap updates.

Specify a refresh window

Depending on your setup, you might want your snaps to update regularly, but only at specific times that don't disturb normal operation.

You can achieve this by specifying a refresh timer. This option defines a refresh window for all snaps that are installed on the system.

For example, to configure your system to update snaps only between 8:00 am and 9:00 am on Mondays, set the following option:

```
sudo snap set system refresh.timer=mon,8:00-9:00
```

You can use a similar mechanism (setting `refresh.hold`) to hold snap updates as well. However, in this case the snaps will be refreshed after 90 days, irrespective of the value of `refresh.hold`.

See Control updates with system options in the snap documentation for detailed information.

Keep cluster members in sync

The cluster members that are part of the LXD deployment must always run the same version of the LXD snap. This means that when the snap on one of the cluster members is refreshed, it must also be refreshed on all other cluster members before the LXD cluster is operational again.

Snap updates are delivered as progressive releases, which means that updated snap versions are made available to different machines at different times. This method can cause a problem for cluster updates if some cluster members are refreshed to a version that is not available to other cluster members yet.

To avoid this problem, use the `--cohort="+"` flag when refreshing your snaps:

```
sudo snap refresh lxd --cohort="+"
```

This flag ensures that all machines in a cluster see the same snap revision and are therefore not affected by a progressive rollout.

Use a Snap Store Proxy

If you manage a large LXD cluster and you need absolute control over when updates are applied, consider installing a Snap Store Proxy.

The Snap Store Proxy is a separate application that sits between the snap client command on your machines and the snap store. You can configure the Snap Store Proxy to make only specific snap revisions available for installation.

See the Snap Store Proxy documentation for information about how to install and register the Snap Store Proxy.

After setting it up, configure the snap clients on all cluster members to use the proxy. See Configuring snap devices for instructions.

You can then configure the Snap Store Proxy to override the revision for the LXD snap:

```
sudo snap-proxy override lxd <channel>=<revision>
```

For example:

```
sudo snap-proxy override lxd stable=25846
```

Configure the snap

The LXD snap has several configuration options that control the behavior of the installed LXD server. For example, you can define a LXD user group to achieve a multi-user environment for LXD (see *Confine projects to specific LXD users* for more information).

See the LXD snap page for a list of available configuration options.

To set any of these options, use the following command:

```
sudo snap set lxd <key>=<value>
```

For example:

```
sudo snap set lxd daemon.user.group=lxd-users
```

To see all configuration options that are set on the snap, use the following command:

```
sudo snap get lxd
```

Note: This command returns only configuration options that have been explicitly set.

See Configure snaps in the snap documentation for more information about snap configuration options.

Start and stop the daemon

To start and stop the LXD daemon, you can use the `start` and `stop` commands of the snap:

```
sudo snap stop lxd
sudo snap start lxd
```

These commands are equivalent to running the corresponding `systemctl` commands:

```
sudo systemctl stop snap.lxd.daemon.service snap.lxd.daemon.unix.socket
sudo systemctl start snap.lxd.daemon.unix.socket; lxc list
```

Stopping the daemon also stops all running instances.

To restart the LXD daemon, use the following command:

```
sudo systemctl restart snap.lxd.daemon
```

Restarting the daemon stops all running instances. If you want to keep the instances running, reload the daemon instead:

```
sudo systemctl reload snap.lxd.daemon
```

Note: To restart the daemon, you can also use the snap commands. To stop all running instances and restart:

```
sudo snap restart lxd
```

To keep the instances running and reload:

```
sudo snap restart --reload lxd
```

However, there is currently a bug in `snapd` that causes undesired side effects when using the `snap restart` command. Therefore, we recommend using the `systemctl` commands instead.

How to enable access to the UI and the documentation:

How to access the LXD web UI

Note: The LXD web UI is available as part of the LXD snap.

See the LXD-UI GitHub repository for the source code.

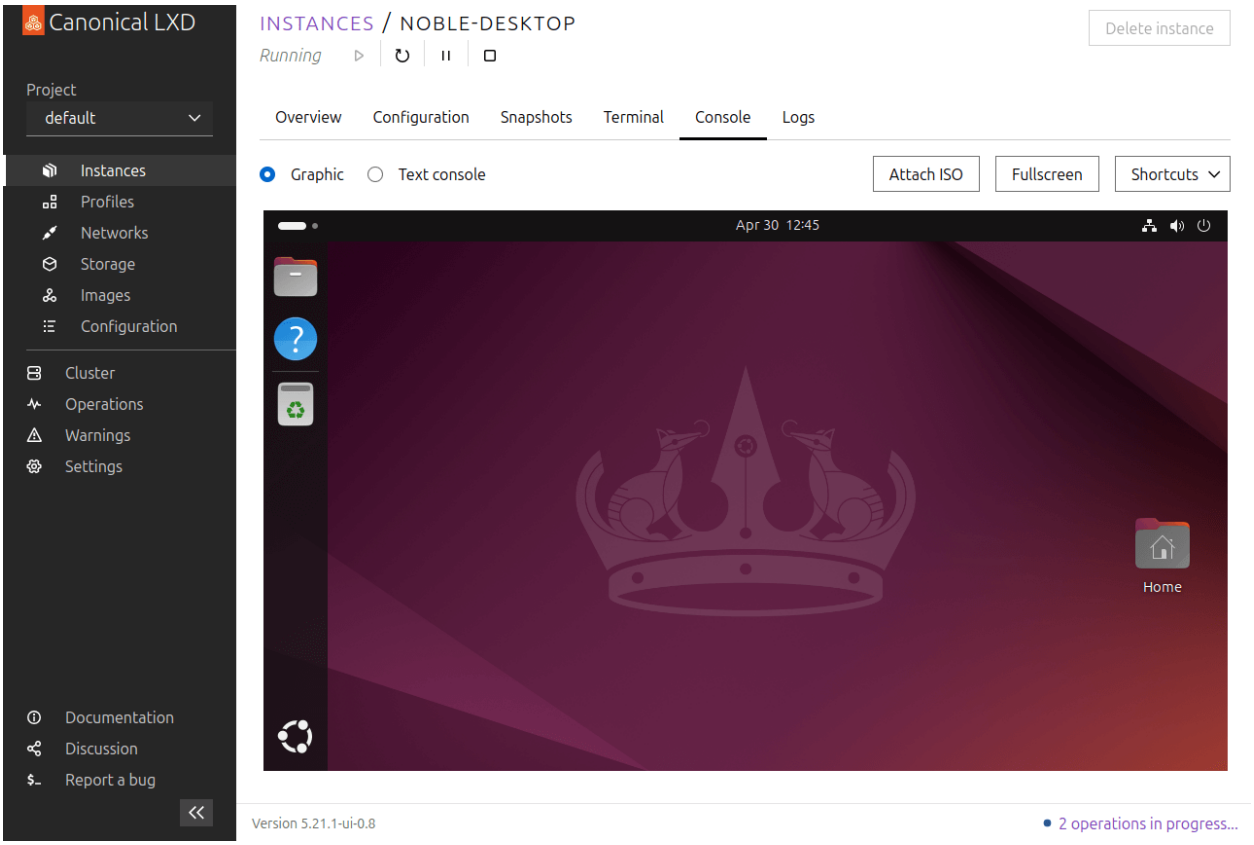


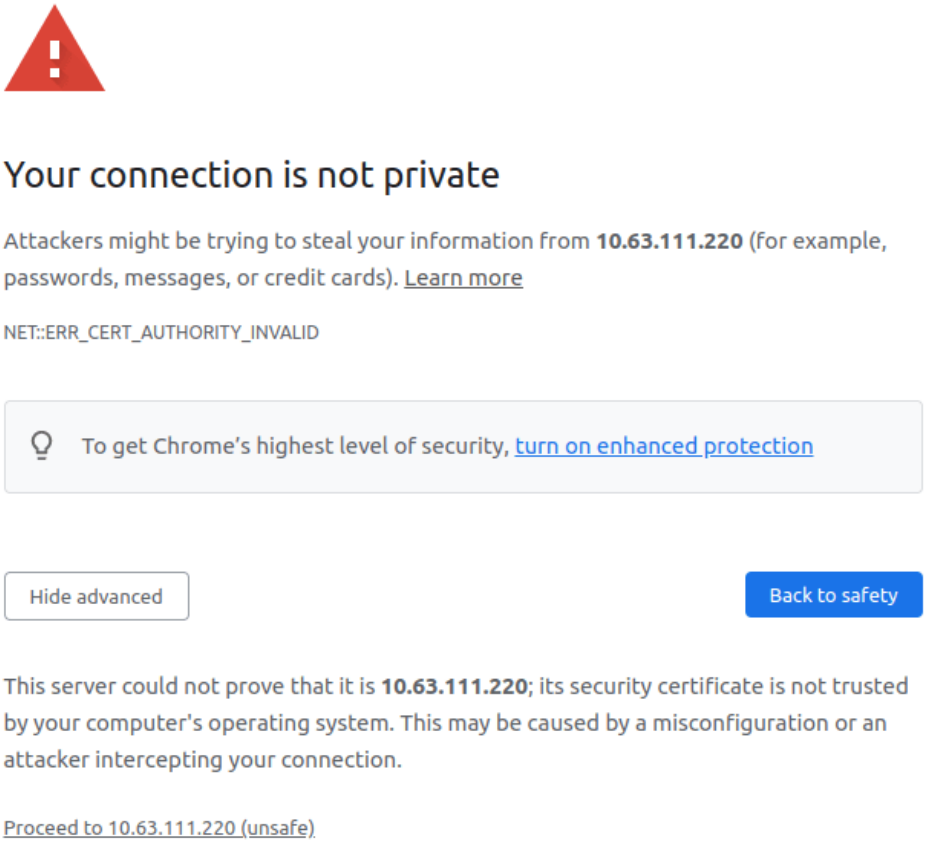
Fig. 1: Graphical console of an instance in the LXD web UI

The LXD web UI provides you with a graphical interface to manage your LXD server and instances. It does not provide full functionality yet, but it is constantly evolving, already covering many of the features of the LXD command-line client.

Complete the following steps to access the LXD web UI:

1. Make sure that your LXD server is *exposed to the network*. You can expose the server during *initialization*, or afterwards by setting the `core.https_address` server configuration option.
2. Access the UI in your browser by entering the server address (for example, `https://192.0.2.10:8443`).

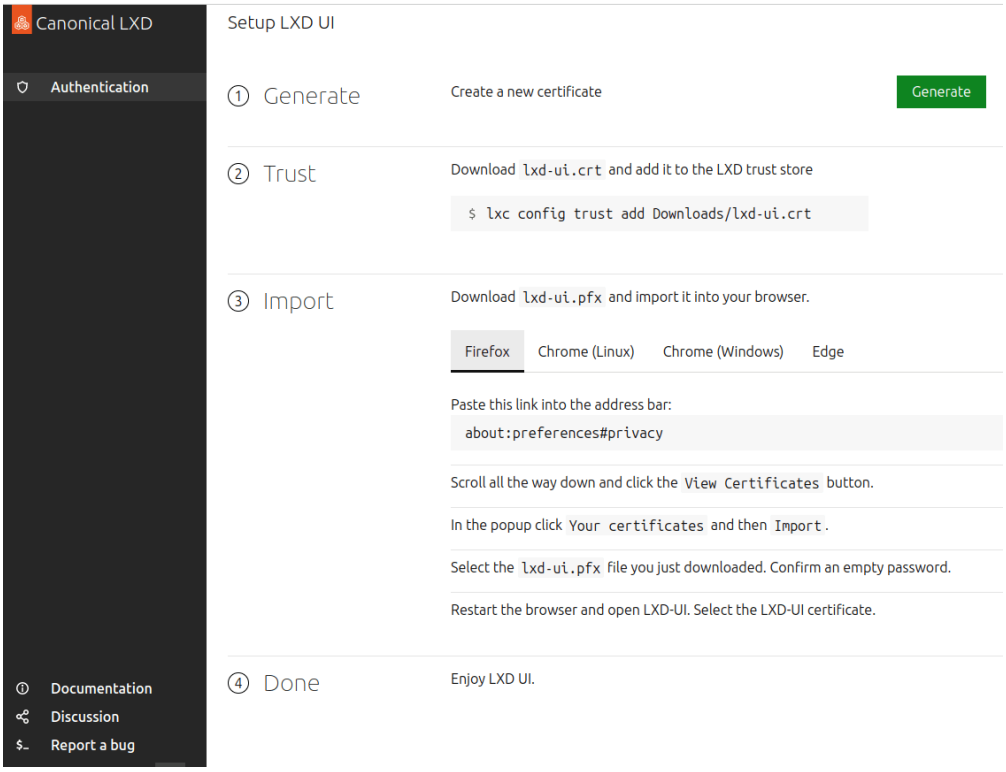
   If you have not set up a secure *TLS server certificate*, LXD uses a self-signed certificate, which will cause a security warning in your browser. Use your browser's mechanism to continue despite the security warning.



3. Set up the certificates that are required for the UI client to authenticate with the LXD server by following the steps presented in the UI. These steps include creating a set of certificates, adding the private key to your browser, and adding the public key to the server's trust store.

   See *Remote API authentication* for more information.

After setting up the certificates, you can start creating instances, editing profiles, or configuring your server.



Enable or disable the UI

The *snap configuration option* `lxd ui.enable` controls whether the UI is enabled for LXD.

Starting with LXD 5.21, the UI is enabled by default. If you want to disable it, set the option to `false`:

```
sudo snap set lxd ui.enable=false
sudo systemctl reload snap.lxd.daemon
```

To enable it again, or to enable it for older LXD versions (that include the UI), set the option to `true`:

```
sudo snap set lxd ui.enable=true
sudo systemctl reload snap.lxd.daemon
```

How to access the local LXD documentation

The latest version of the LXD documentation is available at documentation.ubuntu.com/lxd.

Alternatively, you can access a local version of the LXD documentation that is embedded in the LXD snap. This version of the documentation exactly matches the version of your LXD deployment, but might be missing additions, fixes, or clarifications that were added after the release of the snap.

Complete the following steps to access the local LXD documentation:

1. Make sure that your LXD server is *exposed to the network*. You can expose the server during *initialization*, or afterwards by setting the *core.https_address* server configuration option.
2. Access the documentation in your browser by entering the server address followed by `/documentation/` (for example, `https://192.0.2.10:8443/documentation/`).

If you have not set up a secure *TLS server certificate*, LXD uses a self-signed certificate, which will cause a security warning in your browser. Use your browser's mechanism to continue despite the security warning.

How to get support and contribute:

How to get support

LXD maintains different release branches in parallel.

Long term support (LTS) releases
The current LTS releases are LXD 5.21.x (snap channel `5.21/stable` - this is the default channel), LXD 5.0.x (snap channel `5.0/stable`) and LXD 4.0.x (snap channel `4.0/stable`).

The LTS releases follow the Ubuntu release schedule and are released every two years:

- LXD 5.21 is supported until June 2029. It gets frequent bugfix and security updates, but does not receive any feature additions. Updates to this release happen approximately every six months, but this schedule should be seen as a rough estimation that can change based on priorities and discovered bugs.
- LXD 5.0 is supported until June 2027.
- LXD 4.0 is supported until June 2025.

Feature releases
After LXD 5.21 is released, the next feature release will be LXD 6.x (starting with 6.1). It is available through the snap channels `latest/stable`, `latest/candidate`, and `latest/edge`, in addition to channels for the most recent specific releases (for example, `6.1/stable`). See `snap info lxd` for a full list of available channels.

Feature releases are pushed out about every month and contain new features as well as bugfixes. The normal support length for those releases is until the next release comes out. Some Linux distributions might offer longer support for particular feature releases that they decided to ship.

Support and community

The following channels are available for you to interact with the LXD community.

Bug reports

You can file bug reports and feature requests at: `https://github.com/canonical/lxd/issues/new`

Forum

A discussion forum is available at: `https://discourse.ubuntu.com/c/lxd/`

IRC

If you prefer live discussions, you can find us in `#lxd` on `irc.libera.chat`. See Getting started with IRC if needed.

Commercial support

Commercial support for LXD is available through Ubuntu Pro (Ubuntu Pro (Infra-only) or full Ubuntu Pro). The support covers all LTS versions for five years starting from the day of the release.

See the full service description for detailed information about what support Ubuntu Pro provides.

Documentation

The official documentation is available at: `https://documentation.ubuntu.com/lxd/en/latest/`

You can find additional resources on the website, on YouTube and in the Tutorials section in the forum.

How to contribute to LXD

The LXD team appreciates contributions to the project, through pull requests, issues on the GitHub repository, or discussions or questions on the forum.

Check the following guidelines before contributing to the project.

Code of Conduct

When contributing, you must adhere to the Code of Conduct, which is available at: `https://github.com/canonical/lxd/blob/main/CODE_OF_CONDUCT.md`

License and copyright

All contributors must sign the Canonical contributor license agreement, which gives Canonical permission to use the contributions. The author of a change remains the copyright holder of their code (no copyright assignment).

By default, any contribution to this project is licensed out under the project license: AGPL-3.0-only.

By exception, Canonical may import code under licenses compatible with AGPL-3.0-only, such as Apache-2.0. Such code will remain under its original license and will be identified as such in the commit message or its file header.

Some files and commits are licensed out under Apache-2.0 rather than AGPL-3.0-only. These are marked as Apache-2.0 in their package-level COPYING file, file header or commit message.

Pull requests

Changes to this project should be proposed as pull requests on GitHub at: https://github.com/canonical/lxd

Proposed changes will then go through review there and once approved, be merged in the main branch.

Commit structure

Separate commits should be used for:

- API extension (`api: Add XYZ extension`, contains `doc/api-extensions.md` and `shared/version/api.go`)
- Documentation (`doc: Update XYZ` for files in `doc/`)
- API structure (`shared/api: Add XYZ` for changes to `shared/api/`)
- Go client package (`client: Add XYZ` for changes to `client/`)
- CLI (`lxc/<command>: Change XYZ` for changes to `lxc/`)
- Scripts (`scripts: Update bash completion for XYZ` for changes to `scripts/`)
- LXD daemon (`lxd/<package>: Add support for XYZ` for changes to `lxd/`)
- Tests (`tests: Add test for XYZ` for changes to `tests/`)

The same kind of pattern extends to the other tools in the LXD code tree and depending on complexity, things may be split into even smaller chunks.

When updating strings in the CLI tool (`lxc/`), you may need a commit to update the templates:

```
make i18n
git commit -a -s -m "i18n: Update translation templates" po/
```

When updating API (`shared/api`), you may need a commit to update the swagger YAML:

```
make update-api
git commit -s -m "doc/rest-api: Refresh swagger YAML" doc/rest-api.yaml
```

This structure makes it easier for contributions to be reviewed and also greatly simplifies the process of back-porting fixes to stable branches.

Developer Certificate of Origin

To improve tracking of contributions to this project we use the DCO 1.1 and use a "sign-off" procedure for all changes going into the branch.

The sign-off is a simple line at the end of the explanation for the commit which certifies that you wrote it or otherwise have the right to pass it on as an open-source contribution.

```
Developer Certificate of Origin
Version 1.1

Copyright (C) 2004, 2006 The Linux Foundation and its contributors.
660 York Street, Suite 102,
San Francisco, CA 94110 USA
```

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```
Everyone is permitted to copy and distribute verbatim copies of this
license document, but changing it is not allowed.

Developer's Certificate of Origin 1.1

By making a contribution to this project, I certify that:

(a) The contribution was created in whole or in part by me and I
    have the right to submit it under the open source license
    indicated in the file; or

(b) The contribution is based upon previous work that, to the best
    of my knowledge, is covered under an appropriate open source
    license and I have the right under that license to submit that
    work with modifications, whether created in whole or in part
    by me, under the same open source license (unless I am
    permitted to submit under a different license), as indicated
    in the file; or

(c) The contribution was provided directly to me by some other
    person who certified (a), (b) or (c) and I have not modified
    it.

(d) I understand and agree that this project and the contribution
    are public and that a record of the contribution (including all
    personal information I submit with it, including my sign-off) is
    maintained indefinitely and may be redistributed consistent with
    this project or the open source license(s) involved.
```

An example of a valid sign-off line is:

```
Signed-off-by: Random J Developer <random@developer.org>
```

Use a known identity and a valid e-mail address. Sorry, no anonymous contributions are allowed.

We also require each commit be individually signed-off by their author, even when part of a larger set. You may find `git commit -s` useful.

Contribute to the code

Follow the steps below to set up your development environment to get started working on new features for LXD.

Install LXD from source

To build the dependencies, follow the instructions in *Install LXD from source*.

Add your fork as a remote

After setting up your build environment, add your GitHub fork as a remote:

```
git remote add myfork git@github.com:<your_username>/lxd.git
git remote update
```

Then switch to it:

```
git checkout myfork/main
```

Build LXD

Finally, you should be able to run `make` inside the repository and build your fork of the project.

At this point, you most likely want to create a new branch for your changes on your fork:

```
git checkout -b [name_of_your_new_branch]
git push myfork [name_of_your_new_branch]
```

Important notes for new LXD contributors

- Persistent data is stored in the `LXD_DIR` directory, which is generated by `lxd init`. The `LXD_DIR` defaults to `/var/lib/lxd`, or `/var/snap/lxd/common/lxd` for snap users.
- As you develop, you may want to change the `LXD_DIR` for your fork of LXD so as to avoid version conflicts.
- Binaries compiled from your source will be generated in the `$(go env GOPATH)/bin` directory by default.
  - You will need to explicitly invoke these binaries (not the global `lxd` you may have installed) when testing your changes.
  - You may choose to create an alias in your `~/.bashrc` to call these binaries with the appropriate flags more conveniently.
- If you have a `systemd` service configured to run the LXD daemon from a previous installation of LXD, you may want to disable it to avoid version conflicts.

Contribute to the documentation

We want LXD to be as easy and straight-forward to use as possible. Therefore, we aim to provide documentation that contains the information that users need to work with LXD, that covers all common use cases, and that answers typical questions.

You can contribute to the documentation in various different ways. We appreciate your contributions!

Typical ways to contribute are:

- Add or update documentation for new features or feature improvements that you contribute to the code. We'll review the documentation update and merge it together with your code.
- Add or update documentation that clarifies any doubts you had when working with the product. Such contributions can be done through a pull request or through a post in the Tutorials section on the forum. New tutorials will be considered for inclusion in the docs (through a link or by including the actual content).
- To request a fix to the documentation, open a documentation issue on GitHub. We'll evaluate the issue and update the documentation accordingly.
- Post a question or a suggestion on the forum. We'll monitor the posts and, if needed, update the documentation accordingly.
- Ask questions or provide suggestions in the `#lxd` channel on IRC. Given the dynamic nature of IRC, we cannot guarantee answers or reactions to IRC posts, but we monitor the channel and try to improve our documentation based on the received feedback.

If images are added (`doc/images`), prioritize either SVG or PNG format and make sure to optimize PNG images for smaller size using a service like TinyPNG or similar.

Documentation framework

LXD's documentation is built with Sphinx and hosted on Read the Docs.

It is written in Markdown with MyST extensions. For syntax help and guidelines, see the documentation cheat sheet (source).

For structuring, the documentation uses the Diátaxis approach.

Build the documentation

To build the documentation, run `make doc` from the root directory of the repository. This command installs the required tools and renders the output to the `doc/html/` directory. To update the documentation for changed files only (without re-installing the tools), run `make doc-incremental`.

Before opening a pull request, make sure that the documentation builds without any warnings (warnings are treated as errors). To preview the documentation locally, run `make doc-serve` and go to `http://localhost:8001` to view the rendered documentation.

When you open a pull request, a preview of the documentation output is built automatically. To see the output, view the details for the `docs/readthedocs.com:canonical-lxd` check on the pull request.

Automatic documentation checks

GitHub runs automatic checks on the documentation to verify the spelling, the validity of links, correct formatting of the Markdown files, and the use of inclusive language.

You can (and should!) run these tests locally as well with the following commands:

- Check the spelling: `make doc-spellcheck`
- Check the validity of links: `make doc-linkcheck`
- Check the Markdown formatting: `make doc-lint`
- Check for inclusive language: `make doc-woke`

Document configuration options

Note: We are currently in the process of moving the documentation of configuration options to code comments. At the moment, not all configuration options follow this approach.

The documentation of configuration options is extracted from comments in the Go code. Look for comments that start with `lxdmeta:generate` in the code.

When you add or change a configuration option, make sure to include the required documentation comment for it. See the `lxd-metadata` README file for information about the format.

Then run `make generate-config` to re-generate the `doc/config_options.txt` file. The updated file should be checked in.

The documentation includes sections from the `doc/config_options.txt` to display a group of configuration options. For example, to include the core server options:

```
% Include content from [config_options.txt](config_options.txt)
```{include} config_options.txt
    :start-after: <!-- config group server-core start -->
    :end-before: <!-- config group server-core end -->
```
```

If you add a configuration option to an existing group, you don't need to do any updates to the documentation files. The new option will automatically be picked up. You only need to add an include to a documentation file if you are defining a new group.

In addition, the following clip gives a quick and easy introduction for standard use cases:

You can also find a series of demos and tutorials on YouTube:

Related topics

Tutorials:

- *First steps with LXD*

Explanation:

- *About containers and VMs*

Reference:

- *Requirements*

LXD server and client

The following how-to guides cover common operations related to the LXD server:

How to expose LXD to the network

By default, LXD can be used only by local users through a Unix socket and is not accessible over the network.

To expose LXD to the network, you must configure it to listen to addresses other than the local Unix socket. To do so, set the `core.https_address` server configuration option.

For example, allow access to the LXD server on port `8443`:

CLI

API

```
lxc config set core.https_address :8443
```

```
lxc query --request PATCH /1.0 --data '{
  "config": {
    "core.https_address": ":8443"
  }
}'
```

To allow access through a specific IP address, use `ip addr` to find an available address and then set it. For example:

```
user@host:~$ ip addr        1:  lo:  <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state
UNKNOWN group default qlen 1000 link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
inet 127.0.0.1/8 scope host lo valid_lft forever preferred_lft forever inet6 ::1/
128 scope host valid_lft forever preferred_lft forever2:  enp5s0:  <BROADCAST,
MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000 link/ether
00:16:3e:e3:f3:3f brd ff:ff:ff:ff:ff:ff inet 10.68.216.12/24 metric 100 brd 10.68.
216.255 scope global dynamic enp5s0 valid_lft 3028sec preferred_lft 3028sec inet6
fd42:e819:7a51:5a7b:216:3eff:fee3:f33f/64 scope global mngtmpaddr noprefixroute valid_lft
forever preferred_lft forever inet6 fe80::216:3eff:fee3:f33f/64 scope link valid_lft
forever preferred_lft forever3:  lxdbr0:  <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu
1500 qdisc noqueue state DOWN group default qlen 1000 link/ether 00:16:3e:8d:f3:72 brd
ff:ff:ff:ff:ff:ff inet 10.64.82.1/24 scope global lxdbr0 valid_lft forever preferred_lft
forever inet6 fd42:f4ab:4399:e6eb::1/64 scope global valid_lft forever preferred_lft
forever user@host:~$ lxc config set core.https_address 10.68.216.12  All remote clients can then
connect to LXD and access any image that is marked for public use.
```

Authenticate with the LXD server

To be able to access the remote API, clients must authenticate with the LXD server. There are several authentication methods; see *Remote API authentication* for detailed information.

The recommended method is to add the client's TLS certificate to the server's trust store through a trust token. To authenticate a client using a trust token, complete the following steps:

1. On the server, generate a trust token.

   CLI

   API

   To generate a trust token, enter the following command on the server:

   ```
   lxc config trust add
   ```

   Enter the name of the client that you want to add. The command generates and prints a token that can be used to add the client certificate.

   To generate a trust token, send a POST request to the `/1.0/certificates` endpoint:

   ```
   lxc query --request POST /1.0/certificates --data '{
     "name": "<client_name>",
     "token": true,
     "type": "client"
   }'
   ```

   See `POST /1.0/certificates` for more information.

   The return value of this query contains an operation that has the information that is required to generate the trust token:

   ```
   {
    "class": "token",
    ...
    "metadata": {
       "addresses": [
          "<server_address>"
       ],
       "fingerprint": "<fingerprint>",
       ...
       "secret": "<secret>"
    },
   ...
   }
   ```

   Use this information to generate the trust token:

   ```
   echo -n '{"client_name":"<client_name>","fingerprint":"<fingerprint>",'\
   '"addresses":["<server_address>"],'\
   '"secret":"<secret>","expires_at":"0001-01-01T00:00:00Z"}' | base64 -w0
   ```

2. Authenticate the client.

   CLI

   API

On the client, add the server with the following command:

```
lxc remote add <remote_name> <token>
```

Note: If your LXD server is behind NAT, you must specify its external public address when adding it as a remote for a client:

```
lxc remote add <name> <IP_address>
```

When you are prompted for the admin password, specify the generated token.

When generating the token on the server, LXD includes a list of IP addresses that the client can use to access the server. However, if the server is behind NAT, these addresses might be local addresses that the client cannot connect to. In this case, you must specify the external address manually.

On the client, generate a certificate to use for the connection:

```
openssl req -x509 -newkey rsa:2048 -keyout "<keyfile_name>" -nodes \
-out "<crtfile_name>" -subj "/CN=<client_name>"
```

Then send a POST request to the `/1.0/certificates?public` endpoint to authenticate:

```
curl -k -s --key "<keyfile_name>" --cert "<crtfile_name>" \
-X POST https://<server_address>/1.0/certificates \
--data '{ "password": "<trust_token>" }'
```

See `POST /1.0/certificates?public` for more information.

See *Remote API authentication* for detailed information and other authentication methods.

How to configure the LXD server

See *Server configuration* for all configuration options that are available for the LXD server.

If the LXD server is part of a cluster, some of the options apply to the cluster, while others apply only to the local server, thus the cluster member. In the *Server configuration* option tables, options that apply to the cluster are marked with a `global` scope, while options that apply to the local server are marked with a `local` scope.

Configure server options

CLI

API

You can configure a server option with the following command:

```
lxc config set <key> <value>
```

For example, to allow remote access to the LXD server on port 8443, enter the following command:

```
lxc config set core.https_address :8443
```

In a cluster setup, to configure a server option for a cluster member only, add the `--target` flag. For example, to configure where to store image tarballs on a specific cluster member, enter a command similar to the following:

```
lxc config set storage.images_volume my-pool/my-volume --target member02
```

Send a PATCH request to the `/1.0` endpoint to update one or more server options:

```
lxc query --request PATCH /1.0 --data '{
  "config": {
    "<key>": "<value>",
    "<key>": "<value>"
  }
}'
```

For example, to allow remote access to the LXD server on port 8443, send the following request:

```
lxc query --request PATCH /1.0 --data '{
  "config": {
    "core.https_address": ":8443"
  }
}'
```

In a cluster setup, to configure a server option for a cluster member only, add the `target` parameter to the query. For example, to configure where to store image tarballs on a specific cluster member, send a request similar to the following:

```
lxc query --request PATCH /1.0?target=member02 --data '{
  "config": {
    "storage.images_volume": "my-pool/my-volume"
  }
}'
```

See `PATCH /1.0` for more information.

Display the server configuration

CLI

API

To display the current server configuration, enter the following command:

```
lxc config show
```

In a cluster setup, to show the local configuration for a specific cluster member, add the `--target` flag.

Send a GET request to the `/1.0` endpoint to display the current server environment and configuration:

```
lxc query --request GET /1.0
```

In a cluster setup, to show the local environment and configuration for a specific cluster member, add the `target` parameter to the query:

```
lxc query --request GET /1.0?target=<cluster_member>
```

See `GET /1.0` for more information.

Edit the full server configuration

CLI

API

To edit the full server configuration as a YAML file, enter the following command:

```
lxc config edit
```

In a cluster setup, to edit the local configuration for a specific cluster member, add the `--target` flag.

To update the full server configuration, send a PUT request to the `/1.0` endpoint:

```
lxc query --request PUT /1.0 --data '<server_configuration>'
```

In a cluster setup, to update the full server configuration for a specific cluster member, add the `target` parameter to the query:

```
lxc query --request PUT /1.0?target=<cluster_member> '<server_configuration>'
```

See `PUT /1.0` for more information.

The following how-to guides cover common operations related to the LXD client (`lxc`):

How to add remote servers

Remote servers are a concept in the LXD command-line client. By default, the command-line client interacts with the local LXD daemon, but you can add other servers or clusters to interact with.

If you are using the API, you can interact with different remotes by using their exposed API addresses.

One use case for remote servers is to distribute images that can be used to create instances on local servers. See *Remote image servers* for more information.

You can also add a full LXD server as a remote server to your client. In this case, you can interact with the remote server in the same way as with your local daemon. For example, you can manage instances or update the server configuration on the remote server.

Authentication

To be able to add a LXD server as a remote server, the server's API must be exposed, which means that its *`core.https_address`* server configuration option must be set.

When adding the server, you must then authenticate with it using the chosen method for *Remote API authentication*.

See *How to expose LXD to the network* for more information.

List configured remotes

To see all configured remote servers, enter the following command:

```
lxc remote list
```

Remote servers that use the simple streams format are pure image servers. Servers that use the `lxd` format are LXD servers, which either serve solely as image servers or might provide some images in addition to serving as regular LXD servers. See *Remote server types* for more information.

Add a remote LXD server

To add a LXD server as a remote, enter the following command:

```
lxc remote add <remote_name> <IP|FQDN|URL> [flags]
```

Some authentication methods require specific flags (for example, use *`lxc remote add <remote_name> <IP|FQDN|URL> --auth-type=oidc`* for OIDC authentication). See *Authenticate with the LXD server* and *Remote API authentication* for more information.

For example, enter the following command to add a remote through an IP address:

```
lxc remote add my-remote 192.0.2.10
```

You are prompted to confirm the remote server fingerprint and then asked for the password or token, depending on the authentication method used by the remote.

Select a default remote

The LXD command-line client is pre-configured with the `local` remote, which is the local LXD daemon.

To select a different remote as the default remote, enter the following command:

```
lxc remote switch <remote_name>
```

To see which server is configured as the default remote, enter the following command:

```
lxc remote get-default
```

Configure a global remote

You can configure remotes on a global, per-system basis. These remotes are available for every user of the LXD server for which you add the configuration.

Users can override these system remotes (for example, by running *`lxc remote rename`* or *`lxc remote set-url`*), which results in the remote and its associated certificates being copied to the user configuration.

To configure a global remote, edit the `config.yml` file that is located in one of the following directories:

- the directory specified by `LXD_GLOBAL_CONF` (if defined)
- `/var/snap/lxd/common/global-conf/` (if you use the snap)
- `/etc/lxd/` (otherwise)

Certificates for the remotes must be stored in the `servercerts` directory in the same location (for example, `/etc/lxd/servercerts/`). They must match the remote name (for example, `foo.crt`).

See the following example configuration:

```
remotes:
  foo:
    addr: https://192.0.2.4:8443
    auth_type: tls
    project: default
    protocol: lxd
    public: false
  bar:
    addr: https://192.0.2.5:8443
    auth_type: tls
    project: default
    protocol: lxd
    public: false
```

How to add command aliases

The LXD command-line client supports adding aliases for commands that you use frequently. You can use aliases as shortcuts for longer commands, or to automatically add flags to existing commands.

To manage command aliases, you use the *`lxc alias`* command.

For example, to always ask for confirmation when deleting an instance, create an alias for `lxc delete` that always runs `lxc delete -i`:

```
lxc alias add delete "delete -i"
```

To see all configured aliases, run *`lxc alias list`*. Run *`lxc alias --help`* to see all available subcommands.

Related topics

Explanation:

- *About `lxd` and `lxc`*
- *About the LXD database*

Reference:

- *Architectures*
- *Server configuration*
- *REST API*

2.2.2 Work with LXD

After the initial setup, you can start working with LXD by creating instances. You'll also need to set up and configure other entities.

Instances

The following how-to guides cover common operations related to instances.

How to create and manage instances:

How to create instances

When creating an instance, you must specify the *image* on which the instance should be based.

Images contain a basic operating system (for example, a Linux distribution) and some LXD-related information. Images for various operating systems are available on the built-in remote image servers. See *Images* for more information.

If you don't specify a name for the instance, LXD will automatically generate one. Instance names must be unique within a LXD deployment (also within a cluster). See *Instance name requirements* for additional requirements.

CLI

API

UI

To create an instance, you can use either the `lxc init` or the `lxc launch` command. The `lxc init` command only creates the instance, while the `lxc launch` command creates and starts it.

Enter the following command to create a container:

```
lxc launch|init <image_server>:<image_name> <instance_name> [flags]
```

Unless the image is available locally, you must specify the name of the image server and the name of the image (for example, `ubuntu:24.04` for the official 24.04 Ubuntu image).

See `lxc launch --help` or `lxc init --help` for a full list of flags. The most common flags are:

- `--config` to specify a configuration option for the new instance
- `--device` to override *device options* for a device provided through a profile, or to specify an *initial configuration for the root disk device* (syntax: `--device <device_name>,<device_option>=<value>`)
- `--profile` to specify a *profile* to use for the new instance
- `--network` or `--storage` to make the new instance use a specific network or storage pool
- `--target` to create the instance on a specific cluster member
- `--vm` to create a virtual machine instead of a container

Instead of specifying the instance configuration as flags, you can pass it to the command as a YAML file.

For example, to launch a container with the configuration from `config.yaml`, enter the following command:

```
lxc launch ubuntu:24.04 ubuntu-config < config.yaml
```

Tip: Check the contents of an existing instance configuration (*lxc config show <instance_name> --expanded*) to see the required syntax of the YAML file.

To create an instance, send a POST request to the `/1.0/instances` endpoint:

```
lxc query --request POST /1.0/instances --data '{
  "name": "<instance_name>",
  "source": {
    "alias": "<image_alias>",
    "protocol": "simplestreams",
    "server": "<server_URL>",
    "type": "image"
  }
}'
```

The return value of this query contains an operation ID, which you can use to query the status of the operation:

```
lxc query --request GET /1.0/operations/<operation_ID>
```

Use the following query to monitor the state of the instance:

```
lxc query --request GET /1.0/instances/<instance_name>/state
```

See `POST /1.0/instances` and `GET /1.0/instances/{name}/state` for more information.

The request creates the instance, but does not start it. To start an instance, send a PUT request to change the instance state:

```
lxc query --request PUT /1.0/instances/<instance_name>/state --data '{"action": "start"}'
```

See *Start an instance* for more information.

To create an instance, go to the *Instances* section and click *Create instance*.

On the resulting screen, optionally enter a name and description for the instance. Then click *Browse images* to select the image to be used for the instance. Depending on the selected image, you might be able to select the *instance type* (container or virtual machine). You can also specify one or more profiles to use for the instance.

To further tweak the instance configuration or add devices to the instance, go to any of the tabs under *Advanced*. You can also edit the full instance configuration on the *YAML configuration* tab.

Finally, click *Create* or *Create and start* to create the instance.

Examples

The following CLI and API examples create the instances, but don't start them. If you are using the CLI client, you can use *lxc launch* instead of *lxc init* to automatically start them after creation.

In the UI, you can choose between *Create* and *Create and start* when you are ready to create the instance.

Create a container

To create a container with an Ubuntu 24.04 image from the `ubuntu` server using the instance name `ubuntu-container`:

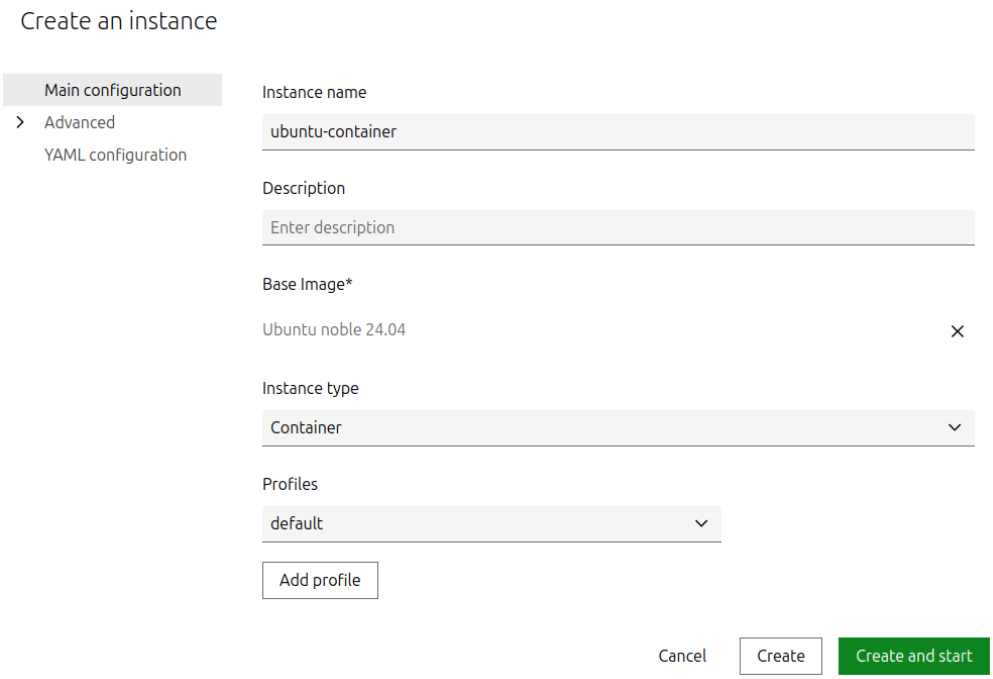
CLI

API

UI

```
lxc init ubuntu:24.04 ubuntu-container
```

```
lxc query --request POST /1.0/instances --data '{
  "name": "ubuntu-container",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  }
}'
```



Create a virtual machine

To create a virtual machine with an Ubuntu 24.04 image from the `ubuntu` server using the instance name `ubuntu-vm`:

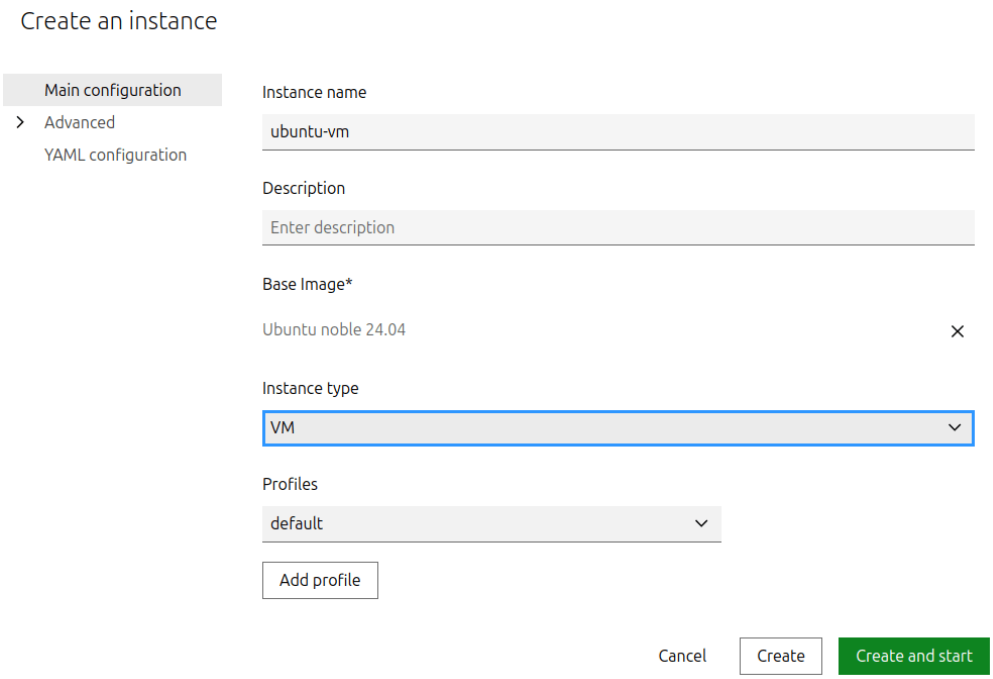
CLI

API

UI

```
lxc init ubuntu:24.04 ubuntu-vm --vm
```

```
lxc query --request POST /1.0/instances --data '{
  "name": "ubuntu-vm",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  },
  "type": "virtual-machine"
}'
```



Or with a bigger disk:

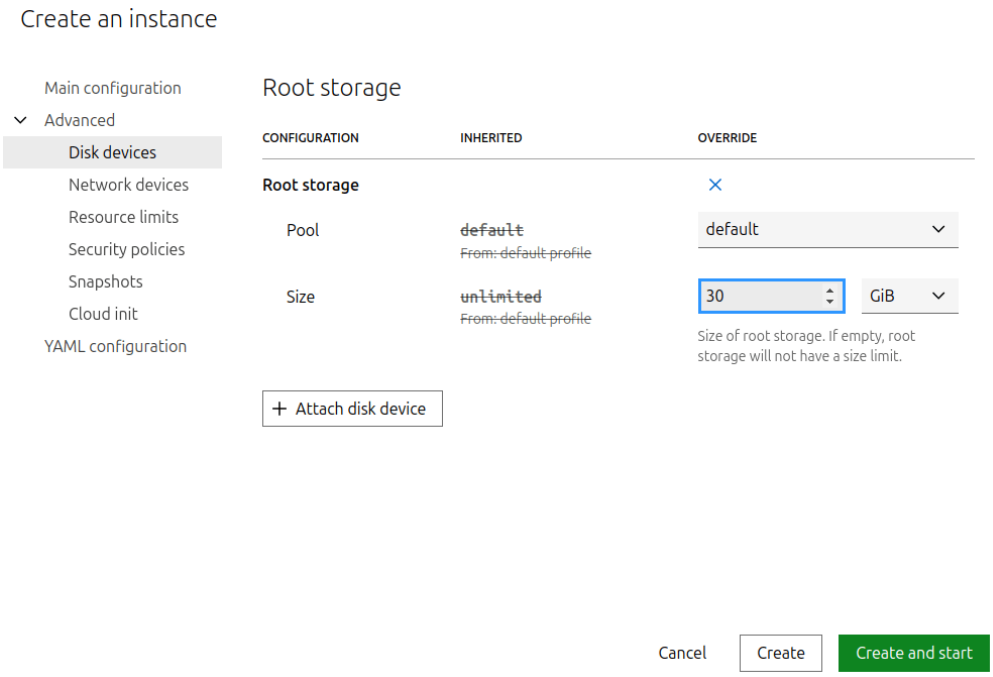
CLI

API

UI

```
lxc init ubuntu:24.04 ubuntu-vm-big --vm --device root,size=30GiB
```

```
lxc query --request POST /1.0/instances --data '{
  "devices": {
    "root": {
      "path": "/",
      "pool": "default",
      "size": "30GiB",
      "type": "disk"
    }
  },
  "name": "ubuntu-vm-big",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  },
  "type": "virtual-machine"
}'
```



Create a container with specific configuration options

To create a container and limit its resources to one vCPU and 8 GiB of RAM:

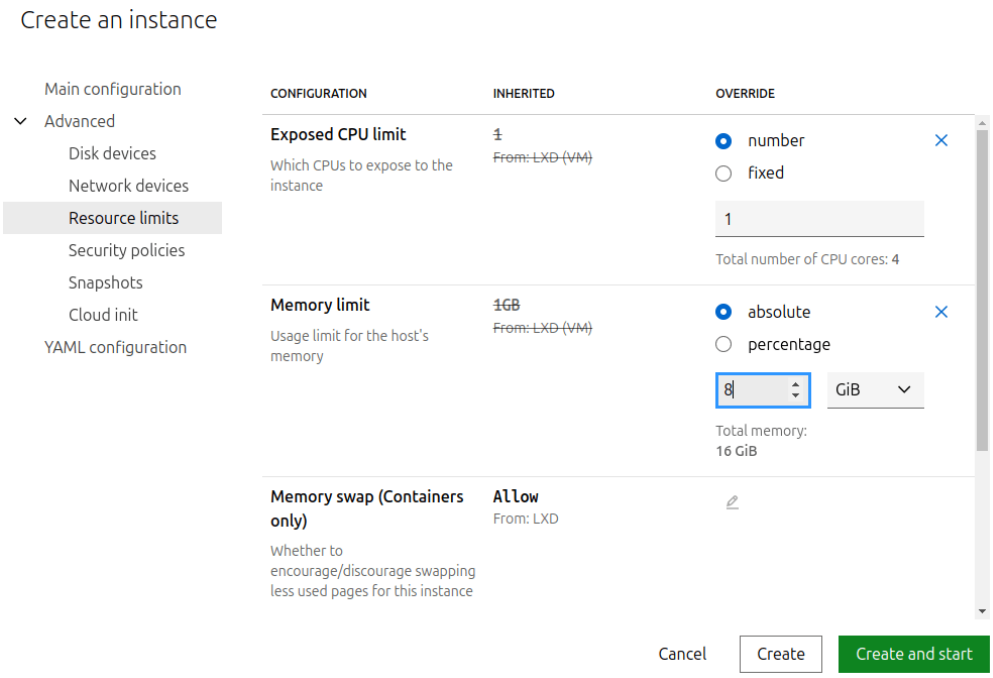
CLI

API

UI

```
lxc init ubuntu:24.04 ubuntu-limited --config limits.cpu=1 --config limits.memory=8GiB
```

```
lxc query --request POST /1.0/instances --data '{
  "config": {
    "limits.cpu": "1",
    "limits.memory": "8GiB"
  },
  "name": "ubuntu-limited",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  }
}'
```



Create a VM on a specific cluster member

To create a virtual machine on the cluster member `micro2`, enter the following command:

CLI

API

UI

```
lxc init ubuntu:24.04 ubuntu-vm-server2 --vm --target micro2
```

```
lxc query --request POST /1.0/instances?target=micro2 --data '{
  "name": "ubuntu-vm-server2",
  "source": {
    "alias": "24.04",
```

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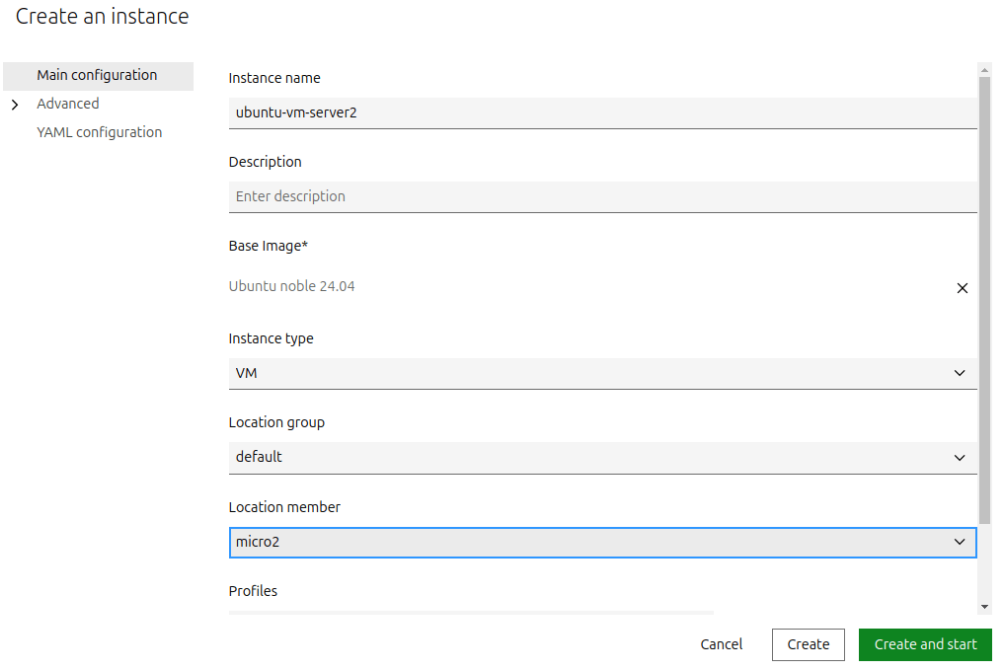
```
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  },
  "type": "virtual-machine"
}'
```



Create a container with a specific instance type

LXD supports simple instance types for clouds. Those are represented as a string that can be passed at instance creation time.

The list of supported clouds and instance types can be found at `images.lxd.canonical.com/meta/instance-types/`.

The syntax allows the three following forms:

- `<instance type>`
- `<cloud>:<instance type>`
- `c<CPU>-m<RAM in GiB>`

For example, the following three instance types are equivalent:

- `t2.micro`
- `aws:t2.micro`
- `c1-m1`

To create a container with this instance type:

CLI

API

UI

```
lxc init ubuntu:24.04 my-instance --type t2.micro
```

```
lxc query --request POST /1.0/instances --data '{
  "instance_type": "t2.micro",
  "name": "my-instance",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  }
}'
```

Creating an instance with a specific cloud instance type is currently not possible through the UI. Configure the corresponding options manually or through a profile.

Create a VM that boots from an ISO

To create a VM that boots from an ISO:

CLI

API

UI

First, create an empty VM that we can later install from the ISO image:

```
lxc init iso-vm --empty --vm
```

The second step is to import an ISO image that can later be attached to the VM as a storage volume:

```
lxc storage volume import <pool> <path-to-image.iso> iso-volume --type=iso
```

Lastly, attach the custom ISO volume to the VM using the following command:

```
lxc config device add iso-vm iso-volume disk pool=<pool> source=iso-volume boot.
↪priority=10
```

The *boot.priority* configuration key ensures that the VM will boot from the ISO first. Start the VM and *connect to the console* as there might be a menu you need to interact with:

```
lxc start iso-vm --console
```

Once you're done in the serial console, disconnect from the console using `Ctrl+a q` and *connect to the VGA console* using the following command:

```
lxc console iso-vm --type=vga
```

You should now see the installer. After the installation is done, detach the custom ISO volume:

```
lxc storage volume detach <pool> iso-volume iso-vm
```

Now the VM can be rebooted, and it will boot from disk.

First, create an empty VM that we can later install from the ISO image:

```
lxc query --request POST /1.0/instances --data '{
  "name": "iso-vm",
  "source": {
    "type": "none"
  },
  "type": "virtual-machine"
}'
```

The second step is to import an ISO image that can later be attached to the VM as a storage volume:

```
curl -X POST -H "Content-Type: application/octet-stream" -H "X-LXD-name: iso-volume" \
-H "X-LXD-type: iso" --data-binary @<path-to-image.iso> --unix-socket /var/snap/lxd/
↪common/lxd/unix.socket \
lxd/1.0/storage-pools/<pool>/volumes/custom
```

Note: When importing an ISO image, you must send both binary data from a file and additional headers. The *lxc query* command cannot do this, so you need to use `curl` or another tool instead.

Lastly, attach the custom ISO volume to the VM using the following command:

```
lxc query --request PATCH /1.0/instances/iso-vm --data '{
  "devices": {
    "iso-volume": {
      "boot.priority": "10",
      "pool": "<pool>",
      "source": "iso-volume",
      "type": "disk"
    }
  }
}'
```

The *boot.priority* configuration key ensures that the VM will boot from the ISO first. Start the VM and *connect to the console* as there might be a menu you need to interact with:

```
lxc query --request PUT /1.0/instances/iso-vm/state --data '{"action": "start"}'
lxc query --request POST /1.0/instances/iso-vm/console --data '{
  "height": 24,
  "type": "console",
  "width": 80
}'
```

Once you're done in the serial console, disconnect from the console using `Ctrl+a q` and *connect to the VGA console* using the following command:

```
lxc query --request POST /1.0/instances/iso-vm/console --data '{
  "height": 24,
  "type": "vga",
```

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```
  "width": 80
}'
```

You should now see the installer. After the installation is done, detach the custom ISO volume:

```
lxc query --request GET /1.0/instances/iso-vm
lxc query --request PUT /1.0/instances/iso-vm --data '{
  [...]
  "devices": {}
  [...]
}'
```

Note: You cannot remove the device through a PATCH request, but you must use a PUT request. Therefore, get the current configuration first and then provide the relevant configuration with an empty devices list through the PUT request.

Now the VM can be rebooted, and it will boot from disk.

In the *Create instance* dialog, click *Use custom ISO* instead of *Browse images*. You can then upload your ISO file and install a VM from it.

How to configure instances

You can configure instances by setting *Instance properties*, *Instance options*, or by adding and configuring *Devices*.

See the following sections for instructions.

Note: To store and reuse different instance configurations, use *profiles*.

Configure instance options

You can specify instance options when you *create an instance*. Alternatively, you can update the instance options after the instance is created.

CLI

API

UI

Use the `lxc config set` command to update instance options. Specify the instance name and the key and value of the instance option:

```
lxc config set <instance_name> <option_key>=<option_value> <option_key>=<option_value> ..
↪.
```

Send a PATCH request to the instance to update instance options. Specify the instance name and the key and value of the instance option:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "config": {
    "<option_key>": "<option_value>",
    "<option_key>": "<option_value>"
  }
}'
```

See PATCH /1.0/instances/{name} for more information.

To update instance options, go to the *Configuration* tab of the instance detail page and click *Edit instance*.

Find the configuration option that you want to update and change its value. Click *Save changes* to save the updated configuration.

To configure instance options that are not displayed in the UI, follow the instructions in *Edit the full instance configuration*.

See *Instance options* for a list of available options and information about which options are available for which instance type.

For example, change the memory limit for your container:

CLI

API

UI

To set the memory limit to 8 GiB, enter the following command:

```
lxc config set my-container limits.memory=8GiB
```

To set the memory limit to 8 GiB, send the following request:

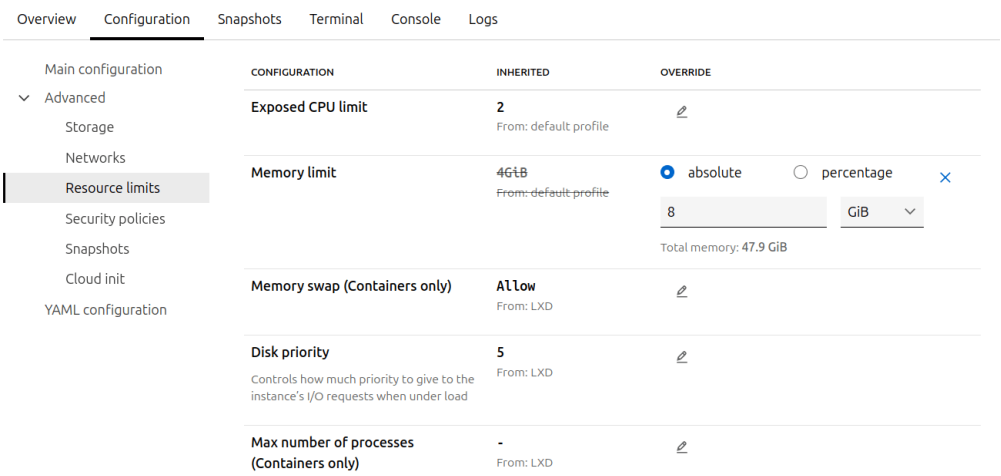
```
lxc query --request PATCH /1.0/instances/my-container --data '{
  "config": {
    "limits.memory": "8GiB"
  }
}'
```

To set the memory limit to 8 GiB, go to the *Configuration* tab of the instance detail page and select *Advanced* > *Resource limits*. Then click *Edit instance*.

Select *Override* for the **Memory limit** and enter 8 GiB as the absolute value.

Note: Some of the instance options are updated immediately while the instance is running. Others are updated only when the instance is restarted.

See the "Live update" information in the *Instance options* reference for information about which options are applied immediately while the instance is running.



Configure instance properties

CLI

API

UI

To update instance properties after the instance is created, use the *lxc config set* command with the `--property` flag. Specify the instance name and the key and value of the instance property:

```
lxc config set <instance_name> <property_key>=<property_value> <property_key>=<property_
↪value> ... --property
```

Using the same flag, you can also unset a property just like you would unset a configuration option:

```
lxc config unset <instance_name> <property_key> --property
```

You can also retrieve a specific property value with:

```
lxc config get <instance_name> <property_key> --property
```

To update instance properties through the API, use the same mechanism as for configuring instance options. The only difference is that properties are on the root level of the configuration, while options are under the `config` field.

Therefore, to set an instance property, send a PATCH request to the instance:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "<property_key>": "<property_value>",
  "<property_key>": "property_value>"
  }
}'
```

To unset an instance property, send a PUT request that contains the full instance configuration that you want except for the property that you want to unset.

See `PATCH /1.0/instances/{name}` and `PUT /1.0/instances/{name}` for more information.

The LXD UI does not distinguish between instance options and instance properties. Therefore, you can configure instance properties in the same way as you *configure instance options*.

Configure devices

Generally, devices can be added or removed for a container while it is running. VMs support hotplugging for some device types, but not all.

See *Devices* for a list of available device types and their options.

Note: Every device entry is identified by a name unique to the instance.

Devices from profiles are applied to the instance in the order in which the profiles are assigned to the instance. Devices defined directly in the instance configuration are applied last. At each stage, if a device with the same name already exists from an earlier stage, the whole device entry is overridden by the latest definition.

Device names are limited to a maximum of 64 characters.

CLI

API

UI

To add and configure an instance device for your instance, use the `lxc config device add` command.

Specify the instance name, a device name, the device type and maybe device options (depending on the *device type*):

```
lxc config device add <instance_name> <device_name> <device_type> <device_option_key>=
↪<device_option_value> <device_option_key>=<device_option_value> ...
```

For example, to add the storage at `/share/c1` on the host system to your instance at path `/opt`, enter the following command:

```
lxc config device add my-container disk-storage-device disk source=/share/c1 path=/opt
```

To configure instance device options for a device that you have added earlier, use the `lxc config device set` command:

```
lxc config device set <instance_name> <device_name> <device_option_key>=<device_option_
↪value> <device_option_key>=<device_option_value> ...
```

Device options for a device inherited from a profile cannot be updated within the instance. Use the `lxc config device override` command to create a copy of the profile device with updated device options. The newly created instance device will override the inherited device.

Specify the instance name, device name and the device options that should be overridden:

```
lxc config device override <instance_name> <device_name> <device_option_key>=<device_
↪option_value> <device_option_key>=<device_option_value> ...
```

Note: You can also specify device options by using the `--device` flag when *creating an instance*. This is useful if you want to override device options for a device that is provided through a *profile*.

To remove a device, use the `lxc config device remove` command. See `lxc config device --help` for a full list of available commands.

To add and configure an instance device for your instance, use the same mechanism of patching the instance configuration. The device configuration is located under the `devices` field of the configuration.

Specify the instance name, a device name, the device type and maybe device options (depending on the *device type*):

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "devices": {
    "<device_name>": {
      "type": "<device_type>",
      "<device_option_key>": "<device_option_value>",
      "<device_option_key>": "device_option_value>"
    }
  }
}'
```

For example, to add the storage at `/share/c1` on the host system to your instance at path `/opt`, enter the following command:

```
lxc query --request PATCH /1.0/instances/my-container --data '{
  "devices": {
    "disk-storage-device": {
      "type": "disk",
      "source": "/share/c1",
      "path": "/opt"
    }
  }
}'
```

See `PATCH /1.0/instances/{name}` for more information.

The UI does not support all device types yet, but you can configure disk and network devices for your instances.

To attach a device to your instance, or modify an existing device, update your instance configuration (in the same way as you *configure instance options*). Select *Advanced* > *Disk devices* > *Attach disk device* or *Advanced* > *Network devices* > *Attach network* to create a device and attach it to your instance.

Note: Some of the devices that are displayed in the instance configuration are inherited from a *profile* or defined through a *project*. Depending on the type of device, it might not be possible to edit these devices for an instance.

To add and configure devices that are not currently supported in the UI, follow the instructions in *Edit the full instance configuration*.

Display instance configuration

CLI

API

UI

To display the current configuration of your instance, including writable instance properties, instance options, devices and device options, enter the following command:

```
lxc config show <instance_name> --expanded
```

To retrieve the current configuration of your instance, including writable instance properties, instance options, devices and device options, send a GET request to the instance:

```
lxc query --request GET /1.0/instances/<instance_name>
```

See GET /1.0/instances/{name} for more information.

To view the current configuration of your instance, go to *Instances*, select your instance, and then switch to the *Configuration* tab.

To see the full configuration including instance properties, instance options, devices and device options (also the ones that aren't yet supported by the UI), select *YAML configuration*. This view shows the full YAML of the instance configuration.

Edit the full instance configuration

CLI

API

UI

To edit the full instance configuration, including writable instance properties, instance options, devices and device options, enter the following command:

```
lxc config edit <instance_name>
```

Note: For convenience, the *lxc config edit* command displays the full configuration including read-only instance properties. However, you cannot edit those properties. Any changes are ignored.

To update the full instance configuration, including writable instance properties, instance options, devices and device options, send a PUT request to the instance:

```
lxc query --request PUT /1.0/instances/<instance_name> --data '<instance_configuration>'
```

See PUT /1.0/instances/{name} for more information.

Note: If you include changes to any read-only instance properties in the configuration you provide, they are ignored.

Instead of using the UI forms to configure your instance, you can choose to edit the YAML configuration of the instance. You must use this method if you need to update any configurations that are not available in the UI.

Important: When doing updates, do not navigate away from the YAML configuration without saving your changes. If you do, your updates are lost.

To edit the YAML configuration of your instance, go to the instance detail page, switch to the *Configuration* tab and select *YAML configuration*. Then click *Edit instance*.

Edit the YAML configuration as required. Then click *Save changes* to save the updated configuration.

Note: For convenience, the YAML contains the full configuration including read-only instance properties. However, you cannot edit those properties. Any changes are ignored.

How to manage instances

When listing the existing instances, you can see their type, status, and location (if applicable). You can filter the instances and display only the ones that you are interested in.

CLI

API

UI

Enter the following command to list all instances:

```
lxc list
```

You can filter the instances that are displayed, for example, by type, status or the cluster member where the instance is located:

```
lxc list type=container
lxc list status=running
lxc list location=server1
```

You can also filter by name. To list several instances, use a regular expression for the name. For example:

```
lxc list ubuntu.*
```

Enter `lxc list --help` to see all filter options.

Query the `/1.0/instances` endpoint to list all instances. You can use *Recursion* to display more information about the instances:

```
lxc query --request GET /1.0/instances?recursion=2
```

You can *filter* the instances that are displayed, by name, type, status or the cluster member where the instance is located:

```
lxc query --request GET /1.0/instances?filter=name+eq+ubuntu
lxc query --request GET /1.0/instances?filter=type+eq+container
lxc query --request GET /1.0/instances?filter=status+eq+running
lxc query --request GET /1.0/instances?filter=location+eq+server1
```

To list several instances, use a regular expression for the name. For example:

```
lxc query --request GET /1.0/instances?filter=name+eq+ubuntu.*
```

See `GET /1.0/instances` for more information.

Go to *Instances* to see a list of all instances.

You can filter the instances that are displayed by status, instance type, or the profile they use by selecting the corresponding filter.

In addition, you can search for instances by entering a search text. The text you enter is matched against the name, the description, and the name of the base image.

Show information about an instance

CLI

API

UI

Enter the following command to show detailed information about an instance:

```
lxc info <instance_name>
```

Add `--show-log` to the command to show the latest log lines for the instance:

```
lxc info <instance_name> --show-log
```

Query the following endpoint to show detailed information about an instance:

```
lxc query --request GET /1.0/instances/<instance_name>
```

See `GET /1.0/instances/{name}` for more information.

Clicking an instance line in the overview will show a summary of the instance information right next to the instance list.

Click the instance name to go to the instance detail page, which contains detailed information about the instance.

Start an instance

CLI

API

UI

Enter the following command to start an instance:

```
lxc start <instance_name>
```

You will get an error if the instance does not exist or if it is running already.

To immediately attach to the console when starting, pass the `--console` flag. For example:

```
lxc start <instance_name> --console
```

See *How to access the console* for more information.

To start an instance, send a PUT request to change the instance state:

```
lxc query --request PUT /1.0/instances/<instance_name>/state --data '{"action": "start"}'
```

The return value of this query contains an operation ID, which you can use to query the status of the operation:

```
lxc query --request GET /1.0/operations/<operation_ID>
```

Use the following query to monitor the state of the instance:

```
lxc query --request GET /1.0/instances/<instance_name>/state
```

See GET /1.0/instances/{name}/state and PUT /1.0/instances/{name}/statefor more information.

To start an instance, go to the instance list or the respective instance and click the *Start* button ().

You can also start several instances at the same time by selecting them in the instance list and clicking the *Start* button at the top.

On the instance detail page, select the *Console* tab to see the boot log with information about the instance starting up. Once it is running, you can select the *Terminal* tab to access the instance.

Stop an instance

CLI

API

UI

Enter the following command to stop an instance:

```
lxc stop <instance_name>
```

You will get an error if the instance does not exist or if it is not running.

To stop an instance, send a PUT request to change the instance state:

```
lxc query --request PUT /1.0/instances/<instance_name>/state --data '{"action": "stop"}'
```

The return value of this query contains an operation ID, which you can use to query the status of the operation:

```
lxc query --request GET /1.0/operations/<operation_ID>
```

Use the following query to monitor the state of the instance:

```
lxc query --request GET /1.0/instances/<instance_name>/state
```

See GET /1.0/instances/{name}/state and PUT /1.0/instances/{name}/statefor more information.

To stop an instance, go to the instance list or the respective instance and click the *Stop* button (). You are then prompted to confirm.

Tip: To skip the confirmation prompt, hold the `Shift` key while clicking.

You can choose to force-stop the instance. If stopping the instance takes a long time or the instance is not responding to the stop request, click the spinning stop button to go back to the confirmation prompt, where you can select to force-stop the instance.

You can also stop several instances at the same time by selecting them in the instance list and clicking the *Stop* button at the top.

Delete an instance

If you don't need an instance anymore, you can remove it. The instance must be stopped before you can delete it.

CLI

API

UI

Enter the following command to delete an instance:

```
lxc delete <instance_name>
```

To delete an instance, send a DELETE request to the instance:

```
lxc query --request DELETE /1.0/instances/<instance_name>
```

See `DELETE /1.0/instances/{name}` for more information.

To delete an instance, go to its instance detail page and click *Delete instance*. You are then prompted to confirm.

Tip: To skip the confirmation prompt, hold the `Shift` key while clicking.

You can also delete several instances at the same time by selecting them in the instance list and clicking the *Delete* button at the top.

Caution: This command permanently deletes the instance and all its snapshots.

Prevent accidental deletion of instances

There are different ways to prevent accidental deletion of instances:

- To protect a specific instance from being deleted, set `security.protection.delete` to `true` for the instance. See *How to configure instances* for instructions.
- In the CLI client, you can create an alias to be prompted for approval every time you use the `lxc delete` command:

  ```
  lxc alias add delete "delete -i"
  ```

Rebuild an instance

If you want to wipe and re-initialize the root disk of your instance but keep the instance configuration, you can rebuild the instance.

Rebuilding is only possible for instances that do not have any snapshots.

Stop your instance before rebuilding it.

CLI

API

UI

Enter the following command to rebuild the instance with a different image:

```
lxc rebuild <image_name> <instance_name>
```

Enter the following command to rebuild the instance with an empty root disk:

```
lxc rebuild <instance_name> --empty
```

For more information about the `rebuild` command, see *`lxc rebuild --help`*.

To rebuild the instance with a different image, send a POST request to the instance's `rebuild` endpoint. For example:

```
lxc query --request POST /1.0/instances/<instance_name>/rebuild --data '{
  "source": {
    "alias": "<image_alias>",
    "protocol": "simplestreams",
    "server": "<server_URL>"
  }
}'
```

To rebuild the instance with an empty root disk, specify the source type as `none`:

```
lxc query --request POST /1.0/instances/<instance_name>/rebuild --data '{
  "source": {
    "type": "none"
  }
}'
```

See `POST /1.0/instances/{name}/rebuild` for more information.

Rebuilding an instance is not yet supported in the UI.

How to use profiles

Profiles store a set of configuration options. They can contain *Instance options*, *Devices*, and device options.

You can apply any number of profiles to an instance. They are applied in the order they are specified, so the last profile to specify a specific key takes precedence. However, instance-specific configuration always overrides the configuration coming from the profiles.

Note: Profiles can be applied to containers and virtual machines. Therefore, they might contain options and devices that are valid for either type.

When applying a profile that contains configuration that is not suitable for the instance type, this configuration is ignored and does not result in an error.

If you don't specify any profiles when launching a new instance, the `default` profile is applied automatically. This profile defines a network interface and a root disk. The `default` profile cannot be renamed or removed.

View profiles

CLI

API

UI

Enter the following command to display a list of all available profiles:

```
lxc profile list
```

Enter the following command to display the contents of a profile:

```
lxc profile show <profile_name>
```

To display all available profiles, send a request to the `/1.0/profiles` endpoint:

```
lxc query --request GET /1.0/profiles?recursion=1
```

To display a specific profile, send a request to that profile:

```
lxc query --request GET /1.0/profiles/<profile_name>
```

See `GET /1.0/profiles` and `GET /1.0/profiles/{name}` for more information.

Go to the *Profiles* section to view all available profiles.

To view information about a specific profile, click its line in the overview. To display the full information about a profile, including its configuration, click the profile name to go to the profile detail page.

Create an empty profile

CLI

API

UI

Enter the following command to create an empty profile:

```
lxc profile create <profile_name>
```

To create an empty profile, send a POST request to the `/1.0/profiles` endpoint:

```
lxc query --request POST /1.0/profiles --data '{"name": "<profile_name>"}'
```

See `POST /1.0/profiles` for more information.

To create a profile, go to the *Profiles* section and click *Create profile*.

Enter at least a profile name and click *Create* to save the new profile.

Edit a profile

You can either set specific configuration options for a profile or edit the full profile. See *Instance configuration* (and its subpages) for the available options.

Set specific options for a profile

CLI

API

UI

To set an instance option for a profile, use the `lxc profile set` command. Specify the profile name and the key and value of the instance option:

```
lxc profile set <profile_name> <option_key>=<option_value> <option_key>=<option_value> ..
↪.
```

To add and configure an instance device for your profile, use the `lxc profile device add` command. Specify the profile name, a device name, the device type and maybe device options (depending on the *device type*):

```
lxc profile device add <profile_name> <device_name> <device_type> <device_option_key>=
↪<device_option_value> <device_option_key>=<device_option_value> ...
```

To configure instance device options for a device that you have added to the profile earlier, use the `lxc profile device set` command:

```
lxc profile device set <profile_name> <device_name> <device_option_key>=<device_option_
↪value> <device_option_key>=<device_option_value> ...
```

To set an instance option for a profile, send a PATCH request to the profile. Specify the key and value of the instance option under the `"config"` field:

```
lxc query --request PATCH /1.0/profiles/<profile_name> --data '{
  "config": {
    "<option_key>": "<option_value>",
    "<option_key>": "<option_value>"
  }
}'
```

To add and configure an instance device for your profile, specify the device name, the device type and maybe device options (depending on the *device type*) under the `"devices"` field:

```
lxc query --request PATCH /1.0/profiles/<profile_name> --data '{
  "devices": {
    "<device_name>": {
      "type": "<device_type>",
      "<device_option_key>": "<device_option_value>",
      "<device_option_key>": "<device_option_value>"
    }
  }
}'
```

See PATCH /1.0/profiles/{name} for more information.

To configure a profile, select it from the *Profiles* overview, switch to the *Configuration* tab and click *Edit profile*. You can then configure options for the profile in the same way as you *configure instance options*.

Edit the full profile

Instead of setting each configuration option separately, you can provide all options at once.

Check the contents of an existing profile or instance configuration for the required fields. For example, the `default` profile might look like this:

```
config: {}
description: Default LXD profile
devices:
  eth0:
    name: eth0
    network: lxdbr0
    type: nic
  root:
    path: /
    pool: default
    type: disk
name: default
used_by:
```

Instance options are provided as an array under `config`. Instance devices and instance device options are provided under `devices`.

CLI

API

UI

To edit a profile using your standard terminal editor, enter the following command:

```
lxc profile edit <profile_name>
```

Alternatively, you can create a YAML file (for example, `profile.yaml`) with the configuration and write the configuration to the profile with the following command:

```
lxc profile edit <profile_name> < profile.yaml
```

To update the entire profile configuration, send a PUT request to the profile:

```
lxc query --request PUT /1.0/profiles/<profile_name> --data '{
  "config": { ... },
  "description": "<description>",
  "devices": { ... }
}'
```

See PUT /1.0/profiles/{name} for more information.

To edit the YAML configuration of a profile, go to the profile detail page, switch to the *Configuration* tab and select *YAML configuration*. Then click *Edit profile*.

Edit the YAML configuration as required. Then click *Save changes* to save the updated configuration.

Important: When doing updates, do not navigate away from the YAML configuration without saving your changes. If you do, your updates are lost.

Apply a profile to an instance

CLI

API

UI

Enter the following command to apply a profile to an instance:

```
lxc profile add <instance_name> <profile_name>
```

Tip: Check the configuration after adding the profile: *lxc config show <instance_name>*

You will see that your profile is now listed under `profiles`. However, the configuration options from the profile are not shown under `config` (unless you add the `--expanded` flag). The reason for this behavior is that these options are taken from the profile and not the configuration of the instance.

This means that if you edit a profile, the changes are automatically applied to all instances that use the profile.

You can also specify profiles when launching an instance by adding the `--profile` flag:

```
lxc launch <image> <instance_name> --profile <profile> --profile <profile> ...
```

To apply a profile to an instance, add it to the profile list in the instance configuration:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "profiles": [ "default", "<profile_name>" ]
}'
```

See `PATCH /1.0/instances/{name}` for more information.

You can also specify profiles when *creating an instance*:

```
lxc query --request POST /1.0/instances --data '{
  "name": "<instance_name>",
  "profiles": [ "default", "<profile_name>" ],
  "source": {
    "alias": "<image_alias>",
    "protocol": "simplestreams",
    "server": "<server_URL>",
    "type": "image"
  }
}'
```

To apply a profile to an instance, select the instance from the *Instances* overview, switch to the *Configuration* tab and click *Edit instance*. You can then select a profile from the drop-down list, or click *Add profile* to attach another profile in addition to the one (or more) that are already attached to the instance.

If you attach more than one profile to an instance, you can specify the order in which the profiles are applied by moving each profile up or down the list.

You can also apply profiles in the same way when *creating an instance*.

Remove a profile from an instance

CLI

API

UI

Enter the following command to remove a profile from an instance:

```
lxc profile remove <instance_name> <profile_name>
```

To remove a profile from an instance, send a PATCH request to the instance configuration with the new profile list. For example, to revert back to using only the default profile:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "profiles": [ "default" ]
}'
```

See `PATCH /1.0/instances/{name}` for more information.

To remove a profile from an instance, select the instance from the *Instances* overview, switch to the *Configuration* tab and click *Edit instance*. Click the *Delete* link next to a profile to remove it from the instance.

How to troubleshoot failing instances

If your instance fails to start and ends up in an error state, this usually indicates a bigger issue related to either the image that you used to create the instance or the server configuration.

To troubleshoot the problem, complete the following steps:

1. Save the relevant log files and debug information:

   Instance log
   Display the instance log:

   CLI

   API

   UI

   ```
   lxc info <instance_name> --show-log
   ```

   ```
   lxc query --request GET /1.0/instances/<instance_name>/logs/lxc.log
   ```

   Navigate to the instance detail page and switch to the *Logs* tab to view the available log files.

   Console log
   Display the console log:

   CLI

   API

   UI

```
lxc console <instance_name> --show-log
```

This command is available only for containers.

```
lxc query --request GET /1.0/instances/<instance_name>/console
```

This endpoint is available only for containers.

Navigate to the instance detail page and switch to the *Console* tab to view the console. The console is displayed only when the instance is running.

Detailed server information

The LXD snap includes a tool that collects the relevant server information for debugging. Enter the following command to run it:

```
sudo lxd.buginfo
```

2. Reboot the machine that runs your LXD server.
3. Try starting your instance again. If the error occurs again, compare the logs to check if it is the same error.

   If it is, and if you cannot figure out the source of the error from the log information, open a question in the forum. Make sure to include the log files you collected.

Troubleshooting example

In this example, let's investigate a RHEL 7 system in which `systemd` cannot start.

`user@host:~$ lxc console --show-log systemd Console log: Failed to insert module 'autofs4'Failed to insert module 'unix'Failed to mount sysfs at /sys: Operation not permittedFailed to mount proc at /proc: Operation not permitted[!!!!!!] Failed to mount API filesystems, freezing.` The errors here say that `/sys` and `/proc` cannot be mounted - which is correct in an unprivileged container. However, LXD mounts these file systems automatically if it can.

The *container requirements* specify that every container must come with an empty `/dev`, `/proc` and `/sys` directory, and that `/sbin/init` must exist. If those directories don't exist, LXD cannot mount them, and `systemd` will then try to do so. As this is an unprivileged container, `systemd` does not have the ability to do this, and it then freezes.

So you can see the environment before anything is changed, and you can explicitly change the init system in a container using the *raw.lxc* configuration parameter. This is equivalent to setting `init=/bin/bash` on the Linux kernel command line.

```
lxc config set systemd raw.lxc 'lxc.init.cmd = /bin/bash'
```

Here is what it looks like:

`user@host:~$ lxc config set systemd raw.lxc 'lxc.init.cmd = /bin/bash' user@host:~$ lxc start systemd user@host:~$ lxc console --show-log systemd Console log: [root@systemd /]#` Now that the container has started, you can check it and see that things are not running as well as expected:

`user@host:~$ lxc exec systemd -- bash [root@systemd ~]# ls[root@systemd ~]# mountmount: failed to read mtab: No such file or directory[root@systemd ~]# cd /[root@systemd /]# ls /proc/sys[root@systemd /]# exit` Because LXD tries to auto-heal, it created some of the directories when it was starting up. Shutting down and restarting the container fixes the problem, but the original cause is still there - the template does not contain the required files.

How to work with instances:

How to access files in an instance

You can manage files inside an instance using the LXD client or the API without needing to access the instance through the network. Files can be individually edited or deleted, pushed from or pulled to the local machine. Alternatively, if you're using the LXD client, you can mount the instance's file system onto the local machine.

Note: The UI does not currently support accessing files in an instance.

For containers, these file operations always work and are handled directly by LXD. For virtual machines, the `lxd-agent` process must be running inside of the virtual machine for them to work.

Edit instance files

CLI

API

To edit an instance file from your local machine, enter the following command:

```
lxc file edit <instance_name>/<path_to_file>
```

For example, to edit the `/etc/hosts` file in the instance, enter the following command:

```
lxc file edit my-instance/etc/hosts
```

Note: The file must already exist on the instance. You cannot use the `edit` command to create a file on the instance.

There is no API endpoint that lets you edit files directly on an instance. Instead, you need to *pull the content of the file from the instance*, edit it, and then *push the modified content back to the instance*.

Delete files from the instance

CLI

API

To delete a file from your instance, enter the following command:

```
lxc file delete <instance_name>/<path_to_file>
```

Send the following DELETE request to delete a file from your instance:

```
lxc query --request DELETE /1.0/instances/<instance_name>/files?path=<path_to_file>
```

See `DELETE /1.0/instances/{name}/files` for more information.

Pull files from the instance to the local machine

CLI

API

To pull a file from your instance to your local machine, enter the following command:

```
lxc file pull <instance_name>/<path_to_file> <local_file_path>
```

For example, to pull the `/etc/hosts` file to the current directory, enter the following command:

```
lxc file pull my-instance/etc/hosts .
```

Instead of pulling the instance file into a file on the local system, you can also pull it to stdout and pipe it to stdin of another command. This can be useful, for example, to check a log file:

```
lxc file pull my-instance/var/log/syslog - | less
```

To pull a directory with all contents, enter the following command:

```
lxc file pull -r <instance_name>/<path_to_directory> <local_location>
```

Send the following request to pull the contents of a file from your instance to your local machine:

```
lxc query --request GET /1.0/instances/<instance_name>/files?path=<path_to_file>
```

You can then write the contents to a local file, or pipe them to stdin of another command.

For example, to pull the contents of the `/etc/hosts` file and write them to a `my-instance-hosts` file in the current directory, enter the following command:

```
lxc query --request GET /1.0/instances/my-instance/files?path=/etc/hosts > my-instance-
↪hosts
```

To examine a log file, enter the following command:

```
lxc query --request GET /1.0/instances/<instance_name>/files?path=<file_path> | less
```

To pull the contents of a directory, send the following request:

```
lxc query --request GET /1.0/instances/<instance_name>/files?path=<path_to_directory>
```

This request returns a list of files in the directory, and you can then pull the contents of each file.

See `GET /1.0/instances/{name}/files` for more information.

Push files from the local machine to the instance

CLI

API

To push a file from your local machine to your instance, enter the following command:

```
lxc file push <local_file_path> <instance_name>/<path_to_file>
```

You can specify the file permissions by adding the `--gid`, `--uid`, and `--mode` flags.

To push a directory with all contents, enter the following command:

```
lxc file push -r <local_location> <instance_name>/<path_to_directory>
```

Send the following request to write content to a file on your instance:

```
lxc query --request POST /1.0/instances/<instance_name>/files?path=<path_to_file> --data
↪<content>
```

See `POST /1.0/instances/{name}/files` for more information.

To push content directly from a file, you must use a tool that can send raw data from a file, which *`lxc query`* does not support. For example, with curl:

```
curl -X POST -H "Content-Type: application/octet-stream" --data @<local_file_path> \
--unix-socket /var/snap/lxd/common/lxd/unix.socket \
lxd/1.0/instances/<instance_name>/files?path=<path_to_file>
```

Mount a file system from the instance

CLI

API

You can mount an instance file system into a local path on your client.

To do so, make sure that you have `sshfs` installed. Then run the following command (note that if you're using the snap, the command requires root permissions):

```
lxc file mount <instance_name>/<path_to_directory> <local_location>
```

You can then access the files from your local machine.

Set up an SSH SFTP listener

Alternatively, you can set up an SSH SFTP listener. This method allows you to connect with any SFTP client and with a dedicated user name. Also, if you're using the snap, it does not require root permission.

To do so, first set up the listener by entering the following command:

```
lxc file mount <instance_name> [--listen <address>:<port>]
```

For example, to set up the listener on a random port on the local machine (for example, `127.0.0.1:45467`):

```
lxc file mount my-instance
```

If you want to access your instance files from outside your local network, you can pass a specific address and port:

```
lxc file mount my-instance --listen 192.0.2.50:2222
```

> **Caution:** Be careful when doing this, because it exposes your instance remotely.

To set up the listener on a specific address and a random port:

```
lxc file mount my-instance --listen 192.0.2.50:0
```

The command prints out the assigned port and a user name and password for the connection.

Tip: You can specify a user name by passing the `--auth-user` flag.

Use this information to access the file system. For example, if you want to use `sshfs` to connect, enter the following command:

```
sshfs <user_name>@<address>:<path_to_directory> <local_location> -p <port>
```

For example:

```
sshfs xFn8ai8c@127.0.0.1:/home my-instance-files -p 35147
```

You can then access the file system of your instance at the specified location on the local machine.

Mounting a file system is not directly supported through the API, but requires additional processing logic on the client side.

How to access the console

You can access the instance console to log in to the instance and see log messages. The console is available at boot time already, so you can use it to see boot messages and, if necessary, debug startup issues of a container or VM.

CLI

API

UI

Use the *`lxc console`* command to attach to instance consoles. To get an interactive console, enter the following command:

```
lxc console <instance_name>
```

To show new log messages (only for containers), pass the `--show-log` flag:

```
lxc console <instance_name> --show-log
```

You can also immediately attach to the console when you start your instance:

```
lxc start <instance_name> --console
lxc start <instance_name> --console=vga
```

Tip: To exit the console, enter `Ctrl+a q`.

To start an interactive console, send a POST request to the `console` endpoint:

```
lxc query --request POST /1.0/instances/<instance_name>/console --data '{
  "height": 24,
  "type": "console",
```

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(continued from previous page)

```
  "width": 80
}'
```

This query sets up two WebSockets that you can use for connection. One WebSocket is used for control, and the other transmits the actual console data.

See POST /1.0/instances/{name}/console for more information.

To access the WebSockets, you need the operation ID and the secrets for each socket. This information is available in the operation started by the query, for example:

```
{
  "class": "websocket",
  "created_at": "2024-01-31T10:11:48.135150288Z",
  "description": "Showing console",
  "err": "",
  "id": "<operation_ID>",
  "location": "none",
  "may_cancel": false,
  "metadata": {
    "fds": {
      "0": "<data_socket_secret>",
      "control": "<control_socket_secret>"
    }
  }
[...]
}
```

How to connect to the WebSockets depends on the tooling that you use (see GET /1.0/operations/{id}/websocket for general information). To quickly check whether the connection is successful and you can read from the socket, you can use a tool like websocat:

```
websocat --text \
--ws-c-uri=ws://unix.socket/1.0/operations/<operation_ID>/websocket?secret=<data_socket_
↪secret> \
- ws-c:unix:/var/snap/lxd/common/lxd/unix.socket
```

Alternatively, if you just want to retrieve new log messages from the console instead of connecting through a WebSocket, you can send a GET request to the `console` endpoint:

```
lxc query --request GET /1.0/instances/<instance_name>/console
```

See GET /1.0/instances/{name}/console for more information. Note that this operation is supported only for containers, not for VMs.

Navigate to the instance detail page and switch to the *Console* tab to view the console.

Access the graphical console (for virtual machines)

On virtual machines, log on to the console to get graphical output. Using the console you can, for example, install an operating system using a graphical interface or run a desktop environment.

An additional advantage is that the console is available even if the `lxd-agent` process is not running. This means that you can access the VM through the console before the `lxd-agent` starts up, and also if the `lxd-agent` is not available at all.

CLI

API

UI

To start the VGA console with graphical output for your VM, you must install a SPICE client (for example, `virt-viewer` or `spice-gtk-client`). Then enter the following command:

```
lxc console <vm_name> --type vga
```

To start the VGA console with graphical output for your VM, send a POST request to the `console` endpoint:

```
lxc query --request POST /1.0/instances/<instance_name>/console --data '{
  "height": 0,
  "type": "vga",
  "width": 0
}'
```

See `POST /1.0/instances/{name}/console` for more information.

Navigate to the instance detail page and switch to the *Console* tab to view the console.

For virtual machines, you can switch between the graphic console and the text console.

How to run commands in an instance

LXD allows to run commands inside an instance using the LXD client or the API, without needing to access the instance through the network.

For containers, this always works and is handled directly by LXD. For virtual machines, the `lxd-agent` process must be running inside of the virtual machine for this to work.

Note: The UI does not currently support sending commands to an instance. However, it provides a terminal that gives you *shell access to your instance*.

Run commands inside your instance

CLI

API

To run a single command from the terminal of the host machine, use the *`lxc exec`* command:

```
lxc exec <instance_name> -- <command>
```

For example, enter the following command to update the package list on your container:

```
lxc exec my-instance -- apt-get update
```

Send a POST request to the instance's `exec` endpoint to run a single command from the terminal of the host machine:

```
lxc query --request POST /1.0/instances/<instance_name>/exec --data '{
  "command": [ "<command>" ]
}'
```

For example, enter the following command to update the package list on your container:

```
lxc query --request POST /1.0/instances/my-instance/exec --data '{
  "command": [ "apt-get", "update" ]
}'
```

See POST /1.0/instances/{name}/exec for more information.

Execution mode

LXD can execute commands either interactively or non-interactively.

CLI

API

In interactive mode, a pseudo-terminal device (PTS) is used to handle input (stdin) and output (stdout, stderr). This mode is automatically selected by the CLI if connected to a terminal emulator (and not run from a script). To force interactive mode, add either `--force-interactive` or `--mode interactive` to the command.

In non-interactive mode, pipes are allocated instead (one for each of stdin, stdout and stderr). This method allows running a command and properly getting separate stdin, stdout and stderr as required by many scripts. To force non-interactive mode, add either `--force-noninteractive` or `--mode non-interactive` to the command.

In both modes, the operation creates a control socket that can be used for out-of-band communication with LXD. You can send signals and window sizing information through this socket.

Interactive mode

In interactive mode, the operation creates an additional single bi-directional WebSocket. To force interactive mode, add `"interactive": true` and `"wait-for-websocket": true` to the request data. For example:

```
lxc query --request POST /1.0/instances/my-instance/exec --data '{
  "command": [ "/bin/bash" ],
  "interactive": true,
  "wait-for-websocket": true
}'
```

Non-interactive mode

In non-interactive mode, the operation creates three additional WebSockets: one each for stdin, stdout, and stderr. To force non-interactive mode, add `"interactive": false` to the request data.

When running a command in non-interactive mode, you can instruct LXD to record the output of the command. To do so, add `"record-output": true` to the request data. You can then send a request to the `exec-output` endpoint to retrieve the list of files that contain command output:

```
lxc query --request GET /1.0/instances/<instance_name>/logs/exec-output
```

To display the output of one of the files, send a request to one of the files:

```
lxc query --request GET /1.0/instances/<instance_name>/logs/exec-output/<record-
↪output-file>
```

When you don't need the command output anymore, you can delete it:

```
lxc query --request DELETE /1.0/instances/<instance_name>/logs/exec-output/<record-
↪output-file>
```

See `GET /1.0/instances/{name}/logs/exec-output`, `GET /1.0/instances/{name}/logs/exec-output/{filename}`, and `DELETE /1.0/instances/{name}/logs/exec-output/{filename}` for more information.

User, groups and working directory

LXD has a policy not to read data from within the instances or trust anything that can be found in the instance. Therefore, LXD does not parse files like `/etc/passwd`, `/etc/group` or `/etc/nsswitch.conf` to handle user and group resolution.

As a result, LXD doesn't know the home directory for the user or the supplementary groups the user is in.

By default, LXD runs commands as `root` (UID 0) with the default group (GID 0) and the working directory set to `/root`. You can override the user, group and working directory by specifying absolute values.

CLI

API

You can override the default settings by adding the following flags to the *`lxc exec`* command:

- `--user` - the user ID for running the command
- `--group` - the group ID for running the command
- `--cwd` - the directory in which the command should run

You can override the default settings by adding the following fields to the request data:

- `"user": <user_ID>` - the user ID for running the command
- `"group": <group_ID>` - the group ID for running the command
- `"cwd": "<directory>"` - the directory in which the command should run

Environment

You can pass environment variables to an exec session in the following two ways:

Set environment variables as instance options

CLI

API

UI

To set the `<ENVVAR>` environment variable to `<value>` in the instance, set the `environment.<ENVVAR>` instance option (see *`environment.*`*):

```
lxc config set <instance_name> environment.<ENVVAR>=<value>
```

To set the <ENVVAR> environment variable to <value> in the instance, set the environment.<ENVVAR> instance option (see *environment.**):

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "config": {
    "environment.<ENVVAR>": "<value>"
  }
}'
```

To set the <ENVVAR> environment variable to <value> in the instance, go to the instance detail page, switch to the *Configuration* tab and select *YAML configuration*. Then click *Edit instance*.

Add the environment.<ENVVAR> configuration under the config section. For example:

```
config:
  environment.<ENVVAR>: "<value>"
```

Click *Save changes*.

Pass environment variables to the exec command

CLI

API

To pass an environment variable to the exec command, use the --env flag. For example:

```
lxc exec <instance_name> --env <ENVVAR>=<value> -- <command>
```

To pass an environment variable to the exec command, add an environment field to the request data. For example:

```
lxc query --request POST /1.0/instances/<instance_name>/exec --data '{
  "command": [ "<command>" ],
  "environment": {
    "<ENVVAR>": "<value>"
  }
}'
```

In addition, LXD sets the following default values (unless they are passed in one of the ways described above):

Variable name	Condition	Value
PATH	-	Concatenation of: • /usr/local/sbin • /usr/local/bin • /usr/sbin • /usr/bin • /sbin • /bin • /snap (if applicable) • /etc/NIXOS (if applicable)
LANG	-	C.UTF-8
HOME	running as root (UID 0)	/root
USER	running as root (UID 0)	root

Get shell access to your instance

If you want to run commands directly in your instance, run a shell command inside it.

CLI

API

UI

Enter the following command (assuming that the `/bin/bash` command exists in your instance):

```
lxc exec <instance_name> -- /bin/bash
```

Enter the following command (assuming that the `/bin/bash` command exists in your instance):

```
lxc query --request POST /1.0/instances/<instance_name>/exec --data '{
  "command": [ "/bin/bash" ]
}'
```

Navigate to the instance detail page and switch to the *Terminal* tab to access the shell.

By default, you are logged in as the `root` user. If you want to log in as a different user, enter the following command:

CLI

API

UI

```
lxc exec <instance_name> -- su --login <user_name>
```

To exit the instance shell, enter `exit` or press `Ctrl+d`.

```
lxc query --request POST /1.0/instances/<instance_name>/exec --data '{
  "command": [ "su", "--login", "<user_name>" ]
}'
```

```
su --login <user_name>
```

To exit the user shell and go back to the root shell, enter `exit` or press `Ctrl+d`.

Note: Depending on the operating system that you run in your instance, you might need to create a user first.

How to use `cloud-init`

`cloud-init` is a tool for automatically initializing and customizing an instance of a Linux distribution.

By adding `cloud-init` configuration to your instance, you can instruct `cloud-init` to execute specific actions at the first start of an instance. Possible actions include, for example:

- Updating and installing packages
- Applying certain configurations
- Adding users
- Enabling services

- Running commands or scripts
- Automatically growing the file system of a VM to the size of the disk

See the Cloud-init documentation for detailed information.

Note: The `cloud-init` actions are run only once on the first start of the instance. Rebooting the instance does not re-trigger the actions.

`cloud-init` support in images

To use `cloud-init`, you must base your instance on an image that has `cloud-init` installed:

- All images from the `ubuntu` and `ubuntu-daily` *image servers* have `cloud-init` support. However, images for Ubuntu releases prior to `20.04` require special handling to integrate properly with `cloud-init`, so that `lxc exec` works correctly with virtual machines that use those images. Refer to *VM `cloud-init`*.
- Images from the `images` remote have `cloud-init`-enabled variants, which are usually bigger in size than the default variant. The cloud variants use the `/cloud` suffix, for example, `images:alpine/edge/cloud`.

Configuration options

LXD supports two different sets of configuration options for configuring `cloud-init`: `cloud-init.*` and `user.*`. Which of these sets you must use depends on the `cloud-init` support in the image that you use. As a rule of thumb, newer images support the `cloud-init.*` configuration options, while older images support `user.*`. However, there might be exceptions to that rule.

The following configuration options are supported:

- `cloud-init.vendor-data` or `user.vendor-data` (see Vendor data)
- `cloud-init.user-data` or `user.user-data` (see User data formats)
- `cloud-init.network-config` or `user.network-config` (see Network configuration)

For more information about the configuration options, see the *`cloud-init` instance options*, and the documentation for the LXD data source in the `cloud-init` documentation.

Vendor data and user data

Both `vendor-data` and `user-data` are used to provide cloud configuration data to `cloud-init`.

The main idea is that `vendor-data` is used for the general default configuration, while `user-data` is used for instance-specific configuration. This means that you should specify `vendor-data` in a profile and `user-data` in the instance configuration. LXD does not enforce this method, but allows using both `vendor-data` and `user-data` in profiles and in the instance configuration.

If both `vendor-data` and `user-data` are supplied for an instance, `cloud-init` merges the two configurations. However, if you use the same keys in both configurations, merging might not be possible. In this case, configure how `cloud-init` should merge the provided data. See Merging user data sections for instructions.

How to configure `cloud-init`

To configure `cloud-init` for an instance, add the corresponding configuration options to a *profile* that the instance uses or directly to the *instance configuration*.

When configuring `cloud-init` directly for an instance, keep in mind that `cloud-init` runs only on the first start of the instance. That means that you must configure `cloud-init` before you start the instance. If you are using the CLI client, create the instance with `lxc init` instead of `lxc launch`, and then start it after completing the configuration.

YAML format for `cloud-init` configuration

The `cloud-init` options require YAML's literal style format. You use a pipe symbol (`|`) to indicate that all indented text after the pipe should be passed to `cloud-init` as a single string, with new lines and indentation preserved.

The `vendor-data` and `user-data` options usually start with `#cloud-config`.

For example:

```
config:
  cloud-init.user-data: |
    #cloud-config
    package_upgrade: true
    packages:
      - package1
      - package2
```

Tip: See How to validate user data for information on how to check whether the syntax is correct.

Configure `cloud-init` through the API

If you are using the API to configure your instance, provide the `cloud-init` configuration as a string with escaped newline characters.

For example:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "config": {
    "cloud-init.user-data": "#cloud-config\npackage_upgrade: true\npackages:\n  -␣
↪package1\n  - package2"
  }
}'
```

Alternatively, to avoid mistakes, write the configuration to a file and include that in your request. For example, create `cloud-init.txt` with the following content:

```
#cloud-config
package_upgrade: true
packages:
  - package1
  - package2
```

Then send the following request:

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
"config": {
  "cloud-init.user-data": "'"$(awk -v ORS='\\n' '1' cloud-init.txt)"'"
  }
}'
```

How to check the `cloud-init` status

`cloud-init` runs automatically on the first start of an instance. Depending on the configured actions, it might take a while until it finishes.

To check the `cloud-init` status, log on to the instance and enter the following command:

```
cloud-init status
```

If the result is `status: running`, `cloud-init` is still working. If the result is `status: done`, it has finished.

Alternatively, use the `--wait` flag to be notified only when `cloud-init` is finished:

```
root@instance:~# cloud-init status --wait     ..................................status:
done
```

How to specify user or vendor data

The `user-data` and `vendor-data` configuration can be used to, for example, upgrade or install packages, add users, or run commands.

The provided values must have a first line that indicates what type of user data format is being passed to `cloud-init`. For activities like upgrading packages or setting up a user, `#cloud-config` is the data format to use.

The configuration data is stored in the following files in the instance's root file system:

- `/var/lib/cloud/instance/cloud-config.txt`
- `/var/lib/cloud/instance/user-data.txt`

Examples

See the following sections for the user data (or vendor data) configuration for different example use cases.

You can find more advanced examples in the `cloud-init` documentation.

Upgrade packages

To trigger a package upgrade from the repositories for the instance right after the instance is created, use the `package_upgrade` key:

```
config:
  cloud-init.user-data: |
    #cloud-config
    package_upgrade: true
```

Install packages

To install specific packages when the instance is set up, use the `packages` key and specify the package names as a list:

```
config:
  cloud-init.user-data: |
    #cloud-config
    packages:
      - git
      - openssh-server
```

Set the time zone

To set the time zone for the instance on instance creation, use the `timezone` key:

```
config:
  cloud-init.user-data: |
    #cloud-config
    timezone: Europe/Rome
```

Run commands

To run a command (such as writing a marker file), use the `runcmd` key and specify the commands as a list:

```
config:
  cloud-init.user-data: |
    #cloud-config
    runcmd:
      - [touch, /run/cloud.init.ran]
```

Add a user account

To add a user account, use the `user` key. See the Including users and groups example in the `cloud-init` documentation for details about default users and which keys are supported.

```
config:
  cloud-init.user-data: |
    #cloud-config
    user:
      - name: documentation_example
```

How to specify network configuration data

By default, `cloud-init` configures a DHCP client on an instance's `eth0` interface. You can define your own network configuration using the `network-config` option to override the default configuration (this is due to how the template is structured).

`cloud-init` then renders the relevant network configuration on the system using either `ifupdown` or `netplan`, depending on the Ubuntu release.

The configuration data is stored in the following files in the instance's root file system:

- `/var/lib/cloud/seed/nocloud-net/network-config`
- `/etc/network/interfaces.d/50-cloud-init.cfg` (if using `ifupdown`)
- `/etc/netplan/50-cloud-init.yaml` (if using `netplan`)

Example

To configure a specific network interface with a static IPv4 address and also use a custom name server, use the following configuration:

```
config:
  cloud-init.network-config: |
    version: 1
    config:
      - type: physical
        name: eth1
        subnets:
          - type: static
            ipv4: true
            address: 10.10.101.20
            netmask: 255.255.255.0
            gateway: 10.10.101.1
            control: auto
      - type: nameserver
        address: 10.10.10.254
```

How to add a routed NIC device to a virtual machine

When adding a *routed NIC device* to an instance, you must configure the instance to use the link-local gateway IPs as default routes. For containers, this is configured for you automatically. For virtual machines, the gateways must be configured manually or via a mechanism like `cloud-init`.

To configure the gateways with `cloud-init`, firstly initialize an instance:

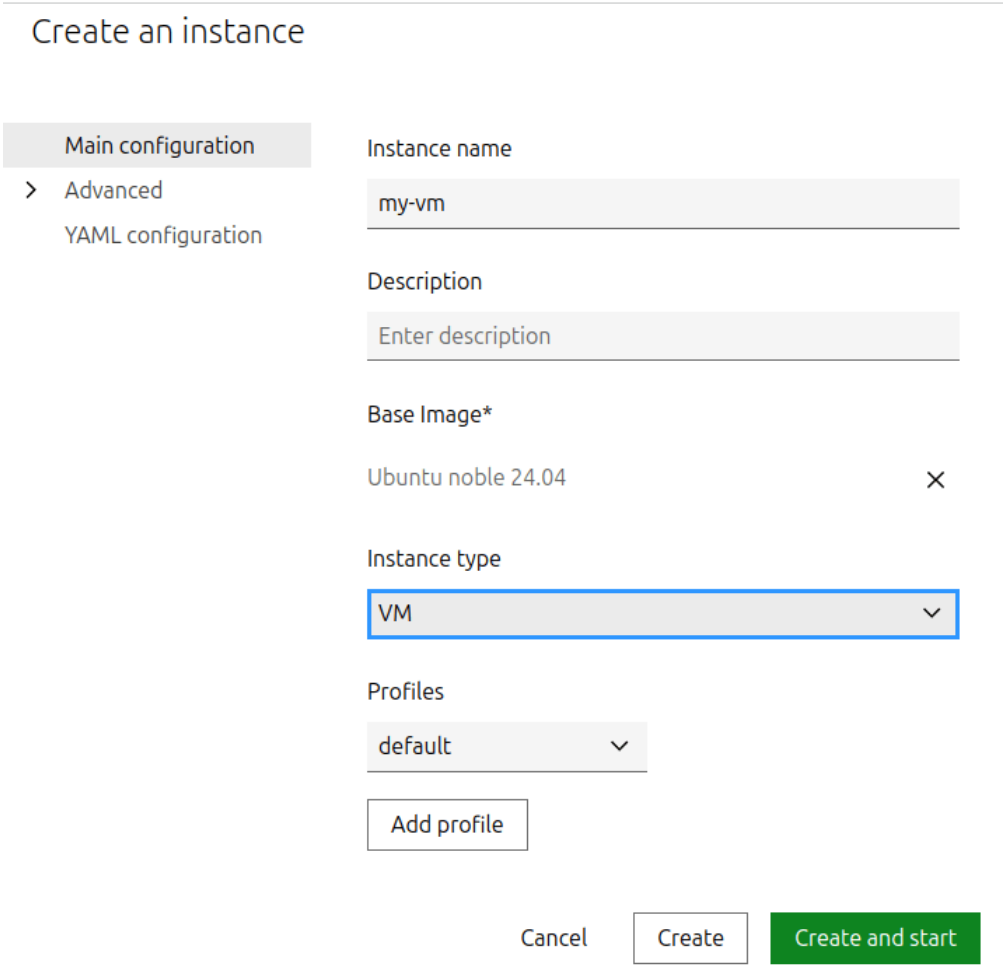
CLI

API

UI

```
lxc init ubuntu:24.04 my-vm --vm
```

```
lxc query --request POST /1.0/instances --data '{
  "name": "my-vm",
  "source": {
    "alias": "24.04",
    "protocol": "simplestreams",
    "server": "https://cloud-images.ubuntu.com/releases",
    "type": "image"
  },
  "type": "virtual-machine"
}'
```



Then add the routed NIC device:

CLI

API

UI

```
lxc config device add my-vm eth0 nic nictype=routed parent=my-parent ipv4.address=192.0.
↪2.2 ipv6.address=2001:db8::2
```

```
lxc query --request PATCH /1.0/instances/my-vm --data '{
  "devices": {
    "eth0": {
      "ipv4.address": "192.0.2.2",
      "ipv6.address": "2001:db8::2",
      "nictype": "routed",
      "parent": "my-parent",
      "type": "nic"
    }
  }
}'
```

You cannot add a routed NIC device through the UI directly. Therefore, go to the instance detail page, switch to the *Configuration* tab and select *YAML configuration*. Then click *Edit instance* and add the routed NIC device to the `devices` section. For example:

```
devices:
  eth0:
    ipv4.address: 192.0.2.2
    ipv6.address: 2001:db8::2
    nictype: routed
    parent: my-parent
    type: nic
```

In this configuration, `my-parent-network` is your parent network, and the IPv4 and IPv6 addresses are within the subnet of the parent.

Next we will add some `netplan` configuration to the instance using the `cloud-init.network-config` configuration key:

CLI

API

UI

```
cat <<EOF | lxc config set my-vm cloud-init.network-config -
network:
  version: 2
  ethernets:
    enp5s0:
      routes:
      - to: default
        via: 169.254.0.1
        on-link: true
      - to: default
        via: fe80::1
        on-link: true
      addresses:
      - 192.0.2.2/32
      - 2001:db8::2/128
EOF
```

```
cat > cloud-init.txt <<EOF
network:
```

(continues on next page)

(continued from previous page)

```
  version: 2
  ethernets:
    enp5s0:
      routes:
      - to: default
        via: 169.254.0.1
        on-link: true
      - to: default
        via: fe80::1
        on-link: true
      addresses:
      - 192.0.2.2/32
      - 2001:db8::2/128
EOF

lxc query --request PATCH /1.0/instances/my-vm --data '{
  "config": {
    "cloud-init.network-config": "'"$(awk -v ORS='\\n' '1' cloud-init.txt)"'"
  }
}'
```

On the instance detail page, switch to the *Advanced* > *Cloud-init* tab and click *Edit instance*.

Click the *Create override* icon for the *Network config* and enter the following configuration:

```
network:
  version: 2
  ethernets:
    enp5s0:
      routes:
      - to: default
        via: 169.254.0.1
        on-link: true
      - to: default
        via: fe80::1
        on-link: true
      addresses:
      - 192.0.2.2/32
      - 2001:db8::2/128
```

This `netplan` configuration adds the *static link-local next-hop addresses* (`169.254.0.1` and `fe80::1`) that are required. For each of these routes we set `on-link` to `true`, which specifies that the route is directly connected to the interface. We also add the addresses that we configured in our routed NIC device. For more information on `netplan`, see their documentation.

Note: This `netplan` configuration does not include a name server. To enable DNS within the instance, you must set a valid DNS IP address. If there is a `lxdbr0` network on the host, the name server can be set to that IP instead.

Before you start your instance, make sure that you have *configured the parent network* to enable proxy ARP/NDP.

Then start your instance:

CLI

API

UI

```
lxc start my-vm
```

```
lxc query --request PUT /1.0/instances/my-vm/state --data '{"action": "start"}'
```

Go to the instance list or the respective instance and click the *Start* button ().

How to export and move instances:

How to back up instances

There are different ways of backing up your instances:

- *Use snapshots for instance backup*
- *Use export files for instance backup*
- *Copy an instance to a backup server*

Which method to choose depends both on your use case and on the storage driver you use.

In general, snapshots are quick and space efficient (depending on the storage driver), but they are stored in the same storage pool as the instance and therefore not too reliable. Export files can be stored on different disks and are therefore more reliable. They can also be used to restore the instance into a different storage pool. If you have a separate, network-connected LXD server available, regularly copying instances to this other server gives high reliability as well, and this method can also be used to back up snapshots of the instance.

Note: Custom storage volumes might be attached to an instance, but they are not part of the instance. Therefore, the content of a custom storage volume is not stored when you back up your instance. You must back up the data of your storage volume separately. See *How to back up custom storage volumes* for instructions.

Use snapshots for instance backup

You can save your instance at a point in time by creating an instance snapshot, which makes it easy to restore the instance to a previous state.

Instance snapshots are stored in the same storage pool as the instance volume itself.

Most storage drivers support optimized snapshot creation (see *Feature comparison*). For these drivers, creating snapshots is both quick and space-efficient. For the `dir` driver, snapshot functionality is available but not very efficient. For the `lvm` driver, snapshot creation is quick, but restoring snapshots is efficient only when using thin-pool mode.

Create a snapshot

CLI

API

UI

Use the following command to create a snapshot of an instance:

```
lxc snapshot <instance_name> [<snapshot name>]
```

The snapshot name is optional. If you don't specify one, the name follows the naming pattern defined in `snapshots.pattern`.

Add the `--reuse` flag in combination with a snapshot name to replace an existing snapshot.

By default, snapshots are kept forever, unless the `snapshots.expiry` configuration option is set. To retain a specific snapshot even if a general expiry time is set, use the `--no-expiry` flag.

For virtual machines, you can add the `--stateful` flag to capture not only the data included in the instance volume but also the running state of the instance. Note that this feature is not fully supported for containers because of CRIU limitations.

To create a snapshot of an instance, send a POST request to the `snapshots` endpoint:

```
lxc query --request POST /1.0/instances/<instance_name>/snapshots --data '{"name": "
↪<snapshot_name>"}'
```

The snapshot name is optional. If you set it to an empty string, the name follows the naming pattern defined in *snapshots.pattern*.

By default, snapshots are kept forever, unless the *snapshots.expiry* configuration option is set. To set an expiration date, add the`expires_at` field to the request data. To retain a specific snapshot even if a general expiry time is set, set the `expires_at` field to `"0001-01-01T00:00:00Z"`.

If you want to replace an existing snapshot, *delete it* first and then create another snapshot with the same name.

For virtual machines, you can add `"stateful": true` to the request data to capture not only the data included in the instance volume but also the running state of the instance. Note that this feature is not fully supported for containers because of CRIU limitations.

See `POST /1.0/instances/{name}/snapshots` for more information.

To create a snapshot of an instance, go to the instance detail page and switch to the *Snapshots* tab. Click *Create snapshot* to open the dialog to create a snapshot.

The snapshot name is optional. If you don't specify one, the name follows the naming pattern defined in *snapshots.pattern*. You can check and update this option by switching to the *Configuration* tab and selecting *Advanced* > *Snapshots*, or simply by clicking *See configuration*.

By default, snapshots are kept forever, unless you specify an expiry date and time, or the *snapshots.expiry* configuration option is set for the instance.

For virtual machines, you can choose to create a stateful snapshot to capture not only the data included in the instance volume but also the running state of the instance. Note that this feature requires *migration.stateful* to be enabled.

View, edit or delete snapshots

CLI

API

UI

Use the following command to display the snapshots for an instance:

```
lxc info <instance_name>
```

You can view or modify snapshots in a similar way to instances, by referring to the snapshot with `<instance_name>/<snapshot_name>`.

To show configuration information about a snapshot, use the following command:

```
lxc config show <instance_name>/<snapshot_name>
```

To change the expiry date of a snapshot, use the following command:

```
lxc config edit <instance_name>/<snapshot_name>
```

Note: In general, snapshots cannot be edited, because they preserve the state of the instance. The only exception is the expiry date. Other changes to the configuration are silently ignored.

To delete a snapshot, use the following command:

```
lxc delete <instance_name>/<snapshot_name>
```

To retrieve the snapshots for an instance, send a GET request to the `snapshots` endpoint:

```
lxc query --request GET /1.0/instances/<instance_name>/snapshots
```

To show configuration information about a snapshot, send the following request:

```
lxc query --request GET /1.0/instances/<instance_name>/snapshots/<snapshot_name>
```

To change the expiry date of a snapshot, send a PATCH request:

```
lxc query --request PATCH /1.0/instances/<instance_name>/snapshots/<snapshot_name> --
↪data '{
  "expires_at": "2029-03-23T17:38:37.753398689-04:00"
}'
```

Note: In general, snapshots cannot be modified, because they preserve the state of the instance. The only exception is the expiry date. Other changes to the configuration are silently ignored.

To delete a snapshot, send a DELETE request:

```
lxc query --request DELETE /1.0/instances/<instance_name>/snapshots/<snapshot_name>
```

See `GET /1.0/instances/{name}/snapshots`, `GET /1.0/instances/{name}/snapshots/{snapshot}`, `PATCH /1.0/instances/{name}/snapshots/{snapshot}`, and `DELETE /1.0/instances/{name}/snapshots/{snapshot}` for more information.

To see all snapshots for an instance, go to the instance detail page and switch to the *Snapshots* tab.

From the snapshot list, you can choose to edit the name or expiry date of a specific snapshot, create an image based on the snapshot, restore it to the instance, or delete it.

Schedule instance snapshots

You can configure an instance to automatically create snapshots at specific times (at most once every minute). To do so, set the `snapshots.schedule` instance option.

For example, to configure daily snapshots:

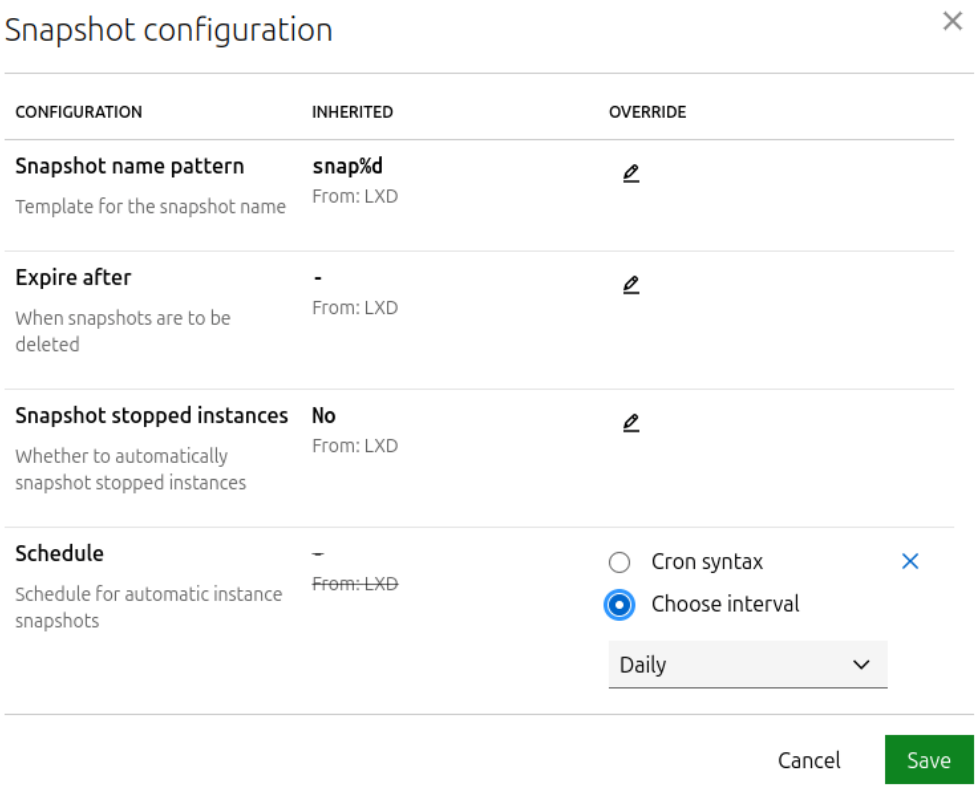
CLI

API

UI

```
lxc config set <instance_name> snapshots.schedule @daily
```

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "config": {
    "snapshots.schedule": "@daily"
  }
}'
```



To configure taking a snapshot every day at 6 am:

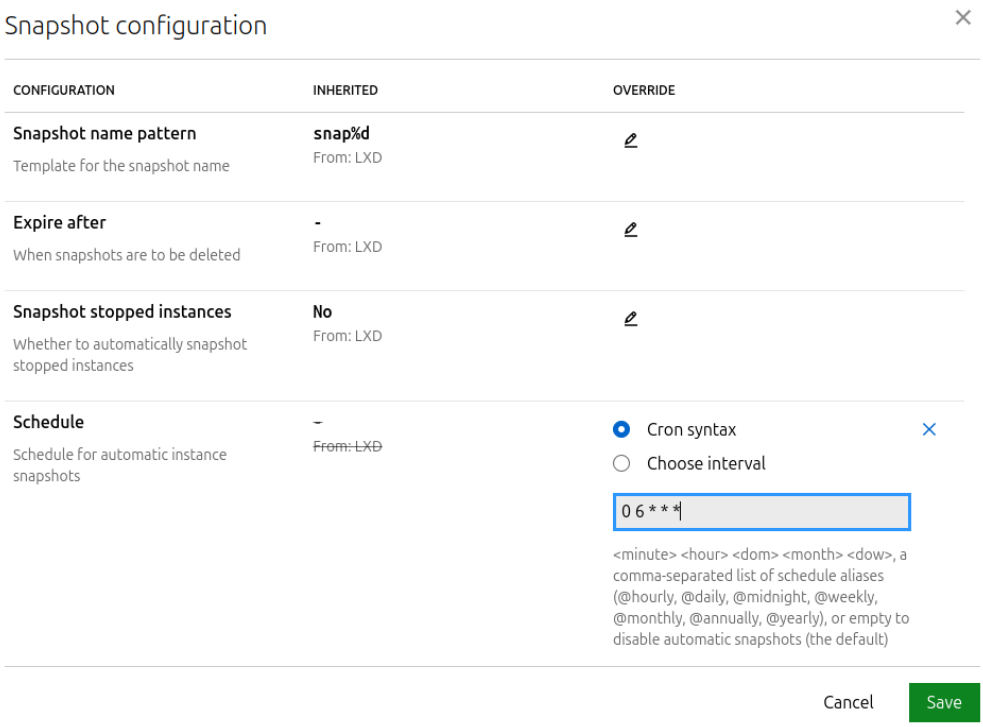
CLI

API

UI

```
lxc config set <instance_name> snapshots.schedule "0 6 * * *"
```

```
lxc query --request PATCH /1.0/instances/<instance_name> --data '{
  "config": {
    "snapshots.schedule": "0 6 * * *"
  }
}'
```



When scheduling regular snapshots, consider setting an automatic expiry (*snapshots.expiry*) and a naming pattern for snapshots (*snapshots.pattern*). You should also configure whether you want to take snapshots of instances that are not running (*snapshots.schedule.stopped*).

Restore an instance snapshot

You can restore an instance to any of its snapshots.

CLI

API

UI

To restore an instance to a snapshot, use the following command:

```
lxc restore <instance_name> <snapshot_name>
```

If the snapshot is stateful (which means that it contains information about the running state of the instance), you can add the `--stateful` flag to restore the state.

To restore an instance to a snapshot, send a PUT request to the instance:

```
lxc query --request PUT /1.0/instances/<instance_name> --data '{
  "restore": "<instance_name>/<snapshot_name>"
}'
```

If the snapshot is stateful (which means that it contains information about the running state of the instance), you can add `"stateful": true` to the request data:

```
lxc query --request PUT /1.0/instances/<instance_name> --data '{
  "restore": "<instance_name>/<snapshot_name>",
  "stateful": true
}'
```

See `PUT /1.0/instances/{name}` for more information.

To restore an instance to a snapshot, click the *Restore snapshot* button () next to the snapshot that you want to restore.

If the snapshot is stateful (which means that it contains information about the running state of the instance), select *Restore the instance state* if you want to restore the state.

Use export files for instance backup

You can export the full content of your instance to a standalone file that can be stored at any location. For highest reliability, store the backup file on a different file system to ensure that it does not get lost or corrupted.

Note: The UI does not currently support exporting and importing instances.

Export an instance

CLI

API

Use the following command to export an instance to a compressed file (for example, `/path/to/my-instance.tgz`):

```
lxc export <instance_name> [<file_path>]
```

If you do not specify a file path, the export file is saved as `<instance_name>.<extension>` in the working directory (for example, `my-container.tar.gz`).

Warning: If the output file (`<instance_name>.<extension>` or the specified file path) already exists, the command overwrites the existing file without warning.

You can add any of the following flags to the command:

`--compression`
: By default, the output file uses `gzip` compression. You can specify a different compression algorithm (for example, `bzip2`) or turn off compression with `--compression=none`.

`--optimized-storage`
: If your storage pool uses the `btrfs` or the `zfs` driver, add the `--optimized-storage` flag to store the data as a driver-specific binary blob instead of an archive of individual files. In this case, the export file can only be used with pools that use the same storage driver.

  Exporting a volume in optimized mode is usually quicker than exporting the individual files. Snapshots are exported as differences from the main volume, which decreases their size and makes them easily accessible.

`--instance-only`
: By default, the export file contains all snapshots of the instance. Add this flag to export the instance without its snapshots.

To create a backup of an instance, send a POST request to the `backups` endpoint:

```
lxc query --request POST /1.0/instances/<instance_name>/backups --data '{"name": ""}'
```

You can specify a name for the backup, or use the default (`backup0`, `backup1` and so on).

You can add any of the following fields to the request data:

`"compression_algorithm": "bzip2"`
: By default, the output file uses `gzip` compression. You can specify a different compression algorithm (for example, `bzip2`) or turn off compression with `none`.

`"optimized-storage": true`
: If your storage pool uses the `btrfs` or the `zfs` driver, set the `"optimized-storage"` field to `true` to store the data as a driver-specific binary blob instead of an archive of individual files. In this case, the backup can only be used with pools that use the same storage driver.

  Exporting a volume in optimized mode is usually quicker than exporting the individual files. Snapshots are exported as differences from the main volume, which decreases their size and makes them easily accessible.

`"instance-only": true`
: By default, the backup contains all snapshots of the instance. Set this field to `true` to back up the instance without its snapshots.

After creating the backup, you can download it with the following request:

```
lxc query --request GET /1.0/instances/<instance_name>/backups/<backup_name>/export >
↪<file_name>
```

Remember to delete the backup when you don't need it anymore:

```
lxc query --request DELETE /1.0/instances/<instance_name>/backups/<backup_name>
```

See `POST /1.0/instances/{name}/backups`, `GET /1.0/instances/{name}/backups/{backup}/export`, and `DELETE /1.0/instances/{name}/backups/{backup}` for more information.

Restore an instance from an export file

You can import an export file (for example, `/path/to/my-backup.tgz`) as a new instance.

CLI

API

To import an export file, use the following command:

```
lxc import <file_path> [<instance_name>]
```

If you do not specify an instance name, the original name of the exported instance is used for the new instance. If an instance with that name already (or still) exists in the specified storage pool, the command returns an error. In that case, either delete the existing instance before importing the backup or specify a different instance name for the import.

Add the `--storage` flag to specify which storage pool to use, or the `--device` flag to override the device configuration (syntax: `--device <device_name>,<device_option>=<value>`).

To import an export file, post it to the `/1.0/instances` endpoint:

```
curl -X POST -H "Content-Type: application/octet-stream" -T <file_path> \
--unix-socket /var/snap/lxd/common/lxd/unix.socket lxd/1.0/instances
```

If an instance with that name already (or still) exists in the specified storage pool, the command returns an error. In this case, delete the existing instance before importing the backup.

See `POST /1.0/instances` for more information.

Copy an instance to a backup server

You can copy an instance to a secondary backup server to back it up.

See *Secondary backup LXD server* for more information, and *How to move existing LXD instances between servers* for instructions.

How to move existing LXD instances between servers

If you use the LXD client, you can move or copy instances from one LXD server (remote or local) to another.

Note: *Remote servers* are a concept of the LXD client. Therefore, there is no direct equivalent for moving instances in the API or the UI.

However, you can *export an instance* from one server and *import it* to another server.

To move an instance from one LXD server to another, use the *`lxc move`* command:

```
lxc move [<source_remote>:]<source_instance_name> <target_remote>:[<target_instance_name>
↪]
```

Note: When moving a container, you must stop it first. See *Live migration for containers* for more information.

When moving a virtual machine, you must either enable *Live migration for virtual machines* or stop it first.

Alternatively, you can use the *`lxc copy`* command if you want to duplicate the instance:

```
lxc copy [<source_remote>:]<source_instance_name> <target_remote>:[<target_instance_name>
↪]
```

Tip: If the volume already exists in the target location, use the `--refresh` flag to update the copy (see *Optimized volume transfer* for the benefits).

In both cases, you don't need to specify the source remote if it is your default remote, and you can leave out the target instance name if you want to use the same instance name. If you want to move the instance to a specific cluster member, specify it with the `--target` flag. In this case, do not specify the source and target remote.

You can add the `--mode` flag to choose a transfer mode, depending on your network setup:

`pull` (default)
: Instruct the target server to connect to the source server and pull the respective instance.

`push`
: Instruct the source server to connect to the target server and push the instance.

`relay`
: Instruct the client to connect to both the source and the target server and transfer the data through the client.

If you need to adapt the configuration for the instance to run on the target server, you can either specify the new configuration directly (using `--config`, `--device`, `--storage` or `--target-project`) or through profiles (using `--no-profiles` or `--profile`). See *`lxc move --help`* for all available flags.

Live migration

Live migration means migrating an instance while it is running. This method is supported for virtual machines. For containers, there is limited support.

Live migration for virtual machines

Virtual machines can be moved to another server while they are running, thus without any downtime.

To allow for live migration, you must enable support for stateful migration. To do so, ensure the following configuration:

- Set *`migration.stateful`* to `true` on the instance.
- Set *`size.state`* of the virtual machine's root disk device to at least the size of the virtual machine's *`limits.memory`* setting.

Note: If you are using a shared storage pool like Ceph RBD to back your instance, you don't need to set *`size.state`* to perform live migration.

Note: When *`migration.stateful`* is enabled in LXD, virtiofs shares are disabled, and files are only shared via the 9P protocol. Consequently, guest OSes lacking 9P support, such as CentOS 8, cannot share files with the host unless stateful migration is disabled. Additionally, the `lxd-agent` will not function for these guests under these conditions.

Live migration for containers

For containers, there is limited support for live migration using CRIU (Checkpoint/Restore in Userspace). However, because of extensive kernel dependencies, only very basic containers (non-`systemd` containers without a network device) can be migrated reliably. In most real-world scenarios, you should stop the container, move it over and then start it again.

If you want to use live migration for containers, you must enable CRIU on both the source and the target server. If you are using the snap, use the following commands to enable CRIU:

```
snap set lxd criu.enable=true
sudo systemctl reload snap.lxd.daemon
```

Otherwise, make sure you have CRIU installed on both systems.

To optimize the memory transfer for a container, set the *migration.incremental.memory* property to `true` to make use of the pre-copy features in CRIU. With this configuration, LXD instructs CRIU to perform a series of memory dumps for the container. After each dump, LXD sends the memory dump to the specified remote. In an ideal scenario, each memory dump will decrease the delta to the previous memory dump, thereby increasing the percentage of memory that is already synced. When the percentage of synced memory is equal to or greater than the threshold specified via *migration.incremental.memory.goal*, or the maximum number of allowed iterations specified via *migration.incremental.memory.iterations* is reached, LXD instructs CRIU to perform a final memory dump and transfers it.

How to import instances:

How to import physical or virtual machines to LXD instances

If you have an existing machine, either physical or virtual (VM or container), you can use the `lxd-migrate` tool to create a LXD instance based on your existing disk or image.

The tool copies the provided partition, disk or image to the LXD storage pool of the provided LXD server, sets up an instance using that storage and allows you to configure additional settings for the new instance.

Note: If you want to configure your new instance during the migration process, set up the entities that you want your instance to use before starting the migration process.

By default, the new instance will use the entities specified in the `default` profile. You can specify a different profile (or a profile list) to customize the configuration. See *How to use profiles* for more information. You can also override *Instance options*, the *storage pool* to be used and the size for the *storage volume*, and the *network* to be used.

Alternatively, you can update the instance configuration after the migration is complete.

The tool can create both containers and virtual machines:

- When creating a container, you must provide a disk or partition that contains the root file system for the container. For example, this could be the `/` root disk of the machine or container where you are running the tool.
- When creating a virtual machine, you must provide a bootable disk, partition or image. This means that just providing a file system is not sufficient, and you cannot create a virtual machine from a container that you are running. It is also not possible to create a virtual machine from the physical machine that you are using to do the migration, because the migration tool would be using the disk that it is copying. Instead, you could provide a bootable image, or a bootable partition or disk that is currently not in use.

  Tip: If you want to convert a Windows VM from a foreign hypervisor (not from QEMU/KVM with Q35/`virtio-scsi`), you must install the `virtio-win` drivers to your Windows. Otherwise, your VM won't boot.

  1. Install `virt-v2v` version >= 2.3.4 (this is the minimal version that supports the `--block-driver` option).
  2. Install the `virtio-win` package, or download the `virtio-win.iso` image and put it into the `/usr/share/virtio-win` folder.
  3. You might also need to install `rhsrvany`.

Now you can use `virt-v2v` to convert images from a foreign hypervisor to `raw` images for LXD and include the required drivers:

```
# Example 1. Convert a vmdk disk image to a raw image suitable for lxd-migrate
sudo virt-v2v --block-driver virtio-scsi -o local -of raw -os ./os -i vmx ./test-vm.
↪vmx
# Example 2. Convert a QEMU/KVM qcow2 image and integrate virtio-scsi driver
sudo virt-v2v --block-driver virtio-scsi -o local -of raw -os ./os -if qcow2 -i␣
↪disk test-vm-disk.qcow2
```

You can find the resulting image in the `os` directory and use it with `lxd-migrate` on the next steps.

Complete the following steps to migrate an existing machine to a LXD instance:

1. Download the `bin.linux.lxd-migrate` tool (`bin.linux.lxd-migrate.aarch64` or `bin.linux.lxd-migrate.x86_64`) from the **Assets** section of the latest LXD release.
2. Place the tool on the machine that you want to use to create the instance. Make it executable (usually by running `chmod u+x bin.linux.lxd-migrate`).
3. Make sure that the machine has `rsync` installed. If it is missing, install it (for example, with `sudo apt install rsync`).
4. Run the tool:

   ```
   sudo ./bin.linux.lxd-migrate
   ```

   The tool then asks you to provide the information required for the migration.

   Tip: As an alternative to running the tool interactively, you can provide the configuration as parameters to the command. See `./bin.linux.lxd-migrate --help` for more information.

   1. Specify the LXD server URL, either as an IP address or as a DNS name.

      Note: The LXD server must be *exposed to the network*. If you want to import to a local LXD server, you must still expose it to the network. You can then specify `127.0.0.1` as the IP address to access the local server.

   2. Check and confirm the certificate fingerprint.
   3. Choose a method for authentication (see *Remote API authentication*).

      For example, if you choose using a certificate token, log on to the LXD server and create a token for the machine on which you are running the migration tool with *`lxc config trust add`*. Then use the generated token to authenticate the tool.

   4. Choose whether to create a container or a virtual machine. See *About containers and VMs*.
   5. Specify a name for the instance that you are creating.
   6. Provide the path to a root file system (for containers) or a bootable disk, partition or image file (for virtual machines).
   7. For containers, optionally add additional file system mounts.
   8. For virtual machines, specify whether secure boot is supported.

9. Optionally, configure the new instance. You can do so by specifying *profiles*, directly setting *configuration options* or changing *storage* or *network* settings.

   Alternatively, you can configure the new instance after the migration.

10. When you are done with the configuration, start the migration process.

```
user@host:~$ sudo ./bin.linux.lxd-migrate      Please provide LXD server URL: https:/
/192.0.2.7:8443Certificate fingerprint:  xxxxxxxxxxxxxxxxok (y/n)? y 1) Use a
certificate token2) Use an existing TLS authentication certificate3) Generate a
temporary TLS authentication certificatePlease pick an authentication mechanism
above:  1Please provide the certificate token:  xxxxxxxxxxxxxxx Remote LXD
server:  Hostname:  bar Version:  5.4 Would you like to create a container (1) or
virtual-machine (2)?:  1Name of the new instance:  fooPlease provide the path to a
root filesystem:  /Do you want to add additional filesystem mounts? [default=no]:
Instance to be created:  Name:  foo Project:  default Type:  container Source:
/  Additional overrides can be applied at this stage:1) Begin the migration with
the above configuration2) Override profile list3) Set additional configuration
options4) Change instance storage pool or volume size5) Change instance network
Please pick one of the options above [default=1]:  3Please specify config keys and
values (key=value ...):  limits.cpu=2 Instance to be created:  Name:  foo Project:
default Type:  container Source:  /  Config:  limits.cpu:  "2" Additional overrides
can be applied at this stage:1) Begin the migration with the above configuration2)
Override profile list3) Set additional configuration options4) Change instance
storage pool or volume size5) Change instance network Please pick one of the options
above [default=1]:  4Please provide the storage pool to use:  defaultDo you want to
change the storage size? [default=no]:  yesPlease specify the storage size:  20GiB
Instance to be created:  Name:  foo Project:  default Type:  container Source:
/  Storage pool:  default Storage pool size:  20GiB Config:  limits.cpu:  "2"
Additional overrides can be applied at this stage:1) Begin the migration with the
above configuration2) Override profile list3) Set additional configuration options4)
Change instance storage pool or volume size5) Change instance network Please pick
one of the options above [default=1]:  5Please specify the network to use for
the instance:  lxdbr0 Instance to be created:  Name:  foo Project:  default Type:
container Source:  /  Storage pool:  default Storage pool size:  20GiB Network
name:  lxdbr0 Config:  limits.cpu:  "2" Additional overrides can be applied at this
stage:1) Begin the migration with the above configuration2) Override profile list3)
Set additional configuration options4) Change instance storage pool or volume size5)
Change instance network Please pick one of the options above [default=1]:  1Instance
foo successfully created
```

```
user@host:~$ sudo ./bin.linux.lxd-migrate      Please provide LXD server URL: https:/
/192.0.2.7:8443Certificate fingerprint:  xxxxxxxxxxxxxxxxxxok (y/n)? y 1) Use a
certificate token2) Use an existing TLS authentication certificate3) Generate a
temporary TLS authentication certificatePlease pick an authentication mechanism
above:  1Please provide the certificate token:  xxxxxxxxxxxxxxx Remote LXD
server:  Hostname:  bar Version:  5.4 Would you like to create a container (1)
or virtual-machine (2)?:  2Name of the new instance:  fooPlease provide the path
to a root filesystem:  ./virtual-machine.imgDoes the VM support UEFI Secure Boot?
[default=no]:  no Instance to be created:  Name:  foo Project:  default Type:
virtual-machine Source:  ./virtual-machine.img Config:  security.secureboot:
"false" Additional overrides can be applied at this stage:1) Begin the migration
with the above configuration2) Override profile list3) Set additional configuration
options4) Change instance storage pool or volume size5) Change instance network
Please pick one of the options above [default=1]:  3Please specify config keys and
values (key=value ...):  limits.cpu=2 Instance to be created:  Name:  foo Project:
```

```
default Type:  virtual-machine Source:  ./virtual-machine.img Config:  limits.
cpu:  "2" security.secureboot:  "false" Additional overrides can be applied at this
stage:1) Begin the migration with the above configuration2) Override profile list3)
Set additional configuration options4) Change instance storage pool or volume size5)
Change instance network Please pick one of the options above [default=1]:  4Please
provide the storage pool to use:  defaultDo you want to change the storage size?
[default=no]:  yesPlease specify the storage size:  20GiB Instance to be created:
Name:  foo Project:  default Type:  virtual-machine Source:  ./virtual-machine.
img Storage pool:  default Storage pool size:  20GiB Config:  limits.cpu:  "2"
security.secureboot:  "false" Additional overrides can be applied at this stage:1)
Begin the migration with the above configuration2) Override profile list3) Set
additional configuration options4) Change instance storage pool or volume size5)
Change instance network Please pick one of the options above [default=1]:  5Please
specify the network to use for the instance:  lxdbr0 Instance to be created:  Name:
foo Project:  default Type:  virtual-machine Source:  ./virtual-machine.img Storage
pool:  default Storage pool size:  20GiB Network name:  lxdbr0 Config:  limits.
cpu:  "2" security.secureboot:  "false" Additional overrides can be applied at this
stage:1) Begin the migration with the above configuration2) Override profile list3)
Set additional configuration options4) Change instance storage pool or volume size5)
Change instance network Please pick one of the options above [default=1]:  1Instance
foo successfully created
```

5. When the migration is complete, check the new instance and update its configuration to the new environment. Typically, you must update at least the storage configuration (`/etc/fstab`) and the network configuration.

How to migrate containers from LXC to LXD

If you are using LXC and want to migrate all or some of your LXC containers to a LXD installation on the same machine, you can use the `lxc-to-lxd` tool. The LXC containers must exist on the same machine as the LXD server.

The tool analyzes the LXC configuration and copies the data and configuration of your existing LXC containers into new LXD containers.

Note: Alternatively, you can use the `lxd-migrate` tool within a LXC container to migrate it to LXD (see *How to import physical or virtual machines to LXD instances*). However, this tool does not migrate any of the LXC container configuration.

Get the tool

If you're using the snap, the `lxc-to-lxd` is automatically installed. It is available as `lxd.lxc-to-lxd`.

Note: The `lxd.lxc-to-lxd` command was last included in the 5.0 snap which should be installed to do the conversion from `lxc` to `lxd`:

```
sudo install lxd --channel=5.0/stable
sudo lxd.lxc-to-lxd --all
```

After successfully running the `lxd.lxc-to-lxd` command, you can then switch to a newer snap channel if desired, like the latest one:

```
sudo refresh lxd --channel=latest/stable
```

Otherwise, make sure that you have `go` (*Go*) installed and get the tool with the following command:

```
go install github.com/canonical/lxd/lxc-to-lxd@latest
```

Prepare your LXC containers

You can migrate one container at a time or all of your LXC containers at the same time.

Note: Migrated containers use the same name as the original containers. You cannot migrate containers with a name that already exists as an instance name in LXD.

Therefore, rename any LXC containers that might cause name conflicts before you start the migration process.

Before you start the migration process, stop the LXC containers that you want to migrate.

Start the migration process

Run `sudo lxd.lxc-to-lxd [flags]` to migrate the containers. (This command assumes that you are using the snap; otherwise, replace `lxd.lxc-to-lxd` with `lxc-to-lxd`, also in the following examples.)

For example, to migrate all containers:

```
sudo lxd.lxc-to-lxd --all
```

To migrate only the `lxc1` container:

```
sudo lxd.lxc-to-lxd --containers lxc1
```

To migrate two containers (`lxc1` and `lxc2`) and use the `my-storage` storage pool in LXD:

```
sudo lxd.lxc-to-lxd --containers lxc1,lxc2 --storage my-storage
```

To test the migration of all containers without actually running it:

```
sudo lxd.lxc-to-lxd --all --dry-run
```

To migrate all containers but limit the `rsync` bandwidth to 5000 KB/s:

```
sudo lxd.lxc-to-lxd --all --rsync-args --bwlimit=5000
```

Run `sudo lxd.lxc-to-lxd --help` to check all available flags.

Note: If you get an error that the `linux64` architecture isn't supported, either update the tool to the latest version or change the architecture in the LXC container configuration from `linux64` to either `amd64` or `x86_64`.

Check the configuration

The tool analyzes the LXC configuration and the configuration of the container (or containers) and migrates as much of the configuration as possible. You will see output similar to the following:

```
user@host:~$ sudo lxd.lxc-to-lxd --containers lxc1      Parsing LXC configurationChecking
for unsupported LXC configuration keysChecking for existing containersChecking whether
container has already been migratedValidating whether incomplete AppArmor support
is enabledValidating whether mounting a minimal /dev is enabledValidating container
rootfsProcessing network configurationProcessing storage configurationProcessing
environment configurationProcessing container boot configurationProcessing container
apparmor configurationProcessing container seccomp configurationProcessing container
SELinux configurationProcessing container capabilities configurationProcessing container
architecture configurationCreating containerTransferring container:  lxc1:  ...Container
'lxc1' successfully created
```

After the migration process is complete, you can check and, if necessary, update the configuration in LXD before you start the migrated LXD container.

Related topics

Explanation:

- *Instance types in LXD*

Reference:

- *Container runtime environment*
- *Instance configuration*

Images

The following how-to guides cover common operations related to images.

How to work with existing images:

How to use remote images

The `lxc` CLI command is pre-configured with several remote image servers. See *Remote image servers* for an overview.

Note:

- If you are using the API, you can interact with different LXD servers by using their exposed API addresses. See *Authenticate with the LXD server* for instructions on how to authenticate with the servers.

  How to manage images describes how to interact with images on any LXD server through the API.

- The UI is pre-configured with several remote image servers, but does not currently support adding other servers or managing remote images.

  You can see the available remote images (and which server they are hosted on) when you select the base image for a new instance.

List configured remotes

To see all configured remote servers, enter the following command:

```
lxc remote list
```

Remote servers that use the simple streams format are pure image servers. Servers that use the `lxd` format are LXD servers, which either serve solely as image servers or might provide some images in addition to serving as regular LXD servers. See *Remote server types* for more information.

List available images on a remote

To list all remote images on a server, enter the following command:

```
lxc image list <remote>:
```

You can filter the results. See *Filter available images* for instructions.

Add a remote server

How to add a remote depends on the protocol that the server uses.

Add a simple streams server

To add a simple streams server as a remote, enter the following command:

```
lxc remote add <remote_name> <URL> --protocol=simplestreams
```

The URL must use HTTPS.

Add a remote LXD server

To add a LXD server as a remote, enter the following command:

```
lxc remote add <remote_name> <IP|FQDN|URL> [flags]
```

Some authentication methods require specific flags (for example, use *`lxc remote add <remote_name> <IP|FQDN|URL> --auth-type=oidc`* for OIDC authentication). See *Authenticate with the LXD server* and *Remote API authentication* for more information.

For example, enter the following command to add a remote through an IP address:

```
lxc remote add my-remote 192.0.2.10
```

You are prompted to confirm the remote server fingerprint and then asked for the password or token, depending on the authentication method used by the remote.

Reference an image

To reference an image, specify its remote and its alias or fingerprint, separated with a colon. For example:

```
ubuntu:24.04
ubuntu-minimal:24.04
images:alpine/edge
local:ed7509d7e83f
```

Select a default remote

If you specify an image name without the name of the remote, the default image server is used.

To see which server is configured as the default image server, enter the following command:

```
lxc remote get-default
```

To select a different remote as the default image server, enter the following command:

```
lxc remote switch <remote_name>
```

How to manage images

When working with images, you can inspect various information about the available images, view and edit their properties and configure aliases to refer to specific images. You can also export an image to a file, which can be useful to *copy or import it* on another machine.

List available images

CLI

API

UI

To list all images on a server, enter the following command:

```
lxc image list [<remote>:]
```

If you do not specify a remote, the *default remote* is used.

Query the `/1.0/images` endpoint to list all images on the server:

```
lxc query --request GET /1.0/images
```

To include information about each image, add `recursion=1`:

```
lxc query --request GET /1.0/images?recursion=1
```

See `GET /1.0/images` and `GET /1.0/images?recursion=1` for more information.

Note: The `/1.0/images` endpoint is available on LXD servers, but not on simple streams servers (see *Remote server types*). Public image servers, like the official Ubuntu image server, use the simple streams format.

To retrieve the list of images from a simple streams server, start at the `streams/v1/index.sjson` index (for example, `https://cloud-images.ubuntu.com/releases/streams/v1/index.sjson`).

Go to *Images* to view all images on the local server.

Filter available images

CLI

API

UI

To filter the results that are displayed, specify a part of the alias or fingerprint after the command. For example, to show all Ubuntu 24.04 images, enter the following command:

```
lxc image list ubuntu: 24.04
```

You can specify several filters as well. For example, to show all Arm 64-bit Ubuntu 24.04 images, enter the following command:

```
lxc image list ubuntu: 24.04 arm64
```

To filter for properties other than alias or fingerprint, specify the filter in <key>=<value> format. For example:

```
lxc image list ubuntu: 24.04 architecture=x86_64
```

You can *filter* the images that are displayed by any of their fields.

For example, to show all Ubuntu images, or all images for version 24.04:

```
lxc query --request GET /1.0/images?filter=properties.os+eq+ubuntu
lxc query --request GET /1.0/images?filter=properties.version+eq+24.04
```

You can specify several filters as well. For example, to show all Arm 64-bit images for virtual machines, enter the following command:

```
lxc query --request GET /1.0/images?filter=architecture+eq+arm64+and+type+eq+virtual-
↪machine
```

You can also use a regular expression:

```
lxc query --request GET "/1.0/images?filter=fingerprint+eq+be25.*"
```

See `GET /1.0/images` and *Filtering* for more information.

To filter the images that are displayed, use the search box.

For example, to show all Ubuntu images, search for `ubuntu`. To display only images for version 24.04, search for `24.04`.

View image information

CLI

API

UI

To view information about an image, enter the following command:

```
lxc image info <image_ID>
```

As the image ID, you can specify either the image's alias or its fingerprint. For a remote image, remember to include the remote server (for example, `ubuntu:24.04`).

To display only the image properties, enter the following command:

```
lxc image show <image_ID>
```

You can also display a specific image property (located under the `properties` key) with the following command:

```
lxc image get-property <image_ID> <key>
```

For example, to show the release name of the official Ubuntu 24.04 image, enter the following command:

```
lxc image get-property ubuntu:24.04 release
```

To view all information about an image, query it using its fingerprint:

```
lxc query --request GET /1.0/images/<fingerprint>
```

See `GET /1.0/images/{fingerprint}` for more information.

If you don't know the fingerprint but the alias, you can retrieve the fingerprint by querying the `/1.0/images/aliases/{alias}` endpoint:

```
lxc query --request GET /1.0/images/aliases/<alias>
```

See `GET /1.0/images/aliases/{name}` for more information.

The UI does not currently support viewing detailed image information.

Edit image properties

CLI

API

UI

To set a specific image property that is located under the `properties` key, enter the following command:

```
lxc image set-property <image_ID> <key> <value>
```

Note: These properties can be used to convey information about the image. They do not configure LXD's behavior in any way.

To edit the full image properties, including the top-level properties, enter the following command:

```
lxc image edit <image_ID>
```

To set a specific image property that is located under the `properties` key, send a PATCH request to the image:

```
lxc query --request PATCH /1.0/images/<fingerprint> --data '{
  "properties": {
    "<key>": "<value>"
  }
}'
```

See `PATCH /1.0/images/{fingerprint}` for more information.

Note: These properties can be used to convey information about the image. They do not configure LXD's behavior in any way.

To update the full image properties, including the top-level properties, send a PUT request with the full image data:

```
lxc query --request PUT /1.0/images/<fingerprint> --data '<image_configuration>'
```

See `PUT /1.0/images/{fingerprint}` for more information.

The UI does not currently support editing image properties.

Delete an image

CLI

API

UI

To delete a local copy of an image, enter the following command:

```
lxc image delete <image_ID>
```

To delete a local copy of an image, send a DELETE request:

```
lxc query --request DELETE /1.0/images/<fingerprint>
```

See `DELETE /1.0/images/{fingerprint}` for more information.

In the images list, click the *Delete* button () next to an image to delete it.

You can also select several images and click the *Delete images* button at the top to delete all selected images.

Deleting an image won't affect running instances that are already using it, but it will remove the image locally.

After deletion, if the image was downloaded from a remote server, it will be removed from local cache and downloaded again on next use. However, if the image was manually created (not cached), the image will be deleted.

Configure image aliases

Configuring an alias for an image can be useful to make it easier to refer to an image, since remembering an alias is usually easier than remembering a fingerprint. Most importantly, however, you can change an alias to point to a different image, which allows creating an alias that always provides a current image (for example, the latest version of a release).

CLI

API

UI

You can see some of the existing aliases in the image list. To see the full list, enter the following command:

```
lxc image alias list
```

You can directly assign an alias to an image when you *copy or import* or *publish* it. Alternatively, enter the following command:

```
lxc image alias create <alias_name> <image_fingerprint>
```

You can also delete an alias:

```
lxc image alias delete <alias_name>
```

To rename an alias, enter the following command:

```
lxc image alias rename <alias_name> <new_alias_name>
```

If you want to keep the alias name, but point the alias to a different image (for example, a newer version), you must delete the existing alias and then create a new one.

To retrieve a list of all defined aliases, query the `/1.0/images/aliases` endpoint:

```
lxc query --request GET /1.0/images/aliases
```

To include information about each alias, add `recursion=1`:

```
lxc query --request GET /1.0/images/aliases?recursion=1
```

See `GET /1.0/images/aliases` and `GET /1.0/images/aliases?recursion=1` for more information.

You can directly assign an alias to an image when you *copy or import* or *publish* it. Alternatively, send a POST request to the `/1.0/images/aliases` endpoint to create an alias:

```
lxc query --request POST /1.0/images/aliases --data '{
  "name": "<alias_name>",
  "target": "<image_fingerprint>"
}'
```

See `POST /1.0/images/aliases` for more information.

You can also delete an alias:

```
lxc query --request DELETE /1.0/images/aliases/<alias_name>
```

To rename an alias, send a POST request to the alias:

```
lxc query --request POST /1.0/images/aliases/<alias_name> --data '{
  "name": "<new_alias_name>"
}'
```

If you want to keep the alias name, but point the alias to a different image (for example, a newer version), send a PATCH request to the alias:

```
lxc query --request PATCH /1.0/images/aliases/<alias_name> --data '{
  "target": "<new_fingerprint>"
}'
```

See `DELETE /1.0/images/aliases/{name}`, `POST /1.0/images/aliases/{name}`, and `PATCH /1.0/images/aliases/{name}` for more information.

The UI displays configured aliases in the images list, but it does not currently support configuring image aliases.

Export an image to a set of files

Images are located in the image store of your local server or a remote LXD server. You can export them to a file or a set of files though (see *Image tarballs*). This method can be useful to back up image files or to transfer them to an air-gapped environment.

CLI

API

UI

To export a container image to a set of files, enter the following command:

```
lxc image export [<remote>:]<image> [<output_directory_path>]
```

To export a virtual machine image to a set of files, add the `--vm` flag:

```
lxc image export [<remote>:]<image> [<output_directory_path>] --vm
```

Send a query to the `export` endpoint of the image to retrieve it:

```
curl -X GET --unix-socket /var/snap/lxd/common/lxd/unix.socket lxd/1.0/images/
↪<fingerprint>/export \
-H "Content-Type: multipart/form-data" -o <output-file>
```

If the image is a *split image*, the output file contains two separate tarballs in multipart format.

See `GET /1.0/images/{fingerprint}/export` for more information.

The UI does not currently support exporting images.

See *Image format* for a description of the file structure used for the image.

How to associate profiles with an image

You can associate one or more profiles with a specific image. Instances that are created from the image will then automatically use the associated profiles in the order they were specified.

To associate a list of profiles with an image, add the profiles to the image configuration in the `profiles` section (see *Edit image properties*).

CLI

API

UI

Use the `lxc image edit` command to edit the `profiles` section:

```
profiles:
- default
```

To update the full image properties, including the `profiles` section, send a PUT request with the full image data:

```
lxc query --request PUT /1.0/images/<fingerprint> --data '<image_configuration>'
```

See `PUT /1.0/images/{fingerprint}` for more information.

The UI does not currently support editing the image configuration. Therefore, you cannot associate profiles with an image through the UI.

Most provided images come with a profile list that includes only the `default` profile. To prevent any profile (including the `default` profile) from being associated with an image, pass an empty list.

Note: Passing an empty list is different than passing `nil`. If you pass `nil` as the profile list, only the `default` profile is associated with the image.

You can override the associated profiles for an image when creating an instance by adding the `--profile` or the `--no-profiles` flag to the launch or init command (when using the CLI), or by specifying a list of profiles in the request data (when using the API).

How to import and create images:

How to copy and import images

To add images to an image store, you can either copy them from another server or import them from files (either local files or files on a web server).

Note: The UI does not currently support copying or importing images.

There is support for importing custom ISO files, but these ISO files are different from images. When you create an instance from a custom ISO file, the ISO file is mounted as a storage volume in a new empty VM, and you can then install the VM from the ISO file. See *Content type `iso`* and *Create a VM that boots from an ISO* for more information.

Copy an image from a remote

CLI

API

To copy an image from one server to another, enter the following command:

```
lxc image copy [<source_remote>:]<image> <target_remote>:
```

Note: To copy the image to your local image store, specify `local:` as the target remote.

See *`lxc image copy --help`* for a list of all available flags. The most relevant ones are:

`--alias`
: Assign an alias to the copy of the image.

`--copy-aliases`
: Copy the aliases that the source image has.

`--auto-update`
: Keep the copy up-to-date with the original image.

`--vm`
: When copying from an alias, copy the image that can be used to create virtual machines.

To copy an image from one server to another, *export it to your local machine* and then *import it to the other server*.

Import an image from files

If you have image files that use the required *Image format*, you can import them into your image store.

There are several ways of obtaining such image files:

- Exporting an existing image (see *Export an image to a set of files*)
- Building your own image using `distrobuilder` (see *Build an image*)
- Downloading image files from a *remote image server* (note that it is usually easier to *use the remote image* directly instead of downloading it to a file and importing it)

Import from the local file system

CLI

API

To import an image from the local file system, use the *`lxc image import`* command. This command supports both *unified images* (compressed file or directory) and *split images* (two files).

To import a unified image from one file or directory, enter the following command:

```
lxc image import <image_file_or_directory_path> [<target_remote>:]
```

To import a split image, enter the following command:

```
lxc image import <metadata_tarball_path> <rootfs_tarball_path> [<target_remote>:]
```

In both cases, you can assign an alias with the `--alias` flag. See *`lxc image import --help`* for all available flags.

To import an image from the local file system, send a POST request to the `/1.0/images` endpoint.

For example, to import a unified image from one file:

```
curl -X POST --unix-socket /var/snap/lxd/common/lxd/unix.socket lxd/1.0/images \
--data-binary @<image_file_path>
```

To import a split image from a metadata file and a rootfs file:

```
curl -X POST --unix-socket /var/snap/lxd/common/lxd/unix.socket lxd/1.0/images \
--form metadata=@<metadata_tarball_path> --form rootfs.img=<rootfs_tarball_path>
```

See `POST /1.0/images` for more information.

Import from a file on a remote web server

You can import image files from a remote web server by URL. This method is an alternative to running a LXD server for the sole purpose of distributing an image to users. It only requires a basic web server with support for custom headers (see *Custom HTTP headers*).

The image files must be provided as unified images (see *Unified tarball*).

CLI

API

To import an image file from a remote web server, enter the following command:

```
lxc image import <URL>
```

You can assign an alias to the local image with the `--alias` flag.

To import an image file from a remote web server, send a POST request with the image URL to the `/1.0/images` endpoint:

```
lxc query --request POST /1.0/images --data '{
  "source": {
    "type": "url",
    "url": "<URL>"
  }
}'
```

See `POST /1.0/images` for more information.

Custom HTTP headers

LXD requires the following custom HTTP headers to be set by the web server:

`LXD-Image-Hash`
: The SHA256 of the image that is being downloaded.

`LXD-Image-URL`
: The URL from which to download the image.

LXD sets the following headers when querying the server:

`LXD-Server-Architectures`
: A comma-separated list of architectures that the client supports.

`LXD-Server-Version`
: The version of LXD in use.

How to create images

If you want to create and share your own images, you can do this either based on an existing instance or snapshot or by building your own image from scratch.

Publish an image from an instance or snapshot

If you want to be able to use an instance or an instance snapshot as the base for new instances, you should create and publish an image from it.

When publishing an image from an instance, make sure that the instance is stopped.

CLI

API

UI

To publish an image from an instance, enter the following command:

```
lxc publish <instance_name> [<remote>:]
```

To publish an image from a snapshot, enter the following command:

```
lxc publish <instance_name>/<snapshot_name> [<remote>:]
```

In both cases, you can specify an alias for the new image with the `--alias` flag, set an expiration date with `--expire` and make the image publicly available with `--public`. If an image with the same name already exists, add the `--reuse` flag to overwrite it. See *`lxc publish --help`* for a full list of available flags.

To publish an image from an instance or a snapshot, send a POST request with the suitable source type to the `/1.0/images` endpoint.

To publish an image from an instance:

```
lxc query --request POST /1.0/images --data '{
  "source": {
    "name": "<instance_name>",
    "type": "instance"
  }
}'
```

To publish an image from a snapshot:

```
lxc query --request POST /1.0/images --data '{
  "source": {
    "name": "<instance_name>/<snapshot_name>",
    "type": "snapshot"
  }
}'
```

In both cases, you can include additional configuration (for example, you can include aliases, set a custom expiration date, or make the image publicly available). For example:

```
lxc query --request POST /1.0/images --data '{
  "aliases": [ { "name": "<alias>" } ],
  "expires_at": "2025-03-23T20:00:00-04:00",
  "public": true,
  "source": {
    "name": "<instance_name>",
    "type": "instance"
  }
}'
```

See `POST /1.0/images` for more information.

The UI does not currently support publishing an image from an instance, but you can publish from a snapshot.

To do so, go to the instance detail page and switch to the *Snapshots* tab. Then click the *Create image* button () and optionally enter an alias for the new image. You can also choose whether the image should be publicly available.

Publishing the image might take a few minutes. You can check the status under *Operations*.

The publishing process can take quite a while because it generates a tarball from the instance or snapshot and then compresses it. As this can be particularly I/O and CPU intensive, publish operations are serialized by LXD.

Prepare the instance for publishing

Before you publish an image from an instance, clean up all data that should not be included in the image. Usually, this includes the following data:

- Instance metadata (use *`lxc config metadata`* or `PATCH /1.0/instances/{name}/metadata`/`PUT /1.0/instances/{name}/metadata` to edit)
- File templates (use *`lxc config template`* or `POST /1.0/instances/{name}/metadata/templates` to edit)
- Instance-specific data inside the instance itself (for example, host SSH keys and `dbus/systemd machine-id`)

Build an image

For building your own images, you can use `distrobuilder`.

See the `distrobuilder` documentation for instructions for installing and using the tool.

Related topics

Explanation:

- *About images*

Reference:

- *Image format*
- *Remote image servers*

Projects

The following how-to guides cover common operations related to projects:

How to create and configure projects

You can configure projects at creation time or later. However, note that it is not possible to modify the features that are enabled for a project when the project contains instances.

Create a project

To create a project, use the *lxc project create* command.

You can specify configuration options by using the `--config` flag. See *Project configuration* for the available configuration options.

For example, to create a project called `my-project` that isolates instances, but allows access to the default project's images and profiles, enter the following command:

```
lxc project create my-project --config features.images=false --config features.
↪profiles=false
```

To create a project called `my-restricted-project` that blocks access to security-sensitive features (for example, container nesting) but allows backups, enter the following command:

```
lxc project create my-restricted-project --config restricted=true --config restricted.
↪backups=allow
```

Tip: When you create a project without specifying configuration options, *features.profiles* is set to `true`, which means that profiles are isolated in the project.

Consequently, the new project does not have access to the `default` profile of the `default` project and therefore misses required configuration for creating instances (like the root disk). To fix this, use the *lxc profile device add* command to add a root disk device to the project's `default` profile.

Configure a project

To configure a project, you can either set a specific configuration option or edit the full project.

Some configuration options can only be set for projects that do not contain any instances.

Set specific configuration options

To set a specific configuration option, use the *lxc project set* command.

For example, to limit the number of containers that can be created in `my-project` to five, enter the following command:

```
lxc project set my-project limits.containers=5
```

To unset a specific configuration option, use the *lxc project unset* command.

Note: If you unset a configuration option, it is set to its default value. This default value might differ from the initial value that is set when the project is created.

Edit the project

To edit the full project configuration, use the *lxc project edit* command. For example:

```
lxc project edit my-project
```

How to work with different projects

If you have more projects than just the `default` project, you must make sure to use or address the correct project when working with LXD.

Note: If you have projects that are *confined to specific users*, only users with full access to LXD can see all projects.

Users without full access can only see information for the projects to which they have access.

List projects

To list all projects (that you have permission to see), enter the following command:

```
lxc project list
```

By default, the output is presented as a list:

```
user@host:~$ lxc project list+----------------------+--------+----------+-----------------+-----------
NAME | IMAGES | PROFILES | STORAGE VOLUMES | STORAGE BUCKETS | NETWORKS | NETWORK ZONES |
DESCRIPTION | USED BY |+----------------------+--------+----------+-----------------+-----------------+-
default | YES | YES | YES | YES | YES | YES | Default LXD project | 19
|+----------------------+--------+----------+-----------------+-----------------+----------+-----------
my-project (current) | YES | NO | NO | NO | YES | YES | | 0 |+----------------------+--------+----------
```

You can request a different output format by adding the `--format` flag. See *lxc project list --help* for more information.

Switch projects

By default, all commands that you issue in LXD affect the project that you are currently using. To see which project you are in, use the *lxc project list* command.

To switch to a different project, enter the following command:

```
lxc project switch <project_name>
```

Target a project

Instead of switching to a different project, you can target a specific project when running a command. Many LXD commands support the `--project` flag to run an action in a different project.

Note: You can target only projects that you have permission for.

The following sections give some typical examples where you would typically target a project instead of switching to it.

List instances in a project

To list the instances in a specific project, add the `--project` flag to the *lxc list* command. For example:

```
lxc list --project my-project
```

Move an instance to another project

To move an instance from one project to another, enter the following command:

```
lxc move <instance_name> <new_instance_name> --project <source_project> --target-project
↪<target_project>
```

You can keep the same instance name if no instance with that name exists in the target project.

For example, to move the instance `my-instance` from the `default` project to `my-project` and keep the instance name, enter the following command:

```
lxc move my-instance my-instance --project default --target-project my-project
```

Copy a profile to another project

If you create a project with the default settings, profiles are isolated in the project (*features.profiles* is set to `true`). Therefore, the project does not have access to the default profile (which is part of the `default` project), and you will see an error similar to the following when trying to create an instance:

```
user@host:~$ lxc launch ubuntu:24.04 my-instance       Creating my-instanceError:  Failed
instance creation:  Failed creating instance record:  Failed initialising instance:
Failed getting root disk:  No root device could be found
```

To fix this, you can copy the contents of the `default` project's default profile into the current project's default profile. To do so, enter the following command:

```
lxc profile show default --project default | lxc profile edit default
```

How to confine projects to specific users

You can use projects to confine the activities of different users or clients. See *Confined projects in a multi-user environment* for more information.

How to confine a project to a specific user depends on the authentication method you choose.

Confine projects to specific TLS clients

You can confine access to specific projects by restricting the TLS client certificate that is used to connect to the LXD server. See *TLS client certificates* for detailed information.

To confine the access from the time the client certificate is added, you must either use token authentication or add the client certificate to the server directly. If you use password authentication, you can restrict the client certificate only after it has been added.

Use the following command to add a restricted client certificate:

Token authentication

Add client certificate

```
lxc config trust add --projects <project_name> --restricted
```

```
lxc config trust add <certificate_file> --projects <project_name> --restricted
```

The client can then add the server as a remote in the usual way (*lxc remote add <server_name> <token>* or *lxc remote add <server_name> <server_address>*) and can only access the project or projects that have been specified.

To confine access for an existing certificate (either because the access restrictions change or because the certificate was added with a trust password), use the following command:

```
lxc config trust edit <fingerprint>
```

Make sure that `restricted` is set to `true` and specify the projects that the certificate should give access to under `projects`.

Note: You can specify the `--project` flag when adding a remote. This configuration pre-selects the specified project. However, it does not confine the client to this project.

Confine projects to specific LXD users

If you use the LXD snap, you can configure the multi-user LXD daemon contained in the snap to dynamically create projects for all users in a specific user group.

To do so, set the `daemon.user.group` configuration option to the corresponding user group:

```
sudo snap set lxd daemon.user.group=<user_group>
```

Make sure that all user accounts that you want to be able to use LXD are a member of this group.

Once a member of the group issues a LXD command, LXD creates a confined project for this user and switches to this project. If LXD has not been *initialized* at this point, it is automatically initialized (with the default settings).

If you want to customize the project settings, for example, to impose limits or restrictions, you can do so after the project has been created. To modify the project configuration, you must have full access to LXD, which means you must be part of the `lxd` group and not only the group that you configured as the LXD user group.

Related topics

Explanation:

- *About projects*

Reference:

- *Project configuration*

Storage

The following how-to guides cover common operations related to storage.

How to create, manage, and use storage:

How to manage storage pools

See the following sections for instructions on how to create, configure, view and resize *Storage pools*.

Create a storage pool

LXD creates a storage pool during initialization. You can add more storage pools later, using the same driver or different drivers.

To create a storage pool, use the following command:

```
lxc storage create <pool_name> <driver> [configuration_options...]
```

Unless specified otherwise, LXD sets up loop-based storage with a sensible default size (20% of the free disk space, but at least 5 GiB and at most 30 GiB).

See the *Storage drivers* documentation for a list of available configuration options for each driver.

Examples

See the following examples for how to create a storage pool using different storage drivers.

Directory

Btrfs

LVM

ZFS

Ceph RBD

CephFS

Ceph Object

Create a directory pool named `pool1`:

```
lxc storage create pool1 dir
```

Use the existing directory `/data/lxd` for `pool2`:

```
lxc storage create pool2 dir source=/data/lxd
```

Create a loop-backed pool named `pool1`:

```
lxc storage create pool1 btrfs
```

Use the existing Btrfs file system at `/some/path` for `pool2`:

```
lxc storage create pool2 btrfs source=/some/path
```

Create a pool named `pool3` on `/dev/sdX`:

```
lxc storage create pool3 btrfs source=/dev/sdX
```

Create a loop-backed pool named `pool1` (the LVM volume group will also be called `pool1`):

```
lxc storage create pool1 lvm
```

Use the existing LVM volume group called `my-pool` for `pool2`:

```
lxc storage create pool2 lvm source=my-pool
```

Use the existing LVM thin pool called `my-pool` in volume group `my-vg` for `pool3`:

```
lxc storage create pool3 lvm source=my-vg lvm.thinpool_name=my-pool
```

Create a pool named `pool4` on `/dev/sdX` (the LVM volume group will also be called `pool4`):

```
lxc storage create pool4 lvm source=/dev/sdX
```

Create a pool named `pool5` on `/dev/sdX` with the LVM volume group name `my-pool`:

```
lxc storage create pool5 lvm source=/dev/sdX lvm.vg_name=my-pool
```

Create a loop-backed pool named `pool1` (the ZFS zpool will also be called `pool1`):

```
lxc storage create pool1 zfs
```

Create a loop-backed pool named `pool2` with the ZFS zpool name `my-tank`:

```
lxc storage create pool2 zfs zfs.pool_name=my-tank
```

Use the existing ZFS zpool `my-tank` for `pool3`:

```
lxc storage create pool3 zfs source=my-tank
```

Use the existing ZFS dataset `my-tank/slice` for `pool4`:

```
lxc storage create pool4 zfs source=my-tank/slice
```

Use the existing ZFS dataset `my-tank/zvol` for `pool5` and configure it to use ZFS block mode:

```
lxc storage create pool5 zfs source=my-tank/zvol volume.zfs.block_mode=yes
```

Create a pool named `pool6` on `/dev/sdX` (the ZFS zpool will also be called `pool6`):

```
lxc storage create pool6 zfs source=/dev/sdX
```

Create a pool named `pool7` on `/dev/sdX` with the ZFS zpool name `my-tank`:

```
lxc storage create pool7 zfs source=/dev/sdX zfs.pool_name=my-tank
```

Create an OSD storage pool named `pool1` in the default Ceph cluster (named `ceph`):

```
lxc storage create pool1 ceph
```

Create an OSD storage pool named `pool2` in the Ceph cluster `my-cluster`:

```
lxc storage create pool2 ceph ceph.cluster_name=my-cluster
```

Create an OSD storage pool named `pool3` with the on-disk name `my-osd` in the default Ceph cluster:

```
lxc storage create pool3 ceph ceph.osd.pool_name=my-osd
```

Use the existing OSD storage pool `my-already-existing-osd` for `pool4`:

```
lxc storage create pool4 ceph source=my-already-existing-osd
```

Use the existing OSD erasure-coded pool `ecpool` and the OSD replicated pool `rpl-pool` for `pool5`:

```
lxc storage create pool5 ceph source=rpl-pool ceph.osd.data_pool_name=ecpool
```

Note: Each CephFS file system consists of two OSD storage pools, one for the actual data and one for the file metadata.

Use the existing CephFS file system `my-filesystem` for `pool1`:

```
lxc storage create pool1 cephfs source=my-filesystem
```

Use the sub-directory `my-directory` from the `my-filesystem` file system for `pool2`:

```
lxc storage create pool2 cephfs source=my-filesystem/my-directory
```

Create a CephFS file system `my-filesystem` with a data pool called `my-data` and a metadata pool called `my-metadata` for `pool3`:

```
lxc storage create pool3 cephfs source=my-filesystem cephfs.create_missing=true cephfs.
↪data_pool=my-data cephfs.meta_pool=my-metadata
```

Note: When using the Ceph Object driver, you must have a running Ceph Object Gateway `radosgw` URL available beforehand.

Use the existing Ceph Object Gateway `https://www.example.com/radosgw` to create `pool1`:

```
lxc storage create pool1 cephobject cephobject.radosgw.endpoint=https://www.example.com/
↪radosgw
```

Create a storage pool in a cluster

If you are running a LXD cluster and want to add a storage pool, you must create the storage pool for each cluster member separately. The reason for this is that the configuration, for example, the storage location or the size of the pool, might be different between cluster members.

Therefore, you must first create a pending storage pool on each member with the `--target=<cluster_member>` flag and the appropriate configuration for the member. Make sure to use the same storage pool name for all members. Then create the storage pool without specifying the `--target` flag to actually set it up.

For example, the following series of commands sets up a storage pool with the name `my-pool` at different locations and with different sizes on three cluster members:

```
user@host:~$ lxc storage create my-pool zfs source=/dev/sdX size=10GiB --target=vm01
Storage pool my-pool pending on member vm01    user@host:~$ lxc storage create my-pool zfs
source=/dev/sdX size=15GiB --target=vm02       Storage pool my-pool pending on member vm02
user@host:~$ lxc storage create my-pool zfs source=/dev/sdY size=10GiB --target=vm03
Storage pool my-pool pending on member vm03    user@host:~$ lxc storage create my-pool zfs
Storage pool my-pool created Also see How to configure storage for a cluster.
```

Note: For most storage drivers, the storage pools exist locally on each cluster member. That means that if you create a storage volume in a storage pool on one member, it will not be available on other cluster members.

This behavior is different for Ceph-based storage pools (`ceph`, `cephfs` and `cephobject`) where each storage pool exists in one central location and therefore, all cluster members access the same storage pool with the same storage volumes.

Configure storage pool settings

See the *Storage drivers* documentation for the available configuration options for each storage driver.

General keys for a storage pool (like `source`) are top-level. Driver-specific keys are namespaced by the driver name.

Use the following command to set configuration options for a storage pool:

```
lxc storage set <pool_name> <key> <value>
```

For example, to turn off compression during storage pool migration for a `dir` storage pool, use the following command:

```
lxc storage set my-dir-pool rsync.compression false
```

You can also edit the storage pool configuration by using the following command:

```
lxc storage edit <pool_name>
```

View storage pools

You can display a list of all available storage pools and check their configuration.

Use the following command to list all available storage pools:

```
lxc storage list
```

The resulting table contains the storage pool that you created during initialization (usually called `default` or `local`) and any storage pools that you added.

To show detailed information about a specific pool, use the following command:

```
lxc storage show <pool_name>
```

To see usage information for a specific pool, run the following command:

```
lxc storage info <pool_name>
```

Resize a storage pool

If you need more storage, you can increase the size of your storage pool by changing the `size` configuration key:

```
lxc storage set <pool_name> size=<new_size>
```

This will only work for loop-backed storage pools that are managed by LXD. You can only grow the pool (increase its size), not shrink it.

How to manage storage volumes

See the following sections for instructions on how to create, configure, view and resize *Storage volumes*.

Create a custom storage volume

When you create an instance, LXD automatically creates a storage volume that is used as the root disk for the instance.

You can add custom storage volumes to your instances. Such custom storage volumes are independent of the instance, which means that they can be backed up separately and are retained until you delete them. Custom storage volumes with content type `filesystem` can also be shared between different instances.

See *Storage volumes* for detailed information.

Create the volume

Use the following command to create a custom storage volume of type `block` or `filesystem` in a storage pool:

```
lxc storage volume create <pool_name> <volume_name> [configuration_options...]
```

See the *Storage drivers* documentation for a list of available storage volume configuration options for each driver.

By default, custom storage volumes use the `filesystem` *content type*. To create a custom storage volume with the content type `block`, add the `--type` flag:

```
lxc storage volume create <pool_name> <volume_name> --type=block [configuration_options..
↪.]
```

To add a custom storage volume on a cluster member, add the `--target` flag:

```
lxc storage volume create <pool_name> <volume_name> --target=<cluster_member>␣
↪[configuration_options...]
```

Note: For most storage drivers, custom storage volumes are not replicated across the cluster and exist only on the member for which they were created. This behavior is different for Ceph-based storage pools (`ceph` and `cephfs`), where volumes are available from any cluster member.

To create a custom storage volume of type `iso`, use the `import` command instead of the `create` command:

```
lxc storage volume import <pool_name> <iso_path> <volume_name> --type=iso
```

Attach the volume to an instance

After creating a custom storage volume, you can add it to one or more instances as a *disk device*.

The following restrictions apply:

- Custom storage volumes of *content type* `block` or `iso` cannot be attached to containers, but only to virtual machines.
- To avoid data corruption, storage volumes of *content type* `block` should never be attached to more than one virtual machine at a time.

- Storage volumes of *content type* `iso` are always read-only, and can therefore be attached to more than one virtual machine at a time without corrupting data.
- File system storage volumes can't be attached to virtual machines while they're running.

For custom storage volumes with the content type `filesystem`, use the following command, where `<location>` is the path for accessing the storage volume inside the instance (for example, `/data`):

```
lxc storage volume attach <pool_name> <filesystem_volume_name> <instance_name> <location>
```

Custom storage volumes with the content type `block` do not take a location:

```
lxc storage volume attach <pool_name> <block_volume_name> <instance_name>
```

By default, the custom storage volume is added to the instance with the volume name as the *device* name. If you want to use a different device name, you can add it to the command:

```
lxc storage volume attach <pool_name> <filesystem_volume_name> <instance_name> <device_
↪name> <location>
lxc storage volume attach <pool_name> <block_volume_name> <instance_name> <device_name>
```

Attach the volume as a device

The *`lxc storage volume attach`* command is a shortcut for adding a disk device to an instance. Alternatively, you can add a disk device for the storage volume in the usual way:

```
lxc config device add <instance_name> <device_name> disk pool=<pool_name> source=<volume_
↪name> [path=<location>]
```

When using this way, you can add further configuration to the command if needed. See *disk device* for all available device options.

Configure I/O limits

When you attach a storage volume to an instance as a *disk device*, you can configure I/O limits for it. To do so, set the *`limits.read`*, *`limits.write`* or *`limits.max`* properties to the corresponding limits. See the *Type: disk* reference for more information.

The limits are applied through the Linux `blkio` cgroup controller, which makes it possible to restrict I/O at the disk level (but nothing finer grained than that).

Note: Because the limits apply to a whole physical disk rather than a partition or path, the following restrictions apply:

- Limits will not apply to file systems that are backed by virtual devices (for example, device mapper).
- If a file system is backed by multiple block devices, each device will get the same limit.
- If two disk devices that are backed by the same disk are attached to the same instance, the limits of the two devices will be averaged.

All I/O limits only apply to actual block device access. Therefore, consider the file system's own overhead when setting limits. Access to cached data is not affected by the limit.

Use the volume for backups or images

Instead of attaching a custom volume to an instance as a disk device, you can also use it as a special kind of volume to store *backups* or *images*.

To do so, you must set the corresponding *server configuration*:

- To use a custom volume to store the backup tarballs:

```
lxc config set storage.backups_volume <pool_name>/<volume_name>
```

- To use a custom volume to store the image tarballs:

```
lxc config set storage.images_volume <pool_name>/<volume_name>
```

Configure storage volume settings

See the *Storage drivers* documentation for the available configuration options for each storage driver.

Use the following command to set configuration options for a storage volume:

```
lxc storage volume set <pool_name> [<volume_type>/]<volume_name> <key> <value>
```

The default *storage volume type* is `custom`, so you can leave out the `<volume_type>/` when configuring a custom storage volume.

For example, to set the size of your custom storage volume `my-volume` to 1 GiB, use the following command:

```
lxc storage volume set my-pool my-volume size=1GiB
```

To set the snapshot expiry time for your virtual machine `my-vm` to one month, use the following command:

```
lxc storage volume set my-pool virtual-machine/my-vm snapshots.expiry 1M
```

You can also edit the storage volume configuration by using the following command:

```
lxc storage volume edit <pool_name> [<volume_type>/]<volume_name>
```

Configure default values for storage volumes

You can define default volume configurations for a storage pool. To do so, set a storage pool configuration with a `volume` prefix, thus `volume.<VOLUME_CONFIGURATION>=<VALUE>`.

This value is then used for all new storage volumes in the pool, unless it is set explicitly for a volume or an instance. In general, the defaults set on a storage pool level (before the volume was created) can be overridden through the volume configuration, and the volume configuration can be overridden through the instance configuration (for storage volumes of *type* `container` or `virtual-machine`).

For example, to set a default volume size for a storage pool, use the following command:

```
lxc storage set [<remote>:]<pool_name> volume.size <value>
```

View storage volumes

You can display a list of all available storage volumes and check their configuration.

To list all available storage volumes, use the following command:

```
lxc storage volume list
```

To display the storage volumes for all projects (not only the default project), add the `--all-projects` flag.

You can also display the storage volumes in a specific storage pool by specifying the pool name:

```
lxc storage volume list <pool_name>
```

The resulting table contains, among other information, the *storage volume type* and the *content type* for each storage volume.

Note: Custom storage volumes might use the same name as instance volumes (for example, you might have a container named `c1` with a container storage volume named `c1` and a custom storage volume named `c1`). Therefore, to distinguish between instance storage volumes and custom storage volumes, all instance storage volumes must be referred to as `<volume_type>/<volume_name>` (for example, `container/c1` or `virtual-machine/vm`) in commands.

To show detailed configuration information about a specific volume, use the following command:

```
lxc storage volume show <pool_name> [<volume_type>/]<volume_name>
```

To show state information about a specific volume, use the following command:

```
lxc storage volume info <pool_name> [<volume_type>/]<volume_name>
```

In both commands, the default *storage volume type* is `custom`, so you can leave out the `<volume_type>/` when displaying information about a custom storage volume.

Resize a storage volume

If you need more storage in a volume, you can increase the size of your storage volume. In some cases, it is also possible to reduce the size of a storage volume.

To resize a storage volume, set its size configuration:

```
lxc storage volume set <pool_name> <volume_name> size <new_size>
```

Important:

- Growing a storage volume usually works (if the storage pool has sufficient storage).
- Shrinking a storage volume is only possible for storage volumes with content type `filesystem`. It is not guaranteed to work though, because you cannot shrink storage below its current used size.
- Shrinking a storage volume with content type `block` is not possible.

How to manage storage buckets and keys

See the following sections for instructions on how to create, configure, view and resize *Storage buckets* and how to manage storage bucket keys.

Install requirements for local storage buckets

LXD uses MinIO to set up local storage buckets. To use this feature with LXD, you must install both the server and client binaries.

- MinIO Server:
  - Source:
    - MinIO Server on GitHub
  - Direct download for various architectures:
    - MinIO Server pre-built for `amd64`
    - MinIO Server pre-built for `arm64`
    - MinIO Server pre-built for `arm`
    - MinIO Server pre-built for `ppc64le`
    - MinIO Server pre-built for `s390x`
- MinIO Client:
  - Source:
    - MinIO Client on GitHub
  - Direct download for various architectures:
    - MinIO Client pre-built for `amd64`
    - MinIO Client pre-built for `arm64`
    - MinIO Client pre-built for `arm`
    - MinIO Client pre-built for `ppc64le`
    - MinIO Client pre-built for `s390x`

If LXD is installed from a Snap, you must configure the snap environment to detect the binaries, and restart LXD. Note that the path to the directory containing the binaries must not be under the home directory of any user.

```
snap set lxd minio.path=/path/to/directory/containing/both/binaries
snap restart lxd
```

If LXD is installed from another source, both binaries must be included in the `$PATH` that LXD was started with.

Configure the S3 address

If you want to use storage buckets on local storage (thus in a `dir`, `btrfs`, `lvm`, or `zfs` pool), you must configure the S3 address for your LXD server. This is the address that you can then use to access the buckets through the S3 protocol.

To configure the S3 address, set the *core.storage_buckets_address* server configuration option. For example:

```
lxc config set core.storage_buckets_address :8555
```

Manage storage buckets

Storage buckets provide access to object storage exposed using the S3 protocol.

Unlike custom storage volumes, storage buckets are not added to an instance, but applications can instead access them directly via their URL.

See *Storage buckets* for detailed information.

Create a storage bucket

Use the following command to create a storage bucket in a storage pool:

```
lxc storage bucket create <pool_name> <bucket_name> [configuration_options...]
```

See the *Storage drivers* documentation for a list of available storage bucket configuration options for each driver that supports object storage.

To add a storage bucket on a cluster member, add the `--target` flag:

```
lxc storage bucket create <pool_name> <bucket_name> --target=<cluster_member>␣
↪[configuration_options...]
```

Note: For most storage drivers, storage buckets are not replicated across the cluster and exist only on the member for which they were created. This behavior is different for `cephobject` storage pools, where buckets are available from any cluster member.

Configure storage bucket settings

See the *Storage drivers* documentation for the available configuration options for each storage driver that supports object storage.

Use the following command to set configuration options for a storage bucket:

```
lxc storage bucket set <pool_name> <bucket_name> <key> <value>
```

For example, to set the quota size of a bucket, use the following command:

```
lxc storage bucket set my-pool my-bucket size 1MiB
```

You can also edit the storage bucket configuration by using the following command:

```
lxc storage bucket edit <pool_name> <bucket_name>
```

Use the following command to delete a storage bucket and its keys:

```
lxc storage bucket delete <pool_name> <bucket_name>
```

View storage buckets

You can display a list of all available storage buckets in a storage pool and check their configuration.

To list all available storage buckets in a storage pool, use the following command:

```
lxc storage bucket list <pool_name>
```

To show detailed information about a specific bucket, use the following command:

```
lxc storage bucket show <pool_name> <bucket_name>
```

Resize a storage bucket

By default, storage buckets do not have a quota applied.

To set or change a quota for a storage bucket, set its size configuration:

```
lxc storage bucket set <pool_name> <bucket_name> size <new_size>
```

Important:

- Growing a storage bucket usually works (if the storage pool has sufficient storage).
- You cannot shrink a storage bucket below its current used size.

Manage storage bucket keys

To access a storage bucket, applications must use a set of S3 credentials made up of an *access key* and a *secret key*. You can create multiple sets of credentials for a specific bucket.

Each set of credentials is given a key name. The key name is used only for reference and does not need to be provided to the application that uses the credentials.

Each set of credentials has a *role* that specifies what operations they can perform on the bucket.

The roles available are:

- `admin` - Full access to the bucket
- `read-only` - Read-only access to the bucket (list and get files only)

If the role is not specified when creating a bucket key, the role used is `read-only`.

Create storage bucket keys

Use the following command to create a set of credentials for a storage bucket:

```
lxc storage bucket key create <pool_name> <bucket_name> <key_name> [configuration_
↪options...]
```

Use the following command to create a set of credentials for a storage bucket with a specific role:

```
lxc storage bucket key create <pool_name> <bucket_name> <key_name> --role=admin␣
↪[configuration_options...]
```

These commands will generate and display a random set of credential keys.

Edit or delete storage bucket keys

Use the following command to edit an existing bucket key:

```
lxc storage bucket key edit <pool_name> <bucket_name> <key_name>
```

Use the following command to delete an existing bucket key:

```
lxc storage bucket key delete <pool_name> <bucket_name> <key_name>
```

View storage bucket keys

Use the following command to see the keys defined for an existing bucket:

```
lxc storage bucket key list <pool_name> <bucket_name>
```

Use the following command to see a specific bucket key:

```
lxc storage bucket key show <pool_name> <bucket_name> <key_name>
```

How to create an instance in a specific storage pool

Instance storage volumes are created in the storage pool that is specified by the instance's root disk device. This configuration is normally provided by the profile or profiles applied to the instance. See *Default storage pool* for detailed information.

To use a different storage pool when creating or launching an instance, add the `--storage` flag. This flag overrides the root disk device from the profile. For example:

```
lxc launch <image> <instance_name> --storage <storage_pool>
```

Move instance storage volumes to another pool

To move an instance storage volume to another storage pool, make sure the instance is stopped. Then use the following command to move the instance to a different pool:

```
lxc move <instance_name> --storage <target_pool_name>
```

How to export and move custom storage volumes:

How to back up custom storage volumes

There are different ways of backing up your custom storage volumes:

- *Use snapshots for volume backup*
- *Use export files for volume backup*
- *Copy custom storage volumes*

Which method to choose depends both on your use case and on the storage driver you use.

In general, snapshots are quick and space efficient (depending on the storage driver), but they are stored in the same storage pool as the volume and therefore not too reliable. Export files can be stored on different disks and are therefore more reliable. They can also be used to restore the volume into a different storage pool. If you have a separate, network-connected LXD server available, regularly copying volumes to this other server gives high reliability as well, and this method can also be used to back up snapshots of the volume.

Note: Custom storage volumes might be attached to an instance, but they are not part of the instance. Therefore, the content of a custom storage volume is not stored when you *back up your instance*. You must back up the data of your storage volume separately.

Use snapshots for volume backup

A snapshot saves the state of the storage volume at a specific time, which makes it easy to restore the volume to a previous state. It is stored in the same storage pool as the volume itself.

Most storage drivers support optimized snapshot creation (see *Feature comparison*). For these drivers, creating snapshots is both quick and space-efficient. For the `dir` driver, snapshot functionality is available but not very efficient. For the `lvm` driver, snapshot creation is quick, but restoring snapshots is efficient only when using thin-pool mode.

Create a snapshot of a custom storage volume

Use the following command to create a snapshot for a custom storage volume:

```
lxc storage volume snapshot <pool_name> <volume_name> [<snapshot_name>]
```

The snapshot name is optional. If you don't specify one, the name follows the naming pattern defined in `snapshots.pattern`.

Add the `--reuse` flag in combination with a snapshot name to replace an existing snapshot.

By default, snapshots are kept forever, unless the `snapshots.expiry` configuration option is set. To retain a specific snapshot even if a general expiry time is set, use the `--no-expiry` flag.

View, edit or delete snapshots

Use the following command to display the snapshots for a storage volume:

```
lxc storage volume info <pool_name> <volume_name>
```

You can view or modify snapshots in a similar way to custom storage volumes, by referring to the snapshot with `<volume_name>/<snapshot_name>`.

To show information about a snapshot, use the following command:

```
lxc storage volume show <pool_name> <volume_name>/<snapshot_name>
```

To edit a snapshot (for example, to add a description or change the expiry date), use the following command:

```
lxc storage volume edit <pool_name> <volume_name>/<snapshot_name>
```

To delete a snapshot, use the following command:

```
lxc storage volume delete <pool_name> <volume_name>/<snapshot_name>
```

Schedule snapshots of a custom storage volume

You can configure a custom storage volume to automatically create snapshots at specific times. To do so, set the `snapshots.schedule` configuration option for the storage volume (see *Configure storage volume settings*).

For example, to configure daily snapshots, use the following command:

```
lxc storage volume set <pool_name> <volume_name> snapshots.schedule @daily
```

To configure taking a snapshot every day at 6 am, use the following command:

```
lxc storage volume set <pool_name> <volume_name> snapshots.schedule "0 6 * * *"
```

When scheduling regular snapshots, consider setting an automatic expiry (`snapshots.expiry`) and a naming pattern for snapshots (`snapshots.pattern`). See the *Storage drivers* documentation for more information about those configuration options.

Restore a snapshot of a custom storage volume

You can restore a custom storage volume to the state of any of its snapshots.

To do so, you must first stop all instances that use the storage volume. Then use the following command:

```
lxc storage volume restore <pool_name> <volume_name> <snapshot_name>
```

You can also restore a snapshot into a new custom storage volume, either in the same storage pool or in a different one (even a remote storage pool). To do so, use the following command:

```
lxc storage volume copy <source_pool_name>/<source_volume_name>/<source_snapshot_name>
↪<target_pool_name>/<target_volume_name>
```

Use export files for volume backup

You can export the full content of your custom storage volume to a standalone file that can be stored at any location. For highest reliability, store the backup file on a different file system to ensure that it does not get lost or corrupted.

Export a custom storage volume

Use the following command to export a custom storage volume to a compressed file (for example, `/path/to/my-backup.tgz`):

```
lxc storage volume export <pool_name> <volume_name> [<file_path>]
```

If you do not specify a file path, the export file is saved as `backup.tar.gz` in the working directory.

> **Warning:** If the output file already exists, the command overwrites the existing file without warning.

You can add any of the following flags to the command:

`--compression`
: By default, the output file uses `gzip` compression. You can specify a different compression algorithm (for example, `bzip2`) or turn off compression with `--compression=none`.

`--optimized-storage`
: If your storage pool uses the `btrfs` or the `zfs` driver, add the `--optimized-storage` flag to store the data as a driver-specific binary blob instead of an archive of individual files. In this case, the export file can only be used with pools that use the same storage driver.

  Exporting a volume in optimized mode is usually quicker than exporting the individual files. Snapshots are exported as differences from the main volume, which decreases their size and makes them easily accessible.

`--volume-only`
: By default, the export file contains all snapshots of the storage volume. Add this flag to export the volume without its snapshots.

Restore a custom storage volume from an export file

You can import an export file (for example, `/path/to/my-backup.tgz`) as a new custom storage volume. To do so, use the following command:

```
lxc storage volume import <pool_name> <file_path> [<volume_name>]
```

If you do not specify a volume name, the original name of the exported storage volume is used for the new volume. If a volume with that name already (or still) exists in the specified storage pool, the command returns an error. In that case, either delete the existing volume before importing the backup or specify a different volume name for the import.

How to move or copy storage volumes

You can *copy* or *move* custom storage volumes from one storage pool to another, or copy or rename them within the same storage pool.

To move instance storage volumes from one storage pool to another, *move the corresponding instance* to another pool.

When copying or moving a volume between storage pools that use different drivers, the volume is automatically converted.

Copy custom storage volumes

Use the following command to copy a custom storage volume:

```
lxc storage volume copy <source_pool_name>/<source_volume_name> <target_pool_name>/
↪<target_volume_name>
```

Add the `--volume-only` flag to copy only the volume and skip any snapshots that the volume might have. If the volume already exists in the target location, use the `--refresh` flag to update the copy (see *Optimized volume transfer* for the benefits).

Specify the same pool as the source and target pool to copy the volume within the same storage pool. You must specify different volume names for source and target in this case.

When copying from one storage pool to another, you can either use the same name for both volumes or rename the new volume.

Move or rename custom storage volumes

Before you can move or rename a custom storage volume, all instances that use it must be *stopped*.

Use the following command to move or rename a storage volume:

```
lxc storage volume move <source_pool_name>/<source_volume_name> <target_pool_name>/
↪<target_volume_name>
```

Specify the same pool as the source and target pool to rename the volume while keeping it in the same storage pool. You must specify different volume names for source and target in this case.

When moving from one storage pool to another, you can either use the same name for both volumes or rename the new volume.

Copy or move between cluster members

For most storage drivers (except for `ceph` and `ceph-fs`), storage volumes exist only on the cluster member for which they were created.

To copy or move a custom storage volume from one cluster member to another, add the `--target` and `--destination-target` flags to specify the source cluster member and the target cluster member, respectively.

Copy or move between projects

Add the `--target-project` to copy or move a custom storage volume to a different project.

Copy or move between LXD servers

You can copy or move custom storage volumes between different LXD servers by specifying the remote for each pool:

```
lxc storage volume copy <source_remote>:<source_pool_name>/<source_volume_name> <target_
↪remote>:<target_pool_name>/<target_volume_name>
lxc storage volume move <source_remote>:<source_pool_name>/<source_volume_name> <target_
↪remote>:<target_pool_name>/<target_volume_name>
```

You can add the `--mode` flag to choose a transfer mode, depending on your network setup:

`pull` (default)
: Instruct the target server to pull the respective storage volume.

`push`
: Push the storage volume from the source server to the target server.

`relay`
: Pull the storage volume from the source server to the local client, and then push it to the target server.

If the volume already exists in the target location, use the `--refresh` flag to update the copy (see *Optimized volume transfer* for the benefits).

Move instance storage volumes to another pool

To move an instance storage volume to another storage pool, make sure the instance is stopped. Then use the following command to move the instance to a different pool:

```
lxc move <instance_name> --storage <target_pool_name>
```

Related topics

Explanation:

- *About storage pools, volumes and buckets*

Reference:

- *Storage drivers*

Networking

The following how-to guides cover common operations related to networking.

How to create and configure a network:

How to create a network

To create a managed network, use the *lxc network* command and its subcommands. Append `--help` to any command to see more information about its usage and available flags.

Network types

The following network types are available:

Network type	Documentation	Configuration options
`bridge`	*Bridge network*	*Configuration options*
`ovn`	*OVN network*	*Configuration options*
`macvlan`	*Macvlan network*	*Configuration options*
`sriov`	*SR-IOV network*	*Configuration options*
`physical`	*Physical network*	*Configuration options*

Create a network

Use the following command to create a network:

```
lxc network create <name> --type=<network_type> [configuration_options...]
```

See *Network types* for a list of available network types and links to their configuration options.

If you do not specify a `--type` argument, the default type of `bridge` is used.

Create a network in a cluster

If you are running a LXD cluster and want to create a network, you must create the network for each cluster member separately. The reason for this is that the network configuration, for example, the name of the parent network interface, might be different between cluster members.

Therefore, you must first create a pending network on each member with the `--target=<cluster_member>` flag and the appropriate configuration for the member. Make sure to use the same network name for all members. Then create the network without specifying the `--target` flag to actually set it up.

For example, the following series of commands sets up a physical network with the name `UPLINK` on three cluster members:

`user@host:~$ lxc network create UPLINK --type=physical parent=br0 --target=vm01 Network UPLINK pending on member vm01 user@host:~$ lxc network create UPLINK --type=physical parent=br0 --target=vm02 Network UPLINK pending on member vm02 user@host:~$ lxc network create UPLINK --type=physical parent=br0 --target=vm03 Network UPLINK pending on member vm03 user@host:~$ lxc network create UPLINK --type=physical Network UPLINK created` Also see *How to configure networks for a cluster*.

Attach a network to an instance

After creating a managed network, you can attach it to an instance as a *NIC device*.

To do so, use the following command:

```
lxc network attach <network_name> <instance_name> [<device_name>] [<interface_name>]
```

The device name and the interface name are optional, but we recommend specifying at least the device name. If not specified, LXD uses the network name as the device name, which might be confusing and cause problems. For example, LXD images perform IP auto-configuration on the `eth0` interface, which does not work if the interface is called differently.

For example, to attach the network `my-network` to the instance `my-instance` as `eth0` device, enter the following command:

```
lxc network attach my-network my-instance eth0
```

Attach the network as a device

The *`lxc network attach`* command is a shortcut for adding a NIC device to an instance. Alternatively, you can add a NIC device based on the network configuration in the usual way:

```
lxc config device add <instance_name> <device_name> nic network=<network_name>
```

When using this way, you can add further configuration to the command to override the default settings for the network if needed. See *NIC device* for all available device options.

How to configure a network

To configure an existing network, use either the *`lxc network set`* and *`lxc network unset`* commands (to configure single settings) or the `lxc network edit` command (to edit the full configuration). To configure settings for specific cluster members, add the `--target` flag.

For example, the following command configures a DNS server for a physical network:

```
lxc network set UPLINK dns.nameservers=8.8.8.8
```

The available configuration options differ depending on the network type. See *Network types* for links to the configuration options for each network type.

There are separate commands to configure advanced networking features. See the following documentation:

- *How to configure network ACLs*
- *How to configure network forwards*
- *How to configure network load balancers*
- *How to configure network zones*
- *How to create OVN peer routing relationships* (OVN only)

How to configure specific networking features:

How to configure LXD as a BGP server

Note: The BGP server feature is available for the *Bridge network* and the *Physical network*.

BGP (Border Gateway Protocol) is a protocol that allows exchanging routing information between autonomous systems.

If you want to directly route external addresses to specific LXD servers or instances, you can configure LXD as a BGP server. LXD will then act as a BGP peer and advertise relevant routes and next hops to external routers, for example, your network router. It automatically establishes sessions with upstream BGP routers and announces the addresses and subnets that it's using.

The BGP server feature can be used to allow a LXD server or cluster to directly use internal/external address space by getting the specific subnets or addresses routed to the correct host. This way, traffic can be forwarded to the target instance.

For bridge networks, the following addresses and networks are being advertised:

- Network `ipv4.address` or `ipv6.address` subnets (if the matching `nat` property isn't set to `true`)
- Network `ipv4.nat.address` or `ipv6.nat.address` subnets (if the matching `nat` property is set to `true`)
- Network forward addresses
- Addresses or subnets specified in `ipv4.routes.external` or `ipv6.routes.external` on an instance NIC that is connected to the bridge network

Make sure to add your subnets to the respective configuration options. Otherwise, they won't be advertised.

For physical networks, no addresses are advertised directly at the level of the physical network. Instead, the networks, forwards and routes of all downstream networks (the networks that specify the physical network as their uplink network through the `network` option) are advertised in the same way as for bridge networks.

Note: At this time, it is not possible to announce only some specific routes/addresses to particular peers. If you need this, filter prefixes on the upstream routers.

Configure the BGP server

To configure LXD as a BGP server, set the following server configuration options on all cluster members:

- *`core.bgp_address`* - the IP address for the BGP server
- *`core.bgp_asn`* - the ASN (Autonomous System Number) for the local server
- *`core.bgp_routerid`* - the unique identifier for the BGP server

For example, set the following values:

```
lxc config set core.bgp_address=192.0.2.50:179
lxc config set core.bgp_asn=65536
lxc config set core.bgp_routerid=192.0.2.50
```

Once these configuration options are set, LXD starts listening for BGP sessions.

Configure next-hop (`bridge` only)

For bridge networks, you can override the next-hop configuration. By default, the next-hop is set to the address used for the BGP session.

To configure a different address, set `bgp.ipv4.nexthop` or `bgp.ipv6.nexthop`.

Configure BGP peers for OVN networks

If you run an OVN network with an uplink network (`physical` or `bridge`), the uplink network is the one that holds the list of allowed subnets and the BGP configuration. Therefore, you must configure BGP peers on the uplink network that contain the information that is required to connect to the BGP server.

Set the following configuration options on the uplink network:

- `bgp.peers.<name>.address` - the peer address to be used by the downstream networks
- `bgp.peers.<name>.asn` - the ASN for the local server
- `bgp.peers.<name>.password` - an optional password for the peer session
- `bgp.peers.<name>.holdtime` - an optional hold time for the peer session (in seconds)

Once the uplink network is configured, downstream OVN networks will get their external subnets and addresses announced over BGP. The next-hop is set to the address of the OVN router on the uplink network.

How to configure network ACLs

Note: Network ACLs are available for the *OVN NIC type*, the *OVN network* and the *Bridge network* (with some exceptions, see *Bridge limitations*).

Network ACLs (Access Control Lists) define traffic rules that allow controlling network access between different instances connected to the same network, and access to and from other networks.

Network ACLs can be assigned directly to the NIC (Network Interface Controller) of an instance or to a network. When assigned to a network, the ACL applies to all NICs connected to the network.

The instance NICs that have a particular ACL applied (either explicitly or implicitly through a network) make up a logical group, which can be referenced from other rules as a source or destination. See *ACL groups* for more information.

Create an ACL

Use the following command to create an ACL:

```
lxc network acl create <ACL_name> [configuration_options...]
```

This command creates an ACL without rules. As a next step, *add rules* to the ACL.

Valid network ACL names must adhere to the following rules:

- Names must be between 1 and 63 characters long.
- Names must be made up exclusively of letters, numbers and dashes from the ASCII table.
- Names must not start with a digit or a dash.
- Names must not end with a dash.

ACL properties

ACLs have the following properties: `config` User-provided free-form key/value pairs

Key:	`config`
Type:	string set
Required:	no

The only supported keys are `user.*` custom keys.

`description` Description of the network ACL

Key:	`description`
Type:	string
Required:	no

`egress` Egress traffic rules

Key:	`egress`
Type:	rule list
Required:	no

`ingress` Ingress traffic rules

Key:	`ingress`
Type:	rule list
Required:	no

`name` Unique name of the network ACL in the project

Key:	`name`
Type:	string
Required:	yes

Add or remove rules

Each ACL contains two lists of rules:

- *Ingress* rules apply to inbound traffic going towards the NIC.
- *Egress* rules apply to outbound traffic leaving the NIC.

To add a rule to an ACL, use the following command, where `<direction>` can be either `ingress` or `egress`:

```
lxc network acl rule add <ACL_name> <direction> [properties...]
```

This command adds a rule to the list for the specified direction.

You cannot edit a rule (except if you *edit the full ACL*), but you can delete rules with the following command:

```
lxc network acl rule remove <ACL_name> <direction> [properties...]
```

You must either specify all properties needed to uniquely identify a rule or add `--force` to the command to delete all matching rules.

Rule ordering and priorities

Rules are provided as lists. However, the order of the rules in the list is not important and does not affect filtering.

LXD automatically orders the rules based on the `action` property as follows:

- `drop`
- `reject`
- `allow`
- Automatic default action for any unmatched traffic (defaults to `reject`, see *Configure default actions*).

This means that when you apply multiple ACLs to a NIC, there is no need to specify a combined rule ordering. If one of the rules in the ACLs matches, the action for that rule is taken and no other rules are considered.

Rule properties

ACL rules have the following properties: `action` Action to take for matching traffic

Key:	`action`
Type:	string
Required:	yes

Possible values are `allow`, `reject`, and `drop`.

`description` Description of the rule

Key:	`description`
Type:	string
Required:	no

`destination` Comma-separated list of destinations

Key:	`destination`
Type:	string
Required:	no

Destinations can be specified as CIDR or IP ranges, destination subject name selectors (for egress rules), or be left empty for any.

`destination_port` Destination ports or port ranges

Key:	`destination_port`
Type:	string
Required:	no

This option is valid only if the protocol is `udp` or `tcp`. Specify a comma-separated list of ports or port ranges (start-end inclusive), or leave the value empty for any.

`icmp_code` ICMP message code

Key:	`icmp_code`
Type:	string
Required:	no

This option is valid only if the protocol is `icmp4` or `icmp6`. Specify the ICMP code number, or leave the value empty for any.

`icmp_type` Type of ICMP message

Key:	`icmp_type`
Type:	string
Required:	no

This option is valid only if the protocol is `icmp4` or `icmp6`. Specify the ICMP type number, or leave the value empty for any.

`protocol` Protocol to match

Key:	`protocol`
Type:	string
Required:	no

Possible values are `icmp4`, `icmp6`, `tcp`, and `udp`. Leave the value empty to match any protocol.

`source` Comma-separated list of sources

Key:	`source`
Type:	string
Required:	no

Sources can be specified as CIDR or IP ranges, source subject name selectors (for ingress rules), or be left empty for any.

`source_port` Source ports or port ranges

Key:	`source_port`
Type:	string
Required:	no

This option is valid only if the protocol is `udp` or `tcp`. Specify a comma-separated list of ports or port ranges (start-end inclusive), or leave the value empty for any.

`state` State of the rule

Key:	`state`
Type:	string
Default:	`enabled`
Required:	yes

Possible values are `enabled`, `disabled`, and `logged`.

Use selectors in rules

Note: This feature is supported only for the *OVN NIC type* and the *OVN network*.

The `source` field (for ingress rules) and the `destination` field (for egress rules) support using selectors instead of CIDR or IP ranges.

With this method, you can use ACL groups or network selectors to define rules for groups of instances without needing to maintain IP lists or create additional subnets.

ACL groups

Instance NICs that are assigned a particular ACL (either explicitly or implicitly through a network) make up a logical port group.

Such ACL groups are called *subject name selectors*, and they can be referenced with the name of the ACL in other ACL groups.

For example, if you have an ACL with the name `foo`, you can specify the group of instance NICs that are assigned this ACL as source with `source=foo`.

Network selectors

You can use *network subject selectors* to define rules based on the network that the traffic is coming from or going to.

There are two special network subject selectors called `@internal` and `@external`. They represent network local and external traffic, respectively. For example:

```
source=@internal
```

If your network supports *network peers*, you can reference traffic to or from the peer connection by using a network subject selector in the format `@<network_name>/<peer_name>`. For example:

```
source=@ovn1/mypeer
```

When using a network subject selector, the network that has the ACL applied to it must have the specified peer connection. Otherwise, the ACL cannot be applied to it.

Log traffic

Generally, ACL rules are meant to control the network traffic between instances and networks. However, you can also use them to log specific network traffic, which can be useful for monitoring, or to test rules before actually enabling them.

To add a rule for logging, create it with the `state=logged` property. You can then display the log output for all logging rules in the ACL with the following command:

```
lxc network acl show-log <ACL_name>
```

Edit an ACL

Use the following command to edit an ACL:

```
lxc network acl edit <ACL_name>
```

This command opens the ACL in YAML format for editing. You can edit both the ACL configuration and the rules.

Assign an ACL

After configuring an ACL, you must assign it to a network or an instance NIC.

To do so, add it to the `security.acls` list of the network or NIC configuration. For networks, use the following command:

```
lxc network set <network_name> security.acls="<ACL_name>"
```

For instance NICs, use the following command:

```
lxc config device set <instance_name> <device_name> security.acls="<ACL_name>"
```

Configure default actions

When one or more ACLs are applied to a NIC (either explicitly or implicitly through a network), a default reject rule is added to the NIC. This rule rejects all traffic that doesn't match any of the rules in the applied ACLs.

You can change this behavior with the network and NIC level `security.acls.default.ingress.action` and `security.acls.default.egress.action` settings. The NIC level settings override the network level settings.

For example, to set the default action for inbound traffic to `allow` for all instances connected to a network, use the following command:

```
lxc network set <network_name> security.acls.default.ingress.action=allow
```

To configure the same default action for an instance NIC, use the following command:

```
lxc config device set <instance_name> <device_name> security.acls.default.ingress.
↪action=allow
```

Bridge limitations

When using network ACLs with a bridge network, be aware of the following limitations:

- Unlike OVN ACLs, bridge ACLs are applied only on the boundary between the bridge and the LXD host. This means they can only be used to apply network policies for traffic going to or from external networks. They cannot be used for to create firewalls, thus firewalls that control traffic between instances connected to the same bridge.
- *ACL groups and network selectors* are not supported.
- When using the `iptables` firewall driver, you cannot use IP range subjects (for example, `192.0.2.1-192.0.2.10`).
- Baseline network service rules are added before ACL rules (in their respective INPUT/OUTPUT chains), because we cannot differentiate between INPUT/OUTPUT and FORWARD traffic once we have jumped into the ACL chain. Because of this, ACL rules cannot be used to block baseline service rules.

How to configure network forwards

Note: Network forwards are available for the *OVN network* and the *Bridge network*.

Network forwards allow an external IP address (or specific ports on it) to be forwarded to an internal IP address (or specific ports on it) in the network that the forward belongs to.

This feature can be useful if you have limited external IP addresses and want to share a single external address between multiple instances. There are two different ways how you can use network forwards in this case:

- Forward all traffic from the external address to the internal address of one instance. This method makes it easy to move the traffic destined for the external address to another instance by simply reconfiguring the network forward.
- Forward traffic from different port numbers of the external address to different instances (and optionally different ports on those instances). This method allows to "share" your external IP address and expose more than one instance at a time.

Tip: Network forwards are very similar to using a *proxy device* in NAT mode.

The difference is that network forwards are applied on a network level, while a proxy device is added for an instance. In addition, proxy devices can be used to proxy traffic between different connection types (for example, TCP and Unix sockets).

Create a network forward

Use the following command to create a network forward:

```
lxc network forward create <network_name> [<listen_address>] [--allocate=ipv{4,6}]␣
↪[configuration_options...]
```

Each forward is assigned to a network. Specify a single external listen address (see *Requirements for listen addresses* for more information about which addresses can be forwarded, depending on the network that you are using). If the network type supports IP allocation, you don't need to specify a listen address. If you leave it out, you must provide the `--allocate` flag.

You can specify an optional default target address by adding the `target_address=<IP_address>` configuration option. If you do, any traffic that does not match a port specification is forwarded to this address. Note that this target address must be within the same subnet as the network that the forward is associated to.

Forward properties

Network forwards have the following properties: `config` User-provided free-form key/value pairs

Key:	`config`
Type:	string set
Required:	no

The only supported keys are `target_address` and `user.*` custom keys.

`description` Description of the network forward

Key:	`description`
Type:	string
Required:	yes

`listen_address` IP address to listen on

Key:	`listen_address`
Type:	string
Required:	no

`ports` List of port specifications

Key:	`ports`
Type:	port list
Required:	no

See *Configure ports*.

Requirements for listen addresses

The requirements for valid listen addresses vary depending on which network type the forward is associated to.

Bridge network

- Any non-conflicting listen address is allowed.
- The listen address must not overlap with a subnet that is in use with another network.
- The `--allocate` flag is not supported.

OVN network

- Allowed listen addresses must be defined in the uplink network's `ipv{n}.routes` settings or the project's *`restricted.networks.subnets`* setting (if set).
- The listen address must not overlap with a subnet that is in use with another network.

- The `--allocate` flag is supported. If used, the OVN network driver will allocate an IP address from the uplink network's `ipv{n}.routes` or the project's *`restricted.networks.subnets`* setting (if set).

Configure ports

You can add port specifications to the network forward to forward traffic from specific ports on the listen address to specific ports on the target address. This target address must be different from the default target address. It must be within the same subnet as the network that the forward is associated to.

Use the following command to add a port specification:

```
lxc network forward port add <network_name> <listen_address> <protocol> <listen_ports>
↪<target_address> [<target_ports>]
```

You can specify a single listen port or a set of ports. If you want to forward the traffic to different ports, you have two options:

- Specify a single target port to forward traffic from all listen ports to this target port.
- Specify a set of target ports with the same number of ports as the listen ports to forward traffic from the first listen port to the first target port, the second listen port to the second target port, and so on.

Port properties

Network forward ports have the following properties: `description` Description of the port or ports

Key:	`description`
Type:	string
Required:	no

`listen_port` Listen port or ports

Key:	`listen_port`
Type:	string
Required:	yes

For example: `80,90-100`

`protocol` Protocol for the port or ports

Key:	`protocol`
Type:	string
Required:	yes

Possible values are `tcp` and `udp`.

`target_address` IP address to forward to

Key:	`target_address`
Type:	string
Required:	yes

`target_port` Target port or ports

Key:	`target_port`
Type:	string
Default:	same as `listen_port`
Required:	no

For example: `70,80-90` or `90`

Edit a network forward

Use the following command to edit a network forward:

```
lxc network forward edit <network_name> <listen_address>
```

This command opens the network forward in YAML format for editing. You can edit both the general configuration and the port specifications.

Delete a network forward

Use the following command to delete a network forward:

```
lxc network forward delete <network_name> <listen_address>
```

How to configure network zones

Note: Network zones are available for the *OVN network* and the *Bridge network*.

Network zones can be used to serve DNS records for LXD networks.

You can use network zones to automatically maintain valid forward and reverse records for all your instances. This can be useful if you are operating a LXD cluster with multiple instances across many networks.

Having DNS records for each instance makes it easier to access network services running on an instance. It is also important when hosting, for example, an outbound SMTP service. Without correct forward and reverse DNS entries for the instance, sent mail might be flagged as potential spam.

Each network can be associated to different zones:

- Forward DNS records - multiple comma-separated zones (no more than one per project)
- IPv4 reverse DNS records - single zone
- IPv6 reverse DNS records - single zone

LXD will then automatically manage forward and reverse records for all instances, network gateways and downstream network ports and serve those zones for zone transfer to the operator's production DNS servers.

Project views

Projects have a *features.networks.zones* feature, which is disabled by default. This controls which project new networks zones are created in. When this feature is enabled new zones are created in the project, otherwise they are created in the default project.

This allows projects that share a network in the default project (i.e those with `features.networks=false`) to have their own project level DNS zones that give a project oriented "view" of the addresses on that shared network (which only includes addresses from instances in their project).

Generated records

Forward records

If you configure a zone with forward DNS records for `lxd.example.net` for your network, it generates records that resolve the following DNS names:

- For all instances in the network: `<instance_name>.lxd.example.net`
- For the network gateway: `<network_name>.gw.lxd.example.net`
- For downstream network ports (for network zones set on an uplink network with a downstream OVN network): `<project_name>-<downstream_network_name>.uplink.lxd.example.net`
- Manual records added to the zone.

You can check the records that are generated with your zone setup with the `dig` command.

This assumes that *core.dns_address* was set to `<DNS_server_IP>:<DNS_server_PORT>`. (Setting that configuration option causes the backend to immediately start serving on that address.)

In order for the `dig` request to be allowed for a given zone, you must set the `peers.NAME.address` configuration option for that zone. `NAME` can be anything random. The value must match the IP address where your `dig` is calling from. You must leave `peers.NAME.key` for that same random `NAME` unset.

For example: `lxc network zone set lxd.example.net peers.whatever.address=192.0.2.1`.

Note: It is not enough for the address to be of the same machine that `dig` is calling from; it needs to match as a string with what the DNS server in `lxd` thinks is the exact remote address. `dig` binds to `0.0.0.0`, therefore the address you need is most likely the same that you provided to *core.dns_address*.

For example, running `dig @<DNS_server_IP> -p <DNS_server_PORT> axfr lxd.example.net` might give the following output:

```
user@host:~$ dig @192.0.2.200 -p 1053 axfr lxd.example.net       lxd.example.net. 3600 IN
SOA lxd.example.net. ns1.lxd.example.net. 1669736788 120 60 86400 30lxd.example.
net. 300 IN NS ns1.lxd.example.net.lxdtest.gw.lxd.example.net. 300 IN A 192.0.2.
1lxdtest.gw.lxd.example.net. 300 IN AAAA fd42:4131:a53c:7211::1default-ovntest.
uplink.lxd.example.net. 300 IN A 192.0.2.20default-ovntest.uplink.lxd.example.net.
300 IN AAAA fd42:4131:a53c:7211:216:3eff:fe4e:b794c1.lxd.example.net. 300 IN AAAA
fd42:4131:a53c:7211:216:3eff:fe19:6edec1.lxd.example.net. 300 IN A 192.0.2.125manualtest.
lxd.example.net. 300 IN A 8.8.8.8lxd.example.net. 3600 IN SOA lxd.example.net. ns1.lxd.
example.net. 1669736788 120 60 86400 30
```

Reverse records

If you configure a zone for IPv4 reverse DNS records for `2.0.192.in-addr.arpa` for a network using `192.0.2.0/24`, it generates reverse PTR DNS records for addresses from all projects that are referencing that network via one of their forward zones.

For example, running `dig @<DNS_server_IP> -p <DNS_server_PORT> axfr 2.0.192.in-addr.arpa` might give the following output:

```
user@host:~$ dig @192.0.2.200 -p 1053 axfr 2.0.192.in-addr.arpa 2.0.192.in-addr.arpa. 3600
IN SOA 2.0.192.in-addr.arpa. ns1.2.0.192.in-addr.arpa. 1669736828 120 60 86400 302.0.
192.in-addr.arpa. 300 IN NS ns1.2.0.192.in-addr.arpa.1.2.0.192.in-addr.arpa. 300 IN PTR
lxdtest.gw.lxd.example.net.20.2.0.192.in-addr.arpa. 300 IN PTR default-ovntest.uplink.
lxd.example.net.125.2.0.192.in-addr.arpa. 300 IN PTR c1.lxd.example.net.2.0.192.in-addr.
arpa. 3600 IN SOA 2.0.192.in-addr.arpa. ns1.2.0.192.in-addr.arpa. 1669736828 120 60 86400
30
```

Enable the built-in DNS server

To make use of network zones, you must enable the built-in DNS server.

To do so, set the *core.dns_address* configuration option to a local address on the LXD server. To avoid conflicts with an existing DNS we suggest not using the port 53. This is the address on which the DNS server will listen. Note that in a LXD cluster, the address may be different on each cluster member.

Note: The built-in DNS server supports only zone transfers through AXFR. It cannot be directly queried for DNS records. Therefore, the built-in DNS server must be used in combination with an external DNS server (`bind9`, `nsd`, ...), which will transfer the entire zone from LXD, refresh it upon expiry and provide authoritative answers to DNS requests.

Authentication for zone transfers is configured on a per-zone basis, with peers defined in the zone configuration and a combination of IP address matching and TSIG-key based authentication.

Create and configure a network zone

Use the following command to create a network zone:

```
lxc network zone create <network_zone> [configuration_options...]
```

The following examples show how to configure a zone for forward DNS records, one for IPv4 reverse DNS records and one for IPv6 reverse DNS records, respectively:

```
lxc network zone create lxd.example.net
lxc network zone create 2.0.192.in-addr.arpa
lxc network zone create 1.0.0.0.1.0.0.0.8.b.d.0.1.0.0.2.ip6.arpa
```

Note: Zones must be globally unique, even across projects. If you get a creation error, it might be due to the zone already existing in another project.

You can either specify the configuration options when you create the network or configure them afterwards with the following command:

```
lxc network zone set <network_zone> <key>=<value>
```

Use the following command to edit a network zone in YAML format:

```
lxc network zone edit <network_zone>
```

Configuration options

The following configuration options are available for network zones: `dns.nameservers` Comma-separated list of DNS server FQDNs (for NS records)

Key:	`dns.nameservers`
Type:	string set
Required:	no

`network.nat` Whether to generate records for NAT-ed subnets

Key:	`network.nat`
Type:	bool
Default:	true
Required:	no

`peers.NAME.address` IP address of a DNS server

Key:	`peers.NAME.address`
Type:	string
Required:	no

`peers.NAME.key` TSIG key for the server

Key:	`peers.NAME.key`
Type:	string
Required:	no

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string
Required:	no

Note: When generating the TSIG key using `tsig-keygen`, the key name must follow the format `<zone_name>_<peer_name>.`. For example, if your zone name is `lxd.example.net` and the peer name is `bind9`, then the key name must be `lxd.example.net_bind9.`. If this format is not followed, zone transfer might fail.

Add a network zone to a network

To add a zone to a network, set the corresponding configuration option in the network configuration:

- For forward DNS records: `dns.zone.forward`
- For IPv4 reverse DNS records: `dns.zone.reverse.ipv4`
- For IPv6 reverse DNS records: `dns.zone.reverse.ipv6`

For example:

```
lxc network set <network_name> dns.zone.forward="lxd.example.net"
```

Zones belong to projects and are tied to the `networks` features of projects. You can restrict projects to specific domains and sub-domains through the *restricted.networks.zones* project configuration key.

Add custom records

A network zone automatically generates forward and reverse records for all instances, network gateways and downstream network ports. If required, you can manually add custom records to a zone.

To do so, use the *lxc network zone record* command.

Create a record

Use the following command to create a record:

```
lxc network zone record create <network_zone> <record_name>
```

This command creates an empty record without entries and adds it to a network zone.

Record properties

Records have the following properties: `config` User-provided free-form key/value pairs

Key:	`config`
Type:	string set
Required:	no

The only supported keys are `user.*` custom keys.

`description` Description of the record

Key:	`description`
Type:	string
Required:	no

`entries` List of DNS entries

Key:	entries
Type:	entry list
Required:	no

name Unique name of the record

Key:	name
Type:	string
Required:	yes

Add or remove entries

To add an entry to the record, use the following command:

```
lxc network zone record entry add <network_zone> <record_name> <type> <value> [--ttl
↪<TTL>]
```

This command adds a DNS entry with the specified type and value to the record.

For example, to create a dual-stack web server, add a record with two entries similar to the following:

```
lxc network zone record entry add <network_zone> <record_name> A 1.2.3.4
lxc network zone record entry add <network_zone> <record_name> AAAA 1234::1234
```

You can use the `--ttl` flag to set a custom time-to-live (in seconds) for the entry. Otherwise, the default of 300 seconds is used.

You cannot edit an entry (except if you edit the full record with *lxc network zone record edit*), but you can delete entries with the following command:

```
lxc network zone record entry remove <network_zone> <record_name> <type> <value>
```

How to configure specific networking features (managed bridge networks only):

How to configure your firewall

Important: This guide applies to managed bridge networks only.

Linux firewalls are based on `netfilter`. LXD uses the same subsystem, which can lead to connectivity issues.

If you run a firewall on your system, you might need to configure it to allow network traffic between the managed LXD bridge and the host. Otherwise, some network functionality (DHCP, DNS and external network access) might not work as expected.

You might also see conflicts between the rules defined by your firewall (or another application) and the firewall rules that LXD adds. For example, your firewall might erase LXD rules if it is started after the LXD daemon, which might interrupt network connectivity to the instance.

`xtables` vs. `nftables`

There are different userspace commands to add rules to `netfilter`: `xtables` (`iptables` for IPv4 and `ip6tables` for IPv6) and `nftables`.

`xtables` provides an ordered list of rules, which might cause issues if multiple systems add and remove entries from the list. `nftables` adds the ability to separate rules into namespaces, which helps to separate rules from different applications. However, if a packet is blocked in one namespace, it is not possible for another namespace to allow it. Therefore, rules in one namespace can still affect rules in another namespace, and firewall applications can still impact LXD network functionality.

If your system supports and uses `nftables`, LXD detects this and switches to `nftables` mode. In this mode, LXD adds its rules into the `nftables`, using its own `nftables` namespace.

Use LXD's firewall

By default, managed LXD bridges add firewall rules to ensure full functionality. If you do not run another firewall on your system, you can let LXD manage its firewall rules.

To enable or disable this behavior, use the `ipv4.firewall` or `ipv6.firewall` *configuration options*.

Use another firewall

Firewall rules added by other applications might interfere with the firewall rules that LXD adds. Therefore, if you use another firewall, you should disable LXD's firewall rules. You must also configure your firewall to allow network traffic between the instances and the LXD bridge, so that the LXD instances can access the DHCP and DNS server that LXD runs on the host.

See the following sections for instructions on how to disable LXD's firewall rules and how to properly configure `firewalld` and UFW, respectively.

Disable LXD's firewall rules

Run the following commands to prevent LXD from setting firewall rules for a specific network bridge (for example, `lxdbr0`):

```
lxc network set <network_bridge> ipv6.firewall false
lxc network set <network_bridge> ipv4.firewall false
```

`firewalld`: Add the bridge to the trusted zone

To allow traffic to and from the LXD bridge in `firewalld`, add the bridge interface to the `trusted` zone. To do this permanently (so that it persists after a reboot), run the following commands:

```
sudo firewall-cmd --zone=trusted --change-interface=<network_bridge> --permanent
sudo firewall-cmd --reload
```

For example:

```
sudo firewall-cmd --zone=trusted --change-interface=lxdbr0 --permanent
sudo firewall-cmd --reload
```

Warning:

The commands given above show a simple example configuration. Depending on your use case, you might need more advanced rules and the example configuration might inadvertently introduce a security risk.

UFW: Add rules for the bridge

If UFW has a rule to drop all unrecognized traffic, it blocks the traffic to and from the LXD bridge. In this case, you must add rules to allow traffic to and from the bridge, as well as allowing traffic forwarded to it.

To do so, run the following commands:

```
sudo ufw allow in on <network_bridge>
sudo ufw route allow in on <network_bridge>
sudo ufw route allow out on <network_bridge>
```

For example:

```
sudo ufw allow in on lxdbr0
sudo ufw route allow in on lxdbr0
sudo ufw route allow out on lxdbr0
```

Warning: The commands given above show a simple example configuration. Depending on your use case, you might need more advanced rules and the example configuration might inadvertently introduce a security risk.

Here's an example for more restrictive firewall rules that limit access from the guests to the host to only DHCP and DNS and allow all outbound connections:

```
# allow the guest to get an IP from the LXD host
sudo ufw allow in on lxdbr0 to any port 67 proto udp
sudo ufw allow in on lxdbr0 to any port 547 proto udp

# allow the guest to resolve host names from the LXD host
sudo ufw allow in on lxdbr0 to any port 53

# allow the guest to have access to outbound connections
CIDR4="$(lxc network get lxdbr0 ipv4.address | sed 's|\.[0-9]\+/|.0/|')"
CIDR6="$(lxc network get lxdbr0 ipv6.address | sed 's|:[0-9]\+/|::/|')"
sudo ufw route allow in on lxdbr0 from "${CIDR4}"
sudo ufw route allow in on lxdbr0 from "${CIDR6}"
```

Prevent connectivity issues with LXD and Docker

Running LXD and Docker on the same host can cause connectivity issues. A common reason for these issues is that Docker sets the global FORWARD policy to `drop`, which prevents LXD from forwarding traffic and thus causes the instances to lose network connectivity. See Docker on a router for detailed information.

There are different ways of working around this problem:

Uninstall Docker
: The easiest way to prevent such issues is to uninstall Docker from the system that runs LXD and restart the system. You can run Docker inside a LXD container or virtual machine instead.

See Running Docker inside of a LXD container for detailed information.

Enable IPv4 forwarding

If uninstalling Docker is not an option, enabling IPv4 forwarding before the Docker service starts will prevent Docker from modifying the global FORWARD policy. LXD bridge networks enable this setting normally. However, if LXD starts after Docker, then Docker will already have modified the global FORWARD policy.

> **Warning:** Enabling IPv4 forwarding can cause your Docker container ports to be reachable from any machine on your local network. Depending on your environment, this might be undesirable. See local network container access issue for more information.

To enable IPv4 forwarding before Docker starts, ensure that the following `sysctl` setting is enabled:

```
net.ipv4.conf.all.forwarding=1
```

Important: You must make this setting persistent across host reboots.

One way of doing this is to add a file to the `/etc/sysctl.d/` directory using the following commands:

```
echo "net.ipv4.conf.all.forwarding=1" > /etc/sysctl.d/99-forwarding.conf
systemctl restart systemd-sysctl
```

Allow egress network traffic flows

If you do not want the Docker container ports to be potentially reachable from any machine on your local network, you can apply a more complex solution provided by Docker.

Use the following commands to explicitly allow egress network traffic flows from your LXD managed bridge interface:

```
iptables -I DOCKER-USER -i <network_bridge> -j ACCEPT
iptables -I DOCKER-USER -o <network_bridge> -m conntrack --ctstate RELATED,
↪ESTABLISHED -j ACCEPT
```

For example, if your LXD managed bridge is called `lxdbr0`, you can allow egress traffic to flow using the following commands:

```
iptables -I DOCKER-USER -i lxdbr0 -j ACCEPT
iptables -I DOCKER-USER -o lxdbr0 -m conntrack --ctstate RELATED,ESTABLISHED -j␣
↪ACCEPT
```

Important: You must make these firewall rules persistent across host reboots. How to do this depends on your Linux distribution.

How to integrate with `systemd-resolved`

Important: This guide applies to managed bridge networks only.

If the system that runs LXD uses `systemd-resolved` to perform DNS lookups, you should notify `resolved` of the domains that LXD can resolve. To do so, add the DNS servers and domains provided by a LXD network bridge to the `resolved` configuration.

Note: The *dns.mode* option must be set to `managed` or `dynamic` if you want to use this feature.

Depending on the configured *dns.domain*, you might need to disable DNSSEC in `resolved` to allow for DNS resolution. This can be done through the `DNSSEC` option in `resolved.conf`.

Configure resolved

To add a network bridge to the `resolved` configuration, specify the DNS addresses and domains for the respective bridge.

DNS address

You can use the IPv4 address, the IPv6 address or both. The address must be specified without the subnet netmask.

To retrieve the IPv4 address for the bridge, use the following command:

```
lxc network get <network_bridge> ipv4.address
```

To retrieve the IPv6 address for the bridge, use the following command:

```
lxc network get <network_bridge> ipv6.address
```

DNS domain

To retrieve the DNS domain name for the bridge, use the following command:

```
lxc network get <network_bridge> dns.domain
```

If this option is not set, the default domain name is `lxd`.

Use the following commands to configure `resolved`:

```
resolvectl dns <network_bridge> <dns_address>
resolvectl domain <network_bridge> ~<dns_domain>
```

Note: When configuring `resolved` with the DNS domain name, you should prefix the name with ~. The ~ tells `resolved` to use the respective name server to look up only this domain.

Depending on which shell you use, you might need to include the DNS domain in quotes to prevent the ~ from being expanded.

For example:

```
resolvectl dns lxdbr0 192.0.2.10
resolvectl domain lxdbr0 '~lxd'
```

Note: Alternatively, you can use the `systemd-resolve` command. This command has been deprecated in newer releases of `systemd`, but it is still provided for backwards compatibility.

```
systemd-resolve --interface <network_bridge> --set-domain ~<dns_domain> --set-dns <dns_
↪address>
```

The `resolved` configuration persists as long as the bridge exists. You must repeat the commands after each reboot and after LXD is restarted, or make it persistent as described below.

Make the `resolved` configuration persistent

You can automate the `systemd-resolved` DNS configuration, so that it is applied on system start and takes effect when LXD creates the network interface.

To do so, create a `systemd` unit file named `/etc/systemd/system/lxd-dns-<network_bridge>.service` with the following content:

```
[Unit]
Description=LXD per-link DNS configuration for <network_bridge>
BindsTo=sys-subsystem-net-devices-<network_bridge>.device
After=sys-subsystem-net-devices-<network_bridge>.device

[Service]
Type=oneshot
ExecStart=/usr/bin/resolvectl dns <network_bridge> <dns_address>
ExecStart=/usr/bin/resolvectl domain <network_bridge> <dns_domain>
ExecStopPost=/usr/bin/resolvectl revert <network_bridge>
RemainAfterExit=yes

[Install]
WantedBy=sys-subsystem-net-devices-<network_bridge>.device
```

Replace `<network_bridge>` in the file name and content with the name of your bridge (for example, `lxdbr0`). Also replace `<dns_address>` and `<dns_domain>` as described in *Configure resolved*.

Then enable and start the service with the following commands:

```
sudo systemctl daemon-reload
sudo systemctl enable --now lxd-dns-<network_bridge>
```

If the respective bridge already exists (because LXD is already running), you can use the following command to check that the new service has started:

```
sudo systemctl status lxd-dns-<network_bridge>.service
```

You should see output similar to the following:

```
user@host:~$ sudo systemctl status lxd-dns-lxdbr0.service          lxd-dns-lxdbr0.service
- LXD per-link DNS configuration for lxdbr0 Loaded:  loaded (/etc/systemd/system/
lxd-dns-lxdbr0.service; enabled; vendor preset:  enabled) Active:  inactive (dead)
```

since Mon 2021-06-14 17:03:12 BST; 1min 2s ago Process: 9433 ExecStart=/usr/bin/resolvectl dns lxdbr0 n.n.n.n (code=exited, status=0/SUCCESS) Process: 9434 ExecStart=/usr/bin/resolvectl domain lxdbr0 ~lxd (code=exited, status=0/SUCCESS) Main PID: 9434 (code=exited, status=0/SUCCESS) To check that `resolved` has applied the settings, use `resolvectl status <network_bridge>`:

user@host:~$ resolvectl status lxdbr0 Link 6 (lxdbr0) Current Scopes: DNSDefaultRoute setting: no LLMNR setting: yesMulticastDNS setting: no DNSOverTLS setting: no DNSSEC setting: no DNSSEC supported: no Current DNS Server: n.n.n.n DNS Servers: n.n.n.n DNS Domain: ~lxd How to configure specific networking features (OVN networks only):

How to set up OVN with LXD

See the following sections for how to set up a basic OVN network, either as a standalone network or to host a small LXD cluster.

Set up a standalone OVN network

Complete the following steps to create a standalone OVN network that is connected to a managed LXD parent bridge network (for example, `lxdbr0`) for outbound connectivity.

1. Install the OVN tools on the local server:

```
sudo apt install ovn-host ovn-central
```

2. Configure the OVN integration bridge:

```
sudo ovs-vsctl set open_vswitch . \
   external_ids:ovn-remote=unix:/var/run/ovn/ovnsb_db.sock \
   external_ids:ovn-encap-type=geneve \
   external_ids:ovn-encap-ip=127.0.0.1
```

3. Create an OVN network:

```
lxc network set <parent_network> ipv4.dhcp.ranges=<IP_range> ipv4.ovn.ranges=<IP_
↪range>
lxc network create ovntest --type=ovn network=<parent_network>
```

4. Create an instance that uses the `ovntest` network:

```
lxc init ubuntu:24.04 c1
lxc config device override c1 eth0 network=ovntest
lxc start c1
```

5. Run *`lxc list`* to show the instance information:

```
user@host:~$ lxc list+------+---------+---------------------+-----------------------------------
NAME | STATE | IPV4 | IPV6 | TYPE | SNAPSHOTS |+------+---------+---------------------+-----------
c1 | RUNNING | 192.0.2.2 (eth0) | 2001:db8:cff3:5089:216:3eff:fef0:549f (eth0) |
CONTAINER | 0 |+------+---------+---------------------+-----------------------------------------
```

Set up a LXD cluster on OVN

Complete the following steps to set up a LXD cluster that uses an OVN network.

Just like LXD, the distributed database for OVN must be run on a cluster that consists of an odd number of members. The following instructions use the minimum of three servers, which run both the distributed database for OVN and the OVN controller. In addition, you can add any number of servers to the LXD cluster that run only the OVN controller. See the linked YouTube video for the complete tutorial using four machines.

1. Complete the following steps on the three machines that you want to run the distributed database for OVN:
    1. Install the OVN tools:

    ```
    sudo apt install ovn-central ovn-host
    ```

    2. Mark the OVN services as enabled to ensure that they are started when the machine boots:

    ```
    systemctl enable ovn-central
    systemctl enable ovn-host
    ```

    3. Stop OVN for now:

    ```
    systemctl stop ovn-central
    ```

    4. Note down the IP address of the machine:

    ```
    ip -4 a
    ```

    5. Open `/etc/default/ovn-central` for editing.
    6. Paste in one of the following configurations (replace `<server_1>`, `<server_2>` and `<server_3>` with the IP addresses of the respective machines, and `<local>` with the IP address of the machine that you are on).
        - For the first machine:

        ```
        OVN_CTL_OPTS=" \
            --db-nb-addr=<local> \
            --db-nb-create-insecure-remote=yes \
            --db-sb-addr=<local> \
            --db-sb-create-insecure-remote=yes \
            --db-nb-cluster-local-addr=<local> \
            --db-sb-cluster-local-addr=<local> \
            --ovn-northd-nb-db=tcp:<server_1>:6641,tcp:<server_2>:6641,tcp:<server_
        ↪3>:6641 \
            --ovn-northd-sb-db=tcp:<server_1>:6642,tcp:<server_2>:6642,tcp:<server_
        ↪3>:6642"
        ```

        - For the second and third machine:

        ```
        OVN_CTL_OPTS=" \
             --db-nb-addr=<local> \
            --db-nb-cluster-remote-addr=<server_1> \
            --db-nb-create-insecure-remote=yes \
            --db-sb-addr=<local> \
            --db-sb-cluster-remote-addr=<server_1> \
            --db-sb-create-insecure-remote=yes \
            --db-nb-cluster-local-addr=<local> \
        ```

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```
    --db-sb-cluster-local-addr=<local> \
    --ovn-northd-nb-db=tcp:<server_1>:6641,tcp:<server_2>:6641,tcp:<server_
↪3>:6641 \
    --ovn-northd-sb-db=tcp:<server_1>:6642,tcp:<server_2>:6642,tcp:<server_
↪3>:6642"
```

7. Start OVN:

```
systemctl start ovn-central
```

2. On the remaining machines, install only `ovn-host` and make sure it is enabled:

```
sudo apt install ovn-host
systemctl enable ovn-host
```

3. On all machines, configure Open vSwitch (replace the variables as described above):

```
sudo ovs-vsctl set open_vswitch . \
   external_ids:ovn-remote=tcp:<server_1>:6642,tcp:<server_2>:6642,tcp:<server_3>
↪:6642 \
   external_ids:ovn-encap-type=geneve \
   external_ids:ovn-encap-ip=<local>
```

4. Create a LXD cluster by running `lxd init` on all machines. On the first machine, create the cluster. Then join the other machines with tokens by running *`lxc cluster add <machine_name>`* on the first machine and specifying the token when initializing LXD on the other machine.

5. On the first machine, create and configure the uplink network:

```
lxc network create UPLINK --type=physical parent=<uplink_interface> --target=
↪<machine_name_1>
lxc network create UPLINK --type=physical parent=<uplink_interface> --target=
↪<machine_name_2>
lxc network create UPLINK --type=physical parent=<uplink_interface> --target=
↪<machine_name_3>
lxc network create UPLINK --type=physical parent=<uplink_interface> --target=
↪<machine_name_4>
lxc network create UPLINK --type=physical \
   ipv4.ovn.ranges=<IP_range> \
   ipv6.ovn.ranges=<IP_range> \
   ipv4.gateway=<gateway> \
   ipv6.gateway=<gateway> \
   dns.nameservers=<name_server>
```

To determine the required values:

Uplink interface

A high availability OVN cluster requires a shared layer 2 network, so that the active OVN chassis can move between cluster members (which effectively allows the OVN router's external IP to be reachable from a different host).

Therefore, you must specify either an unmanaged bridge interface or an unused physical interface as the parent for the physical network that is used for OVN uplink. The instructions assume that you are using a manually created unmanaged bridge. See How to configure network bridges for instructions on how to set up this bridge.

Gateway
Run `ip -4 route show default` and `ip -6 route show default`.

Name server
Run `resolvectl`.

IP ranges
Use suitable IP ranges based on the assigned IPs.

6. Still on the first machine, configure LXD to be able to communicate with the OVN DB cluster. To do so, find the value for `ovn-northd-nb-db` in `/etc/default/ovn-central` and provide it to LXD with the following command:

```
lxc config set network.ovn.northbound_connection <ovn-northd-nb-db>
```

7. Finally, create the actual OVN network (on the first machine):

```
lxc network create my-ovn --type=ovn
```

8. To test the OVN network, create some instances and check the network connectivity:

```
lxc launch ubuntu:24.04 c1 --network my-ovn
lxc launch ubuntu:24.04 c2 --network my-ovn
lxc launch ubuntu:24.04 c3 --network my-ovn
lxc launch ubuntu:24.04 c4 --network my-ovn
lxc list
lxc exec c4 -- bash
ping <IP of c1>
ping <nameserver>
ping6 -n www.example.com
```

Send OVN logs to LXD

Complete the following steps to have the OVN controller send its logs to LXD.

1. Enable the syslog socket:

```
lxc config set core.syslog_socket=true
```

2. Open `/etc/default/ovn-host` for editing.
3. Paste the following configuration:

```
OVN_CTL_OPTS=" \
       --ovn-controller-log='-vsyslog:info --syslog-method=unix:/var/snap/lxd/
↪common/lxd/syslog.socket'"
```

4. Restart the OVN controller:

```
systemctl restart ovn-controller.service
```

You can now use *`lxc monitor`* to see logs from the OVN controller:

```
lxc monitor --type=ovn
```

You can also send the logs to Loki. To do so, add the `ovn` value to the *`loki.types`* configuration key, for example:

```
lxc config set loki.types=ovn
```

Tip: You can include logs for OVN `northd`, OVN north-bound `ovsdb-server`, and OVN south-bound `ovsdb-server` as well. To do so, edit `/etc/default/ovn-central`:

```
OVN_CTL_OPTS=" \
   --ovn-northd-log='-vsyslog:info --syslog-method=unix:/var/snap/lxd/common/lxd/syslog.
↪socket' \
   --ovn-nb-log='-vsyslog:info --syslog-method=unix:/var/snap/lxd/common/lxd/syslog.
↪socket' \
   --ovn-sb-log='-vsyslog:info --syslog-method=unix:/var/snap/lxd/common/lxd/syslog.
↪socket'"

sudo systemctl restart ovn-central.service
```

How to configure network load balancers

Note: Network load balancers are currently available for the *OVN network*.

Network load balancers are similar to forwards in that they allow specific ports on an external IP address to be forwarded to specific ports on internal IP addresses in the network that the load balancer belongs to. The difference between load balancers and forwards is that load balancers can be used to share ingress traffic between multiple internal backend addresses.

This feature can be useful if you have limited external IP addresses or want to share a single external address and ports over multiple instances.

A load balancer is made up of:

- A single external listen IP address.
- One or more named backends consisting of an internal IP and optional port ranges.
- One or more listen port ranges that are configured to forward to one or more named backends.

Create a network load balancer

Use the following command to create a network load balancer:

```
lxc network load-balancer create <network_name> [<listen_address>] [--allocate=ipv{4,6}]␣
↪[configuration_options...]
```

Each load balancer is assigned to a network. Listen addresses are subject to restrictions (see *Requirements for listen addresses* for more information about which addresses can be load-balanced). If a listen address is not given, the `--allocate` flag must be provided.

Load balancer properties

Network load balancers have the following properties: `backends` List of backend specifications

Key:	`backends`
Type:	backend list
Required:	no

See *Configure backends*.

`config` User-provided free-form key/value pairs

Key:	`config`
Type:	string set
Required:	no

The only supported keys are `user.*` custom keys.

`description` Description of the network load balancer

Key:	`description`
Type:	string
Required:	no

`listen_address` IP address to listen on

Key:	`listen_address`
Type:	string
Required:	no

`ports` List of port specifications

Key:	`ports`
Type:	port list
Required:	no

See *Configure ports*.

Requirements for listen addresses

The following requirements must be met for valid listen addresses:

- Allowed listen addresses must be defined in the uplink network's `ipv{n}.routes` settings or the project's *`restricted.networks.subnets`* setting (if set).
- The listen address must not overlap with a subnet that is in use with another network or entity in that network.
- If the `--allocate` flag is provided, an IP address will be allocated from the uplink network's `ipv{n}.routes` or the project's *`restricted.networks.subnets`* setting (if set).

Configure backends

You can add backend specifications to the network load balancer to define target addresses (and optionally ports). The backend target address must be within the same subnet as the network that the load balancer is associated to.

Use the following command to add a backend specification:

```
lxc network load-balancer backend add <network_name> <listen_address> <backend_name>
↪<listen_ports> <target_address> [<target_ports>]
```

The target ports are optional. If not specified, the load balancer will use the listen ports for the backend for the backend target ports.

If you want to forward the traffic to different ports, you have two options:

- Specify a single target port to forward traffic from all listen ports to this target port.
- Specify a set of target ports with the same number of ports as the listen ports to forward traffic from the first listen port to the first target port, the second listen port to the second target port, and so on.

Backend properties

Network load balancer backends have the following properties: `description` Description of the backend

Key:	`description`
Type:	string
Required:	no

`name` Name of the backend

Key:	`name`
Type:	string
Required:	yes

`target_address` IP address to forward to

Key:	`target_address`
Type:	string
Required:	yes

`target_port` Target port or ports

Key:	`target_port`
Type:	string
Default:	same as *`listen_port`*
Required:	no

For example: `70,80-90` or `90`

Configure ports

You can add port specifications to the network load balancer to forward traffic from specific ports on the listen address to specific ports on one or more target backends.

Use the following command to add a port specification:

```
lxc network load-balancer port add <network_name> <listen_address> <protocol> <listen_
↪ports> <backend_name>[,<backend_name>...]
```

You can specify a single listen port or a set of ports. The backend(s) specified must have target port(s) settings compatible with the port's listen port(s) setting.

Port properties

Network load balancer ports have the following properties: `description` Description of the port or ports

Key:	`description`
Type:	string
Required:	no

`listen_port` Listen port or ports

Key:	`listen_port`
Type:	string
Required:	yes

For example: `80,90-100`

`protocol` Protocol for the port or ports

Key:	`protocol`
Type:	string
Required:	yes

Possible values are `tcp` and `udp`.

`target_backend` Backend name or names to forward to

Key:	`target_backend`
Type:	backend list
Required:	yes

Edit a network load balancer

Use the following command to edit a network load balancer:

```
lxc network load-balancer edit <network_name> <listen_address>
```

This command opens the network load balancer in YAML format for editing. You can edit both the general configuration, backend and the port specifications.

Delete a network load balancer

Use the following command to delete a network load balancer:

```
lxc network load-balancer delete <network_name> <listen_address>
```

How to create OVN peer routing relationships

Important: This guide applies to OVN networks only.

By default, traffic between two OVN networks goes through the uplink network. This path is inefficient, however, because packets must leave the OVN subsystem and transit through the host's networking stack (and, potentially, an external network) and back into the OVN subsystem of the target network. Depending on how the host's networking is configured, this might limit the available bandwidth (if the OVN overlay network is on a higher bandwidth network than the host's external network).

Therefore, LXD allows creating peer routing relationships between two OVN networks. Using this method, traffic between the two networks can go directly from one OVN network to the other and thus stays within the OVN subsystem, rather than transiting through the uplink network.

Create a routing relationship between networks

To add a peer routing relationship between two networks, you must create a network peering for both networks. The relationship must be mutual. If you set it up on only one network, the routing relationship will be in pending state, but not active.

When creating the peer routing relationship, specify a peering name that identifies the relationship for the respective network. The name can be chosen freely, and you can use it later to edit or delete the relationship.

Use the following commands to create a peer routing relationship between networks in the same project:

```
lxc network peer create <network1> <peering_name> <network2> [configuration_options]
lxc network peer create <network2> <peering_name> <network1> [configuration_options]
```

You can also create peer routing relationships between OVN networks in different projects:

```
lxc network peer create <network1> <peering_name> <project2/network2> [configuration_
↪options] --project=<project1>
lxc network peer create <network2> <peering_name> <project1/network1> [configuration_
↪options] --project=<project2>
```

Important: If the project or the network name is incorrect, the command will not return any error indicating that the respective project/network does not exist, and the routing relationship will remain in pending state. This behavior prevents users in a different project from discovering whether a project and network exists.

Peering properties

Peer routing relationships have the following properties: `config` User-provided free-form key/value pairs

Key:	`config`
Type:	string set
Required:	no

The only supported keys are `user.*` custom keys.

`description` Description of the network peering

Key:	`description`
Type:	string
Required:	no

`name` Name of the network peering on the local network

Key:	`name`
Type:	string
Required:	yes

`status` Status indicating if pending or created

Key:	`status`
Type:	string
Required:	–

Indicates if mutual peering exists with the target network. This property is read-only and cannot be updated.

`target_network` Which network to create a peering with

Key:	`target_network`
Type:	string
Required:	yes

This option must be set at create time.

`target_project` Which project the target network exists in

Key:	`target_project`
Type:	string
Required:	yes

This option must be set at create time.

List routing relationships

To list all network peerings for a network, use the following command:

```
lxc network peer list <network>
```

Edit a routing relationship

Use the following command to edit a network peering:

```
lxc network peer edit <network> <peering_name>
```

This command opens the network peering in YAML format for editing.

How to troubleshoot your networking setup:

How to display IPAM information of a LXD deployment

IPAM (IP Address Management) is a method used to plan, track, and manage the information associated with a computer network's IP address space. In essence, it's a way of organizing, monitoring, and manipulating the IP space in a network.

Checking the IPAM information for your LXD setup can help you debug networking issues. You can see which IP addresses are used for instances, network interfaces, forwards, and load balancers and use this information to track down where traffic is lost.

To display IPAM information, enter the following command:

```
lxc network list-allocations
```

By default, this command shows the IPAM information for the `default` project. You can select a different project with the `--project` flag, or specify `--all-projects` to display the information for all projects.

The resulting output will look something like this:

```
+---------------------+-----------------+----------+------+-------------------+
|       USED BY       |      ADDRESS    |   TYPE   | NAT  | HARDWARE ADDRESS  |
+---------------------+-----------------+----------+------+-------------------+
| /1.0/networks/lxdbr0 | 192.0.2.0/24    | network  | true |                   |
+---------------------+-----------------+----------+------+-------------------+
| /1.0/networks/lxdbr0 | 2001:db8::/32   | network  | true |                   |
+---------------------+-----------------+----------+------+-------------------+
| /1.0/instances/u1    | 2001:db8::1/128 | instance | true | 00:16:3e:04:f0:95 |
+---------------------+-----------------+----------+------+-------------------+
| /1.0/instances/u1    | 192.0.2.2/32    | instance | true | 00:16:3e:04:f0:95 |
+---------------------+-----------------+----------+------+-------------------+

...
```

Each listed entry lists the IP address (in CIDR notation) of one of the following LXD entities: `network`, `network-forward`, `network-load-balancer`, and `instance`. An entry contains an IP address using the CIDR notation. It also contains a LXD resource URI, the type of the entity, whether it is in NAT mode, and the hardware address (only for the `instance` entity).

Related topics

Explanation:

- *About networking*

Reference:

- *Networks*

Troubleshooting

If you run into problems when using LXD, check the following how-to guides to see if they help resolve your issue:

Additional instructions are available in the following guides:

How to debug LXD

For information on debugging instance issues, see *How to troubleshoot failing instances*.

Debugging `lxc` and `lxd`

Here are different ways to help troubleshooting `lxc` and `lxd` code.

`lxc --debug`

Adding `--debug` flag to any client command will give extra information about internals. If there is no useful info, it can be added with the logging call:

```
logger.Debugf("Hello: %s", "Debug")
```

`lxc monitor`

This command will monitor messages as they appear on remote server.

REST API through local socket

On server side the most easy way is to communicate with LXD through local socket. This command accesses `GET /1.0` and formats JSON into human readable form using jq utility:

```
curl --unix-socket /var/lib/lxd/unix.socket lxd/1.0 | jq .
```

or for snap users:

```
curl --unix-socket /var/snap/lxd/common/lxd/unix.socket lxd/1.0 | jq .
```

See the *RESTful API* for available API.

REST API through HTTPS

HTTPS connection to LXD requires valid client certificate that is generated on first `lxc remote add`. This certificate should be passed to connection tools for authentication and encryption.

If desired, `openssl` can be used to examine the certificate (`~/.config/lxc/client.crt` or `~/snap/lxd/common/config/client.crt` for snap users):

```
openssl x509 -text -noout -in client.crt
```

Among the lines you should see:

```
Certificate purposes:
SSL client : Yes
```

With command line tools

```
wget --no-check-certificate --certificate=$HOME/.config/lxc/client.crt --private-key=
↪$HOME/.config/lxc/client.key -qO - https://127.0.0.1:8443/1.0

# or for snap users
wget --no-check-certificate --certificate=$HOME/snap/lxd/common/config/client.crt --
↪private-key=$HOME/snap/lxd/common/config/client.key -qO - https://127.0.0.1:8443/1.0
```

With browser

Some browser plugins provide convenient interface to create, modify and replay web requests. To authenticate against LXD server, convert `lxc` client certificate into importable format and import it into browser.

For example this produces `client.pfx` in Windows-compatible format:

```
openssl pkcs12 -clcerts -inkey client.key -in client.crt -export -out client.pfx
```

After that, opening `https://127.0.0.1:8443/1.0` should work as expected.

Debug the LXD database

The files of the global *database* are stored under the `./database/global` sub-directory of your LXD data directory (e.g. `/var/lib/lxd/database/global` or `/var/snap/lxd/common/lxd/database/global` for snap users).

Since each member of the cluster also needs to keep some data which is specific to that member, LXD also uses a plain SQLite database (the "local" database), which you can find in `./database/local.db`.

Backups of the global database directory and of the local database file are made before upgrades, and are tagged with the `.bak` suffix. You can use those if you need to revert the state as it was before the upgrade.

Dumping the database content or schema

If you want to get a SQL text dump of the content or the schema of the databases, use the `lxd sql <local|global> [.dump|.schema]` command, which produces the equivalent output of the `.dump` or `.schema` directives of the `sqlite3` command line tool.

Running custom queries from the console

If you need to perform SQL queries (e.g. `SELECT`, `INSERT`, `UPDATE`) against the local or global database, you can use the `lxd sql` command (run `lxd sql --help` for details).

You should only need to do that in order to recover from broken updates or bugs. Please consult the LXD team first (creating a GitHub issue or forum post).

Running custom queries at LXD daemon startup

In case the LXD daemon fails to start after an upgrade because of SQL data migration bugs or similar problems, it's possible to recover the situation by creating `.sql` files containing queries that repair the broken update.

To perform repairs against the local database, write a `./database/patch.local.sql` file containing the relevant queries, and similarly a `./database/patch.global.sql` for global database repairs.

Those files will be loaded very early in the daemon startup sequence and deleted if the queries were successful (if they fail, no state will change as they are run in a SQL transaction).

As above, please consult the LXD team first.

Syncing the cluster database to disk

If you want to flush the content of the cluster database to disk, use the `lxd sql global .sync` command, that will write a plain SQLite database file into `./database/global/db.bin`, which you can then inspect with the `sqlite3` command line tool.

Frequently asked questions

The following sections give answers to frequently asked questions. They explain how to resolve common issues and point you to more detailed information.

Why do my instances not have network access?

Most likely, your firewall blocks network access for your instances. See *How to configure your firewall* for more information about the problem and how to fix it.

Another frequent reason for connectivity issues is running LXD and Docker on the same host. See *Prevent connectivity issues with LXD and Docker* for instructions on how to fix such issues.

How to enable the LXD server for remote access?

By default, the LXD server is not accessible from the network, because it only listens on a local Unix socket.

You can enable it for remote access by following the instructions in *How to expose LXD to the network*.

When I do a `lxc remote add`, it asks for a password or token?

To be able to access the remote API, clients must authenticate with the LXD server. Depending on how the remote server is configured, you must provide either a trust token issued by the server or specify a trust password (if *`core.trust_password`* is set).

See *Authenticate with the LXD server* for instructions on how to authenticate using a trust token (the recommended way), and *Remote API authentication* for information about other authentication methods.

Why should I not run privileged containers?

A privileged container can do things that affect the entire host - for example, it can use things in `/sys` to reset the network card, which will reset it for the entire host, causing network blips. See *Container security* for more information.

Almost everything can be run in an unprivileged container, or - in cases of things that require unusual privileges, like wanting to mount NFS file systems inside the container - you might need to use bind mounts.

Can I bind-mount my home directory in a container?

Yes, you can do this by using a *disk device*:

```
lxc config device add container-name home disk source=/home/${USER} path=/home/ubuntu
```

For unprivileged containers, you need to make sure that the user in the container has working read/write permissions. Otherwise, all files will show up as the overflow UID/GID (`65536:65536`) and access to anything that's not world-readable will fail. Use either of the following methods to grant the required permissions:

- Pass `shift=true` to the *`lxc config device add`* call. This depends on the kernel and file system supporting either idmapped mounts (see *`lxc info`*).
- Add a `raw.idmap` entry (see *Idmaps for user namespace*).
- Place recursive POSIX ACLs on your home directory.

Privileged containers do not have this issue because all UID/GID in the container are the same as outside. But that's also the cause of most of the security issues with such privileged containers.

How can I run Docker inside a LXD container?

To run Docker inside a LXD container, set the *`security.nesting`* option of the container to `true`:

```
lxc config set <container> security.nesting true
```

If you plan to use the OverlayFS storage driver in Docker, you should also set the *`security.syscalls.intercept.mknod`* and *`security.syscalls.intercept.setxattr`* options to `true`. See *`mknod/mknodat`* and *`setxattr`* for more information.

Note that LXD containers cannot load kernel modules, so depending on your Docker configuration, you might need to have extra kernel modules loaded by the host. You can do so by setting a comma-separated list of kernel modules that your container needs:

```
lxc config set <container_name> linux.kernel_modules <modules>
```

In addition, creating a `/.dockerenv` file in your container can help Docker ignore some errors it's getting due to running in a nested environment.

Where does the LXD client (`lxc`) store its configuration?

The *`lxc`* command stores its configuration under `~/.config/lxc`, or in `~/snap/lxd/common/config` for snap users.

Various configuration files are stored in that directory, for example:

- `client.crt`: client certificate (generated on demand)
- `client.key`: client key (generated on demand)
- `config.yml`: configuration file (info about `remotes`, `aliases`, etc.)
- `servercerts/`: directory with server certificates belonging to `remotes`

Why can I not ping my LXD instance from another host?

Many switches do not allow MAC address changes, and will either drop traffic with an incorrect MAC or disable the port totally. If you can ping a LXD instance from the host, but are not able to ping it from a different host, this could be the cause.

The way to diagnose this problem is to run a `tcpdump` on the uplink and you will see either `ARP Who has `xx.xx.xx.xx` tell `yy.yy.yy.yy` `, with you sending responses but them not getting acknowledged, or ICMP packets going in and out successfully, but never being received by the other host.

How can I monitor what LXD is doing?

To see detailed information about what LXD is doing and what processes it is running, use the *`lxc monitor`* command.

For example, to show a human-readable output of all types of messages, enter the following command:

```
lxc monitor --pretty
```

See *`lxc monitor --help`* for all options, and *How to debug LXD* for more information.

Why does LXD stall when creating an instance?

Check if your storage pool is out of space (by running *`lxc storage info <pool_name>`*). In that case, LXD cannot finish unpacking the image, and the instance that you're trying to create shows up as stopped.

To get more insight into what is happening, run *`lxc monitor`* (see *How can I monitor what LXD is doing?*), and check `sudo dmesg` for any I/O errors.

Why does starting containers suddenly fail?

If starting containers suddenly fails with a cgroup-related error message (`Failed to mount "/sys/fs/cgroup"`), this might be due to running a VPN client on the host.

This is a known issue for both Mullvad VPN and Private Internet Access VPN, but might occur for other VPN clients as well. The problem is that the VPN client mounts the `net_cls` cgroup1 over cgroup2 (which LXD uses).

The easiest fix for this problem is to stop the VPN client and unmount the `net_cls` cgroup1 with the following command:

```
umount /sys/fs/cgroup/net_cls
```

If you need to keep the VPN client running, mount the `net_cls` cgroup1 in another location and reconfigure your VPN client accordingly. See this Discourse post for instructions for Mullvad VPN.

Why does LXD not start on Ubuntu 20.04 or earlier?

If you are running LXD on Ubuntu 20.04 or earlier, you might be missing support for ZFS 2.1 in the kernel (see the *requirements*).

If LXD fails to start, check the `/var/snap/lxd/common/lxd/logs/lxd.log` log file for the following error to see if the reason is missing ZFS support:

```
Error: Required tool 'zpool' is missing
```

If you are on Ubuntu 20.04, you can resolve the issue by installing the HWE kernel and rebooting the nodes to provide the required kernel drivers for ZFS 2.1:

```
sudo apt-get update
sudo apt-get install linux-generic-hwe-20.04
```

If you are on earlier versions of Ubuntu, you should use a compatible LTS release of LXD.

If you cannot resolve the issue on your own, see *How to get support* for information about where to get help.

2.2.3 Get ready for production

Once you are ready for production, consider setting up a LXD cluster to support the required load. You should also monitor you server or servers and configure them for the expected load.

Clustering

The following how-to guides cover common operations related to clustering.

How to create and configure a cluster:

How to form a cluster

When forming a LXD cluster, you start with a bootstrap server. This bootstrap server can be an existing LXD server or a newly installed one.

After initializing the bootstrap server, you can join additional servers to the cluster. See *Cluster members* for more information.

You can form the LXD cluster interactively by providing configuration information during the initialization process or by using preseed files that contain the full configuration.

To quickly and automatically set up a basic LXD cluster, you can use MicroCloud. Note, however, that this project is still in an early phase.

Configure the cluster interactively

To form your cluster, you must first run `lxd init` on the bootstrap server. After that, run it on the other servers that you want to join to the cluster.

When forming a cluster interactively, you answer the questions that `lxd init` prompts you with to configure the cluster.

Initialize the bootstrap server

To initialize the bootstrap server, run `lxd init` and answer the questions according to your desired configuration.

You can accept the default values for most questions, but make sure to answer the following questions accordingly:

- `Would you like to use LXD clustering?`

  Select **yes**.

- `What IP address or DNS name should be used to reach this server?`

  Make sure to use an IP or DNS address that other servers can reach.

- `Are you joining an existing cluster?`

  Select **no**.

- `Setup password authentication on the cluster?`

  Select **no** to use *authentication tokens* (recommended) or **yes** to use a *trust password*.

```
user@host:~$ lxd init        Would you like to use LXD clustering? (yes/no) [default=no]:
yesWhat IP address or DNS name should be used to reach this server? [default=192.0.2.
101]:Are you joining an existing cluster? (yes/no) [default=no]:  noWhat member name
should be used to identify this server in the cluster? [default=server1]:Setup password
authentication on the cluster? (yes/no) [default=no]:  noDo you want to configure a
new local storage pool? (yes/no) [default=yes]:Name of the storage backend to use
(btrfs, dir, lvm, zfs) [default=zfs]:Create a new ZFS pool? (yes/no) [default=yes]:Would
you like to use an existing empty block device (e.g. a disk or partition)? (yes/no)
[default=no]:Size in GiB of the new loop device (1GiB minimum) [default=9GiB]:Do you
want to configure a new remote storage pool? (yes/no) [default=no]:Would you like to
connect to a MAAS server? (yes/no) [default=no]:Would you like to configure LXD to use
an existing bridge or host interface? (yes/no) [default=no]:Would you like to create a
new Fan overlay network? (yes/no) [default=yes]:What subnet should be used as the Fan
underlay? [default=auto]:Would you like stale cached images to be updated automatically?
(yes/no) [default=yes]:Would you like a YAML "lxd init" preseed to be printed? (yes/no)
[default=no]:
```

After the initialization process finishes, your first cluster member should be up and available on your network. You can check this with *lxc cluster list*.

Join additional servers

You can now join further servers to the cluster.

Note: The servers that you add should be newly installed LXD servers. If you are using existing servers, make sure to clear their contents before joining them, because any existing data on them will be lost.

To join a server to the cluster, run `lxd init` on the cluster. Joining an existing cluster requires root privileges, so make sure to run the command as root or with `sudo`.

Basically, the initialization process consists of the following steps:

1. Request to join an existing cluster.

   Answer the first questions that `lxd init` asks accordingly:

   - `Would you like to use LXD clustering?`

     Select **yes**.

   - `What IP address or DNS name should be used to reach this server?`

     Make sure to use an IP or DNS address that other servers can reach.

   - `Are you joining an existing cluster?`

     Select **yes**.

   - `Do you have a join token?`

     Select **yes** if you configured the bootstrap server to use *authentication tokens* (recommended) or **no** if you configured it to use a *trust password*.

2. Authenticate with the cluster.

   There are two alternative methods, depending on which authentication method you choose when configuring the bootstrap server.

   Authentication tokens (recommended)

   Trust password

   If you configured your cluster to use *authentication tokens*, you must generate a join token for each new member. To do so, run the following command on an existing cluster member (for example, the bootstrap server):

   ```
   lxc cluster add <new_member_name>
   ```

   This command returns a single-use join token that is valid for a configurable time (see *cluster.join_token_expiry*). Enter this token when `lxd init` prompts you for the join token.

   The join token contains the addresses of the existing online members, as well as a single-use secret and the fingerprint of the cluster certificate. This reduces the amount of questions that you must answer during `lxd init`, because the join token can be used to answer these questions automatically.

   If you configured your cluster to use a *trust password*, `lxd init` requires more information about the cluster before it can start the authorization process:

   1. Specify a name for the new cluster member.

2. Provide the address of an existing cluster member (the bootstrap server or any other server you have already added).
3. Verify the fingerprint for the cluster.
4. If the fingerprint is correct, enter the trust password to authorize with the cluster.

3. Confirm that all local data for the server is lost when joining a cluster.
4. Configure server-specific settings (see *Member configuration* for more information).

   You can accept the default values or specify custom values for each server.

Authentication tokens (recommended)

Trust password

```
user@host:~$ sudo lxd init   Would you like to use LXD clustering? (yes/no) [default=no]:
yesWhat IP address or DNS name should be used to reach this server? [default=192.
0.2.102]:Are you joining an existing cluster? (yes/no) [default=no]:  yesDo you
have a join token? (yes/no/[token]) [default=no]:  yesPlease provide join token:
eyJzZXJ2ZXJfbmFtZSI6InJwaTAxIiwiZmluZ2VycHJpbnQiOiIyNjZjZmExZDk0ZDZiMjk2Nzk0YjU0YzJlYzdjOTMwNDA5ZjIzNjdh
existing data is lost when joining a cluster, continue? (yes/no) [default=no] yesChoose
"size" property for storage pool "local":Choose "source" property for storage pool
"local":Choose "zfs.pool_name" property for storage pool "local":Would you like a
YAML "lxd init" preseed to be printed? (yes/no) [default=no]:                user@host:~$
sudo lxd init       Would you like to use LXD clustering? (yes/no) [default=no]:  yesWhat
IP address or DNS name should be used to reach this server? [default=192.0.2.
102]:Are you joining an existing cluster? (yes/no) [default=no]:  yesDo you have a
join token? (yes/no/[token]) [default=no]:  noWhat member name should be used to
identify this server in the cluster? [default=server2]:IP address or FQDN of an
existing cluster member (may include port):  192.0.2.101:8443Cluster fingerprint:
2915dafdf5c159681a9086f732644fb70680533b0fb9005b8c6e9bca51533113You can validate this
fingerprint by running "lxc info" locally on an existing cluster member.Is this the
correct fingerprint? (yes/no/[fingerprint]) [default=no]:  yesCluster trust password:All
existing data is lost when joining a cluster, continue? (yes/no) [default=no] yesChoose
"size" property for storage pool "local":Choose "source" property for storage pool
"local":Choose "zfs.pool_name" property for storage pool "local":Would you like a YAML
"lxd init" preseed to be printed? (yes/no) [default=no]:
```

After the initialization process finishes, your server is added as a new cluster member. You can check this with *`lxc cluster list`*.

Configure the cluster through preseed files

To form your cluster, you must first run `lxd init` on the bootstrap server. After that, run it on the other servers that you want to join to the cluster.

Instead of answering the `lxd init` questions interactively, you can provide the required information through preseed files. You can feed a file to `lxd init` with the following command:

```
cat <preseed-file> | lxd init --preseed
```

You need a different preseed file for every server.

Initialize the bootstrap server

The required contents of the preseed file depend on whether you want to use *authentication tokens* (recommended) or a *trust password* for authentication.

Authentication tokens (recommended)

Trust password

To enable clustering, the preseed file for the bootstrap server must contain the following fields:

```
config:
  core.https_address: <IP_address_and_port>
cluster:
  server_name: <server_name>
  enabled: true
```

Here is an example preseed file for the bootstrap server:

```
config:
  core.https_address: 192.0.2.101:8443
  images.auto_update_interval: 15
storage_pools:
- name: default
  driver: dir
- name: my-pool
  driver: zfs
networks:
- name: lxdbr0
  type: bridge
profiles:
- name: default
  devices:
    root:
      path: /
      pool: my-pool
      type: disk
    eth0:
      name: eth0
      nictype: bridged
      parent: lxdbr0
      type: nic
cluster:
  server_name: server1
  enabled: true
```

To enable clustering, the preseed file for the bootstrap server must contain the following fields:

```
config:
  core.https_address: <IP_address_and_port>
  core.trust_password: <trust_password>
cluster:
  server_name: <server_name>
  enabled: true
```

Here is an example preseed file for the bootstrap server:

```
config:
  core.trust_password: the_password
  core.https_address: 192.0.2.101:8443
  images.auto_update_interval: 15
storage_pools:
- name: default
  driver: dir
- name: my-pool
  driver: zfs
networks:
- name: lxdbr0
  type: bridge
profiles:
- name: default
  devices:
    root:
      path: /
      pool: my-pool
      type: disk
    eth0:
      name: eth0
      nictype: bridged
      parent: lxdbr0
      type: nic
cluster:
  server_name: server1
  enabled: true
```

See *Preseed YAML file fields* for the complete fields of the preseed YAML file.

Join additional servers

The required contents of the preseed files depend on whether you configured the bootstrap server to use *authentication tokens* (recommended) or a *trust password* for authentication.

The preseed files for new cluster members require only a `cluster` section with data and configuration values that are specific to the joining server.

Authentication tokens (recommended)

Trust password

The preseed file for additional servers must include the following fields:

```
cluster:
  enabled: true
  server_address: <IP_address_of_server>
  cluster_token: <join_token>
```

Here is an example preseed file for a new cluster member:

```
cluster:
  enabled: true
  server_address: 192.0.2.102:8443
```

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```
  cluster_token:␣
↪eyJzZXJ2ZXJfbmFtZSI6Im5vZGUyIiwiZmluZ2VycHJpbnQiOiJjZjlmNmVhMWIzYjhiNjgxNzQ1YTY1NTY2YjM3ZGUwOTUzNjRmM
  member_config:
  - entity: storage-pool
    name: default
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: driver
    value: "zfs"
```

The preseed file for additional servers must include the following fields:

```
cluster:
  server_name: <server_name>
  enabled: true
  cluster_address: <IP_address_of_bootstrap_server>
  server_address: <IP_address_of_server>
  cluster_password: <trust_password>
  cluster_certificate: <certificate> # use this or cluster_certificate_path
  cluster_certificate_path: <path_to-certificate_file> # use this or cluster_certificate
```

To create a YAML-compatible entry for the `cluster_certificate` key, run one the following commands on the bootstrap server:

- When using the snap: `sed ':a;N;$!ba;s/\n/\n\n/g' /var/snap/lxd/common/lxd/cluster.crt`
- Otherwise: `sed ':a;N;$!ba;s/\n/\n\n/g' /var/lib/lxd/cluster.crt`

Alternatively, copy the `cluster.crt` file from the bootstrap server to the server that you want to join and specify its path in the `cluster_certificate_path` key.

Here is an example preseed file for a new cluster member:

```
cluster:
  server_name: server2
  enabled: true
  server_address: 192.0.2.102:8443
  cluster_address: 192.0.2.101:8443
  cluster_certificate: "-----BEGIN CERTIFICATE-----

opyQ1VRpAg2sV2C4W8irbNqeUsTeZZxhLqp4vNOXXBBrSqUCdPu1JXADV0kavg1l

2sXYoMobyV3K+RaJgsr1OiHjacGiGCQT3YyNGGY/n5zgT/8xI0Dquvja0bNkaf6f

...

-----END CERTIFICATE-----
"
```

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```
  cluster_password: the_password
  member_config:
  - entity: storage-pool
    name: default
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: driver
    value: "zfs"
```

See *Preseed YAML file fields* for the complete fields of the preseed YAML file.

Use MicroCloud

Instead of setting up your LXD cluster manually, you can use MicroCloud to get a fully highly available LXD cluster with OVN and with Ceph storage up and running.

To install the required snaps, run the following command:

```
snap install lxd microceph microovn microcloud
```

Then start the bootstrapping process with the following command:

```
microcloud init
```

During the initialization process, MicroCloud detects the other servers, sets up OVN networking and prompts you to add disks to Ceph.

When the initialization is complete, you'll have an OVN cluster, a Ceph cluster and a LXD cluster, and LXD itself will have been configured with both networking and storage suitable for use in a cluster.

See the MicroCloud documentation for more information.

How to manage a cluster

After your cluster is formed, use *`lxc cluster list`* to see a list of its members and their status:

```
user@host:~$ lxc cluster list+---------+----------------------------+------------------+--------------+
NAME | URL | ROLES | ARCHITECTURE | FAILURE DOMAIN | DESCRIPTION | STATE | MESSAGE
|+---------+----------------------------+------------------+--------------+----------------+-----------
server1 | https://192.0.2.101:8443 | database-leader | x86_64 | default | | ONLINE |
Fully operational || | | database | | | | |+---------+----------------------------+------------------
server2 | https://192.0.2.102:8443 | database-standby | aarch64 | default | | ONLINE |
Fully operational |+---------+----------------------------+------------------+--------------+----------
server3 | https://192.0.2.103:8443 | database-standby | aarch64 | default | | ONLINE |
Fully operational |+---------+----------------------------+------------------+--------------+----------
```

To see more detailed information about an individual cluster member, run the following command:

```
lxc cluster show <member_name>
```

To see state and usage information for a cluster member, run the following command:

```
lxc cluster info <member_name>
```

Configure your cluster

To configure your cluster, use *lxc config*. For example:

```
lxc config set cluster.max_voters 5
```

Keep in mind that some *server configuration options* are global and others are local. You can configure the global options on any cluster member, and the changes are propagated to the other cluster members through the distributed database. The local options are set only on the server where you configure them (or alternatively on the server that you target with `--target`).

In addition to the server configuration, there are a few cluster configurations that are specific to each cluster member. See *Cluster member configuration* for all available configurations.

To set these configuration options, use *lxc cluster set* or *lxc cluster edit*. For example:

```
lxc cluster set server1 scheduler.instance manual
```

Assign member roles

To add or remove a *member role* for a cluster member, use the *lxc cluster role* command. For example:

```
lxc cluster role add server1 event-hub
```

Note: You can add or remove only those roles that are not assigned automatically by LXD.

Edit the cluster member configuration

To edit all properties of a cluster member, including the member-specific configuration, the member roles, the failure domain and the cluster groups, use the *lxc cluster edit* command.

Evacuate and restore cluster members

There are scenarios where you might need to empty a given cluster member of all its instances (for example, for routine maintenance like applying system updates that require a reboot, or to perform hardware changes).

To do so, use the *lxc cluster evacuate* command. This command migrates all instances on the given server, moving them to other cluster members. The evacuated cluster member is then transitioned to an "evacuated" state, which prevents the creation of any instances on it.

You can control how each instance is moved through the *cluster.evacuate* instance configuration key. Instances are shut down cleanly, respecting the *boot.host_shutdown_timeout* configuration key.

When the evacuated server is available again, use the *lxc cluster restore* command to move the server back into a normal running state. This command also moves the evacuated instances back from the servers that were temporarily holding them.

Automatic evacuation

If you set the *cluster.healing_threshold* configuration to a non-zero value, instances are automatically evacuated if a cluster member goes offline.

When the evacuated server is available again, you must manually restore it.

Delete cluster members

To cleanly delete a member from the cluster, use the following command:

```
lxc cluster remove <member_name>
```

You can only cleanly delete members that are online and that don't have any instances located on them.

Deal with offline cluster members

If a cluster member goes permanently offline, you can force-remove it from the cluster. Make sure to do so as soon as you discover that you cannot recover the member. If you keep an offline member in your cluster, you might encounter issues when upgrading your cluster to a newer version.

To force-remove a cluster member, enter the following command on one of the cluster members that is still online:

```
lxc cluster remove --force <member_name>
```

Caution: Force-removing a cluster member will leave the member's database in an inconsistent state (for example, the storage pool on the member will not be removed). As a result, it will not be possible to re-initialize LXD later, and the server must be fully reinstalled.

Upgrade cluster members

To upgrade a cluster, you must upgrade all of its members. All members must be upgraded to the same version of LXD.

Caution: Do not attempt to upgrade your cluster if any of its members are offline. Offline members cannot be upgraded, and your cluster will end up in a blocked state.

Also note that if you are using the snap, upgrades might happen automatically, so to prevent any issues you should always recover or remove offline members immediately.

To upgrade a single member, simply upgrade the LXD package on the host and restart the LXD daemon. For example, if you are using the snap then refresh to the latest version and cohort in the current channel (also reloads LXD):

```
sudo snap refresh lxd --cohort="+"
```

If the new version of the daemon has database schema or API changes, the upgraded member might transition into a "blocked" state. In this case, the member does not serve any LXD API requests (which means that `lxc` commands don't work on that member anymore), but any running instances will continue to run.

This happens if there are other cluster members that have not been upgraded and are therefore running an older version. Run *`lxc cluster list`* on a cluster member that is not blocked to see if any members are blocked.

As you proceed upgrading the rest of the cluster members, they will all transition to the "blocked" state. When you upgrade the last member, the blocked members will notice that all servers are now up-to-date, and the blocked members become operational again.

Update the cluster certificate

In a LXD cluster, the API on all servers responds with the same shared certificate, which is usually a standard self-signed certificate with an expiry set to ten years.

The certificate is stored at `/var/snap/lxd/common/lxd/cluster.crt` (if you use the snap) or `/var/lib/lxd/cluster.crt` (otherwise) and is the same on all cluster members.

You can replace the standard certificate with another one, for example, a valid certificate obtained through ACME services (see *TLS server certificate* for more information). To do so, use the *`lxc cluster update-certificate`* command. This command replaces the certificate on all servers in your cluster.

How to configure networks for a cluster

All members of a cluster must have identical networks defined. The only configuration keys that may differ between networks on different members are *`bridge.external_interfaces`*, *`parent`*, *`bgp.ipv4.nexthop`*, and *`bgp.ipv6.nexthop`*. See *Member configuration* for more information.

Creating additional networks is a two-step process:

1. Define and configure the new network across all cluster members. For example, for a cluster that has three members:

   ```
   lxc network create --target server1 my-network
   lxc network create --target server2 my-network
   lxc network create --target server3 my-network
   ```

   Note: You can pass only the member-specific configuration keys `bridge.external_interfaces`, `parent`, `bgp.ipv4.nexthop` and `bgp.ipv6.nexthop`. Passing other configuration keys results in an error.

   These commands define the network, but they don't create it. If you run *`lxc network list`*, you can see that the network is marked as "pending".

2. Run the following command to instantiate the network on all cluster members:

   ```
   lxc network create my-network
   ```

   Note: You can add configuration keys that are not member-specific to this command.

   If you missed a cluster member when defining the network, or if a cluster member is down, you get an error.

Also see *Create a network in a cluster*.

Separate REST API and clustering networks

You can configure different networks for the REST API endpoint of your clients and for internal traffic between the members of your cluster. This separation can be useful, for example, to use a virtual address for your REST API, with DNS round robin.

To do so, you must specify different addresses for *cluster.https_address* (the address for internal cluster traffic) and *core.https_address* (the address for the REST API):

1. Create your cluster as usual, and make sure to use the address that you want to use for internal cluster traffic as the cluster address. This address is set as the `cluster.https_address` configuration.
2. After joining your members, set the `core.https_address` configuration to the address for the REST API. For example:

```
lxc config set core.https_address 0.0.0.0:8443
```

Note: `core.https_address` is specific to the cluster member, so you can use different addresses on different members. You can also use a wildcard address to make the member listen on multiple interfaces.

How to configure storage for a cluster

All members of a cluster must have identical storage pools. The only configuration keys that may differ between pools on different members are *source*, *size*, *zfs.pool_name*, *lvm.thinpool_name* and *lvm.vg_name*. See *Member configuration* for more information.

LXD creates a default `local` storage pool for each cluster member during initialization.

Creating additional storage pools is a two-step process:

1. Define and configure the new storage pool across all cluster members. For example, for a cluster that has three members:

```
lxc storage create --target server1 data zfs source=/dev/vdb1
lxc storage create --target server2 data zfs source=/dev/vdc1
lxc storage create --target server3 data zfs source=/dev/vdb1 size=10GiB
```

Note: You can pass only the member-specific configuration keys `source`, `size`, `zfs.pool_name`, `lvm.thinpool_name` and `lvm.vg_name`. Passing other configuration keys results in an error.

These commands define the storage pool, but they don't create it. If you run *lxc storage list*, you can see that the pool is marked as "pending".

2. Run the following command to instantiate the storage pool on all cluster members:

```
lxc storage create data zfs
```

Note: You can add configuration keys that are not member-specific to this command.

If you missed a cluster member when defining the storage pool, or if a cluster member is down, you get an error.

Also see *Create a storage pool in a cluster*.

View member-specific pool configuration

Running *lxc storage show <pool_name>* shows the cluster-wide configuration of the storage pool.

To view the member-specific configuration, use the `--target` flag. For example:

```
lxc storage show data --target server2
```

Create storage volumes

For most storage drivers (all except for Ceph-based storage drivers), storage volumes are not replicated across the cluster and exist only on the member for which they were created. Run *lxc storage volume list <pool_name>* to see on which member a certain volume is located.

When creating a storage volume, use the `--target` flag to create a storage volume on a specific cluster member. Without the flag, the volume is created on the cluster member on which you run the command. For example, to create a volume on the current cluster member `server1`:

```
lxc storage volume create local vol1
```

To create a volume with the same name on another cluster member:

```
lxc storage volume create local vol1 --target server2
```

Different volumes can have the same name as long as they live on different cluster members. Typical examples for this are image volumes.

You can manage storage volumes in a cluster in the same way as you do in non-clustered deployments, except that you must pass the `--target` flag to your commands if more than one cluster member has a volume with the given name. For example, to show information about the storage volumes:

```
lxc storage volume show local vol1 --target server1
lxc storage volume show local vol1 --target server2
```

How to work with a cluster:

How to manage instances in a cluster

In a cluster setup, each instance lives on one of the cluster members. You can operate each instance from any cluster member, so you do not need to log on to the cluster member on which the instance is located.

Launch an instance on a specific cluster member

When you launch an instance, you can target it to run on a specific cluster member. You can do this from any cluster member.

For example, to launch an instance named `c1` on the cluster member `server2`, use the following command:

```
lxc launch ubuntu:24.04 c1 --target server2
```

You can launch instances on specific cluster members or on specific *cluster groups*.

If you do not specify a target, the instance is assigned to a cluster member automatically. See *Automatic placement of instances* for more information.

Check where an instance is located

To check on which member an instance is located, list all instances in the cluster:

```
lxc list
```

The location column indicates the member on which each instance is running.

Move an instance

You can move an existing instance to another cluster member. For example, to move the instance `c1` to the cluster member `server1`, use the following commands:

```
lxc stop c1
lxc move c1 --target server1
lxc start c1
```

See *How to move existing LXD instances between servers* for more information.

To move an instance to a member of a cluster group, use the group name prefixed with `@` for the `--target` flag. For example:

```
lxc move c1 --target @group1
```

How to set up cluster groups

Cluster members can be assigned to *Cluster groups*. By default, all cluster members belong to the `default` group.

To create a cluster group, use the *`lxc cluster group create`* command. For example:

```
lxc cluster group create gpu
```

To assign a cluster member to one or more groups, use the *`lxc cluster group assign`* command. This command removes the specified cluster member from all the cluster groups it currently is a member of and then adds it to the specified group or groups.

For example, to assign `server1` to only the `gpu` group, use the following command:

```
lxc cluster group assign server1 gpu
```

To assign `server1` to the `gpu` group and also keep it in the `default` group, use the following command:

```
lxc cluster group assign server1 default,gpu
```

To add a cluster member to a specific group without removing it from other groups, use the *`lxc cluster group add`* command.

For example, to add `server1` to the `gpu` group and also keep it in the `default` group, use the following command:

```
lxc cluster group add server1 gpu
```

Launch an instance on a cluster group member

With cluster groups, you can target an instance to run on one of the members of the cluster group, instead of targeting it to run on a specific member.

Note: *scheduler.instance* must be set to either `all` (the default) or `group` to allow instances to be targeted to a cluster group.

See *Automatic placement of instances* for more information.

To launch an instance on a member of a cluster group, follow the instructions in *Launch an instance on a specific cluster member*, but use the group name prefixed with `@` for the `--target` flag. For example:

```
lxc launch ubuntu:24.04 c1 --target=@gpu
```

How to recover a cluster:

How to recover a cluster

It might happen that one or several members of your cluster go offline or become unreachable. In that case, no operations are possible on this member, and neither are operations that require a state change across all members. See *Offline members and fault tolerance* and *Automatic evacuation* for more information.

If you can bring the offline cluster members back or delete them from the cluster, operation resumes as normal. If this is not possible, there are a few ways to recover the cluster, depending on the scenario that caused the failure. See the following sections for details.

Note: When your cluster is in a state that needs recovery, most `lxc` commands do not work, because the LXD client cannot connect to the LXD daemon.

Therefore, the commands to recover the cluster are provided directly by the LXD daemon (`lxd`). Run `lxd cluster --help` for an overview of all available commands.

Recover from quorum loss

Every LXD cluster has a specific number of members (configured through *cluster.max_voters*) that serve as voting members of the distributed database. If you permanently lose a majority of these cluster members (for example, you have a three-member cluster and you lose two members), the cluster loses quorum and becomes unavailable. However, if at least one database member survives, it is possible to recover the cluster.

To do so, complete the following steps:

1. Log on to any surviving member of your cluster and run the following command:

   ```
   sudo lxd cluster list-database
   ```

   This command shows which cluster members have one of the database roles.

2. Pick one of the listed database members that is still online as the new leader. Log on to the machine (if it differs from the one you are already logged on to).

3. Make sure that the LXD daemon is not running on the machine. For example, if you're using the snap:

```
sudo snap stop lxd
```

4. Log on to all other cluster members that are still online and stop the LXD daemon.
5. On the server that you picked as the new leader, run the following command:

```
sudo lxd cluster recover-from-quorum-loss
```

6. Start the LXD daemon again on all machines, starting with the new leader. For example, if you're using the snap:

```
sudo snap start lxd
```

The database should now be back online. No information has been deleted from the database. All information about the cluster members that you have lost is still there, including the metadata about their instances. This can help you with further recovery steps if you need to re-create the lost instances.

To permanently delete the cluster members that you have lost, force-remove them. See *Delete cluster members*.

Recover cluster members with changed addresses

If some members of your cluster are no longer reachable, or if the cluster itself is unreachable due to a change in IP address or listening port number, you can reconfigure the cluster.

To do so, edit the cluster configuration on each member of the cluster and change the IP addresses or listening port numbers as required. You cannot remove any members during this process. The cluster configuration must contain the description of the full cluster, so you must do the changes for all cluster members on all cluster members.

You can edit the *Member roles* of the different members, but with the following limitations:

- A cluster member that does not have a `database*` role cannot become a voter, because it might lack a global database.
- At least two members must remain voters (except in the case of a two-member cluster, where one voter suffices), or there will be no quorum.

Log on to each cluster member and complete the following steps:

1. Stop the LXD daemon. For example, if you're using the snap:

```
sudo snap stop lxd
```

2. Run the following command:

```
sudo lxd cluster edit
```

3. Edit the YAML representation of the information that this cluster member has about the rest of the cluster:

```
# Latest dqlite segment ID: 1234

members:
  - id: 1             # Internal ID of the member (Read-only)
    name: server1     # Name of the cluster member (Read-only)
    address: 192.0.2.10:8443 # Last known address of the member (Writeable)
    role: voter              # Last known role of the member (Writeable)
  - id: 2             # Internal ID of the member (Read-only)
    name: server2     # Name of the cluster member (Read-only)
    address: 192.0.2.11:8443 # Last known address of the member (Writeable)
```

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```
    role: stand-by           # Last known role of the member (Writeable)
  - id: 3                 # Internal ID of the member (Read-only)
    name: server3         # Name of the cluster member (Read-only)
    address: 192.0.2.12:8443 # Last known address of the member (Writeable)
    role: spare              # Last known role of the member (Writeable)
```

You can edit the addresses and the roles.

After doing the changes on all cluster members, start the LXD daemon on all members again. For example, if you're using the snap:

```
sudo snap start lxd
```

The cluster should now be fully available again with all members reporting in. No information has been deleted from the database. All information about the cluster members and their instances is still there.

Manually alter Raft membership

In some situations, you might need to manually alter the Raft membership configuration of the cluster because of some unexpected behavior.

For example, if you have a cluster member that was removed uncleanly, it might not show up in *`lxc cluster list`* but still be part of the Raft configuration. To see the Raft configuration, run the following command:

```
lxd sql local "SELECT * FROM raft_nodes"
```

In that case, run the following command to remove the leftover node:

```
lxd cluster remove-raft-node <address>
```

Related topics

Explanation:

- *About clustering*

Reference:

- *Cluster member configuration*

Production setup

The following how-to guides cover common operations to prepare your LXD server setup for production.

How to check and improve the performance:

How to benchmark performance

The performance of your LXD server or cluster depends on a lot of different factors, ranging from the hardware, the server configuration, the selected storage driver and the network bandwidth to the overall usage patterns.

To find the optimal configuration, you should run benchmark tests to evaluate different setups.

LXD provides a benchmarking tool for this purpose. This tool allows you to initialize or launch a number of containers and measure the time it takes for the system to create the containers. If you run this tool repeatedly with different configurations, you can compare the performance and evaluate which is the ideal configuration.

Get the tool

To get the `lxd-benchmark` tool, you can download a pre-built binary:

1. Download the `bin.linux.lxd-benchmark` tool (`bin.linux.lxd-benchmark.aarch64` or `bin.linux.lxd-benchmark.x86_64`) from the **Assets** section of the latest LXD release.
2. Save the binary as `lxd-benchmark` and make it executable (usually by running `chmod u+x lxd-benchmark`).

If you have `go` (*Go*) installed, you can build the tool with the following command:

```
go install github.com/canonical/lxd/lxd-benchmark@latest
```

Run the tool

Run `lxd-benchmark [action]` to measure the performance of your LXD setup.

The benchmarking tool uses the current LXD configuration, but users of the snap must export the `LXD_DIR` variable for the configuration to be found:

```
  export LXD_DIR=/var/snap/lxd/common/lxd
```

If you want to use a different project, specify it with `--project`.

For all actions, you can specify the number of parallel threads to use (default is to use a dynamic batch size). You can also choose to append the results to a CSV report file and label them in a certain way.

See `lxd-benchmark help` for all available actions and flags.

Select an image

Before you run the benchmark, select what kind of image you want to use.

Local image
: If you want to measure the time it takes to create a container and ignore the time it takes to download the image, you should copy the image to your local image store before you run the benchmarking tool.

  To do so, run a command similar to the following and specify the fingerprint (for example, `2d21da400963`) of the image when you run `lxd-benchmark`:

  ```
  lxc image copy ubuntu:24.04 local:
  ```

  You can also assign an alias to the image and specify that alias (for example, `ubuntu`) when you run `lxd-benchmark`:

```
lxc image copy ubuntu:24.04 local: --alias ubuntu
```

Remote image

If you want to include the download time in the overall result, specify a remote image (for example, `ubuntu:24.04`). The default image that `lxd-benchmark` uses is the latest Ubuntu image (`ubuntu:`), so if you want to use this image, you can leave out the image name when running the tool.

Create and launch containers

Run the following command to create a number of containers:

```
lxd-benchmark init --count <number> <image>
```

Add `--privileged` to the command to create privileged containers.

For example:

Command	Description
`lxd-benchmark init --count 10 --privileged`	Create ten privileged containers that use the latest Ubuntu image.
`lxd-benchmark init --count 20 --parallel 4 ubuntu-minimal:24.04`	Create 20 containers that use the Ubuntu Minimal 24.04 image, using four parallel threads.
`lxd-benchmark init 2d21da400963`	Create one container that uses the local image with the fingerprint `2d21da400963`.
`lxd-benchmark init --count 10 ubuntu`	Create ten containers that use the image with the alias `ubuntu`.

If you use the `init` action, the benchmarking containers are created but not started. To start the containers that you created, run the following command:

```
lxd-benchmark start
```

Alternatively, use the `launch` action to both create and start the containers:

```
lxd-benchmark launch --count 10 <image>
```

For this action, you can add the `--freeze` flag to freeze each container right after it starts. Freezing a container pauses its processes, so this flag allows you to measure the pure launch times without interference of the processes that run in each container after startup.

Delete containers

To delete the benchmarking containers that you created, run the following command:

```
lxd-benchmark delete
```

Note: You must delete all existing benchmarking containers before you can run a new benchmark.

How to increase the network bandwidth

You can increase the network bandwidth of your LXD setup by configuring the transmit queue length (`txqueuelen`). This change makes sense in the following scenarios:

- You have a NIC with 1 GbE or higher on a LXD host with a lot of local activity (instance-instance connections or host-instance connections).
- You have an internet connection with 1 GbE or higher on your LXD host.

The more instances you use, the more you can benefit from this tweak.

Note: The following instructions use a `txqueuelen` value of 10000, which is commonly used with 10GbE NICs, and a `net.core.netdev_max_backlog` value of 182757. Depending on your network, you might need to use different values.

In general, you should use small `txqueuelen` values with slow devices with a high latency, and high `txqueuelen` values with devices with a low latency. For the `net.core.netdev_max_backlog` value, a good guideline is to use the minimum value of the `net.ipv4.tcp_mem` configuration.

Increase the network bandwidth on the LXD host

Complete the following steps to increase the network bandwidth on the LXD host:

1. Increase the transmit queue length (`txqueuelen`) of both the real NIC and the LXD NIC (for example, `lxdbr0`). You can do this temporarily for testing with the following command:

   ```
   ifconfig <interface> txqueuelen 10000
   ```

   To make the change permanent, add the following command to your interface configuration in `/etc/network/interfaces`:

   ```
   up ip link set eth0 txqueuelen 10000
   ```

2. Increase the receive queue length (`net.core.netdev_max_backlog`). You can do this temporarily for testing with the following command:

   ```
   echo 182757 > /proc/sys/net/core/netdev_max_backlog
   ```

   To make the change permanent, add the following configuration to `/etc/sysctl.conf`:

   ```
   net.core.netdev_max_backlog = 182757
   ```

Increase the transmit queue length on the instances

You must also change the `txqueuelen` value for all Ethernet interfaces in your instances. To do this, use one of the following methods:

- Apply the same changes as described above for the LXD host.
- Set the `queue.tx.length` device option on the instance profile or configuration.

How to monitor your server:

How to monitor metrics

LXD collects metrics for all running instances as well as some internal metrics. These metrics cover the CPU, memory, network, disk and process usage. They are meant to be consumed by Prometheus, and you can use Grafana to display the metrics as graphs. See *Provided metrics* for lists of available metrics and *Set up a Grafana dashboard* for instructions on how to display the metrics in Grafana.

In a cluster environment, LXD returns only the values for instances running on the server that is being accessed. Therefore, you must scrape each cluster member separately.

The instance metrics are updated when calling the `/1.0/metrics` endpoint. To handle multiple scrapers, they are cached for 8 seconds. Fetching metrics is a relatively expensive operation for LXD to perform, so if the impact is too high, consider scraping at a higher than default interval.

Query the raw data

To view the raw data that LXD collects, use the *`lxc query`* command to query the `/1.0/metrics` endpoint:

```
user@host:~$ lxc query /1.0/metrics                        # HELP lxd_cpu_seconds_total The
total number of CPU time used in seconds.# TYPE lxd_cpu_seconds_total
counterlxd_cpu_seconds_total{cpu="0",mode="system",name="u1",project="default",
type="container"} 60.304517lxd_cpu_seconds_total{cpu="0",mode="user",name="u1",
project="default",type="container"} 145.647502lxd_cpu_seconds_total{cpu="0",
mode="iowait",name="vm",project="default",type="virtual-machine"} 4614.
78lxd_cpu_seconds_total{cpu="0",mode="irq",name="vm",project="default",
type="virtual-machine"} 0lxd_cpu_seconds_total{cpu="0",mode="idle",name="vm",
project="default",type="virtual-machine"} 412762lxd_cpu_seconds_total{cpu="0",
mode="nice",name="vm",project="default",type="virtual-machine"} 35.
06lxd_cpu_seconds_total{cpu="0",mode="softirq",name="vm",project="default",
type="virtual-machine"} 2.41lxd_cpu_seconds_total{cpu="0",mode="steal",name="vm",
project="default",type="virtual-machine"} 9.84lxd_cpu_seconds_total{cpu="0",
mode="system",name="vm",project="default",type="virtual-machine"} 340.
84lxd_cpu_seconds_total{cpu="0",mode="user",name="vm",project="default",
type="virtual-machine"} 261.25# HELP lxd_cpu_effective_total The total number of
effective CPUs.# TYPE lxd_cpu_effective_total gaugelxd_cpu_effective_total{name="u1",
project="default",type="container"} 4lxd_cpu_effective_total{name="vm",project="default",
type="virtual-machine"} 0# HELP lxd_disk_read_bytes_total The total number of bytes
read.# TYPE lxd_disk_read_bytes_total counterlxd_disk_read_bytes_total{device="loop5",
name="u1",project="default",type="container"} 2048lxd_disk_read_bytes_total{device="loop3",
name="vm",project="default",type="virtual-machine"} 353280...
```

Set up Prometheus

To gather and store the raw metrics, you should set up Prometheus. You can then configure it to scrape the metrics through the metrics API endpoint.

Expose the metrics endpoint

To expose the `/1.0/metrics` API endpoint, you must set the address on which it should be available.

To do so, you can set either the *core.metrics_address* server configuration option or the *core.https_address* server configuration option. The `core.metrics_address` option is intended for metrics only, while the `core.https_address` option exposes the full API. So if you want to use a different address for the metrics API than for the full API, or if you want to expose only the metrics endpoint but not the full API, you should set the `core.metrics_address` option.

For example, to expose the full API on the `8443` port, enter the following command:

```
lxc config set core.https_address ":8443"
```

To expose only the metrics API endpoint on the `8444` port, enter the following command:

```
lxc config set core.metrics_address ":8444"
```

To expose only the metrics API endpoint on a specific IP address and port, enter a command similar to the following:

```
lxc config set core.metrics_address "192.0.2.101:8444"
```

Add a metrics certificate to LXD

Authentication for the `/1.0/metrics` API endpoint is done through a metrics certificate. A metrics certificate (type `metrics`) is different from a client certificate (type `client`) in that it is meant for metrics only and doesn't work for interaction with instances or any other LXD entities.

To create a certificate, enter the following command:

```
openssl req -x509 -newkey ec -pkeyopt ec_paramgen_curve:secp384r1 -sha384 -keyout␣
↪metrics.key -nodes -out metrics.crt -days 3650 -subj "/CN=metrics.local"
```

Note: The command requires OpenSSL version 1.1.0 or later.

Then add this certificate to the list of trusted clients, specifying the type as `metrics`:

```
lxc config trust add metrics.crt --type=metrics
```

If requiring TLS client authentication isn't possible in your environment, the `/1.0/metrics` API endpoint can be made available to unauthenticated clients. While not recommended, this might be acceptable if you have other controls in place to restrict who can reach that API endpoint. To disable the authentication on the metrics API:

```
# Disable authentication (NOT RECOMMENDED)
lxc config set core.metrics_authentication false
```

Make the metrics certificate available for Prometheus

If you run Prometheus on a different machine than your LXD server, you must copy the required certificates to the Prometheus machine:

- The metrics certificate (`metrics.crt`) and key (`metrics.key`) that you created
- The LXD server certificate (`server.crt`) located in `/var/snap/lxd/common/lxd/` (if you are using the snap) or `/var/lib/lxd/` (otherwise)

Copy these files into a `tls` directory that is accessible to Prometheus, for example, `/var/snap/prometheus/common/tls` (if you are using the snap) or `/etc/prometheus/tls` (otherwise). See the following example commands:

```
# Create tls directory
mkdir /var/snap/prometheus/common/tls

# Copy newly created certificate and key to tls directory
cp metrics.crt metrics.key /var/snap/prometheus/common/tls/

# Copy LXD server certificate to tls directory
cp /var/snap/lxd/common/lxd/server.crt /var/snap/prometheus/common/tls/
```

If you are not using the snap, you must also make sure that Prometheus can read these files (usually, Prometheus is run as user `prometheus`):

```
chown -R prometheus:prometheus /etc/prometheus/tls
```

Configure Prometheus to scrape from LXD

Finally, you must add LXD as a target to the Prometheus configuration.

To do so, edit `/var/snap/prometheus/current/prometheus.yml` (if you are using the snap) or `/etc/prometheus/prometheus.yaml` (otherwise) and add a job for LXD.

Here's what the configuration needs to look like:

```
global:
  # How frequently to scrape targets by default. The Prometheus default value is 1m.
  scrape_interval: 15s

scrape_configs:
  - job_name: lxd
    metrics_path: '/1.0/metrics'
    scheme: 'https'
    static_configs:
      - targets: ['foo.example.com:8443']
    tls_config:
      ca_file: 'tls/server.crt'
      cert_file: 'tls/metrics.crt'
      key_file: 'tls/metrics.key'
      # XXX: server_name is required if the target name
      #      is not covered by the certificate (not in the SAN list)
      server_name: 'foo'
```

Note:

- By default, the Grafana Prometheus data source assumes the `scrape_interval` to be 15 seconds. If you decide to use a different `scrape_interval` value, you must change it in both the Prometheus configuration and the Grafana Prometheus data source configuration. Otherwise, the Grafana `$__rate_interval` value will be calculated incorrectly, which might cause a `no data` response in queries that use it.
- The `server_name` must be specified if the LXD server certificate does not contain the same host name as used in the `targets` list. To verify this, open `server.crt` and check the Subject Alternative Name (SAN) section.

  For example, assume that `server.crt` has the following content:

  `user@host:~$ openssl x509 -noout -text -in /var/snap/prometheus/common/tls/server.crt ... X509v3 Subject Alternative Name: DNS:foo, IP Address:127.0.0.1, IP Address:0:0:0:0:0:0:0:1...` Since the Subject Alternative Name (SAN) list doesn't include the host name provided in the `targets` list (`foo.example.com`), you must override the name used for comparison using the `server_name` directive.

Here is an example of a `prometheus.yml` configuration where multiple jobs are used to scrape the metrics of multiple LXD servers:

```
global:
  # How frequently to scrape targets by default. The Prometheus default value is 1m.
  scrape_interval: 15s

scrape_configs:
  # abydos, langara and orilla are part of a single cluster (called `hdc` here)
  # initially bootstrapped by abydos which is why all 3 targets
  # share the same `ca_file` and `server_name`. That `ca_file` corresponds
  # to the `/var/snap/lxd/common/lxd/cluster.crt` file found on every member of
  # the LXD cluster.
  #
  # Note: the `project` param is are provided when not using the `default` project
  #       or when multiple projects are used.
  #
  # Note: each member of the cluster only provide metrics for instances it runs locally
  #       this is why the `lxd-hdc` cluster lists 3 targets
  - job_name: "lxd-hdc"
    metrics_path: '/1.0/metrics'
    params:
      project: ['jdoe']
    scheme: 'https'
    static_configs:
      - targets:
        - 'abydos.hosts.example.net:8444'
        - 'langara.hosts.example.net:8444'
        - 'orilla.hosts.example.net:8444'
    tls_config:
      ca_file: 'tls/abydos.crt'
      cert_file: 'tls/metrics.crt'
      key_file: 'tls/metrics.key'
      server_name: 'abydos'

  # jupiter, mars and saturn are 3 standalone LXD servers.
```

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```
  # Note: only the `default` project is used on them, so it is not specified.
  - job_name: "lxd-jupiter"
    metrics_path: '/1.0/metrics'
    scheme: 'https'
    static_configs:
      - targets: ['jupiter.example.com:9101']
    tls_config:
      ca_file: 'tls/jupiter.crt'
      cert_file: 'tls/metrics.crt'
      key_file: 'tls/metrics.key'
      server_name: 'jupiter'

  - job_name: "lxd-mars"
    metrics_path: '/1.0/metrics'
    scheme: 'https'
    static_configs:
      - targets: ['mars.example.com:9101']
    tls_config:
      ca_file: 'tls/mars.crt'
      cert_file: 'tls/metrics.crt'
      key_file: 'tls/metrics.key'
      server_name: 'mars'

  - job_name: "lxd-saturn"
    metrics_path: '/1.0/metrics'
    scheme: 'https'
    static_configs:
      - targets: ['saturn.example.com:9101']
    tls_config:
      ca_file: 'tls/saturn.crt'
      cert_file: 'tls/metrics.crt'
      key_file: 'tls/metrics.key'
      server_name: 'saturn'
```

After editing the configuration, restart Prometheus (`snap restart prometheus` if using the snap, otherwise `systemctl restart prometheus`) to start scraping.

How to send logs to Loki

LXD publishes information about its activity in the form of events. The `lxc monitor` command allows you to view this information in your shell. There are two categories of LXD events: logs and life cycle. The `lxc monitor --type=logging --pretty` command will filter and display log type events like activity of the raft cluster, for instance, while `lxc monitor --type=lifecycle --pretty` will only display life cycle events like instances starting or stopping.

In a production environment, you might want to keep a log of these events in a dedicated system. Loki is one such system, and LXD provides a configuration option to forward its event stream to Loki.

Configure LXD to send logs

See the Loki documentation for instructions on installing it:

- Install Loki

Once you have a Loki server up and running, you can instruct LXD to send logs to your Loki server by setting the following option:

```
lxc config set loki.api.url=http://<loki_server_IP>:3100
```

Query Loki logs

Loki logs are typically viewed/queried using Grafana but Loki provides a command line utility called LogCLI allowing to query logs from your Loki server without the need for Grafana.

See the LogCLI documentation for instructions on installing it:

- Install LogCLI

With your LogCLI utility up and running, first configure it to query the server you have installed before by setting the appropriate environment variable:

```
export LOKI_ADDR=http://<loki_server_IP>:3100
```

You can then query the Loki server to validate that your LXD events are getting through. LXD events all have the `app` key set to `lxd` so you can use the following `logcli` command to see LXD logs in Loki.

```
user@host:~$ logcli query -t '{app="lxd"}'                2024-02-14T21:31:20Z {app="lxd",
instance="node3", type="logging"} level="info" Updating instance types2024-02-14T21:31:20Z
{app="lxd", instance="node3", type="logging"} level="info" Expiring log
files2024-02-14T21:31:20Z {app="lxd", instance="node3", type="logging"}
level="info" Pruning resolved warnings2024-02-14T21:31:20Z {app="lxd",
instance="node3", type="logging"} level="info" Updating images2024-02-14T21:31:20Z
{app="lxd", instance="node3", type="logging"} level="info" Done pruning resolved
warnings2024-02-14T21:31:20Z {app="lxd", instance="node3", type="logging"} level="info"
Done expiring log files2024-02-14T21:31:20Z {app="lxd", instance="node3", type="logging"}
level="info" Done updating images...
```

Add labels

LXD pushes log entries with a set of predefined labels like `app`, `project`, `instance` and `name`. To see all existing labels, you can use `logcli labels`. Some log entries might contain information in their message that you would like to access as if they were keys. In the example below, you might want to have `requester-username` as a key to query.

```
2024-02-15T22:52:25Z {app="lxd", instance="node3", location="node3", name="c1", project=
↪"default", type="lifecycle"} requester-username="ubuntu" action="instance-started"␣
↪source="/1.0/instances/c1" requester-address="@" requester-protocol="unix" instance-
↪started
...
```

Use the following command to instruct LXD to move all occurrences of `requester-username="<user>"` into the label section:

```
lxc config set loki.labels="requester-username"
```

This will transform the above log entry into:

```
2024-02-09T21:26:32Z {app="lxd", instance="node3", location="node3", name="c2", project=
↪"default", requester_username="ubuntu", type="lifecycle"} action="instance-started"␣
↪source="/1.0/instances/c2" requester-address="@" requester-protocol="unix" instance-
↪started
...
```

Note the replacement of `-` by `_`, as `-` cannot be used in keys. As `requested_username` is now a key, you can query Loki using it like this:

```
logcli query -t '{requester_username="ubuntu"}'
```

Set up a Grafana dashboard

To visualize the metrics and logs data, set up Grafana. LXD provides a Grafana dashboard that is configured to display the LXD metrics scraped by Prometheus and events sent to Loki.

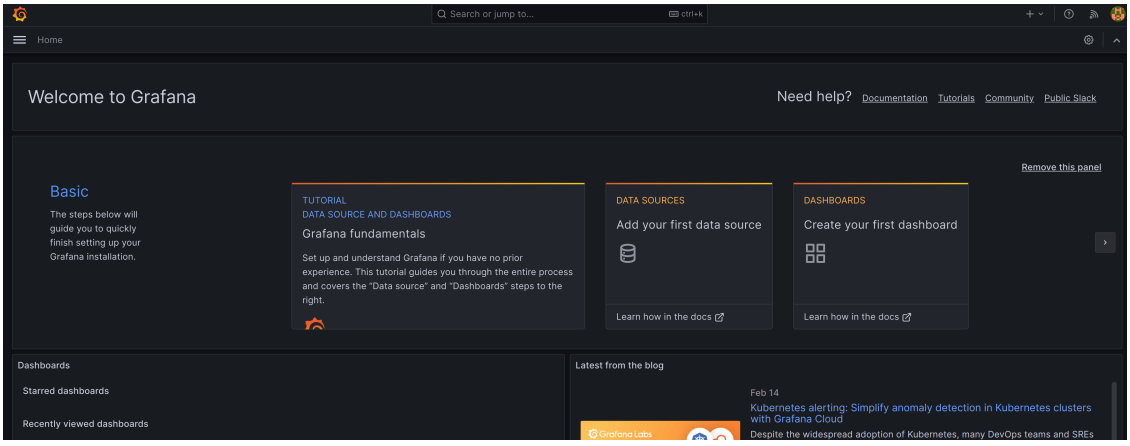
Note: The dashboard requires Grafana 8.4 or later.

See the Grafana documentation for instructions on installing and signing in:

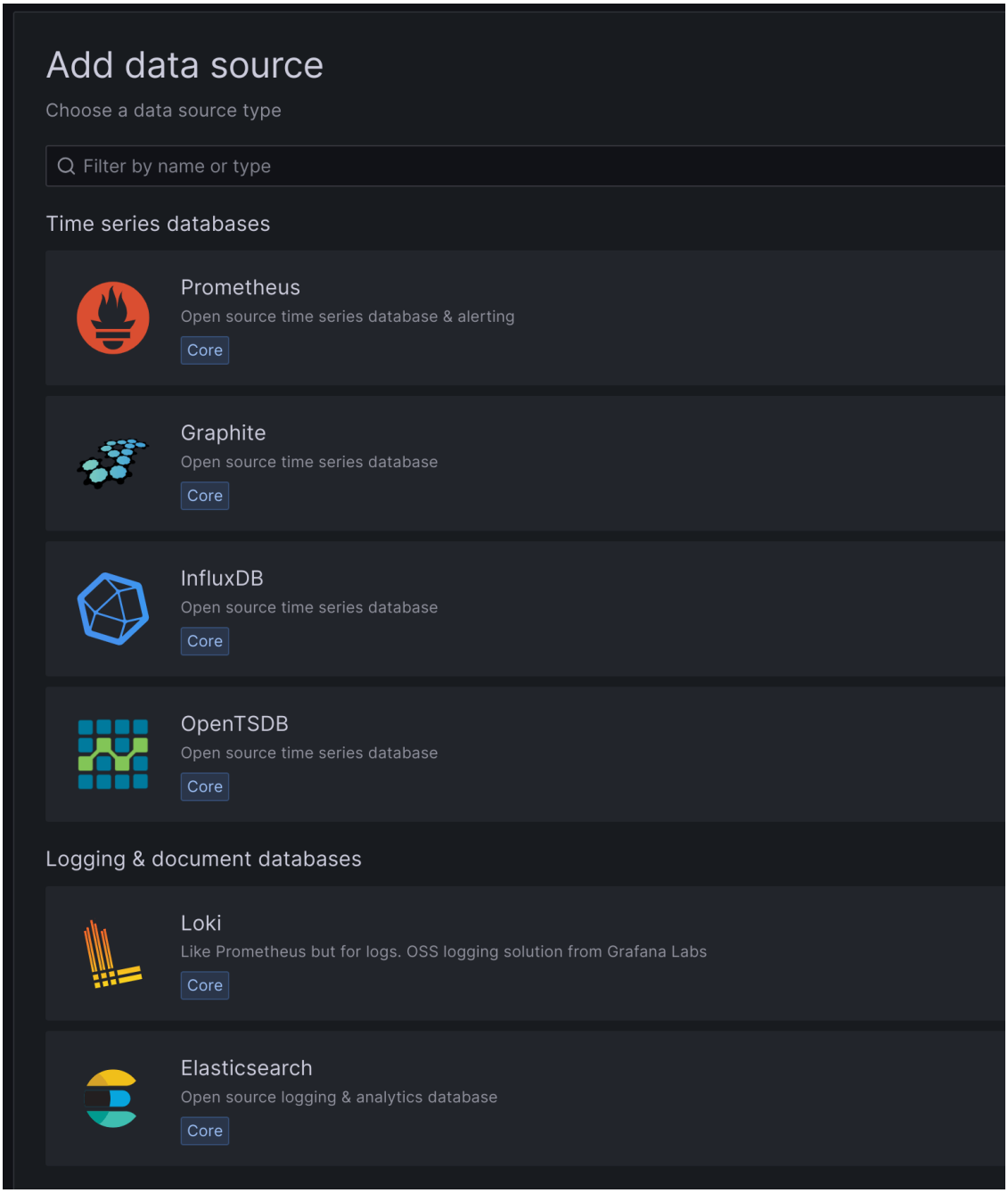
- Install Grafana
- Sign in to Grafana

Complete the following steps to import the LXD dashboard:

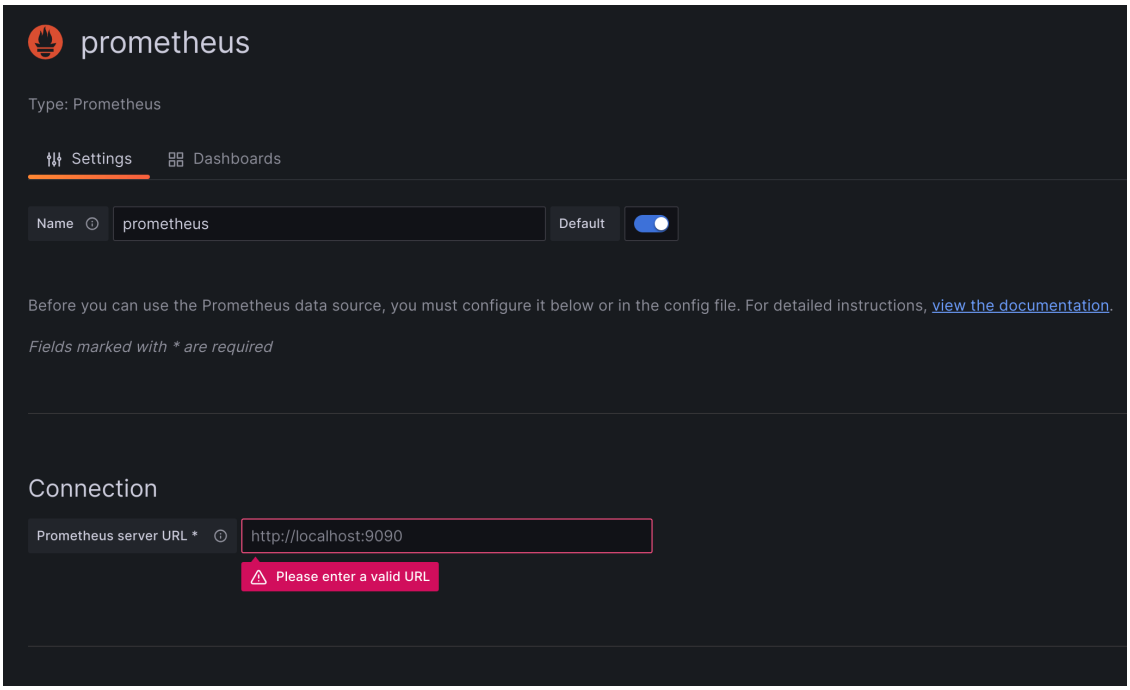
1. Configure Prometheus as a data source:
    1. From the Basic (quick setup) panel, choose *Data Sources*.



    2. Select *Prometheus*.



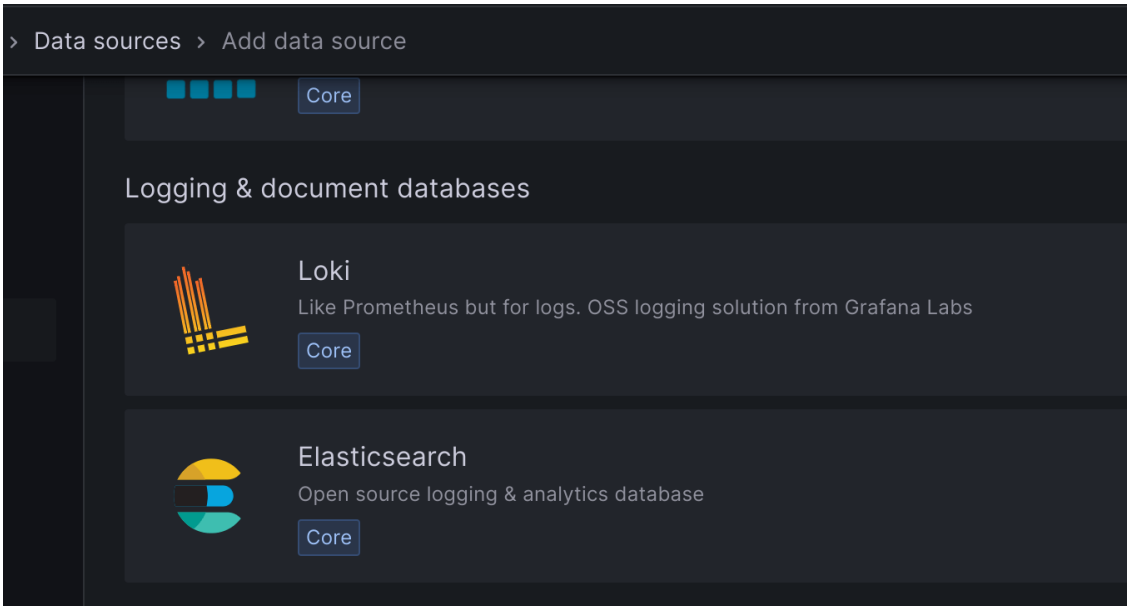
3. In the *URL* field, enter the address of your Prometheus installation (`http://localhost:9090/` if running Prometheus locally).



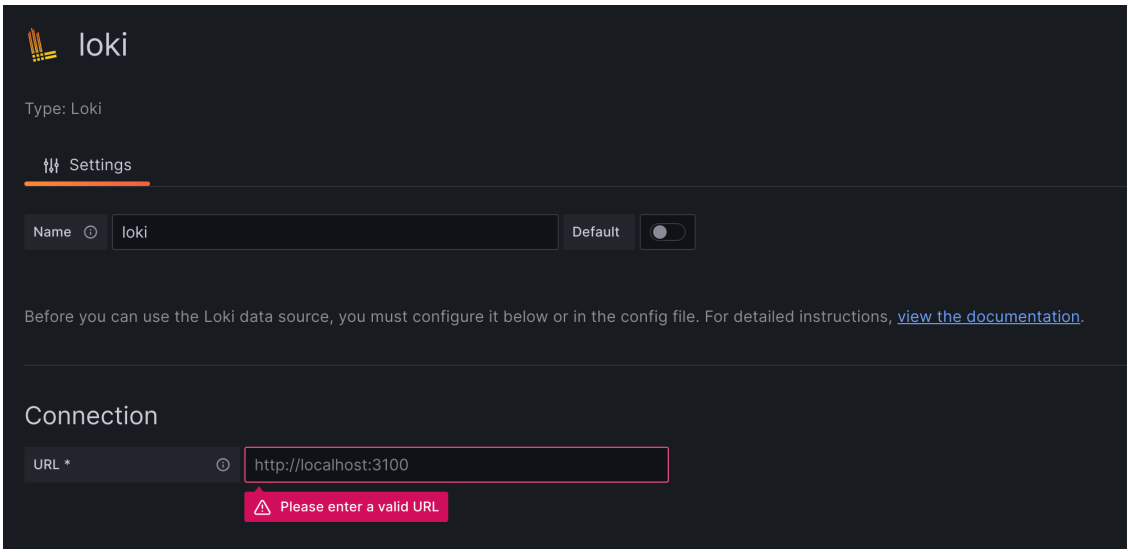
4. Keep the default configuration for the other fields and click *Save & test*.

2. Configure Loki as another data source:

   1. Select *Loki*.



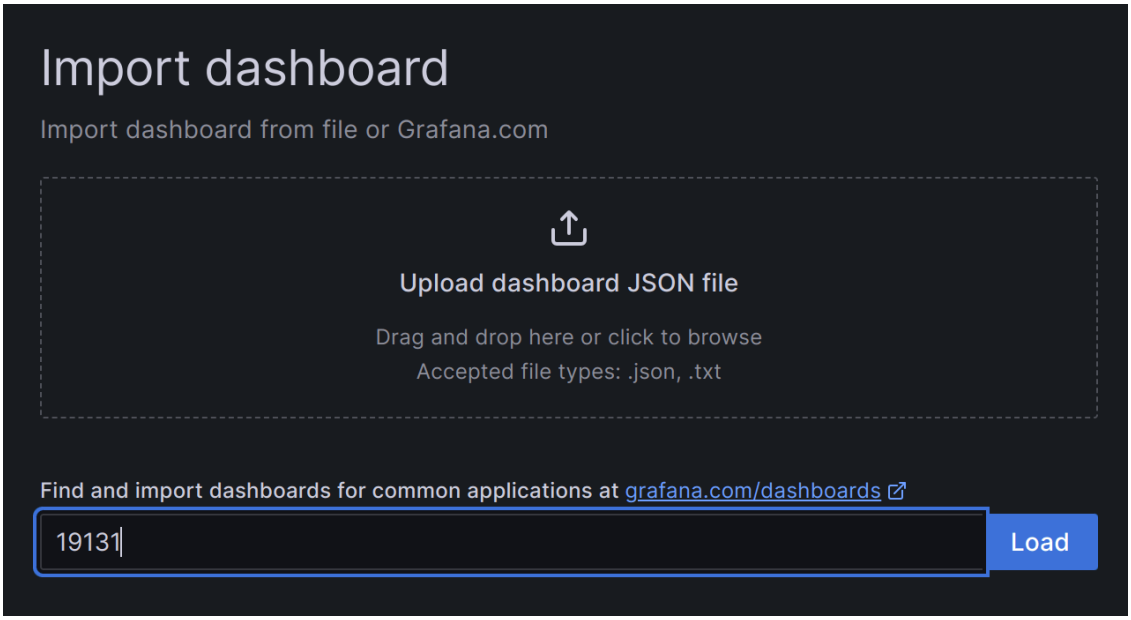
   2. In the *URL* field, enter the address of your Loki installation (`http://localhost:3100/` if running Loki locally).



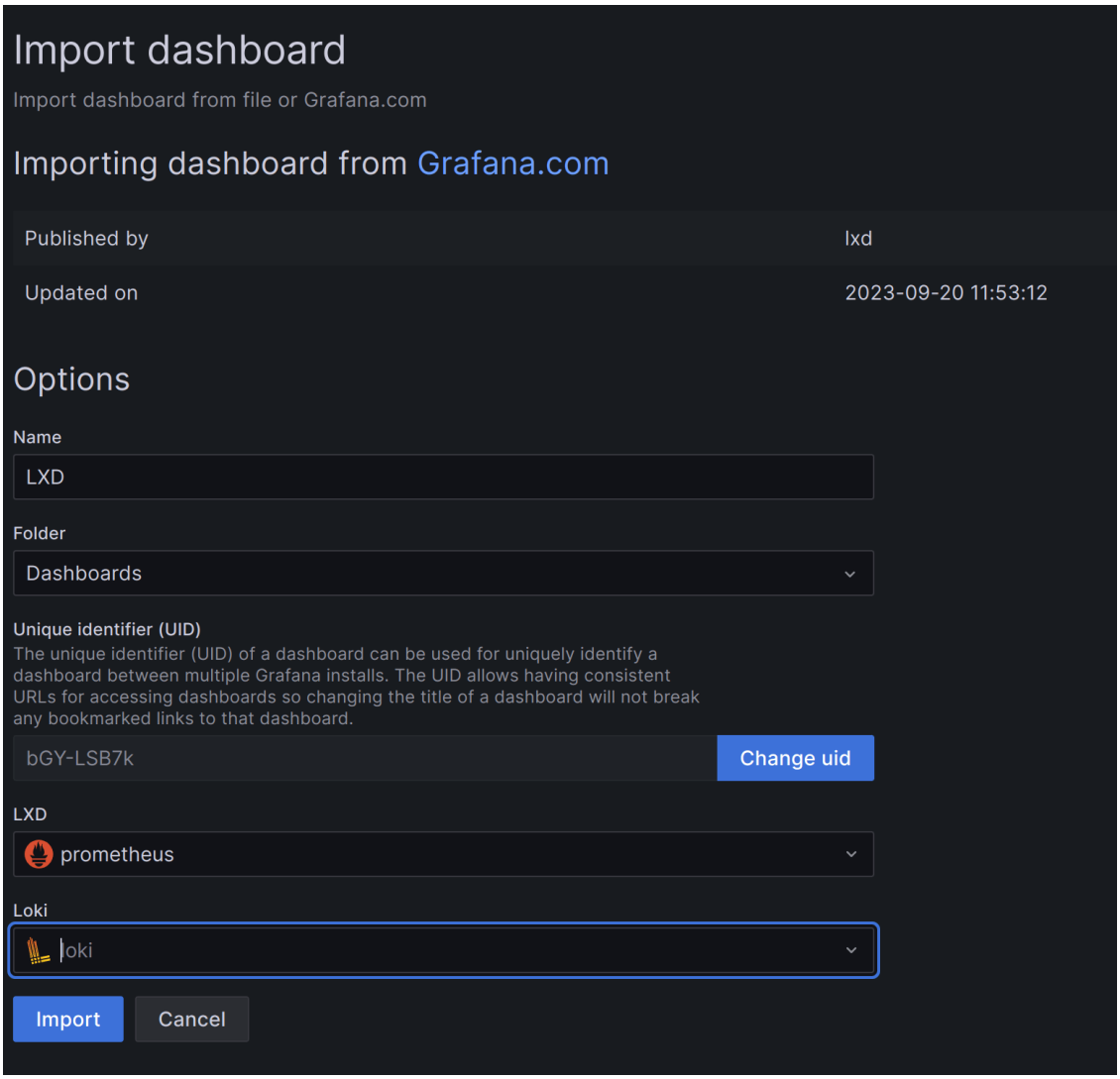
3. Keep the default configuration for the other fields and click *Save & test*.

3. Import the LXD dashboard:

   1. Go back to the Basic (quick setup) panel and now choose *Dashboards* > *Import a dashboard*.
   2. In the *Find and import dashboards* field, enter the dashboard ID `19131`.



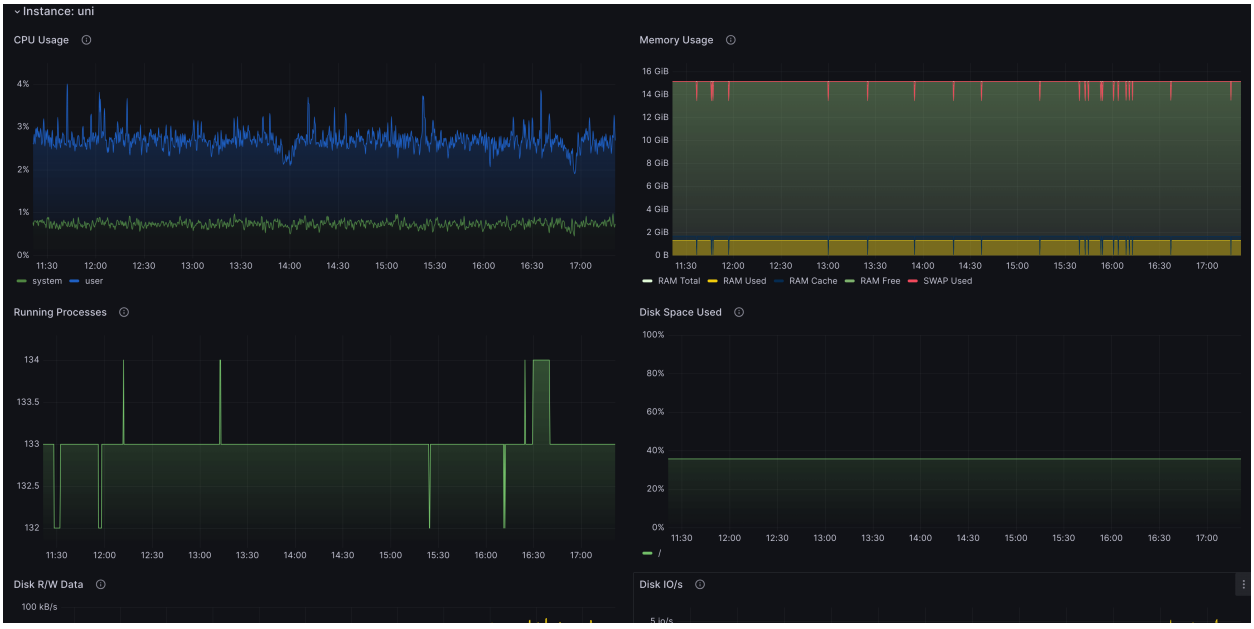
   3. Click *Load*.
   4. In the *LXD* drop-down menu, select the Prometheus and Loki data sources that you configured.



5. Click *Import*.

You should now see the LXD dashboard. You can select the project and filter by instances.

At the bottom of the page, you can see data for each instance.



Note: For proper operation of the Loki part of the dashboard, you need to ensure that the `instance` field matches the Prometheus job name. You can change the `instance` field through the `loki.instance` configuration key.

How to back up your server and recover from failure:

How to back up a LXD server

In a production setup, you should always back up the contents of your LXD server.

The LXD server contains a variety of different entities, and when choosing your backup strategy, you must decide which of these entities you want to back up and how frequently you want to save them.

What to back up

The various contents of your LXD server are located on your file system and, in addition, recorded in the *LXD database*. Therefore, only backing up the database or only backing up the files on disk does not give you a full functional backup.

Your LXD server contains the following entities:

- Instances (database records and file systems)
- Images (database records, image files, and file systems)
- Networks (database records and state files)
- Profiles (database records)
- Storage volumes (database records and file systems)

Consider which of these you need to back up. For example, if you don't use custom images, you don't need to back up your images since they are available on the image server. If you use only the `default` profile, or only the standard `lxdbr0` network bridge, you might not need to worry about backing them up, because they can easily be re-created.

Full backup

To create a full backup of all contents of your LXD server, back up the `/var/snap/lxd/common/lxd` (for snap users) or `/var/lib/lxd` (otherwise) directory.

This directory contains your local storage, the LXD database, and your configuration. It does not contain separate storage devices, however. That means that whether the directory also contains the data of your instances depends on the storage drivers that you use.

Important: If your LXD server uses any external storage (for example, LVM volume groups, ZFS zpools, or any other resource that isn't directly self-contained to LXD), you must back this up separately.

See *How to back up custom storage volumes* for instructions.

To back up your data, create a tarball of `/var/snap/lxd/common/lxd` (for snap users) or `/var/lib/lxd` (otherwise). If you are not using the snap package and your source system has a `/etc/subuid` and `/etc/subgid` file, you should also back up these files. Restoring them avoids needless shifting of instance file systems.

To restore your data, complete the following steps:

1. Stop LXD on your server (for example, with `sudo snap stop lxd`).
2. Delete the directory (`/var/snap/lxd/common/lxd` for snap users or `/var/lib/lxd` otherwise).
3. Restore the directory from the backup.
4. Delete and restore any external storage devices.
5. If you are not using the snap, restore the `/etc/subuid` and `/etc/subgid` files.
6. Restart LXD (for example, with `sudo snap start lxd` or by restarting your machine).

Export a snapshot

If you are using the LXD snap, you can also create a full backup by exporting a snapshot of the snap:

1. Create a snapshot:

   ```
   sudo snap save lxd
   ```

   Note down the ID of the snapshot (shown in the `Set` column).

2. Export the snapshot to a file:

   ```
   sudo snap export-snapshot <ID> <output_file>
   ```

See Snapshots in the Snapcraft documentation for details.

Partial backup

If you decide to only back up specific entities, you have different options for how to do this. You should consider doing some of these partial backups even if you are doing full backups in addition. It can be easier and safer to, for example, restore a single instance or reconfigure a profile than to restore the full LXD server.

Back up instances and volumes

Instances and storage volumes are backed up in a very similar way (because when backing up an instance, you basically back up its instance volume, see *Storage volume types*).

See *How to back up instances* and *How to back up custom storage volumes* for detailed information. The following sections give a brief summary of the options you have for backing up instances and volumes.

Secondary backup LXD server

LXD supports copying and moving instances and storage volumes between two hosts. See *How to move existing LXD instances between servers* and *How to move or copy storage volumes* for instructions.

So if you have a spare server, you can regularly copy your instances and storage volumes to that secondary server to back them up. Use the `--refresh` flag to update the copies (see *Optimized volume transfer* for the benefits).

If needed, you can either switch over to the secondary server or copy your instances or storage volumes back from it.

If you use the secondary server as a pure storage server, it doesn't need to be as powerful as your main LXD server.

Export tarballs

You can use the `export` command to export instances and volumes to a backup tarball. By default, those tarballs include all snapshots.

You can use an optimized export option, which is usually quicker and results in a smaller size of the tarball. However, you must then use the same storage driver when restoring the backup tarball.

See *Use export files for instance backup* and *Use export files for volume backup* for instructions.

Snapshots

Snapshots save the state of an instance or volume at a specific point in time. However, they are stored in the same storage pool and are therefore likely to be lost if the original data is deleted or lost. This means that while snapshots are very quick and easy to create and restore, they don't constitute a secure backup.

See *Use snapshots for instance backup* and *Use snapshots for volume backup* for more information.

Back up the database

While there is no trivial method to restore the contents of the *LXD database*, it can still be very convenient to keep a backup of its content. Such a backup can make it much easier to re-create, for example, networks or profiles if the need arises.

Use the following command to dump the content of the local database to a file:

```
lxd sql local .dump > <output_file>
```

Use the following command to dump the content of the global database to a file:

```
lxd sql global .dump > <output_file>
```

You should include these two commands in your regular LXD backup.

How to recover instances in case of disaster

LXD provides a tool for disaster recovery in case the *LXD database* is corrupted or otherwise lost.

The tool scans the storage pools for instances and imports the instances that it finds back into the database. You need to re-create the required entities that are missing (usually profiles, projects, and networks).

Important: This tool should be used for disaster recovery only. Do not rely on this tool as an alternative to proper backups; you will lose data like profiles, network definitions, or server configuration.

The tool must be run interactively and cannot be used in automated scripts.

The tool is available through the `lxd recover` command (note the `lxd` command rather than the normal `lxc` command).

Recovery process

When you run the tool, it scans all storage pools that still exist in the database, looking for missing volumes that can be recovered. You can also specify the details of any unknown storage pools (those that exist on disk but do not exist in the database), and the tool attempts to scan those too.

After mounting the specified storage pools (if not already mounted), the tool scans them for unknown volumes that look like they are associated with LXD. LXD maintains a `backup.yaml` file in each instance's storage volume, which contains all necessary information to recover a given instance (including instance configuration, attached devices, storage volume, and pool configuration). This data can be used to rebuild the instance, storage volume, and storage pool database records. Before recovering an instance, the tool performs some consistency checks to compare what is in the `backup.yaml` file with what is actually on disk (such as matching snapshots). If all checks out, the database records are re-created.

If the storage pool database record also needs to be created, the tool uses the information from an instance's `backup.yaml` file as the basis of its configuration, rather than what the user provided during the discovery phase. However, if this information is not available, the tool falls back to restoring the pool's database record with what was provided by the user.

The tool asks you to re-create missing entities like networks. However, the tool does not know how the instance was configured. That means that if some configuration was specified through the `default` profile, you must also re-add the required configuration to the profile. For example, if the `lxdbr0` bridge is used in an instance and you are prompted to re-create it, you must add it back to the `default` profile so that the recovered instance uses it.

Example

This is how a recovery process could look:

```
user@host:~$ lxd recover               This LXD server currently has the following storage
pools:Would you like to recover another storage pool? (yes/no) [default=no]:  yesName
of the storage pool:  defaultName of the storage backend (btrfs, ceph, cephfs,
cephobject, dir, lvm, zfs):  zfsSource of the storage pool (block device, volume group,
dataset, path, ... as applicable):  /var/snap/lxd/common/lxd/storage-pools/default/
containersAdditional storage pool configuration property (KEY=VALUE, empty when done):
zfs.pool_name=defaultAdditional storage pool configuration property (KEY=VALUE, empty
when done):Would you like to recover another storage pool? (yes/no) [default=no]:The
recovery process will be scanning the following storage pools:  - NEW: "default"
(backend="zfs", source="/var/snap/lxd/common/lxd/storage-pools/default/containers")Would
you like to continue with scanning for lost volumes? (yes/no) [default=yes]:  yesScanning
for unknown volumes...The following unknown volumes have been found:  - Container "u1"
on pool "default" in project "default" (includes 0 snapshots) - Container "u2" on pool
"default" in project "default" (includes 0 snapshots)You are currently missing the
following:  - Network "lxdbr0" in project "default"Please create those missing entries
and then hit ENTER: ^Z[1]+ Stopped lxd recover     user@host:~$ lxc network create lxdbr0
Network lxdbr0 created user@host:~$ fg lxd recover The following unknown volumes have been
found:  - Container "u1" on pool "default" in project "default" (includes 0 snapshots)
- Container "u2" on pool "default" in project "default" (includes 0 snapshots)Would you
like those to be recovered? (yes/no) [default=no]:  yesStarting recovery...  user@host:~$
lxc list  +------+---------+------+------+-----------+-----------+| NAME | STATE | IPV4 |
IPV6 | TYPE | SNAPSHOTS |+------+---------+------+------+-----------+-----------+| u1 |
STOPPED | | | CONTAINER | 0 |+------+---------+------+------+-----------+-----------+| u2
| STOPPED | | | CONTAINER | 0 |+------+---------+------+------+-----------+-----------+
user@host:~$ lxc profile device add default eth0 nic network=lxdbr0 name=eth0
Device eth0 added to default     user@host:~$ lxc start u1          user@host:~$ lxc list
+------+---------+------------------+-----------------------------------------------+-----------+--------
NAME | STATE | IPV4 | IPV6 | TYPE | SNAPSHOTS |+------+---------+------------------+-----------------------
u1 | RUNNING | 192.0.2.49 (eth0) | 2001:db8:8b6:abfe:216:3eff:fe82:918e (eth0) |
CONTAINER | 0 |+------+---------+------------------+-----------------------------------------------+-----
u2 | STOPPED | | | CONTAINER | 0 |+------+---------+------------------+-------------------------------
```

Related topics

Explanation:

- *About performance tuning*

Reference:

- *Provided metrics*
- *Server settings for a LXD production setup*

2.3 Explanation

The explanatory guides in this section introduce you to the concepts used in LXD and help you understand how things fit together.

2.3.1 Important concepts

Before you start working with LXD, you need to be familiar with some important concepts about LXD and the instance types it provides.

About `lxd` and `lxc`

LXD is frequently confused with LXC, and the fact that LXD provides both a `lxd` command and a `lxc` command doesn't make things easier.

LXD vs. LXC

LXD and LXC are two distinct implementations of Linux containers.

LXC is a low-level user space interface for the Linux kernel containment features. It consists of tools (`lxc-*` commands), templates, and library and language bindings.

LXD is a more intuitive and user-friendly tool aimed at making it easy to work with Linux containers. It is an alternative to LXC's tools and distribution template system, with the added features that come from being controllable over the network. Under the hood, LXD uses LXC to create and manage the containers.

LXD provides a superset of the features that LXC supports, and it is easier to use. Therefore, if you are unsure which of the tools to use, you should go for LXD. LXC should be seen as an alternative for experienced users that want to run Linux containers on distributions that don't support LXD.

LXD daemon

The central part of LXD is its daemon. It runs persistently in the background, manages the instances, and handles all requests. The daemon provides a REST API that you can access directly or through a client (for example, the default command-line client that comes with LXD).

See *Daemon behavior* for more information about the LXD daemon.

`lxd` vs. `lxc`

To control LXD, you typically use two different commands: `lxd` and `lxc`.

LXD daemon
: The `lxd` command controls the LXD daemon. Since the daemon is typically started automatically, you hardly ever need to use the `lxd` command. An exception is the `lxd init` subcommand that you run to *initialize LXD*.

  There are also some subcommands for debugging and administrating the daemon, but they are intended for advanced users only. See `lxd --help` for an overview of all available subcommands.

LXD client
: The `lxc` command is a command-line client for LXD, which you can use to interact with the LXD daemon. You use the `lxc` command to manage your instances, the server settings, and overall the entities you create in LXD. See *`lxc --help`* for an overview of all available subcommands.

  The `lxc` tool is not the only client you can use to interact with the LXD daemon. You can also use the API, the UI, or a custom LXD client.

About containers and VMs

LXD provides support for two different types of *instances*: *system containers* and *virtual machines*.

When running a system container, LXD simulates a virtual version of a full operating system. To do this, it uses the functionality provided by the kernel running on the host system.

When running a virtual machine, LXD uses the hardware of the host system, but the kernel is provided by the virtual machine. Therefore, virtual machines can be used to run, for example, a different operating system.

Application containers vs. system containers

Application containers (as provided by, for example, Docker) package a single process or application. System containers, on the other hand, simulate a full operating system and let you run multiple processes at the same time.

Therefore, application containers are suitable to provide separate components, while system containers provide a full solution of libraries, applications, databases and so on. In addition, you can use system containers to create different user spaces and isolate all processes belonging to each user space, which is not what application containers are intended for.

Virtual machines vs. system containers

Virtual machines emulate a physical machine, using the hardware of the host system from a full and completely isolated operating system. System containers, on the other hand, use the OS kernel of the host system instead of creating their own environment. If you run several system containers, they all share the same kernel, which makes them faster and more light-weight than virtual machines.

With LXD, you can create both system containers and virtual machines. You should use a system container to leverage the smaller size and increased performance if all functionality you require is compatible with the kernel of your host operating system. If you need functionality that is not supported by the OS kernel of your host system or you want to run a completely different OS, use a virtual machine.

Instance types in LXD

LXD supports the following types of instances:

Containers
: Containers are the default type for instances. They are currently the most complete implementation of LXD instances and support more features than virtual machines.

  Containers are implemented through the use of `liblxc` (LXC).

Virtual machines
: Virtual machines (VMs) are natively supported since version 4.0 of LXD. Thanks to a built-in agent, they can be used almost like containers.

  LXD uses `qemu` to provide the VM functionality.

Note: Currently, virtual machines support fewer features than containers, but the plan is to support the same set of features for both instance types in the future.

To see which features are available for virtual machines, check the condition field in the *Instance options* documentation.

Related topics

How-to guides:

- *Instances*

Reference:

- *Container runtime environment*
- *Instance configuration*

2.3.2 Entities in LXD

When working with LXD, you should have a basic understanding of the different entities that are used in LXD. See the *How-to guides* for instructions on how to work with these entities, and the following guides to understand the concepts behind them.

About images

LXD uses an image-based workflow. Each instance is based on an image, which contains a basic operating system (for example, a Linux distribution) and some LXD-related information.

Images are available from remote image stores (see *Remote image servers* for an overview), but you can also create your own images, either based on an existing instances or a rootfs image.

You can copy images from remote servers to your local image store, or copy local images to remote servers. You can also use a local image to create a remote instance.

Each image is identified by a fingerprint (SHA256). To make it easier to manage images, LXD allows defining one or more aliases for each image.

Caching

When you create an instance using a remote image, LXD downloads the image and caches it locally. It is stored in the local image store with the cached flag set. The image is kept locally as a private image until either:

- The image has not been used to create a new instance for the number of days set in *images.remote_cache_expiry*.
- The image's expiry date (one of the image properties; see *Edit image properties* for information on how to change it) is reached.

LXD keeps track of the image usage by updating the `last_used_at` image property every time a new instance is spawned from the image.

Auto-update

LXD can automatically keep images that come from a remote server up to date.

Note: Only images that are requested through an alias can be updated. If you request an image through a fingerprint, you request an exact image version.

Whether auto-update is enabled for an image depends on how the image was downloaded:

- If the image was downloaded and cached when creating an instance, it is automatically updated if *images.auto_update_cached* was set to `true` (the default) at download time.
- If the image was copied from a remote server using the *lxc image copy* command, it is automatically updated only if the `--auto-update` flag was specified.

You can change this behavior for an image by *editing the* `auto_update` *property*.

On startup and after every *images.auto_update_interval* (by default, every six hours), the LXD daemon checks for more recent versions of all the images in the store that are marked to be auto-updated and have a recorded source server.

When a new version of an image is found, it is downloaded into the image store. Then any aliases pointing to the old image are moved to the new one, and the old image is removed from the store.

To not delay instance creation, LXD does not check if a new version is available when creating an instance from a cached image. This means that the instance might use an older version of an image for the new instance until the image is updated at the next update interval.

Special image properties

Image properties that begin with the prefix `requirements` (for example, `requirements.XYZ`) are used by LXD to determine the compatibility of the host system and the instance that is created based on the image. If these are incompatible, LXD does not start the instance.

The following requirements are supported:

Key	Type	Default	Description
`requirements.secureboot`	string	-	If set to `false`, indicates that the image cannot boot under secure boot.
`requirements.cgroup`	string	-	If set to `v1`, indicates that the image requires the host to run cgroup v1.
`requirements.nesting`	bool	-	If set to `true`, indicates that the image cannot work without nesting enabled.

Related topics

How-to guides:

- *Images*

Reference:

- *Image format*
- *Remote image servers*

About storage pools, volumes and buckets

LXD stores its data in storage pools, divided into storage volumes of different content types (like images or instances). You could think of a storage pool as the disk that is used to store data, while storage volumes are different partitions on this disk that are used for specific purposes.

In addition to storage volumes, there are storage buckets, which use the Amazon S3 (Simple Storage Service) protocol. Like storage volumes, storage buckets are part of a storage pool.

Storage pools

During initialization, LXD prompts you to create a first storage pool. If required, you can create additional storage pools later (see *Create a storage pool*).

Each storage pool uses a storage driver. The following storage drivers are supported:

- *Directory* - `dir`
- *Btrfs* - `btrfs`
- *LVM* - `lvm`
- *ZFS* - `zfs`
- *Ceph RBD* - `ceph`
- *CephFS* - `cephfs`
- *Ceph Object* - `cephobject`

See the following how-to guides for additional information:

- *How to manage storage pools*
- *How to create an instance in a specific storage pool*

Data storage location

Where the LXD data is stored depends on the configuration and the selected storage driver. Depending on the storage driver that is used, LXD can either share the file system with its host or keep its data separate.

Storage location	Directory	Btrfs	LVM	ZFS	Ceph (all)
Shared with the host	✓	✓	-	✓	-
Dedicated disk/partition	-	✓	✓	✓	-
Loop disk	-	✓	✓	✓	-
Remote storage	-	-	-	-	✓

Shared with the host

Sharing the file system with the host is usually the most space-efficient way to run LXD. In most cases, it is also the easiest to manage.

This option is supported for the `dir` driver, the `btrfs` driver (if the host is Btrfs and you point LXD to a dedicated sub-volume) and the `zfs` driver (if the host is ZFS and you point LXD to a dedicated dataset on your zpool).

Dedicated disk or partition

Having LXD use an empty partition on your main disk or a full dedicated disk keeps its storage completely independent from the host.

This option is supported for the `btrfs` driver, the `lvm` driver and the `zfs` driver.

Loop disk

LXD can create a loop file on your main drive and have the selected storage driver use that. This method is functionally similar to using a disk or partition, but it uses a large file on your main drive instead. This means that every write must go through the storage driver and your main drive's file system, which leads to decreased performance.

The loop files reside in `/var/snap/lxd/common/lxd/disks/` if you are using the snap, or in `/var/lib/lxd/disks/` otherwise.

Loop files usually cannot be shrunk. They will grow up to the configured limit, but deleting instances or images will not cause the file to shrink. You can increase their size though; see *Resize a storage pool*.

Remote storage

The `ceph`, `cephfs` and `cephobject` drivers store the data in a completely independent Ceph storage cluster that must be set up separately.

Default storage pool

There is no concept of a default storage pool in LXD.

When you create a storage volume, you must specify the storage pool to use.

When LXD automatically creates a storage volume during instance creation, it uses the storage pool that is configured for the instance. This configuration can be set in either of the following ways:

- Directly on an instance: *lxc launch <image> <instance_name> --storage <storage_pool>*
- Through a profile: *lxc profile device add <profile_name> root disk path=/ pool=<storage_pool>* and *lxc launch <image> <instance_name> --profile <profile_name>*
- Through the default profile

In a profile, the storage pool to use is defined by the pool for the root disk device:

```
root:
  type: disk
  path: /
  pool: default
```

In the default profile, this pool is set to the storage pool that was created during initialization.

Storage volumes

When you create an instance, LXD automatically creates the required storage volumes for it. You can create additional storage volumes.

See the following how-to guides for additional information:

- *How to manage storage volumes*
- *How to move or copy storage volumes*
- *How to back up custom storage volumes*

Storage volume types

Storage volumes can be of the following types:

container/virtual-machine
: LXD automatically creates one of these storage volumes when you launch an instance. It is used as the root disk for the instance, and it is destroyed when the instance is deleted.

  This storage volume is created in the storage pool that is specified in the profile used when launching the instance (or the default profile, if no profile is specified). The storage pool can be explicitly specified by providing the `--storage` flag to the launch command.

image
: LXD automatically creates one of these storage volumes when it unpacks an image to launch one or more instances from it. You can delete it after the instance has been created. If you do not delete it manually, it is deleted automatically ten days after it was last used to launch an instance.

  The image storage volume is created in the same storage pool as the instance storage volume, and only for storage pools that use a *storage driver* that supports optimized image storage.

`custom`
: You can add one or more custom storage volumes to hold data that you want to store separately from your instances. Custom storage volumes can be shared between instances, and they are retained until you delete them.

  You can also use custom storage volumes to hold your backups or images.

  You must specify the storage pool for the custom volume when you create it.

Content types

Each storage volume uses one of the following content types:

`filesystem`
: This content type is used for containers and container images. It is the default content type for custom storage volumes.

  Custom storage volumes of content type `filesystem` can be attached to both containers and virtual machines, and they can be shared between instances.

`block`
: This content type is used for virtual machines and virtual machine images. You can create a custom storage volume of type `block` by using the `--type=block` flag.

  Custom storage volumes of content type `block` can only be attached to virtual machines. They should not be shared between instances, because simultaneous access can lead to data corruption.

`iso`
: This content type is used for custom ISO volumes. A custom storage volume of type `iso` can only be created by importing an ISO file using *`lxc storage volume import`*.

  Custom storage volumes of content type `iso` can only be attached to virtual machines. They can be attached to multiple machines simultaneously as they are always read-only.

Storage buckets

Storage buckets provide object storage functionality via the S3 protocol.

They can be used in a way that is similar to custom storage volumes. However, unlike storage volumes, storage buckets are not attached to an instance. Instead, applications can access a storage bucket directly using its URL.

Each storage bucket is assigned one or more access keys, which the applications must use to access it.

Storage buckets can be located on local storage (with `dir`, `btrfs`, `lvm` or `zfs` pools) or on remote storage (with `cephobject` pools).

To enable storage buckets for local storage pool drivers and allow applications to access the buckets via the S3 protocol, you must configure the *`core.storage_buckets_address`* server setting.

See the following how-to guide for additional information:

- *How to manage storage buckets and keys*

Related topics

How-to guides:

- *Storage*

Reference:

- *Storage drivers*

About networking

There are different ways to connect your instances to the Internet. The easiest method is to have LXD create a network bridge during initialization and use this bridge for all instances, but LXD supports many different and advanced setups for networking.

Network devices

To grant direct network access to an instance, you must assign it at least one network device, also called NIC. You can configure the network device in one of the following ways:

- Use the default network bridge that you set up during the LXD initialization. Check the default profile to see the default configuration:

  ```
  lxc profile show default
  ```

  This method is used if you do not specify a network device for your instance.

- Use an existing network interface by adding it as a network device to your instance. This network interface is outside of LXD control. Therefore, you must specify all information that LXD needs to use the network interface.

  Use a command similar to the following:

  ```
  lxc config device add <instance_name> <device_name> nic nictype=<nic_type> ...
  ```

  See *Type: `nic`* for a list of available NIC types and their configuration properties.

  For example, you could add a pre-existing Linux bridge (`br0`) with the following command:

  ```
  lxc config device add <instance_name> eth0 nic nictype=bridged parent=br0
  ```

- *Create a managed network* and add it as a network device to your instance. With this method, LXD has all required information about the configured network, and you can directly attach it to your instance as a device:

  ```
  lxc network attach <network_name> <instance_name> <device_name>
  ```

  See *Attach a network to an instance* for more information.

Managed networks

Managed networks in LXD are created and configured with the `lxc network [create|edit|set]` command.

Depending on the network type, LXD either fully controls the network or just manages an external network interface.

Note that not all *NIC types* are supported as network types. LXD can only set up some of the types as managed networks.

Fully controlled networks

Fully controlled networks create network interfaces and provide most functionality, including, for example, the ability to do IP management.

LXD supports the following network types:

Bridge network
: A network bridge creates a virtual L2 Ethernet switch that instance NICs can connect to, making it possible for them to communicate with each other and the host. LXD bridges can leverage underlying native Linux bridges and Open vSwitch.

  In LXD context, the `bridge` network type creates an L2 bridge that connects the instances that use it together into a single network L2 segment. This makes it possible to pass traffic between the instances. The bridge can also provide local DHCP and DNS.

  This is the default network type.

OVN network
: OVN (Open Virtual Network) is a software-defined networking system that supports virtual network abstraction. You can use it to build your own private cloud. See `www.ovn.org` for more information.

  In LXD context, the `ovn` network type creates a logical network. To set it up, you must install and configure the OVN tools. In addition, you must create an uplink network that provides the network connection for OVN. As the uplink network, you should use one of the external network types or a managed LXD bridge.

Tip: Unlike the other network types, you can create and manage an OVN network inside a *project*. This means that you can create your own OVN network as a non-admin user, even in a restricted project.

External networks

External networks use network interfaces that already exist. Therefore, LXD has limited possibility to control them, and LXD features like network ACLs, network forwards and network zones are not supported.

The main purpose for using external networks is to provide an uplink network through a parent interface. This external network specifies the presets to use when connecting instances or other networks to a parent interface.

LXD supports the following external network types:

Macvlan network
: Macvlan is a virtual LAN (Local Area Network) that you can use if you want to assign several IP addresses to the same network interface, basically splitting up the network interface into several sub-interfaces with their own IP addresses. You can then assign IP addresses based on the randomly generated MAC addresses.

  In LXD context, the `macvlan` network type provides a preset configuration to use when connecting instances to a parent macvlan interface.

SR-IOV network
: SR-IOV (Single root I/O virtualization) is a hardware standard that allows a single network card port to appear as several virtual network interfaces in a virtualized environment.

  In LXD context, the `sriov` network type provides a preset configuration to use when connecting instances to a parent SR-IOV interface.

Physical network
: The `physical` network type connects to an existing physical network, which can be a network interface or a bridge, and serves as an uplink network for OVN.

  It provides a preset configuration to use when connecting OVN networks to a parent interface.

Recommendations

In general, if you can use a managed network, you should do so because networks are easy to configure and you can reuse the same network for several instances without repeating the configuration.

Which network type to choose depends on your specific use case. If you choose a fully controlled network, it provides more functionality than using a network device.

As a general recommendation:

- If you are running LXD on a single system or in a public cloud, use a *Bridge network*, possibly in connection with the Ubuntu Fan.
- If you are running LXD in your own private cloud, use an *OVN network*.

  Note: OVN requires a shared L2 uplink network for proper operation. Therefore, using OVN is usually not possible if you run LXD in a public cloud.

- To connect an instance NIC to a managed network, use the `network` property rather than the `parent` property, if possible. This way, the NIC can inherit the settings from the network and you don't need to specify the `nictype`.

Related topics

How-to guides:

- *Networking*

Reference:

- *Networks*

About the LXD database

LXD uses a distributed database to store the server configuration and state, which allows for quicker queries than if the configuration was stored inside each instance's directory (as it is done by LXC, for example).

To understand the advantages, consider a query against the configuration of all instances, like "what instances are using `br0`?". To answer that question without a database, you would have to iterate through every single instance, load and parse its configuration, and then check which network devices are defined in there. With a database, you can run a simple query on the database to retrieve this information.

Dqlite

In a LXD cluster, all members of the cluster must share the same database state. Therefore, LXD uses Dqlite, a distributed version of SQLite. Dqlite provides replication, fault-tolerance, and automatic failover without the need of external database processes.

When using LXD as a single machine and not as a cluster, the Dqlite database effectively behaves like a regular SQLite database.

File location

The database files are stored in the `database` sub-directory of your LXD data directory (thus `/var/snap/lxd/common/lxd/database/` if you use the snap, or `/var/lib/lxd/database/` otherwise).

Upgrading LXD to a newer version might require updating the database schema. In this case, LXD automatically stores a backup of the database and then runs the update. See *Upgrade LXD* for more information.

Backup

See *Back up the database* for instructions on how to back up the contents of the LXD database.

About `lxc show` and `info`

For the entities managed by LXD, the `lxc` command provides a `list` sub-command, and might provide `show` and `info` sub-commands. The purpose of the `info` sub-command is to show current state information, and the purpose of the `show` sub-command is to show configuration information and how the entity is used by other entities.

For example, the `lxc network info` command shows IP address and traffic statistics:

```
Name: lxdbr0
MAC address: 00:16:3e:d3:ec:41
MTU: 1500
State: up

Ips:
  inet    192.0.2.1
  inet6   2001:db8:f4a1:53d2::1
  inet6   fe80::216:3eff:fed3:ec41

Network usage:
  Bytes received: 127.66kB
  Bytes sent: 15.54kB
  Packets received: 1433
  Packets sent: 175
```

The `lxc network show` command, on the other hand, shows how the network is configured, and which entities are using the network:

```
config:
  ipv4.address: 192.0.2.1/24
  ipv4.nat: "true"
  ipv6.address: 2001:db8:f4a1:53d2::1/64
```

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```
  ipv6.nat: "true"
description: ""
name: lxdbr0
type: bridge
used_by:
- /1.0/instances/ubuntu
- /1.0/profiles/default
managed: true
status: Created
locations:
- none
```

Refer to the manual pages for details of the commands for managing entities:

- Instances: *lxc list*, *lxc info*
- Images: *lxc image list*, *lxc image info*, *lxc image show*
- Networks: *lxc network list*, *lxc network info*, *lxc network show*
- Profiles: *lxc profile list*, *lxc profile show*
- Projects: *lxc project list*, *lxc project info*, *lxc project show*
- Storage: *lxc storage list*, *lxc storage info*, *lxc storage show*

2.3.3 Access management

In LXD, access to the API is controlled through TLS or OpenID Connect authentication. When using OpenID Connect, you can grant permissions to access specific entities to different clients. You can also restrict access to LXD entities by confining them to specific projects.

Remote API authentication

Remote communications with the LXD daemon happen using JSON over HTTPS. This requires the LXD API to be exposed over the network; see *How to expose LXD to the network* for instructions.

To be able to access the remote API, clients must authenticate with the LXD server. The following authentication methods are supported:

- *TLS client certificates*
- *OpenID Connect authentication*

TLS client certificates

When using TLS (Transport Layer Security) client certificates for authentication, both the client and the server will generate a key pair the first time they're launched. The server will use that key pair for all HTTPS connections to the LXD socket. The client will use its certificate as a client certificate for any client-server communication.

To cause certificates to be regenerated, simply remove the old ones. On the next connection, a new certificate is generated.

Communication protocol

The supported protocol must be TLS 1.3 or better.

It's possible to force LXD to accept TLS 1.2 by setting the `LXD_INSECURE_TLS` environment variable on both client and server. However this isn't a supported setup and should only ever be used when forced to use an outdated corporate proxy.

All communications must use perfect forward secrecy, and ciphers must be limited to strong elliptic curve ones (such as ECDHE-RSA or ECDHE-ECDSA).

Any generated key should be at least 4096 bit RSA, preferably 384 bit ECDSA. When using signatures, only SHA-2 signatures should be trusted.

Since we control both client and server, there is no reason to support any backward compatibility to broken protocol or ciphers.

Trusted TLS clients

You can obtain the list of TLS certificates trusted by a LXD server with *`lxc config trust list`*.

Trusted clients can be added in either of the following ways:

- *Adding trusted certificates to the server*
- *Adding client certificates using a trust password*
- *Adding client certificates using tokens*

The workflow to authenticate with the server is similar to that of SSH, where an initial connection to an unknown server triggers a prompt:

1. When the user adds a server with *`lxc remote add`*, the server is contacted over HTTPS, its certificate is downloaded and the fingerprint is shown to the user.
2. The user is asked to confirm that this is indeed the server's fingerprint, which they can manually check by connecting to the server or by asking someone with access to the server to run the info command and compare the fingerprints.
3. The server attempts to authenticate the client:
   - If the client certificate is in the server's trust store, the connection is granted.
   - If the client certificate is not in the server's trust store, the server prompts the user for a token or the trust password. If the provided token or trust password matches, the client certificate is added to the server's trust store and the connection is granted. Otherwise, the connection is rejected.

To revoke trust to a client, remove its certificate from the server with *`lxc config trust remove <fingerprint>`*.

TLS clients can be restricted to a subset of projects, see *Restricted TLS certificates* for more information.

Adding trusted certificates to the server

The preferred way to add trusted clients is to directly add their certificates to the trust store on the server. To do so, copy the client certificate to the server and register it using *lxc config trust add <file>*.

Adding client certificates using a trust password

To allow establishing a new trust relationship from the client side, you must set a trust password (*core.trust_password*) for the server. Clients can then add their own certificate to the server's trust store by providing the trust password when prompted.

In a production setup, unset `core.trust_password` after all clients have been added. This prevents brute-force attacks trying to guess the password.

Adding client certificates using tokens

You can also add new clients by using tokens. This is a safer way than using the trust password, because tokens expire after a configurable time (*core.remote_token_expiry*) or once they've been used.

To use this method, generate a token for each client by calling *lxc config trust add*, which will prompt for the client name. The clients can then add their certificates to the server's trust store by providing the generated token when prompted for the trust password.

Note: If your LXD server is behind NAT, you must specify its external public address when adding it as a remote for a client:

```
lxc remote add <name> <IP_address>
```

When you are prompted for the admin password, specify the generated token.

When generating the token on the server, LXD includes a list of IP addresses that the client can use to access the server. However, if the server is behind NAT, these addresses might be local addresses that the client cannot connect to. In this case, you must specify the external address manually.

Alternatively, the clients can provide the token directly when adding the remote: *lxc remote add <name> <token>*.

Using a PKI system

In a PKI (Public key infrastructure) setup, a system administrator manages a central PKI that issues client certificates for all the LXD clients and server certificates for all the LXD daemons.

To enable PKI mode, complete the following steps:

1. Add the CA (Certificate authority) certificate to all machines:
   - Place the `client.ca` file in the clients' configuration directories (`~/.config/lxc` or `~/snap/lxd/common/config` for snap users).
   - Place the `server.ca` file in the server's configuration directory (`/var/lib/lxd` or `/var/snap/lxd/common/lxd` for snap users).
2. Place the certificates issued by the CA on the clients and the server, replacing the automatically generated ones.
3. Restart the server.

In that mode, any connection to a LXD daemon will be done using the pre-seeded CA certificate.

If the server certificate isn't signed by the CA, the connection will simply go through the normal authentication mechanism. If the server certificate is valid and signed by the CA, then the connection continues without prompting the user for the certificate.

Note that the generated certificates are not automatically trusted. You must still add them to the server in one of the ways described in *Trusted TLS clients*.

OpenID Connect authentication

LXD supports using OpenID Connect to authenticate users through an OIDC (OpenID Connect) Identity Provider.

To configure LXD to use OIDC authentication, set the `oidc.*` server configuration options. Your OIDC provider must be configured to enable the Device Authorization Grant type.

To add a remote pointing to a LXD server configured with OIDC authentication, run `lxc remote add <remote_name> <remote_address>`. You are then prompted to authenticate through your web browser, where you must confirm that the device code displayed in the browser matches the device code that is displayed in the terminal window. The LXD client then retrieves and stores an access token, which it provides to LXD for all interactions. The identity provider might also provide a refresh token. In this case, the LXD client uses this refresh token to attempt to retrieve another access token when the current access token has expired.

When an OIDC client initially authenticates with LXD, it does not have access to the majority of the LXD API. OIDC clients must be granted access by an administrator, see *Fine-grained authorization*.

TLS server certificate

LXD supports issuing server certificates using ACME (Automatic Certificate Management Environment) services, for example, Let's Encrypt.

To enable this feature, set the following server configuration:

- `acme.domain`: The domain for which the certificate should be issued.
- `acme.email`: The email address used for the account of the ACME service.
- `acme.agree_tos`: Must be set to `true` to agree to the ACME service's terms of service.
- `acme.ca_url`: The directory URL of the ACME service. By default, LXD uses "Let's Encrypt".

For this feature to work, LXD must be reachable from port 80. This can be achieved by using a reverse proxy such as HAProxy.

Here's a minimal HAProxy configuration that uses `lxd.example.net` as the domain. After the certificate has been issued, LXD will be reachable from `https://lxd.example.net/`.

```
# Global configuration
global
  log /dev/log local0
  chroot /var/lib/haproxy
  stats socket /run/haproxy/admin.sock mode 660 level admin
  stats timeout 30s
  user haproxy
  group haproxy
  daemon
  ssl-default-bind-options ssl-min-ver TLSv1.2
```

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```
  tune.ssl.default-dh-param 2048
  maxconn 100000

# Default settings
defaults
  mode tcp
  timeout connect 5s
  timeout client 30s
  timeout client-fin 30s
  timeout server 120s
  timeout tunnel 6h
  timeout http-request 5s
  maxconn 80000

# Default backend - Return HTTP 301 (TLS upgrade)
backend http-301
  mode http
  redirect scheme https code 301

# Default backend - Return HTTP 403
backend http-403
  mode http
  http-request deny deny_status 403

# HTTP dispatcher
frontend http-dispatcher
  bind :80
  mode http

  # Backend selection
  tcp-request inspect-delay 5s

  # Dispatch
  default_backend http-403
  use_backend http-301 if { hdr(host) -i lxd.example.net }

# SNI dispatcher
frontend sni-dispatcher
  bind :443
  mode tcp

  # Backend selection
  tcp-request inspect-delay 5s

  # require TLS
  tcp-request content reject unless { req.ssl_hello_type 1 }

  # Dispatch
  default_backend http-403
  use_backend lxd-nodes if { req.ssl_sni -i lxd.example.net }

# LXD nodes
```

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```
backend lxd-nodes
  mode tcp

  option tcp-check

  # Multiple servers should be listed when running a cluster
  server lxd-node01 1.2.3.4:8443 check
  server lxd-node02 1.2.3.5:8443 check
  server lxd-node03 1.2.3.6:8443 check
```

Failure scenarios

In the following scenarios, authentication is expected to fail.

Server certificate changed

The server certificate might change in the following cases:

- The server was fully reinstalled and therefore got a new certificate.
- The connection is being intercepted (MITM (Machine in the middle)).

In such cases, the client will refuse to connect to the server because the certificate fingerprint does not match the fingerprint in the configuration for this remote.

It is then up to the user to contact the server administrator to check if the certificate did in fact change. If it did, the certificate can be replaced by the new one, or the remote can be removed altogether and re-added.

Server trust relationship revoked

The server trust relationship is revoked for a client if another trusted client or the local server administrator removes the trust entry for the client on the server.

In this case, the server still uses the same certificate, but all API calls return a 403 code with an error indicating that the client isn't trusted.

Related topics

Explanation:

- *About security*

How-to guides:

- *How to expose LXD to the network*

Remote API authorization

When LXD is *exposed over the network* it is possible to restrict API access via two mechanisms:

- *Restricted TLS certificates*
- *Fine-grained authorization*

Restricted TLS certificates

It is possible to restrict a *TLS client* to one or multiple projects. In this case, the client will also be prevented from performing global configuration changes or altering the configuration (limits, restrictions) of the projects it's allowed access to.

To restrict access, use `lxc config trust edit <fingerprint>`. Set the `restricted` key to `true` and specify a list of projects to restrict the client to. If the list of projects is empty, the client will not be allowed access to any of them.

Fine-grained authorization

It is possible to restrict *OIDC clients* to granular actions on specific LXD resources. For example, one could restrict a user to be able to view, but not edit, a single instance.

There are four key concepts that LXD uses to manage these fine-grained permissions:

- **Entitlements**: An entitlement encapsulates an action that can be taken against a LXD API resource type. Some entitlements might apply to many resource types, whereas other entitlements can only apply to a single resource type. For example, the entitlement `can_view` is available for all resource types, but the entitlement `can_exec` is only available for LXD resources of type `instance`.
- **Permissions**: A permission is the application of an entitlement to a particular LXD resource. For example, given the entitlement `can_exec` that is only defined for instances, a permission is the combination of `can_exec` and a single instance, as uniquely defined by its API URL (for example, `/1.0/instances/c1?project=foo`).
- **Identities (users)**: An identity is any authenticated party that makes requests to LXD, including TLS clients. When an OIDC client adds a LXD server as a remote, the OIDC client is saved in LXD as an identity. Permissions cannot be assigned to identities directly.
- **Groups**: A group is a collection of one or more identities. Identities can belong to one or more groups. Permissions can be assigned to groups. TLS clients cannot currently be assigned to groups.

Explore permissions

To discover available permissions that can be assigned to a group, or view permissions that are currently assigned, run the following command:

```
lxc auth permission list --max-entitlements 0
```

The entity type column displays the LXD API resource type, this value is required when adding a permission to a group.

The URL column displays the URL of the LXD API resource.

The entitlements column displays all available entitlements for that entity type. If any groups are already assigned permissions on the API resource at the displayed URL, they are listed alongside the entitlements that they have been granted.

Some useful permissions at a glance:

- The `admin` entitlement on entity type `server` gives full access to LXD. This is equivalent to an unrestricted TLS client or Unix socket access.
- The `project_manager` entitlement on entity type `server` grants access to create, edit, and delete projects, and all resources belonging to those projects. However, this permission does not allow access to server configuration, storage pool configuration, or certificate/identity management.
- The `operator` entitlement on entity type `project` grants access to create, edit, and delete all resources belonging to the project against which the permission is granted. Members of a group with this permission will not be able to edit the project configuration itself. This is equivalent to a restricted TLS client with access to the same project.
- The `user` entitlement on entity type `instance` grants access to view an instance, pull/push files, get a console, and begin a terminal session. Members of a group with this entitlement cannot edit the instance configuration.

Note: Due to a limitation in the LXD client, if `can_exec` is granted to a group for a particular instance, members of the group will not be able to start a terminal session unless `can_view_events` is additionally granted for the parent project of the instance. We are working to resolve this.

Explore identities

To discover available identities that can be assigned to a group, or view identities that are currently assigned, run the following command:

```
lxc auth identity list
```

The authentication method column displays the method by which the client authenticates with LXD.

The type column displays the type of identity. Identity types are a superset of TLS certificate types and additionally include OIDC clients.

The name column displays the name of the identity. For TLS clients, this will be the name of the certificate. For OIDC clients this will be the name of the client as given by the IdP (identity provider) (requested via the profile scope).

The identifier column displays a unique identifier for the identity within that authentication method. For TLS clients, this will be the certificate fingerprint. For OIDC clients, this will be the email address of the client.

The groups column displays any groups that are currently assigned to the identity. Groups cannot currently be assigned to TLS clients.

Note: OIDC clients will only be displayed in the list of identities once they have authenticated with LXD.

Manage permissions

In LXD, identities cannot be granted permissions directly. Instead, identities are added to groups, and groups are granted permissions. To create a group, run:

```
lxc auth group create <group_name>
```

To add an identity to a group, run:

```
lxc auth identity group add <authentication_method>/<identifier> <group_name>
```

For example, for OIDC clients:

```
lxc auth identity group add oidc/<email_address> <group_name>
```

The identity is now a member of the group. To add permissions to the group, run:

```
lxc auth group permission add <group_name> <entity_type> [<entity_name>] <entitlement> [
↪<key>=<value>...]
```

Here are some examples:

- `lxc auth group permission add administrator server admin` grants members of `administrator` the `admin` entitlement on `server`.
- `lxc auth group permission add junior-dev project sandbox operator` grants members of `junior-dev` the `operator` entitlement on project `sandbox`.
- `lxc auth group permission add my-group instance c1 user project=default` grants members of `my-group` the `user` entitlement on instance `c1` in project `default`.

Some entity types require more than one supplementary argument to uniquely specify the entity. For example, entities of type `storage_volume` and `storage_bucket` require an additional `pool=<storage_pool_name>` argument.

Use groups defined by the identity provider

It is common practice to manage users, roles, and groups centrally via an identity provider (IdP). In LXD, identity provider groups allow groups that are defined by the IdP to be mapped to LXD groups. When an OIDC client makes a request to LXD, any groups that can be extracted from the client's identity token are mapped to LXD groups, giving the client the same effective permissions.

To configure IdP group mappings in LXD, first configure your IdP to add groups to identity and access tokens as a custom claim. This configuration depends on your IdP. In Auth0, for example, you can add the "roles" that a user has as a custom claim via an action. Alternatively, if RBAC (role-based access control) is enabled for the audience, a "permissions" claim can be added automatically. In Keycloak, you can define a mapper to set Keycloak groups in the token.

Then configure LXD to extract this claim. To do so, set the value of the *`oidc.groups.claim`* configuration key to the value of the field name of the custom claim:

```
lxc config set oidc.groups.claim=<claim_name>
```

LXD will then expect the identity and access tokens to contain a claim with this name. The value of the claim must be a JSON array containing a string value for each IdP group name. If the group names are extracted successfully, LXD will be aware of the IdP groups for the duration of the request.

Next, configure a mapping between an IdP group and a LXD group as follows:

```
lxc auth identity-provider-group create <idp_group_name>
lxc auth identity-provider-group group add <idp_group_name> <lxd_group_name>
```

IdP groups can be mapped to multiple LXD groups, and multiple IdP groups can be mapped to the same LXD group.

Important: LXD does not store the identity provider groups that are extracted from identity or access tokens. This can obfuscate the true permissions of an identity. For example, if an identity belongs to LXD group "foo", an administrator

can view the permissions of group "foo" to determine the level of access of the identity. However, if identity provider group mappings are configured, direct group membership alone does not determine their level of access. The command `lxc auth identity info` can be run by any identity to view a full list of their own effective groups and permissions as granted directly or indirectly via IdP groups.

About projects

You can use projects to keep your LXD server clean by grouping related instances together. In addition to isolated instances, each project can also have specific images, profiles, networks, and storage.

For example, projects can be useful in the following scenarios:

- You run a huge number of instances for different purposes, for example, for different customer projects. You want to keep these instances separate to make it easier to locate and maintain them, and you might want to reuse the same instance names in each customer project for consistency reasons. Each instance in a customer project should use the same base configuration (for example, networks and storage), but the configuration might differ between customer projects.

  In this case, you can create a LXD project for each customer project (thus each group of instances) and use different profiles, networks, and storage for each LXD project.

- Your LXD server is shared between multiple users. Each user runs their own instances, and might want to configure their own profiles. You want to keep the user instances confined, so that each user can interact only with their own instances and cannot see the instances created by other users. In addition, you want to be able to limit resources for each user and make sure that the instances of different users cannot interfere with one another.

  In this case, you can set up a multi-user environment with confined projects.

LXD comes with a `default` project. See *How to create and configure projects* for instructions on how to add projects.

Isolation of projects

Projects always encapsulate the instances they contain, which means that instances cannot be shared between projects and instance names can be duplicated in several projects. When you are in a specific project, you can see only the instances that belong to this project.

Other entities (images, profiles, networks, and storage) can be either isolated in the project or inherited from the `default` project. To configure which entities are isolated, you enable or disable the respective *feature* in the project. If a feature is enabled, the corresponding entity is isolated in the project; if the feature is disabled, it is inherited from the `default` project.

For example, if you enable *`features.networks`* for a project, the project uses a separate set of networks and not the networks defined in the `default` project. If you disable *`features.images`*, the project has access to the images defined in the `default` project, and any images you add while you're using the project are also added to the `default` project.

See the list of available *Project features* for information about which features are enabled or disabled when you create a project.

Note: You must select the features that you want to enable before starting to use a new project. When a project contains instances, the features are locked. To edit them, you must remove all instances first.

New features that are added in an upgrade are disabled for existing projects.

Confined projects in a multi-user environment

If your LXD server is used by multiple users (for example, in a lab environment), you can use projects to confine the activities of each user. This method isolates the instances and other entities (depending on the feature configuration), as described in *Isolation of projects*. It also confines users to their own user space and prevents them from gaining access to other users' instances or data. Any changes that affect the LXD server and its configuration, for example, adding or removing storage, are not permitted.

In addition, this method allows users to work with LXD without being a member of the `lxd` group (see *Access to the LXD daemon*). Members of the `lxd` group have full access to LXD, including permission to attach file system paths and tweak the security features of an instance, which makes it possible to gain root access to the host system. Using confined projects limits what users can do in LXD, but it also prevents users from gaining root access.

Authentication methods for projects

There are different ways of authentication that you can use to confine projects to specific users:

Client certificates
: You can restrict the *TLS client certificates* to allow access to specific projects only. The projects must exist before you can restrict access to them. A client that connects using a restricted certificate can see only the project or projects that the client has been granted access to.

Multi-user LXD daemon
: The LXD snap contains a multi-user LXD daemon that allows dynamic project creation on a per-user basis. You can configure a specific user group other than the `lxd` group to give restricted LXD access to every user in the group.

  When a user that is a member of this group starts using LXD, LXD automatically creates a confined project for this user.

  If you're not using the snap, you can still use this feature if your distribution supports it.

See *How to confine projects to specific users* for instructions on how to enable and configure the different authentication methods.

Related topics

How-to guides:

- *Projects*

Reference:

- *Project configuration*

2.3.4 Production setup

When you're ready to move your LXD setup to production, you should read up on the concepts that are important for providing a scalable, reliable, and secure environment.

About clustering

To spread the total workload over several servers, LXD can be run in clustering mode. In this scenario, any number of LXD servers share the same distributed database that holds the configuration for the cluster members and their instances. The LXD cluster can be managed uniformly using the `lxc` client or the REST API.

This feature was introduced as part of the `clustering` API extension and is available since LXD 3.0.

Tip: If you want to quickly set up a basic LXD cluster, check out MicroCloud.

Cluster members

A LXD cluster consists of one bootstrap server and at least two further cluster members. It stores its state in a *distributed database*, which is a Dqlite database replicated using the Raft algorithm.

While you could create a cluster with only two members, it is strongly recommended that the number of cluster members be at least three. With this setup, the cluster can survive the loss of at least one member and still be able to establish quorum for its distributed state.

When you create the cluster, the Dqlite database runs on only the bootstrap server until a third member joins the cluster. Then both the second and the third server receive a replica of the database.

See *How to form a cluster* for more information.

Member roles

In a cluster with three members, all members replicate the distributed database that stores the state of the cluster. If the cluster has more members, only some of them replicate the database. The remaining members have access to the database, but don't replicate it.

At each time, there is an elected cluster leader that monitors the health of the other members.

Each member that replicates the database has either the role of a *voter* or of a *stand-by*. If the cluster leader goes offline, one of the voters is elected as the new leader. If a voter member goes offline, a stand-by member is automatically promoted to voter. The database (and hence the cluster) remains available as long as a majority of voters is online.

The following roles can be assigned to LXD cluster members. Automatic roles are assigned by LXD itself and cannot be modified by the user.

Role	Automatic	Description
`database`	yes	Voting member of the distributed database
`database-leader`	yes	Current leader of the distributed database
`database-standby`	yes	Stand-by (non-voting) member of the distributed database
`event-hub`	no	Exchange point (hub) for the internal LXD events (requires at least two)
`ovn-chassis`	no	Uplink gateway candidate for OVN networks

The default number of voter members (`cluster.max_voters`) is three. The default number of stand-by members (`cluster.max_standby`) is two. With this configuration, your cluster will remain operational as long as you switch off at most one voting member at a time.

See *How to manage a cluster* for more information.

Offline members and fault tolerance

If a cluster member is down for more than the configured offline threshold, its status is marked as offline. In this case, no operations are possible on this member, and neither are operations that require a state change across all members.

As soon as the offline member comes back online, operations are available again.

If the member that goes offline is the leader itself, the other members will elect a new leader.

If you can't or don't want to bring the server back online, you can *delete it from the cluster*.

You can tweak the amount of seconds after which a non-responding member is considered offline by setting the `cluster.offline_threshold` configuration. The default value is 20 seconds. The minimum value is 10 seconds.

To automatically *evacuate* instances from an offline member, set the `cluster.healing_threshold` configuration to a non-zero value.

See *How to recover a cluster* for more information.

Failure domains

You can use failure domains to indicate which cluster members should be given preference when assigning roles to a cluster member that has gone offline. For example, if a cluster member that currently has the database role gets shut down, LXD tries to assign its database role to another cluster member in the same failure domain, if one is available.

To update the failure domain of a cluster member, use the `lxc cluster edit <member>` command and change the `failure_domain` property from `default` to another string.

Member configuration

LXD cluster members are generally assumed to be identical systems. This means that all LXD servers joining a cluster must have an identical configuration to the bootstrap server, in terms of storage pools and networks.

To accommodate things like slightly different disk ordering or network interface naming, there is an exception for some configuration options related to storage and networks, which are member-specific.

When such settings are present in a cluster, any server that is being added must provide a value for them. Most often, this is done through the interactive `lxd init` command, which asks the user for the value for a number of configuration keys related to storage or networks.

Those settings typically include:

- The source device and size for a storage pool
- The name for a ZFS zpool, LVM thin pool or LVM volume group
- External interfaces and BGP next-hop for a bridged network
- The name of the parent network device for managed `physical` or `macvlan` networks

See *How to configure storage for a cluster* and *How to configure networks for a cluster* for more information.

If you want to look up the questions ahead of time (which can be useful for scripting), query the `/1.0/cluster` API endpoint. This can be done through `lxc query /1.0/cluster` or through other API clients.

Images

By default, LXD replicates images on as many cluster members as there are database members. This typically means up to three copies within the cluster.

You can increase that number to improve fault tolerance and the likelihood of the image being locally available. To do so, set the `cluster.images_minimal_replica` configuration. The special value of `-1` can be used to have the image copied to all cluster members.

Cluster groups

In a LXD cluster, you can add members to cluster groups. You can use these cluster groups to launch instances on a cluster member that belongs to a subset of all available members. For example, you could create a cluster group for all members that have a GPU and then launch all instances that require a GPU on this cluster group.

By default, all cluster members belong to the `default` group.

See *How to set up cluster groups* and *Launch an instance on a specific cluster member* for more information.

Automatic placement of instances

In a cluster setup, each instance lives on one of the cluster members. When you launch an instance, you can target it to a specific cluster member, to a cluster group or have LXD automatically assign it to a cluster member.

By default, the automatic assignment picks the cluster member that has the lowest number of instances. If several members have the same amount of instances, one of the members is chosen at random.

However, you can control this behavior with the `scheduler.instance` configuration option:

- If `scheduler.instance` is set to `all` for a cluster member, this cluster member is selected for an instance if:
  - The instance is created without `--target` and the cluster member has the lowest number of instances.
  - The instance is targeted to live on this cluster member.
  - The instance is targeted to live on a member of a cluster group that the cluster member is a part of, and the cluster member has the lowest number of instances compared to the other members of the cluster group.
- If `scheduler.instance` is set to `manual` for a cluster member, this cluster member is selected for an instance if:
  - The instance is targeted to live on this cluster member.
- If `scheduler.instance` is set to `group` for a cluster member, this cluster member is selected for an instance if:
  - The instance is targeted to live on this cluster member.
  - The instance is targeted to live on a member of a cluster group that the cluster member is a part of, and the cluster member has the lowest number of instances compared to the other members of the cluster group.

Instance placement scriptlet

LXD supports using custom logic to control automatic instance placement by using an embedded script (scriptlet). This method provides more flexibility than the built-in instance placement functionality.

The instance placement scriptlet must be written in the Starlark language (which is a subset of Python). The scriptlet is invoked each time LXD needs to know where to place an instance. The scriptlet receives information about the instance that is being placed and the candidate cluster members that could host the instance. It is also possible for the scriptlet to request information about each candidate cluster member's state and the hardware resources available.

An instance placement scriptlet must implement the `instance_placement` function with the following signature:

`instance_placement(request, candidate_members)`:

- `request` is an object that contains an expanded representation of `scriptlet.InstancePlacement`. This request includes `project` and `reason` fields. The `reason` can be `new`, `evacuation` or `relocation`.
- `candidate_members` is a `list` of cluster member objects representing `api.ClusterMember` entries.

For example:

```
def instance_placement(request, candidate_members):
    # Example of logging info, this will appear in LXD's log.
    log_info("instance placement started: ", request)

    # Example of applying logic based on the instance request.
    if request.name == "foo":
        # Example of logging an error, this will appear in LXD's log.
        log_error("Invalid name supplied: ", request.name)

        fail("Invalid name") # Exit with an error to reject instance placement.

    # Place the instance on the first candidate server provided.
    set_target(candidate_members[0].server_name)

    return # Return empty to allow instance placement to proceed.
```

The scriptlet must be applied to LXD by storing it in the *`instances.placement.scriptlet`* global configuration setting.

For example, if the scriptlet is saved inside a file called `instance_placement.star`, then it can be applied to LXD with the following command:

```
cat instance_placement.star | lxc config set instances.placement.scriptlet=-
```

To see the current scriptlet applied to LXD, use the `lxc config get instances.placement.scriptlet` command.

The following functions are available to the scriptlet (in addition to those provided by Starlark):

- `log_info(*messages)`: Add a log entry to LXD's log at `info` level. `messages` is one or more message arguments.
- `log_warn(*messages)`: Add a log entry to LXD's log at `warn` level. `messages` is one or more message arguments.
- `log_error(*messages)`: Add a log entry to LXD's log at `error` level. `messages` is one or more message arguments.

- `set_cluster_member_target(member_name)`: Set the cluster member where the instance should be created. `member_name` is the name of the cluster member the instance should be created on. If this function is not called, then LXD will use its built-in instance placement logic.
- `get_cluster_member_state(member_name)`: Get the cluster member's state. Returns an object with the cluster member's state in the form of `api.ClusterMemberState`. `member_name` is the name of the cluster member to get the state for.
- `get_cluster_member_resources(member_name)`: Get information about resources on the cluster member. Returns an object with the resource information in the form of `api.Resources`. `member_name` is the name of the cluster member to get the resource information for.
- `get_instance_resources()`: Get information about the resources the instance will require. Returns an object with the resource information in the form of `scriptlet.InstanceResources`.

Note: Field names in the object types are equivalent to the JSON field names in the associated Go types.

Related topics

How-to guides:

- *Clustering*

Reference:

- *Cluster member configuration*

About performance tuning

When you are ready to move your LXD setup to production, you should take some time to optimize the performance of your system. There are different aspects that impact performance. The following steps help you to determine the choices and settings that you should tune to improve your LXD setup.

Run benchmarks

LXD provides a benchmarking tool to evaluate the performance of your system. You can use the tool to initialize or launch a number of containers and measure the time it takes for the system to create the containers. By running the tool repeatedly with different LXD configurations, system settings or even hardware setups, you can compare the performance and evaluate which is the ideal configuration.

See *How to benchmark performance* for instructions on running the tool.

Monitor instance metrics

LXD collects metrics for all running instances as well as some internal metrics. These metrics cover the CPU, memory, network, disk and process usage. They are meant to be consumed by Prometheus, and you can use Grafana to display the metrics as graphs. See *Provided metrics* for lists of available metrics and *Set up a Grafana dashboard* for instructions on how to display the metrics in Grafana.

You should regularly monitor the metrics to evaluate the resources that your instances use. The numbers help you to determine if there are any spikes or bottlenecks, or if usage patterns change and require updates to your configuration.

See *How to monitor metrics* for more information about metrics collection.

Tune server settings

The default kernel settings for most Linux distributions are not optimized for running a large number of containers or virtual machines. Therefore, you should check and modify the relevant server settings to avoid hitting limits caused by the default settings.

Typical errors that you might see when you encounter those limits are:

- `Failed to allocate directory watch: Too many open files`
- `<Error> <Error>: Too many open files`
- `failed to open stream: Too many open files in...`
- `neighbour: ndisc_cache: neighbor table overflow!`

See *Server settings for a LXD production setup* for a list of relevant server settings and suggested values.

Tune the network bandwidth

If you have a lot of local activity between instances or between the LXD host and the instances, or if you have a fast internet connection, you should consider increasing the network bandwidth of your LXD setup. You can do this by increasing the transmit and receive queue lengths.

See *How to increase the network bandwidth* for instructions.

Related topics

How-to guides:

- *How to benchmark performance*
- *How to increase the network bandwidth*
- *How to monitor metrics*

Reference:

- *Provided metrics*
- *Server settings for a LXD production setup*

About security

Consider the following aspects to ensure that your LXD installation is secure:

- Keep your operating system up-to-date and install all available security patches.
- Use only supported LXD versions (LTS releases or monthly feature releases).
- Restrict access to the LXD daemon and the remote API.
- Configure your network interfaces to be secure.
- Do not use privileged containers unless required. If you use privileged containers, put appropriate security measures in place.

See the following sections for detailed information.

If you discover a security issue, see the LXD security policy for information on how to report the issue.

Supported versions

Never use unsupported LXD versions in a production environment.

LXD has two types of releases:

- Monthly feature releases
- LTS releases

For feature releases, only the latest one is supported, and we usually don't do point releases. Instead, users are expected to wait until the next monthly release.

For LTS releases, we do periodic bugfix releases that include an accumulation of bugfixes from the feature releases. Such bugfix releases do not include new features.

Access to the LXD daemon

LXD is a daemon that can be accessed locally over a Unix socket or, if configured, remotely over a TLS socket. Anyone with access to the socket can fully control LXD, which includes the ability to attach host devices and file systems or to tweak the security features for all instances.

Therefore, make sure to restrict the access to the daemon to trusted users.

Local access to the LXD daemon

The LXD daemon runs as root and provides a Unix socket for local communication. Access control for LXD is based on group membership. The root user and all members of the `lxd` group can interact with the local daemon.

Important: Local access to LXD through the Unix socket always grants full access to LXD. This includes the ability to attach file system paths or devices to any instance as well as tweak the security features on any instance.

Therefore, you should only give such access to users who you'd trust with root access to your system.

Access to the remote API

By default, access to the daemon is only possible locally. By setting the `core.https_address` configuration option, you can expose the same API over the network on a TLS socket. See *How to expose LXD to the network* for instructions. Remote clients can then connect to LXD and access any image that is marked for public use.

There are several ways to authenticate remote clients as trusted clients to allow them to access the API. See *Remote API authentication* for details.

In a production setup, you should set `core.https_address` to the single address where the server should be available (rather than any address on the host). In addition, you should set firewall rules to allow access to the LXD port only from authorized hosts/subnets.

Container security

LXD containers can use a wide range of features for security.

Also see the LXC security page on `linuxcontainers.org` for details on LXC container security and the applied kernel features.

Unprivileged containers

By default, containers are *unprivileged*, meaning that they operate inside a user namespace, restricting the abilities of users in the container to that of regular users on the host with limited privileges on the devices that the container owns.

Unprivileged containers are safe by design: The container UID 0 is mapped to an unprivileged user outside of the container. It has extra rights only on resources that it owns itself.

This mechanism ensures that most security issues (for example, container escape or resource abuse) that might occur in a container apply just as well to a random unprivileged user, which means they are a generic kernel security bug rather than a LXD issue.

Tip: If data sharing between containers isn't needed, you can enable *`security.idmap.isolated`*, which will use non-overlapping UID/GID maps for each container, preventing potential DoS (Denial of Service) attacks on other containers.

Privileged containers

LXD can also run *privileged* containers. In privileged containers, the container UID 0 is mapped to the host's UID 0.

Such privileged containers are not root-safe, and a user with root access in such a container will be able to DoS the host as well as find ways to escape confinement.

LXC applies some protection measures to privileged containers to prevent accidental damage of the host (where damage is defined as things like reconfiguring host hardware, reconfiguring the host kernel, or accessing the host file system). This protection of the host and prevention of escape is achieved through mandatory access control (`apparmor`, `selinux`), Seccomp filters, dropping of capabilities, and namespaces. These measures are valuable when running trusted workloads, but they do not make privileged containers root-safe.

Therefore, you should not use privileged containers unless required. If you use them, make sure to put appropriate security measures in place.

Container name leakage

The default server configuration makes it easy to list all cgroups on a system and, by extension, all running containers.

You can prevent this name leakage by blocking access to `/sys/kernel/slab` and `/proc/sched_debug` before you start any containers. To do so, run the following commands:

```
chmod 400 /proc/sched_debug
chmod 700 /sys/kernel/slab/
```

Network security

Make sure to configure your network interfaces to be secure. Which aspects you should consider depends on the networking mode you decide to use.

Bridged NIC security

The default networking mode in LXD is to provide a "managed" private network bridge that each instance connects to. In this mode, there is an interface on the host called `lxdbr0` that acts as the bridge for the instances.

The host runs an instance of `dnsmasq` for each managed bridge, which is responsible for allocating IP addresses and providing both authoritative and recursive DNS services.

Instances using DHCPv4 will be allocated an IPv4 address, and a DNS record will be created for their instance name. This prevents instances from being able to spoof DNS records by providing false host name information in the DHCP request.

The `dnsmasq` service also provides IPv6 router advertisement capabilities. This means that instances will auto-configure their own IPv6 address using SLAAC, so no allocation is made by `dnsmasq`. However, instances that are also using DHCPv4 will also get an AAAA DNS record created for the equivalent SLAAC IPv6 address. This assumes that the instances are not using any IPv6 privacy extensions when generating IPv6 addresses.

In this default configuration, whilst DNS names cannot not be spoofed, the instance is connected to an Ethernet bridge and can transmit any layer 2 traffic that it wishes, which means an instance that is not trusted can effectively do MAC or IP spoofing on the bridge.

In the default configuration, it is also possible for instances connected to the bridge to modify the LXD host's IPv6 routing table by sending (potentially malicious) IPv6 router advertisements to the bridge. This is because the `lxdbr0` interface is created with `/proc/sys/net/ipv6/conf/lxdbr0/accept_ra` set to `2`, meaning that the LXD host will accept router advertisements even though `forwarding` is enabled (see `/proc/sys/net/ipv4/*` Variables for more information).

However, LXD offers several bridged NIC security features that can be used to control the type of traffic that an instance is allowed to send onto the network. These NIC settings should be added to the profile that the instance is using, or they can be added to individual instances, as shown below.

The following security features are available for bridged NICs:

Key	Type	Default	Required	Description
`security.mac_filtering`	bool	`false`	no	Prevent the instance from spoofing another instance's MAC address
`security.ipv4_filtering`	bool	`false`	no	Prevent the instance from spoofing another instance's IPv4 address (enables `mac_filtering`)
`security.ipv6_filtering`	bool	`false`	no	Prevent the instance from spoofing another instance's IPv6 address (enables `mac_filtering`)

One can override the default bridged NIC settings from the profile on a per-instance basis using:

```
lxc config device override <instance> <NIC> security.mac_filtering=true
```

Used together, these features can prevent an instance connected to a bridge from spoofing MAC and IP addresses. These options are implemented using either `xtables` (`iptables`, `ip6tables` and `ebtables`) or `nftables`, depending on what is available on the host.

It's worth noting that those options effectively prevent nested containers from using the parent network with a different MAC address (i.e using bridged or `macvlan` NICs).

The IP filtering features block ARP and NDP advertisements that contain a spoofed IP, as well as blocking any packets that contain a spoofed source address.

If `security.ipv4_filtering` or `security.ipv6_filtering` is enabled and the instance cannot be allocated an IP address (because `ipvX.address=none` or there is no DHCP service enabled on the bridge), then all IP traffic for that protocol is blocked from the instance.

When `security.ipv6_filtering` is enabled, IPv6 router advertisements are blocked from the instance.

When `security.ipv4_filtering` or `security.ipv6_filtering` is enabled, any Ethernet frames that are not ARP, IPv4 or IPv6 are dropped. This prevents stacked VLAN Q-in-Q (802.1ad) frames from bypassing the IP filtering.

Routed NIC security

An alternative networking mode is available called "routed". It provides a virtual Ethernet device pair between container and host. In this networking mode, the LXD host functions as a router, and static routes are added to the host directing traffic for the container's IPs towards the container's `veth` interface.

By default, the `veth` interface created on the host has its `accept_ra` setting disabled to prevent router advertisements from the container modifying the IPv6 routing table on the LXD host. In addition to that, the `rp_filter` on the host is set to 1 to prevent source address spoofing for IPs that the host does not know the container has.

Related topics

How-to guides:

- *How to expose LXD to the network*

Explanation:

- *Remote API authentication*

2.4 Reference

The reference material in this section provides technical descriptions of LXD.

2.4.1 General information

Before you start using LXD, you should check the system requirements. You should also be aware of the supported architectures, the available image servers, the format for images, and the environment used for containers.

Requirements

Go

LXD requires Go 1.22.0 or higher and is only tested with the Golang compiler.

We recommend having at least 2GiB of RAM to allow the build to complete.

Kernel requirements

The minimum supported kernel version is 5.15, but older kernels should also work to some degree.

LXD requires a kernel with support for:

- Namespaces (`pid`, `net`, `uts`, `ipc` and `mount`)
- Seccomp
- Native Linux AIO (`io_setup(2)`, etc.)

The following optional features also require extra kernel options or newer versions:

- Namespaces (`user` and `cgroup`)
- AppArmor (including Ubuntu patch for mount mediation)
- Control Groups (`blkio`, `cpuset`, `devices`, `memory`, `pids` and `net_prio`)
- CRIU (exact details to be found with CRIU upstream)
- SKBPRIO/QFQ qdiscs (for `limits.priority`, minimum kernel 5.17)

As well as any other kernel feature required by the LXC version in use.

LXC

LXD requires LXC 5.0.0 or higher with the following build options:

- `apparmor` (if using LXD's AppArmor support)
- `seccomp`

To run recent version of various distributions, including Ubuntu, LXCFS should also be installed.

QEMU

For virtual machines, QEMU 6.2 or higher is required. Some features like Confidential Guest support require a more recent QEMU and kernel version.

Hardware-assisted virtualization (Intel VT-x, AMD-V, etc) is required for running virtual machines. Additional hardware support (Intel VT-d, AMD-Vi) may be required for device pass-through.

ZFS

For the ZFS storage driver, ZFS 2.1 or higher is required. Some features like `zfs_delegate` requires 2.2 or higher to be used.

Additional libraries (and development headers)

LXD uses `dqlite` for its database, to build and set it up, you can run `make deps`.

LXD itself also uses a number of (usually packaged) C libraries:

- `libacl1`
- `libcap2`
- `liblz4` (for `dqlite`)
- `libuv1` (for `dqlite`)
- `libsqlite3` >= 3.37.2 (for `dqlite`)

Make sure you have all these libraries themselves and their development headers (`-dev` packages) installed.

Related topics

Tutorials:

- *First steps with LXD*

How-to guides:

- *Getting started*

Architectures

LXD can run on just about any architecture that is supported by the Linux kernel and by Go.

Some entities in LXD are tied to an architecture, for example, the instances, instance snapshots and images.

The following table lists all supported architectures including their unique identifier and the name used to refer to them. The architecture names are typically aligned with the Linux kernel architecture names.

ID	Name	Notes	Personalities
1	i686	32bit Intel x86	
2	x86_64	64bit Intel x86	x86
3	armv7l	32bit ARMv7 little-endian	
4	aarch64	64bit ARMv8 little-endian	armv7 (optional)
5	ppc	32bit PowerPC big-endian	
6	ppc64	64bit PowerPC big-endian	powerpc
7	ppc64le	64bit PowerPC little-endian	
8	s390x	64bit ESA/390 big-endian	
9	mips	32bit MIPS	
10	mips64	64bit MIPS	mips
11	riscv32	32bit RISC-V little-endian	
12	riscv64	64bit RISC-V little-endian	

Note: LXD cares only about the kernel architecture, not the particular userspace flavor as determined by the toolchain.

That means that LXD considers ARMv7 hard-float to be the same as ARMv7 soft-float and refers to both as `armv7`. If useful to the user, the exact userspace ABI may be set as an image and container property, allowing easy query.

Remote image servers

The *lxc* CLI command comes pre-configured with the following default remote image servers:

images:
: This server provides unofficial images for a variety of Linux distributions. The images are built to be compact and minimal, and therefore the default image variants do not include `cloud-init`. Where possible, `/cloud` variants that include `cloud-init` are provided. See *cloud-init support in images*.

  This server does not provide official Ubuntu images (for those, use the `ubuntu:` server). It does, however, provide desktop variants of current Ubuntu releases.

  See `images.lxd.canonical.com` for an overview of available images.

ubuntu:
: This server provides official stable Ubuntu images. All images are cloud images, which means that they include both `cloud-init` and the `lxd-agent`.

  See `cloud-images.ubuntu.com/releases` for an overview of available images.

ubuntu-daily:
: This server provides official daily Ubuntu images. All images are cloud images, which means that they include both `cloud-init` and the `lxd-agent`.

  See `cloud-images.ubuntu.com/daily` for an overview of available images.

ubuntu-minimal:
: This server provides official Ubuntu Minimal images. All images are cloud images, which means that they include both `cloud-init` and the `lxd-agent`.

  See `cloud-images.ubuntu.com/minimal/releases` for an overview of available images.

ubuntu-minimal-daily:
: This server provides official daily Ubuntu Minimal images. All images are cloud images, which means that they include both `cloud-init` and the `lxd-agent`.

  See `cloud-images.ubuntu.com/minimal/daily` for an overview of available images.

Remote server types

LXD supports the following types of remote image servers:

Simple streams servers
: Pure image servers that use the simple streams format. The default image servers are simple streams servers.

Public LXD servers
: LXD servers that are used solely to serve images and do not run instances themselves.

  To make a LXD server publicly available over the network on port 8443, set the `core.https_address` configuration option to `:8443` and do not configure any authentication methods (see *How to expose LXD to the network* for more information). Then set the images that you want to share to `public`.

LXD servers
: Regular LXD servers that you can manage over a network, and that can also be used as image servers.

  For security reasons, you should restrict the access to the remote API and configure an authentication method to control access. See *How to expose LXD to the network* and *Remote API authentication* for more information.

Related topics

How-to guides:

- *Images*

Explanation:

- *About images*

Image format

Images contain a root file system and a metadata file that describes the image. They can also contain templates for creating files inside an instance that uses the image.

Images can be packaged as either a unified image (single file) or a split image (two files).

Content

Images for containers have the following directory structure:

```
metadata.yaml
rootfs/
templates/
```

Images for VMs have the following directory structure:

```
metadata.yaml
rootfs.img
templates/
```

For both instance types, the `templates/` directory is optional.

Metadata

The `metadata.yaml` file contains information that is relevant to running the image in LXD. It includes the following information:

```
architecture: x86_64
creation_date: 1424284563
properties:
  description: Ubuntu 24.04 LTS Intel 64bit
  os: Ubuntu
  release: noble 24.04
templates:
  ...
```

The `architecture` and `creation_date` fields are mandatory. The `properties` field contains a set of default properties for the image. The `os`, `release`, `name` and `description` fields are commonly used, but are not mandatory.

The `templates` field is optional. See *Templates (optional)* for information on how to configure templates.

Root file system

For containers, the `rootfs/` directory contains a full file system tree of the root directory (`/`) in the container.

Virtual machines use a `rootfs.img` `qcow2` file instead of a `rootfs/` directory. This file becomes the main disk device.

Templates (optional)

You can use templates to dynamically create files inside an instance. To do so, configure template rules in the `metadata.yaml` file and place the template files in a `templates/` directory.

As a general rule, you should never template a file that is owned by a package or is otherwise expected to be overwritten by normal operation of an instance.

Template rules

For each file that should be generated, create a rule in the `metadata.yaml` file. For example:

```
templates:
  /etc/hosts:
    when:
      - create
      - rename
    template: hosts.tpl
    properties:
      foo: bar
  /etc/hostname:
    when:
      - start
    template: hostname.tpl
  /etc/network/interfaces:
    when:
      - create
    template: interfaces.tpl
    create_only: true
```

The `when` key can be one or more of:

- `create` - run at the time a new instance is created from the image
- `copy` - run when an instance is created from an existing one
- `start` - run every time the instance is started

The `template` key points to the template file in the `templates/` directory.

You can pass user-defined template properties to the template file through the `properties` key.

Set the `create_only` key if you want LXD to create the file if it doesn't exist, but not overwrite an existing file.

Template files

Template files use the Pongo2 format.

They always receive the following context:

Variable	Type	Description
`trigger`	`string`	Name of the event that triggered the template
`path`	`string`	Path of the file that uses the template
`instance`	`map[string]string`	Key/value map of instance properties (name, architecture, privileged and ephemeral)
`config`	`map[string]string`	Key/value map of the instance's configuration
`devices`	`map[string]map[string]st`	Key/value map of the devices assigned to the instance
`propertie`	`map[string]string`	Key/value map of the template properties specified in `metadata.yaml`

For convenience, the following functions are exported to the Pongo2 templates:

- `config_get("user.foo", "bar")` - Returns the value of `user.foo`, or `"bar"` if not set.

Image tarballs

LXD supports two LXD-specific image formats: a unified tarball and split tarballs.

These tarballs can be compressed. LXD supports a wide variety of compression algorithms for tarballs. However, for compatibility purposes, you should use `gzip` or `xz`.

Unified tarball

A unified tarball is a single tarball (usually `*.tar.xz`) that contains the full content of the image, including the metadata, the root file system and optionally the template files.

This is the format that LXD itself uses internally when publishing images. It is usually easier to work with; therefore, you should use the unified format when creating LXD-specific images.

The image identifier for such images is the SHA-256 of the tarball.

Split tarballs

A split image consists of two separate tarballs. One tarball contains the metadata and optionally the template files (usually `*.tar.xz`), and the other contains the root file system (usually `*.squashfs` for containers or `*.qcow2` for virtual machines).

For containers, the root file system tarball can be SquashFS-formatted. For virtual machines, the `rootfs.img` file always uses the `qcow2` format. It can optionally be compressed using `qcow2`'s native compression.

This format is designed to allow for easy image building from existing non-LXD rootfs tarballs that are already available. You should also use this format if you want to create images that can be consumed by both LXD and other tools.

The image identifier for such images is the SHA-256 of the concatenation of the metadata and root file system tarball (in that order).

Related topics

How-to guides:

- *Images*

Explanation:

- *About images*

Container runtime environment

LXD attempts to present a consistent environment to all containers it runs.

The exact environment will differ slightly based on kernel features and user configuration, but otherwise, it is identical for all containers.

File system

LXD assumes that any image it uses to create a new container comes with at least the following root-level directories:

- `/dev` (empty)
- `/proc` (empty)
- `/sbin/init` (executable)
- `/sys` (empty)

Devices

LXD containers have a minimal and ephemeral `/dev` based on a `tmpfs` file system. Since this is a `tmpfs` and not a `devtmpfs` file system, device nodes appear only if manually created.

The following standard set of device nodes is set up automatically:

- `/dev/console`
- `/dev/fd`
- `/dev/full`
- `/dev/log`
- `/dev/null`
- `/dev/ptmx`
- `/dev/random`
- `/dev/stdin`
- `/dev/stderr`
- `/dev/stdout`
- `/dev/tty`
- `/dev/urandom`
- `/dev/zero`

In addition to the standard set of devices, the following devices are also set up for convenience:

- `/dev/fuse`
- `/dev/net/tun`
- `/dev/mqueue`

Network

LXD containers may have any number of network devices attached to them. The naming for those (unless overridden by the user) is `ethX`, where `X` is an incrementing number.

Container-to-host communication

LXD sets up a socket at `/dev/lxd/sock` that the root user in the container can use to communicate with LXD on the host.

See *Communication between instance and host* for the API documentation.

Mounts

The following mounts are set up by default:

- `/proc` ()
- `/sys` (`sysfs`)
- `/sys/fs/cgroup/*` (`cgroupfs`) (only on kernels that lack cgroup namespace support)

If they are present on the host, the following paths will also automatically be mounted:

- `/proc/sys/fs/binfmt_misc`
- `/sys/firmware/efi/efivars`
- `/sys/fs/fuse/connections`
- `/sys/fs/pstore`
- `/sys/kernel/debug`
- `/sys/kernel/security`

The reason for passing all of those paths is that legacy init systems require them to be mounted, or be mountable, inside the container.

The majority of those paths will not be writable (or even readable) from inside an unprivileged container. In privileged containers, they will be blocked by the AppArmor policy.

LXCFS

If LXCFS is present on the host, it is automatically set up for the container.

This normally results in a number of `/proc` files being overridden through bind-mounts. On older kernels, a virtual version of `/sys/fs/cgroup` might also be set up by LXCFS.

PID1

LXD spawns whatever is located at `/sbin/init` as the initial process of the container (PID 1). This binary should act as a proper init system, including handling re-parented processes.

LXD's communication with PID1 in the container is limited to two signals:

- `SIGINT` to trigger a reboot of the container
- `SIGPWR` (or alternatively `SIGRTMIN+3`) to trigger a clean shutdown of the container

The initial environment of PID1 is blank except for `container=lxc`, which can be used by the init system to detect the runtime.

All file descriptors above the default three are closed prior to PID1 being spawned.

Related topics

How-to guides:

- *Instances*

Explanation:

- *Instance types in LXD*

2.4.2 Configuration options

LXD is highly configurable. Check the available configuration options for the LXD server and the different entities used in LXD.

Index

Server configuration

The LXD server can be configured through a set of key/value configuration options.

The key/value configuration is namespaced. The following options are available:

- *Core configuration*
- *ACME configuration*
- *OpenID Connect configuration*
- *Cluster configuration*
- *Images configuration*
- *Loki configuration*
- *Miscellaneous options*

See *How to configure the LXD server* for instructions on how to set the configuration options.

Note: Options marked with a `global` scope are immediately applied to all cluster members. Options with a `local` scope must be set on a per-member basis.

Core configuration

The following server options control the core daemon configuration: `core.bgp_address` Address to bind the BGP server to

Key:	`core.bgp_address`
Type:	string
Scope:	local

See *How to configure LXD as a BGP server*.

`core.bgp_asn` BGP Autonomous System Number for the local server

Key:	`core.bgp_asn`
Type:	string
Scope:	global

`core.bgp_routerid` A unique identifier for the BGP server

Key:	`core.bgp_routerid`
Type:	string
Scope:	local

The identifier must be formatted as an IPv4 address.

`core.debug_address` Address to bind the `pprof` debug server to (HTTP)

Key:	`core.debug_address`
Type:	string
Scope:	local

`core.dns_address` Address to bind the authoritative DNS server to

Key:	`core.dns_address`
Type:	string
Scope:	local

See *Enable the built-in DNS server*.

`core.https_address` Address to bind for the remote API (HTTPS)

Key:	`core.https_address`
Type:	string
Scope:	local

See *How to expose LXD to the network*.

`core.https_allowed_credentials` Whether to set `Access-Control-Allow-Credentials`

Key:	`core.https_allowed_credentials`
Type:	bool
Default:	`false`
Scope:	global

If enabled, the `Access-Control-Allow-Credentials` HTTP header value is set to `true`.

`core.https_allowed_headers` `Access-Control-Allow-Headers` HTTP header value

Key:	`core.https_allowed_headers`
Type:	string
Scope:	global

`core.https_allowed_methods` `Access-Control-Allow-Methods` HTTP header value

Key:	`core.https_allowed_methods`
Type:	string
Scope:	global

`core.https_allowed_origin` `Access-Control-Allow-Origin` HTTP header value

Key:	`core.https_allowed_origin`
Type:	string
Scope:	global

`core.https_trusted_proxy` Trusted servers to provide the client's address

Key:	`core.https_trusted_proxy`
Type:	string
Scope:	global

Specify a comma-separated list of IP addresses of trusted servers that provide the client's address through the proxy connection header.

`core.metrics_address` Address to bind the metrics server to (HTTPS)

Key:	`core.metrics_address`
Type:	string
Scope:	local

See *How to monitor metrics*.

`core.metrics_authentication` Whether to enforce authentication on the metrics endpoint

Key:	`core.metrics_authentication`
Type:	bool
Default:	`true`
Scope:	global

`core.proxy_http` HTTP proxy to use

Key:	`core.proxy_http`
Type:	string
Scope:	global

If this option is not specified, LXD falls back to the `HTTP_PROXY` environment variable (if set).

`core.proxy_https` HTTPS proxy to use

Key:	`core.proxy_https`
Type:	string
Scope:	global

If this option is not specified, LXD falls back to the `HTTPS_PROXY` environment variable (if set).

`core.proxy_ignore_hosts` Hosts that don't need the proxy

Key:	`core.proxy_ignore_hosts`
Type:	string
Scope:	global

Specify this option in a similar format to `NO_PROXY` (for example, `1.2.3.4,1.2.3.5`)

If this option is not specified, LXD falls back to the `NO_PROXY` environment variable (if set).

`core.remote_token_expiry` Time after which a remote add token expires

Key:	`core.remote_token_expiry`
Type:	string
Default:	no expiry
Scope:	global

`core.shutdown_timeout` How long to wait before shutdown

Key:	`core.shutdown_timeout`
Type:	integer
Default:	`5`
Scope:	global

Specify the number of minutes to wait for running operations to complete before the LXD server shuts down.

`core.storage_buckets_address` Address to bind the storage object server to (HTTPS)

Key:	`core.storage_buckets_address`
Type:	string
Scope:	local

See *How to manage storage buckets and keys*.

`core.syslog_socket` Whether to enable the syslog unixgram socket listener

Key:	`core.syslog_socket`
Type:	bool
Default:	`false`
Scope:	local

Set this option to `true` to enable the syslog unixgram socket to receive log messages from external processes.

`core.trust_ca_certificates` Whether to automatically trust clients signed by the CA

Key:	`core.trust_ca_certificates`
Type:	bool
Default:	`false`
Scope:	global

`core.trust_password` Password to be provided by clients to set up a trust

Key:	`core.trust_password`
Type:	string
Scope:	global

ACME configuration

The following server options control the *ACME* configuration: `acme.agree_tos` Agree to ACME terms of service

Key:	`acme.agree_tos`
Type:	bool
Default:	`false`
Scope:	global

`acme.ca_url` URL to the directory resource of the ACME service

Key:	`acme.ca_url`
Type:	string
Default:	`https://acme-v02.api.letsencrypt.org/directory`
Scope:	global

`acme.domain` Domain for which the certificate is issued

Key:	`acme.domain`
Type:	string
Scope:	global

`acme.email` Email address used for the account registration

Key:	`acme.email`
Type:	string
Scope:	global

OpenID Connect configuration

The following server options configure external user authentication through *OpenID Connect authentication*: `oidc.audience` Expected audience value for the application

Key:	`oidc.audience`
Type:	string
Scope:	global

This value is required by some providers.

`oidc.client.id` OpenID Connect client ID

Key:	`oidc.client.id`
Type:	string
Scope:	global

`oidc.groups.claim` Expected audience value for the application

Key:	`oidc.groups.claim`
Type:	string
Scope:	global

Specify a custom claim to be requested when performing OIDC flows. Configure a corresponding custom claim in your identity provider and add organization level groups to it. These can be mapped to LXD groups for automatic access control.

`oidc.issuer` OpenID Connect Discovery URL for the provider

Key:	`oidc.issuer`
Type:	string
Scope:	global

Cluster configuration

The following server options control *Clustering*: `cluster.healing_threshold` Threshold when to evacuate an offline cluster member

Key:	`cluster.healing_threshold`
Type:	integer
Default:	`0`
Scope:	global

Specify the number of seconds after which an offline cluster member is to be evacuated. To disable evacuating offline members, set this option to `0`.

`cluster.https_address` Address to use for clustering traffic

Key:	`cluster.https_address`
Type:	string
Scope:	local

See *Separate REST API and clustering networks*.

`cluster.images_minimal_replica` Number of cluster members that replicate an image

Key:	`cluster.images_minimal_replica`
Type:	integer
Default:	3
Scope:	global

Specify the minimal number of cluster members that keep a copy of a particular image. Set this option to `1` for no replication, or to `-1` to replicate images on all members.

`cluster.join_token_expiry` Time after which a cluster join token expires

Key:	`cluster.join_token_expiry`
Type:	string
Default:	`3H`
Scope:	global

`cluster.max_standby` Number of database stand-by members

Key:	`cluster.max_standby`
Type:	integer
Default:	`2`
Scope:	global

Specify the maximum number of cluster members that are assigned the database stand-by role. This must be a number between `0` and `5`.

`cluster.max_voters` Number of database voter members

Key:	`cluster.max_voters`
Type:	integer
Default:	`3`
Scope:	global

Specify the maximum number of cluster members that are assigned the database voter role. This must be an odd number `>= 3`.

`cluster.offline_threshold` Threshold when an unresponsive member is considered offline

Key:	`cluster.offline_threshold`
Type:	integer
Default:	`20`
Scope:	global

Specify the number of seconds after which an unresponsive member is considered offline.

Images configuration

The following server options configure how to handle *Images*: `images.auto_update_cached` Whether to automatically update cached images

Key:	`images.auto_update_cached`
Type:	bool
Default:	`true`
Scope:	global

`images.auto_update_interval` Interval at which to look for updates to cached images

Key:	images.auto_update_interval
Type:	integer
Default:	6
Scope:	global

Specify the interval in hours. To disable looking for updates to cached images, set this option to `0`.

`images.compression_algorithm` Compression algorithm to use for new images

Key:	images.compression_algorithm
Type:	string
Default:	gzip
Scope:	global

Possible values are `bzip2`, `gzip`, `lzma`, `xz`, or `none`.

`images.default_architecture` Default architecture to use in a mixed-architecture cluster

Key:	images.default_architecture
Type:	string

`images.remote_cache_expiry` When an unused cached remote image is flushed

Key:	images.remote_cache_expiry
Type:	integer
Default:	10
Scope:	global

Specify the number of days after which the unused cached image expires.

Loki configuration

The following server options configure the external log aggregation system: `loki.api.ca_cert` CA certificate for the Loki server

Key:	loki.api.ca_cert
Type:	string
Scope:	global

`loki.api.url` URL to the Loki server

Key:	loki.api.url
Type:	string
Scope:	global

Specify the protocol, name or IP and port. For example `https://loki.example.com:3100`. LXD will automatically add the `/loki/api/v1/push` suffix so there's no need to add it here.

`loki.auth.password` Password used for Loki authentication

Key:	`loki.auth.password`
Type:	string
Scope:	global

`loki.auth.username` User name used for Loki authentication

Key:	`loki.auth.username`
Type:	string
Scope:	global

`loki.instance` Name to use as the instance field in Loki events.

Key:	`loki.instance`
Type:	string
Default:	Local server host name or cluster member name
Scope:	global

This allows replacing the default instance value (server host name) by a more relevant value like a cluster identifier.

`loki.labels` Labels for a Loki log entry

Key:	`loki.labels`
Type:	string
Scope:	global

Specify a comma-separated list of values that should be used as labels for a Loki log entry.

`loki.loglevel` Minimum log level to send to the Loki server

Key:	`loki.loglevel`
Type:	string
Default:	`info`
Scope:	global

`loki.types` Events to send to the Loki server

Key:	`loki.types`
Type:	string
Default:	`lifecycle,logging`
Scope:	global

Specify a comma-separated list of events to send to the Loki server. The events can be any combination of `lifecycle`, `logging`, and `ovn`.

Miscellaneous options

The following server options configure server-specific settings for *Instances*, MAAS integration, *OVN* integration, *Backups* and *Storage*: `backups.compression_algorithm` Compression algorithm to use for backups

Key:	`backups.compression_algorithm`
Type:	string
Default:	`gzip`
Scope:	global

Possible values are `bzip2`, `gzip`, `lzma`, `xz`, or `none`.

`instances.migration.stateful` Whether to set `migration.stateful` to `true` for the instances

Key:	`instances.migration.stateful`
Type:	bool
Scope:	global

You can override this setting for relevant instances, either in the instance-specific configuration or through a profile.

`instances.nic.host_name` How to set the host name for a NIC

Key:	`instances.nic.host_name`
Type:	string
Default:	`random`
Scope:	global

Possible values are `random` and `mac`.

If set to `random`, use the random host interface name as the host name. If set to `mac`, generate a host name in the form `lxd<mac_address>` (MAC without leading two digits).

`instances.placement.scriptlet` Instance placement scriptlet for automatic instance placement

Key:	`instances.placement.scriptlet`
Type:	string
Scope:	global

When using custom automatic instance placement logic, this option stores the scriptlet. See *Instance placement scriptlet* for more information.

`maas.api.key` API key to manage MAAS

Key:	`maas.api.key`
Type:	string
Scope:	global

`maas.api.url` URL of the MAAS server

Key:	maas.api.url
Type:	string
Scope:	global

maas.machine Name of this LXD host in MAAS

Key:	maas.machine
Type:	string
Default:	host name
Scope:	local

network.ovn.ca_cert OVN SSL certificate authority

Key:	network.ovn.ca_cert
Type:	string
Default:	Content of /etc/ovn/ovn-central.crt if present
Scope:	global

network.ovn.client_cert OVN SSL client certificate

Key:	network.ovn.client_cert
Type:	string
Default:	Content of /etc/ovn/cert_host if present
Scope:	global

network.ovn.client_key OVN SSL client key

Key:	network.ovn.client_key
Type:	string
Default:	Content of /etc/ovn/key_host if present
Scope:	global

network.ovn.integration_bridge OVS integration bridge to use for OVN networks

Key:	network.ovn.integration_bridge
Type:	string
Default:	br-int
Scope:	global

network.ovn.northbound_connection OVN northbound database connection string

Key:	network.ovn.northbound_connection
Type:	string
Default:	unix:/var/run/ovn/ovnnb_db.sock
Scope:	global

storage.backups_volume Volume to use to store backup tarballs

Key:	`storage.backups_volume`
Type:	string
Scope:	local

Specify the volume using the syntax `POOL/VOLUME`.

`storage.images_volume` Volume to use to store the image tarballs

Key:	`storage.images_volume`
Type:	string
Scope:	local

Specify the volume using the syntax `POOL/VOLUME`.

Related topics

How-to guides:

- *How to configure the LXD server*

Instance configuration

The instance configuration consists of different categories:

Instance properties
: Instance properties are specified when the instance is created. They include, for example, the instance name and architecture. Some of the properties are read-only and cannot be changed after creation, while others can be updated by *setting their property value* or *editing the full instance configuration*.

  In the YAML configuration, properties are on the top level.

  See *Instance properties* for a reference of available instance properties.

Instance options
: Instance options are configuration options that are related directly to the instance. They include, for example, startup options, security settings, hardware limits, kernel modules, snapshots and user keys. These options can be specified as key/value pairs during instance creation (through the `--config key=value` flag). After creation, they can be configured with the `lxc config set` and `lxc config unset` commands.

  In the YAML configuration, options are located under the `config` entry.

  See *Instance options* for a reference of available instance options, and *Configure instance options* for instructions on how to configure the options.

Instance devices
: Instance devices are attached to an instance. They include, for example, network interfaces, mount points, USB and GPU devices. Devices are usually added after an instance is created with the `lxc config device add` command, but they can also be added to a profile or a YAML configuration file that is used to create an instance.

  Each type of device has its own specific set of options, referred to as *instance device options*.

  In the YAML configuration, devices are located under the `devices` entry.

  See *Devices* for a reference of available devices and the corresponding instance device options, and *Configure devices* for instructions on how to add and configure instance devices.

Instance properties

Instance properties are set when the instance is created. They cannot be part of a *profile*.

The following instance properties are available: `architecture` Instance architecture

Key:	`architecture`
Type:	string
Read-only:	no

`name` Instance name

Key:	`name`
Type:	string
Read-only:	yes

See *Instance name requirements*.

Instance name requirements

The instance name can be changed only by renaming the instance with the `lxc rename` command.

Valid instance names must fulfill the following requirements:

- The name must be between 1 and 63 characters long.
- The name must contain only letters, numbers and dashes from the ASCII table.
- The name must not start with a digit or a dash.
- The name must not end with a dash.

The purpose of these requirements is to ensure that the instance name can be used in DNS records, on the file system, in various security profiles and as the host name of the instance itself.

Instance options

Instance options are configuration options that are directly related to the instance.

See *Configure instance options* for instructions on how to set the instance options.

The key/value configuration is namespaced. The following options are available:

- *Miscellaneous options*
- *Boot-related options*
- `cloud-init` *configuration*
- *Resource limits*
- *Migration options*
- *NVIDIA and CUDA configuration*
- *Raw instance configuration overrides*
- *Security policies*

- *Snapshot scheduling and configuration*
- *Volatile internal data*

Note that while a type is defined for each option, all values are stored as strings and should be exported over the REST API as strings (which makes it possible to support any extra values without breaking backward compatibility).

Miscellaneous options

In addition to the configuration options listed in the following sections, these instance options are supported: `agent.nic_config` Whether to use the name and MTU of the default network interfaces

Key:	`agent.nic_config`
Type:	bool
Default:	`false`
Live update:	no
Condition:	virtual machine

For containers, the name and MTU of the default network interfaces is used for the instance devices. For virtual machines, set this option to `true` to set the name and MTU of the default network interfaces to be the same as the instance devices.

`cluster.evacuate` What to do when evacuating the instance

Key:	`cluster.evacuate`
Type:	string
Default:	`auto`
Live update:	no

The `cluster.evacuate` provides control over how instances are handled when a cluster member is being evacuated.

Available Modes:

- `auto` *(default)*: The system will automatically decide the best evacuation method based on the instance's type and configured devices:
  - If any device is not suitable for migration, the instance will not be migrated (only stopped).
  - Live migration will be used only for virtual machines with the `migration.stateful` setting enabled and for which all its devices can be migrated as well.
- `live-migrate`: Instances are live-migrated to another node. This means the instance remains running and operational during the migration process, ensuring minimal disruption.
- `migrate`: In this mode, instances are migrated to another node in the cluster. The migration process will not be live, meaning there will be a brief downtime for the instance during the migration.
- `stop`: Instances are not migrated. Instead, they are stopped on the current node.

See *Evacuate and restore cluster members* for more information.

`linux.kernel_modules` Kernel modules to load or allow loading

Key:	`linux.kernel_modules`
Type:	string
Live update:	yes
Condition:	container

Specify the kernel modules as a comma-separated list.

The modules are loaded before the instance starts, or they can be loaded by a privileged user if *linux.kernel_modules.load* is set to `ondemand`.

`linux.kernel_modules.load` How to load kernel modules

Key:	`linux.kernel_modules.load`
Type:	string
Default:	`boot`
Live update:	no
Condition:	container

This option specifies how to load the kernel modules that are specified in *linux.kernel_modules*. Possible values are `boot` (load the modules when booting the container) and `ondemand` (intercept the `finit_modules()` syscall and allow a privileged user in the container's user namespace to load the modules).

`linux.sysctl.*` Override for the corresponding `sysctl` setting in the container

Key:	`linux.sysctl.*`
Type:	string
Live update:	no
Condition:	container

`user.*` Free-form user key/value storage

Key:	`user.*`
Type:	string
Live update:	no

User keys can be used in search.

`environment.*` Environment variables for the instance

Key:	`environment.*`
Type:	string
Live update:	yes (exec)

You can export key/value environment variables to the instance. These are then set for *lxc exec*.

Boot-related options

The following instance options control the boot-related behavior of the instance: `boot.autostart` Whether to always start the instance when LXD starts

Key:	`boot.autostart`
Type:	bool
Live update:	no

If set to `false`, restore the last state.

`boot.autostart.delay` Delay after starting the instance

Key:	`boot.autostart.delay`
Type:	integer
Default:	0
Live update:	no

The number of seconds to wait after the instance started before starting the next one.

`boot.autostart.priority` What order to start the instances in

Key:	`boot.autostart.priority`
Type:	integer
Default:	0
Live update:	no

The instance with the highest value is started first.

`boot.debug_edk2` Enable debug version of the `edk2`

Key:	`boot.debug_edk2`
Type:	bool

The instance should use a debug version of the `edk2`. A log file can be found in `$LXD_DIR/logs/<instance_name>/edk2.log`.

`boot.host_shutdown_timeout` How long to wait for the instance to shut down

Key:	`boot.host_shutdown_timeout`
Type:	integer
Default:	30
Live update:	yes

Number of seconds to wait for the instance to shut down before it is force-stopped.

`boot.stop.priority` What order to shut down the instances in

Key:	`boot.stop.priority`
Type:	integer
Default:	0
Live update:	no

The instance with the highest value is shut down first.

`cloud-init` configuration

The following instance options control the *cloud-init* configuration of the instance: `cloud-init.network-config` Network configuration for `cloud-init`

Key:	`cloud-init.network-config`
Type:	string
Default:	`DHCP on eth0`
Live update:	no
Condition:	If supported by image

The content is used as seed value for `cloud-init`.

`cloud-init.user-data` User data for `cloud-init`

Key:	`cloud-init.user-data`
Type:	string
Default:	`#cloud-config`
Live update:	no
Condition:	If supported by image

The content is used as seed value for `cloud-init`.

`cloud-init.vendor-data` Vendor data for `cloud-init`

Key:	`cloud-init.vendor-data`
Type:	string
Default:	`#cloud-config`
Live update:	no
Condition:	If supported by image

The content is used as seed value for `cloud-init`.

`user.network-config` Legacy version of `cloud-init.network-config`

Key:	`user.network-config`
Type:	string
Default:	`DHCP on eth0`
Live update:	no
Condition:	If supported by image

`user.user-data` Legacy version of `cloud-init.user-data`

Key:	`user.user-data`
Type:	string
Default:	`#cloud-config`
Live update:	no
Condition:	If supported by image

`user.vendor-data` Legacy version of `cloud-init.vendor-data`

Key:	`user.vendor-data`
Type:	string
Default:	`#cloud-config`
Live update:	no
Condition:	If supported by image

Support for these options depends on the image that is used and is not guaranteed.

If you specify both `cloud-init.user-data` and `cloud-init.vendor-data`, the content of both options is merged. Therefore, make sure that the `cloud-init` configuration you specify in those options does not contain the same keys.

Resource limits

The following instance options specify resource limits for the instance: `limits.cpu` Which CPUs to expose to the instance

Key:	`limits.cpu`
Type:	string
Default:	1 (VMs)
Live update:	yes

A number or a specific range of CPUs to expose to the instance.

See *CPU pinning* for more information.

`limits.cpu.allowance` How much of the CPU can be used

Key:	`limits.cpu.allowance`
Type:	string
Default:	100%
Live update:	yes
Condition:	container

To control how much of the CPU can be used, specify either a percentage (`50%`) for a soft limit or a chunk of time (`25ms/100ms`) for a hard limit.

See *Allowance and priority (container only)* for more information.

`limits.cpu.nodes` Which NUMA nodes to place the instance CPUs on

Key:	`limits.cpu.nodes`
Type:	string
Live update:	yes

A comma-separated list of NUMA node IDs or ranges to place the instance CPUs on.

See *Allowance and priority (container only)* for more information.

`limits.cpu.priority` CPU scheduling priority compared to other instances

Key:	`limits.cpu.priority`
Type:	integer
Default:	`10` (maximum)
Live update:	yes
Condition:	container

When overcommitting resources, specify the CPU scheduling priority compared to other instances that share the same CPUs. Specify an integer between 0 and 10.

See *Allowance and priority (container only)* for more information.

`limits.disk.priority` Priority of the instance's I/O requests

Key:	`limits.disk.priority`
Type:	integer
Default:	`5` (medium)
Live update:	yes

Controls how much priority to give to the instance's I/O requests when under load.

Specify an integer between 0 and 10.

`limits.hugepages.1GB` Limit for the number of 1 GB huge pages

Key:	`limits.hugepages.1GB`
Type:	string
Live update:	yes
Condition:	container

Fixed value (in bytes) to limit the number of 1 GB huge pages. Various suffixes are supported (see *Units for storage and network limits*).

See *Huge page limits* for more information.

`limits.hugepages.1MB` Limit for the number of 1 MB huge pages

Key:	`limits.hugepages.1MB`
Type:	string
Live update:	yes
Condition:	container

Fixed value (in bytes) to limit the number of 1 MB huge pages. Various suffixes are supported (see *Units for storage and network limits*).

See *Huge page limits* for more information.

`limits.hugepages.2MB` Limit for the number of 2 MB huge pages

Key:	`limits.hugepages.2MB`
Type:	string
Live update:	yes
Condition:	container

Fixed value (in bytes) to limit the number of 2 MB huge pages. Various suffixes are supported (see *Units for storage and network limits*).

See *Huge page limits* for more information.

`limits.hugepages.64KB` Limit for the number of 64 KB huge pages

Key:	`limits.hugepages.64KB`
Type:	string
Live update:	yes
Condition:	container

Fixed value (in bytes) to limit the number of 64 KB huge pages. Various suffixes are supported (see *Units for storage and network limits*).

See *Huge page limits* for more information.

`limits.memory` Usage limit for the host's memory

Key:	`limits.memory`
Type:	string
Default:	`1Gib` (VMs)
Live update:	yes

Percentage of the host's memory or a fixed value in bytes. Various suffixes are supported.

See *Units for storage and network limits* for details.

`limits.memory.enforce` Whether the memory limit is `hard` or `soft`

Key:	`limits.memory.enforce`
Type:	string
Default:	`hard`
Live update:	yes
Condition:	container

If the instance's memory limit is `hard`, the instance cannot exceed its limit. If it is `soft`, the instance can exceed its memory limit when extra host memory is available.

`limits.memory.hugepages` Whether to back the instance using huge pages

Key:	`limits.memory.hugepages`
Type:	bool
Default:	`false`
Live update:	no
Condition:	virtual machine

If this option is set to `false`, regular system memory is used.

`limits.memory.swap` Whether to encourage/discourage swapping less used pages for this instance

Key:	`limits.memory.swap`
Type:	bool
Default:	`true`
Live update:	yes
Condition:	container

`limits.memory.swap.priority` Prevents the instance from being swapped to disk

Key:	`limits.memory.swap.priority`
Type:	integer
Default:	`10` (maximum)
Live update:	yes
Condition:	container

Specify an integer between 0 and 10. The higher the value, the less likely the instance is to be swapped to disk.

`limits.processes` Maximum number of processes that can run in the instance

Key:	`limits.processes`
Type:	integer
Default:	empty
Live update:	yes
Condition:	container

If left empty, no limit is set.

`limits.kernel.*` Kernel resources per instance

Key:	`limits.kernel.*`
Type:	string
Live update:	no
Condition:	container

You can set kernel limits on an instance, for example, you can limit the number of open files. See *Kernel resource limits* for more information.

CPU limits

You have different options to limit CPU usage:

- Set *`limits.cpu`* to restrict which CPUs the instance can see and use. See *CPU pinning* for how to set this option.
- Set *`limits.cpu.allowance`* to restrict the load an instance can put on the available CPUs. This option is available only for containers. See *Allowance and priority (container only)* for how to set this option.

It is possible to set both options at the same time to restrict both which CPUs are visible to the instance and the allowed usage of those instances. However, if you use *`limits.cpu.allowance`* with a time limit, you should avoid using *`limits.cpu`* in addition, because that puts a lot of constraints on the scheduler and might lead to less efficient allocations.

The CPU limits are implemented through a mix of the `cpuset` and `cpu` cgroup controllers.

CPU pinning

limits.cpu results in CPU pinning through the `cpuset` controller. You can specify either which CPUs or how many CPUs are visible and available to the instance:

- To specify which CPUs to use, set `limits.cpu` to either a set of CPUs (for example, `1,2,3`) or a CPU range (for example, `0-3`).

  To pin to a single CPU, use the range syntax (for example, `1-1`) to differentiate it from a number of CPUs.

- If you specify a number (for example, `4`) of CPUs, LXD will do dynamic load-balancing of all instances that aren't pinned to specific CPUs, trying to spread the load on the machine. Instances are re-balanced every time an instance starts or stops, as well as whenever a CPU is added to the system.

CPU limits for virtual machines

Note: LXD supports live-updating the *limits.cpu* option. However, for virtual machines, this only means that the respective CPUs are hotplugged. Depending on the guest operating system, you might need to either restart the instance or complete some manual actions to bring the new CPUs online.

LXD virtual machines default to having just one vCPU allocated, which shows up as matching the host CPU vendor and type, but has a single core and no threads.

When *limits.cpu* is set to a single integer, LXD allocates multiple vCPUs and exposes them to the guest as full cores. Those vCPUs are not pinned to specific physical cores on the host. The number of vCPUs can be updated while the VM is running.

When *limits.cpu* is set to a range or comma-separated list of CPU IDs (as provided by *lxc info --resources*), the vCPUs are pinned to those physical cores. In this scenario, LXD checks whether the CPU configuration lines up with a realistic hardware topology and if it does, it replicates that topology in the guest. When doing CPU pinning, it is not possible to change the configuration while the VM is running.

For example, if the pinning configuration includes eight threads, with each pair of thread coming from the same core and an even number of cores spread across two CPUs, the guest will show two CPUs, each with two cores and each core with two threads. The NUMA layout is similarly replicated and in this scenario, the guest would most likely end up with two NUMA nodes, one for each CPU socket.

In such an environment with multiple NUMA nodes, the memory is similarly divided across NUMA nodes and be pinned accordingly on the host and then exposed to the guest.

All this allows for very high performance operations in the guest as the guest scheduler can properly reason about sockets, cores and threads as well as consider NUMA topology when sharing memory or moving processes across NUMA nodes.

Allowance and priority (container only)

limits.cpu.allowance drives either the CFS scheduler quotas when passed a time constraint, or the generic CPU shares mechanism when passed a percentage value:

- The time constraint (for example, `20ms/50ms`) is a hard limit. For example, if you want to allow the container to use a maximum of one CPU, set *limits.cpu.allowance* to a value like `100ms/100ms`. The value is relative to one CPU worth of time, so to restrict to two CPUs worth of time, use something like `100ms/50ms` or `200ms/100ms`.

- When using a percentage value, the limit is a soft limit that is applied only when under load. It is used to calculate the scheduler priority for the instance, relative to any other instance that is using the same CPU or CPUs. For example, to limit the CPU usage of the container to one CPU when under load, set *limits.cpu.allowance* to `100%`.

limits.cpu.nodes can be used to restrict the CPUs that the instance can use to a specific set of NUMA nodes. To specify which NUMA nodes to use, set *limits.cpu.nodes* to either a set of NUMA node IDs (for example, `0,1`) or a set of NUMA node ranges (for example, `0-1,2-4`).

limits.cpu.priority is another factor that is used to compute the scheduler priority score when a number of instances sharing a set of CPUs have the same percentage of CPU assigned to them.

Huge page limits

LXD allows to limit the number of huge pages available to a container through the `limits.hugepage.[size]` key (for example, *limits.hugepages.1MB*).

Architectures often expose multiple huge-page sizes. The available huge-page sizes depend on the architecture.

Setting limits for huge pages is especially useful when LXD is configured to intercept the `mount` syscall for the `hugetlbfs` file system in unprivileged containers. When LXD intercepts a `hugetlbfs mount` syscall, it mounts the `hugetlbfs` file system for a container with correct `uid` and `gid` values as mount options. This makes it possible to use huge pages from unprivileged containers. However, it is recommended to limit the number of huge pages available to the container through `limits.hugepages.[size]` to stop the container from being able to exhaust the huge pages available to the host.

Limiting huge pages is done through the `hugetlb` cgroup controller, which means that the host system must expose the `hugetlb` controller in the legacy or unified cgroup hierarchy for these limits to apply.

Kernel resource limits

For container instances, LXD exposes a generic namespaced key *limits.kernel.** that can be used to set resource limits.

It is generic in the sense that LXD does not perform any validation on the resource that is specified following the `limits.kernel.*` prefix. LXD cannot know about all the possible resources that a given kernel supports. Instead, LXD simply passes down the corresponding resource key after the `limits.kernel.*` prefix and its value to the kernel. The kernel does the appropriate validation. This allows users to specify any supported limit on their system.

Some common limits are:

Key	Resource	Description
limits.kernel.as	RLIMIT_AS	Maximum size of the process's virtual memory
limits.kernel.core	RLIMIT_CORE	Maximum size of the process's core dump file
limits.kernel.cpu	RLIMIT_CPU	Limit in seconds on the amount of CPU time the process can consume
limits.kernel.data	RLIMIT_DATA	Maximum size of the process's data segment
limits.kernel.fsize	RLIMIT_FSIZE	Maximum size of files the process may create
limits.kernel.locks	RLIMIT_LOCKS	Limit on the number of file locks that this process may establish
limits.kernel.memlock	RLIMIT_MEMLOCK	Limit on the number of bytes of memory that the process may lock in RAM
limits.kernel.nice	RLIMIT_NICE	Maximum value to which the process's nice value can be raised
limits.kernel.nofile	RLIMIT_NOFILE	Maximum number of open files for the process
limits.kernel.nproc	RLIMIT_NPROC	Maximum number of processes that can be created for the user of the calling process
limits.kernel.rtprio	RLIMIT_RTPRIO	Maximum value on the real-time-priority that may be set for this process
limits.kernel.sigpending	RLIMIT_SIGPEND	Maximum number of signals that may be queued for the user of the calling process

A full list of all available limits can be found in the manpages for the `getrlimit(2)/setrlimit(2)` system calls.

To specify a limit within the `limits.kernel.*` namespace, use the resource name in lowercase without the `RLIMIT_` prefix. For example, `RLIMIT_NOFILE` should be specified as `nofile`.

A limit is specified as two colon-separated values that are either numeric or the word `unlimited` (for example, `limits.kernel.nofile=1000:2000`). A single value can be used as a shortcut to set both soft and hard limit to the same value (for example, `limits.kernel.nofile=3000`).

A resource with no explicitly configured limit will inherit its limit from the process that starts up the container. Note that this inheritance is not enforced by LXD but by the kernel.

Migration options

The following instance options control the behavior if the instance is *moved from one LXD server to another*: `migration.incremental.memory` Whether to use incremental memory transfer

Key:	migration.incremental.memory
Type:	bool
Default:	false
Live update:	yes
Condition:	container

Using incremental memory transfer of the instance's memory can reduce downtime.

`migration.incremental.memory.goal` Percentage of memory to have in sync before stopping the instance

Key:	migration.incremental.memory.goal
Type:	integer
Default:	70
Live update:	yes
Condition:	container

migration.incremental.memory.iterations Maximum number of transfer operations to go through before stopping the instance

Key:	migration.incremental.memory.iterations
Type:	integer
Default:	10
Live update:	yes
Condition:	container

migration.stateful Whether to allow for stateful stop/start and snapshots

Key:	migration.stateful
Type:	bool
Default:	false or value from profiles or instances.migration.stateful (if set)
Live update:	no
Condition:	virtual machine

Enabling this option prevents the use of some features that are incompatible with it.

NVIDIA and CUDA configuration

The following instance options specify the NVIDIA and CUDA configuration of the instance: nvidia.driver.capabilities What driver capabilities the instance needs

Key:	nvidia.driver.capabilities
Type:	string
Default:	compute,utility
Live update:	no
Condition:	container

The specified driver capabilities are used to set libnvidia-container NVIDIA_DRIVER_CAPABILITIES.

nvidia.require.cuda Required CUDA version

Key:	nvidia.require.cuda
Type:	string
Live update:	no
Condition:	container

The specified version expression is used to set libnvidia-container NVIDIA_REQUIRE_CUDA.

nvidia.require.driver Required driver version

Key:	`nvidia.require.driver`
Type:	string
Live update:	no
Condition:	container

The specified version expression is used to set `libnvidia-container NVIDIA_REQUIRE_DRIVER`.

`nvidia.runtime` Whether to pass the host NVIDIA and CUDA runtime libraries into the instance

Key:	`nvidia.runtime`
Type:	bool
Default:	`false`
Live update:	no
Condition:	container

Raw instance configuration overrides

The following instance options allow direct interaction with the backend features that LXD itself uses: `raw.apparmor` AppArmor profile entries

Key:	`raw.apparmor`
Type:	blob
Live update:	yes

The specified entries are appended to the generated profile.

`raw.idmap` Raw idmap configuration

Key:	`raw.idmap`
Type:	blob
Live update:	no
Condition:	unprivileged container

For example: `both 1000 1000`

`raw.lxc` Raw LXC configuration to be appended to the generated one

Key:	`raw.lxc`
Type:	blob
Live update:	no
Condition:	container

`raw.qemu` Raw QEMU configuration to be appended to the generated command line

Key:	`raw.qemu`
Type:	blob
Live update:	no
Condition:	virtual machine

`raw.qemu.conf` Addition/override to the generated `qemu.conf` file

Key:	`raw.qemu.conf`
Type:	blob
Live update:	no
Condition:	virtual machine

See *Override QEMU configuration* for more information.

`raw.seccomp` Raw Seccomp configuration

Key:	`raw.seccomp`
Type:	blob
Live update:	no
Condition:	container

Important: Setting these `raw.*` keys might break LXD in non-obvious ways. Therefore, you should avoid setting any of these keys.

Override QEMU configuration

For VM instances, LXD configures QEMU through a configuration file that is passed to QEMU with the `-readconfig` command-line option. This configuration file is generated for each instance before boot. It can be found at `/var/log/lxd/<instance_name>/qemu.conf`.

The default configuration works fine for LXD's most common use case: modern UEFI guests with VirtIO devices. In some situations, however, you might need to override the generated configuration. For example:

- To run an old guest OS that doesn't support UEFI.
- To specify custom virtual devices when VirtIO is not supported by the guest OS.
- To add devices that are not supported by LXD before the machines boots.
- To remove devices that conflict with the guest OS.

To override the configuration, set the *`raw.qemu.conf`* option. It supports a format similar to `qemu.conf`, with some additions. Since it is a multi-line configuration option, you can use it to modify multiple sections or keys.

- To replace a section or key in the generated configuration file, add a section with a different value.

  For example, use the following section to override the default `virtio-gpu-pci` GPU driver:

```
raw.qemu.conf: |-
    [device "qemu_gpu"]
    driver = "qxl-vga"
```

- To remove a section, specify a section without any keys. For example:

```
raw.qemu.conf: |-
    [device "qemu_gpu"]
```

- To remove a key, specify an empty string as the value. For example:

```
raw.qemu.conf: |-
    [device "qemu_gpu"]
    driver = ""
```

- To add a new section, specify a section name that is not present in the configuration file.

The configuration file format used by QEMU allows multiple sections with the same name. Here's a piece of the configuration generated by LXD:

```
[global]
driver = "ICH9-LPC"
property = "disable_s3"
value = "1"

[global]
driver = "ICH9-LPC"
property = "disable_s4"
value = "1"
```

To specify which section to override, specify an index. For example:

```
raw.qemu.conf: |-
    [global][1]
    value = "0"
```

Section indexes start at 0 (which is the default value when not specified), so the above example would generate the following configuration:

```
[global]
driver = "ICH9-LPC"
property = "disable_s3"
value = "1"

[global]
driver = "ICH9-LPC"
property = "disable_s4"
value = "0"
```

Security policies

The following instance options control the *About security* policies of the instance: `security.agent.metrics` Whether the `lxd-agent` is queried for state information and metrics

Key:	`security.agent.metrics`
Type:	bool
Default:	`true`
Live update:	no
Condition:	virtual machine

`security.csm` Whether to use a firmware that supports UEFI-incompatible operating systems

Key:	`security.csm`
Type:	bool
Default:	`false`
Live update:	no
Condition:	virtual machine

When enabling this option, set *`security.secureboot`* to `false`.

`security.devlxd` Whether `/dev/lxd` is present in the instance

Key:	`security.devlxd`
Type:	bool
Default:	`true`
Live update:	no

See *Communication between instance and host* for more information.

`security.devlxd.images` Controls the availability of the `/1.0/images` API over `devlxd`

Key:	`security.devlxd.images`
Type:	bool
Default:	`false`
Live update:	no
Condition:	container

`security.idmap.base` The base host ID to use for the allocation

Key:	`security.idmap.base`
Type:	integer
Live update:	no
Condition:	unprivileged container

Setting this option overrides auto-detection.

`security.idmap.isolated` Whether to use a unique idmap for this instance

Key:	`security.idmap.isolated`
Type:	bool
Default:	`false`
Live update:	no
Condition:	unprivileged container

If specified, the idmap used for this instance is unique among instances that have this option set.

`security.idmap.size` The size of the idmap to use

Key:	`security.idmap.size`
Type:	integer
Live update:	no
Condition:	unprivileged container

`security.nesting` Whether to support running LXD (nested) inside the instance

Key:	`security.nesting`
Type:	bool
Default:	`false`
Live update:	yes
Condition:	container

`security.privileged` Whether to run the instance in privileged mode

Key:	`security.privileged`
Type:	bool
Default:	`false`
Live update:	no
Condition:	container

See *Container security* for more information.

`security.protection.delete` Prevents the instance from being deleted

Key:	`security.protection.delete`
Type:	bool
Default:	`false`
Live update:	yes

`security.protection.shift` Whether to protect the file system from being UID/GID shifted

Key:	`security.protection.shift`
Type:	bool
Default:	`false`
Live update:	yes
Condition:	container

Set this option to `true` to prevent the instance's file system from being UID/GID shifted on startup.

`security.secureboot` Whether UEFI secure boot is enabled with the default Microsoft keys

Key:	`security.secureboot`
Type:	bool
Default:	`true`
Live update:	no
Condition:	virtual machine

When disabling this option, consider enabling *`security.csm`*.

`security.sev` Whether AMD SEV (Secure Encrypted Virtualization) is enabled for this VM

Key:	security.sev
Type:	bool
Default:	false
Live update:	no
Condition:	virtual machine

security.sev.policy.es Whether AMD SEV-ES (SEV Encrypted State) is enabled for this VM

Key:	security.sev.policy.es
Type:	bool
Default:	false
Live update:	no
Condition:	virtual machine

security.sev.session.data The guest owner's base64-encoded session blob

Key:	security.sev.session.data
Type:	string
Default:	true
Live update:	no
Condition:	virtual machine

security.sev.session.dh The guest owner's base64-encoded Diffie-Hellman key

Key:	security.sev.session.dh
Type:	string
Default:	true
Live update:	no
Condition:	virtual machine

security.syscalls.allow List of syscalls to allow

Key:	security.syscalls.allow
Type:	string
Live update:	no
Condition:	container

A \n-separated list of syscalls to allow. This list must be mutually exclusive with security.syscalls.deny*.

security.syscalls.deny List of syscalls to deny

Key:	security.syscalls.deny
Type:	string
Live update:	no
Condition:	container

A \n-separated list of syscalls to deny. This list must be mutually exclusive with security.syscalls.allow.

security.syscalls.deny_compat Whether to block compat_* syscalls (x86_64 only)

Key:	security.syscalls.deny_compat
Type:	bool
Default:	false
Live update:	no
Condition:	container

On x86_64, this option controls whether to block compat_* syscalls. On other architectures, the option is ignored.

security.syscalls.deny_default Whether to enable the default syscall deny

Key:	security.syscalls.deny_default
Type:	bool
Default:	true
Live update:	no
Condition:	container

security.syscalls.intercept.bpf Whether to handle the bpf() system call

Key:	security.syscalls.intercept.bpf
Type:	bool
Default:	false
Live update:	no
Condition:	container

security.syscalls.intercept.bpf.devices Whether to allow BPF programs

Key:	security.syscalls.intercept.bpf.devices
Type:	bool
Default:	false
Live update:	no
Condition:	container

This option controls whether to allow BPF programs for the devices cgroup in the unified hierarchy to be loaded.

security.syscalls.intercept.mknod Whether to handle the mknod and mknodat system calls

Key:	security.syscalls.intercept.mknod
Type:	bool
Default:	false
Live update:	no
Condition:	container

These system calls allow creation of a limited subset of char/block devices.

security.syscalls.intercept.mount Whether to handle the mount system call

Key:	security.syscalls.intercept.mount
Type:	bool
Default:	false
Live update:	no
Condition:	container

security.syscalls.intercept.mount.allowed File systems that can be mounted

Key:	security.syscalls.intercept.mount.allowed
Type:	string
Live update:	yes
Condition:	container

Specify a comma-separated list of file systems that are safe to mount for processes inside the instance.

security.syscalls.intercept.mount.fuse File system that should be redirected to FUSE implementation

Key:	security.syscalls.intercept.mount.fuse
Type:	string
Live update:	yes
Condition:	container

Specify the mounts of a given file system that should be redirected to their FUSE implementation (for example, ext4=fuse2fs).

security.syscalls.intercept.mount.shift Whether to use idmapped mounts for syscall interception

Key:	security.syscalls.intercept.mount.shift
Type:	bool
Default:	false
Live update:	yes
Condition:	container

security.syscalls.intercept.sched_setscheduler Whether to handle the sched_setscheduler system call

Key:	security.syscalls.intercept.sched_setscheduler
Type:	bool
Default:	false
Live update:	no
Condition:	container

This system call allows increasing process priority.

security.syscalls.intercept.setxattr Whether to handle the setxattr system call

Key:	security.syscalls.intercept.setxattr
Type:	bool
Default:	false
Live update:	no
Condition:	container

This system call allows setting a limited subset of restricted extended attributes.

security.syscalls.intercept.sysinfo Whether to handle the sysinfo system call

Key:	security.syscalls.intercept.sysinfo
Type:	bool
Default:	false
Live update:	no
Condition:	container

This system call can be used to get cgroup-based resource usage information.

Snapshot scheduling and configuration

The following instance options control the creation and expiry of *instance snapshots*: snapshots.expiry When snapshots are to be deleted

Key:	snapshots.expiry
Type:	string
Live update:	no

Specify an expression like 1M 2H 3d 4w 5m 6y.

snapshots.pattern Template for the snapshot name

Key:	snapshots.pattern
Type:	string
Default:	snap%d
Live update:	no

Specify a Pongo2 template string that represents the snapshot name. This template is used for scheduled snapshots and for unnamed snapshots.

See *Automatic snapshot names* for more information.

snapshots.schedule Schedule for automatic instance snapshots

Key:	snapshots.schedule
Type:	string
Default:	empty
Live update:	no

Specify either a cron expression (<minute> <hour> <dom> <month> <dow>), a comma-separated list of schedule aliases (@hourly, @daily, @midnight, @weekly, @monthly, @annually, @yearly), or leave empty to disable automatic snapshots.

snapshots.schedule.stopped Whether to automatically snapshot stopped instances

Key:	snapshots.schedule.stopped
Type:	bool
Default:	false
Live update:	no

Automatic snapshot names

The snapshots.pattern option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable creation_date. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set snapshots.pattern to {{ creation_date|date:'2006-01-02_15-04-05' }} to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder %d in the pattern. For the first snapshot, the placeholder is replaced with 0. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

Volatile internal data

The following volatile keys are currently used internally by LXD to store internal data specific to an instance: volatile.<name>.apply_quota Disk quota

Key:	volatile.<name>.apply_quota
Type:	string

The disk quota is applied the next time the instance starts.

volatile.<name>.ceph_rbd RBD device path for Ceph disk devices

Key:	volatile.<name>.ceph_rbd
Type:	string

volatile.<name>.host_name Network device name on the host

Key:	volatile.<name>.host_name
Type:	string

volatile.<name>.hwaddr Network device MAC address

Key:	volatile.<name>.hwaddr
Type:	string

The network device MAC address is used when no `hwaddr` property is set on the device itself.

`volatile.<name>.last_state.created` Whether the network device physical device was created

Key:	`volatile.<name>.last_state.created`
Type:	string

Possible values are `true` or `false`.

`volatile.<name>.last_state.hwaddr` Network device original MAC

Key:	`volatile.<name>.last_state.hwaddr`
Type:	string

The original MAC that was used when moving a physical device into an instance.

`volatile.<name>.last_state.ip_addresses` Last used IP addresses

Key:	`volatile.<name>.last_state.ip_addresses`
Type:	string

Comma-separated list of the last used IP addresses of the network device.

`volatile.<name>.last_state.mtu` Network device original MTU

Key:	`volatile.<name>.last_state.mtu`
Type:	string

The original MTU that was used when moving a physical device into an instance.

`volatile.<name>.last_state.vdpa.name` VDPA device name

Key:	`volatile.<name>.last_state.vdpa.name`
Type:	string

The VDPA device name used when moving a VDPA device file descriptor into an instance.

`volatile.<name>.last_state.vf.hwaddr` SR-IOV virtual function original MAC

Key:	`volatile.<name>.last_state.vf.hwaddr`
Type:	string

The original MAC used when moving a VF into an instance.

`volatile.<name>.last_state.vf.id` SR-IOV virtual function ID

Key:	`volatile.<name>.last_state.vf.id`
Type:	string

The ID used when moving a VF into an instance.

`volatile.<name>.last_state.vf.spoofcheck` SR-IOV virtual function original spoof check setting

Key:	`volatile.<name>.last_state.vf.spoofcheck`
Type:	string

The original spoof check setting used when moving a VF into an instance.

`volatile.<name>.last_state.vf.vlan` SR-IOV virtual function original VLAN

Key:	`volatile.<name>.last_state.vf.vlan`
Type:	string

The original VLAN used when moving a VF into an instance.

`volatile.apply_nvram` Whether to regenerate VM NVRAM the next time the instance starts

Key:	`volatile.apply_nvram`
Type:	bool

`volatile.apply_template` Template hook

Key:	`volatile.apply_template`
Type:	string

The template with the given name is triggered upon next startup.

`volatile.base_image` Hash of the base image

Key:	`volatile.base_image`
Type:	string

The hash of the image that the instance was created from (empty if the instance was not created from an image).

`volatile.cloud_init.instance-id` `instance-id` (UUID) exposed to `cloud-init`

Key:	`volatile.cloud_init.instance-id`
Type:	string

`volatile.evacuate.origin` The origin of the evacuated instance

Key:	`volatile.evacuate.origin`
Type:	string

The cluster member that the instance lived on before evacuation.

`volatile.idmap.base` The first ID in the instance's primary idmap range

Key:	`volatile.idmap.base`
Type:	integer

`volatile.idmap.current` The idmap currently in use by the instance

Key:	`volatile.idmap.current`
Type:	string

`volatile.idmap.next` The idmap to use the next time the instance starts

Key:	`volatile.idmap.next`
Type:	string

`volatile.last_state.idmap` Serialized instance UID/GID map

Key:	`volatile.last_state.idmap`
Type:	string

`volatile.last_state.power` Instance state as of last host shutdown

Key:	`volatile.last_state.power`
Type:	string

`volatile.uuid` Instance UUID

Key:	`volatile.uuid`
Type:	string

The instance UUID is globally unique across all servers and projects.

`volatile.uuid.generation` Instance generation UUID

Key:	`volatile.uuid.generation`
Type:	string

The instance generation UUID changes whenever the instance's place in time moves backwards. It is globally unique across all servers and projects.

`volatile.vsock_id` Instance `vsock ID` used as of last start

Key:	`volatile.vsock_id`
Type:	string

Note: Volatile keys cannot be set by the user.

Devices

Devices are attached to an instance (see *Configure devices*) or to a profile (see *Edit a profile*).

They include, for example, network interfaces, mount points, USB and GPU devices. These devices can have instance device options, depending on the type of the instance device.

LXD supports the following device types:

ID (database)	Name	Condition	Description
0	*none*	-	Inheritance blocker
1	*nic*	-	Network interface
2	*disk*	-	Mount point inside the instance
3	*unix-char*	container	Unix character device
4	*unix-block*	container	Unix block device
5	*usb*	-	USB device
6	*gpu*	-	GPU device
7	*infiniband*	container	InfiniBand device
8	*proxy*	container	Proxy device
9	*unix-hotplug*	container	Unix hotplug device
10	*tpm*	-	TPM device
11	*pci*	VM	PCI device

Each instance comes with a set of *Standard devices*.

Standard devices

LXD provides each instance with the basic devices that are required for a standard POSIX system to work. These devices aren't visible in the instance or profile configuration, and they may not be overridden.

The standard devices are:

Device	Type of device
`/dev/null`	Character device
`/dev/zero`	Character device
`/dev/full`	Character device
`/dev/console`	Character device
`/dev/tty`	Character device
`/dev/random`	Character device
`/dev/urandom`	Character device
`/dev/net/tun`	Character device
`/dev/fuse`	Character device
`lo`	Network interface

Any other devices must be defined in the instance configuration or in one of the profiles used by the instance. The default profile typically contains a network interface that becomes `eth0` in the instance.

Type: none

Note: The none device type is supported for both containers and VMs.

A none device doesn't have any properties and doesn't create anything inside the instance.

Its only purpose is to stop inheriting devices that come from profiles. To do so, add a device with the same name as the one that you do not want to inherit, but with the device type none.

You can add this device either in a profile that is applied after the profile that contains the original device, or directly on the instance.

Configuration examples

Add a none device to an instance:

```
lxc config device add <instance_name> <device_name> none
```

See *Configure devices* for more information.

Type: nic

Note: The nic device type is supported for both containers and VMs.

NICs support hotplugging for both containers and VMs (with the exception of the ipvlan NIC type).

Network devices, also referred to as *Network Interface Controllers* or *NICs*, supply a connection to a network. LXD supports several different types of network devices (*NIC types*).

nictype vs. network

When adding a network device to an instance, there are two methods to specify the type of device that you want to add: through the nictype device option or the network device option.

These two device options are mutually exclusive, and you can specify only one of them when you create a device. However, note that when you specify the network option, the nictype option is derived automatically from the network type.

nictype
: When using the nictype device option, you can specify a network interface that is not controlled by LXD. Therefore, you must specify all information that LXD needs to use the network interface.

  When using this method, the nictype option must be specified when creating the device, and it cannot be changed later.

network
: When using the network device option, the NIC is linked to an existing *managed network*. In this case, LXD has all required information about the network, and you need to specify only the network name when adding the device.

  When using this method, LXD derives the nictype option automatically. The value is read-only and cannot be changed.

Other device options that are inherited from the network are marked with a "yes" in the "Managed" field of the NIC-specific device options. You cannot customize these options directly for the NIC if you're using the `network` method.

See *About networking* for more information.

Available NIC types

The following NICs can be added using the `nictype` or `network` options:

- *`bridged`*: Uses an existing bridge on the host and creates a virtual device pair to connect the host bridge to the instance.
- *`macvlan`*: Sets up a new network device based on an existing one, but using a different MAC address.
- *`sriov`*: Passes a virtual function of an SR-IOV-enabled physical network device into the instance.
- *`physical`*: Passes a physical device from the host through to the instance. The targeted device will vanish from the host and appear in the instance.

The following NICs can be added using only the `network` option:

- *`ovn`*: Uses an existing OVN network and creates a virtual device pair to connect the instance to it.

The following NICs can be added using only the `nictype` option:

- *`ipvlan`*: Sets up a new network device based on an existing one, using the same MAC address but a different IP.
- *`p2p`*: Creates a virtual device pair, putting one side in the instance and leaving the other side on the host.
- *`routed`*: Creates a virtual device pair to connect the host to the instance and sets up static routes and proxy ARP/NDP entries to allow the instance to join the network of a designated parent interface.

The available device options depend on the NIC type and are listed in the following sections.

`nictype: bridged`

Note: You can select this NIC type through the `nictype` option or the `network` option (see *Bridge network* for information about the managed `bridge` network).

A `bridged` NIC uses an existing bridge on the host and creates a virtual device pair to connect the host bridge to the instance.

Device options

NIC devices of type `bridged` have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Managed:	no

A higher value for this option means that the VM boots first.

`host_name` Name of the interface inside the host

Key:	host_name
Type:	string
Default:	randomly assigned
Managed:	no

hwaddr MAC address of the new interface

Key:	hwaddr
Type:	string
Default:	randomly assigned
Managed:	no

ipv4.address IPv4 address to assign to the instance through DHCP

Key:	ipv4.address
Type:	string
Managed:	no

Set this option to none to restrict all IPv4 traffic when *security.ipv4_filtering* is set.

ipv4.routes IPv4 static routes for the NIC to add on the host

Key:	ipv4.routes
Type:	string
Managed:	no

Specify a comma-delimited list of IPv4 static routes for this NIC to add on the host.

ipv4.routes.external IPv4 static routes to route to NIC

Key:	ipv4.routes.external
Type:	string
Managed:	no

Specify a comma-delimited list of IPv4 static routes to route to the NIC and publish on the uplink network (BGP).

ipv6.address IPv6 address to assign to the instance through DHCP

Key:	ipv6.address
Type:	string
Managed:	no

Set this option to none to restrict all IPv6 traffic when *security.ipv6_filtering* is set.

ipv6.routes IPv6 static routes for the NIC to add on the host

Key:	ipv6.routes
Type:	string
Managed:	no

Specify a comma-delimited list of IPv6 static routes for this NIC to add on the host.

`ipv6.routes.external` IPv6 static routes to route to NIC

Key:	`ipv6.routes.external`
Type:	string
Managed:	no

Specify a comma-delimited list of IPv6 static routes to route to the NIC and publish on the uplink network (BGP).

`limits.egress` I/O limit for outgoing traffic

Key:	`limits.egress`
Type:	string
Managed:	no

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.ingress` I/O limit for incoming traffic

Key:	`limits.ingress`
Type:	string
Managed:	no

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.max` I/O limit for both incoming and outgoing traffic

Key:	`limits.max`
Type:	string
Managed:	no

This option is the same as setting both *`limits.ingress`* and *`limits.egress`*.

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.priority` `skb->priority` value for outgoing traffic

Key:	`limits.priority`
Type:	integer
Managed:	no

The `skb->priority` value for outgoing traffic is used by the kernel queuing discipline (qdisc) to prioritize network packets. Specify the value as a 32-bit unsigned integer.

The effect of this value depends on the particular qdisc implementation, for example, `SKBPRIO` or `QFQ`. Consult the kernel qdisc documentation before setting this value.

`maas.subnet.ipv4` MAAS IPv4 subnet to register the instance in

Key:	`maas.subnet.ipv4`
Type:	string
Managed:	yes

`maas.subnet.ipv6` MAAS IPv6 subnet to register the instance in

Key:	`maas.subnet.ipv6`
Type:	string
Managed:	yes

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer
Default:	parent MTU
Managed:	yes

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned
Managed:	no

`network` Managed network to link the device to

Key:	`network`
Type:	string
Managed:	no

You can specify this option instead of specifying the `nictype` directly.

`parent` Name of the host device

Key:	`parent`
Type:	string
Managed:	yes
Required:	if specifying the `nictype` directly

`queue.tx.length` Transmit queue length for the NIC

Key:	`queue.tx.length`
Type:	integer
Managed:	no

`security.ipv4_filtering` Whether to prevent the instance from spoofing an IPv4 address

Key:	`security.ipv4_filtering`
Type:	bool
Default:	`false`
Managed:	no

Set this option to `true` to prevent the instance from spoofing another instance's IPv4 address. This option enables *security.mac_filtering*.

`security.ipv6_filtering` Whether to prevent the instance from spoofing an IPv6 address

Key:	`security.ipv6_filtering`
Type:	bool
Default:	`false`
Managed:	no

Set this option to `true` to prevent the instance from spoofing another instance's IPv6 address. This option enables *security.mac_filtering*.

`security.mac_filtering` Whether to prevent the instance from spoofing a MAC address

Key:	`security.mac_filtering`
Type:	bool
Default:	`false`
Managed:	no

Set this option to `true` to prevent the instance from spoofing another instance's MAC address.

`security.port_isolation` Whether to respect port isolation

Key:	`security.port_isolation`
Type:	bool
Default:	`false`
Managed:	no

Set this option to `true` to prevent the NIC from communicating with other NICs in the network that have port isolation enabled.

`vlan` VLAN ID to use for non-tagged traffic

Key:	`vlan`
Type:	integer
Managed:	no

Set this option to `none` to remove the port from the default VLAN.

`vlan.tagged` VLAN IDs or VLAN ranges to join for tagged traffic

Key:	`vlan.tagged`
Type:	integer
Managed:	no

Specify the VLAN IDs or ranges as a comma-delimited list.

Configuration examples

Add a `bridged` network device to an instance, connecting to a LXD managed network:

```
lxc network create <network_name> --type=bridge
lxc config device add <instance_name> <device_name> nic network=<network_name>
```

Note that `bridge` is the type when creating a managed bridge network, while the device `nictype` that is required when connecting to an unmanaged bridge is `bridged`.

Add a `bridged` network device to an instance, connecting to an existing bridge interface with `nictype`:

```
lxc config device add <instance_name> <device_name> nic nictype=bridged parent=<existing_
↪bridge>
```

See *How to create a network* and *Configure devices* for more information.

`nictype: macvlan`

Note: You can select this NIC type through the `nictype` option or the `network` option (see *Macvlan network* for information about the managed `macvlan` network).

A `macvlan` NIC sets up a new network device based on an existing one, but using a different MAC address.

If you are using a `macvlan` NIC, communication between the LXD host and the instances is not possible. Both the host and the instances can talk to the gateway, but they cannot communicate directly.

Device options

NIC devices of type `macvlan` have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Managed:	no

A higher value for this option means that the VM boots first.

`gvrp` Whether to use GARP VLAN Registration Protocol

Key:	`gvrp`
Type:	bool
Default:	`false`
Managed:	no

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

`hwaddr` MAC address of the new interface

Key:	hwaddr
Type:	string
Default:	randomly assigned
Managed:	no

maas.subnet.ipv4 MAAS IPv4 subnet to register the instance in

Key:	maas.subnet.ipv4
Type:	string
Managed:	yes

maas.subnet.ipv6 MAAS IPv6 subnet to register the instance in

Key:	maas.subnet.ipv6
Type:	string
Managed:	yes

mtu MTU of the new interface

Key:	mtu
Type:	integer
Default:	parent MTU
Managed:	yes

name Name of the interface inside the instance

Key:	name
Type:	string
Default:	kernel assigned
Managed:	no

network Managed network to link the device to

Key:	network
Type:	string
Managed:	no

You can specify this option instead of specifying the nictype directly.

parent Name of the host device

Key:	parent
Type:	string
Managed:	yes
Required:	if specifying the nictype directly

vlan VLAN ID to attach to

Key:	vlan
Type:	integer
Managed:	no

Configuration examples

Add a `macvlan` network device to an instance, connecting to a LXD managed network:

```
lxc network create <network_name> --type=macvlan parent=<existing_NIC>
lxc config device add <instance_name> <device_name> nic network=<network_name>
```

Add a `macvlan` network device to an instance, connecting to an existing network interface with `nictype`:

```
lxc config device add <instance_name> <device_name> nic nictype=macvlan parent=<existing_
↪NIC>
```

See *How to create a network* and *Configure devices* for more information.

`nictype: sriov`

Note: You can select this NIC type through the `nictype` option or the `network` option (see *SR-IOV network* for information about the managed `sriov` network).

An `sriov` NIC passes a virtual function of an SR-IOV-enabled physical network device into the instance.

An SR-IOV-enabled network device associates a set of virtual functions (VFs) with the single physical function (PF) of the network device. PFs are standard PCIe functions. VFs, on the other hand, are very lightweight PCIe functions that are optimized for data movement. They come with a limited set of configuration capabilities to prevent changing properties of the PF.

Given that VFs appear as regular PCIe devices to the system, they can be passed to instances just like a regular physical device.

VF allocation

The `sriov` interface type expects to be passed the name of an SR-IOV enabled network device on the system via the `parent` property. LXD then checks for any available VFs on the system.

By default, LXD allocates the first free VF it finds. If it detects that either none are enabled or all currently enabled VFs are in use, it bumps the number of supported VFs to the maximum value and uses the first free VF. If all possible VFs are in use or the kernel or card doesn't support incrementing the number of VFs, LXD returns an error.

Note: If you need LXD to use a specific VF, use a `physical` NIC instead of a `sriov` NIC and set its `parent` option to the VF name.

Device options

NIC devices of type `sriov` have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Managed:	no

A higher value for this option means that the VM boots first.

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned
Managed:	no

`maas.subnet.ipv4` MAAS IPv4 subnet to register the instance in

Key:	`maas.subnet.ipv4`
Type:	string
Managed:	yes

`maas.subnet.ipv6` MAAS IPv6 subnet to register the instance in

Key:	`maas.subnet.ipv6`
Type:	string
Managed:	yes

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer
Default:	kernel assigned
Managed:	yes

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned
Managed:	no

`network` Managed network to link the device to

Key:	`network`
Type:	string
Managed:	no

You can specify this option instead of specifying the `nictype` directly.

`parent` Name of the host device

Key:	`parent`
Type:	string
Managed:	yes
Required:	if specifying the `nictype` directly

`security.mac_filtering` Whether to prevent the instance from spoofing a MAC address

Key:	`security.mac_filtering`
Type:	bool
Default:	`false`
Managed:	no

Set this option to `true` to prevent the instance from spoofing another instance's MAC address.

`vlan` VLAN ID to attach to

Key:	`vlan`
Type:	integer
Managed:	no

Configuration examples

Add a `sriov` network device to an instance, connecting to a LXD managed network:

```
lxc network create <network_name> --type=sriov parent=<sriov_enabled_NIC>
lxc config device add <instance_name> <device_name> nic network=<network_name>
```

Add a `sriov` network device to an instance, connecting to an existing SR-IOV-enabled interface with `nictype`:

```
lxc config device add <instance_name> <device_name> nic nictype=sriov parent=<sriov_
↪enabled_NIC>
```

See *How to create a network* and *Configure devices* for more information.

`nictype: physical`

Note:

- You can select this NIC type through the `nictype` option or the `network` option (see *Physical network* for information about the managed `physical` network).
- You can have only one `physical` NIC for each parent device.

A `physical` NIC provides straight physical device pass-through from the host. The targeted device will vanish from the host and appear in the instance (which means that you can have only one `physical` NIC for each targeted device).

Device options

NIC devices of type `physical` have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Managed:	no

A higher value for this option means that the VM boots first.

`gvrp` Whether to use GARP VLAN Registration Protocol

Key:	`gvrp`
Type:	bool
Default:	`false`
Managed:	no

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned
Managed:	no

`maas.subnet.ipv4` MAAS IPv4 subnet to register the instance in

Key:	`maas.subnet.ipv4`
Type:	string
Managed:	no

`maas.subnet.ipv6` MAAS IPv6 subnet to register the instance in

Key:	`maas.subnet.ipv6`
Type:	string
Managed:	no

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer
Default:	parent MTU
Managed:	no

`name` Name of the interface inside the instance

Key:	name
Type:	string
Default:	kernel assigned
Managed:	no

network Managed network to link the device to

Key:	network
Type:	string
Managed:	no

You can specify this option instead of specifying the nictype directly.

parent Name of the host device

Key:	parent
Type:	string
Managed:	yes
Required:	if specifying the nictype directly

vlan VLAN ID to attach to

Key:	vlan
Type:	integer
Managed:	no

Configuration examples

Add a physical network device to an instance, connecting to an existing physical network interface with nictype:

```
lxc config device add <instance_name> <device_name> nic nictype=physical parent=
↪<physical_NIC>
```

Adding a physical network device to an instance using a managed network is not possible, because the physical managed network type is intended to be used only with OVN networks.

See *Configure devices* for more information.

nictype: ovn

Note: You can select this NIC type only through the network option (see *OVN network* for information about the managed ovn network).

An ovn NIC uses an existing OVN network and creates a virtual device pair to connect the instance to it.

SR-IOV hardware acceleration

To use acceleration=sriov, you must have a compatible SR-IOV physical NIC that supports the Ethernet

switch device driver model (`switchdev`) in your LXD host. LXD assumes that the physical NIC (PF) is configured in `switchdev` mode and connected to the OVN integration OVS bridge, and that it has one or more virtual functions (VFs) active.

To achieve this, follow these basic prerequisite setup steps:

1. Set up PF and VF:
    1. Activate some VFs on PF (called `enp9s0f0np0` in the following example, with a PCI address of `0000:09:00.0`) and unbind them.
    2. Enable `switchdev` mode and `hw-tc-offload` on the PF.
    3. Rebind the VFs.

```
echo 4 > /sys/bus/pci/devices/0000:09:00.0/sriov_numvfs
for i in $(lspci -nnn | grep "Virtual Function" | cut -d' ' -f1); do echo 0000:
↪$i > /sys/bus/pci/drivers/mlx5_core/unbind; done
devlink dev eswitch set pci/0000:09:00.0 mode switchdev
ethtool -K enp9s0f0np0 hw-tc-offload on
for i in $(lspci -nnn | grep "Virtual Function" | cut -d' ' -f1); do echo 0000:
↪$i > /sys/bus/pci/drivers/mlx5_core/bind; done
```

2. Set up OVS by enabling hardware offload and adding the PF NIC to the integration bridge (normally called `br-int`):

```
ovs-vsctl set open_vswitch . other_config:hw-offload=true
systemctl restart openvswitch-switch
ovs-vsctl add-port br-int enp9s0f0np0
ip link set enp9s0f0np0 up
```

VDPA hardware acceleration

To use `acceleration=vdpa`, you must have a compatible VDPA physical NIC. The setup is the same as for SR-IOV hardware acceleration, except that you must also enable the `vhost_vdpa` module and check that you have some available VDPA management devices :

```
modprobe vhost_vdpa && vdpa mgmtdev show
```

Device options

NIC devices of type `ovn` have the following device options: `acceleration` Enable hardware offloading

Key:	`acceleration`
Type:	string
Default:	`none`
Managed:	no

Possible values are `none`, `sriov`, or `vdpa`. See *SR-IOV hardware acceleration* for more information.

`boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Managed:	no

A higher value for this option means that the VM boots first.

`host_name` Name of the interface inside the host

Key:	`host_name`
Type:	string
Default:	randomly assigned
Managed:	no

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned
Managed:	no

`ipv4.address` IPv4 address to assign to the instance through DHCP

Key:	`ipv4.address`
Type:	string
Managed:	no

`ipv4.routes` IPv4 static routes to route for the NIC

Key:	`ipv4.routes`
Type:	string
Managed:	no

Specify a comma-delimited list of IPv4 static routes to route for this NIC.

`ipv4.routes.external` IPv4 static routes to route to NIC

Key:	`ipv4.routes.external`
Type:	string
Managed:	no

Specify a comma-delimited list of IPv4 static routes to route to the NIC and publish on the uplink network.

`ipv6.address` IPv6 address to assign to the instance through DHCP

Key:	`ipv6.address`
Type:	string
Managed:	no

`ipv6.routes` IPv6 static routes to route to the NIC

Key:	`ipv6.routes`
Type:	string
Managed:	no

Specify a comma-delimited list of IPv6 static routes to route to the NIC.

`ipv6.routes.external` IPv6 static routes to route to NIC

Key:	`ipv6.routes.external`
Type:	string
Managed:	no

Specify a comma-delimited list of IPv6 static routes to route to the NIC and publish on the uplink network.

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned
Managed:	no

`nested` Parent NIC name to nest this NIC under

Key:	`nested`
Type:	string
Managed:	no

See also *vlan*.

`network` Managed network to link the device to

Key:	`network`
Type:	string
Managed:	yes
Required:	yes

`security.acls` Network ACLs to apply

Key:	`security.acls`
Type:	string
Managed:	no

Specify a comma-separated list

`security.acls.default.egress.action` Default action to use for egress traffic

Key:	`security.acls.default.egress.action`
Type:	string
Default:	`reject`
Managed:	no

The specified action is used for all egress traffic that doesn't match any ACL rule.

`security.acls.default.egress.logged` Whether to log egress traffic that doesn't match any ACL rule

Key:	`security.acls.default.egress.logged`
Type:	bool
Default:	`false`
Managed:	no

`security.acls.default.ingress.action` Default action to use for ingress traffic

Key:	`security.acls.default.ingress.action`
Type:	string
Default:	`reject`
Managed:	no

The specified action is used for all ingress traffic that doesn't match any ACL rule.

`security.acls.default.ingress.logged` Whether to log ingress traffic that doesn't match any ACL rule

Key:	`security.acls.default.ingress.logged`
Type:	bool
Default:	`false`
Managed:	no

`vlan` VLAN ID to use when nesting

Key:	`vlan`
Type:	integer
Managed:	no

See also *nested*.

Configuration examples

An `ovn` network device must be added using a managed network. To do so:

```
lxc network create <network_name> --type=ovn network=<parent_network>
lxc config device add <instance_name> <device_name> nic network=<network_name>
```

See *How to set up OVN with LXD* for full instructions, and *How to create a network* and *Configure devices* for more information.

`nictype: ipvlan`

Note:

- This NIC type is available only for containers, not for virtual machines.
- You can select this NIC type only through the `nictype` option.
- This NIC type does not support hotplugging.

An `ipvlan` NIC sets up a new network device based on an existing one, using the same MAC address but a different IP.

If you are using an `ipvlan` NIC, communication between the LXD host and the instances is not possible. Both the host and the instances can talk to the gateway, but they cannot communicate directly.

LXD currently supports IPVLAN in L2 and L3S mode. In this mode, the gateway is automatically set by LXD, but the IP addresses must be manually specified using the `ipv4.address` and/or `ipv6.address` options before the container is started.

DNS

The name servers must be configured inside the container, because they are not set automatically. To do this, set the following `sysctls`:

- When using IPv4 addresses:

```
net.ipv4.conf.<parent>.forwarding=1
```

- When using IPv6 addresses:

```
net.ipv6.conf.<parent>.forwarding=1
net.ipv6.conf.<parent>.proxy_ndp=1
```

Device options

NIC devices of type `ipvlan` have the following device options: `gvrp` Whether to use GARP VLAN Registration Protocol

Key:	`gvrp`
Type:	bool
Default:	`false`

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned

`ipv4.address` IPv4 static addresses to add to the instance

Key:	`ipv4.address`
Type:	string

Specify a comma-delimited list of IPv4 static addresses to add to the instance. In `l2` mode, you can specify them as CIDR values or singular addresses using a subnet of `/24`.

`ipv4.gateway` IPv4 gateway

Key:	ipv4.gateway
Type:	string
Default:	auto (l3s), - (l2)

In l3s mode, the option specifies whether to add an automatic default IPv4 gateway. Possible values are auto and none.

In l2 mode, this option specifies the IPv4 address of the gateway.

ipv4.host_table Custom policy routing table ID to add IPv4 static routes to

Key:	ipv4.host_table
Type:	integer

The custom policy routing table is in addition to the main routing table.

ipv6.address IPv6 static addresses to add to the instance

Key:	ipv6.address
Type:	string

Specify a comma-delimited list of IPv6 static addresses to add to the instance. In l2 mode, you can specify them as CIDR values or singular addresses using a subnet of /64.

ipv6.gateway IPv6 gateway

Key:	ipv6.gateway
Type:	string
Default:	auto (l3s), - (l2)

In l3s mode, the option specifies whether to add an automatic default IPv6 gateway. Possible values are auto and none.

In l2 mode, this option specifies the IPv6 address of the gateway.

ipv6.host_table Custom policy routing table ID to add IPv6 static routes to

Key:	ipv6.host_table
Type:	integer

The custom policy routing table is in addition to the main routing table.

mode IPVLAN mode

Key:	mode
Type:	string
Default:	l3s

Possible values are l2 and l3s.

mtu The MTU of the new interface

Key:	mtu
Type:	integer
Default:	parent MTU

name Name of the interface inside the instance

Key:	name
Type:	string
Default:	kernel assigned

parent Name of the host device

Key:	parent
Type:	string
Required:	yes

vlan VLAN ID to attach to

Key:	vlan
Type:	integer

Configuration examples

Add an ipvlan network device to an instance, connecting to an existing network interface with nictype:

```
lxc stop <instance_name>
lxc config device add <instance_name> <device_name> nic nictype=ipvlan parent=<existing_
↪NIC>
```

Adding an ipvlan network device to an instance using a managed network is not possible.

See *Configure devices* for more information.

nictype: p2p

Note: You can select this NIC type only through the nictype option.

A p2p NIC creates a virtual device pair, putting one side in the instance and leaving the other side on the host.

Device options

NIC devices of type `p2p` have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer

A higher value for this option means that the VM boots first.

`host_name` Name of the interface inside the host

Key:	`host_name`
Type:	string
Default:	randomly assigned

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned

`ipv4.routes` IPv4 static routes for the NIC to add on the host

Key:	`ipv4.routes`
Type:	string

Specify a comma-delimited list of IPv4 static routes for this NIC to add on the host.

`ipv6.routes` IPv6 static routes for the NIC to add on the host

Key:	`ipv6.routes`
Type:	string

Specify a comma-delimited list of IPv6 static routes for this NIC to add on the host.

`limits.egress` I/O limit for outgoing traffic

Key:	`limits.egress`
Type:	string

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.ingress` I/O limit for incoming traffic

Key:	`limits.ingress`
Type:	string

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.max` I/O limit for both incoming and outgoing traffic

Key:	`limits.max`
Type:	string

This option is the same as setting both *`limits.ingress`* and *`limits.egress`*.

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

`limits.priority` `skb->priority` value for outgoing traffic

Key:	`limits.priority`
Type:	integer

The `skb->priority` value for outgoing traffic is used by the kernel queuing discipline (qdisc) to prioritize network packets. Specify the value as a 32-bit unsigned integer.

The effect of this value depends on the particular qdisc implementation, for example, `SKBPRIO` or `QFQ`. Consult the kernel qdisc documentation before setting this value.

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer
Default:	kernel assigned

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned

`queue.tx.length` Transmit queue length for the NIC

Key:	`queue.tx.length`
Type:	integer

Configuration examples

Add a `p2p` network device to an instance using `nictype`:

```
lxc config device add <instance_name> <device_name> nic nictype=p2p
```

Adding a `p2p` network device to an instance using a managed network is not possible.

See *Configure devices* for more information.

nictype: routed

Note: You can select this NIC type only through the `nictype` option.

A `routed` NIC creates a virtual device pair to connect the host to the instance and sets up static routes and proxy ARP/NDP entries to allow the instance to join the network of a designated parent interface. For containers it uses a virtual Ethernet device pair, and for VMs it uses a TAP device.

This NIC type is similar in operation to `ipvlan`, in that it allows an instance to join an external network without needing to configure a bridge and shares the host's MAC address. However, it differs from `ipvlan` because it does not need IPVLAN support in the kernel, and the host and the instance can communicate with each other.

This NIC type respects `netfilter` rules on the host and uses the host's routing table to route packets, which can be useful if the host is connected to multiple networks.

IP addresses, gateways and routes

You must manually specify the IP addresses (using `ipv4.address` and/or `ipv6.address`) before the instance is started.

For containers, the NIC configures the following link-local gateway IPs on the host end and sets them as the default gateways in the container's NIC interface:

```
169.254.0.1
fe80::1
```

For VMs, the gateways must be configured manually or via a mechanism like `cloud-init` (see the *how to guide*).

Note: If your container image is configured to perform DHCP on the interface, it will likely remove the automatically added configuration. In this case, you must configure the IP addresses and gateways manually or via a mechanism like `cloud-init`.

The NIC type configures static routes on the host pointing to the instance's `veth` interface for all of the instance's IPs.

Multiple IP addresses

Each NIC device can have multiple IP addresses added to it.

However, it might be preferable to use multiple `routed` NIC interfaces instead. In this case, set the `ipv4.gateway` and `ipv6.gateway` values to `none` on any subsequent interfaces to avoid default gateway conflicts. Also consider specifying a different host-side address for these subsequent interfaces using `ipv4.host_address` and/or `ipv6.host_address`.

Parent interface

This NIC can operate with and without a `parent` network interface set.

With the `parent` network interface set, proxy ARP/NDP entries of the instance's IPs are added to the parent interface, which allows the instance to join the parent interface's network at layer 2.

To enable this, the following network configuration must be applied on the host via `sysctl`:

- When using IPv4 addresses:

```
net.ipv4.conf.<parent>.forwarding=1
```

- When using IPv6 addresses:

```
net.ipv6.conf.all.forwarding=1
net.ipv6.conf.<parent>.forwarding=1
net.ipv6.conf.all.proxy_ndp=1
net.ipv6.conf.<parent>.proxy_ndp=1
```

Device options

NIC devices of type `routed` have the following device options: `gvrp` Whether to use GARP VLAN Registration Protocol

Key:	`gvrp`
Type:	bool
Default:	`false`

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

`host_name` Name of the interface inside the host

Key:	`host_name`
Type:	string
Default:	randomly assigned

`hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned

`ipv4.address` IPv4 static addresses to add to the instance

Key:	`ipv4.address`
Type:	string

Specify a comma-delimited list of IPv4 static addresses to add to the instance.

`ipv4.gateway` Whether to add an automatic default IPv4 gateway

Key:	`ipv4.gateway`
Type:	string
Default:	`auto`

Possible values are `auto` and `none`.

`ipv4.host_address` IPv4 address to add to the host-side `veth` interface

Key:	`ipv4.host_address`
Type:	string
Default:	`169.254.0.1`

`ipv4.host_table` Custom policy routing table ID to add IPv4 static routes to

Key:	`ipv4.host_table`
Type:	integer

The custom policy routing table is in addition to the main routing table.

`ipv4.neighbor_probe` Whether to probe the parent network for IPv4 address availability

Key:	`ipv4.neighbor_probe`
Type:	bool
Default:	`true`

`ipv4.routes` IPv4 static routes for the NIC to add on the host

Key:	`ipv4.routes`
Type:	string

Specify a comma-delimited list of IPv4 static routes for this NIC to add on the host (without L2 ARP/NDP proxy).

`ipv6.address` IPv6 static addresses to add to the instance

Key:	`ipv6.address`
Type:	string

Specify a comma-delimited list of IPv6 static addresses to add to the instance.

`ipv6.gateway` Whether to add an automatic default IPv6 gateway

Key:	`ipv6.gateway`
Type:	string
Default:	`auto`

Possible values are `auto` and `none`.

`ipv6.host_address` IPv6 address to add to the host-side `veth` interface

Key:	`ipv6.host_address`
Type:	string
Default:	`fe80::1`

`ipv6.host_table` Custom policy routing table ID to add IPv6 static routes to

Key:	`ipv6.host_table`
Type:	integer

The custom policy routing table is in addition to the main routing table.

`ipv6.neighbor_probe` Whether to probe the parent network for IPv6 address availability

Key:	ipv6.neighbor_probe
Type:	bool
Default:	true

ipv6.routes IPv6 static routes for the NIC to add on the host

Key:	ipv6.routes
Type:	string

Specify a comma-delimited list of IPv6 static routes for this NIC to add on the host (without L2 ARP/NDP proxy).

limits.egress I/O limit for outgoing traffic

Key:	limits.egress
Type:	string

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

limits.ingress I/O limit for incoming traffic

Key:	limits.ingress
Type:	string

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

limits.max I/O limit for both incoming and outgoing traffic

Key:	limits.max
Type:	string

This option is the same as setting both *limits.ingress* and *limits.egress*.

Specify the limit in bit/s. Various suffixes are supported (see *Units for storage and network limits*).

limits.priority skb->priority value for outgoing traffic

Key:	limits.priority
Type:	integer

The skb->priority value for outgoing traffic is used by the kernel queuing discipline (qdisc) to prioritize network packets. Specify the value as a 32-bit unsigned integer.

The effect of this value depends on the particular qdisc implementation, for example, SKBPRIO or QFQ. Consult the kernel qdisc documentation before setting this value.

mtu The MTU of the new interface

Key:	mtu
Type:	integer
Default:	parent MTU

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned

`parent` Name of the host device to join the instance to

Key:	`parent`
Type:	string

`queue.tx.length` Transmit queue length for the NIC

Key:	`queue.tx.length`
Type:	integer

`vlan` VLAN ID to attach to

Key:	`vlan`
Type:	integer

Configuration examples

Add a `routed` network device to an instance using `nictype`:

```
lxc config device add <instance_name> <device_name> nic nictype=routed ipv4.address=192.
↪0.2.2 ipv6.address=2001:db8::2
```

Adding a `routed` network device to an instance using a managed network is not possible.

See *Configure devices* for more information.

`bridged`, `macvlan` or `ipvlan` for connection to physical network

The `bridged`, `macvlan` and `ipvlan` interface types can be used to connect to an existing physical network.

`macvlan` effectively lets you fork your physical NIC, getting a second interface that is then used by the instance. This method saves you from creating a bridge device and virtual Ethernet device pairs and usually offers better performance than a bridge.

The downside to this method is that `macvlan` devices, while able to communicate between themselves and to the outside, cannot talk to their parent device. This means that you can't use `macvlan` if you ever need your instances to talk to the host itself.

In such case, a `bridge` device is preferable. A bridge also lets you use MAC filtering and I/O limits, which cannot be applied to a `macvlan` device.

`ipvlan` is similar to `macvlan`, with the difference being that the forked device has IPs statically assigned to it and inherits the parent's MAC address on the network.

MAAS integration

If you're using MAAS to manage the physical network under your LXD host and want to attach your instances directly to a MAAS-managed network, LXD can be configured to interact with MAAS so that it can track your instances.

At the daemon level, you must configure *maas.api.url* and *maas.api.key*, and then set the NIC-specific `maas.subnet.ipv4` and/or `maas.subnet.ipv6` keys on the instance or profile's `nic` entry.

With this configuration, LXD registers all your instances with MAAS, giving them proper DHCP leases and DNS records.

If you set the `ipv4.address` or `ipv6.address` keys on the NIC, those are registered as static assignments in MAAS.

Type: `disk`

Note: The `disk` device type is supported for both containers and VMs. It supports hotplugging for both containers and VMs.

Disk devices supply additional storage to instances.

For containers, they are essentially mount points inside the instance (either as a bind-mount of an existing file or directory on the host, or, if the source is a block device, a regular mount). Virtual machines share host-side mounts or directories through `9p` or `virtiofs` (if available), or as VirtIO disks for block-based disks.

Types of disk devices

You can create disk devices from different sources. The value that you specify for the `source` option specifies the type of disk device that is added. See *Configuration examples* for more detailed information on how to add each type of disk device.

Storage volume
: The most common type of disk device is a storage volume. Specify the storage volume name as the source to add a storage volume as a disk device.

Path on the host
: You can share a path on your host (either a file system or a block device) to your instance. Specify the host path as the source to add it as a disk device.

Ceph RBD
: LXD can use Ceph to manage an internal file system for the instance, but if you have an existing, externally managed Ceph RBD that you would like to use for an instance, you can add it by specifying `ceph:<pool_name>/<volume_name>` as the source.

CephFS
: LXD can use Ceph to manage an internal file system for the instance, but if you have an existing, externally managed Ceph file system that you would like to use for an instance, you can add it by specifying `cephfs:<fs_name>/<path>` as the source.

ISO file
: You can add an ISO file as a disk device for a virtual machine by specifying its file path as the source. It is added as a ROM device inside the VM.

  This source type is applicable only to VMs.

VM `cloud-init`

You can generate a `cloud-init` configuration ISO from the *cloud-init.vendor-data* and *cloud-init.user-data* configuration keys and attach it to a virtual machine by specifying `cloud-init:config` as the source. The `cloud-init` that is running inside the VM then detects the drive on boot and applies the configuration.

This source type is applicable only to VMs.

Adding such a configuration disk might be needed if the VM image that is used includes `cloud-init` but not the `lxd-agent`. This is the case for official Ubuntu images prior to `20.04`. On such images, the following steps enable the LXD agent and thus provide the ability to use `lxc exec` to access the VM:

```
lxc init ubuntu-daily:18.04 --vm u1
lxc config device add u1 config disk source=cloud-init:config
lxc config set u1 cloud-init.user-data - << EOF
#cloud-config
#packages:
#  - linux-image-virtual-hwe-16.04  # 16.04 GA kernel as a problem with vsock
runcmd:
  - mount -t 9p config /mnt
  - cd /mnt
  - ./install.sh
  - cd /
  - umount /mnt
  - systemctl start lxd-agent  # XXX: causes a reboot
EOF
lxc start --console u1
```

Note that for `16.04`, the HWE kernel is required to work around a problem with `vsock` (see the commented out section in the above `cloud-config`).

Initial volume configuration for instance root disk devices

Initial volume configuration allows setting specific configurations for the root disk devices of new instances. These settings are prefixed with `initial.` and are only applied when the instance is created. This method allows creating instances that have unique configurations, independent of the default storage pool settings.

For example, you can add an initial volume configuration for *zfs.block_mode* to an existing profile, and this will then take effect for each new instance you create using this profile:

```
lxc profile device set <profile_name> <device_name> initial.zfs.block_mode=true
```

You can also set an initial configuration directly when creating an instance. For example:

```
lxc init <image> <instance_name> --device <device_name>,initial.zfs.block_mode=true
```

Note that you cannot use initial volume configurations with custom volume options or to set the volume's size.

Device options

`disk` devices have the following device options: `boot.priority` Boot priority for VMs

Key:	`boot.priority`
Type:	integer
Condition:	virtual machine
Required:	no

A higher value indicates a higher boot precedence for the disk device. This is useful for prioritizing boot sources like ISO-backed disks.

`ceph.cluster_name` Cluster name of the Ceph cluster

Key:	`ceph.cluster_name`
Type:	string
Default:	`ceph`
Required:	for Ceph or CephFS sources

`ceph.user_name` User name of the Ceph cluster

Key:	`ceph.user_name`
Type:	string
Default:	`admin`
Required:	for Ceph or CephFS sources

`initial.*` Initial volume configuration

Key:	`initial.*`
Type:	n/a
Required:	no

Initial volume configuration allows setting unique configurations independent of the default storage pool settings. See *Initial volume configuration for instance root disk devices* for more information.

`io.bus` Bus for the device

Key:	`io.bus`
Type:	string
Default:	`virtio-scsi`
Condition:	virtual machine
Required:	no

Possible values are `virtio-scsi` or `nvme`.

`io.cache` Caching mode for the device

Key:	`io.cache`
Type:	string
Default:	none
Condition:	virtual machine
Required:	no

Possible values are `none`, `writeback`, or `unsafe`.

`limits.max` I/O limit in byte/s or IOPS for both read and write

Key:	`limits.max`
Type:	string
Required:	no

This option is the same as setting both *`limits.read`* and *`limits.write`*.

You can specify a value in byte/s (various suffixes supported, see *Units for storage and network limits*) or in IOPS (must be suffixed with `iops`). See also *Configure I/O limits*.

`limits.read` Read I/O limit in byte/s or IOPS

Key:	`limits.read`
Type:	string
Required:	no

You can specify a value in byte/s (various suffixes supported, see *Units for storage and network limits*) or in IOPS (must be suffixed with `iops`). See also *Configure I/O limits*.

`limits.write` Write I/O limit in byte/s or IOPS

Key:	`limits.write`
Type:	string
Required:	no

You can specify a value in byte/s (various suffixes supported, see *Units for storage and network limits*) or in IOPS (must be suffixed with `iops`). See also *Configure I/O limits*.

`path` Mount path

Key:	`path`
Type:	string
Condition:	container
Required:	yes

This option specifies the path inside the container where the disk will be mounted.

`pool` Storage pool to which the disk device belongs

Key:	`pool`
Type:	string
Condition:	storage volumes managed by LXD
Required:	no

`propagation` How a bind-mount is shared between the instance and the host

Key:	`propagation`
Type:	string
Default:	`private`
Required:	no

Possible values are `private` (the default), `shared`, `slave`, `unbindable`, `rshared`, `rslave`, `runbindable`, `rprivate`. See the Linux Kernel shared subtree documentation for a full explanation.

`raw.mount.options` File system specific mount options

Key:	`raw.mount.options`
Type:	string
Required:	no

`readonly` Whether to make the mount read-only

Key:	`readonly`
Type:	bool
Default:	`false`
Required:	no

`recursive` Whether to recursively mount the source path

Key:	`recursive`
Type:	bool
Default:	`false`
Required:	no

`required` Whether to fail if the source doesn't exist

Key:	`required`
Type:	bool
Default:	`true`
Required:	no

`shift` Whether to set up a UID/GID shifting overlay

Key:	`shift`
Type:	bool
Default:	`false`
Condition:	container
Required:	no

If enabled, this option sets up a shifting overlay to translate the source UID/GID to match the container instance.

`size` Disk size

Key:	size
Type:	string
Required:	no

This option is supported only for the rootfs (/).

Specify a value in bytes (various suffixes supported, see *Units for storage and network limits*).

`size.state` Size of the file-system volume used for saving runtime state

Key:	size.state
Type:	string
Condition:	virtual machine
Required:	no

This option is similar to `size`, but applies to the file-system volume used for saving the runtime state in VMs.

`source` Source of a file system or block device

Key:	source
Type:	string
Required:	yes

See *Types of disk devices* for details.

Configuration examples

How to add a disk device depends on its *type*.

Storage volume

To add a storage volume, specify its name as the `source` of the device:

```
lxc config device add <instance_name> <device_name> disk pool=<pool_name> source=
↪<volume_name> [path=<path_in_instance>]
```

The path is required for file system volumes, but not for block volumes.

Alternatively, you can use the `lxc storage volume attach` command to *Attach the volume to an instance*. Both commands use the same mechanism to add a storage volume as a disk device.

Path on the host

To add a host device, specify the host path as the `source`:

```
lxc config device add <instance_name> <device_name> disk source=<path_on_host>␣
↪[path=<path_in_instance>]
```

The path is required for file systems, but not for block devices.

Ceph RBD

To add an existing Ceph RBD volume, specify its pool and volume name:

```
lxc config device add <instance_name> <device_name> disk source=ceph:<pool_name>/
↪<volume_name> ceph.user_name=<user_name> ceph.cluster_name=<cluster_name> [path=
↪<path_in_instance>]
```

The path is required for file systems, but not for block devices.

CephFS
To add an existing CephFS file system, specify its name and path:

```
lxc config device add <instance_name> <device_name> disk source=cephfs:<fs_name>/
↪<path> ceph.user_name=<user_name> ceph.cluster_name=<cluster_name> path=<path_in_
↪instance>
```

ISO file
To add an ISO file, specify its file path as the `source`:

```
lxc config device add <instance_name> <device_name> disk source=<file_path_on_host>
```

VM `cloud-init`
To add `cloud-init` configuration, specify `cloud-init:config` as the source:

```
lxc config device add <instance_name> <device_name> disk source=cloud-init:config
```

See *Configure devices* for more information.

Type: `unix-char`

Note: The `unix-char` device type is supported for containers. It supports hotplugging.

Unix character devices make the specified character device appear as a device in the instance (under `/dev`). You can read from the device and write to it.

Device options

`unix-char` devices have the following device options: `gid` GID of the device owner in the instance

Key:	`gid`
Type:	integer
Default:	`0`

`major` Device major number

Key:	`major`
Type:	integer
Default:	device on host

`minor` Device minor number

Key:	`minor`
Type:	integer
Default:	device on host

`mode` Mode of the device in the instance

Key:	mode
Type:	integer
Default:	0660

`path` Path inside the instance

Key:	path
Type:	string
Required:	either `source` or `path` must be set

`required` Whether this device is required to start the instance

Key:	required
Type:	bool
Default:	true

See *Hotplugging* for more information.

`source` Path on the host

Key:	source
Type:	string
Required:	either `source` or `path` must be set

`uid` UID of the device owner in the instance

Key:	uid
Type:	integer
Default:	0

Configuration examples

Add a `unix-char` device to an instance by specifying its source and path:

```
lxc config device add <instance_name> <device_name> unix-char source=<path_on_host> path=
↪<path_on_instance>
```

If you want to use the same path on the instance as on the host, you can omit the `source` option:

```
lxc config device add <instance_name> <device_name> unix-char path=<path_to_the_device>
```

See *Configure devices* for more information.

Hotplugging

Hotplugging is enabled if you set `required=false` and specify the `source` option for the device.

In this case, the device is automatically passed into the container when it appears on the host, even after the container starts. If the device disappears from the host system, it is removed from the container as well.

Type: `unix-block`

Note: The `unix-block` device type is supported for containers. It supports hotplugging.

Unix block devices make the specified block device appear as a device in the instance (under `/dev`). You can read from the device and write to it.

Device options

`unix-block` devices have the following device options: `gid` GID of the device owner in the instance

Key:	`gid`
Type:	integer
Default:	`0`

`major` Device major number

Key:	`major`
Type:	integer
Default:	device on host

`minor` Device minor number

Key:	`minor`
Type:	integer
Default:	device on host

`mode` Mode of the device in the instance

Key:	`mode`
Type:	integer
Default:	`0660`

`path` Path inside the instance

Key:	`path`
Type:	string
Required:	either `source` or `path` must be set

`required` Whether this device is required to start the instance

Key:	`required`
Type:	bool
Default:	`true`

See *Hotplugging* for more information.

`source` Path on the host

Key:	`source`
Type:	string
Required:	either `source` or `path` must be set

`uid` UID of the device owner in the instance

Key:	`uid`
Type:	integer
Default:	`0`

Configuration examples

Add a `unix-block` device to an instance by specifying its source and path:

```
lxc config device add <instance_name> <device_name> unix-block source=<path_on_host>␣
↪path=<path_on_instance>
```

If you want to use the same path on the instance as on the host, you can omit the `source` option:

```
lxc config device add <instance_name> <device_name> unix-block path=<path_to_the_device>
```

See *Configure devices* for more information.

Hotplugging

Hotplugging is enabled if you set `required=false` and specify the `source` option for the device.

In this case, the device is automatically passed into the container when it appears on the host, even after the container starts. If the device disappears from the host system, it is removed from the container as well.

Type: `usb`

Note: The `usb` device type is supported for both containers and VMs. It supports hotplugging for both containers and VMs.

USB devices make the specified USB device appear in the instance. For performance issues, avoid using devices that require high throughput or low latency.

For containers, only `libusb` devices (at `/dev/bus/usb`) are passed to the instance. This method works for devices that have user-space drivers. For devices that require dedicated kernel drivers, use a *`unix-char` device* or a *`unix-hotplug` device* instead.

For virtual machines, the entire USB device is passed through, so any USB device is supported. When a device is passed to the instance, it vanishes from the host.

Device options

`usb` devices have the following device options: `busnum` The bus number of which the USB device is attached

Key:	`busnum`
Type:	int

`devnum` The device number of the USB device

Key:	`devnum`
Type:	int

`gid` GID of the device owner in the container

Key:	`gid`
Type:	integer
Default:	`0`
Condition:	container

`mode` Mode of the device in the container

Key:	`mode`
Type:	integer
Default:	`0660`
Condition:	container

`productid` Product ID of the USB device

Key:	`productid`
Type:	string

`required` Whether this device is required to start the instance

Key:	`required`
Type:	bool
Default:	`false`

The default is `false`, which means that all devices can be hotplugged.

`serial` The serial number of the USB device

Key:	serial
Type:	string

`uid` UID of the device owner in the container

Key:	uid
Type:	integer
Default:	0
Condition:	container

`vendorid` Vendor ID of the USB device

Key:	vendorid
Type:	string

Configuration examples

Add a `usb` device to an instance by specifying its vendor ID and product ID:

```
lxc config device add <instance_name> <device_name> usb vendorid=<vendor_ID> productid=
↪<product_ID>
```

To determine the vendor ID and product ID, you can use **`lsusb`**, for example.

See *Configure devices* for more information.

Type: `gpu`

GPU devices make the specified GPU device or devices appear in the instance.

Note: For containers, a `gpu` device may match multiple GPUs at once. For VMs, each device can match only a single GPU.

The following types of GPUs can be added using the `gputype` device option:

- *`physical`* (container and VM): Passes an entire GPU through into the instance. This value is the default if `gputype` is unspecified.
- *`mdev`* (VM only): Creates and passes a virtual GPU through into the instance.
- *`mig`* (container only): Creates and passes a MIG (Multi-Instance GPU) through into the instance.
- *`sriov`* (VM only): Passes a virtual function of an SR-IOV-enabled GPU into the instance.

The available device options depend on the GPU type and are listed in the tables in the following sections.

gputype: physical

Note: The `physical` GPU type is supported for both containers and VMs. It supports hotplugging only for containers, not for VMs.

A `physical` GPU device passes an entire GPU through into the instance.

Device options

GPU devices of type `physical` have the following device options: `gid` GID of the device owner in the container

Key:	`gid`
Type:	integer
Default:	`0`
Condition:	container

`id` DRM card ID of the GPU device

Key:	`id`
Type:	string

`mode` Mode of the device in the container

Key:	`mode`
Type:	integer
Default:	`0660`
Condition:	container

`pci` PCI address of the GPU device

Key:	`pci`
Type:	string

`productid` Product ID of the GPU device

Key:	`productid`
Type:	string

`uid` UID of the device owner in the container

Key:	`uid`
Type:	integer
Default:	`0`
Condition:	container

`vendorid` Vendor ID of the GPU device

Key:	`vendorid`
Type:	string

Configuration examples

Add all GPUs from the host system as a `physical` GPU device to an instance:

```
lxc config device add <instance_name> <device_name> gpu gputype=physical
```

Add a specific GPU from the host system as a `physical` GPU device to an instance by specifying its PCI address:

```
lxc config device add <instance_name> <device_name> gpu gputype=physical pci=<pci_
↪address>
```

See *Configure devices* for more information.

`gputype: mdev`

Note: The `mdev` GPU type is supported only for VMs. It does not support hotplugging.

An `mdev` GPU device creates and passes a virtual GPU through into the instance. You can check the list of available `mdev` profiles by running *`lxc info --resources`*.

Device options

GPU devices of type `mdev` have the following device options: `id` DRM card ID of the GPU device

Key:	`id`
Type:	string

`mdev` The `mdev` profile to use

Key:	`mdev`
Type:	string
Default:	`0`
Required:	yes

For example: `i915-GVTg_V5_4`

`pci` PCI address of the GPU device

Key:	`pci`
Type:	string

`productid` Product ID of the GPU device

Key:	`productid`
Type:	string

`vendorid` Vendor ID of the GPU device

Key:	`vendorid`
Type:	string

Configuration examples

Add an `mdev` GPU device to an instance by specifying its `mdev` profile and the PCI address of the GPU:

```
lxc config device add <instance_name> <device_name> gpu gputype=mdev mdev=<mdev_profile>␣
↪pci=<pci_address>
```

See *Configure devices* for more information.

`gputype: mig`

Note: The `mig` GPU type is supported only for containers. It does not support hotplugging.

A `mig` GPU device creates and passes a MIG compute instance through into the instance. Currently, this requires NVIDIA MIG instances to be pre-created.

Device options

GPU devices of type `mig` have the following device options: `id` DRM card ID of the GPU device

Key:	`id`
Type:	string

`mig.ci` Existing MIG compute instance ID

Key:	`mig.ci`
Type:	integer

`mig.gi` Existing MIG GPU instance ID

Key:	`mig.gi`
Type:	integer

`mig.uuid` Existing MIG device UUID

Key:	mig.uuid
Type:	string

You can omit the `MIG-` prefix when specifying this option.

`pci` PCI address of the GPU device

Key:	pci
Type:	string

`productid` Product ID of the GPU device

Key:	productid
Type:	string

`vendorid` Vendor ID of the GPU device

Key:	vendorid
Type:	string

You must set either *mig.uuid* (NVIDIA drivers 470+) or both *mig.ci* and *mig.gi* (old NVIDIA drivers).

Configuration examples

Add a `mig` GPU device to an instance by specifying its UUID and the PCI address of the GPU:

```
lxc config device add <instance_name> <device_name> gpu gputype=mig mig.uuid=<mig_uuid>␣
↪pci=<pci_address>
```

See *Configure devices* for more information.

gputype: sriov

Note: The `sriov` GPU type is supported only for VMs. It does not support hotplugging.

An `sriov` GPU device passes a virtual function of an SR-IOV-enabled GPU into the instance.

Device options

GPU devices of type `sriov` have the following device options: `id` DRM card ID of the parent GPU device

Key:	`id`
Type:	string

`pci` PCI address of the parent GPU device

Key:	`pci`
Type:	string

`productid` Product ID of the parent GPU device

Key:	`productid`
Type:	string

`vendorid` Vendor ID of the parent GPU device

Key:	`vendorid`
Type:	string

Configuration examples

Add a `sriov` GPU device to an instance by specifying the PCI address of the parent GPU:

```
lxc config device add <instance_name> <device_name> gpu gputype=sriov pci=<pci_address>
```

See *Configure devices* for more information.

Type: `infiniband`

Note: The `infiniband` device type is supported for both containers and VMs. It supports hotplugging only for containers, not for VMs.

LXD supports two different kinds of network types for InfiniBand devices:

- `physical`: Passes a physical device from the host through to the instance. The targeted device will vanish from the host and appear in the instance.
- `sriov`: Passes a virtual function of an SR-IOV-enabled physical network device into the instance.

  Note: InfiniBand devices support SR-IOV, but in contrast to other SR-IOV-enabled devices, InfiniBand does not support dynamic device creation in SR-IOV mode. Therefore, you must pre-configure the number of virtual functions by configuring the corresponding kernel module.

Device options

`infiniband` devices have the following device options: `hwaddr` MAC address of the new interface

Key:	`hwaddr`
Type:	string
Default:	randomly assigned
Required:	no

You can specify either the full 20-byte variant or the short 8-byte variant (which will modify only the last 8 bytes of the parent device).

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer
Default:	parent MTU
Required:	no

`name` Name of the interface inside the instance

Key:	`name`
Type:	string
Default:	kernel assigned
Required:	no

`nictype` Device type

Key:	`nictype`
Type:	string
Required:	yes

Possible values are `physical` and `sriov`.

`parent` The name of the host device or bridge

Key:	`parent`
Type:	string
Required:	yes

Configuration examples

Add a `physical infiniband` device to an instance:

```
lxc config device add <instance_name> <device_name> infiniband nictype=physical parent=
↪<device>
```

Add an `sriov infiniband` device to an instance:

```
lxc config device add <instance_name> <device_name> infiniband nictype=sriov parent=
↪<sriov_enabled_device>
```

See *Configure devices* for more information.

Type: `proxy`

Note: The `proxy` device type is supported for both containers (NAT and non-NAT modes) and VMs (NAT mode only). It supports hotplugging for both containers and VMs.

Proxy devices allow forwarding network connections between host and instance. This method makes it possible to forward traffic hitting one of the host's addresses to an address inside the instance, or to do the reverse and have an address in the instance connect through the host.

In *NAT mode*, a proxy device can be used for TCP and UDP proxying. In non-NAT mode, you can also proxy traffic between Unix sockets (which can be useful to, for example, forward graphical GUI or audio traffic from the container to the host system) or even across protocols (for example, you can have a TCP listener on the host system and forward its traffic to a Unix socket inside a container).

The supported connection types are:

- `tcp <-> tcp`
- `udp <-> udp`
- `unix <-> unix`
- `tcp <-> unix`
- `unix <-> tcp`
- `udp <-> tcp`
- `tcp <-> udp`
- `udp <-> unix`
- `unix <-> udp`

To add a `proxy` device, use the following command:

```
lxc config device add <instance_name> <device_name> proxy listen=<type>:<addr>:<port>[-
↪<port>][,<port>] connect=<type>:<addr>:<port> bind=<host/instance_name>
```

Tip: Using a proxy device in NAT mode is very similar to adding a *network forward*.

The difference is that network forwards are applied on a network level, while a proxy device is added for an instance. In addition, network forwards cannot be used to proxy traffic between different connection types.

NAT mode

The proxy device also supports a NAT mode (`nat=true`), where packets are forwarded using NAT rather than being proxied through a separate connection. This mode has the benefit that the client address is maintained without the need for the target destination to support the HAProxy PROXY protocol (which is the only way to pass the client address through when using the proxy device in non-NAT mode).

However, NAT mode is supported only if the host that the instance is running on is the gateway (which is the case if you're using `lxdbr0`, for example).

In NAT mode, the supported connection types are:

- `tcp <-> tcp`
- `udp <-> udp`

When configuring a proxy device with `nat=true`, you must ensure that the target instance has a static IP configured on its NIC device.

Specifying IP addresses

Use the following command to configure a static IP for an instance NIC:

```
lxc config device set <instance_name> <nic_name> ipv4.address=<ipv4_address> ipv6.
↪address=<ipv6_address>
```

To define a static IPv6 address, the parent managed network must have `ipv6.dhcp.stateful` enabled.

When defining IPv6 addresses, use the square bracket notation, for example:

```
connect=tcp:[2001:db8::1]:80
```

You can specify that the connect address should be the IP of the instance by setting the connect IP to the wildcard address (`0.0.0.0` for IPv4 and `[::]` for IPv6).

Note: The listen address can also use wildcard addresses when using non-NAT mode. However, when using NAT mode, you must specify an IP address on the LXD host.

Device options

`proxy` devices have the following device options: `bind` Which side to bind on

Key:	`bind`
Type:	string
Default:	`host`
Required:	no

Possible values are `host` and `instance`.

`connect` Address and port to connect to

Key:	`connect`
Type:	string
Required:	yes

Use the following format to specify the address and port: `<type>:<addr>:<port>[-<port>][,<port>]`

`gid` GID of the owner of the listening Unix socket

Key:	`gid`
Type:	integer
Default:	`0`
Required:	no

`listen` Address and port to bind and listen

Key:	`listen`
Type:	string
Required:	yes

Use the following format to specify the address and port: `<type>:<addr>:<port>[-<port>][,<port>]`

`mode` Mode for the listening Unix socket

Key:	`mode`
Type:	integer
Default:	`0644`
Required:	no

`nat` Whether to optimize proxying via NAT

Key:	`nat`
Type:	bool
Default:	`false`
Required:	no

This option requires that the instance NIC has a static IP address.

`proxy_protocol` Whether to use the HAProxy PROXY protocol

Key:	`proxy_protocol`
Type:	bool
Default:	`false`
Required:	no

This option specifies whether to use the HAProxy PROXY protocol to transmit sender information.

`security.gid` What GID to drop privilege to

Key:	security.gid
Type:	integer
Default:	0
Required:	no

security.uid What UID to drop privilege to

Key:	security.uid
Type:	integer
Default:	0
Required:	no

uid UID of the owner of the listening Unix socket

Key:	uid
Type:	integer
Default:	0
Required:	no

Configuration examples

Add a proxy device that forwards traffic from one address (the listen address) to another address (the connect address) using NAT mode:

```
lxc config device add <instance_name> <device_name> proxy nat=true listen=tcp:<ip_
↪address>:<port> connect=tcp:<ip_address>:<port>
```

Add a proxy device that forwards traffic going to a specific IP to a Unix socket on an instance that might not have a network connection:

```
lxc config device add <instance_name> <device_name> proxy listen=tcp:<ip_address>:<port>␣
↪connect=unix:/<socket_path_on_instance>
```

Add a proxy device that forwards traffic going to a Unix socket on an instance that might not have a network connection to a specific IP address:

```
lxc config device add <instance_name> <device_name> proxy bind=instance listen=unix:/
↪<socket_path_on_instance> connect=tcp:<ip_address>:<port>
```

See *Configure devices* for more information.

Type: unix-hotplug

Note: The unix-hotplug device type is supported for containers. It supports hotplugging.

Unix hotplug devices make the requested Unix device appear as a device in the instance (under /dev). If the device exists on the host system, you can read from it and write to it.

The implementation depends on systemd-udev to be run on the host.

Device options

unix-hotplug devices have the following device options: gid GID of the device owner in the instance

Key:	gid
Type:	integer
Default:	0

mode Mode of the device in the instance

Key:	mode
Type:	integer
Default:	0660

productid Product ID of the Unix device

Key:	productid
Type:	string

required Whether this device is required to start the instance

Key:	required
Type:	bool
Default:	false

The default is false, which means that all devices can be hotplugged.

uid UID of the device owner in the instance

Key:	uid
Type:	integer
Default:	0

vendorid Vendor ID of the Unix device

Key:	vendorid
Type:	string

Configuration examples

Add a `unix-hotplug` device to an instance by specifying its vendor ID and product ID:

```
lxc config device add <instance_name> <device_name> unix-hotplug vendorid=<vendor_ID>␣
↪productid=<product_ID>
```

See *Configure devices* for more information.

Type: `tpm`

Note: The `tpm` device type is supported for both containers and VMs. It supports hotplugging only for containers, not for VMs.

TPM devices enable access to a TPM (Trusted Platform Module) emulator.

TPM devices can be used to validate the boot process and ensure that no steps in the boot chain have been tampered with, and they can securely generate and store encryption keys.

LXD uses a software TPM that supports TPM 2.0. For containers, the main use case is sealing certificates, which means that the keys are stored outside of the container, making it virtually impossible for attackers to retrieve them. For virtual machines, TPM can be used both for sealing certificates and for validating the boot process, which allows using full disk encryption compatible with, for example, Windows BitLocker.

Device options

`tpm` devices have the following device options: `path` Path inside the container

Key:	`path`
Type:	string
Condition:	containers
Required:	for containers

For example: `/dev/tpm0`

`pathrm` Resource manager path inside the container

Key:	`pathrm`
Type:	string
Condition:	containers
Required:	for containers

For example: `/dev/tpmrm0`

Configuration examples

Add a `tpm` device to a container by specifying its path and the resource manager path:

```
lxc config device add <instance_name> <device_name> tpm path=<path_on_instance> pathrm=
↪<resource_manager_path>
```

Add a `tpm` device to a virtual machine:

```
lxc config device add <instance_name> <device_name> tpm
```

See *Configure devices* for more information.

Type: `pci`

Note: The `pci` device type is supported for VMs. It does not support hotplugging.

PCI devices are used to pass raw PCI devices from the host into a virtual machine.

They are mainly intended to be used for specialized single-function PCI cards like sound cards or video capture cards. In theory, you can also use them for more advanced PCI devices like GPUs or network cards, but it's usually more convenient to use the specific device types that LXD provides for these devices (*gpu device* or *nic device*).

Device options

`pci` devices have the following device options: `address` PCI address of the device

Key:	`address`
Type:	string
Required:	yes

Configuration examples

Add a `pci` device to a virtual machine by specifying its PCI address:

```
lxc config device add <instance_name> <device_name> pci address=<pci_address>
```

To determine the PCI address, you can use **`lspci`**, for example.

See *Configure devices* for more information.

Units for storage and network limits

Any value that represents bytes or bits can make use of a number of suffixes to make it easier to understand what a particular limit is.

Both decimal and binary (kibi) units are supported, with the latter mostly making sense for storage limits.

The full list of bit suffixes currently supported is:

- bit (1)
- kbit (1000)
- Mbit (1000^2)
- Gbit (1000^3)
- Tbit (1000^4)
- Pbit (1000^5)
- Ebit (1000^6)
- Kibit (1024)
- Mibit (1024^2)
- Gibit (1024^3)
- Tibit (1024^4)
- Pibit (1024^5)
- Eibit (1024^6)

The full list of byte suffixes currently supported is:

- B or bytes (1)
- kB (1000)
- MB (1000^2)
- GB (1000^3)
- TB (1000^4)
- PB (1000^5)
- EB (1000^6)
- KiB (1024)
- MiB (1024^2)
- GiB (1024^3)
- TiB (1024^4)
- PiB (1024^5)
- EiB (1024^6)

Related topics

How-to guides:

- *Instances*

Explanation:

- *Instance types in LXD*

Preseed YAML file fields

You can configure a new LXD installation and reconfigure an existing installation with a preseed YAML file.

The preseed YAML file fields are as follows:

```
config:
  core.https_address: ""
  core.trust_password: ""
  images.auto_update_interval: 6

networks:
  - config:
      ipv4.address: auto
      ipv4.nat: "true"
      ipv6.address: auto
      ipv6.nat: "true"
    description: ""
    name: lxdbr0
    type: bridge
    project: default

storage_pools:
  - config: {}
    description: ""
    name: default
    driver: zfs

storage_volumes:
- name: my-vol
  pool: data

profiles:
  - config:
      limits.memory: 2GiB
    description: Default LXD profile
    devices:
      eth0:
        name: eth0
        network: lxdbr0
        type: nic
      root:
        path: /
        pool: default
```

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```
        type: disk
    name: default

projects:
  - config:
      features.images: "true"
      features.networks: "true"
      features.networks.zones: "true"
      features.profiles: "true"
      features.storage.buckets: "true"
      features.storage.volumes: "true"
    description: Default LXD project
    name: default

cluster:
  enabled: true
  server_address: ""
  cluster_token: ""
  member_config:
  - entity: storage-pool
    name: default
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: source
    value: ""
  - entity: storage-pool
    name: my-pool
    key: driver
    value: "zfs"
```

Related topics

How-to guides:

- *How to initialize LXD*

Project configuration

Projects can be configured through a set of key/value configuration options. See *Configure a project* for instructions on how to set these options.

The key/value configuration is namespaced. The following options are available:

- *Project features*
- *Project limits*
- *Project restrictions*
- *Project-specific configuration*

Project features

The project features define which entities are isolated in the project and which are inherited from the `default` project.

If a `feature.*` option is set to `true`, the corresponding entity is isolated in the project.

Note: When you create a project without explicitly configuring a specific option, this option is set to the initial value given in the following table.

However, if you unset one of the `feature.*` options, it does not go back to the initial value, but to the default value. The default value for all `feature.*` options is `false`.

`features.images` Whether to use a separate set of images for the project

Key:	`features.images`
Type:	bool
Default:	`false`
Initial value:	`true`

This setting applies to both images and image aliases.

`features.networks` Whether to use a separate set of networks for the project

Key:	`features.networks`
Type:	bool
Default:	`false`
Initial value:	`false`

`features.networks.zones` Whether to use a separate set of network zones for the project

Key:	`features.networks.zones`
Type:	bool
Default:	`false`
Initial value:	`false`

`features.profiles` Whether to use a separate set of profiles for the project

Key:	`features.profiles`
Type:	bool
Default:	`false`
Initial value:	`true`

`features.storage.buckets` Whether to use a separate set of storage buckets for the project

Key:	`features.storage.buckets`
Type:	bool
Default:	`false`
Initial value:	`true`

`features.storage.volumes` Whether to use a separate set of storage volumes for the project

Key:	`features.storage.volumes`
Type:	bool
Default:	`false`
Initial value:	`true`

Project limits

Project limits define a hard upper bound for the resources that can be used by the containers and VMs that belong to a project.

Depending on the `limits.*` option, the limit applies to the number of entities that are allowed in the project (for example, *`limits.containers`* or *`limits.networks`*) or to the aggregate value of resource usage for all instances in the project (for example, *`limits.cpu`* or *`limits.processes`*). In the latter case, the limit usually applies to the *Resource limits* that are configured for each instance (either directly or via a profile), and not to the resources that are actually in use.

For example, if you set the project's *`limits.memory`* configuration to `50GiB`, the sum of the individual values of all *`limits.memory`* configuration keys defined on the project's instances will be kept under 50 GiB.

Similarly, setting the project's *`limits.cpu`* configuration key to `100` means that the sum of individual *`limits.cpu`* values will be kept below 100.

When using project limits, the following conditions must be fulfilled:

- When you set one of the `limits.*` configurations and there is a corresponding configuration for the instance, all instances in the project must have the corresponding configuration defined (either directly or via a profile). See *Resource limits* for the instance configuration options.
- The *`limits.cpu`* configuration cannot be used if *CPU pinning* is enabled. This means that to use *`limits.cpu`* on a project, the *`limits.cpu`* configuration of each instance in the project must be set to a number of CPUs, not a set or a range of CPUs.
- The *`limits.memory`* configuration must be set to an absolute value, not a percentage.

`limits.containers` Maximum number of containers that can be created in the project

Key:	`limits.containers`
Type:	integer

`limits.cpu` Maximum number of CPUs to use in the project

Key:	`limits.cpu`
Type:	integer

This value is the maximum value for the sum of the individual *`limits.cpu`* configurations set on the instances of the project.

`limits.disk` Maximum disk space used by the project

Key:	`limits.disk`
Type:	string

This value is the maximum value of the aggregate disk space used by all instance volumes, custom volumes, and images of the project.

`limits.instances` Maximum number of instances that can be created in the project

Key:	`limits.instances`
Type:	integer

`limits.memory` Usage limit for the host's memory for the project

Key:	`limits.memory`
Type:	string

The value is the maximum value for the sum of the individual *`limits.memory`* configurations set on the instances of the project.

`limits.networks` Maximum number of networks that the project can have

Key:	`limits.networks`
Type:	integer

`limits.processes` Maximum number of processes within the project

Key:	`limits.processes`
Type:	integer

This value is the maximum value for the sum of the individual *`limits.processes`* configurations set on the instances of the project.

`limits.virtual-machines` Maximum number of VMs that can be created in the project

Key:	`limits.virtual-machines`
Type:	integer

Project restrictions

To prevent the instances of a project from accessing security-sensitive features (such as container nesting or raw LXC configuration), set the *`restricted`* configuration option to `true`. You can then use the various `restricted.*` options to pick individual features that would normally be blocked by *`restricted`* and allow them, so they can be used by the instances of the project.

For example, to restrict a project and block all security-sensitive features, but allow container nesting, enter the following commands:

```
lxc project set <project_name> restricted=true
lxc project set <project_name> restricted.containers.nesting=allow
```

Each security-sensitive feature has an associated `restricted.*` project configuration option. If you want to allow the usage of a feature, change the value of its `restricted.*` option. Most `restricted.*` configurations are binary

switches that can be set to either `block` (the default) or `allow`. However, some options support other values for more fine-grained control.

Note: You must set the `restricted` configuration to `true` for any of the `restricted.*` options to be effective. If `restricted` is set to `false`, changing a `restricted.*` option has no effect.

Setting all `restricted.*` keys to `allow` is equivalent to setting `restricted` itself to `false`.

`restricted` Whether to block access to security-sensitive features

Key:	`restricted`
Type:	bool
Default:	`false`

This option must be enabled to allow the `restricted.*` keys to take effect. To temporarily remove the restrictions, you can disable this option instead of clearing the related keys.

`restricted.backups` Whether to prevent creating instance or volume backups

Key:	`restricted.backups`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.cluster.groups` Cluster groups that can be targeted

Key:	`restricted.cluster.groups`
Type:	string

If specified, this option prevents targeting cluster groups other than the provided ones.

`restricted.cluster.target` Whether to prevent targeting of cluster members

Key:	`restricted.cluster.target`
Type:	string
Default:	`block`

Possible values are `allow` or `block`. When set to `allow`, this option allows targeting of cluster members (either directly or via a group) when creating or moving instances.

`restricted.containers.interception` Whether to prevent using system call interception options

Key:	`restricted.containers.interception`
Type:	string
Default:	`block`

Possible values are `allow`, `block`, or `full`. When set to `allow`, interception options that are usually safe are allowed. File system mounting remains blocked.

`restricted.containers.lowlevel` Whether to prevent using low-level container options

Key:	`restricted.containers.lowlevel`
Type:	string
Default:	`block`

Possible values are `allow` or `block`. When set to `allow`, low-level container options like *`raw.lxc`*, *`raw.idmap`*, `volatile.*`, etc. can be used.

`restricted.containers.nesting` Whether to prevent running nested LXD

Key:	`restricted.containers.nesting`
Type:	string
Default:	`block`

Possible values are `allow` or `block`. When set to `allow`, *`security.nesting`* can be set to `true` for an instance.

`restricted.containers.privilege` Which settings for privileged containers to prevent

Key:	`restricted.containers.privilege`
Type:	string
Default:	`unprivileged`

Possible values are `unprivileged`, `isolated`, and `allow`.

- When set to `unpriviliged`, this option prevents setting *`security.privileged`* to `true`.
- When set to `isolated`, this option prevents setting *`security.privileged`* to `true` and forces using a unique idmap per container using *`security.idmap.isolated`* set to `true`.
- When set to `allow`, there is no restriction.

`restricted.devices.disk` Which disk devices can be used

Key:	`restricted.devices.disk`
Type:	string
Default:	`managed`

Possible values are `allow`, `block`, or `managed`.

- When set to `block`, this option prevents using all disk devices except the root one.
- When set to `managed`, this option allows using disk devices only if `pool=` is set.
- When set to `allow`, there is no restriction on which disk devices can be used.

Important: When allowing all disk devices, make sure to set *`restricted.devices.disk.paths`* to a list of path prefixes that you want to allow. If you do not restrict the allowed paths, users can attach any disk device, including shifted devices (`disk` devices with *`shift`* set to `true`), which can be used to gain root access to the system.

`restricted.devices.disk.paths` Which `source` can be used for `disk` devices

Key:	`restricted.devices.disk.paths`
Type:	string

If *restricted.devices.disk* is set to `allow`, this option controls which `source` can be used for `disk` devices. Specify a comma-separated list of path prefixes that restrict the `source` setting. If this option is left empty, all paths are allowed.

`restricted.devices.gpu` Whether to prevent using devices of type `gpu`

Key:	`restricted.devices.gpu`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.infiniband` Whether to prevent using devices of type `infiniband`

Key:	`restricted.devices.infiniband`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.nic` Which network devices can be used

Key:	`restricted.devices.nic`
Type:	string
Default:	`managed`

Possible values are `allow`, `block`, or `managed`.

- When set to `block`, this option prevents using all network devices.
- When set to `managed`, this option allows using network devices only if `network`= is set.
- When set to `allow`, there is no restriction on which network devices can be used.

`restricted.devices.pci` Whether to prevent using devices of type `pci`

Key:	`restricted.devices.pci`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.proxy` Whether to prevent using devices of type `proxy`

Key:	`restricted.devices.proxy`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.unix-block` Whether to prevent using devices of type `unix-block`

Key:	`restricted.devices.unix-block`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.unix-char` Whether to prevent using devices of type `unix-char`

Key:	`restricted.devices.unix-char`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.unix-hotplug` Whether to prevent using devices of type `unix-hotplug`

Key:	`restricted.devices.unix-hotplug`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.devices.usb` Whether to prevent using devices of type `usb`

Key:	`restricted.devices.usb`
Type:	string
Default:	`block`

Possible values are `allow` or `block`.

`restricted.idmap.gid` Which host GID ranges are allowed in `raw.idmap`

Key:	`restricted.idmap.gid`
Type:	string

This option specifies the host GID ranges that are allowed in the instance's *raw.idmap* setting.

`restricted.idmap.uid` Which host UID ranges are allowed in `raw.idmap`

Key:	`restricted.idmap.uid`
Type:	string

This option specifies the host UID ranges that are allowed in the instance's *raw.idmap* setting.

`restricted.networks.access` Which network names are allowed for use in this project

Key:	`restricted.networks.access`
Type:	string

Specify a comma-delimited list of network names that are allowed for use in this project. If this option is not set, all networks are accessible.

Note that this setting depends on the *restricted.devices.nic* setting.

`restricted.networks.subnets` Which network subnets are allocated for use in this project

Key:	`restricted.networks.subnets`
Type:	string
Default:	`block`

Specify a comma-delimited list of network subnets from the uplink networks that are allocated for use in this project. Use the form `<uplink>:<subnet>`.

`restricted.networks.uplinks` Which network names can be used as uplink in this project

Key:	`restricted.networks.uplinks`
Type:	string
Default:	`block`

Specify a comma-delimited list of network names that can be used as uplink for networks in this project.

`restricted.networks.zones` Which network zones can be used in this project

Key:	`restricted.networks.zones`
Type:	string
Default:	`block`

Specify a comma-delimited list of network zones that can be used (or something under them) in this project.

`restricted.snapshots` Whether to prevent creating instance or volume snapshots

Key:	`restricted.snapshots`
Type:	string
Default:	`block`

`restricted.virtual-machines.lowlevel` Whether to prevent using low-level VM options

Key:	`restricted.virtual-machines.lowlevel`
Type:	string
Default:	`block`

Possible values are `allow` or `block`. When set to `allow`, low-level VM options like *raw.qemu*, `volatile.*`, etc. can be used.

Project-specific configuration

There are some *Server configuration* options that you can override for a project. In addition, you can add user metadata for a project. `backups.compression_algorithm` Compression algorithm to use for backups

Key:	`backups.compression_algorithm`
Type:	string

Specify which compression algorithm to use for backups in this project. Possible values are `bzip2`, `gzip`, `lzma`, `xz`, or `none`.

`images.auto_update_cached` Whether to automatically update cached images in the project

Key:	`images.auto_update_cached`
Type:	bool

`images.auto_update_interval` Interval at which to look for updates to cached images

Key:	`images.auto_update_interval`
Type:	integer

Specify the interval in hours. To disable looking for updates to cached images, set this option to `0`.

`images.compression_algorithm` Compression algorithm to use for new images in the project

Key:	`images.compression_algorithm`
Type:	string

Possible values are `bzip2`, `gzip`, `lzma`, `xz`, or `none`.

`images.default_architecture` Default architecture to use in a mixed-architecture cluster

Key:	`images.default_architecture`
Type:	string

`images.remote_cache_expiry` When an unused cached remote image is flushed in the project

Key:	`images.remote_cache_expiry`
Type:	integer

Specify the number of days after which the unused cached image expires.

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string

Related topics

How-to guides:

- *Projects*

Explanation:

- *About projects*

Storage drivers

LXD supports the following storage drivers for storing images, instances and custom volumes:

Btrfs - `btrfs`

Btrfs (B-tree file system) is a local file system based on the COW (copy-on-write) principle. COW means that data is stored to a different block after it has been modified instead of overwriting the existing data, reducing the risk of data corruption. Unlike other file systems, Btrfs is extent-based, which means that it stores data in contiguous areas of memory.

In addition to basic file system features, Btrfs offers RAID and volume management, pooling, snapshots, checksums, compression and other features.

To use Btrfs, make sure you have `btrfs-progs` installed on your machine.

Terminology

A Btrfs file system can have *subvolumes*, which are named binary subtrees of the main tree of the file system with their own independent file and directory hierarchy. A *Btrfs snapshot* is a special type of subvolume that captures a specific state of another subvolume. Snapshots can be read-write or read-only.

`btrfs` driver in LXD

The `btrfs` driver in LXD uses a subvolume per instance, image and snapshot. When creating a new entity (for example, launching a new instance), it creates a Btrfs snapshot.

Btrfs doesn't natively support storing block devices. Therefore, when using Btrfs for VMs, LXD creates a big file on disk to store the VM. This approach is not very efficient and might cause issues when creating snapshots.

Btrfs can be used as a storage backend inside a container in a nested LXD environment. In this case, the parent container itself must use Btrfs. Note, however, that the nested LXD setup does not inherit the Btrfs quotas from the parent (see *Quotas* below).

Quotas

Btrfs supports storage quotas via qgroups. Btrfs qgroups are hierarchical, but new subvolumes will not automatically be added to the qgroups of their parent subvolumes. This means that users can trivially escape any quotas that are set. Therefore, if strict quotas are needed, you should consider using a different storage driver (for example, ZFS with `refquota` or LVM with Btrfs on top).

When using quotas, you must take into account that Btrfs extents are immutable. When blocks are written, they end up in new extents. The old extents remain until all their data is dereferenced or rewritten. This means that a quota can be reached even if the total amount of space used by the current files in the subvolume is smaller than the quota.

Note: This issue is seen most often when using VMs on Btrfs, due to the random I/O nature of using raw disk image files on top of a Btrfs subvolume.

Therefore, you should never use VMs with Btrfs storage pools.

If you really need to use VMs with Btrfs storage pools, set the instance root disk's *`size.state`* property to twice the size of the root disk's size. This configuration allows all blocks in the disk image file to be rewritten without reaching the qgroup quota. Setting the *`btrfs.mount_options`* storage pool option to `compress-force` can also avoid this scenario, because a side effect of enabling compression is to reduce the maximum extent size such that block rewrites don't cause as much storage to be double-tracked. However, this is a storage pool option, and it therefore affects all volumes on the pool.

Configuration options

The following configuration options are available for storage pools that use the `btrfs` driver and for storage volumes in these pools.

Storage pool configuration

`btrfs.mount_options` Mount options for block devices

Key:	`btrfs.mount_options`
Type:	string
Default:	`user_subvol_rm_allowed`

`size` Size of the storage pool (for loop-based pools)

Key:	`size`
Type:	string
Default:	auto (20% of free disk space, >= 5 GiB and <= 30 GiB)

When creating loop-based pools, specify the size in bytes (*suffixes* are supported). You can increase the size to grow the storage pool.

The default (`auto`) creates a storage pool that uses 20% of the free disk space, with a minimum of 5 GiB and a maximum of 30 GiB.

`source` Path to an existing block device, loop file, or Btrfs subvolume

Key:	`source`
Type:	string

`source.wipe` Whether to wipe the block device before creating the pool

Key:	`source.wipe`
Type:	bool
Default:	`false`

Set this option to `true` to wipe the block device specified in `source` prior to creating the storage pool.

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

Storage bucket configuration

To enable storage buckets for local storage pool drivers and allow applications to access the buckets via the S3 protocol, you must configure the *`core.storage_buckets_address`* server setting. `size` Size/quota of the storage bucket

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

CephFS - `cephfs`

Ceph is an open-source storage platform that stores its data in a storage cluster based on RADOS (Reliable Autonomic Distributed Object Store). It is highly scalable and, as a distributed system without a single point of failure, very reliable.

Tip: If you want to quickly set up a basic Ceph cluster, check out MicroCeph.

Ceph provides different components for block storage and for file systems.

CephFS (Ceph File System) is Ceph's file system component that provides a robust, fully-featured POSIX-compliant distributed file system. Internally, it maps files to Ceph objects and stores file metadata (for example, file ownership, directory paths, access permissions) in a separate data pool.

Terminology

Ceph uses the term *object* for the data that it stores. The daemon that is responsible for storing and managing data is the *Ceph OSD (Object Storage Daemon)*. Ceph's storage is divided into *pools*, which are logical partitions for storing objects. They are also referred to as *data pools*, *storage pools* or *OSD pools*.

A *CephFS file system* consists of two OSD storage pools, one for the actual data and one for the file metadata.

`cephfs` driver in LXD

Note: The `cephfs` driver can only be used for custom storage volumes with content type `filesystem`.

For other storage volumes, use the *Ceph* driver. That driver can also be used for custom storage volumes with content type `filesystem`, but it implements them through Ceph RBD images.

Unlike other storage drivers, this driver does not set up the storage system but assumes that you already have a Ceph cluster installed.

You can either create the CephFS file system that you want to use beforehand and specify it through the *`source`* option, or specify the *`cephfs.create_missing`* option to automatically create the file system and the data and metadata OSD pools (with the names given in *`cephfs.data_pool`* and *`cephfs.meta_pool`*).

This driver also behaves differently than other drivers in that it provides remote storage. As a result and depending on the internal network, storage access might be a bit slower than for local storage. On the other hand, using remote storage has big advantages in a cluster setup, because all cluster members have access to the same storage pools with the exact same contents, without the need to synchronize storage pools.

LXD assumes that it has full control over the OSD storage pool. Therefore, you should never maintain any file system entities that are not owned by LXD in a LXD OSD storage pool, because LXD might delete them.

The `cephfs` driver in LXD supports snapshots if snapshots are enabled on the server side.

Configuration options

The following configuration options are available for storage pools that use the `cephfs` driver and for storage volumes in these pools.

Storage pool configuration

`cephfs.cluster_name` Name of the Ceph cluster that contains the CephFS file system

Key:	`cephfs.cluster_name`
Type:	string
Default:	`ceph`

`cephfs.create_missing` Automatically create the CephFS file system

Key:	`cephfs.create_missing`
Type:	bool
Default:	`false`

Use this option if the CephFS file system does not exist yet. LXD will then automatically create the file system and the missing data and metadata OSD pools.

`cephfs.data_pool` Data OSD pool name

Key:	`cephfs.data_pool`
Type:	string

This option specifies the name for the data OSD pool that should be used when creating a file system automatically.

`cephfs.fscache` Enable use of kernel `fscache` and `cachefilesd`

Key:	`cephfs.fscache`
Type:	bool
Default:	`false`

`cephfs.meta_pool` Metadata OSD pool name

Key:	`cephfs.meta_pool`
Type:	string

This option specifies the name for the file metadata OSD pool that should be used when creating a file system automatically.

`cephfs.osd_pg_num` Number of placement groups when creating missing OSD pools

Key:	`cephfs.osd_pg_num`
Type:	string

This option specifies the number of OSD pool placement groups (`pg_num`) to use when creating a missing OSD pool.

`cephfs.path` The base path for the CephFS mount

Key:	`cephfs.path`
Type:	string
Default:	`/`

`cephfs.user.name` The Ceph user to use

Key:	`cephfs.user.name`
Type:	string
Default:	`admin`

`source` Existing CephFS file system or file system path to use

Key:	`source`
Type:	string

`volatile.pool.pristine` Whether the CephFS file system was empty on creation time

Key:	`volatile.pool.pristine`
Type:	string
Default:	`true`

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

Ceph Object - `cephobject`

Ceph is an open-source storage platform that stores its data in a storage cluster based on RADOS. It is highly scalable and, as a distributed system without a single point of failure, very reliable.

Tip: If you want to quickly set up a basic Ceph cluster, check out MicroCeph.

Ceph provides different components for block storage and for file systems.

Ceph Object Gateway is an object storage interface built on top of `librados` to provide applications with a RESTful gateway to Ceph Storage Clusters. It provides object storage functionality with an interface that is compatible with a large subset of the Amazon S3 RESTful API.

Terminology

Ceph uses the term *object* for the data that it stores. The daemon that is responsible for storing and managing data is the *Ceph OSD*. Ceph's storage is divided into *pools*, which are logical partitions for storing objects. They are also referred to as *data pools*, *storage pools* or *OSD pools*.

A *Ceph Object Gateway* consists of several OSD pools and one or more *Ceph Object Gateway daemon* (`radosgw`) processes that provide object gateway functionality.

`cephobject` driver in LXD

Note: The `cephobject` driver can only be used for buckets.

For storage volumes, use the *Ceph* or *CephFS* drivers.

Unlike other storage drivers, this driver does not set up the storage system but assumes that you already have a Ceph cluster installed.

You must set up a `radosgw` environment beforehand and ensure that its HTTP/HTTPS endpoint URL is reachable from the LXD server or servers. See Manual Deployment for information on how to set up a Ceph cluster and Ceph Object Gateway on how to set up a `radosgw` environment.

The `radosgw` URL can be specified at pool creation time using the *`cephobject.radosgw.endpoint`* option.

LXD uses the `radosgw-admin` command to manage buckets. So this command must be available and operational on the LXD servers.

This driver also behaves differently than other drivers in that it provides remote storage. As a result and depending on the internal network, storage access might be a bit slower than for local storage. On the other hand, using remote storage has big advantages in a cluster setup, because all cluster members have access to the same storage pools with the exact same contents, without the need to synchronize storage pools.

LXD assumes that it has full control over the OSD storage pool. Therefore, you should never maintain any file system entities that are not owned by LXD in a LXD OSD storage pool, because LXD might delete them.

Configuration options

The following configuration options are available for storage pools that use the `cephobject` driver and for storage buckets in these pools.

Storage pool configuration

`cephobject.bucket.name_prefix` Prefix to add to bucket names in Ceph

Key:	`cephobject.bucket.name_prefix`
Type:	string

`cephobject.cluster_name` The Ceph cluster to use

Key:	`cephobject.cluster_name`
Type:	string

`cephobject.radosgw.endpoint` URL of the `radosgw` gateway process

Key:	`cephobject.radosgw.endpoint`
Type:	string

`cephobject.radosgw.endpoint_cert_file` TLS client certificate to use for endpoint communication

Key:	`cephobject.radosgw.endpoint_cert_file`
Type:	string

Specify the path to the file that contains the TLS client certificate.

`cephobject.user.name` The Ceph user to use

Key:	`cephobject.user.name`
Type:	string
Default:	`admin`

`volatile.pool.pristine` Whether the `radosgw` `lxd-admin` user existed at creation time

Key:	`volatile.pool.pristine`
Type:	string
Default:	`true`

Storage bucket configuration

`size` Quota of the storage bucket

Key:	`size`
Type:	string

Ceph RBD - `ceph`

Ceph is an open-source storage platform that stores its data in a storage cluster based on RADOS. It is highly scalable and, as a distributed system without a single point of failure, very reliable.

Tip: If you want to quickly set up a basic Ceph cluster, check out MicroCeph.

Ceph provides different components for block storage and for file systems.

Ceph RBD (RADOS Block Device) is Ceph's block storage component that distributes data and workload across the Ceph cluster. It uses thin provisioning, which means that it is possible to over-commit resources.

Terminology

Ceph uses the term *object* for the data that it stores. The daemon that is responsible for storing and managing data is the *Ceph OSD*. Ceph's storage is divided into *pools*, which are logical partitions for storing objects. They are also referred to as *data pools*, *storage pools* or *OSD pools*.

Ceph block devices are also called *RBD images*, and you can create *snapshots* and *clones* of these RBD images.

`ceph` driver in LXD

Note: To use the Ceph RBD driver, you must specify it as `ceph`. This is slightly misleading, because it uses only Ceph RBD (block storage) functionality, not full Ceph functionality. For storage volumes with content type `filesystem` (images, containers and custom file-system volumes), the `ceph` driver uses Ceph RBD images with a file system on top (see *`block.filesystem`*).

Alternatively, you can use the *CephFS* driver to create storage volumes with content type `filesystem`.

Unlike other storage drivers, this driver does not set up the storage system but assumes that you already have a Ceph cluster installed.

This driver also behaves differently than other drivers in that it provides remote storage. As a result and depending on the internal network, storage access might be a bit slower than for local storage. On the other hand, using remote storage has big advantages in a cluster setup, because all cluster members have access to the same storage pools with the exact same contents, without the need to synchronize storage pools.

The `ceph` driver in LXD uses RBD images for images, and snapshots and clones to create instances and snapshots.

LXD assumes that it has full control over the OSD storage pool. Therefore, you should never maintain any file system entities that are not owned by LXD in a LXD OSD storage pool, because LXD might delete them.

Due to the way copy-on-write works in Ceph RBD, parent RBD images can't be removed until all children are gone. As a result, LXD automatically renames any objects that are removed but still referenced. Such objects are kept with a `zombie_` prefix until all references are gone and the object can safely be removed.

Limitations

The `ceph` driver has the following limitations:

Sharing custom volumes between instances
: Custom storage volumes with *content type* `filesystem` can usually be shared between multiple instances different cluster members. However, because the Ceph RBD driver "simulates" volumes with content type `filesystem` by putting a file system on top of an RBD image, custom storage volumes can only be assigned to a single instance at a time. If you need to share a custom volume with content type `filesystem`, use the *CephFS* driver instead.

Sharing the OSD storage pool between installations
: Sharing the same OSD storage pool between multiple LXD installations is not supported.

Using an OSD pool of type "erasure"
: To use a Ceph OSD pool of type "erasure", you must create the OSD pool beforehand. You must also create a separate OSD pool of type "replicated" that will be used for storing metadata. This is required because Ceph RBD does not support `omap`. To specify which pool is "erasure coded", set the *`ceph.osd.data_pool_name`* configuration option to the erasure coded pool name and the *`source`* configuration option to the replicated pool name.

Configuration options

The following configuration options are available for storage pools that use the `ceph` driver and for storage volumes in these pools.

Storage pool configuration

`ceph.cluster_name` Name of the Ceph cluster in which to create new storage pools

Key:	`ceph.cluster_name`
Type:	string
Default:	`ceph`

`ceph.osd.data_pool_name` Name of the OSD data pool

Key:	`ceph.osd.data_pool_name`
Type:	string

`ceph.osd.pg_num` Number of placement groups for the OSD storage pool

Key:	`ceph.osd.pg_num`
Type:	string
Default:	`32`

`ceph.osd.pool_name` Name of the OSD storage pool

Key:	`ceph.osd.pool_name`
Type:	string
Default:	name of the pool

`ceph.rbd.clone_copy` Whether to use RBD lightweight clones

Key:	`ceph.rbd.clone_copy`
Type:	bool
Default:	`true`

Enable this option to use RBD lightweight clones rather than full dataset copies.

`ceph.rbd.du` Whether to use RBD `du`

Key:	`ceph.rbd.du`
Type:	bool
Default:	`true`

This option specifies whether to use RBD `du` to obtain disk usage data for stopped instances.

`ceph.rbd.features` Comma-separated list of RBD features to enable on the volumes

Key:	`ceph.rbd.features`
Type:	string
Default:	`layering`

`ceph.user.name` The Ceph user to use when creating storage pools and volumes

Key:	`ceph.user.name`
Type:	string
Default:	`admin`

`source` Existing OSD storage pool to use

Key:	`source`
Type:	string

`volatile.pool.pristine` Whether the pool was empty on creation time

Key:	`volatile.pool.pristine`
Type:	string
Default:	`true`

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`block.filesystem` File system of the storage volume

Key:	`block.filesystem`
Type:	string
Default:	same as `volume.block.filesystem`
Condition:	block-based volume with content type `filesystem`

Valid options are: `btrfs`, `ext4`, `xfs` If not set, `ext4` is assumed.

`block.mount_options` Mount options for block-backed file system volumes

Key:	`block.mount_options`
Type:	string
Default:	same as `volume.block.mount_options`
Condition:	block-based volume with content type `filesystem`

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

Dell PowerFlex - `powerflex`

Dell PowerFlex is a software-defined storage solution from Dell Technologies. Among other things it offers the consumption of redundant block storage across the network.

LXD offers access to PowerFlex storage clusters by making use of the NVMe/TCP transport protocol. In addition, PowerFlex offers copy-on-write snapshots, thin provisioning and other features.

To use PowerFlex, make sure you have the required kernel modules installed on your host system. On Ubuntu these are `nvme_fabrics` and `nvme_tcp`, which come bundled in the `linux-modules-extra-$(uname -r)` package.

Terminology

PowerFlex groups various so-called SDS (storage data servers) under logical groups within a protection domain. Those SDS are the hosts that contribute storage capacity to the PowerFlex cluster. A *protection domain* contains storage pools, which represent a set of physical storage devices from different SDS. LXD creates its volumes in those storage pools.

You can take a snapshot of any volume in PowerFlex, which will create an independent copy of the parent volume. PowerFlex volumes get added as a NVMe drive to the respective LXD host the volume got mapped to. For this, the LXD host connects to one or multiple NVMe SDT (storage data targets) provided by PowerFlex. Those SDT run as components on the PowerFlex storage layer.

`powerflex` driver in LXD

The `powerflex` driver in LXD uses PowerFlex volumes for custom storage volumes, instances and snapshots. For storage volumes with content type `filesystem` (containers and custom file-system volumes), the `powerflex` driver uses volumes with a file system on top (see *`block.filesystem`*). By default, LXD creates thin-provisioned PowerFlex volumes.

LXD expects the PowerFlex protection domain and storage pool already to be set up. Furthermore, LXD assumes that it has full control over the storage pool. Therefore, you should never maintain any volumes that are not owned by LXD in a PowerFlex storage pool, because LXD might delete them.

This driver behaves differently than some of the other drivers in that it provides remote storage. As a result and depending on the internal network, storage access might be a bit slower than for local storage. On the other hand, using remote storage has big advantages in a cluster setup, because all cluster members have access to the same storage pools with the exact same contents, without the need to synchronize storage pools.

When creating a new storage pool using the `powerflex` driver, LXD tries to discover one of the SDT from the given storage pool. Alternatively, you can specify which SDT to use with *`powerflex.sdt`*. LXD instructs the NVMe initiator to connect to all the other SDT when first connecting to the subsystem.

Due to the way copy-on-write works in PowerFlex, snapshots of any volume don't rely on its parent. As a result, volume snapshots are fully functional volumes themselves, and it's possible to take additional snapshots from such volume snapshots. This tree of dependencies is called the *PowerFlex vTree*. Both volumes and their snapshots get added as standalone NVMe disks to the LXD host.

Volume names

Due to a *limitation* in PowerFlex, volume names cannot exceed 31 characters. Therefore the driver is using the volume's *`volatile.uuid`* to generate a fixed length volume name. A UUID of `5a2504b0-6a6c-4849-8ee7-ddb0b674fd14` will render to the base64-encoded string `WiUEsGpsSEmO592wtnT9FA==`.

To be able to identify the volume types and snapshots, special identifiers are prepended to the volume names:

Type	Identifier	Example
Container	`c_`	`c_WiUEsGpsSEmO592wtnT9FA==`
Virtual machine	`v_`	`v_WiUEsGpsSEmO592wtnT9FA==.b`
Image (ISO)	`i_`	`i_WiUEsGpsSEmO592wtnT9FA==.i`
Custom volume	`u_`	`u_WiUEsGpsSEmO592wtnT9FA==`

Limitations

The `powerflex` driver has the following limitations:

Limit of snapshots in a single vTree
An internal limitation in the PowerFlex vTree does not allow to take more than 126 snapshots of any volume in PowerFlex. This limit also applies to any child of any of the parent volume's snapshots. A single vTree can only have 126 branches.

Non-optimized image storage
Due to the limit of 126 snapshots in the vTree, the PowerFlex driver doesn't come with support for optimized image storage. This would limit LXD to create only 126 instances from an image. Instead, when launching a new instance, the image's contents get copied to the instance's root volume.

Copying volumes
PowerFlex does not support creating a copy of the volume so that it gets its own vTree. Therefore, LXD falls back to copying the volume on the local system. This implicates an increased use of bandwidth due to the volume's contents being transferred over the network twice.

Volume size constraints
In PowerFlex, the size of a volume must be in multiples of 8 GiB. This results in the smallest possible volume size of 8 GiB. However, if not specified otherwise, volumes are getting thin-provisioned by LXD. PowerFlex volumes can only be increased in size.

Sharing custom volumes between instances
The PowerFlex driver "simulates" volumes with content type `filesystem` by putting a file system on top of a PowerFlex volume. Therefore, custom storage volumes can only be assigned to a single instance at a time.

Sharing the PowerFlex storage pool between installations
Sharing the same PowerFlex storage pool between multiple LXD installations is not supported.

Recovering PowerFlex storage pools
Recovery of PowerFlex storage pools using `lxd recover` is not supported.

Configuration options

The following configuration options are available for storage pools that use the `powerflex` driver and for storage volumes in these pools.

Storage pool configuration

`powerflex.clone_copy` Whether to use non-sparse copies for snapshots

Key:	`powerflex.clone_copy`
Type:	bool
Default:	`true`

If this option is set to `true`, PowerFlex makes a non-sparse copy when creating a snapshot of an instance or custom volume. See *Limitations* for more information.

`powerflex.domain` Name of the PowerFlex protection domain

Key:	`powerflex.domain`
Type:	string

This option is required only if *powerflex.pool* is specified using its name.

`powerflex.gateway` Address of the PowerFlex Gateway

Key:	`powerflex.gateway`
Type:	string

`powerflex.gateway.verify` Whether to verify the PowerFlex Gateway's certificate

Key:	`powerflex.gateway.verify`
Type:	bool
Default:	`true`

`powerflex.mode` How volumes are mapped to the local server

Key:	`powerflex.mode`
Type:	string
Default:	the discovered mode

The mode gets discovered automatically if the system provides the necessary kernel modules. Currently, only `nvme` is supported.

`powerflex.pool` ID of the PowerFlex storage pool

Key:	`powerflex.pool`
Type:	string

If you want to specify the storage pool via its name, also set *powerflex.domain*.

`powerflex.sdt` PowerFlex NVMe/TCP SDT

Key:	`powerflex.sdt`
Type:	string
Default:	one of the SDT

`powerflex.user.name` User for PowerFlex Gateway authentication

Key:	`powerflex.user.name`
Type:	string
Default:	`admin`

`powerflex.user.password` Password for PowerFlex Gateway authentication

Key:	`powerflex.user.password`
Type:	string

`rsync.bwlimit` Upper limit on the socket I/O for `rsync`

Key:	rsync.bwlimit
Type:	string
Default:	0 (no limit)

When rsync must be used to transfer storage entities, this option specifies the upper limit to be placed on the socket I/O.

rsync.compression Whether to use compression while migrating storage pools

Key:	rsync.compression
Type:	bool
Default:	true

volume.size Size/quota of the storage volume

Key:	volume.size
Type:	string
Default:	8GiB

The size must be in multiples of 8 GiB. See *Limitations* for more information.

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

block.filesystem File system of the storage volume

Key:	block.filesystem
Type:	string
Default:	same as volume.block.filesystem
Condition:	block-based volume with content type filesystem

Valid options are: btrfs, ext4, xfs If not set, ext4 is assumed.

block.mount_options Mount options for block-backed file system volumes

Key:	block.mount_options
Type:	string
Default:	same as volume.block.mount_options
Condition:	block-based volume with content type filesystem

block.type Whether to create a thin or thick provisioned volume

Key:	block.type
Type:	string
Default:	same as volume.block.type or thick

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`

The size must be in multiples of 8 GiB. See *Limitations* for more information.

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

Directory - `dir`

The directory storage driver is a basic backend that stores its data in a standard file and directory structure. This driver is quick to set up and allows inspecting the files directly on the disk, which can be convenient for testing. However, LXD operations are *not optimized* for this driver.

`dir` driver in LXD

The `dir` driver in LXD is fully functional and provides the same set of features as other drivers. However, it is much slower than all the other drivers because it must unpack images and do instant copies of instances, snapshots and images.

Unless specified differently during creation (with the `source` configuration option), the data is stored in the `/var/snap/lxd/common/lxd/storage-pools/` (for snap installations) or `/var/lib/lxd/storage-pools/` directory.

Quotas

The `dir` driver supports storage quotas when running on either ext4 or XFS with project quotas enabled at the file system level.

Configuration options

The following configuration options are available for storage pools that use the `dir` driver and for storage volumes in these pools.

Storage pool configuration

`rsync.bwlimit` Upper limit on the socket I/O for `rsync`

Key:	`rsync.bwlimit`
Type:	string
Default:	`0` (no limit)

When `rsync` must be used to transfer storage entities, this option specifies the upper limit to be placed on the socket I/O.

`rsync.compression` Whether to use compression while migrating storage pools

Key:	`rsync.compression`
Type:	bool
Default:	`true`

`source` Path to an existing directory

Key:	`source`
Type:	string

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	size
Type:	string
Default:	same as volume.size
Condition:	appropriate driver

snapshots.expiry When snapshots are to be deleted

Key:	snapshots.expiry
Type:	string
Default:	same as volume.snapshots.expiry
Condition:	custom volume

Specify an expression like 1M 2H 3d 4w 5m 6y.

snapshots.pattern Template for the snapshot name

Key:	snapshots.pattern
Type:	string
Default:	same as volume.snapshots.pattern or snap%d
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The snapshots.pattern option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable creation_date. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set snapshots.pattern to {{ creation_date|date:'2006-01-02_15-04-05' }} to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder %d in the pattern. For the first snapshot, the placeholder is replaced with 0. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

snapshots.schedule Schedule for automatic volume snapshots

Key:	snapshots.schedule
Type:	string
Default:	same as snapshots.schedule
Condition:	custom volume

Specify either a cron expression (<minute> <hour> <dom> <month> <dow>), a comma-separated list of schedule aliases (@hourly, @daily, @midnight, @weekly, @monthly, @annually, @yearly), or leave empty to disable automatic snapshots (the default).

volatile.uuid The volume's UUID

Key:	volatile.uuid
Type:	string
Default:	random UUID

Storage bucket configuration

To enable storage buckets for local storage pool drivers and allow applications to access the buckets via the S3 protocol, you must configure the *core.storage_buckets_address* server setting.

Storage buckets do not have any configuration for `dir` pools. Unlike the other storage pool drivers, the `dir` driver does not support bucket quotas via the `size` setting.

LVM - `lvm`

LVM (Logical Volume Manager) is a storage management framework rather than a file system. It is used to manage physical storage devices, allowing you to create a number of logical storage volumes that use and virtualize the underlying physical storage devices.

Note that it is possible to over-commit the physical storage in the process, to allow flexibility for scenarios where not all available storage is in use at the same time.

To use LVM, make sure you have `lvm2` installed on your machine.

Terminology

LVM can combine several physical storage devices into a *volume group*. You can then allocate *logical volumes* of different types from this volume group.

One supported volume type is a *thin pool*, which allows over-committing the resources by creating thinly provisioned volumes whose total allowed maximum size is larger than the available physical storage. Another type is a *volume snapshot*, which captures a specific state of a logical volume.

`lvm` driver in LXD

The `lvm` driver in LXD uses logical volumes for images, and volume snapshots for instances and snapshots.

LXD assumes that it has full control over the volume group. Therefore, you should not maintain any file system entities that are not owned by LXD in an LVM volume group, because LXD might delete them. However, if you need to reuse an existing volume group (for example, because your setup has only one volume group), you can do so by setting the *lvm.vg.force_reuse* configuration.

By default, LVM storage pools use an LVM thin pool and create logical volumes for all LXD storage entities (images, instances and custom volumes) in there. This behavior can be changed by setting *lvm.use_thinpool* to `false` when you create the pool. In this case, LXD uses "normal" logical volumes for all storage entities that are not snapshots. Note that this entails serious performance and space reductions for the `lvm` driver (close to the `dir` driver both in speed and storage usage). The reason for this is that most storage operations must fall back to using `rsync`, because logical volumes that are not thin pools do not support snapshots of snapshots. In addition, non-thin snapshots take up much more storage space than thin snapshots, because they must reserve space for their maximum size at creation time. Therefore, this option should only be chosen if the use case requires it.

For environments with a high instance turnover (for example, continuous integration) you should tweak the backup `retain_min` and `retain_days` settings in `/etc/lvm/lvm.conf` to avoid slowdowns when interacting with LXD.

Configuration options

The following configuration options are available for storage pools that use the `lvm` driver and for storage volumes in these pools.

Storage pool configuration

`lvm.thinpool_metadata_size` The size of the thin pool metadata volume

Key:	`lvm.thinpool_metadata_size`
Type:	string
Default:	`0` (auto)

By default, LVM calculates an appropriate size.

`lvm.thinpool_name` Thin pool where volumes are created

Key:	`lvm.thinpool_name`
Type:	string
Default:	`LXDThinPool`

`lvm.use_thinpool` Whether the storage pool uses a thin pool for logical volumes

Key:	`lvm.use_thinpool`
Type:	bool
Default:	`true`

`lvm.vg.force_reuse` Force using an existing non-empty volume group

Key:	`lvm.vg.force_reuse`
Type:	bool
Default:	`false`

`lvm.vg_name` Name of the volume group to create

Key:	`lvm.vg_name`
Type:	string
Default:	name of the pool

`rsync.bwlimit` Upper limit on the socket I/O for `rsync`

Key:	`rsync.bwlimit`
Type:	string
Default:	`0` (no limit)

When `rsync` must be used to transfer storage entities, this option specifies the upper limit to be placed on the socket I/O.

`rsync.compression` Whether to use compression while migrating storage pools

Key:	`rsync.compression`
Type:	bool
Default:	`true`

`size` Size of the storage pool (for loop-based pools)

Key:	`size`
Type:	string
Default:	auto (20% of free disk space, >= 5 GiB and <= 30 GiB)

When creating loop-based pools, specify the size in bytes (*suffixes* are supported). You can increase the size to grow the storage pool.

The default (`auto`) creates a storage pool that uses 20% of the free disk space, with a minimum of 5 GiB and a maximum of 30 GiB.

`source` Path to an existing block device, loop file, or LVM volume group

Key:	`source`
Type:	string

`source.wipe` Whether to wipe the block device before creating the pool

Key:	`source.wipe`
Type:	bool
Default:	`false`

Set this option to `true` to wipe the block device specified in `source` prior to creating the storage pool.

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`block.filesystem` File system of the storage volume

Key:	`block.filesystem`
Type:	string
Default:	same as `volume.block.filesystem`
Condition:	block-based volume with content type `filesystem`

Valid options are: `btrfs`, `ext4`, `xfs` If not set, `ext4` is assumed.

`block.mount_options` Mount options for block-backed file system volumes

Key:	`block.mount_options`
Type:	string
Default:	same as `volume.block.mount_options`
Condition:	block-based volume with content type `filesystem`

`lvm.stripes` Number of stripes to use for new volumes (or thin pool volume)

Key:	`lvm.stripes`
Type:	string
Default:	same as `volume.lvm.stripes`

`lvm.stripes.size` Size of stripes to use

Key:	`lvm.stripes.size`
Type:	string
Default:	same as `volume.lvm.stripes.size`

The size must be at least 4096 bytes, and a multiple of 512 bytes.

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

Storage bucket configuration

To enable storage buckets for local storage pool drivers and allow applications to access the buckets via the S3 protocol, you must configure the *`core.storage_buckets_address`* server setting. `size` Size/quota of the storage bucket

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

ZFS - `zfs`

ZFS (Zettabyte file system) combines both physical volume management and a file system. A ZFS installation can span across a series of storage devices and is very scalable, allowing you to add disks to expand the available space in the storage pool immediately.

ZFS is a block-based file system that protects against data corruption by using checksums to verify, confirm and correct every operation. To run at a sufficient speed, this mechanism requires a powerful environment with a lot of RAM.

In addition, ZFS offers snapshots and replication, RAID management, copy-on-write clones, compression and other features.

To use ZFS, make sure you have `zfsutils-linux` installed on your machine.

Terminology

ZFS creates logical units based on physical storage devices. These logical units are called *ZFS pools* or *zpools*. Each zpool is then divided into a number of . These can be of different types:

- A can be seen as a partition or a mounted file system.
- A *ZFS volume* represents a block device.
- A *ZFS snapshot* captures a specific state of either a or a ZFS volume. ZFS snapshots are read-only.
- A *ZFS clone* is a writable copy of a ZFS snapshot.

`zfs` driver in LXD

The `zfs` driver in LXD uses and ZFS volumes for images and custom storage volumes, and ZFS snapshots and clones to create instances from images and for instance and custom volume snapshots. By default, LXD enables compression when creating a ZFS pool.

LXD assumes that it has full control over the ZFS pool and . Therefore, you should never maintain any or file system entities that are not owned by LXD in a ZFS pool or , because LXD might delete them.

Due to the way copy-on-write works in ZFS, parent can't be removed until all children are gone. As a result, LXD automatically renames any objects that are removed but still referenced. Such objects are kept at a random `deleted/` path until all references are gone and the object can safely be removed. Note that this method might have ramifications for restoring snapshots. See *Limitations* below.

LXD automatically enables trimming support on all newly created pools on ZFS 0.8 or later. This increases the lifetime of SSDs by allowing better block re-use by the controller, and it also allows to free space on the root file system when using a loop-backed ZFS pool. If you are running a ZFS version earlier than 0.8 and want to enable trimming, upgrade to at least version 0.8. Then use the following commands to make sure that trimming is automatically enabled for the ZFS pool in the future and trim all currently unused space:

```
zpool upgrade ZPOOL-NAME
zpool set autotrim=on ZPOOL-NAME
zpool trim ZPOOL-NAME
```

Limitations

The `zfs` driver has the following limitations:

Restoring from older snapshots
: ZFS doesn't support restoring from snapshots other than the latest one. You can, however, create new instances from older snapshots. This method makes it possible to confirm whether a specific snapshot contains what you need. After determining the correct snapshot, you can *remove the newer snapshots* so that the snapshot you need is the latest one and you can restore it.

  Alternatively, you can configure LXD to automatically discard the newer snapshots during restore. To do so, set the *`zfs.remove_snapshots`* configuration for the volume (or the corresponding `volume.zfs.remove_snapshots` configuration on the storage pool for all volumes in the pool).

  Note, however, that if *`zfs.clone_copy`* is set to `true`, instance copies use ZFS snapshots too. In that case, you cannot restore an instance to a snapshot taken before the last copy without having to also delete all its descendants. If this is not an option, you can copy the wanted snapshot into a new instance and then delete the old instance. You will, however, lose any other snapshots the instance might have had.

Observing I/O quotas
: I/O quotas are unlikely to affect very much. That's because ZFS is a port of a Solaris module (using SPL) and not a native Linux file system using the Linux VFS API, which is where I/O limits are applied.

Feature support in ZFS
: Some features, like the use of idmaps or delegation of a ZFS dataset, require ZFS 2.2 or higher and are therefore not widely available yet.

Quotas

ZFS provides two different quota properties: `quota` and `refquota`. `quota` restricts the total size of a , including its snapshots and clones. `refquota` restricts only the size of the data in the , not its snapshots and clones.

By default, LXD uses the `quota` property when you set up a quota for your storage volume. If you want to use the `refquota` property instead, set the *`zfs.use_refquota`* configuration for the volume (or the corresponding `volume.zfs.use_refquota` configuration on the storage pool for all volumes in the pool).

You can also set the *`zfs.reserve_space`* (or `volume.zfs.reserve_space`) configuration to use ZFS `reservation` or `refreservation` along with `quota` or `refquota`.

Configuration options

The following configuration options are available for storage pools that use the `zfs` driver and for storage volumes in these pools.

Storage pool configuration

`size` Size of the storage pool (for loop-based pools)

Key:	`size`
Type:	string
Default:	auto (20% of free disk space, >= 5 GiB and <= 30 GiB)

When creating loop-based pools, specify the size in bytes (*suffixes* are supported). You can increase the size to grow the storage pool.

The default (`auto`) creates a storage pool that uses 20% of the free disk space, with a minimum of 5 GiB and a maximum of 30 GiB.

`source` Path to an existing block device, loop file, or ZFS dataset/pool

Key:	`source`
Type:	string

`source.wipe` Whether to wipe the block device before creating the pool

Key:	`source.wipe`
Type:	bool
Default:	`false`

Set this option to `true` to wipe the block device specified in `source` prior to creating the storage pool.

`zfs.clone_copy` Whether to use ZFS lightweight clones

Key:	`zfs.clone_copy`
Type:	string
Default:	`true`

Set this option to `true` or `false` to enable or disable using ZFS lightweight clones rather than full dataset copies. Set the option to `rebase` to copy based on the initial image.

`zfs.export` Disable zpool export while an unmount is being performed

Key:	`zfs.export`
Type:	bool
Default:	`true`

`zfs.pool_name` Name of the zpool

Key:	`zfs.pool_name`
Type:	string
Default:	name of the pool

Tip: In addition to these configurations, you can also set default values for the storage volume configurations. See *Configure default values for storage volumes*.

Storage volume configuration

`block.filesystem` File system of the storage volume

Key:	`block.filesystem`
Type:	string
Default:	same as `volume.block.filesystem`
Condition:	block-based volume with content type `filesystem` (`zfs.block_mode` enabled)

Valid options are: `btrfs`, `ext4`, `xfs` If not set, `ext4` is assumed.

`block.mount_options` Mount options for block-backed file system volumes

Key:	`block.mount_options`
Type:	string
Default:	same as `volume.block.mount_options`
Condition:	block-based volume with content type `filesystem` (`zfs.block_mode` enabled)

`security.shifted` Enable ID shifting overlay

Key:	`security.shifted`
Type:	bool
Default:	same as `volume.security.shifted` or `false`
Condition:	custom volume

Enabling this option allows attaching the volume to multiple isolated instances.

`security.unmapped` Disable ID mapping for the volume

Key:	`security.unmapped`
Type:	bool
Default:	same as `volume.security.unmappped` or `false`
Condition:	custom volume

`size` Size/quota of the storage volume

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

`snapshots.expiry` When snapshots are to be deleted

Key:	`snapshots.expiry`
Type:	string
Default:	same as `volume.snapshots.expiry`
Condition:	custom volume

Specify an expression like `1M 2H 3d 4w 5m 6y`.

`snapshots.pattern` Template for the snapshot name

Key:	`snapshots.pattern`
Type:	string
Default:	same as `volume.snapshots.pattern` or `snap%d`
Condition:	custom volume

You can specify a naming template that is used for scheduled snapshots and unnamed snapshots.

The `snapshots.pattern` option takes a Pongo2 template string to format the snapshot name.

To add a time stamp to the snapshot name, use the Pongo2 context variable `creation_date`. Make sure to format the date in your template string to avoid forbidden characters in the snapshot name. For example, set `snapshots.pattern` to `{{ creation_date|date:'2006-01-02_15-04-05' }}` to name the snapshots after their time of creation, down to the precision of a second.

Another way to avoid name collisions is to use the placeholder `%d` in the pattern. For the first snapshot, the placeholder is replaced with `0`. For subsequent snapshots, the existing snapshot names are taken into account to find the highest number at the placeholder's position. This number is then incremented by one for the new name.

`snapshots.schedule` Schedule for automatic volume snapshots

Key:	`snapshots.schedule`
Type:	string
Default:	same as `snapshots.schedule`
Condition:	custom volume

Specify either a cron expression (`<minute> <hour> <dom> <month> <dow>`), a comma-separated list of schedule aliases (`@hourly`, `@daily`, `@midnight`, `@weekly`, `@monthly`, `@annually`, `@yearly`), or leave empty to disable automatic snapshots (the default).

`volatile.uuid` The volume's UUID

Key:	`volatile.uuid`
Type:	string
Default:	random UUID

`zfs.block_mode` Whether to use a formatted `zvol` rather than a dataset

Key:	`zfs.block_mode`
Type:	bool
Default:	same as `volume.zfs.block_mode`

`zfs.block_mode` can be set only for custom storage volumes. To enable ZFS block mode for all storage volumes in the pool, including instance volumes, use `volume.zfs.block_mode`.

`zfs.blocksize` Size of the ZFS block

Key:	`zfs.blocksize`
Type:	string
Default:	same as `volume.zfs.blocksize`

The size must be between 512 bytes and 16 MiB and must be a power of 2. For a block volume, a maximum value of 128 KiB will be used even if a higher value is set.

Depending on the value of *zfs.block_mode*, the specified size is used to set either `volblocksize` or `recordsize` in ZFS.

`zfs.delegate` Whether to delegate the ZFS dataset

Key:	`zfs.delegate`
Type:	bool
Default:	same as `volume.zfs.delegate`
Condition:	ZFS 2.2 or higher

This option controls whether to delegate the ZFS dataset and anything underneath it to the container or containers that use it. This allows using the `zfs` command in the container.

`zfs.remove_snapshots` Remove snapshots as needed

Key:	`zfs.remove_snapshots`
Type:	bool
Default:	same as `volume.zfs.remove_snapshots` or `false`

`zfs.reserve_space` Use `reservation`/`refreservation` along with `quota`/`refquota`

Key:	`zfs.reserve_space`
Type:	bool
Default:	same as `volume.zfs.reserve_space` or `false`

`zfs.use_refquota` Use `refquota` instead of `quota` for space

Key:	`zfs.use_refquota`
Type:	bool
Default:	same as `volume.zfs.use_refquota` or `false`

Storage bucket configuration

To enable storage buckets for local storage pool drivers and allow applications to access the buckets via the S3 protocol, you must configure the *core.storage_buckets_address* server setting. `size` Size/quota of the storage bucket

Key:	`size`
Type:	string
Default:	same as `volume.size`
Condition:	appropriate driver

See the corresponding pages for driver-specific information and configuration options.

Feature comparison

Where possible, LXD uses the advanced features of each storage system to optimize operations.

Feature	Directory	Btrfs	LVM	ZFS	Ceph RBD	CephFS	Ceph Object	Dell PowerFlex
Optimized image storage	no	yes	yes	yes	yes	n/a	n/a	no
Optimized instance creation	no	yes	yes	yes	yes	n/a	n/a	no
Optimized snapshot creation	no	yes	yes	yes	yes	yes	n/a	yes
Optimized image transfer	no	yes	no	yes	yes	n/a	n/a	no
Optimized volume transfer	no	yes	no	yes	yes[1]	n/a	n/a	no
Optimized volume refresh	no	yes	yes[2]	yes	yes[3]	n/a	n/a	no
Copy on write	no	yes	yes	yes	yes	yes	n/a	yes
Block based	no	no	yes	no	yes	no	n/a	yes
Instant cloning	no	yes	yes	yes	yes	yes	n/a	no
Storage driver usable inside a container	yes	yes	no	yes[4]	no	n/a	n/a	no
Restore from older snapshots (not latest)	yes	yes	yes	no	yes	yes	n/a	yes
Storage quotas	yes[5]	yes	yes	yes	yes	yes	yes	yes
Available on `lxd init`	yes	yes	yes	yes	yes	no	no	no
Object storage	yes	yes	yes	yes	no	no	yes	no

Optimized image storage

Most of the storage drivers have some kind of optimized image storage format. To make instance creation near instantaneous, LXD clones a pre-made image volume when creating an instance rather than unpacking the image tarball from scratch.

To prevent preparing such a volume on a storage pool that might never be used with that image, the volume is generated on demand. Therefore, the first instance takes longer to create than subsequent ones.

Optimized volume transfer

Btrfs, ZFS and Ceph RBD have an internal send/receive mechanism that allows for optimized volume transfer.

LXD uses this optimized transfer when transferring instances and snapshots between storage pools that use the same storage driver, if the storage driver supports optimized transfer and the optimized transfer is actually quicker. Otherwise, LXD uses `rsync` to transfer container and file system volumes, or raw block transfer to transfer virtual machine and custom block volumes.

The optimized transfer uses the underlying storage driver's native functionality for transferring data, which is usually faster than using `rsync` or raw block transfer.

[1] Volumes of type `block` will fall back to non-optimized transfer when migrating to an older LXD server that doesn't yet support the `RBD_AND_RSYNC` migration type.

[2] Requires *`lvm.use_thinpool`* to be enabled. Only when refreshing local volumes.

[3] Only for volumes of type `block`.

[4] Requires *`zfs.delegate`* to be enabled.

[5] The `dir` driver supports storage quotas when running on either ext4 or XFS with project quotas enabled at the file system level.

Optimized volume refresh

The full potential of the optimized transfer becomes apparent when refreshing a copy of an instance or custom volume that uses periodic snapshots. If the optimized transfer isn't supported by the driver or its implementation of volume refresh, instead of the delta, the entire volume including its snapshot(s) will be copied using either `rsync` or raw block transfer. LXD will try to keep the overhead low by transferring only the volume itself or any snapshots that are missing on the target.

When optimized refresh is available for an instance or custom volume, LXD bases the refresh on the latest snapshot, which means:

- When you take a first snapshot and refresh the copy, the transfer will take roughly the same time as a full copy. LXD transfers the new snapshot and the difference between the snapshot and the main volume.
- For subsequent snapshots, the transfer is considerably faster. LXD does not transfer the full new snapshot, but only the difference between the new snapshot and the latest snapshot that already exists on the target.
- When refreshing without a new snapshot, LXD transfers only the differences between the main volume and the latest snapshot on the target. This transfer is usually faster than using `rsync` (as long as the latest snapshot is not too outdated).

On the other hand, refreshing copies of instances without snapshots (either because the instance doesn't have any snapshots or because the refresh uses the `--instance-only` flag) would actually be slower than using `rsync` or raw block transfer. In such cases, the optimized transfer would transfer the difference between the (non-existent) latest snapshot and the main volume, thus the full volume. Therefore, LXD uses `rsync` or raw block transfer instead of the optimized transfer for refreshes without snapshots.

Recommended setup

The two best options for use with LXD are ZFS and Btrfs. They have similar functionalities, but ZFS is more reliable.

Whenever possible, you should dedicate a full disk or partition to your LXD storage pool. LXD allows to create loop-based storage, but this isn't recommended for production use. See *Data storage location* for more information.

The directory backend should be considered as a last resort option. It supports all main LXD features, but is slow and inefficient because it cannot perform instant copies or snapshots. Therefore, it constantly copies the instance's full storage.

Security considerations

Currently, the Linux kernel might silently ignore mount options and not apply them when a block-based file system (for example, `ext4`) is already mounted with different mount options. This means when dedicated disk devices are shared between different storage pools with different mount options set, the second mount might not have the expected mount options. This becomes security relevant when, for example, one storage pool is supposed to provide `acl` support and the second one is supposed to not provide `acl` support.

For this reason, it is currently recommended to either have dedicated disk devices per storage pool or to ensure that all storage pools that share the same dedicated disk device use the same mount options.

Related topics

How-to guides:

- *Storage*

Explanation:

- *About storage pools, volumes and buckets*

Networks

LXD supports different network types for *Managed networks*.

Fully controlled networks

Fully controlled networks create network interfaces and provide most functionality, including, for example, the ability to do IP management.

LXD supports the following network types:

Bridge network

As one of the possible network configuration types under LXD, LXD supports creating and managing network bridges.

A network bridge creates a virtual L2 Ethernet switch that instance NICs can connect to, making it possible for them to communicate with each other and the host. LXD bridges can leverage underlying native Linux bridges and Open vSwitch.

The `bridge` network type allows to create an L2 bridge that connects the instances that use it together into a single network L2 segment. Bridges created by LXD are managed, which means that in addition to creating the bridge interface itself, LXD also sets up a local `dnsmasq` process to provide DHCP, IPv6 route announcements and DNS services to the network. By default, it also performs NAT for the bridge.

See *How to configure your firewall* for instructions on how to configure your firewall to work with LXD bridge networks.

Note: Static DHCP assignments depend on the client using its MAC address as the DHCP identifier. This method prevents conflicting leases when copying an instance, and thus makes statically assigned leases work properly.

IPv6 prefix size

If you're using IPv6 for your bridge network, you should use a prefix size of 64.

Larger subnets (i.e., using a prefix smaller than 64) should work properly too, but they aren't typically that useful for SLAAC (Stateless Address Auto-configuration).

Smaller subnets are in theory possible (when using stateful DHCPv6 for IPv6 allocation), but they aren't properly supported by `dnsmasq` and might cause problems. If you must create a smaller subnet, use static allocation or another standalone router advertisement daemon.

Configuration options

The following configuration key namespaces are currently supported for the `bridge` network type:

- `bgp` (BGP peer configuration)
- `bridge` (L2 interface configuration)
- `dns` (DNS server and resolution configuration)
- `fan` (configuration specific to the Ubuntu FAN overlay)
- `ipv4` (L3 IPv4 configuration)
- `ipv6` (L3 IPv6 configuration)
- `maas` (MAAS network identification)
- `security` (network ACL configuration)
- `raw` (raw configuration file content)
- `tunnel` (cross-host tunneling configuration)
- `user` (free-form key/value for user metadata)

Note: LXD uses the CIDR notation where network subnet information is required, for example, `192.0.2.0/24` or `2001:db8::/32`. This does not apply to cases where a single address is required, for example, local/remote addresses of tunnels, NAT addresses or specific addresses to apply to an instance.

The following configuration options are available for the `bridge` network type: `bgp.ipv4.nexthop` Override the IPv4 next-hop for advertised prefixes

Key:	`bgp.ipv4.nexthop`
Type:	string
Default:	local address
Condition:	BGP server

`bgp.ipv6.nexthop` Override the IPv6 next-hop for advertised prefixes

Key:	`bgp.ipv6.nexthop`
Type:	string
Default:	local address
Condition:	BGP server

`bgp.peers.NAME.address` Peer address (IPv4 or IPv6)

Key:	`bgp.peers.NAME.address`
Type:	string
Condition:	BGP server

`bgp.peers.NAME.asn` Peer AS number

Key:	bgp.peers.NAME.asn
Type:	integer
Condition:	BGP server

bgp.peers.NAME.holdtime Peer session hold time

Key:	bgp.peers.NAME.holdtime
Type:	integer
Default:	180
Condition:	BGP server
Required:	no

Specify the hold time in seconds.

bgp.peers.NAME.password Peer session password

Key:	bgp.peers.NAME.password
Type:	string
Default:	(no password)
Condition:	BGP server
Required:	no

bridge.driver Bridge driver

Key:	bridge.driver
Type:	string
Default:	native

Possible values are native and openvswitch.

bridge.external_interfaces Unconfigured network interfaces to include in the bridge

Key:	bridge.external_interfaces
Type:	string

Specify a comma-separated list of unconfigured network interfaces to include in the bridge.

bridge.hwaddr MAC address for the bridge

Key:	bridge.hwaddr
Type:	string

bridge.mode Bridge operation mode

Key:	bridge.mode
Type:	string
Default:	standard

Possible values are `standard` and `fan`.

`bridge.mtu` Bridge MTU

Key:	`bridge.mtu`
Type:	integer
Default:	`1500` if `bridge.mode=standard`, `1480` if `bridge.mode=fan` and `fan.type=ipip`, or `1450` if `bridge.mode=fan` and `fan.type=vxlan`

The default value varies depending on whether the bridge uses a tunnel or a fan setup.

`dns.domain` Domain to advertise to DHCP clients and use for DNS resolution

Key:	`dns.domain`
Type:	string
Default:	`lxd`

`dns.mode` DNS registration mode

Key:	`dns.mode`
Type:	string
Default:	`managed`

Possible values are `none` for no DNS record, `managed` for LXD-generated static records, and `dynamic` for client-generated records.

`dns.search` Full domain search list

Key:	`dns.search`
Type:	string
Default:	`dns.domain` value

Specify a comma-separated list of domains.

`dns.zone.forward` DNS zone names for forward DNS records

Key:	`dns.zone.forward`
Type:	string

Specify a comma-separated list of DNS zone names.

`dns.zone.reverse.ipv4` DNS zone name for IPv4 reverse DNS records

Key:	`dns.zone.reverse.ipv4`
Type:	string

`dns.zone.reverse.ipv6` DNS zone name for IPv6 reverse DNS records

Key:	`dns.zone.reverse.ipv6`
Type:	string

`fan.overlay_subnet` Subnet to use as the overlay for the FAN

Key:	`fan.overlay_subnet`
Type:	string
Default:	`240.0.0.0/8`
Condition:	fan mode

Use CIDR notation.

`fan.type` Tunneling type for the FAN

Key:	`fan.type`
Type:	string
Default:	`vxlan`
Condition:	fan mode

Possible values are `vxlan` and `ipip`.

`fan.underlay_subnet` Subnet to use as the underlay for the FAN

Key:	`fan.underlay_subnet`
Type:	string
Default:	initial value on creation: `auto`
Condition:	fan mode

Use CIDR notation.

You can set the option to `auto` to use the default gateway subnet.

`ipv4.address` IPv4 address for the bridge

Key:	`ipv4.address`
Type:	string
Default:	initial value on creation: `auto`
Condition:	standard mode

Use CIDR notation.

You can set the option to `none` to turn off IPv4, or to `auto` to generate a new random unused subnet.

`ipv4.dhcp` Whether to allocate IPv4 addresses using DHCP

Key:	`ipv4.dhcp`
Type:	bool
Default:	`true`
Condition:	IPv4 address

`ipv4.dhcp.expiry` When to expire DHCP leases

Key:	ipv4.dhcp.expiry
Type:	string
Default:	1h
Condition:	IPv4 DHCP

ipv4.dhcp.gateway Address of the gateway for the IPv4 subnet

Key:	ipv4.dhcp.gateway
Type:	string
Default:	IPv4 address
Condition:	IPv4 DHCP

ipv4.dhcp.ranges IPv4 ranges to use for DHCP

Key:	ipv4.dhcp.ranges
Type:	string
Default:	all addresses
Condition:	IPv4 DHCP

Specify a comma-separated list of IPv4 ranges in FIRST-LAST format.

ipv4.firewall Whether to generate filtering firewall rules for this network

Key:	ipv4.firewall
Type:	bool
Default:	true
Condition:	IPv4 address

ipv4.nat Whether to use NAT for IPv4

Key:	ipv4.nat
Type:	bool
Default:	false (initial value on creation if ipv4.address is set to auto: true)
Condition:	IPv4 address

ipv4.nat.address Source address used for outbound traffic from the bridge

Key:	ipv4.nat.address
Type:	string
Condition:	IPv4 address

ipv4.nat.order Where to add the required NAT rules

Key:	ipv4.nat.order
Type:	string
Default:	before
Condition:	IPv4 address

Set this option to `before` to add the NAT rules before any pre-existing rules, or to `after` to add them after the pre-existing rules.

`ipv4.ovn.ranges` IPv4 ranges to use for child OVN network routers

Key:	`ipv4.ovn.ranges`
Type:	string

Specify a comma-separated list of IPv4 ranges in FIRST-LAST format.

`ipv4.routes` Additional IPv4 CIDR subnets to route to the bridge

Key:	`ipv4.routes`
Type:	string
Condition:	IPv4 address

Specify a comma-separated list of IPv4 CIDR subnets.

`ipv4.routing` Whether to route IPv4 traffic in and out of the bridge

Key:	`ipv4.routing`
Type:	bool
Default:	`true`
Condition:	IPv4 address

`ipv6.address` IPv6 address for the bridge

Key:	`ipv6.address`
Type:	string
Default:	initial value on creation: `auto`
Condition:	standard mode

Use CIDR notation.

You can set the option to `none` to turn off IPv6, or to `auto` to generate a new random unused subnet.

`ipv6.dhcp` Whether to provide additional network configuration over DHCP

Key:	`ipv6.dhcp`
Type:	bool
Default:	`true`
Condition:	IPv6 address

`ipv6.dhcp.expiry` When to expire DHCP leases

Key:	`ipv6.dhcp.expiry`
Type:	string
Default:	`1h`
Condition:	IPv6 DHCP

`ipv6.dhcp.ranges` IPv6 ranges to use for DHCP

Key:	`ipv6.dhcp.ranges`
Type:	string
Default:	all addresses
Condition:	IPv6 stateful DHCP

Specify a comma-separated list of IPv6 ranges in FIRST-LAST format.

`ipv6.dhcp.stateful` Whether to allocate IPv6 addresses using DHCP

Key:	`ipv6.dhcp.stateful`
Type:	bool
Default:	`false`
Condition:	IPv6 DHCP

`ipv6.firewall` Whether to generate filtering firewall rules for this network

Key:	`ipv6.firewall`
Type:	bool
Default:	`true`
Condition:	IPv6 DHCP

`ipv6.nat` Whether to use NAT for IPv6

Key:	`ipv6.nat`
Type:	bool
Default:	`false` (initial value on creation if `ipv6.address` is set to `auto`: `true`)
Condition:	IPv6 address

`ipv6.nat.address` Source address used for outbound traffic from the bridge

Key:	`ipv6.nat.address`
Type:	string
Condition:	IPv6 address

`ipv6.nat.order` Where to add the required NAT rules

Key:	`ipv6.nat.order`
Type:	string
Default:	`before`
Condition:	IPv6 address

Set this option to `before` to add the NAT rules before any pre-existing rules, or to `after` to add them after the pre-existing rules.

`ipv6.ovn.ranges` IPv6 ranges to use for child OVN network routers

Key:	`ipv6.ovn.ranges`
Type:	string

Specify a comma-separated list of IPv6 ranges in FIRST-LAST format.

`ipv6.routes` Additional IPv6 CIDR subnets to route to the bridge

Key:	`ipv6.routes`
Type:	string
Condition:	IPv6 address

Specify a comma-separated list of IPv6 CIDR subnets.

`ipv6.routing` Whether to route IPv6 traffic in and out of the bridge

Key:	`ipv6.routing`
Type:	bool
Condition:	IPv6 address

`maas.subnet.ipv4` MAAS IPv4 subnet to register instances in

Key:	`maas.subnet.ipv4`
Type:	string
Condition:	IPv4 address; using the `network` property on the NIC

`maas.subnet.ipv6` MAAS IPv6 subnet to register instances in

Key:	`maas.subnet.ipv6`
Type:	string
Condition:	IPv6 address; using the `network` property on the NIC

`raw.dnsmasq` Additional `dnsmasq` configuration to append to the configuration file

Key:	`raw.dnsmasq`
Type:	string

`security.acls` Network ACLs to apply to NICs connected to this network

Key:	`security.acls`
Type:	string

Specify a comma-separated list of network ACLs.

Also see *Bridge limitations*.

`security.acls.default.egress.action` Default action to use for egress traffic

Key:	`security.acls.default.egress.action`
Type:	string
Condition:	`security.acls`

The specified action is used for all egress traffic that doesn't match any ACL rule.

`security.acls.default.egress.logged` Whether to log egress traffic that doesn't match any ACL rule

Key:	`security.acls.default.egress.logged`
Type:	bool
Condition:	`security.acls`

`security.acls.default.ingress.action` Default action to use for ingress traffic

Key:	`security.acls.default.ingress.action`
Type:	string
Condition:	`security.acls`

The specified action is used for all ingress traffic that doesn't match any ACL rule.

`security.acls.default.ingress.logged` Whether to log ingress traffic that doesn't match any ACL rule

Key:	`security.acls.default.ingress.logged`
Type:	bool
Condition:	`security.acls`

`tunnel.NAME.group` Multicast address for `vxlan`

Key:	`tunnel.NAME.group`
Type:	string
Condition:	`vxlan`

This address is used if *`tunnel.NAME.local`* and *`tunnel.NAME.remote`* aren't set.

`tunnel.NAME.id` Specific tunnel ID to use for the `vxlan` tunnel

Key:	`tunnel.NAME.id`
Type:	integer
Condition:	`vxlan`

`tunnel.NAME.interface` Specific host interface to use for the tunnel

Key:	`tunnel.NAME.interface`
Type:	string
Condition:	`vxlan`

`tunnel.NAME.local` Local address for the tunnel

Key:	`tunnel.NAME.local`
Type:	string
Condition:	`gre` or `vxlan`
Required:	not required for multicast `vxlan`

`tunnel.NAME.port` Specific port to use for the `vxlan` tunnel

Key:	`tunnel.NAME.port`
Type:	integer
Default:	`0`
Condition:	`vxlan`

`tunnel.NAME.protocol` Tunneling protocol

Key:	`tunnel.NAME.protocol`
Type:	string
Condition:	standard mode

Possible values are `vxlan` and `gre`.

`tunnel.NAME.remote` Remote address for the tunnel

Key:	`tunnel.NAME.remote`
Type:	string
Condition:	`gre` or `vxlan`
Required:	not required for multicast `vxlan`

`tunnel.NAME.ttl` Specific TTL to use for multicast routing topologies

Key:	`tunnel.NAME.ttl`
Type:	string
Default:	`1`
Condition:	`vxlan`

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string

Supported features

The following features are supported for the `bridge` network type:

- *How to configure network ACLs*
- *How to configure network forwards*
- *How to configure network zones*
- *How to configure LXD as a BGP server*
- *How to integrate with `systemd-resolved`*

Firewall issues

See *How to configure your firewall* for instructions on how to troubleshoot firewall issues.

OVN network

OVN is a software-defined networking system that supports virtual network abstraction. You can use it to build your own private cloud. See `www.ovn.org` for more information.

The `ovn` network type allows to create logical networks using the OVN SDN (software-defined networking). This kind of network can be useful for labs and multi-tenant environments where the same logical subnets are used in multiple discrete networks.

A LXD OVN network can be connected to an existing managed *Bridge network* or *Physical network* to gain access to the wider network. By default, all connections from the OVN logical networks are NATed to an IP allocated from the uplink network.

See *How to set up OVN with LXD* for basic instructions for setting up an OVN network.

Note: Static DHCP assignments depend on the client using its MAC address as the DHCP identifier. This method prevents conflicting leases when copying an instance, and thus makes statically assigned leases work properly.

OVN networking architecture

The following figure shows the OVN network traffic flow in a LXD cluster:

Fig. 2: OVN networking (one network)

The OVN network connects the different cluster members. Network traffic between the cluster members passes through the NIC for inter-cluster traffic (`eth1` in the figure) and is transmitted through an OVN tunnel. This traffic between cluster members is referred to as *OVN east/west traffic*.

For outside connectivity, the OVN network requires an uplink network (a *Bridge network* or a *Physical network*). The OVN network uses a virtual router to connect to the uplink network through the NIC for uplink traffic (`eth0` in the figure). The virtual router is active on only one of the cluster members, and can move to a different member at any time. Independent of where the router resides, the OVN network is available on all cluster members.

Every instance on any cluster member can connect to the OVN network through its virtual NIC (usually `eth0` for containers and `enp5s0` for virtual machines). The traffic between the instances and the uplink network is referred to as *OVN north/south traffic*.

The strengths of using OVN become apparent when looking at a networking architecture with more than one OVN network:

Fig. 3: OVN networking (two networks)

In this case, both depicted OVN networks are completely independent. Both networks are available on all cluster members (with each virtual router being active on one random cluster member). Each instance can use either of the networks, and the traffic on either network is completely isolated from the other network.

Configuration options

The following configuration key namespaces are currently supported for the `ovn` network type:

- `bridge` (L2 interface configuration)
- `dns` (DNS server and resolution configuration)
- `ipv4` (L3 IPv4 configuration)
- `ipv6` (L3 IPv6 configuration)
- `security` (network ACL configuration)
- `user` (free-form key/value for user metadata)

Note: LXD uses the CIDR notation where network subnet information is required, for example, `192.0.2.0/24` or `2001:db8::/32`. This does not apply to cases where a single address is required, for example, local/remote addresses of tunnels, NAT addresses or specific addresses to apply to an instance.

The following configuration options are available for the `ovn` network type: `bridge.hwaddr` MAC address for the bridge

Key:	`bridge.hwaddr`
Type:	string

`bridge.mtu` Bridge MTU

Key:	`bridge.mtu`
Type:	integer
Default:	`1442`

The default value allows the host to host Geneve tunnels.

`dns.domain` Domain to advertise to DHCP clients and use for DNS resolution

Key:	`dns.domain`
Type:	string
Default:	`lxd`

`dns.search` Full domain search list

Key:	`dns.search`
Type:	string
Default:	`dns.domain` value

Specify a comma-separated list of domains.

`dns.zone.forward` DNS zone names for forward DNS records

Key:	`dns.zone.forward`
Type:	string

Specify a comma-separated list of DNS zone names.

`dns.zone.reverse.ipv4` DNS zone name for IPv4 reverse DNS records

Key:	`dns.zone.reverse.ipv4`
Type:	string

`dns.zone.reverse.ipv6` DNS zone name for IPv6 reverse DNS records

Key:	`dns.zone.reverse.ipv6`
Type:	string

`ipv4.address` IPv4 address for the bridge

Key:	`ipv4.address`
Type:	string
Default:	initial value on creation: `auto`
Condition:	standard mode

Use CIDR notation.

You can set the option to `none` to turn off IPv4, or to `auto` to generate a new random unused subnet.

`ipv4.dhcp` Whether to allocate IPv4 addresses using DHCP

Key:	`ipv4.dhcp`
Type:	bool
Default:	`true`
Condition:	IPv4 address

`ipv4.l3only` Whether to enable layer 3 only mode for IPv4

Key:	`ipv4.l3only`
Type:	bool
Default:	`false`
Condition:	IPv4 address

`ipv4.nat` Whether to use NAT for IPv4

Key:	`ipv4.nat`
Type:	bool
Default:	`false` (initial value on creation if `ipv4.address` is set to `auto`: `true`)
Condition:	IPv4 address

`ipv4.nat.address` Source address used for outbound traffic from the network

Key:	`ipv4.nat.address`
Type:	string
Condition:	IPv4 address; requires uplink `ovn.ingress_mode=routed`

`ipv6.address` IPv6 address for the bridge

Key:	`ipv6.address`
Type:	string
Default:	initial value on creation: `auto`
Condition:	standard mode

Use CIDR notation.

You can set the option to `none` to turn off IPv6, or to `auto` to generate a new random unused subnet.

`ipv6.dhcp` Whether to provide additional network configuration over DHCP

Key:	`ipv6.dhcp`
Type:	bool
Default:	`true`
Condition:	IPv6 address

`ipv6.dhcp.stateful` Whether to allocate IPv6 addresses using DHCP

Key:	`ipv6.dhcp.stateful`
Type:	bool
Default:	`false`
Condition:	IPv6 DHCP

`ipv6.l3only` Whether to enable layer 3 only mode for IPv6

Key:	`ipv6.l3only`
Type:	bool
Default:	`false`
Condition:	IPv6 DHCP stateful

`ipv6.nat` Whether to use NAT for IPv6

Key:	`ipv6.nat`
Type:	bool
Default:	`false` (initial value on creation if `ipv6.address` is set to `auto`: `true`)
Condition:	IPv6 address

`ipv6.nat.address` Source address used for outbound traffic from the network

Key:	`ipv6.nat.address`
Type:	string
Condition:	IPv6 address; requires uplink `ovn.ingress_mode=routed`

`network` Uplink network to use for external network access

Key:	`network`
Type:	string

`security.acls` Network ACLs to apply to NICs connected to this network

Key:	`security.acls`
Type:	string

Specify a comma-separated list of network ACLs.

`security.acls.default.egress.action` Default action to use for egress traffic

Key:	`security.acls.default.egress.action`
Type:	string
Default:	`reject`
Condition:	`security.acls`

The specified action is used for all egress traffic that doesn't match any ACL rule.

`security.acls.default.egress.logged` Whether to log egress traffic that doesn't match any ACL rule

Key:	`security.acls.default.egress.logged`
Type:	bool
Default:	`false`
Condition:	`security.acls`

`security.acls.default.ingress.action` Default action to use for ingress traffic

Key:	`security.acls.default.ingress.action`
Type:	string
Default:	`reject`
Condition:	`security.acls`

The specified action is used for all ingress traffic that doesn't match any ACL rule.

`security.acls.default.ingress.logged` Whether to log ingress traffic that doesn't match any ACL rule

Key:	`security.acls.default.ingress.logged`
Type:	bool
Default:	`false`
Condition:	`security.acls`

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string

Supported features

The following features are supported for the `ovn` network type:

- *How to configure network ACLs*
- *How to configure network forwards*
- *How to configure network zones*
- *How to create OVN peer routing relationships*
- *How to configure network load balancers*

External networks

External networks use network interfaces that already exist. Therefore, LXD has limited possibility to control them, and LXD features like network ACLs, network forwards and network zones are not supported.

The main purpose for using external networks is to provide an uplink network through a parent interface. This external network specifies the presets to use when connecting instances or other networks to a parent interface.

LXD supports the following external network types:

Macvlan network

Macvlan is a virtual LAN that you can use if you want to assign several IP addresses to the same network interface, basically splitting up the network interface into several sub-interfaces with their own IP addresses. You can then assign IP addresses based on the randomly generated MAC addresses.

The `macvlan` network type allows to specify presets to use when connecting instances to a parent interface. In this case, the instance NICs can simply set the `network` option to the network they connect to without knowing any of the underlying configuration details.

Note: If you are using a `macvlan` network, communication between the LXD host and the instances is not possible. Both the host and the instances can talk to the gateway, but they cannot communicate directly.

Configuration options

The following configuration key namespaces are currently supported for the `macvlan` network type:

- `maas` (MAAS network identification)
- `user` (free-form key/value for user metadata)

Note: LXD uses the CIDR notation where network subnet information is required, for example, `192.0.2.0/24` or `2001:db8::/32`. This does not apply to cases where a single address is required, for example, local/remote addresses of tunnels, NAT addresses or specific addresses to apply to an instance.

The following configuration options are available for the `macvlan` network type: `gvrp` Whether to use GARP VLAN Registration Protocol

Key:	gvrp
Type:	bool
Default:	false

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

maas.subnet.ipv4 MAAS IPv4 subnet to register instances in

Key:	maas.subnet.ipv4
Type:	string
Condition:	IPv4 address; using the network property on the NIC

maas.subnet.ipv6 MAAS IPv6 subnet to register instances in

Key:	maas.subnet.ipv6
Type:	string
Condition:	IPv4 address; using the network property on the NIC

mtu MTU of the new interface

Key:	mtu
Type:	integer

parent Parent interface to create macvlan NICs on

Key:	parent
Type:	string

user.* User-provided free-form key/value pairs

Key:	user.*
Type:	string

vlan VLAN ID to attach to

Key:	vlan
Type:	integer

Physical network

The `physical` network type connects to an existing physical network, which can be a network interface or a bridge, and serves as an uplink network for OVN.

This network type allows to specify presets to use when connecting OVN networks to a parent interface or to allow an instance to use a physical interface as a NIC. In this case, the instance NICs can simply set the `network`option to the network they connect to without knowing any of the underlying configuration details.

Configuration options

The following configuration key namespaces are currently supported for the `physical` network type:

- `bgp` (BGP peer configuration)
- `dns` (DNS server and resolution configuration)
- `ipv4` (L3 IPv4 configuration)
- `ipv6` (L3 IPv6 configuration)
- `maas` (MAAS network identification)
- `ovn` (OVN configuration)
- `user` (free-form key/value for user metadata)

Note: LXD uses the CIDR notation where network subnet information is required, for example, `192.0.2.0/24` or `2001:db8::/32`. This does not apply to cases where a single address is required, for example, local/remote addresses of tunnels, NAT addresses or specific addresses to apply to an instance.

The following configuration options are available for the `physical` network type: `bgp.peers.NAME.address` Peer address for use by `ovn` downstream networks

Key:	`bgp.peers.NAME.address`
Type:	string
Condition:	BGP server

The address can be IPv4 or IPv6.

`bgp.peers.NAME.asn` Peer AS number for use by `ovn` downstream networks

Key:	`bgp.peers.NAME.asn`
Type:	integer
Condition:	BGP server

`bgp.peers.NAME.holdtime` Peer session hold time

Key:	`bgp.peers.NAME.holdtime`
Type:	integer
Default:	`180`
Condition:	BGP server
Required:	no

Specify the peer session hold time in seconds.

`bgp.peers.NAME.password` Peer session password for use by `ovn` downstream networks

Key:	`bgp.peers.NAME.password`
Type:	string
Default:	(no password)
Condition:	BGP server
Required:	no

`dns.nameservers` DNS server IPs on physical network

Key:	`dns.nameservers`
Type:	string
Condition:	standard mode

Specify a list of DNS server IPs.

`gvrp` Whether to use GARP VLAN Registration Protocol

Key:	`gvrp`
Type:	bool
Default:	`false`

This option specifies whether to register the VLAN using the GARP VLAN Registration Protocol.

`ipv4.gateway` IPv4 address for the gateway and network

Key:	`ipv4.gateway`
Type:	string
Condition:	standard mode

Use CIDR notation.

`ipv4.ovn.ranges` IPv4 ranges to use for child OVN network routers

Key:	`ipv4.ovn.ranges`
Type:	string

Specify a comma-separated list of IPv4 ranges in FIRST-LAST format.

`ipv4.routes` Additional IPv4 CIDR subnets

Key:	`ipv4.routes`
Type:	string
Condition:	IPv4 address

Specify a comma-separated list of IPv4 CIDR subnets that can be used with the child OVN network's *`ipv4.routes.external`* setting.

`ipv4.routes.anycast` Whether to allow IPv4 routes on multiple networks/NICs

Key:	`ipv4.routes.anycast`
Type:	bool
Default:	`false`
Condition:	IPv4 address

If set to `true`, this option allows the overlapping routes to be used on multiple networks/NICs at the same time.

`ipv6.gateway` IPv6 address for the gateway and network

Key:	`ipv6.gateway`
Type:	string
Condition:	standard mode

Use CIDR notation.

`ipv6.ovn.ranges` IPv6 ranges to use for child OVN network routers

Key:	`ipv6.ovn.ranges`
Type:	string

Specify a comma-separated list of IPv6 ranges in FIRST-LAST format.

`ipv6.routes` Additional IPv6 CIDR subnets

Key:	`ipv6.routes`
Type:	string
Condition:	IPv6 address

Specify a comma-separated list of IPv6 CIDR subnets that can be used with the child OVN network's *`ipv6.routes.external`* setting.

`ipv6.routes.anycast` Whether to allow IPv6 routes on multiple networks/NICs

Key:	`ipv6.routes.anycast`
Type:	bool
Default:	`false`
Condition:	IPv6 address

If set to `true`, this option allows the overlapping routes to be used on multiple networks/NICs at the same time.

`maas.subnet.ipv4` MAAS IPv4 subnet to register instances in

Key:	`maas.subnet.ipv4`
Type:	string
Condition:	IPv4 address; using the `network` property on the NIC

`maas.subnet.ipv6` MAAS IPv6 subnet to register instances in

Key:	`maas.subnet.ipv6`
Type:	string
Condition:	IPv6 address; using the `network` property on the NIC

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer

`ovn.ingress_mode` How OVN NIC external IPs are advertised on uplink network

Key:	`ovn.ingress_mode`
Type:	string
Default:	`l2proxy`
Condition:	standard mode

Possible values are `l2proxy` (proxy ARP/NDP) and `routed`.

`parent` Existing interface to use for network

Key:	`parent`
Type:	string

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string

`vlan` VLAN ID to attach to

Key:	`vlan`
Type:	integer

Supported features

The following features are supported for the `physical` network type:

- *How to configure LXD as a BGP server*

SR-IOV network

SR-IOV is a hardware standard that allows a single network card port to appear as several virtual network interfaces in a virtualized environment.

The `sriov` network type allows to specify presets to use when connecting instances to a parent interface. In this case, the instance NICs can simply set the `network` option to the network they connect to without knowing any of the underlying configuration details.

Configuration options

The following configuration key namespaces are currently supported for the `sriov` network type:

- `maas` (MAAS network identification)
- `user` (free-form key/value for user metadata)

Note: LXD uses the CIDR notation where network subnet information is required, for example, `192.0.2.0/24` or `2001:db8::/32`. This does not apply to cases where a single address is required, for example, local/remote addresses of tunnels, NAT addresses or specific addresses to apply to an instance.

The following configuration options are available for the `sriov` network type: `maas.subnet.ipv4` MAAS IPv4 subnet to register instances in

Key:	`maas.subnet.ipv4`
Type:	string
Condition:	IPv4 address; using the `network` property on the NIC

`maas.subnet.ipv6` MAAS IPv6 subnet to register instances in

Key:	`maas.subnet.ipv6`
Type:	string
Condition:	IPv6 address; using the `network` property on the NIC

`mtu` MTU of the new interface

Key:	`mtu`
Type:	integer

`parent` Parent interface to create `sriov` NICs on

Key:	`parent`
Type:	string

`user.*` User-provided free-form key/value pairs

Key:	`user.*`
Type:	string

`vlan` VLAN ID to attach to

Key:	`vlan`
Type:	integer

Related topics

How-to guides:

- *Networking*

Explanation:

- *About networking*

Cluster member configuration

Each cluster member has its own key/value configuration with the following supported namespaces:

- `user` (free form key/value for user metadata)
- `scheduler` (options related to how the member is automatically targeted by the cluster)

The following keys are currently supported: `scheduler.instance` Controls how instances are scheduled to run on this member

Key:	`scheduler.instance`
Type:	string
Default:	`all`

Possible values are `all`, `manual`, and `group`. See *Automatic placement of instances* for more information.

`user.*` Free form user key/value storage

Key:	`user.*`
Type:	string

User keys can be used in search.

Related topics

How-to guides:

- *Clustering*

Explanation:

- *About clustering*

2.4.3 Production setup

Once you are ready for production, make sure your LXD server is configured to support the required load. You should also regularly *monitor the server metrics*.

Server settings for a LXD production setup

To allow your LXD server to run a large number of instances, configure the following settings to avoid hitting server limits.

The `Value` column contains the suggested value for each parameter.

`/etc/security/limits.conf`

Note: For users of the snap, those limits are automatically raised.

Domain	Type	Item	Value	Default	Description
*	soft	nofile	1048576	unset	Maximum number of open files
*	hard	nofile	1048576	unset	Maximum number of open files
root	soft	nofile	1048576	unset	Maximum number of open files
root	hard	nofile	1048576	unset	Maximum number of open files
*	soft	memlocl	unlimite	unset	Maximum locked-in-memory address space (KB)
*	hard	memlocl	unlimite	unset	Maximum locked-in-memory address space (KB)
root	soft	memlocl	unlimite	unset	Maximum locked-in-memory address space (KB), only need with bpf syscall supervision
root	hard	memlocl	unlimite	unset	Maximum locked-in-memory address space (KB), only need with bpf syscall supervision

`/etc/sysctl.conf`

Note: Reboot the server after changing any of these parameters.

`fs.aio-max-nr` Maximum number of concurrent asynchronous I/O operations

Key:	`fs.aio-max-nr`
Type:	integer
Default:	`65536`

Suggested value: `524288`

You might need to increase this limit further if you have a lot of workloads that use the AIO subsystem (for example, MySQL).

`fs.inotify.max_queued_events` Upper limit on the number of events that can be queued

Key:	fs.inotify.max_queued_events
Type:	integer
Default:	16384

Suggested value: 1048576

This option specifies the maximum number of events that can be queued to the corresponding inotify instance (see inotify for more information).

fs.inotify.max_user_instances Upper limit on the number of inotify instances

Key:	fs.inotify.max_user_instances
Type:	integer
Default:	128

Suggested value: 1048576

This option specifies the maximum number of inotify instances that can be created per real user ID (see inotify for more information).

fs.inotify.max_user_watches Upper limit on the number of watches

Key:	fs.inotify.max_user_watches
Type:	integer
Default:	8192

Suggested value: 1048576

This option specifies the maximum number of watches that can be created per real user ID (see inotify for more information).

kernel.dmesg_restrict Whether to deny access to the messages in the kernel ring buffer

Key:	kernel.dmesg_restrict
Type:	integer
Default:	0

Suggested value: 1

Set this option to 1 to deny container access to the messages in the kernel ring buffer. Note that setting this value to 1 will also deny access to non-root users on the host system.

kernel.keys.maxbytes Maximum size of the key ring that non-root users can use

Key:	kernel.keys.maxbytes
Type:	integer
Default:	20000

Suggested value: 2000000

kernel.keys.maxkeys Maximum number of keys that a non-root user can use

Key:	kernel.keys.maxkeys
Type:	integer
Default:	200

Suggested value: 2000

Set this option to a value that is higher than the number of instances.

net.core.bpf_jit_limit Limit on the size of eBPF JIT allocations

Key:	net.core.bpf_jit_limit
Type:	integer
Default:	varies

Suggested value: 1000000000

On kernels < 5.15 that are compiled with CONFIG_BPF_JIT_ALWAYS_ON=y, this value might limit the amount of instances that can be created.

net.ipv4.neigh.default.gc_thresh3 Maximum number of entries in the IPv4 ARP table

Key:	net.ipv4.neigh.default.gc_thresh3
Type:	integer
Default:	1024

Suggested value: 8192

Increase this value if you plan to create over 1024 instances. Otherwise, you will get the error neighbour: ndisc_cache: neighbor table overflow! when the ARP table gets full and the instances cannot get a network configuration. See ip-sysctl for more information.

net.ipv6.neigh.default.gc_thresh3 Maximum number of entries in IPv6 ARP table

Key:	net.ipv6.neigh.default.gc_thresh3
Type:	integer
Default:	1024

Suggested value: 8192

Increase this value if you plan to create over 1024 instances. Otherwise, you will get the error neighbour: ndisc_cache: neighbor table overflow! when the ARP table gets full and the instances cannot get a network configuration. See ip-sysctl for more information.

vm.max_map_count Maximum number of memory map areas a process may have

Key:	vm.max_map_count
Type:	integer
Default:	65530

Suggested value: 262144

Memory map areas are used as a side-effect of calling malloc, directly by mmap and mprotect, and also when loading shared libraries.

Related topics

How-to guides:

- *How to benchmark performance*
- *How to increase the network bandwidth*
- *How to monitor metrics*

Explanation:

- *About performance tuning*

Provided metrics

LXD provides a number of instance metrics and internal metrics. See *How to monitor metrics* for instructions on how to work with these metrics.

Instance metrics

The following instance metrics are provided:

Metric	Description
`lxd_cpu_effective_total`	Total number of effective CPUs
`lxd_cpu_seconds_total{cpu="<cpu>", mode="<mode>"}`	Total number of CPU time used (in seconds)
`lxd_disk_read_bytes_total{device="<dev>"}`	Total number of bytes read
`lxd_disk_reads_completed_total{device="<dev>"}`	Total number of completed reads
`lxd_disk_written_bytes_total{device="<dev>"}`	Total number of bytes written
`lxd_disk_writes_completed_total{device="<dev>"}`	Total number of completed writes
`lxd_filesystem_avail_bytes{device="<dev>",fstype="<type>"}`	Available space (in bytes)
`lxd_filesystem_free_bytes{device="<dev>",fstype="<type>"}`	Free space (in bytes)
`lxd_filesystem_size_bytes{device="<dev>",fstype="<type>"}`	Size of the file system (in bytes)
`lxd_memory_Active_anon_bytes`	Amount of anonymous memory on active LRU list
`lxd_memory_Active_bytes`	Amount of memory on active LRU list
`lxd_memory_Active_file_bytes`	Amount of file-backed memory on active LRU list
`lxd_memory_Cached_bytes`	Amount of cached memory
`lxd_memory_Dirty_bytes`	Amount of memory waiting to be written back to the d
`lxd_memory_HugepagesFree_bytes`	Amount of free memory for `hugetlb`
`lxd_memory_HugepagesTotal_bytes`	Amount of used memory for `hugetlb`
`lxd_memory_Inactive_anon_bytes`	Amount of anonymous memory on inactive LRU list
`lxd_memory_Inactive_bytes`	Amount of memory on inactive LRU list
`lxd_memory_Inactive_file_bytes`	Amount of file-backed memory on inactive LRU list
`lxd_memory_Mapped_bytes`	Amount of mapped memory
`lxd_memory_MemAvailable_bytes`	Amount of available memory
`lxd_memory_MemFree_bytes`	Amount of free memory
`lxd_memory_MemTotal_bytes`	Amount of used memory
`lxd_memory_OOM_kills_total`	The number of out-of-memory kills
`lxd_memory_RSS_bytes`	Amount of anonymous and swap cache memory
`lxd_memory_Shmem_bytes`	Amount of cached file system data that is swap-backed
`lxd_memory_Swap_bytes`	Amount of used swap memory
`lxd_memory_Unevictable_bytes`	Amount of unevictable memory
`lxd_memory_Writeback_bytes`	Amount of memory queued for syncing to disk

continues on next pa

Table 1 – continued from previous page

Metric	Description
lxd_network_receive_bytes_total{device="<dev>"}	Amount of received bytes on a given interface
lxd_network_receive_drop_total{device="<dev>"}	Amount of received dropped bytes on a given interface
lxd_network_receive_errs_total{device="<dev>"}	Amount of received errors on a given interface
lxd_network_receive_packets_total{device="<dev>"}	Amount of received packets on a given interface
lxd_network_transmit_bytes_total{device="<dev>"}	Amount of transmitted bytes on a given interface
lxd_network_transmit_drop_total{device="<dev>"}	Amount of transmitted dropped bytes on a given interfa
lxd_network_transmit_errs_total{device="<dev>"}	Amount of transmitted errors on a given interface
lxd_network_transmit_packets_total{device="<dev>"}	Amount of transmitted packets on a given interface
lxd_procs_total	Number of running processes

Internal metrics

The following internal metrics are provided:

Metric	Description
lxd_go_alloc_bytes_total	Total number of bytes allocated (even if freed)
lxd_go_alloc_bytes	Number of bytes allocated and still in use
lxd_go_buck_hash_sys_bytes	Number of bytes used by the profiling bucket hash table
lxd_go_frees_total	Total number of frees
lxd_go_gc_sys_bytes	Number of bytes used for garbage collection system metadata
lxd_go_goroutines	Number of goroutines that currently exist
lxd_go_heap_alloc_bytes	Number of heap bytes allocated and still in use
lxd_go_heap_idle_bytes	Number of heap bytes waiting to be used
lxd_go_heap_inuse_bytes	Number of heap bytes that are in use
lxd_go_heap_objects	Number of allocated objects
lxd_go_heap_released_bytes	Number of heap bytes released to OS
lxd_go_heap_sys_bytes	Number of heap bytes obtained from system
lxd_go_lookups_total	Total number of pointer lookups
lxd_go_mallocs_total	Total number of mallocs
lxd_go_mcache_inuse_bytes	Number of bytes in use by mcache structures
lxd_go_mcache_sys_bytes	Number of bytes used for mcache structures obtained from system
lxd_go_mspan_inuse_bytes	Number of bytes in use by mspan structures
lxd_go_mspan_sys_bytes	Number of bytes used for mspan structures obtained from system
lxd_go_next_gc_bytes	Number of heap bytes when next garbage collection will take place
lxd_go_other_sys_bytes	Number of bytes used for other system allocations
lxd_go_stack_inuse_bytes	Number of bytes in use by the stack allocator
lxd_go_stack_sys_bytes	Number of bytes obtained from system for stack allocator
lxd_go_sys_bytes	Number of bytes obtained from system
lxd_operations_total	Number of running operations
lxd_uptime_seconds	Daemon uptime (in seconds)
lxd_warnings_total	Number of active warnings

Related topics

How-to guides:

- *How to monitor metrics*

Explanation:

- *About performance tuning*

2.4.4 REST API

All communication between LXD and its clients happens using a RESTful API over HTTP. Check the list of API extensions to see if a feature is available in your version of the API.

REST API

REST API

All communication between LXD and its clients happens using a RESTful API over HTTP. This API is encapsulated over either TLS (for remote operations) or a Unix socket (for local operations).

See *Remote API authentication* for information about how to access the API remotely.

Tip:

- For examples on how the API is used, run any command of the LXD client (`lxc`) with the `--debug` flag. The debug information displays the API calls and the return values.
- For quickly querying the API, the LXD client provides a `lxc query` command.

API versioning

The list of supported major API versions can be retrieved using `GET /`.

The reason for a major API bump is if the API breaks backward compatibility.

Feature additions done without breaking backward compatibility only result in addition to `api_extensions` which can be used by the client to check if a given feature is supported by the server.

Return values

There are three standard return types:

- Standard return value
- Background operation
- Error

Standard return value

For a standard synchronous operation, the following JSON object is returned:

```
{
    "type": "sync",
    "status": "Success",
    "status_code": 200,
    "metadata": {}                          // Extra resource/action specific metadata
}
```

HTTP code must be 200.

Background operation

When a request results in a background operation, the HTTP code is set to 202 (Accepted) and the Location HTTP header is set to the operation URL.

The body is a JSON object with the following structure:

```
{
    "type": "async",
    "status": "OK",
    "status_code": 100,
    "operation": "/1.0/instances/<id>",                    // URL to the background␣
↪operation
    "metadata": {}                                         // Operation metadata (see␣
↪below)
}
```

The operation metadata structure looks like:

```
{
    "id": "a40f5541-5e98-454f-b3b6-8a51ef5dbd3c",          // UUID of the operation
    "class": "websocket",                                  // Class of the operation␣
↪(task, websocket or token)
    "created_at": "2015-11-17T22:32:02.226176091-05:00",   // When the operation was␣
↪created
    "updated_at": "2015-11-17T22:32:02.226176091-05:00",   // Last time the operation␣
↪was updated
    "status": "Running",                                   // String version of the␣
↪operation's status
    "status_code": 103,                                    // Integer version of the␣
↪operation's status (use this rather than status)
    "resources": {                                         // Dictionary of resource␣
↪types (container, snapshots, images) and affected resources
      "containers": [
        "/1.0/instances/test"
      ]
    },
    "metadata": {                                          // Metadata specific to the␣
↪operation in question (in this case, exec)
      "fds": {
```

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```
        "0": "2a4a97af81529f6608dca31f03a7b7e47acc0b8dc6514496eb25e325f9e4fa6a",
        "control": "5b64c661ef313b423b5317ba9cb6410e40b705806c28255f601c0ef603f079a7"
      }
    },
    "may_cancel": false,                                  // Whether the operation can␣
↪be canceled (DELETE over REST)
    "err": ""                                             // The error string should␣
↪the operation have failed
}
```

The body is mostly provided as a user friendly way of seeing what's going on without having to pull the target operation, all information in the body can also be retrieved from the background operation URL.

Error

There are various situations in which something may immediately go wrong, in those cases, the following return value is used:

```
{
    "type": "error",
    "error": "Failure",
    "error_code": 400,
    "metadata": {}                      // More details about the error
}
```

HTTP code must be one of of 400, 401, 403, 404, 409, 412 or 500.

Status codes

The LXD REST API often has to return status information, be that the reason for an error, the current state of an operation or the state of the various resources it exports.

To make it simple to debug, all of those are always doubled. There is a numeric representation of the state which is guaranteed never to change and can be relied on by API clients. Then there is a text version meant to make it easier for people manually using the API to figure out what's happening.

In most cases, those will be called status and `status_code`, the former being the user-friendly string representation and the latter the fixed numeric value.

The codes are always 3 digits, with the following ranges:

- 100 to 199: resource state (started, stopped, ready, ...)
- 200 to 399: positive action result
- 400 to 599: negative action result
- 600 to 999: future use

List of current status codes

Code	Meaning
100	Operation created
101	Started
102	Stopped
103	Running
104	Canceling
105	Pending
106	Starting
107	Stopping
108	Aborting
109	Freezing
110	Frozen
111	Thawed
112	Error
113	Ready
200	Success
400	Failure
401	Canceled

Recursion

To optimize queries of large lists, recursion is implemented for collections. A `recursion` argument can be passed to a GET query against a collection.

The default value is 0 which means that collection member URLs are returned. Setting it to 1 will have those URLs be replaced by the object they point to (typically another JSON object).

Recursion is implemented by simply replacing any pointer to an job (URL) by the object itself.

Filtering

To filter your results on certain values, filter is implemented for collections. A `filter` argument can be passed to a GET query against a collection.

Filtering is available for the instance, image and storage volume endpoints.

There is no default value for filter which means that all results found will be returned. The following is the language used for the filter argument:

```
?filter=field_name eq desired_field_assignment
```

The language follows the OData conventions for structuring REST API filtering logic. Logical operators are also supported for filtering: not (`not`), equals (`eq`), not equals (`ne`), and (`and`), or (`or`). Filters are evaluated with left associativity. Values with spaces can be surrounded with quotes. Nesting filtering is also supported. For instance, to filter on a field in a configuration you would pass:

```
?filter=config.field_name eq desired_field_assignment
```

For filtering on device attributes you would pass:

```
?filter=devices.device_name.field_name eq desired_field_assignment
```

Here are a few GET query examples of the different filtering methods mentioned above:

```
containers?filter=name eq "my container" and status eq Running

containers?filter=config.image.os eq ubuntu or devices.eth0.nictype eq bridged

images?filter=Properties.os eq Centos and not UpdateSource.Protocol eq simplestreams
```

Asynchronous operations

Any operation which may take more than a second to be done must be done in the background, returning a background operation ID to the client.

The client will then be able to either poll for a status update or wait for a notification using the long-poll API.

Notifications

A WebSocket-based API is available for notifications, different notification types exist to limit the traffic going to the client.

It's recommended that the client always subscribes to the operations notification type before triggering remote operations so that it doesn't have to then poll for their status.

PUT vs PATCH

The LXD API supports both PUT and PATCH to modify existing objects.

PUT replaces the entire object with a new definition, it's typically called after the current object state was retrieved through GET.

To avoid race conditions, the ETag header should be read from the GET response and sent as If-Match for the PUT request. This will cause LXD to fail the request if the object was modified between GET and PUT.

PATCH can be used to modify a single field inside an object by only specifying the property that you want to change. To unset a key, setting it to empty will usually do the trick, but there are cases where PATCH won't work and PUT needs to be used instead.

Instances, containers and virtual-machines

The documentation shows paths such as `/1.0/instances/...`, which were introduced with LXD 3.19. Older releases that supported only containers and not virtual machines supply the exact same API at `/1.0/containers/...`.

For backward compatibility reasons, LXD does still expose and support that `/1.0/containers` API, though for the sake of brevity, we decided not to double-document everything.

An additional endpoint at `/1.0/virtual-machines` is also present and much like `/1.0/containers` will only show you instances of that type.

API structure

LXD has an auto-generated Swagger specification describing its API endpoints. The YAML version of this API specification can be found in `rest-api.yaml`. See *Main API specification* for a convenient web rendering of it.

Main API specification

API extensions

The changes below were introduced to the LXD API after the 1.0 API was finalized.

They are all backward compatible and can be detected by client tools by looking at the `api_extensions` field in `GET /1.0`.

`storage_zfs_remove_snapshots`

A *`zfs.remove_snapshots`* daemon configuration key was introduced.

It's a Boolean that defaults to `false` and that when set to `true` instructs LXD to remove any needed snapshot when attempting to restore another.

This is needed as ZFS will only let you restore the latest snapshot.

`container_host_shutdown_timeout`

A *`boot.host_shutdown_timeout`* container configuration key was introduced.

It's an integer which indicates how long LXD should wait for the container to stop before killing it.

Its value is only used on clean LXD daemon shutdown. It defaults to 30s.

`container_stop_priority`

A *`boot.stop.priority`* container configuration key was introduced.

It's an integer which indicates the priority of a container during shutdown.

Containers will shutdown starting with the highest priority level.

Containers with the same priority will shutdown in parallel. It defaults to 0.

`container_syscall_filtering`

A number of new syscalls related container configuration keys were introduced.

- *`security.syscalls.deny_default`*
- *`security.syscalls.deny_compat`*
- *`security.syscalls.deny`*
- *`security.syscalls.allow`*

See *Instance configuration* for how to use them.

Note: Initially, those configuration keys were (accidentally) introduced with offensive names. They have since been renamed (`container_syscall_filtering_allow_deny_syntax`), and the old names are no longer accepted.

auth_pki

This indicates support for PKI authentication mode.

In this mode, the client and server both must use certificates issued by the same PKI.

See *About security* for details.

container_last_used_at

A `last_used_at` field was added to the `GET /1.0/containers/<name>` endpoint.

It is a timestamp of the last time the container was started.

If a container has been created but not started yet, `last_used_at` field will be `1970-01-01T00:00:00Z`

etag

Add support for the ETag header on all relevant endpoints.

This adds the following HTTP header on answers to GET:

- ETag (SHA-256 of user modifiable content)

And adds support for the following HTTP header on PUT requests:

- If-Match (ETag value retrieved through previous GET)

This makes it possible to GET a LXD object, modify it and PUT it without risking to hit a race condition where LXD or another client modified the object in the meantime.

patch

Add support for the HTTP PATCH method.

PATCH allows for partial update of an object in place of PUT.

usb_devices

Add support for USB hotplug.

https_allowed_credentials

To use LXD API with all Web Browsers (via SPAs) you must send credentials (certificate) with each XHR (in order for this to happen, you should set `withCredentials=true` flag to each XHR Request).

Some browsers like Firefox and Safari can't accept server response without `Access-Control-Allow-Credentials: true` header. To ensure that the server will return a response with that header, set *core.https_allowed_credentials* to `true`.

image_compression_algorithm

This adds support for a `compression_algorithm` property when creating an image (`POST /1.0/images`).

Setting this property overrides the server default value (*images.compression_algorithm*).

directory_manipulation

This allows for creating and listing directories via the LXD API, and exports the file type via the X-LXD-type header, which can be either `file` or `directory` right now.

container_cpu_time

This adds support for retrieving CPU time for a running container.

storage_zfs_use_refquota

Introduces a new server property *zfs.use_refquota* which instructs LXD to set the `refquota` property instead of `quota` when setting a size limit on a container. LXD will also then use `usedbydataset` in place of `used` when being queried about disk utilization.

This effectively controls whether disk usage by snapshots should be considered as part of the container's disk space usage.

storage_lvm_mount_options

Adds a new `storage.lvm_mount_options` daemon configuration option which defaults to `discard` and allows the user to set addition mount options for the file system used by the LVM LV.

network

Network management API for LXD.

This includes:

- Addition of the `managed` property on `/1.0/networks` entries
- All the network configuration options (see *Network configuration* for details)
- `POST /1.0/networks` (see *RESTful API* for details)
- `PUT /1.0/networks/<entry>` (see *RESTful API* for details)

- `PATCH /1.0/networks/<entry>` (see *RESTful API* for details)
- `DELETE /1.0/networks/<entry>` (see *RESTful API* for details)
- `ipv4.address` property on `nic` type devices (when `nictype` is `bridged`)
- `ipv6.address` property on `nic` type devices (when `nictype` is `bridged`)
- `security.mac_filtering` property on `nic` type devices (when `nictype` is `bridged`)

profile_usedby

Adds a new `used_by` field to profile entries listing the containers that are using it.

container_push

When a container is created in push mode, the client serves as a proxy between the source and target server. This is useful in cases where the target server is behind a NAT or firewall and cannot directly communicate with the source server and operate in pull mode.

container_exec_recording

Introduces a new Boolean `record-output`, parameter to `/1.0/containers/<name>/exec` which when set to `true` and combined with with `wait-for-websocket` set to `false`, will record stdout and stderr to disk and make them available through the logs interface.

The URL to the recorded output is included in the operation metadata once the command is done running.

That output will expire similarly to other log files, typically after 48 hours.

certificate_update

Adds the following to the REST API:

- ETag header on GET of a certificate
- PUT of certificate entries
- PATCH of certificate entries

container_exec_signal_handling

Adds support `/1.0/containers/<name>/exec` for forwarding signals sent to the client to the processes executing in the container. Currently SIGTERM and SIGHUP are forwarded. Further signals that can be forwarded might be added later.

gpu_devices

Enables adding GPUs to a container.

container_image_properties

Introduces a new `image` configuration key space. Read-only, includes the properties of the parent image.

migration_progress

Transfer progress is now exported as part of the operation, on both sending and receiving ends. This shows up as a `fs_progress` attribute in the operation metadata.

id_map

Enables setting the *security.idmap.isolated*, *security.idmap.size*, and *raw.idmap* fields.

network_firewall_filtering

Add two new keys, *ipv4.firewall* and *ipv6.firewall* which if set to `false` will turn off the generation of `iptables` FORWARDING rules. NAT rules will still be added so long as the matching *ipv4.nat* or *ipv6.nat* key is set to `true`.

Rules necessary for `dnsmasq` to work (DHCP/DNS) will always be applied if `dnsmasq` is enabled on the bridge.

network_routes

Introduces *ipv4.routes* and *ipv6.routes* which allow routing additional subnets to a LXD bridge.

storage

Storage management API for LXD.

This includes:

- `GET /1.0/storage-pools`
- `POST /1.0/storage-pools` (see *RESTful API* for details)
- `GET /1.0/storage-pools/<name>` (see *RESTful API* for details)
- `POST /1.0/storage-pools/<name>` (see *RESTful API* for details)
- `PUT /1.0/storage-pools/<name>` (see *RESTful API* for details)
- `PATCH /1.0/storage-pools/<name>` (see *RESTful API* for details)
- `DELETE /1.0/storage-pools/<name>` (see *RESTful API* for details)
- `GET /1.0/storage-pools/<name>/volumes` (see *RESTful API* for details)
- `GET /1.0/storage-pools/<name>/volumes/<volume_type>` (see *RESTful API* for details)
- `POST /1.0/storage-pools/<name>/volumes/<volume_type>` (see *RESTful API* for details)

- `GET /1.0/storage-pools/<pool>/volumes/<volume_type>/<name>` (see *RESTful API* for details)
- `POST /1.0/storage-pools/<pool>/volumes/<volume_type>/<name>` (see *RESTful API* for details)
- `PUT /1.0/storage-pools/<pool>/volumes/<volume_type>/<name>` (see *RESTful API* for details)
- `PATCH /1.0/storage-pools/<pool>/volumes/<volume_type>/<name>` (see *RESTful API* for details)
- `DELETE /1.0/storage-pools/<pool>/volumes/<volume_type>/<name>` (see *RESTful API* for details)
- All storage configuration options (see *Storage configuration* for details)

file_delete

Implements `DELETE` in `/1.0/containers/<name>/files`

file_append

Implements the `X-LXD-write` header which can be one of `overwrite` or `append`.

network_dhcp_expiry

Introduces *ipv4.dhcp.expiry* and *ipv6.dhcp.expiry* allowing to set the DHCP lease expiry time.

storage_lvm_vg_rename

Introduces the ability to rename a volume group by setting *lvm.vg_name*.

storage_lvm_thinpool_rename

Introduces the ability to rename a thin pool name by setting *lvm.thinpool_name*.

network_vlan

This adds a new *vlan* property to `macvlan` network devices.

When set, this will instruct LXD to attach to the specified VLAN. LXD will look for an existing interface for that VLAN on the host. If one can't be found it will create one itself and then use that as the macvlan parent.

image_create_aliases

Adds a new `aliases` field to `POST /1.0/images` allowing for aliases to be set at image creation/import time.

container_stateless_copy

This introduces a new `live` attribute in `POST /1.0/containers/<name>`. Setting it to `false` tells LXD not to attempt running state transfer.

container_only_migration

Introduces a new Boolean `container_only` attribute. When set to `true` only the container will be copied or moved.

storage_zfs_clone_copy

Introduces a new Boolean *zfs.clone_copy* property for ZFS storage pools. When set to `false` copying a container will be done through `zfs send` and receive. This will make the target container independent of its source container thus avoiding the need to keep dependent snapshots in the ZFS pool around. However, this also entails less efficient storage usage for the affected pool. The default value for this property is `true`, i.e. space-efficient snapshots will be used unless explicitly set to `false`.

unix_device_rename

Introduces the ability to rename the `unix-block`/`unix-char` device inside container by setting `path`, and the `source` attribute is added to specify the device on host. If `source` is set without a `path`, we should assume that `path` will be the same as `source`. If `path` is set without `source` and `major`/`minor` isn't set, we should assume that `source` will be the same as `path`. So at least one of them must be set.

storage_rsync_bwlimit

When `rsync` has to be invoked to transfer storage entities setting `rsync.bwlimit` places an upper limit on the amount of socket I/O allowed.

network_vxlan_interface

This introduces a new *tunnel.NAME.interface* option for networks.

This key control what host network interface is used for a VXLAN tunnel.

storage_btrfs_mount_options

This introduces the *btrfs.mount_options* property for Btrfs storage pools.

This key controls what mount options will be used for the Btrfs storage pool.

entity_description

This adds descriptions to entities like containers, snapshots, networks, storage pools and volumes.

image_force_refresh

This allows forcing a refresh for an existing image.

storage_lvm_lv_resizing

This introduces the ability to resize logical volumes by setting the `size` property in the containers root disk device.

id_map_base

This introduces a new *security.idmap.base* allowing the user to skip the map auto-selection process for isolated containers and specify what host UID/GID to use as the base.

file_symlinks

This adds support for transferring symlinks through the file API. X-LXD-type can now be `symlink` with the request content being the target path.

container_push_target

This adds the `target` field to `POST /1.0/containers/<name>` which can be used to have the source LXD host connect to the target during migration.

network_vlan_physical

Allows use of *vlan* property with `physical` network devices.

When set, this will instruct LXD to attach to the specified VLAN on the `parent` interface. LXD will look for an existing interface for that `parent` and VLAN on the host. If one can't be found it will create one itself. Then, LXD will directly attach this interface to the container.

storage_images_delete

This enabled the storage API to delete storage volumes for images from a specific storage pool.

container_edit_metadata

This adds support for editing a container `metadata.yaml` and related templates via API, by accessing URLs under `/1.0/containers/<name>/metadata`. It can be used to edit a container before publishing an image from it.

container_snapshot_stateful_migration

This enables migrating stateful container snapshots to new containers.

storage_driver_ceph

This adds a Ceph storage driver.

storage_ceph_user_name

This adds the ability to specify the Ceph user.

instance_types

This adds the `instance_type` field to the container creation request. Its value is expanded to LXD resource limits.

storage_volatile_initial_source

This records the actual source passed to LXD during storage pool creation.

storage_ceph_force_osd_reuse

This introduces the `ceph.osd.force_reuse` property for the Ceph storage driver. When set to `true` LXD will reuse an OSD storage pool that is already in use by another LXD instance.

storage_block_filesystem_btrfs

This adds support for Btrfs as a storage volume file system, in addition to `ext4` and `xfs`.

resources

This adds support for querying a LXD daemon for the system resources it has available.

kernel_limits

This adds support for setting process limits such as maximum number of open files for the container via `nofile`. The format is `limits.kernel.[limit name]`.

storage_api_volume_rename

This adds support for renaming custom storage volumes.

network_sriov

This adds support for SR-IOV enabled network devices.

console

This adds support to interact with the container console device and console log.

restrict_devlxd

A new *security.devlxd* container configuration key was introduced. The key controls whether the `/dev/lxd` interface is made available to the instance. If set to `false`, this effectively prevents the container from interacting with the LXD daemon.

migration_pre_copy

This adds support for optimized memory transfer during live migration.

infiniband

This adds support to use InfiniBand network devices.

maas_network

This adds support for MAAS network integration.

When configured at the daemon level, it's then possible to attach a `nic` device to a particular MAAS subnet.

devlxd_events

This adds a WebSocket API to the `devlxd` socket.

When connecting to `/1.0/events` over the `devlxd` socket, you will now be getting a stream of events over WebSocket.

proxy

This adds a new `proxy` device type to containers, allowing forwarding of connections between the host and container.

network_dhcp_gateway

Introduces a new *ipv4.dhcp.gateway* network configuration key to set an alternate gateway.

file_get_symlink

This makes it possible to retrieve symlinks using the file API.

network_leases

Adds a new `/1.0/networks/NAME/leases` API endpoint to query the lease database on bridges which run a LXD-managed DHCP server.

unix_device_hotplug

This adds support for the *required* property for Unix devices.

storage_api_local_volume_handling

This add the ability to copy and move custom storage volumes locally in the same and between storage pools.

operation_description

Adds a `description` field to all operations.

clustering

Clustering API for LXD.

This includes the following new endpoints (see *RESTful API* for details):

- `GET /1.0/cluster`
- `UPDATE /1.0/cluster`
- `GET /1.0/cluster/members`
- `GET /1.0/cluster/members/<name>`

- `POST /1.0/cluster/members/<name>`
- `DELETE /1.0/cluster/members/<name>`

The following existing endpoints have been modified:

- `POST /1.0/containers` accepts a new `target` query parameter
- `POST /1.0/storage-pools` accepts a new `target` query parameter
- `GET /1.0/storage-pool/<name>` accepts a new `target` query parameter
- `POST /1.0/storage-pool/<pool>/volumes/<type>` accepts a new `target` query parameter
- `GET /1.0/storage-pool/<pool>/volumes/<type>/<name>` accepts a new `target` query parameter
- `POST /1.0/storage-pool/<pool>/volumes/<type>/<name>` accepts a new `target` query parameter
- `PUT /1.0/storage-pool/<pool>/volumes/<type>/<name>` accepts a new `target` query parameter
- `PATCH /1.0/storage-pool/<pool>/volumes/<type>/<name>` accepts a new `target` query parameter
- `DELETE /1.0/storage-pool/<pool>/volumes/<type>/<name>` accepts a new `target` query parameter
- `POST /1.0/networks` accepts a new `target` query parameter
- `GET /1.0/networks/<name>` accepts a new `target` query parameter

event_lifecycle

This adds a new `lifecycle` message type to the events API.

storage_api_remote_volume_handling

This adds the ability to copy and move custom storage volumes between remote.

nvidia_runtime

Adds a *nvidia.runtime* configuration option for containers, setting this to `true` will have the NVIDIA runtime and CUDA libraries passed to the container.

container_mount_propagation

This adds a new *propagation* option to the disk device type, allowing the configuration of kernel mount propagation.

container_backup

Add container backup support.

This includes the following new endpoints (see *RESTful API* for details):

- `GET /1.0/containers/<name>/backups`
- `POST /1.0/containers/<name>/backups`
- `GET /1.0/containers/<name>/backups/<name>`
- `POST /1.0/containers/<name>/backups/<name>`

- `DELETE /1.0/containers/<name>/backups/<name>`
- `GET /1.0/containers/<name>/backups/<name>/export`

The following existing endpoint has been modified:

- `POST /1.0/containers` accepts the new source type `backup`

devlxd_images

Adds a *security.devlxd.images* configuration option for containers which controls the availability of a `/1.0/images/FINGERPRINT/export` API over `devlxd`. This can be used by a container running nested LXD to access raw images from the host.

container_local_cross_pool_handling

This enables copying or moving containers between storage pools on the same LXD instance.

proxy_unix

Add support for both Unix sockets and abstract Unix sockets in proxy devices. They can be used by specifying the address as `unix:/path/to/unix.sock` (normal socket) or `unix:@/tmp/unix.sock` (abstract socket).

Supported connections are now:

- `TCP <-> TCP`
- `UNIX <-> UNIX`
- `TCP <-> UNIX`
- `UNIX <-> TCP`

proxy_udp

Add support for UDP in proxy devices.

Supported connections are now:

- `TCP <-> TCP`
- `UNIX <-> UNIX`
- `TCP <-> UNIX`
- `UNIX <-> TCP`
- `UDP <-> UDP`
- `TCP <-> UDP`
- `UNIX <-> UDP`

clustering_join

This makes `GET /1.0/cluster` return information about which storage pools and networks are required to be created by joining nodes and which node-specific configuration keys they are required to use when creating them. Likewise the `PUT /1.0/cluster` endpoint now accepts the same format to pass information about storage pools and networks to be automatically created before attempting to join a cluster.

proxy_tcp_udp_multi_port_handling

Adds support for forwarding traffic for multiple ports. Forwarding is allowed between a range of ports if the port range is equal for source and target (for example `1.2.3.4 0-1000 -> 5.6.7.8 1000-2000`) and between a range of source ports and a single target port (for example `1.2.3.4 0-1000 -> 5.6.7.8 1000`).

network_state

Adds support for retrieving a network's state.

This adds the following new endpoint (see *RESTful API* for details):

- `GET /1.0/networks/<name>/state`

proxy_unix_dac_properties

This adds support for GID, UID, and mode properties for non-abstract Unix sockets.

container_protection_delete

Enables setting the *security.protection.delete* field which prevents containers from being deleted if set to `true`. Snapshots are not affected by this setting.

proxy_priv_drop

Adds *security.uid* and *security.gid* for the proxy devices, allowing privilege dropping and effectively changing the UID/GID used for connections to Unix sockets too.

pprof_http

This adds a new *core.debug_address* configuration option to start a debugging HTTP server.

That server currently includes a `pprof` API and replaces the old `cpu-profile`, `memory-profile` and `print-goroutines` debug options.

proxy_haproxy_protocol

Adds a *proxy_protocol* key to the proxy device which controls the use of the HAProxy PROXY protocol header.

network_hwaddr

Adds a *bridge.hwaddr* key to control the MAC address of the bridge.

proxy_nat

This adds optimized UDP/TCP proxying. If the configuration allows, proxying will be done via `iptables` instead of proxy devices.

network_nat_order

This introduces the *ipv4.nat.order* and *ipv6.nat.order* configuration keys for LXD bridges. Those keys control whether to put the LXD rules before or after any pre-existing rules in the chain.

container_full

This introduces a new `recursion=2` mode for `GET /1.0/containers` which allows for the retrieval of all container structs, including the state, snapshots and backup structs.

This effectively allows for *lxc list* to get all it needs in one query.

backup_compression

This introduces a new *backups.compression_algorithm* configuration key which allows configuration of backup compression.

nvidia_runtime_config

This introduces a few extra configuration keys when using *nvidia.runtime* and the `libnvidia-container` library. Those keys translate pretty much directly to the matching NVIDIA container environment variables:

- *nvidia.driver.capabilities* => `NVIDIA_DRIVER_CAPABILITIES`
- *nvidia.require.cuda* => `NVIDIA_REQUIRE_CUDA`
- *nvidia.require.driver* => `NVIDIA_REQUIRE_DRIVER`

storage_api_volume_snapshots

Add support for storage volume snapshots. They work like container snapshots, only for volumes.

This adds the following new endpoint (see *RESTful API* for details):

- `GET /1.0/storage-pools/<pool>/volumes/<type>/<name>/snapshots`
- `POST /1.0/storage-pools/<pool>/volumes/<type>/<name>/snapshots`
- `GET /1.0/storage-pools/<pool>/volumes/<type>/<volume>/snapshots/<name>`
- `PUT /1.0/storage-pools/<pool>/volumes/<type>/<volume>/snapshots/<name>`
- `POST /1.0/storage-pools/<pool>/volumes/<type>/<volume>/snapshots/<name>`
- `DELETE /1.0/storage-pools/<pool>/volumes/<type>/<volume>/snapshots/<name>`

storage_unmapped

Introduces a new `security.unmapped` Boolean on storage volumes.

Setting it to `true` will flush the current map on the volume and prevent any further idmap tracking and remapping on the volume.

This can be used to share data between isolated containers after attaching it to the container which requires write access.

projects

Add a new project API, supporting creation, update and deletion of projects.

Projects can hold containers, profiles or images at this point and let you get a separate view of your LXD resources by switching to it.

network_vxlan_ttl

This adds a new *tunnel.NAME.ttl* network configuration option which makes it possible to raise the TTL on VXLAN tunnels.

container_incremental_copy

This adds support for incremental container copy. When copying a container using the `--refresh` flag, only the missing or outdated files will be copied over. Should the target container not exist yet, a normal copy operation is performed.

usb_optional_vendorid

As the name implies, the *vendorid* field on USB devices attached to containers has now been made optional, allowing for all USB devices to be passed to a container (similar to what's done for GPUs).

snapshot_scheduling

This adds support for snapshot scheduling. It introduces three new configuration keys: `snapshots.schedule`, `snapshots.schedule.stopped`, and `snapshots.pattern`. Snapshots can be created automatically up to every minute.

snapshots_schedule_aliases

Snapshot schedule can be configured by a comma-separated list of schedule aliases. Available aliases are `<@hourly>` `<@daily>` `<@midnight>` `<@weekly>` `<@monthly>` `<@annually>` `<@yearly>` `<@startup>` for instances, and `<@hourly>` `<@daily>` `<@midnight>` `<@weekly>` `<@monthly>` `<@annually>` `<@yearly>` for storage volumes.

container_copy_project

Introduces a `project` field to the container source JSON object, allowing for copy/move of containers between projects.

clustering_server_address

This adds support for configuring a server network address which differs from the REST API client network address. When bootstrapping a new cluster, clients can set the new *cluster.https_address* configuration key to specify the address of the initial server. When joining a new server, clients can set the *core.https_address* configuration key of the joining server to the REST API address the joining server should listen at, and set the `server_address` key in the `PUT /1.0/cluster` API to the address the joining server should use for clustering traffic (the value of `server_address` will be automatically copied to the `cluster.https_address` configuration key of the joining server).

clustering_image_replication

Enable image replication across the nodes in the cluster. A new *cluster.images_minimal_replica* configuration key was introduced can be used to specify to the minimal numbers of nodes for image replication.

container_protection_shift

Enables setting the *security.protection.shift* option which prevents containers from having their file system shifted.

snapshot_expiry

This adds support for snapshot expiration. The task is run minutely. The configuration option *snapshots.expiry* takes an expression in the form of `1M 2H 3d 4w 5m 6y` (1 minute, 2 hours, 3 days, 4 weeks, 5 months, 6 years), however not all parts have to be used.

Snapshots which are then created will be given an expiry date based on the expression. This expiry date, defined by `expires_at`, can be manually edited using the API or *lxc config edit*. Snapshots with a valid expiry date will be removed when the task in run. Expiry can be disabled by setting `expires_at` to an empty string or `0001-01-01T00:00:00Z` (zero time). This is the default if `snapshots.expiry` is not set.

This adds the following new endpoint (see *RESTful API* for details):

- `PUT /1.0/containers/<name>/snapshots/<name>`

snapshot_expiry_creation

Adds `expires_at` to container creation, allowing for override of a snapshot's expiry at creation time.

network_leases_location

Introduces a `Location` field in the leases list. This is used when querying a cluster to show what node a particular lease was found on.

resources_cpu_socket

Add Socket field to CPU resources in case we get out of order socket information.

resources_gpu

Add a new GPU struct to the server resources, listing all usable GPUs on the system.

resources_numa

Shows the NUMA node for all CPUs and GPUs.

kernel_features

Exposes the state of optional kernel features through the server environment.

id_map_current

This introduces a new internal *volatile.idmap.current* key which is used to track the current mapping for the container.

This effectively gives us:

- *volatile.last_state.idmap* => On-disk idmap
- *volatile.idmap.current* => Current kernel map
- *volatile.idmap.next* => Next on-disk idmap

This is required to implement environments where the on-disk map isn't changed but the kernel map is (e.g. `idmapped mounts`).

event_location

Expose the location of the generation of API events.

storage_api_remote_volume_snapshots

This allows migrating storage volumes including their snapshots.

network_nat_address

This introduces the *ipv4.nat.address* and *ipv6.nat.address* configuration keys for LXD bridges. Those keys control the source address used for outbound traffic from the bridge.

container_nic_routes

This introduces the *ipv4.routes* and *ipv6.routes* properties on `nic` type devices. This allows adding static routes on host to container's NIC.

cluster_internal_copy

This makes it possible to do a normal `POST /1.0/containers` to copy a container between cluster nodes with LXD internally detecting whether a migration is required.

seccomp_notify

If the kernel supports `seccomp`-based syscall interception LXD can be notified by a container that a registered syscall has been performed. LXD can then decide to trigger various actions.

lxc_features

This introduces the `lxc_features` section output from the *`lxc info`* command via the `GET /1.0` route. It outputs the result of checks for key features being present in the underlying LXC library.

container_nic_ipvlan

This introduces the `ipvlan` `nic` device type.

network_vlan_sriov

This introduces VLAN (*`vlan`*) and MAC filtering (*`security.mac_filtering`*) support for SR-IOV devices.

storage_cephfs

Add support for CephFS as a storage pool driver. This can only be used for custom volumes, images and containers should be on Ceph (RBD) instead.

container_nic_ipfilter

This introduces container IP filtering (*`security.ipv4_filtering`* and *`security.ipv6_filtering`*) support for `bridged` NIC devices.

resources_v2

Rework the resources API at `/1.0/resources`, especially:

- CPU
  - Fix reporting to track sockets, cores and threads
  - Track NUMA node per core
  - Track base and turbo frequency per socket
  - Track current frequency per core
  - Add CPU cache information
  - Export the CPU architecture
  - Show online/offline status of threads
- Memory
  - Add huge-pages tracking
  - Track memory consumption per NUMA node too
- GPU
  - Split DRM information to separate struct
  - Export device names and nodes in DRM struct
  - Export device name and node in NVIDIA struct

- Add SR-IOV VF tracking

container_exec_user_group_cwd

Adds support for specifying `User`, `Group` and `Cwd` during `POST /1.0/containers/NAME/exec`.

container_syscall_intercept

Adds the `security.syscalls.intercept.*` configuration keys to control what system calls will be intercepted by LXD and processed with elevated permissions.

container_disk_shift

Adds the *shift* property on `disk` devices which controls the use of the `idmapped mounts` overlay.

storage_shifted

Introduces a new `security.shifted` Boolean on storage volumes.

Setting it to `true` will allow multiple isolated containers to attach the same storage volume while keeping the file system writable from all of them.

This makes use of `idmapped mounts` as an overlay file system.

resources_infiniband

Export InfiniBand character device information (`issm`, `umad`, `uverb`) as part of the resources API.

daemon_storage

This introduces two new configuration keys *storage.images_volume* and *storage.backups_volume* to allow for a storage volume on an existing pool be used for storing the daemon-wide images and backups artifacts.

instances

This introduces the concept of instances, of which currently the only type is `container`.

image_types

This introduces support for a new Type field on images, indicating what type of images they are.

resources_disk_sata

Extends the disk resource API struct to include:

- Proper detection of SATA devices (type)
- Device path
- Drive RPM
- Block size
- Firmware version
- Serial number

clustering_roles

This adds a new `roles` attribute to cluster entries, exposing a list of roles that the member serves in the cluster.

images_expiry

This allows for editing of the expiry date on images.

resources_network_firmware

Adds a `FirmwareVersion` field to network card entries.

backup_compression_algorithm

This adds support for a `compression_algorithm` property when creating a backup (`POST /1.0/containers/<name>/backups`).

Setting this property overrides the server default value (*backups.compression_algorithm*).

ceph_data_pool_name

This adds support for an optional argument (*ceph.osd.data_pool_name*) when creating storage pools using Ceph RBD, when this argument is used the pool will store it's actual data in the pool specified with `data_pool_name` while keeping the metadata in the pool specified by `pool_name`.

container_syscall_intercept_mount

Adds the *security.syscalls.intercept.mount*, *security.syscalls.intercept.mount.allowed*, and *security.syscalls.intercept.mount.shift* configuration keys to control whether and how the `mount` system call will be intercepted by LXD and processed with elevated permissions.

compression_squashfs

Adds support for importing/exporting of images/backups using SquashFS file system format.

container_raw_mount

This adds support for passing in raw mount options for disk devices.

container_nic_routed

This introduces the `routed` `nic` device type.

container_syscall_intercept_mount_fuse

Adds the *security.syscalls.intercept.mount.fuse* key. It can be used to redirect file-system mounts to their fuse implementation. To this end, set e.g. `security.syscalls.intercept.mount.fuse=ext4=fuse2fs`.

container_disk_ceph

This allows for existing a Ceph RBD or CephFS to be directly connected to a LXD container.

virtual-machines

Add virtual machine support.

image_profiles

Allows a list of profiles to be applied to an image when launching a new container.

clustering_architecture

This adds a new `architecture` attribute to cluster members which indicates a cluster member's architecture.

resources_disk_id

Add a new `device_id` field in the disk entries on the resources API.

storage_lvm_stripes

This adds the ability to use LVM stripes on normal volumes and thin pool volumes.

vm_boot_priority

Adds a `boot.priority` property on NIC and disk devices to control the boot order.

unix_hotplug_devices

Adds support for Unix char and block device hotplugging.

api_filtering

Adds support for filtering the result of a GET request for instances and images.

instance_nic_network

Adds support for the `network` property on a NIC device to allow a NIC to be linked to a managed network. This allows it to inherit some of the network's settings and allows better validation of IP settings.

clustering_sizing

Support specifying a custom values for database voters and standbys. The new *cluster.max_voters* and *cluster.max_standby* configuration keys were introduced to specify to the ideal number of database voter and standbys.

firewall_driver

Adds the `Firewall` property to the `ServerEnvironment` struct indicating the firewall driver being used.

storage_lvm_vg_force_reuse

Introduces the ability to create a storage pool from an existing non-empty volume group. This option should be used with care, as LXD can then not guarantee that volume name conflicts won't occur with non-LXD created volumes in the same volume group. This could also potentially lead to LXD deleting a non-LXD volume should name conflicts occur.

container_syscall_intercept_hugetlbfs

When mount syscall interception is enabled and `hugetlbfs` is specified as an allowed file system type LXD will mount a separate `hugetlbfs` instance for the container with the UID and GID mount options set to the container's root UID and GID. This ensures that processes in the container can use huge pages.

limits_hugepages

This allows to limit the number of huge pages a container can use through the `hugetlb` cgroup. This means the `hugetlb` cgroup needs to be available. Note, that limiting huge pages is recommended when intercepting the mount syscall for the `hugetlbfs` file system to avoid allowing the container to exhaust the host's huge pages resources.

container_nic_routed_gateway

This introduces the *ipv4.gateway* and *ipv6.gateway* NIC configuration keys that can take a value of either `auto` or `none`. The default value for the key if unspecified is `auto`. This will cause the current behavior of a default gateway being added inside the container and the same gateway address being added to the host-side interface. If the value is set to `none` then no default gateway nor will the address be added to the host-side interface. This allows multiple routed NIC devices to be added to a container.

projects_restrictions

This introduces support for the *restricted* configuration key on project, which can prevent the use of security-sensitive features in a project.

custom_volume_snapshot_expiry

This allows custom volume snapshots to expiry. Expiry dates can be set individually, or by setting the `snapshots.expiry` configuration key on the parent custom volume which then automatically applies to all created snapshots.

volume_snapshot_scheduling

This adds support for custom volume snapshot scheduling. It introduces two new configuration keys: `snapshots.schedule` and `snapshots.pattern`. Snapshots can be created automatically up to every minute.

trust_ca_certificates

This allows for checking client certificates trusted by the provided CA (`server.ca`). It can be enabled by setting *core.trust_ca_certificates* to `true`. If enabled, it will perform the check, and bypass the trusted password if `true`. An exception will be made if the connecting client certificate is in the provided CRL (`ca.crl`). In this case, it will ask for the password.

snapshot_disk_usage

This adds a new `size` field to the output of `/1.0/instances/<name>/snapshots/<snapshot>` which represents the disk usage of the snapshot.

clustering_edit_roles

This adds a writable endpoint for cluster members, allowing the editing of their roles.

container_nic_routed_host_address

This introduces the *ipv4.host_address* and *ipv6.host_address* NIC configuration keys that can be used to control the host-side `veth` interface's IP addresses. This can be useful when using multiple routed NICs at the same time and needing a predictable next-hop address to use.

This also alters the behavior of *ipv4.gateway* and *ipv6.gateway* NIC configuration keys. When they are set to `auto` the container will have its default gateway set to the value of `ipv4.host_address` or `ipv6.host_address` respectively.

The default values are:

`ipv4.host_address`: `169.254.0.1` `ipv6.host_address`: `fe80::1`

This is backward compatible with the previous default behavior.

container_nic_ipvlan_gateway

This introduces the *ipv4.gateway* and *ipv6.gateway* NIC configuration keys that can take a value of either `auto` or `none`. The default value for the key if unspecified is `auto`. This will cause the current behavior of a default gateway being added inside the container and the same gateway address being added to the host-side interface. If the value is set to `none` then no default gateway nor will the address be added to the host-side interface. This allows multiple IPVLAN NIC devices to be added to a container.

resources_usb_pci

This adds USB and PCI devices to the output of `/1.0/resources`.

resources_cpu_threads_numa

This indicates that the `numa_node` field is now recorded per-thread rather than per core as some hardware apparently puts threads in different NUMA domains.

resources_cpu_core_die

Exposes the `die_id` information on each core.

api_os

This introduces two new fields in `/1.0`, `os` and `os_version`.

Those are taken from the OS-release data on the system.

container_nic_routed_host_table

This introduces the *ipv4.host_table* and *ipv6.host_table* NIC configuration keys that can be used to add static routes for the instance's IPs to a custom policy routing table by ID.

container_nic_ipvlan_host_table

This introduces the *ipv4.host_table* and *ipv6.host_table* NIC configuration keys that can be used to add static routes for the instance's IPs to a custom policy routing table by ID.

container_nic_ipvlan_mode

This introduces the *mode* NIC configuration key that can be used to switch the `ipvlan` mode into either `l2` or `l3s`. If not specified, the default value is `l3s` (which is the old behavior).

In `l2` mode the *ipv4.address* and *ipv6.address* keys will accept addresses in either CIDR or singular formats. If singular format is used, the default subnet size is taken to be /24 and /64 for IPv4 and IPv6 respectively.

In `l2` mode the *ipv4.gateway* and *ipv6.gateway* keys accept only a singular IP address.

resources_system

This adds system information to the output of `/1.0/resources`.

images_push_relay

This adds the push and relay modes to image copy. It also introduces the following new endpoint:

- `POST 1.0/images/<fingerprint>/export`

network_dns_search

This introduces the `dns.search` configuration option on networks.

container_nic_routed_limits

This introduces *limits.ingress*, *limits.egress* and *limits.max* for routed NICs.

instance_nic_bridged_vlan

This introduces the *vlan* and *vlan.tagged* settings for `bridged` NICs.

`vlan` specifies the non-tagged VLAN to join, and `vlan.tagged` is a comma-delimited list of tagged VLANs to join.

network_state_bond_bridge

This adds a `bridge` and `bond` section to the `/1.0/networks/NAME/state` API.

Those contain additional state information relevant to those particular types.

Bond:

- Mode
- Transmit hash
- Up delay
- Down delay
- MII frequency
- MII state
- Lower devices

Bridge:

- ID
- Forward delay
- STP mode
- Default VLAN
- VLAN filtering
- Upper devices

resources_cpu_isolated

Add an `Isolated` property on CPU threads to indicate if the thread is physically `Online` but is configured not to accept tasks.

usedby_consistency

This extension indicates that `UsedBy` should now be consistent with suitable `?project=` and `?target=` when appropriate.

The 5 entities that have `UsedBy` are:

- Profiles
- Projects
- Networks
- Storage pools
- Storage volumes

custom_block_volumes

This adds support for creating and attaching custom block volumes to instances. It introduces the new `--type` flag when creating custom storage volumes, and accepts the values `fs` and `block`.

clustering_failure_domains

This extension adds a new `failure_domain` field to the `PUT /1.0/cluster/<node>` API, which can be used to set the failure domain of a node.

container_syscall_filtering_allow_deny_syntax

A number of new syscalls related container configuration keys were updated.

- *security.syscalls.deny_default*
- *security.syscalls.deny_compat*
- *security.syscalls.deny*
- *security.syscalls.allow*

Support for the offensively named variants was removed.

resources_gpu_mdev

Expose available mediated device profiles and devices in `/1.0/resources`.

console_vga_type

This extends the `/1.0/console` endpoint to take a `?type=` argument, which can be set to `console` (default) or `vga` (the new type added by this extension).

When doing a `POST` to `/1.0/<instance name>/console?type=vga` the data WebSocket returned by the operation in the metadata field will be a bidirectional proxy attached to a SPICE Unix socket of the target virtual machine.

projects_limits_disk

Add *limits.disk* to the available project configuration keys. If set, it limits the total amount of disk space that instances volumes, custom volumes and images volumes can use in the project.

network_type_macvlan

Adds support for additional network type `macvlan` and adds *parent* configuration key for this network type to specify which parent interface should be used for creating NIC device interfaces on top of.

Also adds *network* configuration key support for `macvlan` NICs to allow them to specify the associated network of the same type that they should use as the basis for the NIC device.

network_type_sriov

Adds support for additional network type `sriov` and adds *parent* configuration key for this network type to specify which parent interface should be used for creating NIC device interfaces on top of.

Also adds *network* configuration key support for `sriov` NICs to allow them to specify the associated network of the same type that they should use as the basis for the NIC device.

container_syscall_intercept_bpf_devices

This adds support to intercept the `bpf` syscall in containers. Specifically, it allows to manage device cgroup `bpf` programs.

network_type_ovn

Adds support for additional network type `ovn` with the ability to specify a `bridge` type network as the `parent`.

Introduces a new NIC device type of `ovn` which allows the `network` configuration key to specify which `ovn` type network they should connect to.

Also introduces two new global configuration keys that apply to all `ovn` networks and NIC devices:

- *network.ovn.integration_bridge* - the OVS integration bridge to use.
- *network.ovn.northbound_connection* - the OVN northbound database connection string.

projects_networks

Adds the *features.networks* configuration key to projects and the ability for a project to hold networks.

projects_networks_restricted_uplinks

Adds the *restricted.networks.uplinks* project configuration key to indicate (as a comma-delimited list) which networks the networks created inside the project can use as their uplink network.

custom_volume_backup

Add custom volume backup support.

This includes the following new endpoints (see *RESTful API* for details):

- `GET /1.0/storage-pools/<pool>/<type>/<volume>/backups`
- `POST /1.0/storage-pools/<pool>/<type>/<volume>/backups`
- `GET /1.0/storage-pools/<pool>/<type>/<volume>/backups/<name>`
- `POST /1.0/storage-pools/<pool>/<type>/<volume>/backups/<name>`
- `DELETE /1.0/storage-pools/<pool>/<type>/<volume>/backups/<name>`
- `GET /1.0/storage-pools/<pool>/<type>/<volume>/backups/<name>/export`

The following existing endpoint has been modified:

- `POST /1.0/storage-pools/<pool>/<type>/<volume>` accepts the new source type `backup`

backup_override_name

Adds `Name` field to `InstanceBackupArgs` to allow specifying a different instance name when restoring a backup.

Adds `Name` and `PoolName` fields to `StoragePoolVolumeBackupArgs` to allow specifying a different volume name when restoring a custom volume backup.

storage_rsync_compression

Adds `rsync.compression` configuration key to storage pools. This key can be used to disable compression in `rsync` while migrating storage pools.

network_type_physical

Adds support for additional network type `physical` that can be used as an uplink for `ovn` networks.

The interface specified by *parent* on the `physical` network will be connected to the `ovn` network's gateway.

network_ovn_external_subnets

Adds support for `ovn` networks to use external subnets from uplink networks.

Introduces the *ipv4.routes* and *ipv6.routes* setting on `physical` networks that defines the external routes allowed to be used in child OVN networks in their *ipv4.routes.external* and *ipv6.routes.external* settings.

Introduces the *restricted.networks.subnets* project setting that specifies which external subnets are allowed to be used by OVN networks inside the project (if not set then all routes defined on the uplink network are allowed).

network_ovn_nat

Adds support for *ipv4.nat* and *ipv6.nat* settings on `ovn` networks.

When creating the network if these settings are unspecified, and an equivalent IP address is being generated for the subnet, then the appropriate NAT setting will added set to `true`.

If the setting is missing then the value is taken as `false`.

network_ovn_external_routes_remove

Removes the settings `ipv4.routes.external` and `ipv6.routes.external` from `ovn` networks.

The equivalent settings on the `ovn` NIC type can be used instead for this, rather than having to specify them both at the network and NIC level.

tpm_device_type

This introduces the `tpm` device type.

storage_zfs_clone_copy_rebase

This introduces `rebase` as a value for *zfs.clone_copy* causing LXD to track down any `image` dataset in the ancestry line and then perform send/receive on top of that.

gpu_mdev

This adds support for virtual GPUs. It introduces the *mdev* configuration key for GPU devices which takes a supported `mdev` type, e.g. `i915-GVTg_V5_4`.

resources_pci_iommu

This adds the `IOMMUGroup` field for PCI entries in the resources API.

resources_network_usb

Adds the `usb_address` field to the network card entries in the resources API.

resources_disk_address

Adds the `usb_address` and `pci_address` fields to the disk entries in the resources API.

network_physical_ovn_ingress_mode

Adds *ovn.ingress_mode* setting for `physical` networks.

Sets the method that OVN NIC external IPs will be advertised on uplink network.

Either `l2proxy` (proxy ARP/NDP) or `routed`.

network_ovn_dhcp

Adds *ipv4.dhcp* and *ipv6.dhcp* settings for `ovn` networks.

Allows DHCP (and RA for IPv6) to be disabled. Defaults to on.

network_physical_routes_anycast

Adds *ipv4.routes.anycast* and *ipv6.routes.anycast* Boolean settings for `physical` networks. Defaults to `false`.

Allows OVN networks using physical network as uplink to relax external subnet/route overlap detection when used with *ovn.ingress_mode* set to `routed`.

projects_limits_instances

Adds *limits.instances* to the available project configuration keys. If set, it limits the total number of instances (VMs and containers) that can be used in the project.

network_state_vlan

This adds a `vlan` section to the `/1.0/networks/NAME/state` API.

Those contain additional state information relevant to VLAN interfaces:

- `lower_device`
- `vid`

instance_nic_bridged_port_isolation

This adds the *security.port_isolation* field for bridged NIC instances.

instance_bulk_state_change

Adds the following endpoint for bulk state change (see *RESTful API* for details):

- `PUT /1.0/instances`

network_gvrp

This adds an optional `gvrp` property to `macvlan` and `physical` networks, and to `ipvlan`, `macvlan`, `routed` and `physical` NIC devices.

When set, this specifies whether the VLAN should be registered using GARP VLAN Registration Protocol. Defaults to `false`.

instance_pool_move

This adds a `pool` field to the `POST /1.0/instances/NAME` API, allowing for easy move of an instance root disk between pools.

gpu_sriov

This adds support for SR-IOV enabled GPUs. It introduces the `sriov` GPU type property.

pci_device_type

This introduces the `pci` device type.

storage_volume_state

Add new `/1.0/storage-pools/POOL/volumes/VOLUME/state` API endpoint to get usage data on a volume.

network_acl

This adds the concept of network ACLs to API under the API endpoint prefix `/1.0/network-acls`.

migration_stateful

Add a new *migration.stateful* configuration key.

disk_state_quota

This introduces the *size.state* device configuration key on `disk` devices.

storage_ceph_features

Adds a new *ceph.rbd.features* configuration key on storage pools to control the RBD features used for new volumes.

projects_compression

Adds new *backups.compression_algorithm* and *images.compression_algorithm* configuration keys which allows configuration of backup and image compression per-project.

projects_images_remote_cache_expiry

Add new *images.remote_cache_expiry* configuration key to projects, allowing for set number of days after which an unused cached remote image will be flushed.

certificate_project

Adds a new `restricted` property to certificates in the API as well as `projects` holding a list of project names that the certificate has access to.

network_ovn_acl

Adds a new `security.acls` property to OVN networks and OVN NICs, allowing Network ACLs to be applied.

projects_images_auto_update

Adds new *images.auto_update_cached* and *images.auto_update_interval* configuration keys which allows configuration of images auto update in projects

projects_restricted_cluster_target

Adds new *restricted.cluster.target* configuration key to project which prevent the user from using –target to specify what cluster member to place a workload on or the ability to move a workload between members.

images_default_architecture

Adds new *images.default_architecture* global configuration key and matching per-project key which lets user tell LXD what architecture to go with when no specific one is specified as part of the image request.

network_ovn_acl_defaults

Adds new `security.acls.default.{in,e}gress.action` and `security.acls.default.{in,e}gress.logged` configuration keys for OVN networks and NICs. This replaces the removed ACL `default.action` and `default.logged` keys.

gpu_mig

This adds support for NVIDIA MIG. It introduces the `mig` GPU type and associated configuration keys.

project_usage

Adds an API endpoint to get current resource allocations in a project. Accessible at API `GET /1.0/projects/<name>/state`.

network_bridge_acl

Adds a new *security.acls* configuration key to `bridge` networks, allowing Network ACLs to be applied.

Also adds `security.acls.default.{in,e}gress.action` and `security.acls.default.{in,e}gress.logged` configuration keys for specifying the default behavior for unmatched traffic.

warnings

Warning API for LXD.

This includes the following endpoints (see *Restful API* for details):

- `GET /1.0/warnings`
- `GET /1.0/warnings/<uuid>`
- `PUT /1.0/warnings/<uuid>`
- `DELETE /1.0/warnings/<uuid>`

projects_restricted_backups_and_snapshots

Adds new *restricted.backups* and *restricted.snapshots* configuration keys to project which prevents the user from creation of backups and snapshots.

clustering_join_token

Adds `POST /1.0/cluster/members` API endpoint for requesting a join token used when adding new cluster members without using the trust password.

clustering_description

Adds an editable description to the cluster members.

server_trusted_proxy

This introduces support for *core.https_trusted_proxy* which has LXD parse a HAProxy style connection header on such connections and if present, will rewrite the request's source address to that provided by the proxy server.

clustering_update_cert

Adds `PUT /1.0/cluster/certificate` endpoint for updating the cluster certificate across the whole cluster

storage_api_project

This adds support for copy/move custom storage volumes between projects.

server_instance_driver_operational

This modifies the `driver` output for the `/1.0` endpoint to only include drivers which are actually supported and operational on the server (as opposed to being included in LXD but not operational on the server).

server_supported_storage_drivers

This adds supported storage driver info to server environment info.

event_lifecycle_requestor_address

Adds a new address field to `lifecycle` requestor.

resources_gpu_usb

Add a new `USBAddress` (`usb_address`) field to `ResourcesGPUCard` (GPU entries) in the resources API.

clustering_evacuation

Adds `POST /1.0/cluster/members/<name>/state` endpoint for evacuating and restoring cluster members. It also adds the configuration keys *cluster.evacuate* and *volatile.evacuate.origin* for setting the evacuation method (`auto`, `stop` or `migrate`) and the origin of any migrated instance respectively.

network_ovn_nat_address

This introduces the *ipv4.nat.address* and *ipv6.nat.address* configuration keys for LXD `ovn` networks. Those keys control the source address used for outbound traffic from the OVN virtual network. These keys can only be specified when the OVN network's uplink network has *ovn.ingress_mode* set to `routed`.

network_bgp

This introduces support for LXD acting as a BGP router to advertise routes to `bridge` and `ovn` networks.

This comes with the addition to global configuration of:

- *core.bgp_address*
- *core.bgp_asn*
- *core.bgp_routerid*

The following network configurations keys (`bridge` and `physical`):

- `bgp.peers.<name>.address`
- `bgp.peers.<name>.asn`
- `bgp.peers.<name>.password`

The `nexthop` configuration keys (`bridge`):

- *bgp.ipv4.nexthop*
- *bgp.ipv6.nexthop*

And the following NIC-specific configuration keys (`bridged` NIC type):

- *ipv4.routes.external*
- *ipv6.routes.external*

network_forward

This introduces the networking address forward functionality. Allowing for `bridge` and `ovn` networks to define external IP addresses that can be forwarded to internal IP(s) inside their respective networks.

custom_volume_refresh

Adds support for refresh during volume migration.

network_counters_errors_dropped

This adds the received and sent errors as well as inbound and outbound dropped packets to the network counters.

metrics

This adds metrics to LXD. It returns metrics of running instances using the OpenMetrics format.

This includes the following endpoints:

- `GET /1.0/metrics`

image_source_project

Adds a new `project` field to `POST /1.0/images` allowing for the source project to be set at image copy time.

clustering_config

Adds new `config` property to cluster members with configurable key/value pairs.

network_peer

This adds network peering to allow traffic to flow between OVN networks without leaving the OVN subsystem.

linux_sysctl

Adds new `linux.sysctl.*` configuration keys allowing users to modify certain kernel parameters within containers.

network_dns

Introduces a built-in DNS server and zones API to provide DNS records for LXD instances.

This introduces the following server configuration key:

- *core.dns_address*

The following network configuration key:

- `dns.zone.forward`
- `dns.zone.reverse.ipv4`
- `dns.zone.reverse.ipv6`

And the following project configuration key:

- *restricted.networks.zones*

A new REST API is also introduced to manage DNS zones:

- `/1.0/network-zones` (GET, POST)
- `/1.0/network-zones/<name>` (GET, PUT, PATCH, DELETE)

ovn_nic_acceleration

Adds new *acceleration* configuration key to OVN NICs which can be used for enabling hardware offloading. It takes the values `none` or `sriov`.

certificate_self_renewal

This adds support for renewing a client's own trust certificate.

instance_project_move

This adds a `project` field to the `POST /1.0/instances/NAME` API, allowing for easy move of an instance between projects.

storage_volume_project_move

This adds support for moving storage volume between projects.

cloud_init

This adds a new `cloud-init` configuration key namespace which contains the following keys:

- *cloud-init.vendor-data*
- *cloud-init.user-data*
- *cloud-init.network-config*

It also adds a new endpoint `/1.0/devices` to `devlxd` which shows an instance's devices.

network_dns_nat

This introduces `network.nat` as a configuration option on network zones (DNS).

It defaults to the current behavior of generating records for all instances NICs but if set to `false`, it will instruct LXD to only generate records for externally reachable addresses.

database_leader

Adds new `database-leader` role which is assigned to cluster leader.

instance_all_projects

This adds support for displaying instances from all projects.

clustering_groups

Add support for grouping cluster members.

This introduces the following new endpoints:

- `/1.0/cluster/groups` (GET, POST)
- `/1.0/cluster/groups/<name>` (GET, POST, PUT, PATCH, DELETE)

The following project restriction is added:

- *restricted.cluster.groups*

ceph_rbd_du

Adds a new *ceph.rbd.du* Boolean on Ceph storage pools which allows disabling the use of the potentially slow `rbd du` calls.

instance_get_full

This introduces a new `recursion=1` mode for `GET /1.0/instances/{name}` which allows for the retrieval of all instance structs, including the state, snapshots and backup structs.

qemu_metrics

This adds a new *security.agent.metrics* Boolean which defaults to `true`. When set to `false`, it doesn't connect to the `lxd-agent` for metrics and other state information, but relies on stats from QEMU.

gpu_mig_uuid

Adds support for the new MIG UUID format used by NVIDIA `470+` drivers (for example, `MIG-74c6a31a-fde5-5c61-973b-70e12346c202`), the `MIG-` prefix can be omitted

This extension supersedes old `mig.gi` and `mig.ci` parameters which are kept for compatibility with old drivers and cannot be set together.

event_project

Expose the project an API event belongs to.

clustering_evacuation_live

This adds `live-migrate` as a configuration option to *`cluster.evacuate`*, which forces live-migration of instances during cluster evacuation.

instance_allow_inconsistent_copy

Adds `allow_inconsistent` field to instance source on `POST /1.0/instances`. If `true`, `rsync` will ignore the `Partial transfer due to vanished source files` (code 24) error when creating an instance from a copy.

network_state_ovn

This adds an `ovn` section to the `/1.0/networks/NAME/state` API which contains additional state information relevant to OVN networks:

- chassis

storage_volume_api_filtering

Adds support for filtering the result of a GET request for storage volumes.

image_restrictions

This extension adds on to the image properties to include image restrictions/host requirements. These requirements help determine the compatibility between an instance and the host system.

storage_zfs_export

Introduces the ability to disable zpool export when unmounting pool by setting *`zfs.export`*.

network_dns_records

This extends the network zones (DNS) API to add the ability to create and manage custom records.

This adds:

- `GET /1.0/network-zones/ZONE/records`
- `POST /1.0/network-zones/ZONE/records`
- `GET /1.0/network-zones/ZONE/records/RECORD`
- `PUT /1.0/network-zones/ZONE/records/RECORD`
- `PATCH /1.0/network-zones/ZONE/records/RECORD`
- `DELETE /1.0/network-zones/ZONE/records/RECORD`

storage_zfs_reserve_space

Adds ability to set the `reservation/refreservation` ZFS property along with `quota/refquota`.

network_acl_log

Adds a new `GET /1.0/networks-acls/NAME/log` API to retrieve ACL firewall logs.

storage_zfs_blocksize

Introduces a new *zfs.blocksize* property for ZFS storage volumes which allows to set volume block size.

metrics_cpu_seconds

This is used to detect whether LXD was fixed to output used CPU time in seconds rather than as milliseconds.

instance_snapshot_never

Adds a `@never` option to `snapshots.schedule` which allows disabling inheritance.

certificate_token

This adds token-based certificate addition to the trust store as a safer alternative to a trust password.

It adds the `token` field to `POST /1.0/certificates`.

instance_nic_routed_neighbor_probe

This adds the ability to disable the `routed` NIC IP neighbor probing for availability on the parent network.

Adds the *ipv4.neighbor_probe* and *ipv6.neighbor_probe* NIC settings. Defaulting to `true` if not specified.

event_hub

This adds support for `event-hub` cluster member role and the `ServerEventMode` environment field.

agent_nic_config

If set to `true`, on VM start-up the `lxd-agent` will apply NIC configuration to change the names and MTU of the instance NIC devices.

projects_restricted_intercept

Adds new *restricted.containers.interception* configuration key to allow usually safe system call interception options.

metrics_authentication

Introduces a new *core.metrics_authentication* server configuration option to allow for the `/1.0/metrics` endpoint to be generally available without client authentication.

images_target_project

Adds ability to copy image to a project different from the source.

cluster_migration_inconsistent_copy

Adds `allow_inconsistent` field to `POST /1.0/instances/<name>`. Set to `true` to allow inconsistent copying between cluster members.

cluster_ovn_chassis

Introduces a new `ovn-chassis` cluster role which allows for specifying what cluster member should act as an OVN chassis.

container_syscall_intercept_sched_setscheduler

Adds the *security.syscalls.intercept.sched_setscheduler* to allow advanced process priority management in containers.

storage_lvm_thinpool_metadata_size

Introduces the ability to specify the thin pool metadata volume size via *lvm.thinpool_metadata_size*.

If this is not specified then the default is to let LVM pick an appropriate thin pool metadata volume size.

storage_volume_state_total

This adds `total` field to the `GET /1.0/storage-pools/{name}/volumes/{type}/{volume}/state` API.

instance_file_head

Implements HEAD on `/1.0/instances/NAME/file`.

instances_nic_host_name

This introduces the *instances.nic.host_name* server configuration key that can take a value of either `random` or `mac`. The default value for the key if unspecified is `random`. If it is set to random then use the random host interface names. If it's set to `mac`, then generate a name in the form `lxd1122334455`.

image_copy_profile

Adds ability to modify the set of profiles when image is copied.

container_syscall_intercept_sysinfo

Adds the *security.syscalls.intercept.sysinfo* to allow the `sysinfo` syscall to be populated with cgroup-based resource usage information.

clustering_evacuation_mode

This introduces a `mode` field to the evacuation request which allows for overriding the evacuation mode traditionally set through *cluster.evacuate*.

resources_pci_vpd

Adds a new VPD struct to the PCI resource entries. This struct extracts vendor provided data including the full product name and additional key/value configuration pairs.

qemu_raw_conf

Introduces a *raw.qemu.conf* configuration key to override select sections of the generated `qemu.conf`.

storage_cephfs_fscache

Add support for `fscache`/`cachefilesd` on CephFS pools through a new *cephfs.fscache* configuration option.

network_load_balancer

This introduces the networking load balancer functionality. Allowing `ovn` networks to define port(s) on external IP addresses that can be forwarded to one or more internal IP(s) inside their respective networks.

vsock_api

This introduces a bidirectional `vsock` interface which allows the `lxd-agent` and the LXD server to communicate better.

instance_ready_state

This introduces a new `Ready` state for instances which can be set using `devlxd`.

network_bgp_holdtime

This introduces a new `bgp.peers.<name>.holdtime` configuration key to control the BGP hold time for a particular peer.

storage_volumes_all_projects

This introduces the ability to list storage volumes from all projects.

metrics_memory_oom_total

This introduces a new `lxd_memory_OOM_kills_total` metric to the `/1.0/metrics` API. It reports the number of times the out of memory killer (`OOM`) has been triggered.

storage_buckets

This introduces the storage bucket API. It allows the management of S3 object storage buckets for storage pools.

storage_buckets_create_credentials

This updates the storage bucket API to return initial admin credentials at bucket creation time.

metrics_cpu_effective_total

This introduces a new `lxd_cpu_effective_total` metric to the `/1.0/metrics` API. It reports the total number of effective CPUs.

projects_networks_restricted_access

Adds the *restricted.networks.access* project configuration key to indicate (as a comma-delimited list) which networks can be accessed inside the project. If not specified, all networks are accessible (assuming it is also allowed by the *restricted.devices.nic* setting, described below).

This also introduces a change whereby network access is controlled by the project's *restricted.devices.nic* setting:

- If `restricted.devices.nic` is set to `managed` (the default if not specified), only managed networks are accessible.
- If `restricted.devices.nic` is set to `allow`, all networks are accessible (dependent on the `restricted.networks.access` setting).
- If `restricted.devices.nic` is set to `block`, no networks are accessible.

storage_buckets_local

This introduces the ability to use storage buckets on local storage pools by setting the new *core.storage_buckets_address* global configuration setting.

loki

This adds support for sending life cycle and logging events to a Loki server.

It adds the following global configuration keys:

- *loki.api.ca_cert*: CA certificate which can be used when sending events to the Loki server
- *loki.api.url*: URL to the Loki server (protocol, name or IP and port)
- *loki.auth.username* and *loki.auth.password*: Used if Loki is behind a reverse proxy with basic authentication enabled
- *loki.labels*: Comma-separated list of values which are to be used as labels for Loki events.
- *loki.loglevel*: Minimum log level for events sent to the Loki server.
- *loki.types*: Types of events which are to be sent to the Loki server (`lifecycle` and/or `logging`).

acme

This adds ACME support, which allows Let's Encrypt or other ACME services to issue certificates.

It adds the following global configuration keys:

- *acme.domain*: The domain for which the certificate should be issued.
- *acme.email*: The email address used for the account of the ACME service.
- *acme.ca_url*: The directory URL of the ACME service, defaults to `https://acme-v02.api.letsencrypt.org/directory`.

It also adds the following endpoint, which is required for the HTTP-01 challenge:

- `/.well-known/acme-challenge/<token>`

internal_metrics

This adds internal metrics to the list of metrics. These include:

- Total running operations
- Total active warnings
- Daemon uptime in seconds
- Go memory stats
- Number of goroutines

cluster_join_token_expiry

This adds an expiry to cluster join tokens which defaults to 3 hours, but can be changed by setting the *cluster.join_token_expiry* configuration key.

remote_token_expiry

This adds an expiry to remote add join tokens. It can be set in the *core.remote_token_expiry* configuration key, and default to no expiry.

storage_volumes_created_at

This change adds support for storing the creation date and time of storage volumes and their snapshots.

This adds the `CreatedAt` field to the `StorageVolume` and `StorageVolumeSnapshot` API types.

cpu_hotplug

This adds CPU hotplugging for VMs. Hotplugging is disabled when using CPU pinning, because this would require hotplugging NUMA devices as well, which is not possible.

projects_networks_zones

This adds support for the *features.networks.zones* project feature, which changes which project network zones are associated with when they are created. Previously network zones were tied to the value of *features.networks*, meaning they were created in the same project as networks were.

Now this has been decoupled from *features.networks* to allow projects that share a network in the default project (i.e those with `features.networks=false`) to have their own project level DNS zones that give a project oriented "view" of the addresses on that shared network (which only includes addresses from instances in their project).

This also introduces a change to the network `dns.zone.forward` setting, which now accepts a comma-separated of DNS zone names (a maximum of one per project) in order to associate a shared network with multiple zones.

No change to the `dns.zone.reverse.*` settings have been made, they still only allow a single DNS zone to be set. However the resulting zone content that is generated now includes `PTR` records covering addresses from all projects that are referencing that network via one of their forward zones.

Existing projects that have `features.networks=true` will have `features.networks.zones=true` set automatically, but new projects will need to specify this explicitly.

instance_nic_txqueuelength

Adds a `txqueuelen` key to control the `txqueuelen` parameter of the NIC device.

cluster_member_state

Adds `GET /1.0/cluster/members/<member>/state` API endpoint and associated `ClusterMemberState` API response type.

instances_placement_scriptlet

Adds support for a Starlark scriptlet to be provided to LXD to allow customized logic that controls placement of new instances in a cluster.

The Starlark scriptlet is provided to LXD via the new global configuration option *instances.placement.scriptlet*.

storage_pool_source_wipe

Adds support for a `source.wipe` Boolean on the storage pool, indicating that LXD should wipe partition headers off the requested disk rather than potentially fail due to pre-existing file systems.

zfs_block_mode

This adds support for using ZFS block volumes allowing the use of different file systems on top of ZFS.

This adds the following new configuration options for ZFS storage pools:

- `volume.zfs.block_mode`
- `volume.block.mount_options`
- `volume.block.filesystem`

instance_generation_id

Adds support for instance generation ID. The VM or container generation ID will change whenever the instance's place in time moves backwards. As of now, the generation ID is only exposed through to VM type instances. This allows for the VM guest OS to reinitialize any state it needs to avoid duplicating potential state that has already occurred:

- *volatile.uuid.generation*

disk_io_cache

This introduces a new *io.cache* property to disk devices which can be used to override the VM caching behavior.

amd_sev

Adds support for AMD SEV (Secure Encrypted Virtualization) that can be used to encrypt the memory of a guest VM.

This adds the following new configuration options for SEV encryption:

- *security.sev* : (bool) is SEV enabled for this VM
- *security.sev.policy.es* : (bool) is SEV-ES enabled for this VM
- *security.sev.session.dh* : (string) guest owner's `base64`-encoded Diffie-Hellman key
- *security.sev.session.data* : (string) guest owner's `base64`-encoded session blob

storage_pool_loop_resize

This allows growing loop file backed storage pools by changing the `size` setting of the pool.

migration_vm_live

This adds support for performing VM QEMU to QEMU live migration for both shared storage (clustered Ceph) and non-shared storage pools.

This also adds the `CRIUType_VM_QEMU` value of `3` for the migration `CRIUType` `protobuf` field.

ovn_nic_nesting

This adds support for nesting an `ovn` NIC inside another `ovn` NIC on the same instance. This allows for an OVN logical switch port to be tunneled inside another OVN NIC using VLAN tagging.

This feature is configured by specifying the parent NIC name using the *nested* property and the VLAN ID to use for tunneling with the *vlan* property.

oidc

This adds support for OpenID Connect (OIDC) authentication.

This adds the following new configuration keys:

- *oidc.issuer*
- *oidc.client.id*
- *oidc.audience*

network_ovn_l3only

This adds the ability to set an `ovn` network into "layer 3 only" mode. This mode can be enabled at IPv4 or IPv6 level using *ipv4.l3only* and *ipv6.l3only* configuration options respectively.

With this mode enabled the following changes are made to the network:

- The virtual router's internal port address will be configured with a single host netmask (e.g. /32 for IPv4 or /128 for IPv6).
- Static routes for active instance NIC addresses will be added to the virtual router.
- A discard route for the entire internal subnet will be added to the virtual router to prevent packets destined for inactive addresses from escaping to the uplink network.
- The DHCPv4 server will be configured to indicate that a netmask of 255.255.255.255 be used for instance configuration.

ovn_nic_acceleration_vdpa

This updates the `ovn_nic_acceleration` API extension. The *acceleration* configuration key for OVN NICs can now takes the value `vdpa` to support Virtual Data Path Acceleration (VDPA).

cluster_healing

This adds cluster healing which automatically evacuates offline cluster members.

This adds the following new configuration key:

- *cluster.healing_threshold*

The configuration key takes an integer, and can be disabled by setting it to 0 (default). If set, the value represents the threshold after which an offline cluster member is to be evacuated. In case the value is lower than *cluster.offline_threshold*, that value will be used instead.

When the offline cluster member is evacuated, only remote-backed instances will be migrated. Local instances will be ignored as there is no way of migrating them once the cluster member is offline.

instances_state_total

This extension adds a new `total` field to `InstanceStateDisk` and `InstanceStateMemory`, both part of the instance's state API.

auth_user

Add current user details to the main API endpoint.

This introduces:

- `auth_user_name`
- `auth_user_method`

security_csm

Introduce a new *security.csm* configuration key to control the use of CSM (Compatibility Support Module) to allow legacy operating systems to be run in LXD VMs.

instances_rebuild

This extension adds the ability to rebuild an instance with the same origin image, alternate image or as empty. A new POST /1.0/instances/<name>/rebuild?project=<project> API endpoint has been added as well as a new CLI command *lxc rebuild*.

numa_cpu_placement

This adds the possibility to place a set of CPUs in a desired set of NUMA nodes.

This adds the following new configuration key:

- *limits.cpu.nodes* : (string) comma-separated list of NUMA node IDs or NUMA node ID ranges to place the CPUs (chosen with a dynamic value of *limits.cpu*) in.

custom_volume_iso

This adds the possibility to import ISO images as custom storage volumes.

This adds the --type flag to *lxc storage volume import*.

network_allocations

This adds the possibility to list a LXD deployment's network allocations.

Through the *lxc network list-allocations* command and the --project <PROJECT> | --all-projects flags, you can list all the used IP addresses, hardware addresses (for instances), resource URIs and whether it uses NAT for each instance, network, network forward and network load-balancer.

storage_api_remote_volume_snapshot_copy

This allows copying storage volume snapshots to and from remotes.

zfs_delegate

This implements a new *zfs.delegate* volume Boolean for volumes on a ZFS storage driver. When enabled and a suitable system is in use (requires ZFS 2.2 or higher), the ZFS dataset will be delegated to the container, allowing for its use through the zfs command line tool.

operations_get_query_all_projects

This introduces support for the `all-projects` query parameter for the GET API calls to both `/1.0/operations` and `/1.0/operations?recursion=1`. This parameter allows bypassing the project name filter.

metadata_configuration

Adds the `GET /1.0/metadata/configuration` API endpoint to retrieve the generated metadata configuration in a JSON format. The JSON structure adopts the structure `"configs" > `ENTITY` > `ENTITY_SECTION` > "keys" > [<CONFIG_OPTION_0>, <CONFIG_OPTION_1>, ...]`. Check the list of *configuration options* to see which configuration options are included.

syslog_socket

This introduces a syslog socket that can receive syslog formatted log messages. These can be viewed in the events API and `lxc monitor`, and can be forwarded to Loki. To enable this feature, set *`core.syslog_socket`* to `true`.

event_lifecycle_name_and_project

This adds the fields `Name` and `Project` to `lifecycle` events.

instances_nic_limits_priority

This introduces a new per-NIC `limits.priority` option that works with both cgroup1 and cgroup2 unlike the deprecated `limits.network.priority` instance setting, which only worked with cgroup1.

disk_initial_volume_configuration

This API extension provides the capability to set initial volume configurations for instance root devices. Initial volume configurations are prefixed with `initial.` and can be specified either through profiles or directly during instance initialization using the `--device` flag.

Note that these configuration are applied only at the time of instance creation and subsequent modifications have no effect on existing devices.

operation_wait

This API extension indicates that the `/1.0/operations/{id}/wait` endpoint exists on the server. This indicates to the client that the endpoint can be used to wait for an operation to complete rather than waiting for an operation event via the `/1.0/events` endpoint.

cluster_internal_custom_volume_copy

This extension adds support for copying and moving custom storage volumes within a cluster with a single API call. Calling `POST /1.0/storage-pools/<pool>/custom?target=<target>` will copy the custom volume specified in the `source` part of the request. Calling `POST /1.0/storage-pools/<pool>/custom/<volume>?target=<target>` will move the custom volume from the source, specified in the `source` part of the request, to the target.

disk_io_bus

This introduces a new *io.bus* property to disk devices which can be used to override the bus the disk is attached to.

storage_cephfs_create_missing

This introduces the configuration keys *cephfs.create_missing*, *cephfs.osd_pg_num*, *cephfs.meta_pool* and *cephfs.data_pool* to be used when adding a `cephfs` storage pool to instruct LXD to create the necessary entities for the storage pool, if they do not exist.

instance_move_config

This API extension provides the ability to use flags `--profile`, `--no-profile`, `--device`, and `--config` when moving an instance between projects and/or storage pools.

ovn_ssl_config

This introduces new server configuration keys to provide the SSL CA and client key pair to access the OVN databases. The new configuration keys are *network.ovn.ca_cert*, *network.ovn.client_cert* and *network.ovn.client_key*.

init_preseed_storage_volumes

This API extension provides the ability to configure storage volumes in preseed init.

metrics_instances_count

This extends the metrics to include the containers and virtual machines counts. Instances are counted irrespective of their state.

server_instance_type_info

This API extension enables querying a server's supported instance types. When querying the `/1.0` endpoint, a new field named `instance_types` is added to the retrieved data. This field indicates which instance types are supported by the server.

resources_disk_mounted

Adds a `mounted` field to disk resources that LXD discovers on the system, reporting whether that disk or partition is mounted.

server_version_lts

The API extension adds indication whether the LXD version is an LTS release. This is indicated when command `lxc version` is executed or when `/1.0` endpoint is queried.

oidc_groups_claim

This API extension enables setting an *oidc.groups.claim* configuration key. If OIDC authentication is configured and this claim is set, LXD will request this claim in the scope of OIDC flow. The value of the claim will be extracted and might be used to make authorization decisions.

loki_config_instance

Adds a new *loki.instance* server configuration key to customize the `instance` field in Loki events. This can be used to expose the name of the cluster rather than the individual system name sending the event as that's usually already covered by the `location` field.

storage_volatile_uuid

Adds a new `volatile.uuid` configuration key to all storage volumes, snapshots and buckets. This information can be used by storage drivers as a separate identifier besides the name when working with volumes.

import_instance_devices

This API extension provides the ability to use flags `--device` when importing an instance to override instance's devices.

instances_uefi_vars

This API extension indicates that the `/1.0/instances/{name}/uefi-vars` endpoint is supported on the server. This endpoint allows to get the full list of UEFI variables (HTTP method GET) or replace the entire set of UEFI variables (HTTP method PUT).

instances_migration_stateful

This API extension allows newly created VMs to have their *migration.stateful* configuration key automatically set through the new server-level configuration key *instances.migration.stateful*. If `migration.stateful` is already set at the profile or instance level then `instances.migration.stateful` is not applied.

access_management

Adds new APIs under `/1.0/auth` for viewing and managing identities, groups, and permissions. Adds an embedded OpenFGA authorization driver for enforcing fine-grained permissions.

Important: Prior to the addition of this extension, all OIDC clients were given full access to LXD (equivalent to Unix socket access). This extension revokes access to all OIDC clients. To regain access, a user must:

1. Make a call to the OIDC enabled LXD remote (e.g. `lxc info`) to ensure that their OIDC identity is added to the LXD database.
2. Create a group: `lxc auth group create <group_name>`
3. Grant the group a suitable permission. As all OIDC clients prior to this extension have had full access to LXD, the corresponding permission is `admin` on `server`. To grant this permission to your group, run: `lxc auth group permission add <group_name> server admin`
4. Add themselves to the group. To do this, run: `lxc auth identity group add oidc/<email_address> <group_name>`

Steps 2 to 4 above cannot be performed via OIDC authentication (access has been revoked). They must be performed by a sufficiently privileged user, either via Unix socket or unrestricted TLS client certificate.

For more information on access control for OIDC clients, see *Fine-grained authorization*.

---

vm_disk_io_limits

Adds the ability to limit disk I/O for virtual machines.

storage_volumes_all

This API extension adds support for listing storage volumes from all storage pools via `/1.0/storage-volumes` or `/1.0/storage-volumes/{type}` to filter by volume type. Also adds a `pool` field to storage volumes.

instances_files_modify_permissions

Adds the ability for `POST /1.0/instances/{name}/files` to modify the permissions of files that already exist via the `X-LXD-modify-perm` header.

`X-LXD-modify-perm` should be a comma-separated list of 0 or more of `mode`, `uid`, and `gid`.

image_restriction_nesting

This extension adds a new image restriction, `requirements.nesting` which when `true` indicates that an image cannot be run without nesting.

container_syscall_intercept_finit_module

Adds the *linux.kernel_modules.load* container configuration option. If the option is set to `ondemand`, the `finit_modules()` syscall is intercepted and a privileged user in the container's user namespace can load the Linux kernel modules specified in the allow list *linux.kernel_modules*.

device_usb_serial

This adds new configuration keys *serial*, *busnum* and *devnum* for *device type* *usb*. The feature has been added to make it possible to distinguish between devices with identical *vendorid* and *productid*.

network_allocate_external_ips

Adds the ability to use an unspecified IPv4 (`0.0.0.0`) or IPv6 (`::`) address in the `listen_address` field of the request body for `POST /1.0/networks/{networkName}/load-balancers` and `POST /1.0/networks/{networkName}/forwards`. If an unspecified IP address is used, supported drivers will allocate an available listen address automatically. Allocation of external IP addresses is currently supported by the OVN network driver. The OVN driver will allocate IP addresses from the subnets specified in the uplink network's `ipv4.routes` and `ipv6.routes` configuration options.

Events

Introduction

Events are messages about actions that have occurred over LXD. Using the API endpoint `/1.0/events` directly or via *lxc monitor* will connect to a WebSocket through which logs and life-cycle messages will be streamed.

Event types

LXD Currently supports three event types.

- `logging`: Shows all logging messages regardless of the server logging level.
- `operation`: Shows all ongoing operations from creation to completion (including updates to their state and progress metadata).
- `lifecycle`: Shows an audit trail for specific actions occurring over LXD.

Event structure

Example

```
location: cluster_name
metadata:
  action: network-updated
  requestor:
    protocol: unix
    username: root
  source: /1.0/networks/lxdbr0
timestamp: "2021-03-14T00:00:00Z"
type: lifecycle
```

- `location`: The cluster member name (if clustered).
- `timestamp`: Time that the event occurred in RFC3339 format.
- `type`: The type of event this is (one of `logging`, `operation`, or `lifecycle`).
- `metadata`: Information about the specific event type.

Logging event structure

- `message`: The log message.
- `level`: The log-level of the log.
- `context`: Additional information included in the event.

Operation event structure

- `id`: The UUID of the operation.
- `class`: The type of operation (`task`, `token`, or `websocket`).
- `description`: A description of the operation.
- `created_at`: The operation's creation date.
- `updated_at`: The operation's date of last change.
- `status`: The current state of the operation.
- `status_code`: The operation status code.
- `resources`: Resources affected by this operation.
- `metadata`: Operation specific metadata.
- `may_cancel`: Whether the operation may be canceled.
- `err`: Error message of the operation.
- `location`: The cluster member name (if clustered).

Life-cycle event structure

- `action`: The life-cycle action that occurred.
- `requestor`: Information about who is making the request (if applicable).
- `source`: Path to what is being acted upon.
- `context`: Additional information included in the event.

Supported life-cycle events

Name	Description	Additiona
`certificate-created`	A new certificate has been added to the server trust store.	
`certificate-deleted`	The certificate has been deleted from the trust store.	
`certificate-updated`	The certificate's configuration has been updated.	
`cluster-certificate-updated`	The certificate for the whole cluster has changed.	
`cluster-disabled`	Clustering has been disabled for this machine.	
`cluster-enabled`	Clustering has been enabled for this machine.	
`cluster-group-created`	A new cluster group has been created.	
`cluster-group-deleted`	A cluster group has been deleted.	
`cluster-group-renamed`	A cluster group has been renamed.	
`cluster-group-updated`	A cluster group has been updated.	
`cluster-member-added`	A new machine has joined the cluster.	
`cluster-member-removed`	The cluster member has been removed from the cluster.	
`cluster-member-renamed`	The cluster member has been renamed.	`old_name`
`cluster-member-updated`	The cluster member's configuration been edited.	
`cluster-token-created`	A join token for adding a cluster member has been created.	
`config-updated`	The server configuration has changed.	
`image-alias-created`	An alias has been created for an existing image.	`target`: t
`image-alias-deleted`	An alias has been deleted for an existing image.	`target`: t
`image-alias-renamed`	The alias for an existing image has been renamed.	`old_name`
`image-alias-updated`	The configuration for an image alias has changed.	`target`: t
`image-created`	A new image has been added to the image store.	`type`: `con`
`image-deleted`	The image has been deleted from the image store.	
`image-refreshed`	The local image copy has updated to the current source image version.	
`image-retrieved`	The raw image file has been downloaded from the server.	`target`: d
`image-secret-created`	A one-time key to fetch this image has been created.	
`image-updated`	The image's configuration has changed.	
`instance-backup-created`	A backup of the instance has been created.	
`instance-backup-deleted`	The instance backup has been deleted.	
`instance-backup-renamed`	The instance backup has been renamed.	`old_name`
`instance-backup-retrieved`	The raw instance backup file has been downloaded.	
`instance-console`	Connected to the console of the instance.	`type`: `con`
`instance-console-reset`	The console buffer has been reset.	
`instance-console-retrieved`	The console log has been downloaded.	
`instance-created`	A new instance has been created.	
`instance-deleted`	The instance has been deleted.	
`instance-exec`	A command has been executed on the instance.	`command`:
`instance-file-deleted`	A file on the instance has been deleted.	`file`: path
`instance-file-pushed`	The file has been pushed to the instance.	`file-sou`
`instance-file-retrieved`	The file has been downloaded from the instance.	`file-sou`

Table 2 – continued from previous page

Name	Description	Additiona
instance-log-deleted	The instance's specified log file has been deleted.	
instance-log-retrieved	The instance's specified log file has been downloaded.	
instance-metadata-retrieved	The instance's image metadata has been downloaded.	
instance-metadata-template-created	A new image template file for the instance has been created.	path: rela
instance-metadata-template-deleted	The image template file for the instance has been deleted.	path: rela
instance-metadata-template-retrieved	The image template file for the instance has been downloaded.	path: rela
instance-metadata-updated	The instance's image metadata has changed.	
instance-paused	The instance has been put in a paused state.	
instance-ready	The instance is ready.	
instance-renamed	The instance has been renamed.	old_name
instance-restarted	The instance has restarted.	
instance-restored	The instance has been restored from a snapshot.	snapshot
instance-resumed	The instance has resumed after being paused.	
instance-shutdown	The instance has shut down.	
instance-snapshot-created	A snapshot of the instance has been created.	
instance-snapshot-deleted	The instance snapshot has been deleted.	
instance-snapshot-renamed	The instance snapshot has been renamed.	old_name
instance-snapshot-updated	The instance snapshot's configuration has changed.	
instance-started	The instance has started.	
instance-stopped	The instance has stopped.	
instance-updated	The instance's configuration has changed.	
network-acl-created	A new network ACL has been created.	
network-acl-deleted	The network ACL has been deleted.	
network-acl-renamed	The network ACL has been renamed.	old_name
network-acl-updated	The network ACL configuration has changed.	
network-created	A network device has been created.	
network-deleted	The network device has been deleted.	
network-forward-created	A new network forward has been created.	
network-forward-deleted	The network forward has been deleted.	
network-forward-updated	The network forward has been updated.	
network-peer-created	A new network peer has been created.	
network-peer-deleted	The network peer has been deleted.	
network-peer-updated	The network peer has been updated.	
network-renamed	The network device has been renamed.	old_name
network-updated	The network device's configuration has changed.	
network-zone-created	A new network zone has been created.	
network-zone-deleted	The network zone has been deleted.	
network-zone-record-created	A new network zone record has been created.	
network-zone-record-deleted	The network zone record has been deleted.	
network-zone-record-updated	The network zone record has been updated.	
network-zone-updated	The network zone has been updated.	
operation-cancelled	The operation has been canceled.	
profile-created	A new profile has been created.	
profile-deleted	The profile has been deleted.	
profile-renamed	The profile has been renamed .	old_name
profile-updated	The profile's configuration has changed.	
project-created	A new project has been created.	
project-deleted	The project has been deleted.	
project-renamed	The project has been renamed.	old_name
project-updated	The project's configuration has changed.	

Table 2 – continued from previous page

Name	Description	Additiona
storage-pool-created	A new storage pool has been created.	target: c
storage-pool-deleted	The storage pool has been deleted.	
storage-pool-updated	The storage pool's configuration has changed.	target: c
storage-volume-backup-created	A new backup for the storage volume has been created.	type: con
storage-volume-backup-deleted	The storage volume's backup has been deleted.	
storage-volume-backup-renamed	The storage volume's backup has been renamed.	old_name
storage-volume-backup-retrieved	The storage volume's backup has been downloaded.	
storage-volume-created	A new storage volume has been created.	type: con
storage-volume-deleted	The storage volume has been deleted.	
storage-volume-renamed	The storage volume has been renamed.	old_name
storage-volume-restored	The storage volume has been restored from a snapshot.	snapshot
storage-volume-snapshot-created	A new storage volume snapshot has been created.	type: con
storage-volume-snapshot-deleted	The storage volume's snapshot has been deleted.	
storage-volume-snapshot-renamed	The storage volume's snapshot has been renamed.	old_name
storage-volume-snapshot-updated	The configuration for the storage volume's snapshot has changed.	
storage-volume-updated	The storage volume's configuration has changed.	
warning-acknowledged	The warning's status has been set to "acknowledged".	
warning-deleted	The warning has been deleted.	
warning-reset	The warning's status has been set to "new".	

Communication between instance and host

Communication between the hosted workload (instance) and its host while not strictly needed is a pretty useful feature.

In LXD, this feature is implemented through a `/dev/lxd/sock` node which is created and set up for all LXD instances.

This file is a Unix socket which processes inside the instance can connect to. It's multi-threaded so multiple clients can be connected at the same time.

Note: *security.devlxd* must be set to `true` (which is the default) for an instance to allow access to the socket.

Implementation details

LXD on the host binds `/var/lib/lxd/devlxd/sock` and starts listening for new connections on it.

This socket is then exposed into every single instance started by LXD at `/dev/lxd/sock`.

The single socket is required so we can exceed 4096 instances, otherwise, LXD would have to bind a different socket for every instance, quickly reaching the FD limit.

Authentication

Queries on `/dev/lxd/sock` will only return information related to the requesting instance. To figure out where a request comes from, LXD will extract the initial socket's user credentials and compare that to the list of instances it manages.

Protocol

The protocol on `/dev/lxd/sock` is plain-text HTTP with JSON messaging, so very similar to the local version of the LXD protocol.

Unlike the main LXD API, there is no background operation and no authentication support in the `/dev/lxd/sock` API.

REST-API

API structure

- /
  - /1.0
    - /1.0/config
      - /1.0/config/{key}
    - /1.0/devices
    - /1.0/events
    - /1.0/images/{fingerprint}/export
    - /1.0/meta-data

API details

/

GET

- Description: List of supported APIs
- Return: list of supported API endpoint URLs (by default `['/1.0']`)

Return value:

```
[
    "/1.0"
]
```

/1.0

GET

- Description: Information about the 1.0 API
- Return: JSON object

Return value:

```
{
    "api_version": "1.0",
    "location": "foo.example.com",
    "instance_type": "container",
    "state": "Started",
}
```

PATCH

- Description: Update instance state (valid states are `Ready` and `Started`)
- Return: none

Input:

```
{
   "state": "Ready"
}
```

/1.0/config

GET

- Description: List of configuration keys
- Return: list of configuration keys URL

Note that the configuration key names match those in the instance configuration, however not all configuration namespaces will be exported to `/dev/lxd/sock`. Currently only the `cloud-init.*` and `user.*` keys are accessible to the instance.

At this time, there also aren't any instance-writable namespace.

Return value:

```
[
    "/1.0/config/user.a"
]
```

/1.0/config/<KEY>

GET

- Description: Value of that key
- Return: Plain-text value

Return value:

```
blah
```

/1.0/devices

GET

- Description: Map of instance devices
- Return: JSON object

Return value:

```
{
    "eth0": {
        "name": "eth0",
        "network": "lxdbr0",
        "type": "nic"
    },
    "root": {
        "path": "/",
        "pool": "default",
        "type": "disk"
    }
}
```

/1.0/events

GET

- Description: WebSocket upgrade
- Return: none (never ending flow of events)

Supported arguments are:

- type: comma-separated list of notifications to subscribe to (defaults to all)

The notification types are:

- `config` (changes to any of the `user.*` configuration keys)
- `device` (any device addition, change or removal)

This never returns. Each notification is sent as a separate JSON object:

```
{
    "timestamp": "2017-12-21T18:28:26.846603815-05:00",
    "type": "device",
    "metadata": {
        "name": "kvm",
        "action": "added",
        "config": {
            "type": "unix-char",
            "path": "/dev/kvm"
        }
    }
}
```



```
{
    "timestamp": "2017-12-21T18:28:26.846603815-05:00",
    "type": "config",
    "metadata": {
        "key": "user.foo",
        "old_value": "",
        "value": "bar"
    }
}
```


/1.0/images/<FINGERPRINT>/export

GET

- Description: Download a public/cached image from the host
- Return: raw image or error
- Access: Requires *security.devlxd.images* set to `true`

Return value:

```
See /1.0/images/<FINGERPRINT>/export in the daemon API.
```

/1.0/meta-data

GET

- Description: Container meta-data compatible with cloud-init
- Return: cloud-init meta-data

Return value:

```
#cloud-config
instance-id: af6a01c7-f847-4688-a2a4-37fddd744625
local-hostname: abc
```

Related topics

How-to guides:

- *LXD server and client*

Explanation:

- *About `lxd` and `lxc`*
- *About the LXD database*

2.4.5 Man pages

`lxc` is the command line client for LXD. Its usage is documented in the help pages for the `lxc` commands and sub-commands.

Man pages

`lxc`

Command line client for LXD

Synopsis

Description: Command line client for LXD

All of LXD's features can be driven through the various commands below. For help with any of those, simply call them with –help.

Options

```
      --all            Show less common commands
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc alias* - Manage command aliases
- *lxc auth* - Manage user authorization
- *lxc cluster* - Manage cluster members
- *lxc config* - Manage instance and server configuration options
- *lxc console* - Attach to instance consoles
- *lxc copy* - Copy instances within or in between LXD servers
- *lxc delete* - Delete instances and snapshots
- *lxc exec* - Execute commands in instances
- *lxc export* - Export instance backups
- *lxc file* - Manage files in instances
- *lxc image* - Manage images
- *lxc import* - Import instance backups
- *lxc info* - Show instance or server information
- *lxc init* - Create instances from images
- *lxc launch* - Create and start instances from images
- *lxc list* - List instances
- *lxc monitor* - Monitor a local or remote LXD server
- *lxc move* - Move instances within or in between LXD servers
- *lxc network* - Manage and attach instances to networks
- *lxc operation* - List, show and delete background operations
- *lxc pause* - Pause instances
- *lxc profile* - Manage profiles
- *lxc project* - Manage projects
- *lxc publish* - Publish instances as images
- *lxc query* - Send a raw query to LXD
- *lxc rebuild* - Rebuild instances
- *lxc remote* - Manage the list of remote servers
- *lxc rename* - Rename instances and snapshots
- *lxc restart* - Restart instances
- *lxc restore* - Restore instances from snapshots
- *lxc snapshot* - Create instance snapshots
- *lxc start* - Start instances
- *lxc stop* - Stop instances
- *lxc storage* - Manage storage pools and volumes
- *lxc version* - Show local and remote versions

- *lxc warning* - Manage warnings

lxc alias

Manage command aliases

Synopsis

Description: Manage command aliases

```
lxc alias [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc alias add* - Add new aliases
- *lxc alias list* - List aliases
- *lxc alias remove* - Remove aliases
- *lxc alias rename* - Rename aliases

lxc alias add

Add new aliases

Synopsis

Description: Add new aliases

```
lxc alias add <alias> <target> [flags]
```

Examples

```
lxc alias add list "list -c ns46S"
    Overwrite the "list" command to pass -c ns46S.
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc alias* - Manage command aliases

lxc alias list

List aliases

Synopsis

Description: List aliases

```
lxc alias list [flags]
```

Options

```
-f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc alias* - Manage command aliases

lxc alias remove

Remove aliases

Synopsis

Description: Remove aliases

```
lxc alias remove <alias> [flags]
```

Examples

```
  lxc alias remove my-list
      Remove the "my-list" alias.
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc alias* - Manage command aliases

lxc alias rename

Rename aliases

Synopsis

Description: Rename aliases

```
lxc alias rename <old alias> <new alias> [flags]
```

Examples

```
  lxc alias rename list my-list
      Rename existing alias "list" to "my-list".
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc alias* - Manage command aliases

lxc auth

Manage user authorization

Synopsis

Description: Manage user authorization

```
lxc auth [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc auth group* - Manage groups
- *lxc auth identity* - Manage identities
- *lxc auth identity-provider-group* - Manage groups
- *lxc auth permission* - Inspect permissions

lxc auth group

Manage groups

Synopsis

Description: Manage groups

```
lxc auth group [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth* - Manage user authorization
- *lxc auth group create* - Create groups
- *lxc auth group delete* - Delete groups
- *lxc auth group edit* - Edit groups as YAML
- *lxc auth group list* - List groups
- *lxc auth group permission* - Manage permissions
- *lxc auth group rename* - Rename groups

- *lxc auth group show* - Show group configurations

lxc auth group create

Create groups

Synopsis

Description: Create groups

```
lxc auth group create [<remote>:]<group> [flags]
```

Options

```
  -d, --description string   Group description
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth group delete

Delete groups

Synopsis

Description: Delete groups

```
lxc auth group delete [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth group edit

Edit groups as YAML

Synopsis

Description: Edit groups as YAML

```
lxc auth group edit [<remote>:]<group> [flags]
```

Examples

```
  lxc auth group edit <group> < group.yaml
     Update a group using the content of group.yaml
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth group list

List groups

Synopsis

Description: List groups

```
lxc auth group list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth group permission

Manage permissions

Synopsis

Description: Manage permissions

```
lxc auth group permission [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups
- *lxc auth group permission add* - Add permissions to groups
- *lxc auth group permission remove* - Remove permissions from groups

lxc auth group permission add

Add permissions to groups

Synopsis

Description: Add permissions to groups

```
lxc auth group permission add [<remote>:]<group> <entity_type> [<entity_name>]
↪<entitlement> [<key>=<value>...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group permission* - Manage permissions

lxc auth group permission remove

Remove permissions from groups

Synopsis

Description: Remove permissions from groups

```
lxc auth group permission remove [<remote>:]<group> <entity_type> [<entity_name>]
↪<entitlement> [<key>=<value>...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group permission* - Manage permissions

lxc auth group rename

Rename groups

Synopsis

Description: Rename groups

```
lxc auth group rename [<remote>:]<group> <new_name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth group show

Show group configurations

Synopsis

Description: Show group configurations

```
lxc auth group show [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth group* - Manage groups

lxc auth identity

Manage identities

Synopsis

Description: Manage identities

```
lxc auth identity [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth* - Manage user authorization
- *lxc auth identity edit* - Edit an identity as YAML
- *lxc auth identity group* - Manage groups for the identity
- *lxc auth identity info* - View the current identity
- *lxc auth identity list* - List identities
- *lxc auth identity show* - View an identity

lxc auth identity edit

Edit an identity as YAML

Synopsis

Description: Edit an identity as YAML

```
lxc auth identity edit [<remote>:]<group> [flags]
```

Examples

```
lxc auth identity edit <authentication_method>/<name_or_identifier> < identity.yaml
   Update an identity using the content of identity.yaml
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity* - Manage identities

lxc auth identity group

Manage groups for the identity

Synopsis

Description: Manage groups for the identity

```
lxc auth identity group [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity* - Manage identities
- *lxc auth identity group add* - Add a group to an identity
- *lxc auth identity group remove* - Remove a group from an identity

lxc auth identity group add

Add a group to an identity

Synopsis

Description: Add a group to an identity

```
lxc auth identity group add [<remote>:]<authentication_method>/<name_or_identifier>
↪<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity group* - Manage groups for the identity

lxc auth identity group remove

Remove a group from an identity

Synopsis

Description: Remove a group from an identity

```
lxc auth identity group remove [<remote>:]<authentication_method>/<name_or_identifier>
↪<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity group* - Manage groups for the identity

lxc auth identity info

View the current identity

Synopsis

Description: Show the current identity

This command will display permissions for the current user. This includes contextual information, such as effective groups and permissions that are granted via identity provider group mappings.

```
lxc auth identity info [<remote>:] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity* - Manage identities

lxc auth identity list

List identities

Synopsis

Description: List identities

```
lxc auth identity list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity* - Manage identities

lxc auth identity show

View an identity

Synopsis

Description: Show identity configurations

The argument must be a concatenation of the authentication method and either the name or identifier of the identity, delimited by a forward slash. This command will fail if an identity name is used that is not unique within the authentication method. Use the identifier instead if this occurs.

```
lxc auth identity show [<remote>:]<authentication_method>/<name_or_identifier> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity* - Manage identities

lxc auth identity-provider-group

Manage groups

Synopsis

Description: Manage groups

```
lxc auth identity-provider-group [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth* - Manage user authorization
- *lxc auth identity-provider-group create* - Create identity provider groups
- *lxc auth identity-provider-group delete* - Delete identity provider groups
- *lxc auth identity-provider-group edit* - Edit identity provider groups as YAML
- *lxc auth identity-provider-group group* - Manage identity provider group mappings
- *lxc auth identity-provider-group list* - List identity provider groups
- *lxc auth identity-provider-group rename* - Rename identity provider groups
- *lxc auth identity-provider-group show* - Show an identity provider group

lxc auth identity-provider-group create

Create identity provider groups

Synopsis

Description: Create identity provider groups

```
lxc auth identity-provider-group create [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth identity-provider-group delete

Delete identity provider groups

Synopsis

Description: Delete identity provider groups

```
lxc auth identity-provider-group delete [<remote>:]<identity_provider_group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth identity-provider-group edit

Edit identity provider groups as YAML

Synopsis

Description: Edit identity provider groups as YAML

```
lxc auth identity-provider-group edit [<remote>:]<identity_provider_group> [flags]
```

Examples

```
  lxc auth identity-provider-group edit <identity_provider_group> < identity-provider-
↪group.yaml
    Update an identity provider group using the content of identity-provider-group.yaml
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth identity-provider-group group

Manage identity provider group mappings

Synopsis

Description: Manage identity provider group mappings

```
lxc auth identity-provider-group group [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups
- *lxc auth identity-provider-group group add* - Add a group to an identity provider group
- *lxc auth identity-provider-group group remove* - Remove identities from groups

lxc auth identity-provider-group group add

Add a group to an identity provider group

Synopsis

Description: Add a group to an identity provider group

```
lxc auth identity-provider-group group add [<remote>:]<identity_provider_group> <group>␣
↪[flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity-provider-group group* - Manage identity provider group mappings

lxc auth identity-provider-group group remove

Remove identities from groups

Synopsis

Description: Remove identities from groups

```
lxc auth identity-provider-group group remove [<remote>:]<authentication_method>/<name_
↪or_identifier> <group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity-provider-group group* - Manage identity provider group mappings

lxc auth identity-provider-group list

List identity provider groups

Synopsis

Description: List identity provider groups

```
lxc auth identity-provider-group list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth identity-provider-group rename

Rename identity provider groups

Synopsis

Description: Rename identity provider groups

```
lxc auth identity-provider-group rename [<remote>:]<identity_provider_group> <new_name>␣
↪[flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth identity-provider-group show

Show an identity provider group

Synopsis

Description: Show an identity provider group

```
lxc auth identity-provider-group show [<remote>:]<identity_provider_group> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc auth identity-provider-group* - Manage groups

lxc auth permission

Inspect permissions

Synopsis

Description: Inspect permissions

```
lxc auth permission [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc auth* - Manage user authorization
- *lxc auth permission list* - List permissions

lxc auth permission list

List permissions

Synopsis

Description: List permissions

```
lxc auth permission list [<remote>:] [project=<project_name>] [entity_type=<entity_type>
↪] [flags]
```

Options

```
  -f, --format string          Display format (json, yaml, table, compact, csv) (default
↪"table")
      --max-entitlements int   Maximum number of unassigned entitlements to display␣
↪before overflowing (set to zero to display all) (default 3)
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc auth permission* - Inspect permissions

lxc cluster

Manage cluster members

Synopsis

Description: Manage cluster members

```
lxc cluster [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc cluster add* - Request a join token for adding a cluster member
- *lxc cluster edit* - Edit cluster member configurations as YAML
- *lxc cluster enable* - Enable clustering on a single non-clustered LXD server
- *lxc cluster evacuate* - Evacuate cluster member
- *lxc cluster get* - Get values for cluster member configuration keys
- *lxc cluster group* - Manage cluster groups
- *lxc cluster info* - Show useful information about a cluster member
- *lxc cluster list* - List all the cluster members
- *lxc cluster list-tokens* - List all active cluster member join tokens
- *lxc cluster remove* - Remove a member from the cluster
- *lxc cluster rename* - Rename a cluster member
- *lxc cluster restore* - Restore cluster member
- *lxc cluster revoke-token* - Revoke cluster member join token
- *lxc cluster role* - Manage cluster roles
- *lxc cluster set* - Set a cluster member's configuration keys
- *lxc cluster show* - Show details of a cluster member
- *lxc cluster unset* - Unset a cluster member's configuration keys
- *lxc cluster update-certificate* - Update cluster certificate

`lxc cluster add`

Request a join token for adding a cluster member

Synopsis

Description: Request a join token for adding a cluster member

```
lxc cluster add [[<remote>:]<name>] [flags]
```

Options

```
      --name   Cluster member name (alternative to passing it as an argument)
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster edit

Edit cluster member configurations as YAML

Synopsis

Description: Edit cluster member configurations as YAML

```
lxc cluster edit [<remote>:]<cluster member> [flags]
```

Examples

```
  lxc cluster edit <cluster member> < member.yaml
      Update a cluster member using the content of member.yaml
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster enable

Enable clustering on a single non-clustered LXD server

Synopsis

Description: Enable clustering on a single non-clustered LXD server

```
This command turns a non-clustered LXD server into the first member of a new
LXD cluster, which will have the given name.

It's required that the LXD is already available on the network. You can check
that by running 'lxc config get core.https_address', and possibly set a value
for the address if not yet set.
```

```
lxc cluster enable [<remote>:] <name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster evacuate

Evacuate cluster member

Synopsis

Description: Evacuate cluster member

```
lxc cluster evacuate [<remote>:]<member> [flags]
```

Options

```
      --action   Force a particular evacuation action
      --force    Force evacuation without user confirmation
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster get

Get values for cluster member configuration keys

Synopsis

Description: Get values for cluster member configuration keys

```
lxc cluster get [<remote>:]<member> <key> [flags]
```

Options

```
  -p, --property   Get the key as a cluster property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster group

Manage cluster groups

Synopsis

Description: Manage cluster groups

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members
- *lxc cluster group add* - Add member to group
- *lxc cluster group assign* - Assign sets of groups to cluster members
- *lxc cluster group create* - Create a cluster group
- *lxc cluster group delete* - Delete a cluster group
- *lxc cluster group edit* - Edit a cluster group
- *lxc cluster group list* - List all the cluster groups
- *lxc cluster group remove* - Remove member from group

- *lxc cluster group rename* - Rename a cluster group
- *lxc cluster group show* - Show cluster group configurations

lxc cluster group add

Add member to group

Synopsis

Description: Add a cluster member to a cluster group

```
lxc cluster group add [<remote>:]<member> <group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group assign

Assign sets of groups to cluster members

Synopsis

Description: Assign sets of groups to cluster members

```
lxc cluster group assign [<remote>:]<member> <group> [flags]
```

Examples

```
lxc cluster group assign foo default,bar
    Set the groups for "foo" to "default" and "bar".

lxc cluster group assign foo default
    Reset "foo" to only using the "default" cluster group.
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group create

Create a cluster group

Synopsis

Description: Create a cluster group

```
lxc cluster group create [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group delete

Delete a cluster group

Synopsis

Description: Delete a cluster group

```
lxc cluster group delete [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group edit

Edit a cluster group

Synopsis

Description: Edit a cluster group

```
lxc cluster group edit [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group list

List all the cluster groups

Synopsis

Description: List all the cluster groups

```
lxc cluster group list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group remove

Remove member from group

Synopsis

Description: Remove a cluster member from a cluster group

```
lxc cluster group remove [<remote>:]<member> <group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group rename

Rename a cluster group

Synopsis

Description: Rename a cluster group

```
lxc cluster group rename [<remote>:]<group> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster group show

Show cluster group configurations

Synopsis

Description: Show cluster group configurations

```
lxc cluster group show [<remote>:]<group> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster group* - Manage cluster groups

lxc cluster info

Show useful information about a cluster member

Synopsis

Description: Show useful information about a cluster member

```
lxc cluster info [<remote>:]<member> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster list

List all the cluster members

Synopsis

Description: List all the cluster members

```
lxc cluster list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster list-tokens

List all active cluster member join tokens

Synopsis

Description: List all active cluster member join tokens

```
lxc cluster list-tokens [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster remove

Remove a member from the cluster

Synopsis

Description: Remove a member from the cluster

```
lxc cluster remove [<remote>:]<member> [flags]
```

Options

```
  -f, --force   Force removing a member, even if degraded
      --yes     Don't require user confirmation for using --force
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster rename

Rename a cluster member

Synopsis

Description: Rename a cluster member

```
lxc cluster rename [<remote>:]<member> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster restore

Restore cluster member

Synopsis

Description: Restore cluster member

```
lxc cluster restore [<remote>:]<member> [flags]
```

Options

```
      --force   Force restoration without user confirmation
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster revoke-token

Revoke cluster member join token

Synopsis

Description: Revoke cluster member join token

```
lxc cluster revoke-token [<remote>:]<member> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster role

Manage cluster roles

Synopsis

Description: Manage cluster roles

```
lxc cluster role [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members
- *lxc cluster role add* - Add roles to a cluster member
- *lxc cluster role remove* - Remove roles from a cluster member

lxc cluster role add

Add roles to a cluster member

Synopsis

Description: Add roles to a cluster member

```
lxc cluster role add [<remote>:]<member> <role[,role...]> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc cluster role* - Manage cluster roles

lxc cluster role remove

Remove roles from a cluster member

Synopsis

Description: Remove roles from a cluster member

```
lxc cluster role remove [<remote>:]<member> <role[,role...]> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster role* - Manage cluster roles

lxc cluster set

Set a cluster member's configuration keys

Synopsis

Description: Set a cluster member's configuration keys

```
lxc cluster set [<remote>:]<member> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a cluster property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster show

Show details of a cluster member

Synopsis

Description: Show details of a cluster member

```
lxc cluster show [<remote>:]<member> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster unset

Unset a cluster member's configuration keys

Synopsis

Description: Unset a cluster member's configuration keys

```
lxc cluster unset [<remote>:]<member> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a cluster property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc cluster update-certificate

Update cluster certificate

Synopsis

Description: Update cluster certificate with PEM certificate and key read from input files.

```
lxc cluster update-certificate [<remote>:] <cert.crt> <cert.key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc cluster* - Manage cluster members

lxc config

Manage instance and server configuration options

Synopsis

Description: Manage instance and server configuration options

```
lxc config [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc config device* - Manage devices
- *lxc config edit* - Edit instance or server configurations as YAML
- *lxc config get* - Get values for instance or server configuration keys
- *lxc config metadata* - Manage instance metadata files
- *lxc config set* - Set instance or server configuration keys
- *lxc config show* - Show instance or server configurations
- *lxc config template* - Manage instance file templates
- *lxc config trust* - Manage trusted clients
- *lxc config uefi* - Manage instance UEFI variables
- *lxc config unset* - Unset instance or server configuration keys

lxc config device

Manage devices

Synopsis

Description: Manage devices

```
lxc config device [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options
- *lxc config device add* - Add instance devices
- *lxc config device get* - Get values for device configuration keys
- *lxc config device list* - List instance devices
- *lxc config device override* - Copy profile inherited devices and override configuration keys
- *lxc config device remove* - Remove instance devices
- *lxc config device set* - Set device configuration keys
- *lxc config device show* - Show full device configuration
- *lxc config device unset* - Unset device configuration keys

lxc config device add

Add instance devices

Synopsis

Description: Add instance devices

```
lxc config device add [<remote>:]<instance> <device> <type> [key=value...] [flags]
```

Examples

```
  lxc config device add [<remote>:]instance1 <device-name> disk source=/share/c1 path=/
↪opt
      Will mount the host's /share/c1 onto /opt in the instance.

  lxc config device add [<remote>:]instance1 <device-name> disk pool=some-pool␣
↪source=some-volume path=/opt
      Will mount the some-volume volume on some-pool onto /opt in the instance.
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device get

Get values for device configuration keys

Synopsis

Description: Get values for device configuration keys

```
lxc config device get [<remote>:]<instance> <device> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device list

List instance devices

Synopsis

Description: List instance devices

```
lxc config device list [<remote>:]<instance> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device override

Copy profile inherited devices and override configuration keys

Synopsis

Description: Copy profile inherited devices and override configuration keys

```
lxc config device override [<remote>:]<instance> <device> [key=value...] [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device remove

Remove instance devices

Synopsis

Description: Remove instance devices

```
lxc config device remove [<remote>:]<instance> <name>... [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device set

Set device configuration keys

Synopsis

Description: Set device configuration keys

For backward compatibility, a single configuration key may still be set with: lxc config device set [:]

```
lxc config device set [<remote>:]<instance> <device> <key>=<value>... [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device show

Show full device configuration

Synopsis

Description: Show full device configuration

```
lxc config device show [<remote>:]<instance> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config device unset

Unset device configuration keys

Synopsis

Description: Unset device configuration keys

```
lxc config device unset [<remote>:]<instance> <device> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config device* - Manage devices

lxc config edit

Edit instance or server configurations as YAML

Synopsis

Description: Edit instance or server configurations as YAML

```
lxc config edit [<remote>:][<instance>[/<snapshot>]] [flags]
```

Examples

```
  lxc config edit <instance> < instance.yaml
      Update the instance configuration from config.yaml.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options

lxc config get

Get values for instance or server configuration keys

Synopsis

Description: Get values for instance or server configuration keys

```
lxc config get [<remote>:][<instance>] <key> [flags]
```

Options

```
  -e, --expanded    Access the expanded configuration
  -p, --property    Get the key as an instance property
      --target      Cluster member name
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options

lxc config metadata

Manage instance metadata files

Synopsis

Description: Manage instance metadata files

```
lxc config metadata [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options
- *lxc config metadata edit* - Edit instance metadata files
- *lxc config metadata show* - Show instance metadata files

lxc config metadata edit

Edit instance metadata files

Synopsis

Description: Edit instance metadata files

```
lxc config metadata edit [<remote>:]<instance> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config metadata* - Manage instance metadata files

lxc config metadata show

Show instance metadata files

Synopsis

Description: Show instance metadata files

```
lxc config metadata show [<remote>:]<instance> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config metadata* - Manage instance metadata files

lxc config set

Set instance or server configuration keys

Synopsis

Description: Set instance or server configuration keys

For backward compatibility, a single configuration key may still be set with: lxc config set [:][]

```
lxc config set [<remote>:][<instance>] <key>=<value>... [flags]
```

Examples

```
  lxc config set [<remote>:]<instance> limits.cpu=2
      Will set a CPU limit of "2" for the instance.

  lxc config set core.https_address=[::]:8443
      Will have LXD listen on IPv4 and IPv6 port 8443.

  lxc config set core.trust_password=blah
      Will set the server's trust password to blah.
```

Options

```
  -p, --property   Set the key as an instance property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options

lxc config show

Show instance or server configurations

Synopsis

Description: Show instance or server configurations

```
lxc config show [<remote>:][<instance>[/<snapshot>]] [flags]
```

Options

```
  -e, --expanded   Show the expanded configuration
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options

lxc config template

Manage instance file templates

Synopsis

Description: Manage instance file templates

```
lxc config template [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options
- *lxc config template create* - Create new instance file templates
- *lxc config template delete* - Delete instance file templates
- *lxc config template edit* - Edit instance file templates
- *lxc config template list* - List instance file templates
- *lxc config template show* - Show content of instance file templates

lxc config template create

Create new instance file templates

Synopsis

Description: Create new instance file templates

```
lxc config template create [<remote>:]<instance> <template> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config template* - Manage instance file templates

lxc config template delete

Delete instance file templates

Synopsis

Description: Delete instance file templates

```
lxc config template delete [<remote>:]<instance> <template> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config template* - Manage instance file templates

lxc config template edit

Edit instance file templates

Synopsis

Description: Edit instance file templates

```
lxc config template edit [<remote>:]<instance> <template> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config template* - Manage instance file templates

lxc config template list

List instance file templates

Synopsis

Description: List instance file templates

```
lxc config template list [<remote>:]<instance> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config template* - Manage instance file templates

lxc config template show

Show content of instance file templates

Synopsis

Description: Show content of instance file templates

```
lxc config template show [<remote>:]<instance> <template> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config template* - Manage instance file templates

lxc config trust

Manage trusted clients

Synopsis

Description: Manage trusted clients

```
lxc config trust [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options
- *lxc config trust add* - Add new trusted client
- *lxc config trust edit* - Edit trust configurations as YAML
- *lxc config trust list* - List trusted clients
- *lxc config trust list-tokens* - List all active certificate add tokens
- *lxc config trust remove* - Remove trusted client
- *lxc config trust revoke-token* - Revoke certificate add token
- *lxc config trust show* - Show trust configurations

lxc config trust add

Add new trusted client

Synopsis

Description: Add new trusted client

The following certificate types are supported:

- client (default)
- metrics

If the certificate is omitted, a token will be generated and returned. A client providing a valid token will have its client certificate added to the trusted list and the consumed token will be invalidated. Similar to certificates, tokens can be restricted to one or more projects.

```
lxc config trust add [<remote>:] [<cert>] [flags]
```

Options

```
      --name         Alternative certificate name
      --projects     List of projects to restrict the certificate to
      --restricted   Restrict the certificate to one or more projects
      --type         Type of certificate (default "client")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust edit

Edit trust configurations as YAML

Synopsis

Description: Edit trust configurations as YAML

```
lxc config trust edit [<remote>:]<fingerprint> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust list

List trusted clients

Synopsis

Description: List trusted clients

```
lxc config trust list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust list-tokens

List all active certificate add tokens

Synopsis

Description: List all active certificate add tokens

```
lxc config trust list-tokens [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust remove

Remove trusted client

Synopsis

Description: Remove trusted client

```
lxc config trust remove [<remote>:]<fingerprint> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust revoke-token

Revoke certificate add token

Synopsis

Description: Revoke certificate add token

```
lxc config trust revoke-token [<remote>:] <name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config trust show

Show trust configurations

Synopsis

Description: Show trust configurations

```
lxc config trust show [<remote>:]<fingerprint> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config trust* - Manage trusted clients

lxc config uefi

Manage instance UEFI variables

Synopsis

Description: Manage instance UEFI variables

```
lxc config uefi [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options
- *lxc config uefi edit* - Edit instance UEFI variables
- *lxc config uefi get* - Get UEFI variables for instance
- *lxc config uefi set* - Set UEFI variables for instance
- *lxc config uefi show* - Show instance UEFI variables
- *lxc config uefi unset* - Unset UEFI variables for instance

lxc config uefi edit

Edit instance UEFI variables

Synopsis

Description: Edit instance UEFI variables

```
lxc config uefi edit [<remote>:]<instance> [flags]
```

Examples

```
  lxc config uefi edit <instance> < instance_uefi_vars.yaml
      Set the instance UEFI variables from instance_uefi_vars.yaml.
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config uefi* - Manage instance UEFI variables

lxc config uefi get

Get UEFI variables for instance

Synopsis

Description: Get UEFI variables for instance

```
lxc config uefi get [<remote>:]<instance> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config uefi* - Manage instance UEFI variables

lxc config uefi set

Set UEFI variables for instance

Synopsis

Description: Set UEFI variables for instance

```
lxc config uefi set [<remote>:]<instance> <key>=<value>... [flags]
```

Examples

```
  lxc config uefi set [<remote>:]<instance> testvar-9073e4e0-60ec-4b6e-9903-
↪4c223c260f3c=aabb
      Set a UEFI variable with name "testvar", GUID 9073e4e0-60ec-4b6e-9903-4c223c260f3c␣
↪and value "aabb" (HEX-encoded) for the instance.
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc config uefi* - Manage instance UEFI variables

lxc config uefi show

Show instance UEFI variables

Synopsis

Description: Show instance UEFI variables

```
lxc config uefi show [<remote>:]<instance> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config uefi* - Manage instance UEFI variables

lxc config uefi unset

Unset UEFI variables for instance

Synopsis

Description: Unset UEFI variables for instance

```
lxc config uefi unset [<remote>:]<instance> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config uefi* - Manage instance UEFI variables

lxc config unset

Unset instance or server configuration keys

Synopsis

Description: Unset instance or server configuration keys

```
lxc config unset [<remote>:][<instance>] <key> [flags]
```

Options

```
  -p, --property   Unset the key as an instance property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc config* - Manage instance and server configuration options

lxc console

Attach to instance consoles

Synopsis

Description: Attach to instance consoles

This command allows you to interact with the boot console of an instance as well as retrieve past log entries from it.

```
lxc console [<remote>:]<instance> [flags]
```

Options

```
      --show-log   Retrieve the instance's console log
  -t, --type       Type of connection to establish: 'console' for serial console, 'vga'␣
↪for SPICE graphical output (default "console")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc copy

Copy instances within or in between LXD servers

Synopsis

Description: Copy instances within or in between LXD servers

Transfer modes (–mode):

- pull: Target server pulls the data from the source server (source must listen on network)
- push: Source server pushes the data to the target server (target must listen on network)
- relay: The CLI connects to both source and server and proxies the data (both source and target must listen on network)

The pull transfer mode is the default as it is compatible with all LXD versions.

```
lxc copy [<remote>:]<source>[/<snapshot>] [[<remote>:]<destination>] [flags]
```

Options

```
      --allow-inconsistent   Ignore copy errors for volatile files
  -c, --config               Config key/value to apply to the new instance
  -d, --device               New key/value to apply to a specific device
  -e, --ephemeral            Ephemeral instance
      --instance-only        Copy the instance without its snapshots
      --mode                 Transfer mode. One of pull, push or relay (default "pull")
      --no-profiles          Create the instance with no profiles applied
  -p, --profile              Profile to apply to the new instance
      --refresh              Perform an incremental copy
      --stateless            Copy a stateful instance stateless
  -s, --storage              Storage pool name
      --target               Cluster member name
      --target-project       Copy to a project different from the source
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc delete

Delete instances and snapshots

Synopsis

Description: Delete instances and snapshots

```
lxc delete [<remote>:]<instance>[/<snapshot>] [[<remote>:]<instance>[/<snapshot>]...]␣
↪[flags]
```

Options

```
  -f, --force         Force the removal of running instances
  -i, --interactive   Require user confirmation
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc exec

Execute commands in instances

Synopsis

Description: Execute commands in instances

The command is executed directly using exec, so there is no shell and shell patterns (variables, file redirects, ...) won't be understood. If you need a shell environment you need to execute the shell executable, passing the shell commands as arguments, for example:

```
lxc exec <instance> -- sh -c "cd /tmp && pwd"
```

Mode defaults to non-interactive, interactive mode is selected if both stdin AND stdout are terminals (stderr is ignored).

```
lxc exec [<remote>:]<instance> [flags] [--] <command line>
```

Options

```
      --cwd                    Directory to run the command in (default /root)
  -n, --disable-stdin          Disable stdin (reads from /dev/null)
      --env                    Environment variable to set (e.g. HOME=/home/foo)
  -t, --force-interactive      Force pseudo-terminal allocation
  -T, --force-noninteractive   Disable pseudo-terminal allocation
      --group                  Group ID to run the command as (default 0)
```

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```
      --mode                    Override the terminal mode (auto, interactive or non-
↪interactive) (default "auto")
      --user                    User ID to run the command as (default 0)
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc export

Export instance backups

Synopsis

Description: Export instances as backup tarballs.

```
lxc export [<remote>:]<instance> [target] [--instance-only] [--optimized-storage] [flags]
```

Examples

```
  lxc export u1 backup0.tar.gz
      Download a backup tarball of the u1 instance.
```

Options

```
      --compression         Compression algorithm to use (none for uncompressed)
      --instance-only       Whether or not to only backup the instance (without␣
↪snapshots)
      --optimized-storage   Use storage driver optimized format (can only be restored on␣
↪a similar pool)
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc file

Manage files in instances

Synopsis

Description: Manage files in instances

```
lxc file [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc file delete* - Delete files in instances
- *lxc file edit* - Edit files in instances
- *lxc file mount* - Mount files from instances
- *lxc file pull* - Pull files from instances
- *lxc file push* - Push files into instances

lxc file delete

Delete files in instances

Synopsis

Description: Delete files in instances

```
lxc file delete [<remote>:]<instance>/<path> [[<remote>:]<instance>/<path>...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc file* - Manage files in instances

lxc file edit

Edit files in instances

Synopsis

Description: Edit files in instances

```
lxc file edit [<remote>:]<instance>/<path> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc file* - Manage files in instances

lxc file mount

Mount files from instances

Synopsis

Description: Mount files from instances

```
lxc file mount [<remote>:]<instance>[/<path>] [<target path>] [flags]
```

Examples

```
  lxc file mount foo/root fooroot
     To mount /root from the instance foo onto the local fooroot directory.
```

Options

```
      --auth-user string   Set authentication user when using SSH SFTP listener
      --listen string      Setup SSH SFTP listener on address:port instead of mounting
      --no-auth            Disable authentication when using SSH SFTP listener
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc file* - Manage files in instances

lxc file pull

Pull files from instances

Synopsis

Description: Pull files from instances

```
lxc file pull [<remote>:]<instance>/<path> [[<remote>:]<instance>/<path>...] <target␣
↪path> [flags]
```

Examples

```
  lxc file pull foo/etc/hosts .
     To pull /etc/hosts from the instance and write it to the current directory.
```

Options

```
  -p, --create-dirs   Create any directories necessary
  -r, --recursive     Recursively transfer files
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc file* - Manage files in instances

lxc file push

Push files into instances

Synopsis

Description: Push files into instances

```
lxc file push <source path>... [<remote>:]<instance>/<path> [flags]
```

Examples

```
  lxc file push /etc/hosts foo/etc/hosts
     To push /etc/hosts into the instance "foo".
```

Options

```
  -p, --create-dirs   Create any directories necessary
      --gid           Set the file's gid on push (default -1)
      --mode          Set the file's perms on push
  -r, --recursive     Recursively transfer files
      --uid           Set the file's uid on push (default -1)
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc file* - Manage files in instances

lxc image

Manage images

Synopsis

Description: Manage images

In LXD instances are created from images. Those images were themselves either generated from an existing instance or downloaded from an image server.

When using remote images, LXD will automatically cache images for you and remove them upon expiration.

The image unique identifier is the hash (sha-256) of its representation as a compressed tarball (or for split images, the concatenation of the metadata and rootfs tarballs).

Images can be referenced by their full hash, shortest unique partial hash or alias name (if one is set).

```
lxc image [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc image alias* - Manage image aliases
- *lxc image copy* - Copy images between servers
- *lxc image delete* - Delete images
- *lxc image edit* - Edit image properties
- *lxc image export* - Export and download images
- *lxc image get-property* - Get image properties
- *lxc image import* - Import images into the image store
- *lxc image info* - Show useful information about images
- *lxc image list* - List images
- *lxc image refresh* - Refresh images
- *lxc image set-property* - Set image properties
- *lxc image show* - Show image properties

- *lxc image unset-property* - Unset image properties

lxc image alias

Manage image aliases

Synopsis

Description: Manage image aliases

```
lxc image alias [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images
- *lxc image alias create* - Create aliases for existing images
- *lxc image alias delete* - Delete image aliases
- *lxc image alias list* - List image aliases
- *lxc image alias rename* - Rename aliases

lxc image alias create

Create aliases for existing images

Synopsis

Description: Create aliases for existing images

```
lxc image alias create [<remote>:]<alias> <fingerprint> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image alias* - Manage image aliases

lxc image alias delete

Delete image aliases

Synopsis

Description: Delete image aliases

```
lxc image alias delete [<remote>:]<alias> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image alias* - Manage image aliases

lxc image alias list

List image aliases

Synopsis

Description: List image aliases

Filters may be part of the image hash or part of the image alias name.

```
lxc image alias list [<remote>:] [<filters>...] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image alias* - Manage image aliases

lxc image alias rename

Rename aliases

Synopsis

Description: Rename aliases

```
lxc image alias rename [<remote>:]<alias> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc image alias* - Manage image aliases

lxc image copy

Copy images between servers

Synopsis

Description: Copy images between servers

The auto-update flag instructs the server to keep this image up to date. It requires the source to be an alias and for it to be public.

```
lxc image copy [<remote>:]<image> <remote>: [flags]
```

Options

```
      --alias             New aliases to add to the image
      --auto-update       Keep the image up to date after initial copy
      --copy-aliases      Copy aliases from source
      --mode              Transfer mode. One of pull (default), push or relay (default
↪"pull")
  -p, --profile           Profile to apply to the new image
      --public            Make image public
      --target-project    Copy to a project different from the source
      --vm                Copy virtual machine images
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image delete

Delete images

Synopsis

Description: Delete images

```
lxc image delete [<remote>:]<image> [[<remote>:]<image>...] [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image edit

Edit image properties

Synopsis

Description: Edit image properties

```
lxc image edit [<remote>:]<image> [flags]
```

Examples

```
  lxc image edit <image>
      Launch a text editor to edit the properties

  lxc image edit <image> < image.yaml
      Load the image properties from a YAML file
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image export

Export and download images

Synopsis

Description: Export and download images

The output target is optional and defaults to the working directory.

```
lxc image export [<remote>:]<image> [<target>] [flags]
```

Options

```
      --vm   Query virtual machine images
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image get-property

Get image properties

Synopsis

Description: Get image properties

```
lxc image get-property [<remote>:]<image> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image import

Import images into the image store

Synopsis

Description: Import image into the image store

Directory import is only available on Linux and must be performed as root.

```
lxc image import <tarball>|<directory>|<URL> [<rootfs tarball>] [<remote>:] [key=value...
↪] [flags]
```

Options

```
      --alias    New aliases to add to the image
      --public   Make image public
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image info

Show useful information about images

Synopsis

Description: Show useful information about images

```
lxc image info [<remote>:]<image> [flags]
```

Options

```
      --vm   Query virtual machine images
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image list

List images

Synopsis

Description: List images

Filters may be of the = form for property based filtering, or part of the image hash or part of the image alias name.

The -c option takes a (optionally comma-separated) list of arguments that control which image attributes to output when displaying in table or csv format.

Default column layout is: lfpdasu

Column shorthand chars:

```
  l - Shortest image alias (and optionally number of other aliases)
  L - Newline-separated list of all image aliases
  f - Fingerprint (short)
  F - Fingerprint (long)
  p - Whether image is public
  d - Description
  a - Architecture
  s - Size
  u - Upload date
  t - Type
```

```
lxc image list [<remote>:] [<filter>...] [flags]
```

Options

```
  -c, --columns   Columns (default "lfpdatsu")
  -f, --format    Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image refresh

Refresh images

Synopsis

Description: Refresh images

```
lxc image refresh [<remote>:]<image> [[<remote>:]<image>...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image set-property

Set image properties

Synopsis

Description: Set image properties

```
lxc image set-property [<remote>:]<image> <key> <value> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image show

Show image properties

Synopsis

Description: Show image properties

```
lxc image show [<remote>:]<image> [flags]
```

Options

```
      --vm   Query virtual machine images
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc image unset-property

Unset image properties

Synopsis

Description: Unset image properties

```
lxc image unset-property [<remote>:]<image> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc image* - Manage images

lxc import

Import instance backups

Synopsis

Description: Import backups of instances including their snapshots.

```
lxc import [<remote>:] <backup file> [<instance name>] [flags]
```

Examples

```
  lxc import backup0.tar.gz
      Create a new instance using backup0.tar.gz as the source.
```

Options

```
  -d, --device    New key/value to apply to a specific device
  -s, --storage   Storage pool name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc info

Show instance or server information

Synopsis

Description: Show instance or server information

```
lxc info [<remote>:][<instance>] [flags]
```

Examples

```
  lxc info [<remote>:]<instance> [--show-log]
      For instance information.

  lxc info [<remote>:] [--resources]
      For LXD server information.
```

Options

```
      --resources   Show the resources available to the server
      --show-log    Show the instance's last 100 log lines?
      --target      Cluster member name
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc init

Create instances from images

Synopsis

Description: Create instances from images

```
lxc init [<remote>:]<image> [<remote>:][<name>] [flags]
```

Examples

```
  lxc init ubuntu:24.04 u1
      Create a container (but do not start it)

  lxc init ubuntu:24.04 u1 < config.yaml
      Create a container with configuration from config.yaml

  lxc init ubuntu:24.04 v1 --vm -c limits.cpu=4 -c limits.memory=4GiB
      Create a virtual machine with 4 vCPUs and 4GiB of RAM

  lxc init ubuntu:24.04 v1 --vm -c limits.cpu=2 -c limits.memory=8GiB -d root,size=32GiB
      Create a virtual machine with 2 vCPUs, 8GiB of RAM and a root disk of 32GiB
```

Options

```
  -c, --config        Config key/value to apply to the new instance
  -d, --device        New key/value to apply to a specific device
      --empty         Create an empty instance
  -e, --ephemeral     Ephemeral instance
  -n, --network       Network name
      --no-profiles   Create the instance with no profiles applied
  -p, --profile       Profile to apply to the new instance
  -s, --storage       Storage pool name
      --target        Cluster member name
  -t, --type          Instance type
      --vm            Create a virtual machine
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc launch

Create and start instances from images

Synopsis

Description: Create and start instances from images

```
lxc launch [<remote>:]<image> [<remote>:][<name>] [flags]
```

Examples

```
  lxc launch ubuntu:24.04 u1
      Create and start a container

  lxc launch ubuntu:24.04 u1 < config.yaml
      Create and start a container with configuration from config.yaml

  lxc launch ubuntu:24.04 u2 -t aws:t2.micro
      Create and start a container using the same size as an AWS t2.micro (1 vCPU, 1GiB␣
↪of RAM)

  lxc launch ubuntu:24.04 v1 --vm -c limits.cpu=4 -c limits.memory=4GiB
      Create and start a virtual machine with 4 vCPUs and 4GiB of RAM

  lxc launch ubuntu:24.04 v1 --vm -c limits.cpu=2 -c limits.memory=8GiB -d root,
↪size=32GiB
      Create and start a virtual machine with 2 vCPUs, 8GiB of RAM and a root disk of␣
↪32GiB
```

Options

```
  -c, --config                Config key/value to apply to the new instance
      --console[="console"]   Immediately attach to the console
  -d, --device                New key/value to apply to a specific device
      --empty                 Create an empty instance
  -e, --ephemeral             Ephemeral instance
  -n, --network               Network name
      --no-profiles           Create the instance with no profiles applied
  -p, --profile               Profile to apply to the new instance
  -s, --storage               Storage pool name
      --target                Cluster member name
  -t, --type                  Instance type
      --vm                    Create a virtual machine
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc list

List instances

Synopsis

Description: List instances

Default column layout: ns46tS Fast column layout: nsacPt

A single keyword like "web" which will list any instance with a name starting by "web". A regular expression on the instance name. (e.g. .*web.*01$). A key/value pair referring to a configuration item. For those, the namespace can be abbreviated to the smallest unambiguous identifier. A key/value pair where the key is a shorthand. Multiple values must be delimited by ','. Available shorthands: - type={instance type} - status={instance current lifecycle status} - architecture={instance architecture} - location={location name} - ipv4={ip or CIDR} - ipv6={ip or CIDR}

Examples: - "user.blah=abc" will list all instances with the "blah" user property set to "abc". - "u.blah=abc" will do the same - "security.privileged=true" will list all privileged instances - "s.privileged=true" will do the same - "type=container" will list all container instances - "type=container status=running" will list all running container instances

A regular expression matching a configuration item or its value. (e.g. volatile.eth0.hwaddr=00:16:3e:.*).

When multiple filters are passed, they are added one on top of the other, selecting instances which satisfy them all.

== Columns == The -c option takes a comma separated list of arguments that control which instance attributes to output when displaying in table or csv format.

Column arguments are either pre-defined shorthand chars (see below), or (extended) config keys.

Commas between consecutive shorthand chars are optional.

Pre-defined column shorthand chars: 4 - IPv4 address 6 - IPv6 address a - Architecture b - Storage pool c - Creation date d - Description D - disk usage e - Project name l - Last used date m - Memory usage M - Memory usage (%) n - Name N - Number of Processes p - PID of the instance's init process P - Profiles s - State S - Number of snapshots t - Type (persistent or ephemeral) u - CPU usage (in seconds) L - Location of the instance (e.g. its cluster member) f - Base Image Fingerprint (short) F - Base Image Fingerprint (long)

Custom columns are defined with "[config:|devices:]key[:name][:maxWidth]": KEY: The (extended) config or devices key to display. If [config:|devices:] is omitted then it defaults to config key. NAME: Name to display in the column header. Defaults to the key if not specified or empty.

```
MAXWIDTH: Max width of the column (longer results are truncated).
Defaults to -1 (unlimited). Use 0 to limit to the column header size.
```

```
lxc list [<remote>:] [<filter>...] [flags]
```

Examples

```
  lxc list -c nFs46,volatile.eth0.hwaddr:MAC,config:image.os,devices:eth0.parent:ETHP
    Show instances using the "NAME", "BASE IMAGE", "STATE", "IPV4", "IPV6" and "MAC"␣
↪columns.
    "BASE IMAGE", "MAC" and "IMAGE OS" are custom columns generated from instance␣
↪configuration keys.
    "ETHP" is a custom column generated from a device key.

  lxc list -c ns,user.comment:comment
    List instances with their running state and user comment.
```

Options

```
      --all-projects   Display instances from all projects
  -c, --columns        Columns (default "ns46tSL")
      --fast           Fast mode (same as --columns=nsacPt)
  -f, --format         Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc monitor

Monitor a local or remote LXD server

Synopsis

Description: Monitor a local or remote LXD server

By default the monitor will listen to all message types.

```
lxc monitor [<remote>:] [flags]
```

Examples

```
  lxc monitor --type=logging
      Only show log messages.

  lxc monitor --pretty --type=logging --loglevel=info
      Show a pretty log of messages with info level or higher.

  lxc monitor --type=lifecycle
      Only show lifecycle events.
```

Options

```
      --all-projects   Show events from all projects
  -f, --format         Format (json|pretty|yaml) (default "yaml")
      --loglevel       Minimum level for log messages (only available when using pretty␣
↪format)
      --pretty         Pretty rendering (short for --format=pretty)
      --type           Event type to listen for
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc move

Move instances within or in between LXD servers

Synopsis

Description: Move instances within or in between LXD servers

Transfer modes (–mode):

- pull: Target server pulls the data from the source server (source must listen on network)
- push: Source server pushes the data to the target server (target must listen on network)
- relay: The CLI connects to both source and server and proxies the data (both source and target must listen on network)

The pull transfer mode is the default as it is compatible with all LXD versions.

```
lxc move [<remote>:]<instance>[/<snapshot>] [<remote>:][<instance>[/<snapshot>]] [flags]
```

Examples

```
  lxc move [<remote>:]<source instance> [<remote>:][<destination instance>] [--instance-
↪only]
      Move an instance between two hosts, renaming it if destination name differs.

  lxc move <old name> <new name> [--instance-only]
      Rename a local instance.

  lxc move <instance>/<old snapshot name> <instance>/<new snapshot name>
      Rename a snapshot.
```

Options

```
      --allow-inconsistent   Ignore copy errors for volatile files
  -c, --config               Config key/value to apply to the target instance
  -d, --device               New key/value to apply to a specific device
      --instance-only        Move the instance without its snapshots
      --mode                 Transfer mode. One of pull, push or relay. (default "pull")
      --no-profiles          Unset all profiles on the target instance
  -p, --profile              Profile to apply to the target instance
      --stateless            Copy a stateful instance stateless
  -s, --storage              Storage pool name
      --target               Cluster member name
      --target-project       Copy to a project different from the source
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc network

Manage and attach instances to networks

Synopsis

Description: Manage and attach instances to networks

```
lxc network [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc network acl* - Manage network ACLs
- *lxc network attach* - Attach network interfaces to instances
- *lxc network attach-profile* - Attach network interfaces to profiles
- *lxc network create* - Create new networks
- *lxc network delete* - Delete networks

- *lxc network detach* - Detach network interfaces from instances
- *lxc network detach-profile* - Detach network interfaces from profiles
- *lxc network edit* - Edit network configurations as YAML
- *lxc network forward* - Manage network forwards
- *lxc network get* - Get values for network configuration keys
- *lxc network info* - Get runtime information on networks
- *lxc network list* - List available networks
- *lxc network list-allocations* - List network allocations in use
- *lxc network list-leases* - List DHCP leases
- *lxc network load-balancer* - Manage network load balancers
- *lxc network peer* - Manage network peerings
- *lxc network rename* - Rename networks
- *lxc network set* - Set network configuration keys
- *lxc network show* - Show network configurations
- *lxc network unset* - Unset network configuration keys
- *lxc network zone* - Manage network zones

`lxc network acl`

Manage network ACLs

Synopsis

Description: Manage network ACLs

```
lxc network acl [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks
- *lxc network acl create* - Create new network ACLs
- *lxc network acl delete* - Delete network ACLs
- *lxc network acl edit* - Edit network ACL configurations as YAML
- *lxc network acl get* - Get values for network ACL configuration keys
- *lxc network acl list* - List available network ACLS
- *lxc network acl rename* - Rename network ACLs
- *lxc network acl rule* - Manage network ACL rules
- *lxc network acl set* - Set network ACL configuration keys
- *lxc network acl show* - Show network ACL configurations
- *lxc network acl show-log* - Show network ACL log
- *lxc network acl unset* - Unset network ACL configuration keys

lxc network acl create

Create new network ACLs

Synopsis

Description: Create new network ACLs

```
lxc network acl create [<remote>:]<ACL> [key=value...] [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl delete

Delete network ACLs

Synopsis

Description: Delete network ACLs

```
lxc network acl delete [<remote>:]<ACL> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl edit

Edit network ACL configurations as YAML

Synopsis

Description: Edit network ACL configurations as YAML

```
lxc network acl edit [<remote>:]<ACL> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl get

Get values for network ACL configuration keys

Synopsis

Description: Get values for network ACL configuration keys

```
lxc network acl get [<remote>:]<ACL> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network ACL property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl list

List available network ACLS

Synopsis

Description: List available network ACL

```
lxc network acl list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl rename

Rename network ACLs

Synopsis

Description: Rename network ACLs

```
lxc network acl rename [<remote>:]<ACL> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl rule

Manage network ACL rules

Synopsis

Description: Manage network ACL rules

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs
- *lxc network acl rule add* - Add rules to an ACL
- *lxc network acl rule remove* - Remove rules from an ACL

lxc network acl rule add

Add rules to an ACL

Synopsis

Description: Add rules to an ACL

```
lxc network acl rule add [<remote>:]<ACL> <direction> <key>=<value>... [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl rule* - Manage network ACL rules

lxc network acl rule remove

Remove rules from an ACL

Synopsis

Description: Remove rules from an ACL

```
lxc network acl rule remove [<remote>:]<ACL> <direction> <key>=<value>... [flags]
```

Options

```
      --force   Remove all rules that match
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl rule* - Manage network ACL rules

lxc network acl set

Set network ACL configuration keys

Synopsis

Description: Set network ACL configuration keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:]

```
lxc network acl set [<remote>:]<ACL> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network ACL property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl show

Show network ACL configurations

Synopsis

Description: Show network ACL configurations

```
lxc network acl show [<remote>:]<ACL> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl show-log

Show network ACL log

Synopsis

Description: Show network ACL log

```
lxc network acl show-log [<remote>:]<ACL> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network acl unset

Unset network ACL configuration keys

Synopsis

Description: Unset network ACL configuration keys

```
lxc network acl unset [<remote>:]<ACL> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network ACL property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network acl* - Manage network ACLs

lxc network attach

Attach network interfaces to instances

Synopsis

Description: Attach new network interfaces to instances

```
lxc network attach [<remote>:]<network> <instance> [<device name>] [<interface name>]␣
↪[flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network attach-profile

Attach network interfaces to profiles

Synopsis

Description: Attach network interfaces to profiles

```
lxc network attach-profile [<remote>:]<network> <profile> [<device name>] [<interface␣
↪name>] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network create

Create new networks

Synopsis

Description: Create new networks

```
lxc network create [<remote>:]<network> [key=value...] [flags]
```

Examples

```
  lxc network create foo
      Create a new network called foo

  lxc network create bar network=baz --type ovn
      Create a new OVN network called bar using baz as its uplink network
```

Options

```
      --target   Cluster member name
  -t, --type     Network type
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network delete

Delete networks

Synopsis

Description: Delete networks

```
lxc network delete [<remote>:]<network> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network detach

Detach network interfaces from instances

Synopsis

Description: Detach network interfaces from instances

```
lxc network detach [<remote>:]<network> <instance> [<device name>] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network detach-profile

Detach network interfaces from profiles

Synopsis

Description: Detach network interfaces from profiles

```
lxc network detach-profile [<remote>:]<network> <profile> [<device name>] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network edit

Edit network configurations as YAML

Synopsis

Description: Edit network configurations as YAML

```
lxc network edit [<remote>:]<network> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network forward

Manage network forwards

Synopsis

Description: Manage network forwards

```
lxc network forward [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks
- *lxc network forward create* - Create new network forwards
- *lxc network forward delete* - Delete network forwards
- *lxc network forward edit* - Edit network forward configurations as YAML
- *lxc network forward get* - Get values for network forward configuration keys
- *lxc network forward list* - List available network forwards
- *lxc network forward port* - Manage network forward ports
- *lxc network forward set* - Set network forward keys
- *lxc network forward show* - Show network forward configurations
- *lxc network forward unset* - Unset network forward configuration keys

lxc network forward create

Create new network forwards

Synopsis

Description: Create new network forwards

```
lxc network forward create [<remote>:]<network> [<listen_address>] [key=value...] [flags]
```

Options

```
      --allocate   Auto-allocate an IPv4 or IPv6 listen address. One of 'ipv4', 'ipv6'.
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward delete

Delete network forwards

Synopsis

Description: Delete network forwards

```
lxc network forward delete [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward edit

Edit network forward configurations as YAML

Synopsis

Description: Edit network forward configurations as YAML

```
lxc network forward edit [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward get

Get values for network forward configuration keys

Synopsis

Description: Get values for network forward configuration keys

```
lxc network forward get [<remote>:]<network> <listen_address> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network forward property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward list

List available network forwards

Synopsis

Description: List available network forwards

```
lxc network forward list [<remote>:]<network> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward port

Manage network forward ports

Synopsis

Description: Manage network forward ports

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards
- *lxc network forward port add* - Add ports to a forward
- *lxc network forward port remove* - Remove ports from a forward

lxc network forward port add

Add ports to a forward

Synopsis

Description: Add ports to a forward

```
lxc network forward port add [<remote>:]<network> <listen_address> <protocol> <listen_
↪port(s)> <target_address> [<target_port(s)>] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward port* - Manage network forward ports

lxc network forward port remove

Remove ports from a forward

Synopsis

Description: Remove ports from a forward

```
lxc network forward port remove [<remote>:]<network> <listen_address> [<protocol>] [
↪<listen_port(s)>] [flags]
```

Options

```
      --force    Remove all ports that match
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward port* - Manage network forward ports

lxc network forward set

Set network forward keys

Synopsis

Description: Set network forward keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:] <listen_address>

```
lxc network forward set [<remote>:]<network> <listen_address> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network forward property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward show

Show network forward configurations

Synopsis

Description: Show network forward configurations

```
lxc network forward show [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network forward unset

Unset network forward configuration keys

Synopsis

Description: Unset network forward keys

```
lxc network forward unset [<remote>:]<network> <listen_address> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network forward property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network forward* - Manage network forwards

lxc network get

Get values for network configuration keys

Synopsis

Description: Get values for network configuration keys

```
lxc network get [<remote>:]<network> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network info

Get runtime information on networks

Synopsis

Description: Get runtime information on networks

```
lxc network info [<remote>:]<network> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network list

List available networks

Synopsis

Description: List available networks

```
lxc network list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network list-allocations

List network allocations in use

Synopsis

Description: List network allocations in use

```
lxc network list-allocations [flags]
```

Options

```
      --all-projects     Run against all projects
  -f, --format           Format (csv|json|table|yaml|compact) (default "table")
  -p, --project string   Run again a specific project (default "default")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network list-leases

List DHCP leases

Synopsis

Description: List DHCP leases

```
lxc network list-leases [<remote>:]<network> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network load-balancer

Manage network load balancers

Synopsis

Description: Manage network load balancers

```
lxc network load-balancer [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks
- *lxc network load-balancer backend* - Manage network load balancer backends
- *lxc network load-balancer create* - Create new network load balancers
- *lxc network load-balancer delete* - Delete network load balancers
- *lxc network load-balancer edit* - Edit network load balancer configurations as YAML
- *lxc network load-balancer get* - Get values for network load balancer configuration keys
- *lxc network load-balancer list* - List available network load balancers
- *lxc network load-balancer port* - Manage network load balancer ports
- *lxc network load-balancer set* - Set network load balancer keys
- *lxc network load-balancer show* - Show network load balancer configurations
- *lxc network load-balancer unset* - Unset network load balancer configuration keys

`lxc network load-balancer backend`

Manage network load balancer backends

Synopsis

Description: Manage network load balancer backends

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers
- *lxc network load-balancer backend add* - Add backends to a load balancer
- *lxc network load-balancer backend remove* - Remove backends from a load balancer

lxc network load-balancer backend add

Add backends to a load balancer

Synopsis

Description: Add backend to a load balancer

```
lxc network load-balancer backend add [<remote>:]<network> <listen_address> <backend_
↪name> <target_address> [<target_port(s)>] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer backend* - Manage network load balancer backends

lxc network load-balancer backend remove

Remove backends from a load balancer

Synopsis

Description: Remove backend from a load balancer

```
lxc network load-balancer backend remove [<remote>:]<network> <listen_address> <backend_
↪name> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer backend* - Manage network load balancer backends

lxc network load-balancer create

Create new network load balancers

Synopsis

Description: Create new network load balancers

```
lxc network load-balancer create [<remote>:]<network> [<listen_address>] [key=value...]␣
↪[flags]
```

Options

```
      --allocate   Auto-allocate an IPv4 or IPv6 listen address. One of 'ipv4', 'ipv6'.
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer delete

Delete network load balancers

Synopsis

Description: Delete network load balancers

```
lxc network load-balancer delete [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer edit

Edit network load balancer configurations as YAML

Synopsis

Description: Edit network load balancer configurations as YAML

```
lxc network load-balancer edit [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer get

Get values for network load balancer configuration keys

Synopsis

Description: Get values for network load balancer configuration keys

```
lxc network load-balancer get [<remote>:]<network> <listen_address> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network load balancer property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer list

List available network load balancers

Synopsis

Description: List available network load balancers

```
lxc network load-balancer list [<remote>:]<network> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer port

Manage network load balancer ports

Synopsis

Description: Manage network load balancer ports

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers
- *lxc network load-balancer port add* - Add ports to a load balancer
- *lxc network load-balancer port remove* - Remove ports from a load balancer

lxc network load-balancer port add

Add ports to a load balancer

Synopsis

Description: Add ports to a load balancer

```
lxc network load-balancer port add [<remote>:]<network> <listen_address> <protocol>
↪<listen_port(s)> <backend_name>[,<backend_name>...] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer port* - Manage network load balancer ports

lxc network load-balancer port remove

Remove ports from a load balancer

Synopsis

Description: Remove ports from a load balancer

```
lxc network load-balancer port remove [<remote>:]<network> <listen_address> [<protocol>]␣
↪[<listen_port(s)>] [flags]
```

Options

```
      --force    Remove all ports that match
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer port* - Manage network load balancer ports

lxc network load-balancer set

Set network load balancer keys

Synopsis

Description: Set network load balancer keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:] <listen_address>

```
lxc network load-balancer set [<remote>:]<network> <listen_address> <key>=<value>...␣
↪[flags]
```

Options

```
  -p, --property   Set the key as a network load balancer property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer show

Show network load balancer configurations

Synopsis

Description: Show network load balancer configurations

```
lxc network load-balancer show [<remote>:]<network> <listen_address> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network load-balancer unset

Unset network load balancer configuration keys

Synopsis

Description: Unset network load balancer keys

```
lxc network load-balancer unset [<remote>:]<network> <listen_address> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network load balancer property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network load-balancer* - Manage network load balancers

lxc network peer

Manage network peerings

Synopsis

Description: Manage network peerings

```
lxc network peer [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks
- *lxc network peer create* - Create new network peering
- *lxc network peer delete* - Delete network peerings
- *lxc network peer edit* - Edit network peer configurations as YAML
- *lxc network peer get* - Get values for network peer configuration keys
- *lxc network peer list* - List available network peers

- *lxc network peer set* - Set network peer keys
- *lxc network peer show* - Show network peer configurations
- *lxc network peer unset* - Unset network peer configuration keys

lxc network peer create

Create new network peering

Synopsis

Description: Create new network peering

```
lxc network peer create [<remote>:]<network> <peer_name> <[target project/]target_
↪network> [key=value...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer delete

Delete network peerings

Synopsis

Description: Delete network peerings

```
lxc network peer delete [<remote>:]<network> <peer_name> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer edit

Edit network peer configurations as YAML

Synopsis

Description: Edit network peer configurations as YAML

```
lxc network peer edit [<remote>:]<network> <peer_name> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer get

Get values for network peer configuration keys

Synopsis

Description: Get values for network peer configuration keys

```
lxc network peer get [<remote>:]<network> <peer_name> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network peer property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer list

List available network peers

Synopsis

Description: List available network peers

```
lxc network peer list [<remote>:]<network> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer set

Set network peer keys

Synopsis

Description: Set network peer keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:] <peer_name>

```
lxc network peer set [<remote>:]<network> <peer_name> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network peer property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer show

Show network peer configurations

Synopsis

Description: Show network peer configurations

```
lxc network peer show [<remote>:]<network> <peer name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network peer unset

Unset network peer configuration keys

Synopsis

Description: Unset network peer keys

```
lxc network peer unset [<remote>:]<network> <peer_name> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network peer property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network peer* - Manage network peerings

lxc network rename

Rename networks

Synopsis

Description: Rename networks

```
lxc network rename [<remote>:]<network> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network set

Set network configuration keys

Synopsis

Description: Set network configuration keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:]

```
lxc network set [<remote>:]<network> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network show

Show network configurations

Synopsis

Description: Show network configurations

```
lxc network show [<remote>:]<network> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network unset

Unset network configuration keys

Synopsis

Description: Unset network configuration keys

```
lxc network unset [<remote>:]<network> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks

lxc network zone

Manage network zones

Synopsis

Description: Manage network zones

```
lxc network zone [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network* - Manage and attach instances to networks
- *lxc network zone create* - Create new network zones
- *lxc network zone delete* - Delete network zones
- *lxc network zone edit* - Edit network zone configurations as YAML
- *lxc network zone get* - Get values for network zone configuration keys
- *lxc network zone list* - List available network zoneS

- *lxc network zone record* - Manage network zone records
- *lxc network zone set* - Set network zone configuration keys
- *lxc network zone show* - Show network zone configurations
- *lxc network zone unset* - Unset network zone configuration keys

lxc network zone create

Create new network zones

Synopsis

Description: Create new network zones

```
lxc network zone create [<remote>:]<Zone> [key=value...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone delete

Delete network zones

Synopsis

Description: Delete network zones

```
lxc network zone delete [<remote>:]<Zone> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone edit

Edit network zone configurations as YAML

Synopsis

Description: Edit network zone configurations as YAML

```
lxc network zone edit [<remote>:]<Zone> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone get

Get values for network zone configuration keys

Synopsis

Description: Get values for network zone configuration keys

```
lxc network zone get [<remote>:]<Zone> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network zone property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone list

List available network zoneS

Synopsis

Description: List available network zone

```
lxc network zone list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone record

Manage network zone records

Synopsis

Description: Manage network zone records

```
lxc network zone record [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones
- *lxc network zone record create* - Create new network zone record
- *lxc network zone record delete* - Delete network zone record
- *lxc network zone record edit* - Edit network zone record configurations as YAML
- *lxc network zone record entry* - Manage network zone record entries
- *lxc network zone record get* - Get values for network zone record configuration keys
- *lxc network zone record list* - List available network zone records
- *lxc network zone record set* - Set network zone record configuration keys
- *lxc network zone record show* - Show network zone record configuration
- *lxc network zone record unset* - Unset network zone record configuration keys

lxc network zone record create

Create new network zone record

Synopsis

Description: Create new network zone record

```
lxc network zone record create [<remote>:]<zone> <record> [key=value...] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record delete

Delete network zone record

Synopsis

Description: Delete network zone record

```
lxc network zone record delete [<remote>:]<zone> <record> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record edit

Edit network zone record configurations as YAML

Synopsis

Description: Edit network zone record configurations as YAML

```
lxc network zone record edit [<remote>:]<zone> <record> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record entry

Manage network zone record entries

Synopsis

Description: Manage network zone record entries

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records
- *lxc network zone record entry add* - Add a network zone record entry
- *lxc network zone record entry remove* - Remove a network zone record entry

lxc network zone record entry add

Add a network zone record entry

Synopsis

Description: Add entries to a network zone record

```
lxc network zone record entry add [<remote>:]<zone> <record> <type> <value> [flags]
```

Options

```
      --ttl   Entry TTL
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record entry* - Manage network zone record entries

lxc network zone record entry remove

Remove a network zone record entry

Synopsis

Description: Remove entries from a network zone record

```
lxc network zone record entry remove [<remote>:]<zone> <record> <type> <value> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record entry* - Manage network zone record entries

lxc network zone record get

Get values for network zone record configuration keys

Synopsis

Description: Get values for network zone record configuration keys

```
lxc network zone record get [<remote>:]<zone> <record> <key> [flags]
```

Options

```
  -p, --property   Get the key as a network zone record property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record list

List available network zone records

Synopsis

Description: List available network zone records

```
lxc network zone record list [<remote>:]<zone> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record set

Set network zone record configuration keys

Synopsis

Description: Set network zone record configuration keys

```
lxc network zone record set [<remote>:]<zone> <record> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network zone record property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record show

Show network zone record configuration

Synopsis

Description: Show network zone record configurations

```
lxc network zone record show [<remote>:]<zone> <record> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone record unset

Unset network zone record configuration keys

Synopsis

Description: Unset network zone record configuration keys

```
lxc network zone record unset [<remote>:]<zone> <record> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network zone record property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone record* - Manage network zone records

lxc network zone set

Set network zone configuration keys

Synopsis

Description: Set network zone configuration keys

For backward compatibility, a single configuration key may still be set with: lxc network set [:]

```
lxc network zone set [<remote>:]<Zone> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a network zone property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone show

Show network zone configurations

Synopsis

Description: Show network zone configurations

```
lxc network zone show [<remote>:]<Zone> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc network zone unset

Unset network zone configuration keys

Synopsis

Description: Unset network zone configuration keys

```
lxc network zone unset [<remote>:]<Zone> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a network zone property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc network zone* - Manage network zones

lxc operation

List, show and delete background operations

Synopsis

Description: List, show and delete background operations

```
lxc operation [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc operation delete* - Delete a background operation (will attempt to cancel)
- *lxc operation list* - List background operations
- *lxc operation show* - Show details on a background operation

lxc operation delete

Delete a background operation (will attempt to cancel)

Synopsis

Description: Delete a background operation (will attempt to cancel)

```
lxc operation delete [<remote>:]<operation> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc operation* - List, show and delete background operations

lxc operation list

List background operations

Synopsis

Description: List background operations

```
lxc operation list [<remote>:] [flags]
```

Options

```
      --all-projects   List operations from all projects
  -f, --format         Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc operation* - List, show and delete background operations

lxc operation show

Show details on a background operation

Synopsis

Description: Show details on a background operation

```
lxc operation show [<remote>:]<operation> [flags]
```

Examples

```
  lxc operation show 344a79e4-d88a-45bf-9c39-c72c26f6ab8a
      Show details on that operation UUID
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc operation* - List, show and delete background operations

lxc pause

Pause instances

Synopsis

Description: Pause instances

```
lxc pause [<remote>:]<instance> [[<remote>:]<instance>...] [flags]
```

Options

```
      --all   Run against all instances
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc profile

Manage profiles

Synopsis

Description: Manage profiles

```
lxc profile [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc profile add* - Add profiles to instances
- *lxc profile assign* - Assign sets of profiles to instances
- *lxc profile copy* - Copy profiles
- *lxc profile create* - Create profiles
- *lxc profile delete* - Delete profiles

- *lxc profile device* - Manage devices
- *lxc profile edit* - Edit profile configurations as YAML
- *lxc profile get* - Get values for profile configuration keys
- *lxc profile list* - List profiles
- *lxc profile remove* - Remove profiles from instances
- *lxc profile rename* - Rename profiles
- *lxc profile set* - Set profile configuration keys
- *lxc profile show* - Show profile configurations
- *lxc profile unset* - Unset profile configuration keys

lxc profile add

Add profiles to instances

Synopsis

Description: Add profiles to instances

```
lxc profile add [<remote>:]<instance> <profile> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile assign

Assign sets of profiles to instances

Synopsis

Description: Assign sets of profiles to instances

```
lxc profile assign [<remote>:]<instance> <profiles> [flags]
```

Examples

```
  lxc profile assign foo default,bar
      Set the profiles for "foo" to "default" and "bar".

  lxc profile assign foo default
      Reset "foo" to only using the "default" profile.

  lxc profile assign foo ''
      Remove all profile from "foo"
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile copy

Copy profiles

Synopsis

Description: Copy profiles

```
lxc profile copy [<remote>:]<profile> [<remote>:]<profile> [flags]
```

Options

```
      --refresh          Update the target profile from the source if it already exists
      --target-project   Copy to a project different from the source
```

Options inherited from parent commands

```
      --debug            Show all debug messages
      --force-local      Force using the local unix socket
  -h, --help             Print help
      --project          Override the source project
  -q, --quiet            Don't show progress information
      --sub-commands     Use with help or --help to view sub-commands
  -v, --verbose          Show all information messages
      --version          Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile create

Create profiles

Synopsis

Description: Create profiles

```
lxc profile create [<remote>:]<profile> [flags]
```

Options inherited from parent commands

```
      --debug            Show all debug messages
      --force-local      Force using the local unix socket
  -h, --help             Print help
      --project          Override the source project
  -q, --quiet            Don't show progress information
      --sub-commands     Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile delete

Delete profiles

Synopsis

Description: Delete profiles

```
lxc profile delete [<remote>:]<profile> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile device

Manage devices

Synopsis

Description: Manage devices

```
lxc profile device [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles
- *lxc profile device add* - Add instance devices
- *lxc profile device get* - Get values for device configuration keys
- *lxc profile device list* - List instance devices
- *lxc profile device remove* - Remove instance devices
- *lxc profile device set* - Set device configuration keys
- *lxc profile device show* - Show full device configuration
- *lxc profile device unset* - Unset device configuration keys

lxc profile device add

Add instance devices

Synopsis

Description: Add instance devices

```
lxc profile device add [<remote>:]<profile> <device> <type> [key=value...] [flags]
```

Examples

```
  lxc profile device add [<remote>:]profile1 <device-name> disk source=/share/c1 path=/
↪opt
      Will mount the host's /share/c1 onto /opt in the instance.

  lxc profile device add [<remote>:]profile1 <device-name> disk pool=some-pool␣
↪source=some-volume path=/opt
      Will mount the some-volume volume on some-pool onto /opt in the instance.
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device get

Get values for device configuration keys

Synopsis

Description: Get values for device configuration keys

```
lxc profile device get [<remote>:]<profile> <device> <key> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device list

List instance devices

Synopsis

Description: List instance devices

```
lxc profile device list [<remote>:]<profile> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device remove

Remove instance devices

Synopsis

Description: Remove instance devices

```
lxc profile device remove [<remote>:]<profile> <name>... [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device set

Set device configuration keys

Synopsis

Description: Set device configuration keys

For backward compatibility, a single configuration key may still be set with: lxc profile device set [:]

```
lxc profile device set [<remote>:]<profile> <device> <key>=<value>... [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device show

Show full device configuration

Synopsis

Description: Show full device configuration

```
lxc profile device show [<remote>:]<profile> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile device unset

Unset device configuration keys

Synopsis

Description: Unset device configuration keys

```
lxc profile device unset [<remote>:]<profile> <device> <key> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile device* - Manage devices

lxc profile edit

Edit profile configurations as YAML

Synopsis

Description: Edit profile configurations as YAML

```
lxc profile edit [<remote>:]<profile> [flags]
```

Examples

```
  lxc profile edit <profile> < profile.yaml
      Update a profile using the content of profile.yaml
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile get

Get values for profile configuration keys

Synopsis

Description: Get values for profile configuration keys

```
lxc profile get [<remote>:]<profile> <key> [flags]
```

Options

```
  -p, --property   Get the key as a profile property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile list

List profiles

Synopsis

Description: List profiles

```
lxc profile list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile remove

Remove profiles from instances

Synopsis

Description: Remove profiles from instances

```
lxc profile remove [<remote>:]<instance> <profile> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile rename

Rename profiles

Synopsis

Description: Rename profiles

```
lxc profile rename [<remote>:]<profile> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile set

Set profile configuration keys

Synopsis

Description: Set profile configuration keys

For backward compatibility, a single configuration key may still be set with: lxc profile set [:]

```
lxc profile set [<remote>:]<profile> <key><value>... [flags]
```

Options

```
  -p, --property   Set the key as a profile property
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile show

Show profile configurations

Synopsis

Description: Show profile configurations

```
lxc profile show [<remote>:]<profile> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc profile unset

Unset profile configuration keys

Synopsis

Description: Unset profile configuration keys

```
lxc profile unset [<remote>:]<profile> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a profile property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc profile* - Manage profiles

lxc project

Manage projects

Synopsis

Description: Manage projects

```
lxc project [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc project create* - Create projects
- *lxc project delete* - Delete projects
- *lxc project edit* - Edit project configurations as YAML
- *lxc project get* - Get values for project configuration keys
- *lxc project info* - Get a summary of resource allocations
- *lxc project list* - List projects
- *lxc project rename* - Rename projects
- *lxc project set* - Set project configuration keys
- *lxc project show* - Show project options
- *lxc project switch* - Switch the current project
- *lxc project unset* - Unset project configuration keys

lxc project create

Create projects

Synopsis

Description: Create projects

```
lxc project create [<remote>:]<project> [flags]
```

Options

```
  -c, --config   Config key/value to apply to the new project
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project delete

Delete projects

Synopsis

Description: Delete projects

```
lxc project delete [<remote>:]<project> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project edit

Edit project configurations as YAML

Synopsis

Description: Edit project configurations as YAML

```
lxc project edit [<remote>:]<project> [flags]
```

Examples

```
  lxc project edit <project> < project.yaml
      Update a project using the content of project.yaml
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project get

Get values for project configuration keys

Synopsis

Description: Get values for project configuration keys

```
lxc project get [<remote>:]<project> <key> [flags]
```

Options

```
  -p, --property   Get the key as a project property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project info

Get a summary of resource allocations

Synopsis

Description: Get a summary of resource allocations

```
lxc project info [<remote>:]<project> <key> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project list

List projects

Synopsis

Description: List projects

```
lxc project list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project rename

Rename projects

Synopsis

Description: Rename projects

```
lxc project rename [<remote>:]<project> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project set

Set project configuration keys

Synopsis

Description: Set project configuration keys

For backward compatibility, a single configuration key may still be set with: lxc project set [:]

```
lxc project set [<remote>:]<project> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a project property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project show

Show project options

Synopsis

Description: Show project options

```
lxc project show [<remote>:]<project> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project switch

Switch the current project

Synopsis

Description: Switch the current project

```
lxc project switch [<remote>:]<project> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc project unset

Unset project configuration keys

Synopsis

Description: Unset project configuration keys

```
lxc project unset [<remote>:]<project> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a project property
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc project* - Manage projects

lxc publish

Publish instances as images

Synopsis

Description: Publish instances as images

```
lxc publish [<remote>:]<instance>[/<snapshot>] [<remote>:] [flags] [key=value...]
```

Options

```
      --alias              New alias to define at target
      --compression none   Compression algorithm to use (none for uncompressed)
      --expire             Image expiration date (format: rfc3339)
  -f, --force              Stop the instance if currently running
      --public             Make the image public
      --reuse              If the image alias already exists, delete and create a new one
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc query

Send a raw query to LXD

Synopsis

Description: Send a raw query to LXD

```
lxc query [<remote>:]<API path> [flags]
```

Examples

```
  lxc query -X DELETE --wait /1.0/instances/c1
      Delete local instance "c1".
```

Options

```
  -d, --data      Input data
      --raw       Print the raw response
  -X, --request   Action (defaults to GET) (default "GET")
      --wait      Wait for the operation to complete
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc rebuild

Rebuild instances

Synopsis

Description: Wipe the instance root disk and re-initialize. The original image is used to re-initialize the instance if a different image or –empty is not specified.

```
lxc rebuild [<remote>:]<image> [<remote>:]<instance> [flags]
```

Options

```
      --empty   Rebuild as an empty instance
  -f, --force   If an instance is running, stop it and then rebuild it
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc remote

Manage the list of remote servers

Synopsis

Description: Manage the list of remote servers

```
lxc remote [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc remote add* - Add new remote servers
- *lxc remote get-default* - Show the default remote
- *lxc remote list* - List the available remotes
- *lxc remote remove* - Remove remotes
- *lxc remote rename* - Rename remotes
- *lxc remote set-url* - Set the URL for the remote
- *lxc remote switch* - Switch the default remote

lxc remote add

Add new remote servers

Synopsis

Description: Add new remote servers

URL for remote resources must be HTTPS (https://).

Basic authentication can be used when combined with the "simplestreams" protocol: lxc remote add some-name https://LOGIN:PASSWORD@example.com/some/path –protocol=simplestreams

```
lxc remote add [<remote>] <IP|FQDN|URL|token> [flags]
```

Options

```
      --accept-certificate   Accept certificate
      --auth-type            Server authentication type (tls or oidc)
      --password             Remote admin password
      --project              Project to use for the remote
      --protocol             Server protocol (lxd or simplestreams)
      --public               Public image server
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote get-default

Show the default remote

Synopsis

Description: Show the default remote

```
lxc remote get-default [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote list

List the available remotes

Synopsis

Description: List the available remotes

```
lxc remote list [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote remove

Remove remotes

Synopsis

Description: Remove remotes

```
lxc remote remove <remote> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote rename

Rename remotes

Synopsis

Description: Rename remotes

```
lxc remote rename <remote> <new-name> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote set-url

Set the URL for the remote

Synopsis

Description: Set the URL for the remote

```
lxc remote set-url <remote> <URL> [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc remote switch

Switch the default remote

Synopsis

Description: Switch the default remote

```
lxc remote switch <remote> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc remote* - Manage the list of remote servers

lxc rename

Rename instances and snapshots

Synopsis

Description: Rename instances and snapshots

```
lxc rename [<remote>:]<instance>[/<snapshot>] <instance>[/<snapshot>] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc restart

Restart instances

Synopsis

Description: Restart instances

The opposite of "lxc pause" is "lxc start".

```
lxc restart [<remote>:]<instance> [[<remote>:]<instance>...] [flags]
```

Options

```
      --all                    Run against all instances
      --console[="console"]    Immediately attach to the console
  -f, --force                  Force the instance to stop
      --timeout                Time to wait for the instance to shutdown cleanly (default␣
↪-1)
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc restore

Restore instances from snapshots

Synopsis

Description: Restore instances from snapshots

If –stateful is passed, then the running state will be restored too.

```
lxc restore [<remote>:]<instance> <snapshot> [flags]
```

Examples

```
  lxc snapshot u1 snap0
      Create the snapshot.

  lxc restore u1 snap0
      Restore the snapshot.
```

Options

```
      --stateful   Whether or not to restore the instance's running state from snapshot␣
↪(if available)
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc snapshot

Create instance snapshots

Synopsis

Description: Create instance snapshots

When –stateful is used, LXD attempts to checkpoint the instance's running state, including process memory state, TCP connections, ...

```
lxc snapshot [<remote>:]<instance> [<snapshot name>] [flags]
```

Examples

```
  lxc snapshot u1 snap0
      Create a snapshot of "u1" called "snap0".
```

Options

```
      --no-expiry   Ignore any configured auto-expiry for the instance
      --reuse       If the snapshot name already exists, delete and create a new one
      --stateful    Whether or not to snapshot the instance's running state
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc start

Start instances

Synopsis

Description: Start instances

```
lxc start [<remote>:]<instance> [[<remote>:]<instance>...] [flags]
```

Options

```
      --all                   Run against all instances
      --console[="console"]   Immediately attach to the console
      --stateless             Ignore the instance state
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc stop

Stop instances

Synopsis

Description: Stop instances

```
lxc stop [<remote>:]<instance> [[<remote>:]<instance>...] [flags]
```

Options

```
      --all                   Run against all instances
      --console["console"]    Immediately attach to the console
  -f, --force                 Force the instance to stop
      --stateful              Store the instance state
      --timeout               Time to wait for the instance to shutdown cleanly (default␣
↪-1)
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc storage

Manage storage pools and volumes

Synopsis

Description: Manage storage pools and volumes

```
lxc storage [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc storage bucket* - Manage storage buckets
- *lxc storage create* - Create storage pools
- *lxc storage delete* - Delete storage pools
- *lxc storage edit* - Edit storage pool configurations as YAML
- *lxc storage get* - Get values for storage pool configuration keys
- *lxc storage info* - Show useful information about storage pools
- *lxc storage list* - List available storage pools
- *lxc storage set* - Set storage pool configuration keys
- *lxc storage show* - Show storage pool configurations and resources
- *lxc storage unset* - Unset storage pool configuration keys
- *lxc storage volume* - Manage storage volumes

lxc storage bucket

Manage storage buckets

Synopsis

Description: Manage storage buckets.

```
lxc storage bucket [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes
- *lxc storage bucket create* - Create new custom storage buckets
- *lxc storage bucket delete* - Delete storage buckets
- *lxc storage bucket edit* - Edit storage bucket configurations as YAML
- *lxc storage bucket get* - Get values for storage bucket configuration keys
- *lxc storage bucket key* - Manage storage bucket keys
- *lxc storage bucket list* - List storage buckets
- *lxc storage bucket set* - Set storage bucket configuration keys
- *lxc storage bucket show* - Show storage bucket configurations
- *lxc storage bucket unset* - Unset storage bucket configuration keys

lxc storage bucket create

Create new custom storage buckets

Synopsis

Description: Create new custom storage buckets

```
lxc storage bucket create [<remote>:]<pool> <bucket> [key=value...] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket delete

Delete storage buckets

Synopsis

Description: Delete storage buckets

```
lxc storage bucket delete [<remote>:]<pool> <bucket> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket edit

Edit storage bucket configurations as YAML

Synopsis

Description: Edit storage bucket configurations as YAML

```
lxc storage bucket edit [<remote>:]<pool> <bucket> [flags]
```

Examples

```
  lxc storage bucket edit [<remote>:]<pool> <bucket> < bucket.yaml
      Update a storage bucket using the content of bucket.yaml.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket get

Get values for storage bucket configuration keys

Synopsis

Description: Get values for storage bucket configuration keys

```
lxc storage bucket get [<remote>:]<pool> <bucket> <key> [flags]
```

Options

```
  -p, --property   Get the key as a storage bucket property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket key

Manage storage bucket keys

Synopsis

Description: Manage storage bucket keys.

```
lxc storage bucket key [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets
- *lxc storage bucket key create* - Create key for a storage bucket
- *lxc storage bucket key delete* - Delete key from a storage bucket
- *lxc storage bucket key edit* - Edit storage bucket key as YAML
- *lxc storage bucket key list* - List storage bucket keys
- *lxc storage bucket key show* - Show storage bucket key configurations

lxc storage bucket key create

Create key for a storage bucket

Synopsis

Description: Create key for a storage bucket

```
lxc storage bucket key create [<remote>:]<pool> <bucket> <key> [flags]
```

Options

```
      --access-key   Access key (auto-generated if empty)
      --role         Role (admin or read-only) (default "read-only")
      --secret-key   Secret key (auto-generated if empty)
      --target       Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket key* - Manage storage bucket keys

lxc storage bucket key delete

Delete key from a storage bucket

Synopsis

Description: Delete key from a storage bucket

```
lxc storage bucket key delete [<remote>:]<pool> <bucket> <key> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket key* - Manage storage bucket keys

lxc storage bucket key edit

Edit storage bucket key as YAML

Synopsis

Description: Edit storage bucket key as YAML

```
lxc storage bucket key edit [<remote>:]<pool> <bucket> <key> [flags]
```

Examples

```
  lxc storage bucket edit [<remote>:]<pool> <bucket> <key> < key.yaml
      Update a storage bucket key using the content of key.yaml.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket key* - Manage storage bucket keys

lxc storage bucket key list

List storage bucket keys

Synopsis

Description: List storage bucket keys

```
lxc storage bucket key list [<remote>:]<pool> <bucket> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket key* - Manage storage bucket keys

lxc storage bucket key show

Show storage bucket key configurations

Synopsis

Description: Show storage bucket key configurations

```
lxc storage bucket key show [<remote>:]<pool> <bucket> <key> [flags]
```

Examples

```
  lxc storage bucket key show default data foo
      Will show the properties of a bucket key called "foo" for a bucket called "data"␣
↪in the "default" pool.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage bucket key* - Manage storage bucket keys

lxc storage bucket list

List storage buckets

Synopsis

Description: List storage buckets

```
lxc storage bucket list [<remote>:]<pool> [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket set

Set storage bucket configuration keys

Synopsis

Description: Set storage bucket configuration keys

For backward compatibility, a single configuration key may still be set with: lxc storage bucket set [:]

```
lxc storage bucket set [<remote>:]<pool> <bucket> <key>=<value>... [flags]
```

Options

```
  -p, --property   Set the key as a storage bucket property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket show

Show storage bucket configurations

Synopsis

Description: Show storage bucket configurations

```
lxc storage bucket show [<remote>:]<pool> <bucket> [flags]
```

Examples

```
  lxc storage bucket show default data
      Will show the properties of a bucket called "data" in the "default" pool.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage bucket unset

Unset storage bucket configuration keys

Synopsis

Description: Unset storage bucket configuration keys

```
lxc storage bucket unset [<remote>:]<pool> <bucket> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a storage bucket property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage bucket* - Manage storage buckets

lxc storage create

Create storage pools

Synopsis

Description: Create storage pools

```
lxc storage create [<remote>:]<pool> <driver> [key=value...] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage delete

Delete storage pools

Synopsis

Description: Delete storage pools

```
lxc storage delete [<remote>:]<pool> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage edit

Edit storage pool configurations as YAML

Synopsis

Description: Edit storage pool configurations as YAML

```
lxc storage edit [<remote>:]<pool> [flags]
```

Examples

```
lxc storage edit [<remote>:]<pool> < pool.yaml
    Update a storage pool using the content of pool.yaml.
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage get

Get values for storage pool configuration keys

Synopsis

Description: Get values for storage pool configuration keys

```
lxc storage get [<remote>:]<pool> <key> [flags]
```

Options

```
-p, --property   Get the key as a storage property
    --target     Cluster member name
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage info

Show useful information about storage pools

Synopsis

Description: Show useful information about storage pools

```
lxc storage info [<remote>:]<pool> [flags]
```

Options

```
      --bytes    Show the used and free space in bytes
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage list

List available storage pools

Synopsis

Description: List available storage pools

```
lxc storage list [<remote>:] [flags]
```

Options

```
  -f, --format   Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage set

Set storage pool configuration keys

Synopsis

Description: Set storage pool configuration keys

For backward compatibility, a single configuration key may still be set with: lxc storage set [:]

```
lxc storage set [<remote>:]<pool> <key> <value> [flags]
```

Options

```
  -p, --property   Set the key as a storage property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage show

Show storage pool configurations and resources

Synopsis

Description: Show storage pool configurations and resources

```
lxc storage show [<remote>:]<pool> [flags]
```

Options

```
      --resources   Show the resources available to the storage pool
      --target      Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage unset

Unset storage pool configuration keys

Synopsis

Description: Unset storage pool configuration keys

```
lxc storage unset [<remote>:]<pool> <key> [flags]
```

Options

```
  -p, --property   Unset the key as a storage property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes

lxc storage volume

Manage storage volumes

Synopsis

Description: Manage storage volumes

Unless specified through a prefix, all volume operations affect "custom" (user created) volumes.

```
lxc storage volume [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage* - Manage storage pools and volumes
- *lxc storage volume attach* - Attach new storage volumes to instances
- *lxc storage volume attach-profile* - Attach new storage volumes to profiles
- *lxc storage volume copy* - Copy storage volumes
- *lxc storage volume create* - Create new custom storage volumes
- *lxc storage volume delete* - Delete storage volumes
- *lxc storage volume detach* - Detach storage volumes from instances
- *lxc storage volume detach-profile* - Detach storage volumes from profiles
- *lxc storage volume edit* - Edit storage volume configurations as YAML
- *lxc storage volume export* - Export custom storage volume
- *lxc storage volume get* - Get values for storage volume configuration keys
- *lxc storage volume import* - Import custom storage volumes
- *lxc storage volume info* - Show storage volume state information
- *lxc storage volume list* - List storage volumes
- *lxc storage volume move* - Move storage volumes between pools
- *lxc storage volume rename* - Rename storage volumes and storage volume snapshots
- *lxc storage volume restore* - Restore storage volume snapshots
- *lxc storage volume set* - Set storage volume configuration keys
- *lxc storage volume show* - Show storage volume configurations
- *lxc storage volume snapshot* - Snapshot storage volumes

- *lxc storage volume unset* - Unset storage volume configuration keys

lxc storage volume attach

Attach new storage volumes to instances

Synopsis

Description: Attach new storage volumes to instances

```
lxc storage volume attach [<remote>:]<pool> <volume> <instance> [<device name>] [<path>]␣
↪[flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume attach-profile

Attach new storage volumes to profiles

Synopsis

Description: Attach new storage volumes to profiles

```
lxc storage volume attach-profile [<remote:>]<pool> <volume> <profile> [<device name>] [
↪<path>] [flags]
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume copy

Copy storage volumes

Synopsis

Description: Copy storage volumes

```
lxc storage volume copy [<remote>:]<pool>/<volume>[/<snapshot>] [<remote>:]<pool>/
↪<volume> [flags]
```

Options

```
      --destination-target   Destination cluster member name
      --mode                 Transfer mode. One of pull (default), push or relay.␣
↪(default "pull")
      --refresh              Refresh and update the existing storage volume copies
      --target               Cluster member name
      --target-project       Copy to a project different from the source
      --volume-only          Copy the volume without its snapshots
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume create

Create new custom storage volumes

Synopsis

Description: Create new custom storage volumes

```
lxc storage volume create [<remote>:]<pool> <volume> [key=value...] [flags]
```

Options

```
      --target   Cluster member name
      --type     Content type, block or filesystem (default "filesystem")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume delete

Delete storage volumes

Synopsis

Description: Delete storage volumes

```
lxc storage volume delete [<remote>:]<pool> <volume>[/<snapshot>] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume detach

Detach storage volumes from instances

Synopsis

Description: Detach storage volumes from instances

```
lxc storage volume detach [<remote>:]<pool> <volume> <instance> [<device name>] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume detach-profile

Detach storage volumes from profiles

Synopsis

Description: Detach storage volumes from profiles

```
lxc storage volume detach-profile [<remote:>]<pool> <volume> <profile> [<device name>]␣
↪[flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume edit

Edit storage volume configurations as YAML

Synopsis

Description: Edit storage volume configurations as YAML

```
lxc storage volume edit [<remote>:]<pool> [<type>/]<volume> [flags]
```

Examples

```
Provide the type of the storage volume if it is not custom.
Supported types are custom, image, container and virtual-machine.

lxc storage volume edit [<remote>:]<pool> [<type>/]<volume> < volume.yaml
    Update a storage volume using the content of pool.yaml.
```

Options

```
    --target   Cluster member name
```

Options inherited from parent commands

```
    --debug          Show all debug messages
    --force-local    Force using the local unix socket
-h, --help           Print help
    --project        Override the source project
-q, --quiet          Don't show progress information
    --sub-commands   Use with help or --help to view sub-commands
-v, --verbose        Show all information messages
    --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume export

Export custom storage volume

Synopsis

Description: Export custom storage volume

```
lxc storage volume export [<remote>:]<pool> <volume> [<path>] [flags]
```

Options

```
      --compression         Define a compression algorithm: for backup or none
      --optimized-storage   Use storage driver optimized format (can only be restored on␣
↪a similar pool)
      --target              Cluster member name
      --volume-only         Export the volume without its snapshots
```

Options inherited from parent commands

```
      --debug           Show all debug messages
      --force-local     Force using the local unix socket
  -h, --help            Print help
      --project         Override the source project
  -q, --quiet           Don't show progress information
      --sub-commands    Use with help or --help to view sub-commands
  -v, --verbose         Show all information messages
      --version         Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume get

Get values for storage volume configuration keys

Synopsis

Description: Get values for storage volume configuration keys

```
lxc storage volume get [<remote>:]<pool> [<type>/]<volume>[/<snapshot>] <key> [flags]
```

Examples

```
  Provide the type of the storage volume if it is not custom.
  Supported types are custom, image, container and virtual-machine.

  Add the name of the snapshot if type is one of custom, container or virtual-machine.

  lxc storage volume get default data size
      Returns the size of a custom volume "data" in pool "default".

  lxc storage volume get default virtual-machine/data snapshots.expiry
      Returns the snapshot expiration period for a virtual machine "data" in pool
↪"default".
```

Options

```
  -p, --property   Get the key as a storage volume property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume import

Import custom storage volumes

Synopsis

Description: Import backups of custom volumes including their snapshots.

```
lxc storage volume import [<remote>:]<pool> <backup file> [<volume name>] [flags]
```

Examples

```
  lxc storage volume import default backup0.tar.gz
                 Create a new custom volume using backup0.tar.gz as the source.
```

Options

```
      --target   Cluster member name
      --type     Import type, backup or iso (default "backup")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume info

Show storage volume state information

Synopsis

Description: Show storage volume state information

```
lxc storage volume info [<remote>:]<pool> [<type>/]<volume> [flags]
```

Examples

```
  Provide the type of the storage volume if it is not custom.
  Supported types are custom, container and virtual-machine.

  lxc storage volume info default data
      Returns state information for a custom volume "data" in pool "default".

  lxc storage volume info default virtual-machine/data
      Returns state information for a virtual machine "data" in pool "default".
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume list

List storage volumes

Synopsis

Description: List storage volumes

The -c option takes a (optionally comma-separated) list of arguments that control which image attributes to output when displaying in table or csv format.

Column shorthand chars: p - Storage pool name c - Content type (filesystem or block) d - Description e - Project name L - Location of the instance (e.g. its cluster member) n - Name t - Type of volume (custom, image, container or virtual-machine) u - Number of references (used by) U - Current disk usage

```
lxc storage volume list [<remote>:][<pool>] [<filter>...] [flags]
```

Options

```
      --all-projects   All projects
  -c, --columns        Columns (default "petndcuL")
  -f, --format         Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
```

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```
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume move

Move storage volumes between pools

Synopsis

Description: Move storage volumes between pools

```
lxc storage volume move [<remote>:]<pool>/<volume> [<remote>:]<pool>/<volume> [flags]
```

Options

```
      --destination-target   Destination cluster member name
      --mode                 Transfer mode, one of pull (default), push or relay␣
↪(default "pull")
      --target               Cluster member name
      --target-project       Move to a project different from the source
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume rename

Rename storage volumes and storage volume snapshots

Synopsis

Description: Rename storage volumes

```
lxc storage volume rename [<remote>:]<pool> <old name>[/<old snapshot name>] <new name>[/
↪<new snapshot name>] [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume restore

Restore storage volume snapshots

Synopsis

Description: Restore storage volume snapshots

```
lxc storage volume restore [<remote>:]<pool> <volume> <snapshot> [flags]
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume set

Set storage volume configuration keys

Synopsis

Description: Set storage volume configuration keys

For backward compatibility, a single configuration key may still be set with: lxc storage volume set [:] [/]

```
lxc storage volume set [<remote>:]<pool> [<type>/]<volume> <key>=<value>... [flags]
```

Examples

```
  Provide the type of the storage volume if it is not custom.
  Supported types are custom, image, container and virtual-machine.

  lxc storage volume set default data size=1GiB
      Sets the size of a custom volume "data" in pool "default" to 1 GiB.
```

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```
  lxc storage volume set default virtual-machine/data snapshots.expiry=7d
      Sets the snapshot expiration period for a virtual machine "data" in pool "default"␣
↪to seven days.
```

Options

```
  -p, --property   Set the key as a storage volume property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume show

Show storage volume configurations

Synopsis

Description: Show storage volume configurations

```
lxc storage volume show [<remote>:]<pool> [<type>/]<volume>[/<snapshot>] [flags]
```

Examples

```
  Provide the type of the storage volume if it is not custom.
  Supported types are custom, image, container and virtual-machine.

  Add the name of the snapshot if type is one of custom, container or virtual-machine.

  lxc storage volume show default data
      Will show the properties of a custom volume called "data" in the "default" pool.
```

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```
  lxc storage volume show default container/data
      Will show the properties of the filesystem for a container called "data" in the
↪"default" pool.

  lxc storage volume show default virtual-machine/data/snap0
      Will show the properties of snapshot "snap0" for a virtual machine called "data"␣
↪in the "default" pool.
```

Options

```
      --target   Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume snapshot

Snapshot storage volumes

Synopsis

Description: Snapshot storage volumes

```
lxc storage volume snapshot [<remote>:]<pool> <volume> [<snapshot>] [flags]
```

Options

```
      --no-expiry   Ignore any configured auto-expiry for the storage volume
      --reuse       If the snapshot name already exists, delete and create a new one
      --target      Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc storage volume unset

Unset storage volume configuration keys

Synopsis

Description: Unset storage volume configuration keys

```
lxc storage volume unset [<remote>:]<pool> [<type>/]<volume> <key> [flags]
```

Examples

```
  Provide the type of the storage volume if it is not custom.
  Supported types are custom, image, container and virtual-machine.

  lxc storage volume unset default data size
      Remotes the size/quota of a custom volume "data" in pool "default".

  lxc storage volume unset default virtual-machine/data snapshots.expiry
      Removes the snapshot expiration period for a virtual machine "data" in pool
↪"default".
```

Options

```
  -p, --property   Unset the key as a storage volume property
      --target     Cluster member name
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc storage volume* - Manage storage volumes

lxc version

Show local and remote versions

Synopsis

Description: Show local and remote versions

```
lxc version [<remote>:] [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD

lxc warning

Manage warnings

Synopsis

Description: Manage warnings

```
lxc warning [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc* - Command line client for LXD
- *lxc warning acknowledge* - Acknowledge warning
- *lxc warning delete* - Delete warning
- *lxc warning list* - List warnings
- *lxc warning show* - Show warning

lxc warning acknowledge

Acknowledge warning

Synopsis

Description: Acknowledge warning

```
lxc warning acknowledge [<remote>:]<warning-uuid> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc warning* - Manage warnings

lxc warning delete

Delete warning

Synopsis

Description: Delete warning

```
lxc warning delete [<remote>:]<warning-uuid> [flags]
```

Options

```
  -a, --all   Delete all warnings
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc warning* - Manage warnings

lxc warning list

List warnings

Synopsis

Description: List warnings

The -c option takes a (optionally comma-separated) list of arguments that control which warning attributes to output when displaying in table or csv format.

Default column layout is: utSscpLl

Column shorthand chars:

```
  c - Count
  l - Last seen
  L - Location
  f - First seen
  p - Project
  s - Severity
  S - Status
  u - UUID
  t - Type
```

```
lxc warning list [<remote>:] [flags]
```

Options

```
  -a, --all       List all warnings
  -c, --columns   Columns (default "utSscpLl")
  -f, --format    Format (csv|json|table|yaml|compact) (default "table")
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc warning* - Manage warnings

lxc warning show

Show warning

Synopsis

Description: Show warning

```
lxc warning show [<remote>:]<warning-uuid> [flags]
```

Options inherited from parent commands

```
      --debug          Show all debug messages
      --force-local    Force using the local unix socket
  -h, --help           Print help
      --project        Override the source project
  -q, --quiet          Don't show progress information
      --sub-commands   Use with help or --help to view sub-commands
  -v, --verbose        Show all information messages
      --version        Print version number
```

SEE ALSO

- *lxc warning* - Manage warnings

2.4.6 Implementation details

You don't need to be aware of the internal implementation details to use LXD. However, advanced users might be interested in knowing what happens internally.

Internals

Environment variables

The LXD client and daemon respect some environment variables to adapt to the user's environment and to turn some advanced features on and off.

Note: These environment variables are not available if you use the LXD snap.

Common

Name	Description
LXD_DIR	The LXD data directory
LXD_INSECUR	If set to true, allows all default Go ciphers both for client <-> server communication and server <-> image servers (server <-> server and clustering are not affected)
PATH	List of paths to look into when resolving binaries
http_proxy	Proxy server URL for HTTP
https_proxy	Proxy server URL for HTTPS
no_proxy	List of domains, IP addresses or CIDR ranges that don't require the use of a proxy

Client environment variable

Name	Description
EDITOR	What text editor to use
VISUAL	What text editor to use (if EDITOR isn't set)
LXD_CONF	Path to the LXC configuration directory
LXD_GLOBAL_CONF	Path to the global LXC configuration directory
LXC_REMOTE	Name of the remote to use (overrides configured default remote)

Server environment variable

Name	Description
LXD_EXEC_P	Full path to the LXD binary (used when forking subcommands)
LXD_LXC_TE	Path to the LXC template configuration directory
LXD_SECURI	If set to false, forces AppArmor off
LXD_UNPRIV	If set to true, enforces that only unprivileged containers can be created. Note that any privileged containers that have been created before setting LXD_UNPRIVILEGED_ONLY will continue to be privileged. To use this option effectively it should be set when the LXD daemon is first set up.
LXD_OVMF_P	Path to an OVMF build including OVMF_CODE.fd and OVMF_VARS.ms.fd (deprecated, please use LXD_QEMU_FW_PATH instead)
LXD_QEMU_F	Path (or : separated list of paths) to firmware (OVMF, SeaBIOS) to be used by QEMU
LXD_IDMAPP	Disable idmapped mounts support (useful when testing traditional UID shifting)
LXD_DEVMON	Path to be monitored by the device monitor. This is primarily for testing.

UEFI variables for VMs

UEFI (Unified Extensible Firmware Interface) variables store and represent configuration settings of the UEFI firmware. See UEFI for more information.

You can see a list of UEFI variables on your system by running `ls -l /sys/firmware/efi/efivars/`. Usually, you don't need to touch these variables, but in specific cases they can be useful to debug UEFI, SHIM, or boot loader issues in virtual machines.

To configure UEFI variables for a VM, use the *lxc config uefi* command or the `/1.0/instances/<instance_name>/uefi-vars` endpoint.

For example, to set a variable to a value (hexadecimal):

CLI

API

```
lxc config uefi set <instance_name> <variable_name>-<GUID>=<value>
```

```
lxc query --request PUT /1.0/instances/<instance_name>/uefi-vars --data '{
  "variables": {
    "<variable_name>-<GUID>": {
      "attr": 3,
      "data": "<value>"
    },
  }
}'
```

See PUT /1.0/instances/{name}/uefi-vars for more information.

To display the variables that are set for a specific VM:

CLI

API

```
lxc config uefi show <instance_name>
```

```
lxc query --request GET /1.0/instances/<instance_name>/uefi-vars
```

See GET /1.0/instances/{name}/uefi-vars for more information.

Example

You can use UEFI variables to disable secure boot, for example.

Important: Use this method only for debugging purposes. LXD provides the *security.secureboot* option to control the secure boot behavior.

The following command checks the secure boot state:

```
lxc config uefi get v1 SecureBootEnable-f0a30bc7-af08-4556-99c4-001009c93a44
```

A value of `01` indicates that secure boot is active. You can then turn it off with the following command:

```
lxc config uefi set v1 SecureBootEnable-f0a30bc7-af08-4556-99c4-001009c93a44=00
```

Daemon behavior

This specification covers some of the *LXD daemon*'s behavior.

Startup

On every start, LXD checks that its directory structure exists. If it doesn't, it creates the required directories, generates a key pair and initializes the database.

Once the daemon is ready for work, LXD scans the instances table for any instance for which the stored power state differs from the current one. If an instance's power state was recorded as running and the instance isn't running, LXD starts it.

Signal handling

`SIGINT`, `SIGQUIT`, `SIGTERM`

For those signals, LXD assumes that it's being temporarily stopped and will be restarted at a later time to continue handling the instances.

The instances will keep running and LXD will close all connections and exit cleanly.

`SIGPWR`

Indicates to LXD that the host is going down.

LXD will attempt a clean shutdown of all the instances. After 30 seconds, it kills any remaining instance.

The instance `power_state` in the instances table is kept as it was so that LXD can restore the instances as they were after the host is done rebooting.

`SIGUSR1`

Write a memory profile dump to the file specified with `--memprofile`.

System call interception

LXD supports intercepting some specific system calls from unprivileged containers. If they're considered to be safe, it executes them with elevated privileges on the host.

Doing so comes with a performance impact for the syscall in question and will cause some work for LXD to evaluate the request and if allowed, process it with elevated privileges.

Enabling of specific system call interception options is done on a per-container basis through container configuration options.

Available system calls

mknod / mknodat

The `mknod` and `mknodat` system calls can be used to create a variety of special files.

Most commonly inside containers, they may be called to create block or character devices. Creating such devices isn't allowed in unprivileged containers as this is a very easy way to escalate privileges by allowing direct write access to resources like disks or memory.

But there are files which are safe to create. For those, intercepting this syscall may unblock some specific workloads and allow them to run inside an unprivileged containers.

The devices which are currently allowed are:

- OverlayFS whiteout (char 0:0)
- `/dev/console` (char 5:1)
- `/dev/full` (char 1:7)
- `/dev/null` (char 1:3)
- `/dev/random` (char 1:8)
- `/dev/tty` (char 5:0)
- `/dev/urandom` (char 1:9)
- `/dev/zero` (char 1:5)

All file types other than character devices are currently sent to the kernel as usual, so enabling this feature doesn't change their behavior at all.

This can be enabled by setting *security.syscalls.intercept.mknod* to `true`.

bpf

The `bpf` system call is used to manage eBPF programs in the kernel. Those can be attached to a variety of kernel subsystems.

In general, loading of eBPF programs that are not trusted can be problematic as it can facilitate timing based attacks.

LXD's eBPF support is currently restricted to programs managing devices cgroup entries. To enable it, you need to set both *security.syscalls.intercept.bpf* and *security.syscalls.intercept.bpf.devices* to true.

mount

The `mount` system call allows for mounting both physical and virtual file systems. By default, unprivileged containers are restricted by the kernel to just a handful of virtual and network file systems.

To allow mounting physical file systems, system call interception can be used. LXD offers a variety of options to handle this.

security.syscalls.intercept.mount is used to control the entire feature and needs to be turned on for any of the other options to work.

security.syscalls.intercept.mount.allowed allows specifying a list of file systems which can be directly mounted in the container. This is the most dangerous option as it allows the user to feed data that is not trusted at

the kernel. This can easily be used to crash the host system or to attack it. It should only ever be used in trusted environments.

security.syscalls.intercept.mount.shift can be set on top of that so the resulting mount is shifted to the UID/GID map used by the container. This is needed to avoid everything showing up as `nobody/nogroup` inside of unprivileged containers.

The much safer alternative to those is *security.syscalls.intercept.mount.fuse* which can be set to pairs of file-system name and FUSE handler. When this is set, an attempt at mounting one of the configured file systems will be transparently redirected to instead calling the FUSE equivalent of that file system.

As this is all running as the caller, it avoids the entire issue around the kernel attack surface and so is generally considered to be safe, though you should keep in mind that any kind of system call interception makes for an easy way to overload the host system.

sched_setscheduler

The `sched_setscheduler` system call is used to manage process priority.

Granting this may allow a user to significantly increase the priority of their processes, potentially taking a lot of system resources.

It also allows access to schedulers like `SCHED_FIFO` which are generally considered to be flawed and can significantly impact overall system stability. This is why under normal conditions, only the real root user (or global `CAP_SYS_NICE`) would allow its use.

setxattr

The `setxattr` system call is used to set extended attributes on files.

The attributes which are handled by this currently are:

- `trusted.overlay.opaque` (OverlayFS directory whiteout)

Note that because the mediation must happen on a number of character strings, there is no easy way at present to only intercept the few attributes we care about. As we only allow the attributes above, this may result in breakage for other attributes that would have been previously allowed by the kernel.

This can be enabled by setting *security.syscalls.intercept.setxattr* to `true`.

sysinfo

The `sysinfo` system call is used by some distributions instead of `/proc/` entries to report on resource usage.

In order to provide resource usage information specific to the container, rather than the whole system, this syscall interception mode uses cgroup-based resource usage information to fill in the system call response.

Idmaps for user namespace

LXD runs safe containers. This is achieved mostly through the use of user namespaces which make it possible to run containers unprivileged, greatly limiting the attack surface.

User namespaces work by mapping a set of UIDs and GIDs on the host to a set of UIDs and GIDs in the container.

For example, we can define that the host UIDs and GIDs from 100000 to 165535 may be used by LXD and should be mapped to UID/GID 0 through 65535 in the container.

As a result a process running as UID 0 in the container will actually be running as UID 100000.

Allocations should always be of at least 65536 UIDs and GIDs to cover the POSIX range including root (0) and nobody (65534).

Kernel support

User namespaces require a kernel >= 3.12, LXD will start even on older kernels but will refuse to start containers.

Allowed ranges

On most hosts, LXD will check `/etc/subuid` and `/etc/subgid` for allocations for the `lxd` user and on first start, set the default profile to use the first 65536 UIDs and GIDs from that range.

If the range is shorter than 65536 (which includes no range at all), then LXD will fail to create or start any container until this is corrected.

If some but not all of `/etc/subuid`, `/etc/subgid`, `newuidmap` (path lookup) and `newgidmap` (path lookup) can be found on the system, LXD will fail the startup of any container until this is corrected as this shows a broken shadow setup.

If none of those files can be found, then LXD will assume a 1000000000 UID/GID range starting at a base UID/GID of 1000000.

This is the most common case and is usually the recommended setup when not running on a system which also hosts fully unprivileged containers (where the container runtime itself runs as a user).

Varying ranges between hosts

The source map is sent when moving containers between hosts so that they can be remapped on the receiving host.

Different idmaps per container

LXD supports using different idmaps per container, to further isolate containers from each other. This is controlled with two per-container configuration keys, *`security.idmap.isolated`* and *`security.idmap.size`*.

Containers with `security.idmap.isolated` will have a unique ID range computed for them among the other containers with `security.idmap.isolated` set (if none is available, setting this key will simply fail).

Containers with `security.idmap.size` set will have their ID range set to this size. Isolated containers without this property set default to a ID range of size 65536; this allows for POSIX compliance and a `nobody` user inside the container.

To select a specific map, the `security.idmap.base` key will let you override the auto-detection mechanism and tell LXD what host UID/GID you want to use as the base for the container.

These properties require a container reboot to take effect.

Custom idmaps

LXD also supports customizing bits of the idmap, e.g. to allow users to bind mount parts of the host's file system into a container without the need for any UID-shifting file system. The per-container configuration key for this is *raw.idmap*, and looks like:

```
both 1000 1000
uid 50-60 500-510
gid 100000-110000 10000-20000
```

The first line configures both the UID and GID 1000 on the host to map to UID 1000 inside the container (this can be used for example to bind mount a user's home directory into a container).

The second and third lines map only the UID or GID ranges into the container, respectively. The second entry per line is the source ID, i.e. the ID on the host, and the third entry is the range inside the container. These ranges must be the same size.

This property requires a container reboot to take effect.

Related topics

How-to guides:

- *Troubleshooting*

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