LVX VERITAS VIRTVS

Institute for the Wireless Internet of Things at Northeastern University

Colosseum Containers

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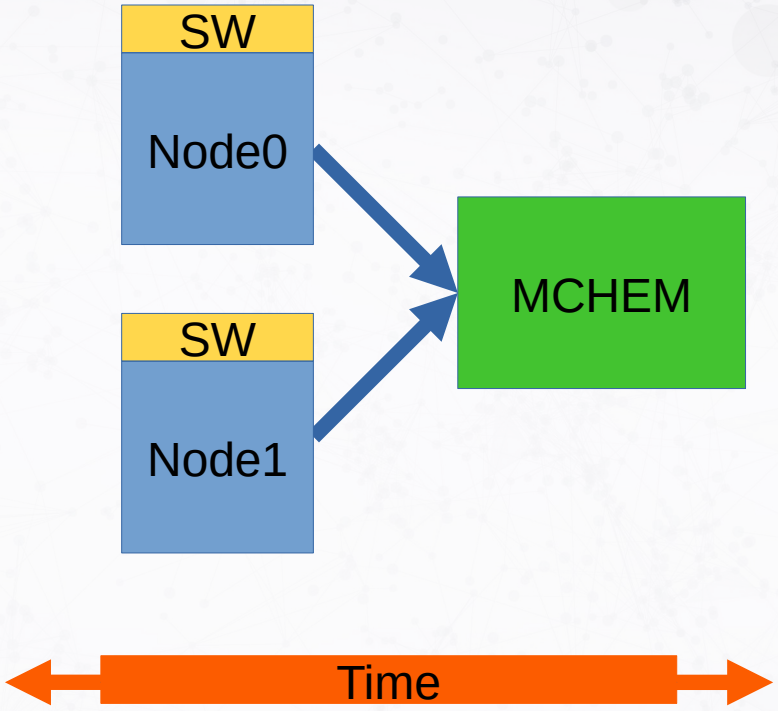
Platforms for Advanced Wireless Research

COLOSSEUM at Northeastern University

Colosseum Experiment

- Reservation
  - Nodes
  - Time
  - Sofware



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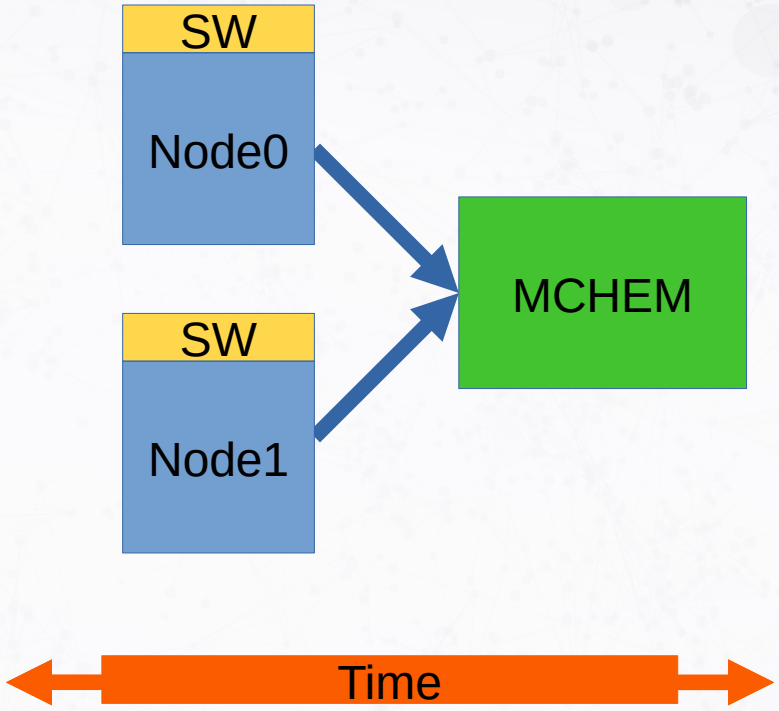
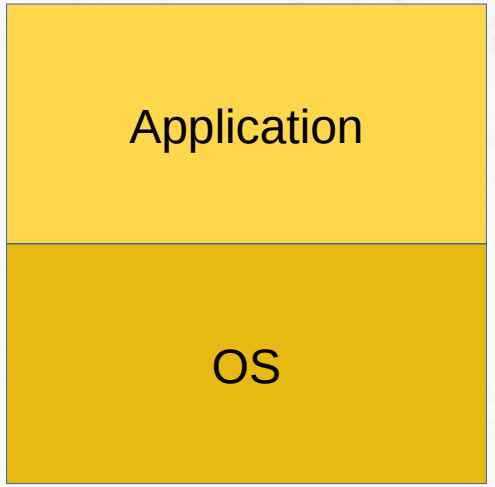
Colosseum Experiment

- Steps:
  - Run software
  - Collect data
  - Save data on the drive (the proxy file server, we shall see later)



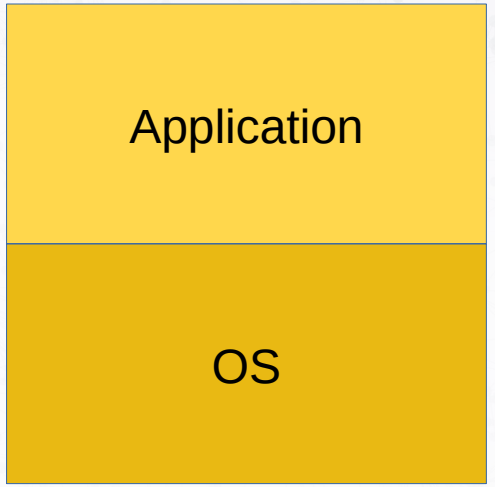
Colosseum Experiment SW

- Software
  - OS
  - Custom/tailored for experiments



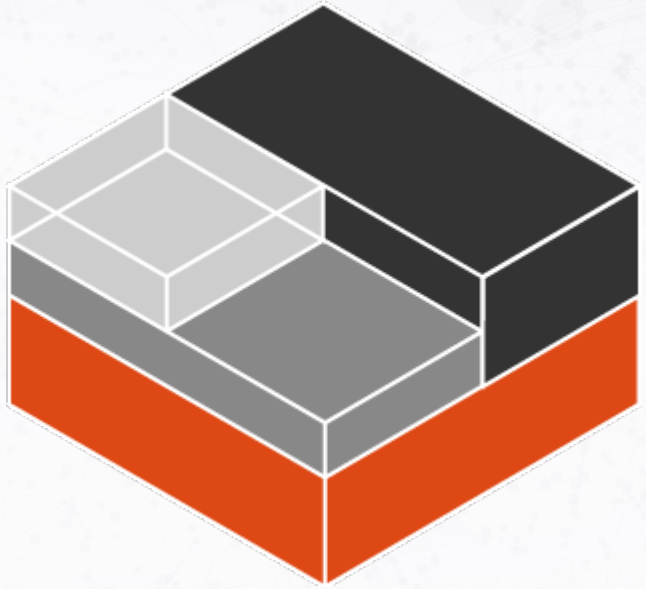
Virtual Machine

- Software is emulated in SRNs
- Linux Containers (LXC)
- Provides nifty clean packaging



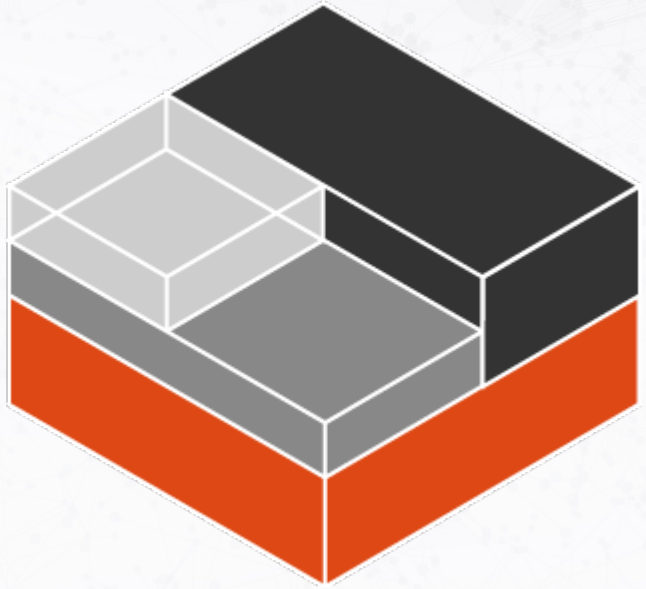
LXC

- Uses Linux kernel namespaces
- Provides hardware controlled access
- Provides process isolation
  - From most hardware
  - From other processes

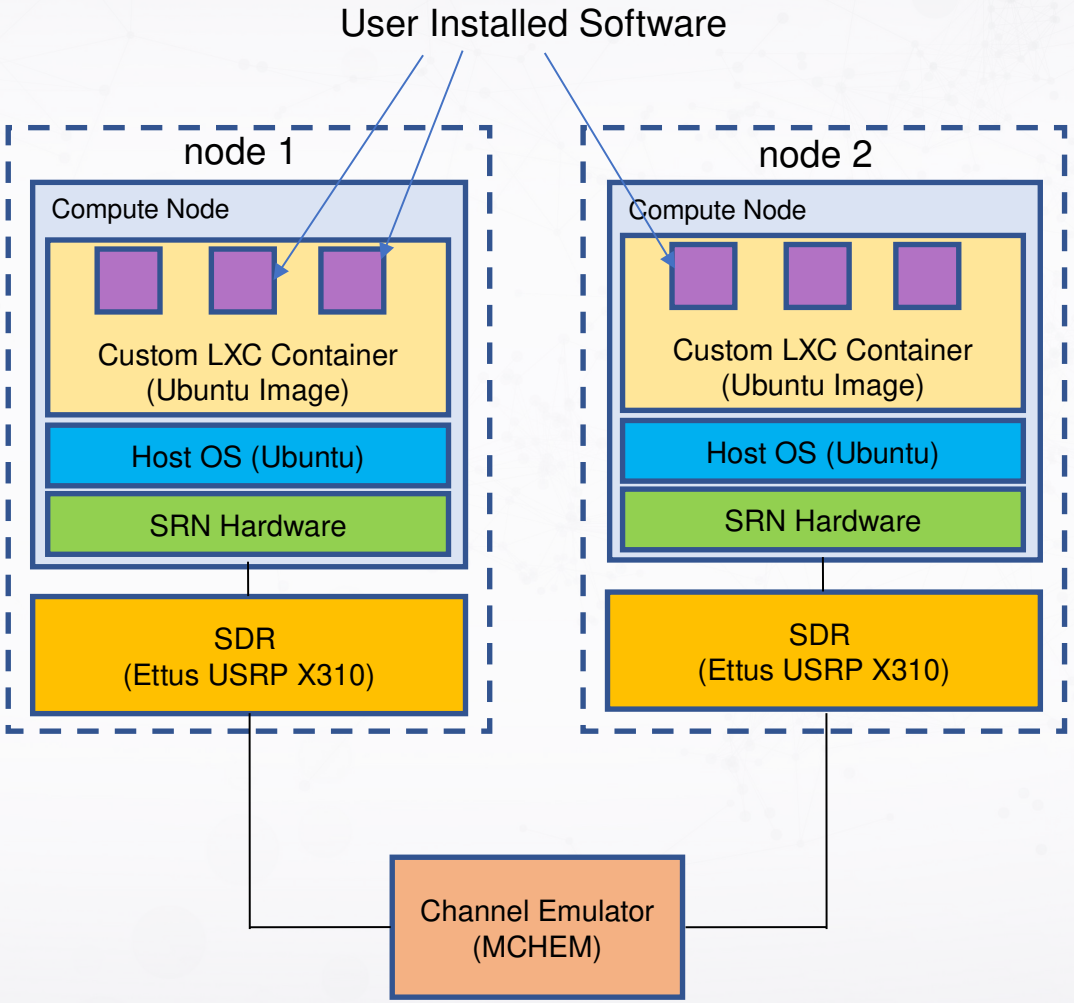


Colosseum containers, recap

- We use containers because:
  -) a way to package experiment software
  -) comprehensive of OS and stacks
  -) provide process isolation and hardware controlled access



Colosseum node architecture



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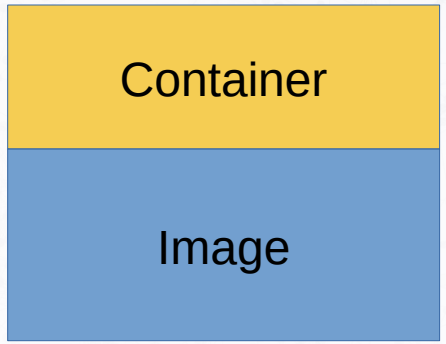
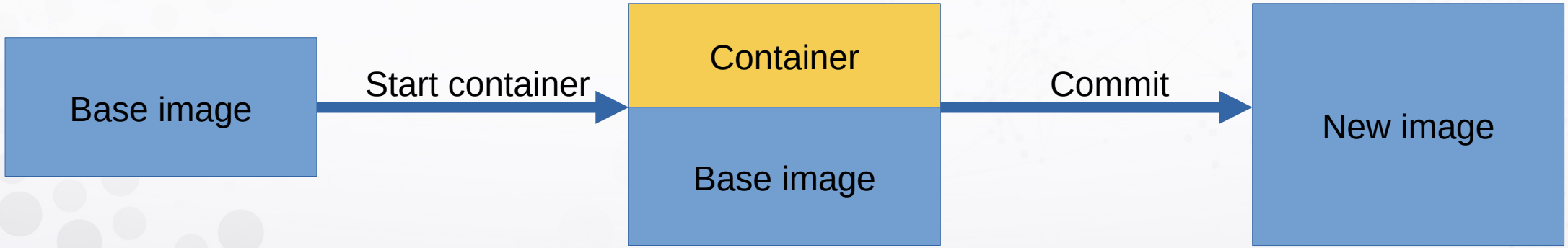
LXC – image and containers

- An **LXC image** is a filesystem comprising the OS and any software
  - Immutable, static
- An **LXC container** is a running instance of an image
  - Can be changed, possibly saved as images



LXC – packaging lifecycle

1. Download a standard image
2. Start a container for that image
3. Customize the container
4. Commit the container to a new image
5. Upload the new image



Colosseum image repo

- A special server, proxy-file
- Folder for common images
  - /share/nas/common
- Folder for custom images
  - /share/nas/<your_group>/images

Proxy-file server

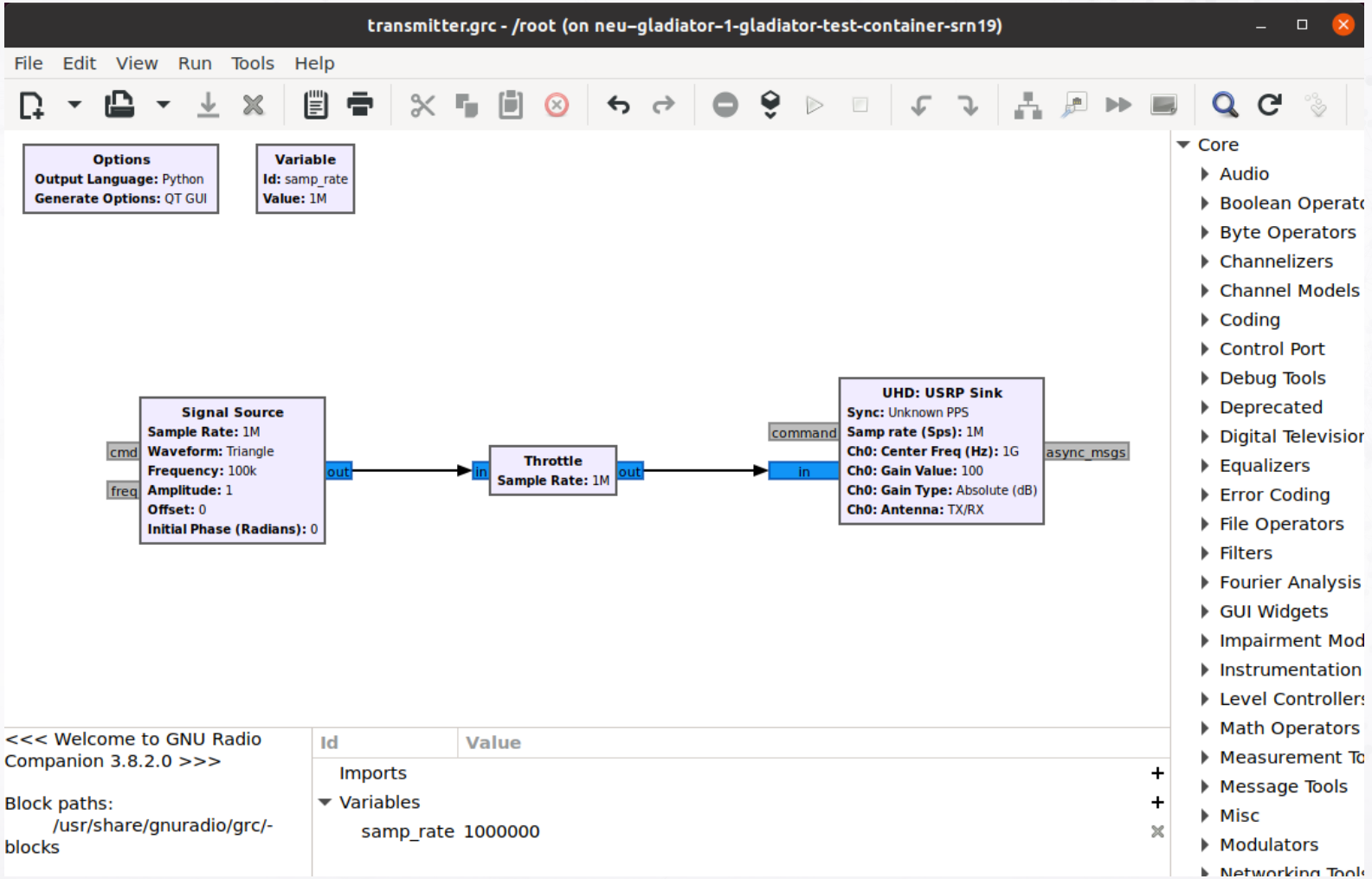
An example, packaging for mobile experiment

- Goal:
- Package software in an image with GNURadio executables
- Make it ready to use in a Colosseum experiment

GNURadio?

- Software development toolkit
- Compose signal processing blocks
- Usable with USRP x310 radios (Colosseum main RF hardware)

GNURadio companion



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GNURadio features

- Send and receive arbitrary wireless signals
- Develop and test new wireless modulation solutions
- Take advantage from the extensive block library, e.g.,
  - Use existing blocks for 802.11 communication

Creating an image for Colosseum

- Pre-requisites:
- A Linux environment
- LXC/LXD installed
- A Colosseum account
- SSH proxy setup (details on the website wiki)

Step 1 – Base image retrieval

- Some starting points are in the Proxy-file server:
- base-1604-cuda.tar.gz
- base-1604-nocuda.tar.gz
- base-2104.tar.gz

- Folders:
- share/nas/common/
- share/nas/gladiators/images/

Step 1 – Base image retrieval

- Some starting points are in the Proxy-file server:
- base-1604-cuda.tar.gz
- base-1604-nocuda.tar.gz
- base-2104.tar.gz

- Folders:
- share/nas/common/
- share/nas/gladiators/images/

```
$> rsync -vP -e ssh file-proxy:/share/nas/gladiators/images/base-2104.tar.gz ./
```

Step 2 – Configuration check

- LXD requires some configuration for running unprivileged containers (safe option)
- Check */etc/subuid* and */etc/subgid* files

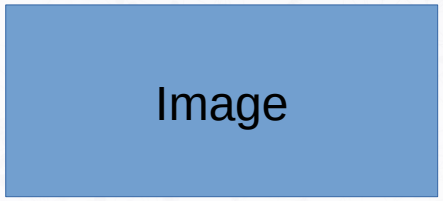
```
lxd:100000:65536
root:100000:65536
```

- Restart LXD

```
$> systemctl restart lxd
```

Step 3 – Base image import in LXC

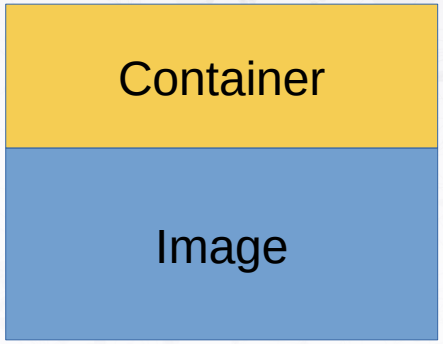
- Need to import the compressed file in LXC




```
$> lxc image import base-2104.tar.gz --alias base
$> lxc image list
```

Step 4 – Start a container

- Initialiaze a container
- Start the container
- Start a terminal interface for the container




```
$> lxc init local:base my-cont
$> lxc start my-cont
$> lxc exec my-cont /bin/bash
```

Step 5 – Customize

- You have full-root access to the system
- The current administrative password is “toor”

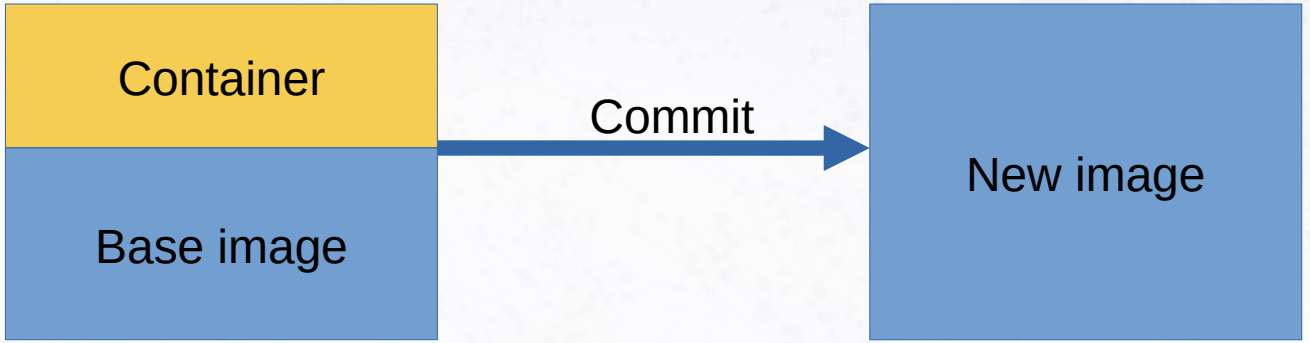
```
#> passwd
```

- In Ubuntu systems, software can be conveniently installed through the apt interface:

```
#> apt update
#> apt install gnuradio gir1.2-gtk-3.0
```

Step 6 – Create custom image

- Ready to “commit” our work, and save it in a new LXC image




```
#> exit
$> lxc stop my-cont
$> lxc publish my-cont --alias my_image
$> lxc image list
```

Step 7 – Upload the custom image

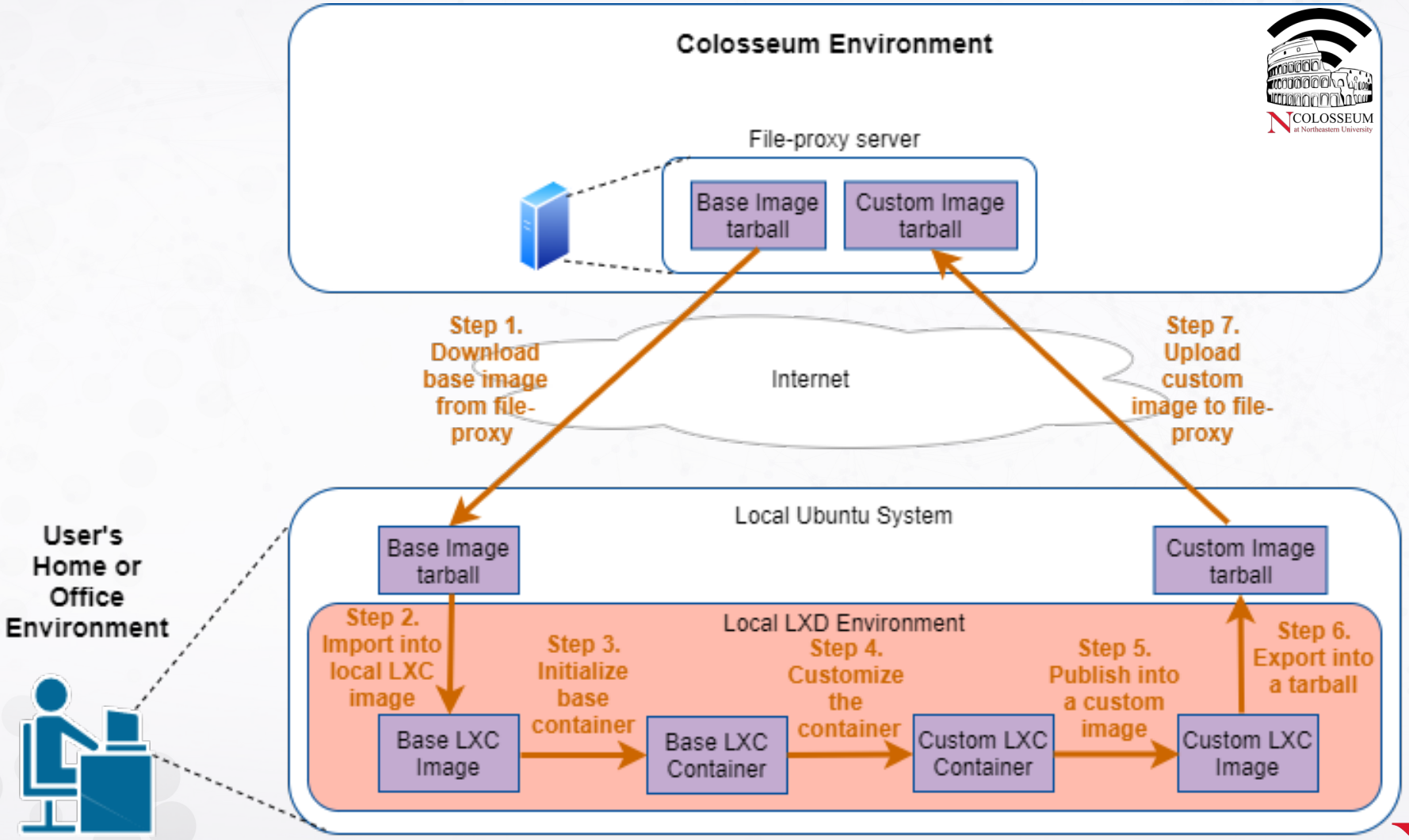
- Export the image as a compressed archive
- Upload it on Colosseum for experiments
- The image identifier **must** be unique for the team

```
$> lxc image export my_image <unique_id>
$> rsync -vP -e ssh <unique_id>.tar.gz file-proxy:/share/nas/gladiators/images/
```

Reminders

- LXC images are immutable
- Every experiment will be consistent and repeatable
- You cannot save data in the Colosseum container

Recap



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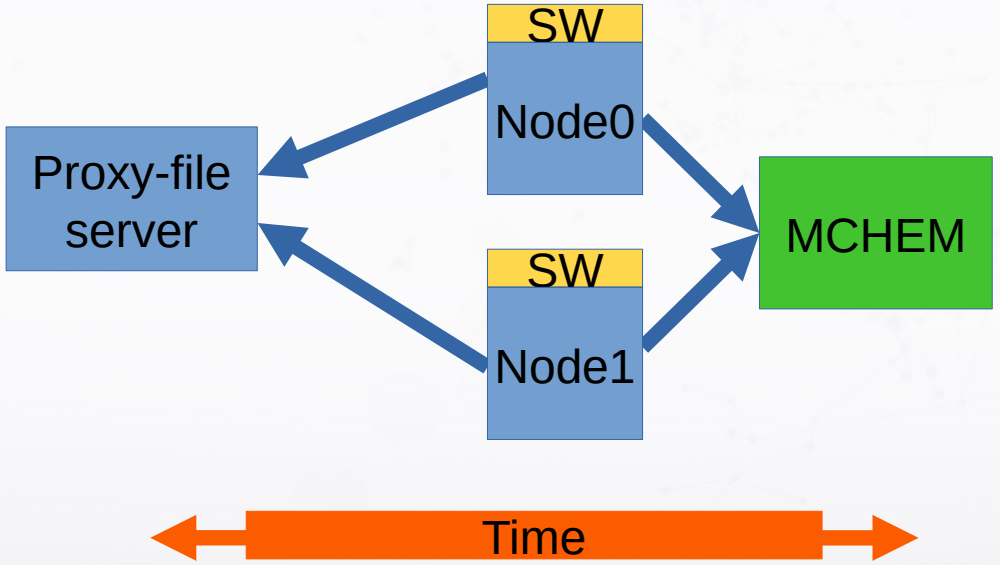
Proxy File Server

Save experiment data

- The LXC container of your image is run with the folder ***share*** pointing to the remote folder */share/<your_team>/reservation/<reservation_id>*



Save experiment data

- Data must be written as an unprivileged users

```
#> su srn-user
$> cp log.data /share/
```

Load Experiment configuration

- The same applies for fetching data from the server and store it in the containers

```
#> cp /share/my.conf .
```

Snapshoting the container

- Another way of saving configurations and setup of a container is by performing a snapshot
- Within the running container, it results in a “publish & export”, producing a archived image, saved on file-proxy server

```
#> colosseumcli snapshot my_second_unique_id
```

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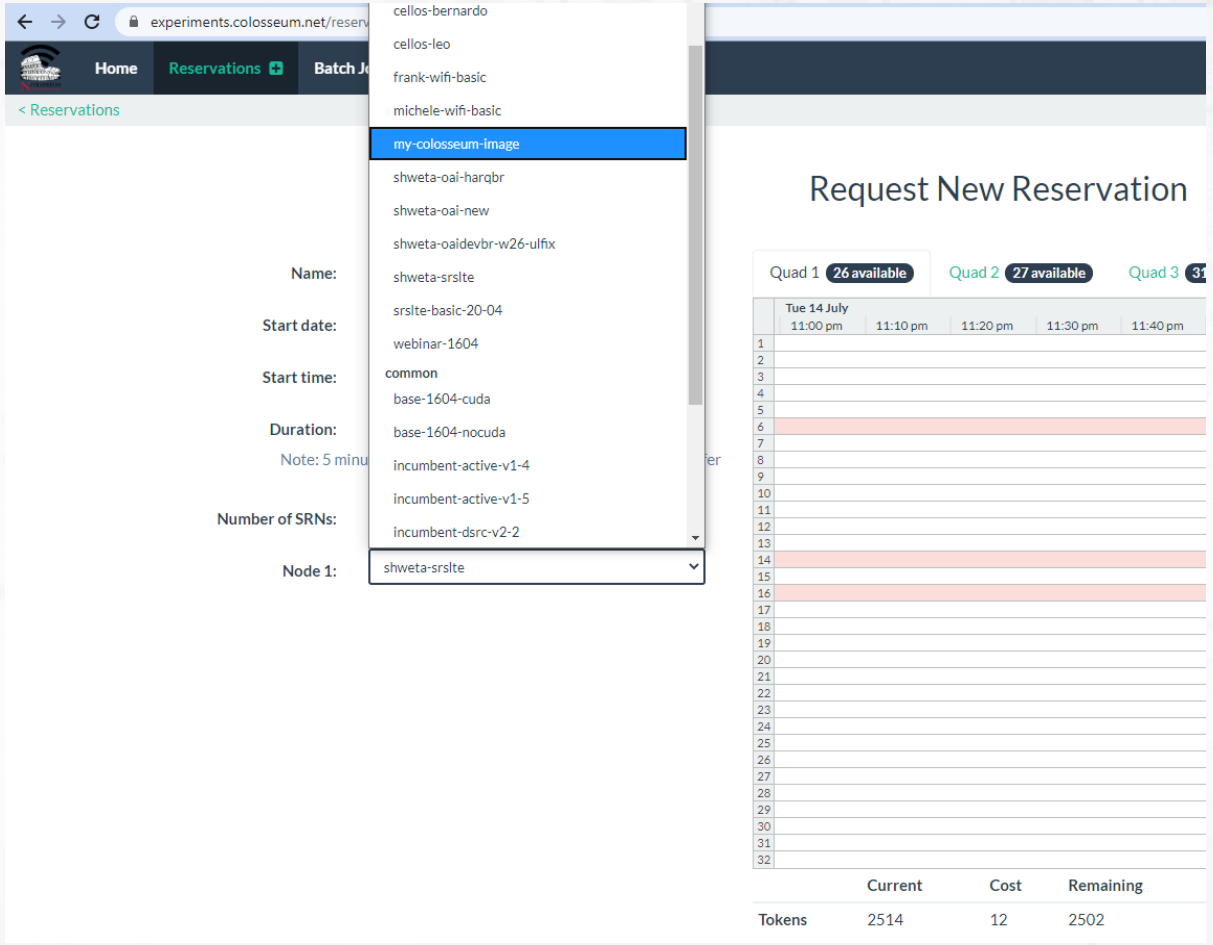
Step 1 – Setup of the reservation

- Upload the image prepared with GNURadio
- Make and start a reservation for two nodes, using the image
- Check the SRNs identifier



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Step 2 – Log in and start RF

- Log-in

Forward of the graphical front-end through ssh

```
$> ssh -Y <srn-hostname1>
$> ssh -Y <srn-hostname2>
```

- Start RF (scenario 1009, with CF 1GHz and 0dB of path loss)

```
#> colosseumcli rf start 1009 -c
```

Step 3 – Start software

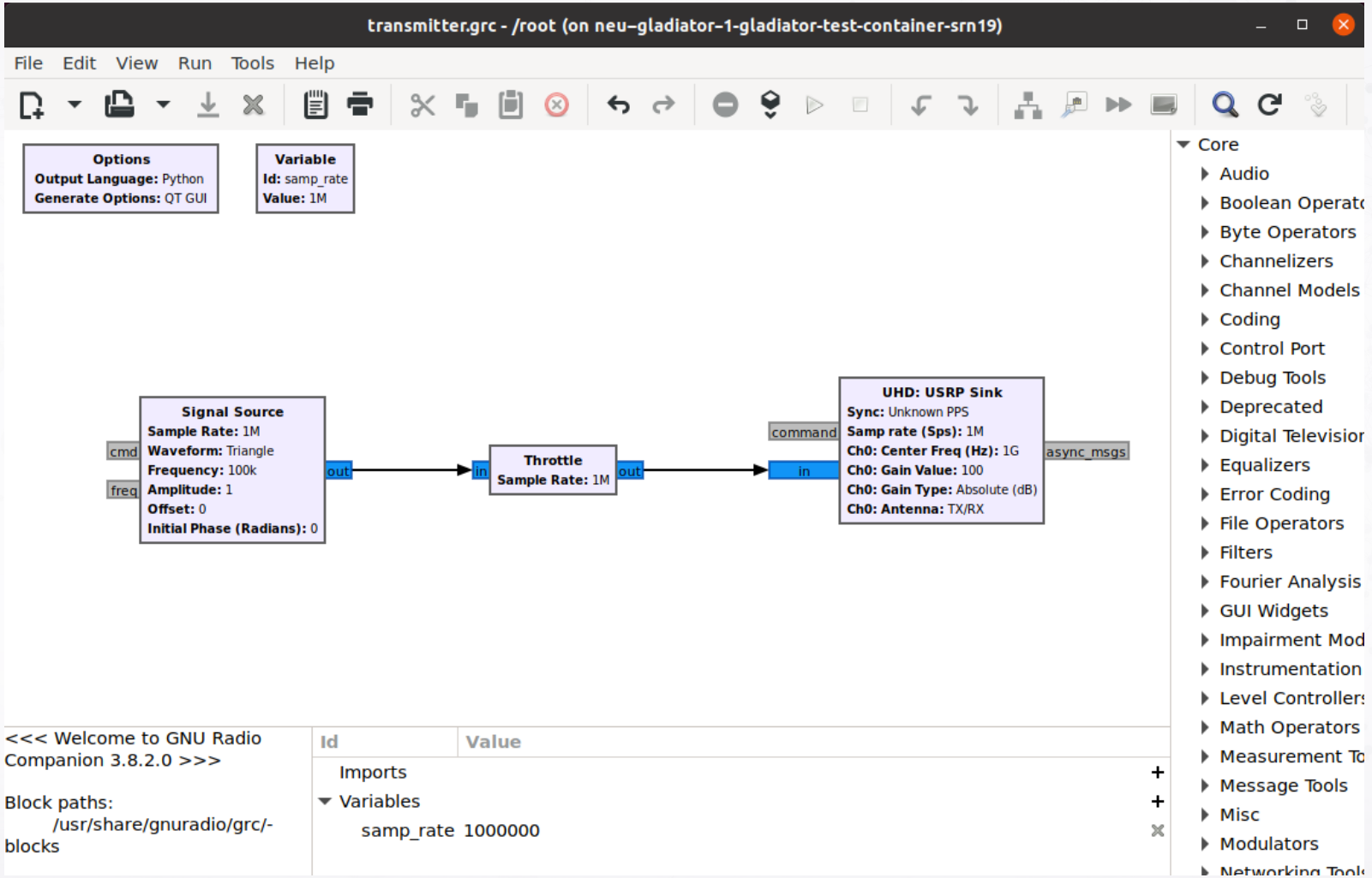
- In both terminals:
- update the FPGA image:

```
#> ./flash_fpga_x310.sh
```

- start GNURadio companion:

```
#> gnuradio-companion
```

Step 4 – Design the transmitter



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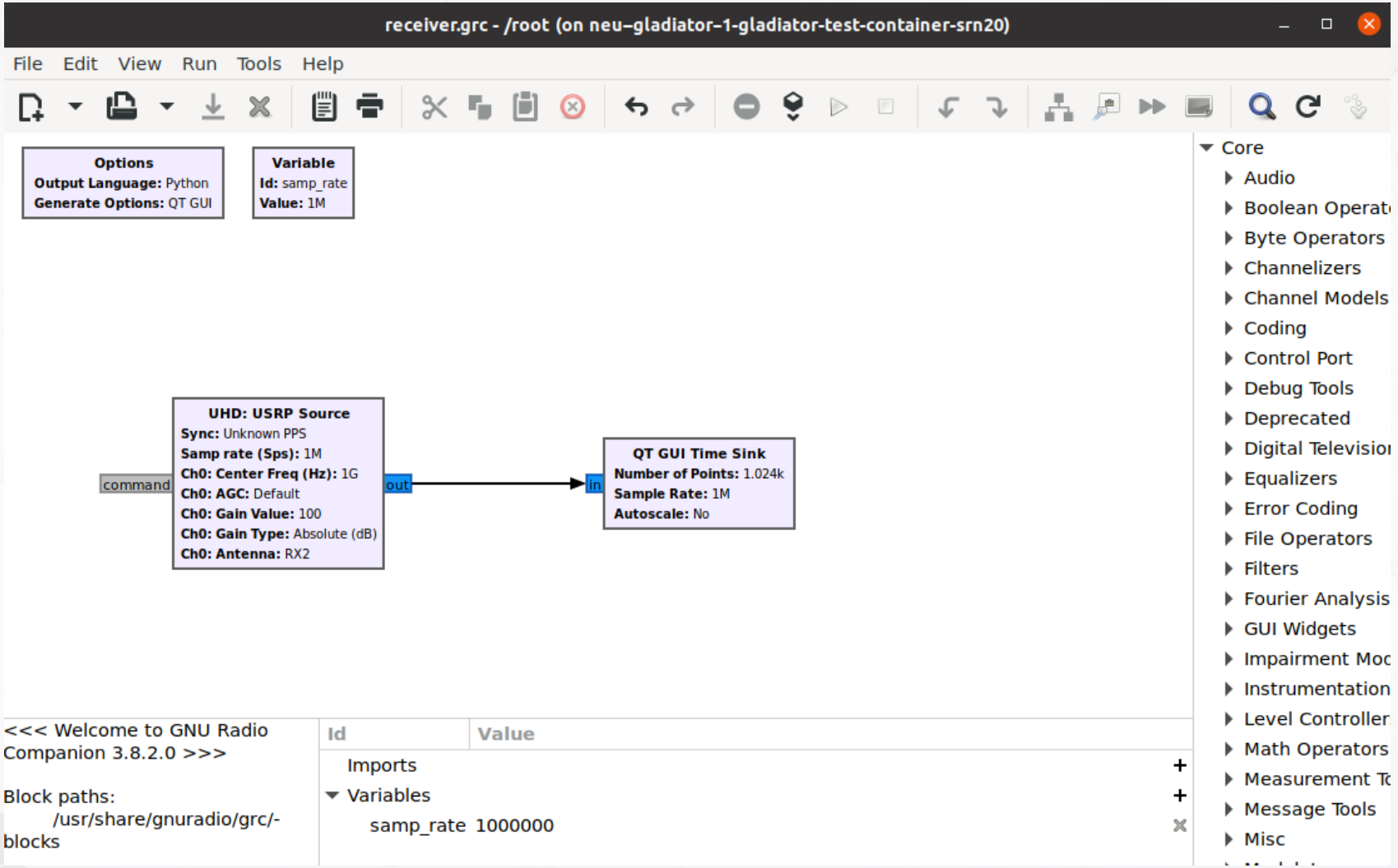
Step 4 – Design the receiver



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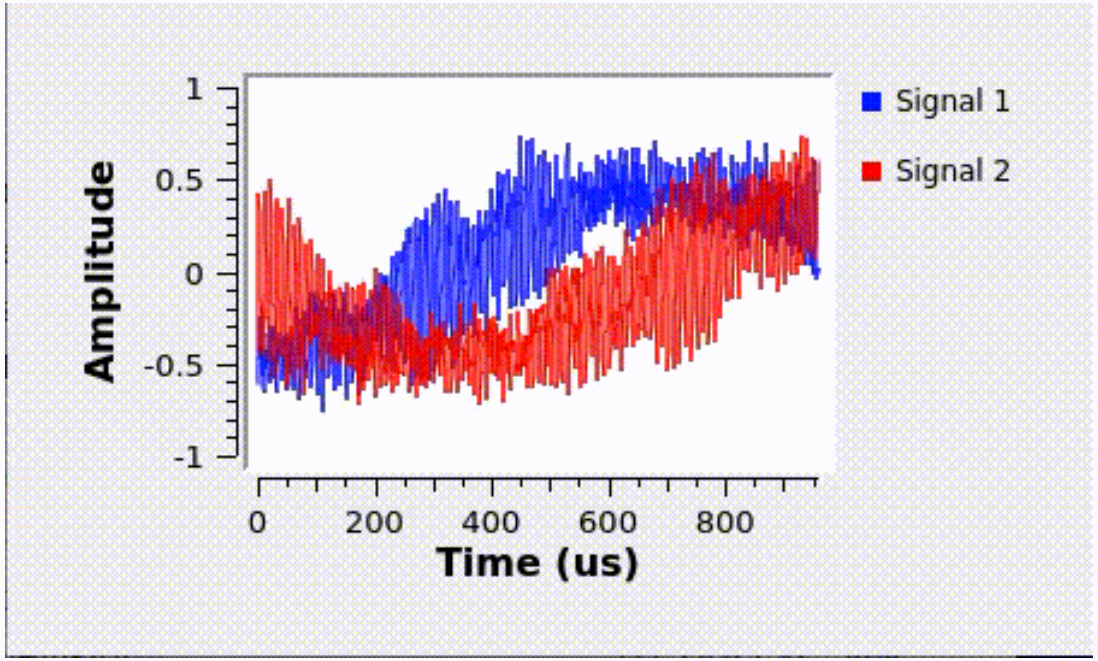
Step 5 – Observe the spectrum



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Colosseum Freshdesk Wiki Links

- Accessing Colosseum Servers:
  - https://colosseumneu.freshdesk.com/support/solutions/articles/61000253362-accessing-colosseum-resources
- SSH Proxy setup
  - https://colosseumneu.freshdesk.com/support/solutions/articles/61000253369-ssh-proxy-setup
- File transfer using scp and rsync:
  - https://colosseumneu.freshdesk.com/a/solutions/articles/61000253365
- Transferring base image from NAS to local machine:
  - https://colosseumneu.freshdesk.com/support/solutions/articles/61000253371-transferring-the-base-lxc-image-from-the-nas
- Details on LXD commands and configuration:
  - https://colosseumneu.freshdesk.com/a/solutions/articles/61000253368
- Working on a container locally and preparing it for upload:
  - https://colosseumneu.freshdesk.com/a/solutions/articles/61000253428
- Uploading a customized container image to File Proxy server:
  - https://colosseumneu.freshdesk.com/support/solutions/articles/61000253372-upload-an-lxc-container
- Installing Colosseum CLI and taking a snapshot of your container
  - https://colosseumneu.freshdesk.com/support/solutions/articles/61000253397-colosseum-cli

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Colosseum containers

- Q & A