

Lab 2: Configure a 5G Core Network based on OpenAirInterface (OAI)

The goal of this lab is to configure OAI 5G CN to connect different UEs. A connection is successful when a PDU session is established successfully. You will have four different UEs (i.e., four different docker compose files to simulate gNB + UE) that you have to connect to your CN.

Browse inside `/home/mobsys/lab2/oai-cn5g-fed/docker-compose` and run the following command to start the 5G CN Network Functions (NFs):

`docker-compose -f docker-compose-basic-nrf.yaml up -d`

execute the following command: `watch docker ps` in another terminal and wait until the status of each container is healthy before connecting the UE.

If you want to stop the instance, use the following command: `docker-compose -f docker-compose-basic-nrf.yaml down`

To connect a UE use:

`docker-compose -f docker-compose-ueX.yaml up -d`

where X is the UE's index.

To disconnect the UE use: `docker-compose -f docker-compose-ueX.yaml down`

After updating the CN docker compose or the database, you need to:

Stop the UE(s): `docker-compose -f docker-compose-ueX.yaml down`

Stop the CN: `docker-compose -f docker-compose-basic-nrf.yaml down`

Start the CN: `docker-compose -f docker-compose-basic-nrf.yaml up -d`

Wait until all the containers are healthy:

Start the UE(s): `docker-compose -f docker-compose-ueX.yaml up -d`

Part 1:

The CN is initially not configured to successfully connect any UE. You will analyze the wireshark captures and container logs to detect what is not configured in the CN and fix it.

You are not allowed to update the UE's docker compose files.

It is recommended that you follow the order of UEs, connect successfully one UE at a time and, at the end, restart everything and provide a wireshark capture showing that all the UEs can connect successfully to the same CN instance (i.e., without adding extra NFs).

Questions:

Start wireshark on "demo-oai".

a/ For each UE, explain why it does not attach successfully to the CN? From which message / logs (copy the text) did you figure it out? Hint: NGAP errors are related to AMF.

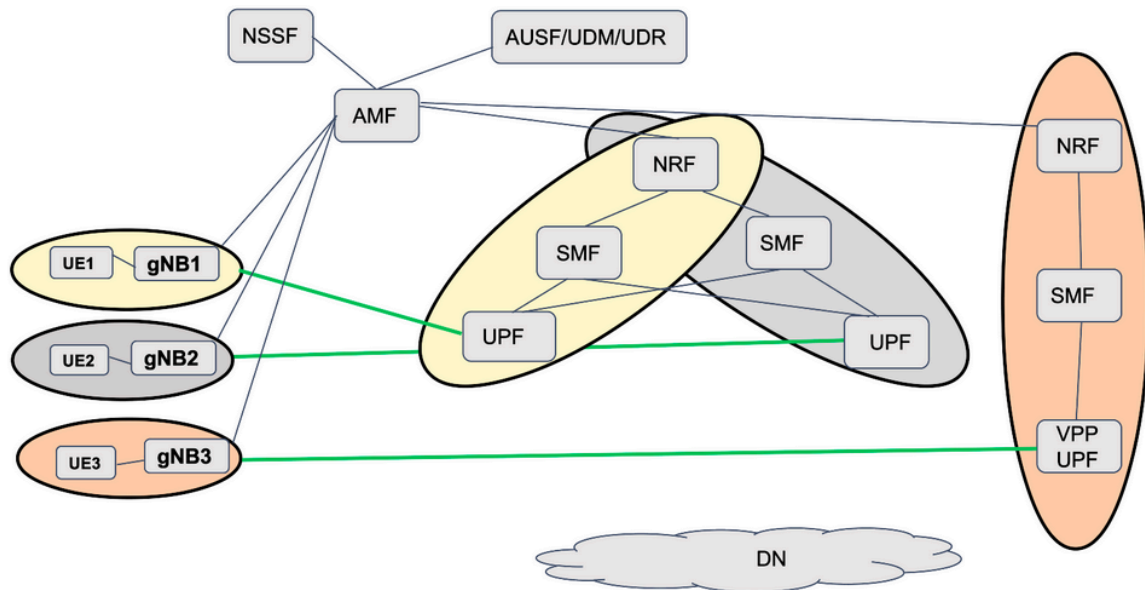
b/ For each UE, what do you propose to fix the issue ? A few hints are proposed to you in the table below. Apply the fixes to the CN configuration file and connect the UEs one after one.

c/ Repeat the test by disconnecting all the UEs, reconnecting the UEs without restarting the CN. Capture the traffic using wireshark and send it with your report.

<i>UE index</i>	<i>hints</i>
1, 2, 3	<i>To be able to associate gNB with a CN, they need to have a common set of parameters. check NGAP Setup request. (slicing, plmn, tracking area) The user (imsi, security parameters) should be present in the database located at database/oai_db.sql, in the table 'AuthenticationSubscription'. Verify if there are many occurrences of imsi/keys in the sql request to be changed.</i>
3, 4	<i>In the phone settings, you have to configure one key parameter to be able to connect to the internet. APN in 4G and DNN in 5G. DNN is configured at SMF and UPF. The environment variables having the same index (like <code>DNN_NI0</code>, <code>NSSAI_SST0</code>) are associated with each other. (you can check the configuration template inside components/oai-xxx/etc to see how they are associated).</i>
4	<i>The requested parameters in a PDU session should be configured in the CN. (slicing, DNN) in AMF, SMF and UPF</i>

Part 2: (Network Slicing)

Stop all the UEs using `docker-compose -f docker-compose-ueX.yaml down`; for each X
 Stop the CN instance using `docker-compose -f docker-compose-basic-nrf.yaml down` and wait until all the containers are removed.
 Start another CN instance using the second file `docker-compose-slicing-nrf.yaml`.



Questions:

- Compare the two files [docker-compose-slicing-nrf.yaml](#) and [docker-compose-basic-nrf.yaml](#)?
- Complete the diagram above by adding: NF ip addresses, DNNs, Slices information.
- What is the role of NSSF function?

The goal is to update the three files [docker-compose-slicing-ueX.yaml](#) in order to connect each UE to a particular slice.

UE 1 -> slice 1 (sst: 128, sd: 128)

UE 2 -> slice 2 (sst: 1, sd: 1)

UE 3 -> slice 3 (sst: 130 sd: 130)

Start Wireshark and capture traffic on the interface "demo-oai".

d/ Update the three files [docker-compose-slicing-ueX.yaml](#) to connect all the UEs to their corresponding slices. You are not allowed to update the CN configuration. Make sure that UE SST is an integer value in decimal while gNB SST and UE SD are strings in hexadecimal.

Once you established a successful PDU session:

e/ Deduce the IP addresses of all the 5G CN elements.

f/ Which element of the 5G CN contacts the NSSF? Why?

e/ What is the answer of the NSSF? On which basis the answer is created?

g/ Why the NSSF is contacted after the AUSF/UDM?

h/ Which entity of the 5G CN contacts the NRF? Why?

i/ What is the answer of the NRF? Why

In case of the NRF is shared between two slices

j/ What is the answer of the NRF?

k/ Draw a diagram showing the messages exchanged between the 5G CN elements from the Registration Request of UE up to the session establishment?

Some useful docker commands:

docker-compose -h : list the available options.

docker-compose -f <FILE> up -d : start containers described in <FILE> in detached mode (-d flag).

docker-compose -f <FILE> down: stop the containers described in <FILE>.

docker-compose -f <FILE> up -d --force-recreate: restart the containers described in <FILE>.

docker logs <CONTAINER NAME>: read the logs of <CONTAINER NAME>.

docker exec -it <CONTAINER NAME> bash: login inside the container <CONTAINER NAME>

docker stop <CONTAINER NAME>: stop the container

docker rm <CONTAINER NAME>: remove the container