

## Remote Operation with POWDER: From GNU Radio to Open Air Interface

Note: An electronic version of this document is available here:  
<https://powderwireless.net/powder/tutorial/oai2019.pdf>

### Tutorial overview

There are two objectives to the tutorial. The first is to provide hands-on exposure to the POWDER platform, its experimental workflow process and the specifically the POWDER *profile* abstraction. The second is to expose attendees to POWDER “building blocks” that might form part of a development/testing workflow for OAI developers.

We will aim to reach these objectives through two hands-on sessions:

1. Basic POWDER platform functionality:

Obtaining an account; logging in; starting a very simple experiment; running GNU Radio Companion in emulated mode; terminating the experiment.

2. Using POWDER to work with OAI:

Modifying a profile to have two compute nodes; downloading, compiling and running a version of OAI 5G NR in simulation mode; terminating the experiment.

### Basic POWDER platform functionality

1. If you don't already have one, request a POWDER account here:

<https://www.powderwireless.net/signup.php?pid=oai2019>

2. Log in to POWDER:

<https://www.powderwireless.net/>

3. Start an experiment (use the “Experiments” menu “Start Experiment” entry if necessary), and search for/change to the `gnuradio_emulab` or `gnuradio_cloudlab` profile.

On the “Schedule” page enter a duration of 2 hours.

4. Once the experiment is ready (several minutes), choose the only node in the experiment and open a browser shell<sup>1</sup>. Within the shell, execute:

```
/share/powder/runvnc.sh
```

5. Open the link given in the shell, of the form:

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<sup>1</sup>Alternatively, if you have uploaded ssh keys when you created your POWDER account, have an ssh client program and have X11 working, you can directly ssh into the nodes in your experiment: Go to the **List View** tab in your experiment view, and use the **SSH command** information to directly ssh into your node and run the `gnuradio-companion` command.

`https://node.foo.oai2019.emulab.net:8787/vnc_auto.html`

6. Within a terminal in the resulting VNC desktop, execute:

```
gnuradio-companion /share/powder/tutorial/psk.grc
```

You will be able to manipulate and run the GNU Radio Companion flow graph on the remote system.

7. When you are finished, return to the experiment page and press the “Terminate” button.

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### Using POWDER to work with OAI

1. Find either the `gnuradio_emulab` or `gnuradio_cloudlab` profile again. (Use the “Experiments” menu “Start Experiment” entry, and search for/change to the `gnuradio_emulab` or `gnuradio_cloudlab` profile.)

2. Rather than instantiating the profile, make your own copy by selecting the “Copy Profile” option. Include your username in the profile name (to prevent collisions).

Note: all python statements and compile/run commands are available to copy and paste from:

`http://powderwireless.net/powder/tutorial/oai2019.txt`

3. Modify your copy of the profile as follows:

- (a) Modify the `disk_image` for `node0` to use an image with OAI requirements/dependencies installed:

```
node0.disk_image = "urn:publicid:IDN+emulab.net+image+PowderTeam:update-nr-image"
```

- (b) Create temporary storage for `node0`:

```
bs0 = node0.Blockstore("bs0", "/mytempdata")
bs0.size = "10GB"
```

- (c) Create another node, `node1`, with the same configuration.

If you are changing the Emulab version of the profile:

```
node1 = request.RawPC( "node1" )
node1.disk_image = "urn:publicid:IDN+emulab.net+image+PowderTeam:update-nr-image"
node1.hardware_type = "d430"
node1.component_manager_id = "urn:publicid:IDN+emulab.net+authority+cm"
bs1 = node1.Blockstore("bs1", "/mytempdata")
bs1.size = "10GB"
```

If you are changing the CloudLab version of the profile:

```

node1 = request.RawPC( "node1" )
node1.disk_image = "urn:publicid:IDN+emulab.net+image+PowderTeam:update-nr-image"
node1.hardware_type = "xl170"
node1.component_manager_id = "urn:publicid:IDN+utah.cloudlab.us+authority+cm"
bs1 = node1.Blockstore("bs1", "/mytempdata")
bs1.size = "10GB"

```

(d) Add a (wired) link between the two nodes:

```

wiredlink = request.Link("link")
wiredlink.addNode(node0)
wiredlink.addNode(node1)

```

4. Try to “Instantiate” your new profile.

On the “Schedule” page enter a duration of 2 hours again.

5. Once your experiment instantiated successfully, there will be *two* nodes in the topology; use one as the gNB and the other as the UE.

Open shells on *both* hosts to compile and run OAI 5G NR.

6. Designate node0 to be the gNB. On node0 compile OAI for gNB functionality:

```

sudo bash

cd /mytempdata
git clone https://gitlab.flux.utah.edu/oai/openairinterface5g.git
cd openairinterface5g/
git checkout develop-nr-working

cd cmake_targets/
./build_oai --gNB -w SIMU
cd ran_build/build
make rfsimulator

```

7. Designate node1 to be the UE. On node1 compile OAI for UE functionality:

```

sudo bash

cd /mytempdata
git clone https://gitlab.flux.utah.edu/oai/openairinterface5g.git
cd openairinterface5g/
git checkout develop-nr-working

cd cmake_targets/

```

```
./build_oai --nrUE -w SIMU
cd ran_build/build
make rfsimulator
```

8. Once the gNB compile is done, start it up:

```
cd /mytempdata/openairinterface5g/cmake_targets/ran_build/build

sudo RFSIMULATOR=enb ./nr-softmodem -O
../../../../targets/PROJECTS/GENERIC-LTE-EPC/CONF/gnb.band78.tm1.106PRB.usrpn300.conf
--parallel-config PARALLEL_SINGLE_THREAD
```

Note: All of the above (starting from sudo RFSIMULATOR) goes in a single command line.

9. Once the UE compile is done, start it up:

```
cd /mytempdata/openairinterface5g/cmake_targets/ran_build/build

sudo RFSIMULATOR='getent hosts node0 | awk '{print $1}'' ./nr-uesoftmodem
--numerology 1 -r 106 -C 3510000000 -E -d
```

Notes:

- Again single command line (starting from sudo RFSIMULATOR).
- If you do not have X11 working, leave off the “-d” option to disable the soft-scope display.
- Alternatively you can start up the browser-based VNC server (as described above) for the UE node and run X11 (and the softscope) in that way.

10. When you are finished, return to the experiment page and press the “Terminate” button.