5g Project

Group no: 2024GR12CS462

Group members:

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1. Install Dependencies

Ensure your system has the required dependencies installed.

```
mani@Mani:/mnt/c/Users/manim$ cd 5gpro
mani@Mani:/mnt/c/Users/manim/5gpro$ sudo apt update
sudo apt install -y docker.io docker-compose python3 python3-pip ansible git
[sudo] password for mani:
Get:1 http://security.ubuntu.com/ubuntu noble-security InRelease [126 kB]
Hit:2 https://repo.mongodb.org/apt/ubuntu jammy/mongodb-org/6.0 InRelease
Hit:4 http://archive.ubuntu.com/ubuntu noble InRelease
Hit:5 https://deb.nodesource.com/node_20.x nodistro InRelease
Hit:6 https://ppa.launchpadcontent.net/open5gs/latest/ubuntu noble InRelease
Get:7 http://archive.ubuntu.com/ubuntu noble-updates InRelease [126 kB]
Hit:3 https://prod-cdn.packages.k8s.io/repositories/isv:/kubernetes:/core:/stable:/v1.29/deb  InRelease
Ign:8 https://pkg.jenkins.io/debian-stable binary/ InRelease
Hit:9 https://pkg.jenkins.io/debian-stable binary/ Release
Get:11 http://archive.ubuntu.com/ubuntu noble-backports InRelease [126 kB]
Get:12 http://security.ubuntu.com/ubuntu noble-security/main amd64 Packages [670 kB]
Get:13 http://archive.ubuntu.com/ubuntu noble-updates/main i386 Packages [437 kB]
Get:14 http://security.ubuntu.com/ubuntu noble-security/main i386 Packages [246 kB]
Get:15 http://security.ubuntu.com/ubuntu noble-security/main Translation-en [128 kB]
Get:16 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Packages [919 kB]
Get:17 http://security.ubuntu.com/ubuntu noble-security/main Components [9008 B]
Get:18 http://security.ubuntu.com/ubuntu noble-security/universe i386 Packages [508 kB]
Get:19 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Packages [819 kB]
Get:20 http://security.ubuntu.com/ubuntu noble-security/universe Translation-en [177 kB]
Get:21 http://security.ubuntu.com/ubuntu noble-security/universe amd64 Components [52.0 kB]
Get:22 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Packages [726 kB]
Get:23 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 Components [151 kB]
Get:24 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 Packages [1037 kB]
Get:25 http://security.ubuntu.com/ubuntu noble-security/restricted Translation-en [145 kB]
Get:26 http://security.ubuntu.com/ubuntu noble-security/restricted amd64 Components [212 B]
Get:27 http://security.ubuntu.com/ubuntu noble-security/multiverse amd64 Components [208 B]
Get:28 http://archive.ubuntu.com/ubuntu noble-updates/universe i386 Packages [629 kB]
Get:29 http://archive.ubuntu.com/ubuntu noble-updates/universe Translation-en [261 kB]
Get:30 http://archive.ubuntu.com/ubuntu noble-updates/universe amd64 Components [364 kB]
```

Start Docker:

```
mani@Mani:/mnt/c/Users/manim/5gpro$ sudo systemctl start docker
sudo systemctl enable docker
```

2. Clone the open 5gc Repository

```
mani@Mani:/mnt/c/Users/manim/5gpro$ git clone --recursive https://github.com/Free5GC/Free5GC.git
cd Free5GC
Cloning into 'Free5GC'...
remote: Enumerating objects: 3217, done.
remote: Counting objects: 100% (615/615), done.
remote: Compressing objects: 100% (176/176), done.
remote: Total 3217 (delta 525), reused 439 (delta 439), pack-reused 2602 (from 3)
Receiving objects: 100% (3217/3217), 1.05 MiB | 73.00 KiB/s, done.
Resolving deltas: 100% (1877/1877), done.
Submodule 'amf' (https://github.com/free5gc/amf.git) registered for path 'NFs/amf'
Submodule 'ausf' (https://github.com/free5gc/ausf.git) registered for path 'NFs/ausf'
Submodule 'chf' (https://github.com/free5gc/chf.git) registered for path 'NFs/chf'
Submodule 'n3iwf' (https://github.com/free5gc/n3iwf.git) registered for path 'NFs/n3iwf'
Submodule 'NFs/nef' (https://github.com/free5gc/nef.git) registered for path 'NFs/nef'
Submodule 'nrf' (https://github.com/free5gc/nrf.git) registered for path 'NFs/nrf'
Submodule 'nssf' (https://github.com/free5gc/nssf.git) registered for path 'NFs/nssf'
Submodule 'pcf' (https://github.com/free5gc/pcf.git) registered for path 'NFs/pcf'
Submodule 'smf' (https://github.com/free5gc/smf.git) registered for path 'NFs/smf'
Submodule 'tngf' (https://github.com/free5gc/tngf.git) registered for path 'NFs/tngf'
Submodule 'udm' (https://github.com/free5gc/udm.git) registered for path 'NFs/udm'
Submodule 'udr' (https://github.com/free5gc/udr.git) registered for path 'NFs/udr'
Submodule 'upf' (https://github.com/free5gc/go-upf.git) registered for path 'NFs/upf'
Submodule 'ci-test' (https://github.com/free5gc/ci-test.git) registered for path 'ci-test'
Submodule 'webconsole' (https://github.com/free5gc/webconsole.git) registered for path 'webconsole'
Cloning into '/mnt/c/Users/manim/5gpro/Free5GC/NFs/amf'...
remote: Enumerating objects: 3292, done.
remote: Counting objects: 100% (854/854), done.
remote: Compressing objects: 100% (276/276), done.
remote: Total 3292 (delta 639), reused 626 (delta 578), pack-reused 2438 (from 3)
Receiving objects: 100% (3292/3292), 1.32 MiB | 875.00 KiB/s, done.
Resolving deltas: 100% (2111/2111), done.
```

3. Identify Your Network Interface

Determine the name of your network interface that connects to the internet. This is required for the playbook execution.

```
mani@Mani:/mnt/c/Users/manim/5gpro$ ifconfig
br-056a628a96e2: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 192.187.3.1  netmask 255.255.255.0  broadcast 192.187.3.255
        ether 02:42:83:a6:fa:0a  txqueuelen 0  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

br-2eb478207fdc: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 192.168.49.1  netmask 255.255.255.0  broadcast 192.168.49.255
        ether 02:42:45:2b:63:62  txqueuelen 0  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

br-942590b9112c: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 172.18.0.1  netmask 255.255.0.0  broadcast 172.18.255.255
        ether 02:42:a4:0d:97:31  txqueuelen 0  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

brric: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 10.0.2.1  netmask 255.255.255.0  broadcast 10.0.2.255
        ether 02:42:f3:86:68:9f  txqueuelen 0  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```
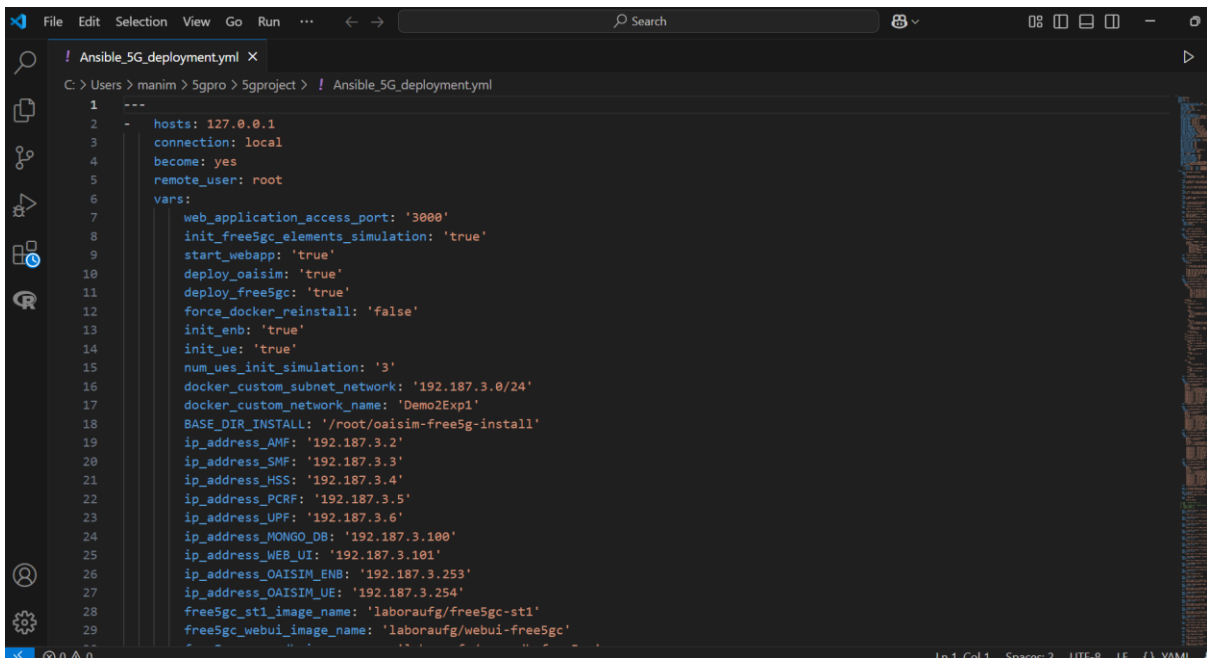
4. Create the Ansible Playbook

Create a file named deploy-5g.yml content like this:

```yaml
---
- hosts: 127.0.0.1
  connection: local
  become: yes
  remote_user: root
  vars:
    web_application_access_port: '3000'
    init_free5gc_elements_simulation: 'true'
    start_webapp: 'true'
    deploy_oaisim: 'true'
    deploy_free5gc: 'true'
    force_docker_reinstall: 'false'
    init_enb: 'true'
    init_ue: 'true'
    num_ues_init_simulation: '3'
    docker_custom_subnet_network: '192.187.3.0/24'
    docker_custom_network_name: 'Demo2Exp1'
    BASE_DIR_INSTALL: '/root/oaisim-free5g-install'
    ip_address_AMF: '192.187.3.2'
    ip_address_SMF: '192.187.3.3'
    ip_address_HSS: '192.187.3.4'
    ip_address_PCRF: '192.187.3.5'
    ip_address_UPF: '192.187.3.6'
    ip_address_MONGO_DB: '192.187.3.100'
    ip_address_WEB_UI: '192.187.3.101'
    ip_address_OAISIM_ENB: '192.187.3.253'
    ip_address_OAISIM_UE: '192.187.3.254'
    free5gc_st1_image_name: 'laboraufg/free5gc-st1'
    free5gc_webui_image_name: 'laboraufg/webui-free5gc'
```

5. Run the Ansible Playbook

```
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ ansible-playbook -K Ansible_5G_deployment.yml -e "internet_network_interface=eth0"
BECOME password:
[WARNING]: No inventory was parsed, only implicit localhost is available
[WARNING]: provided hosts list is empty, only localhost is available. Note that the implicit localhost does not match 'all'

PLAY [127.0.0.1] ***********************************************************************************************************

TASK [Gathering Facts] *****************************************************************************************************
ok: [127.0.0.1]

TASK [Environment validation!] *********************************************************************************************
ok: [127.0.0.1] => {
    "changed": false,
    "msg": "All assertions passed"
}

TASK [fail] ****************************************************************************************************************
skipping: [127.0.0.1]

TASK [fail] ****************************************************************************************************************
skipping: [127.0.0.1]

TASK [fail] ****************************************************************************************************************
skipping: [127.0.0.1]

TASK [fail] ****************************************************************************************************************
skipping: [127.0.0.1]

TASK [fail] ****************************************************************************************************************
skipping: [127.0.0.1]

TASK [Remove old instalation] **********************************************************************************************
changed: [127.0.0.1]
```

```
TASK [Remove docker installation] ******************************************************************************************
skipping: [127.0.0.1]

TASK [Install Basic requirements] ******************************************************************************************
ok: [127.0.0.1]

TASK [Create dir instalation] **********************************************************************************************
changed: [127.0.0.1]

TASK [Build iptables_upf.sh file] ******************************************************************************************
changed: [127.0.0.1]

TASK [Build setup_upf.sh file] *********************************************************************************************
changed: [127.0.0.1]

TASK [Core Network Configuration - Build free5gc.conf] *******************************************************************
changed: [127.0.0.1]

TASK [Core Network Configuration - Build amf.conf] ***********************************************************************
changed: [127.0.0.1]

TASK [Core Network Configuration - Build smf.conf] ***********************************************************************
changed: [127.0.0.1]

TASK [Core Network Configuration - Build hss.conf] ***********************************************************************
changed: [127.0.0.1]

TASK [Core Network Configuration - Build pcrf.conf] **********************************************************************
changed: [127.0.0.1]

TASK [Add Docker GPG key into apt] *****************************************************************************************
ok: [127.0.0.1]
```

```
TASK [Add Docker GPG key into apt] ***********************************************************************************
ok: [127.0.0.1]

TASK [Add Docker APT repository] *************************************************************************************
ok: [127.0.0.1]

TASK [Update APT] ****************************************************************************************************
changed: [127.0.0.1]

TASK [Stop UE container - If exists] *********************************************************************************
changed: [127.0.0.1]

TASK [Stop ENB container - If exists] ********************************************************************************
changed: [127.0.0.1]

TASK [Stop PCRF container - If exists] *******************************************************************************
changed: [127.0.0.1]

TASK [Stop HSS container - If exists] ********************************************************************************
changed: [127.0.0.1]

TASK [Stop SMF container - If exists] ********************************************************************************
changed: [127.0.0.1]

TASK [Stop UPF container - If exists] ********************************************************************************
changed: [127.0.0.1]

TASK [Stop AMF container - If exists] ********************************************************************************
changed: [127.0.0.1]

TASK [Stop WEBUE container - If exists] ******************************************************************************
changed: [127.0.0.1]


TASK [Stop MONGODB container - If exists] ****************************************************************************
changed: [127.0.0.1]

TASK [Run doker prune in stoped containers] **************************************************************************
changed: [127.0.0.1]

TASK [Remove free5gc-st1 image] **************************************************************************************
skipping: [127.0.0.1]

TASK [Remove free5gc-mongodb image] **********************************************************************************
skipping: [127.0.0.1]

TASK [Remove enb-openairsim image] ***********************************************************************************
skipping: [127.0.0.1]

TASK [Remove ue-openairsim image] ************************************************************************************
skipping: [127.0.0.1]

TASK [Remove free5gc-webui image] ************************************************************************************
skipping: [127.0.0.1]

TASK [Remove free5g docker custom network] ***************************************************************************
changed: [127.0.0.1]

TASK [Create Docker custom network] **********************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc MONGO-DB container] ********************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc AMF container] *************************************************************************************
changed: [127.0.0.1]


TASK [Run free5gc UPF container] *************************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc SMF container] *************************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc HSS container] *************************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc PCRF container] ************************************************************************************
changed: [127.0.0.1]

TASK [Run free5gc WEBUI container] ***********************************************************************************
changed: [127.0.0.1]

TASK [Run OpenAirSIM-enB container] **********************************************************************************
changed: [127.0.0.1]

TASK [Run OpenAirSIM-UE container] ***********************************************************************************
changed: [127.0.0.1]

TASK [Build enB rcc.band7.tm1.nfapi.conf file 1/3] *******************************************************************
changed: [127.0.0.1]

TASK [Build enB rcc.band7.tm1.nfapi.conf file 2/3] *******************************************************************
changed: [127.0.0.1]

TASK [Build enB rcc.band7.tm1.nfapi.conf file 3/3] *******************************************************************
changed: [127.0.0.1]

TASK [Build UE ue.nfapi.conf file 1/3] *******************************************************************************
changed: [127.0.0.1]
```

```
TASK [Build UE ue_eurecom_test_sfr.conf file 1/5] ***************************************************************************
changed: [127.0.0.1]

TASK [Build UE ue_eurecom_test_sfr.conf file 2/5] ***************************************************************************
changed: [127.0.0.1]

TASK [Build UE ue_eurecom_test_sfr.conf file 3/5] ***************************************************************************
changed: [127.0.0.1] => (item={'ue_id': 'UE0', 'msin': '0000000001'})
changed: [127.0.0.1] => (item={'ue_id': 'UE1', 'msin': '0000000002'})
changed: [127.0.0.1] => (item={'ue_id': 'UE2', 'msin': '0000000003'})

TASK [Build UE ue_eurecom_test_sfr.conf file 4/5] ***************************************************************************
changed: [127.0.0.1]

TASK [Build UE ue_eurecom_test_sfr.conf file 5/5] ***************************************************************************
changed: [127.0.0.1]

TASK [Exec/Start MONGO-DB container] ********************************************************************************************
changed: [127.0.0.1]

TASK [Running WEBUI container] **************************************************************************************************
changed: [127.0.0.1]

TASK [Build certificates - AMF container] **************************************************************************************
changed: [127.0.0.1]

TASK [Copy config file's to UPF container] *************************************************************************************
changed: [127.0.0.1]

TASK [Build certificates - UPF container] **************************************************************************************
changed: [127.0.0.1]
```

```
TASK [Build certificates - UPF container] **************************************************************************************
changed: [127.0.0.1]

TASK [Build certificates - SMF container] **************************************************************************************
changed: [127.0.0.1]

TASK [Build certificates - HSS container] **************************************************************************************
changed: [127.0.0.1]

TASK [Build certificates - PCRF container] *************************************************************************************
changed: [127.0.0.1]

TASK [Remove amf.conf default file from AMF container] *************************************************************************
changed: [127.0.0.1]

TASK [Remove smf.conf default file from SMF container] *************************************************************************
changed: [127.0.0.1]

TASK [Remove hss.conf default file from HSS container] *************************************************************************
changed: [127.0.0.1]

TASK [Remove pcrf.conf default file from PCRF container] ***********************************************************************
changed: [127.0.0.1]

TASK [Copy config file's to free5gc container's] ******************************************************************************
changed: [127.0.0.1]

TASK [Wait for port WEB_UI response] ********************************************************************************************
ok: [127.0.0.1]

TASK [Get CSRF Access Token - WEBUI container] ********************************************************************************
changed: [127.0.0.1]
```

```
TASK [pause] *******************************************************************************************************************
Pausing for 5 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]

TASK [Login - WEBUI container] **************************************************************************************************
changed: [127.0.0.1]

TASK [Add User equipments - WEBUI container] ***********************************************************************************
changed: [127.0.0.1] => (item={'ue_id': 'UE0', 'msin': '0000000001'})
changed: [127.0.0.1] => (item={'ue_id': 'UE1', 'msin': '0000000002'})
changed: [127.0.0.1] => (item={'ue_id': 'UE2', 'msin': '0000000003'})

TASK [Clear file instalation] **************************************************************************************************
changed: [127.0.0.1]

TASK [Run AMF simulation process] **********************************************************************************************
changed: [127.0.0.1]

TASK [pause] *******************************************************************************************************************
Pausing for 5 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]

TASK [Run UPF simulation process] **********************************************************************************************
changed: [127.0.0.1]

TASK [pause] *******************************************************************************************************************
Pausing for 5 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]
```

```
changed: [127.0.0.1]

TASK [pause] *****************************************************************************************************
Pausing for 5 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]

TASK [Run HSS simulation process] *******************************************************************************
changed: [127.0.0.1]

TASK [pause] *****************************************************************************************************
Pausing for 5 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]

TASK [Run PCRF simulation process] ******************************************************************************
changed: [127.0.0.1]

TASK [Run ENB Simulation process] *******************************************************************************
changed: [127.0.0.1]

TASK [pause] *****************************************************************************************************
Pausing for 15 seconds
(ctrl+C then 'C' = continue early, ctrl+C then 'A' = abort)
ok: [127.0.0.1]

TASK [Run UE Simulation process] ********************************************************************************
changed: [127.0.0.1]

PLAY RECAP ******************************************************************************************************
127.0.0.1                  : ok=78   changed=66   unreachable=0   failed=0   skipped=11   rescued=0   ignored=0

mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$
```

6. Verify Deployment

Checking containers:

```
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ docker ps
CONTAINER ID   IMAGE                        COMMAND   CREATED         STATUS         PORTS                                          NAMES
da4eaa0a5223   laboraufg/ue-openairsim      "bash"    6 minutes ago   Up 6 minutes                                                  ue
69e5d33fa2c5   laboraufg/enb-openairsim     "bash"    6 minutes ago   Up 6 minutes                                                  enb
2e180e0da423   laboraufg/webui-free5gc      "bash"    6 minutes ago   Up 6 minutes   0.0.0.0:3000->3000/tcp, :::3000->3000/tcp      webui
67d5402d65b1   laboraufg/free5gc-st1        "bash"    6 minutes ago   Up 6 minutes                                                  pcrf
6d782d15b2b0   laboraufg/free5gc-st1        "bash"    6 minutes ago   Up 6 minutes                                                  hss
74d797f2bdd3   laboraufg/free5gc-st1        "bash"    6 minutes ago   Up 6 minutes                                                  smf
39def5b7c7f7   laboraufg/free5gc-st1        "bash"    6 minutes ago   Up 6 minutes                                                  upf
6de97869a0f3   laboraufg/free5gc-st1        "bash"    6 minutes ago   Up 6 minutes                                                  amf
ed8d861fb497   laboraufg/mongodb-free5gc    "bash"    6 minutes ago   Up 6 minutes                                                  mongo
db-svc
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$
```

Ping test:

```
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ docker exec -it ue ping -c 4 google.com
PING google.com (172.217.174.238) 56(84) bytes of data.
64 bytes from bom12s03-in-f14.1e100.net (172.217.174.238): icmp_seq=1 ttl=115 time=68.0 ms
64 bytes from bom12s03-in-f14.1e100.net (172.217.174.238): icmp_seq=2 ttl=115 time=25.6 ms
64 bytes from bom12s03-in-f14.1e100.net (172.217.174.238): icmp_seq=3 ttl=115 time=33.5 ms
64 bytes from bom12s03-in-f14.1e100.net (172.217.174.238): icmp_seq=4 ttl=115 time=30.8 ms

--- google.com ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 25.673/39.523/68.067/16.721 ms
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$
```
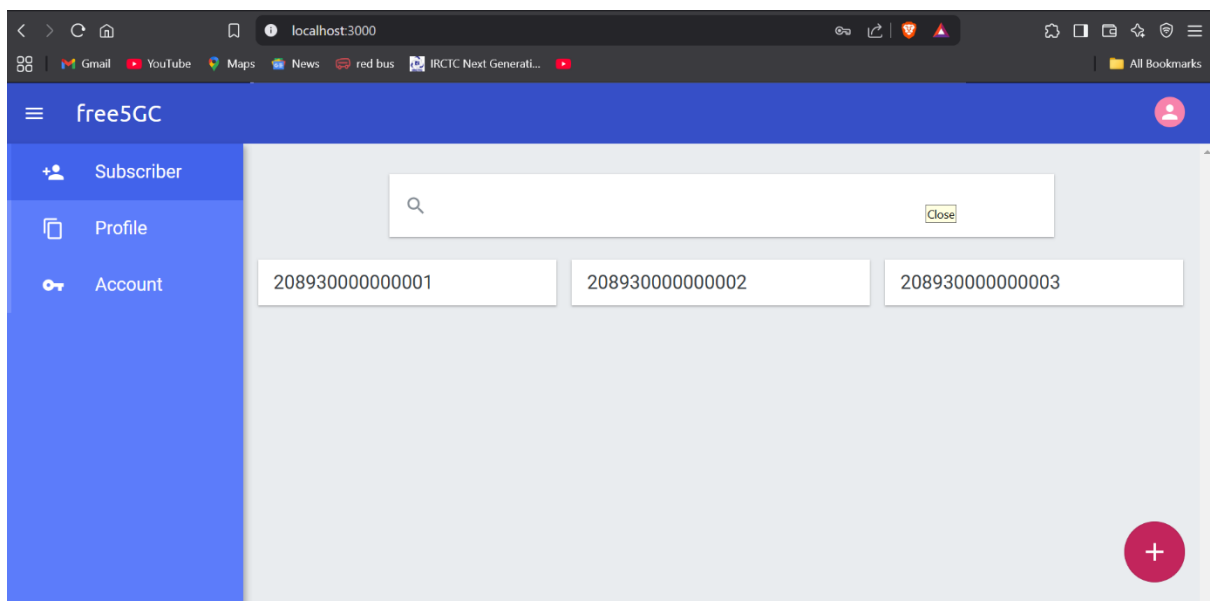
Checking the webui:

Adding subscriber:

```
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ docker exec -it ed8d861fb497 bash
root@ed8d861fb497:~# mongo
MongoDB shell version v3.6.3
connecting to: mongodb://127.0.0.1:27017
MongoDB server version: 3.6.3
Welcome to the MongoDB shell.
For interactive help, type "help".
For more comprehensive documentation, see
        http://docs.mongodb.org/
Questions? Try the support group
        http://groups.google.com/group/mongodb-user
Server has startup warnings:
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten]
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten] ** WARNING: Access control is not enabled for the database.
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten] **          Read and write access to data and configuration is unrestricted.
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten]
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten]
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten] ** WARNING: /sys/kernel/mm/transparent_hugepage/enabled is 'always'.
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten] **          We suggest setting it to 'never'
2025-04-17T14:45:58.455+0000 I CONTROL  [initandlisten]
> use free5gc
switched to db free5gc
).pretty()
> db.subscribers.find().pretty()
{
        "_id" : ObjectId("680114b53fbcdf0027f01f36"),
        "imsi" : "208930000000001",
        "pdn" : [
                {
                        "apn" : "internet",
                        "_id" : ObjectId("680114b53fbcdf0027f01f37"),
                        "pcc_rule" : [ ],
                        "qos" : {
```

```
        "pdn" : [
                {
                        "apn" : "internet",
                        "_id" : ObjectId("680114b63fbcdf0027f01f3b"),
                        "pcc_rule" : [ ],
                        "qos" : {
                                "qci" : 9,
                                "arp" : {
                                        "priority_level" : 8,
                                        "pre_emption_vulnerability" : 1,
                                        "pre_emption_capability" : 1
                                }
                        },
                        "type" : 2
                }
        ],
        "ambr" : {
                "downlink" : NumberLong(1024000),
                "uplink" : NumberLong(1024000)
        },
        "subscribed_rau_tau_timer" : 12,
        "network_access_mode" : 2,
        "subscriber_status" : 0,
        "access_restriction_data" : 32,
        "security" : {
                "k" : "8baf473f2f8fd09487cccbd7097c6862",
                "amf" : "8000",
                "op" : null,
                "opc" : "e734f8734007d6c5ce7a0508809e7e9c"
        },
        "__v" : 0
}
>
```

Verifying added subscriber in the database and the webui:

```
        "_id" : ObjectId("680117933fbcdf0027f01f3c"),
        "imsi" : "208930000000004",
        "pdn" : [
                {
                        "apn" : "internet",
                        "_id" : ObjectId("680117933fbcdf0027f01f3d"),
                        "pcc_rule" : [ ],
                        "qos" : {
                                "qci" : 9,
                                "arp" : {
                                        "priority_level" : 8,
                                        "pre_emption_vulnerability" : 1,
                                        "pre_emption_capability" : 1
                                }
                        },
                        "type" : 2
                }
        ],
        "ambr" : {
                "downlink" : NumberLong(1024000),
                "uplink" : NumberLong(1024000)
        },
        "subscribed_rau_tau_timer" : 12,
        "network_access_mode" : 2,
        "subscriber_status" : 0,
        "access_restriction_data" : 32,
        "security" : {
                "k" : "465B5CE8 B199B49F AA5F0A2E E238A6BC",
                "amf" : "8000",
                "op" : null,
                "opc" : "E8ED289D EBA952E4 283B54E8 8E6183CA"
        },
        "__v" : 0
```

7.implementing ipsec security with deployment

```
(.venv) mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ sudo .venv/bin/python ipsec_enc.py
*** Sending Username and Password using Plaintext ***
Packet:
###[ IP ]###
  version   = 4
  ihl       = 5
  tos       = 0x0
  len       = 45
  id        = 1
  flags     =
  frag      = 0
  ttl       = 64
  proto     = udp
  chksum    = 0xf14d
  src       = 192.187.3.254
  dst       = 192.187.3.253
  \options   \
###[ UDP ]###
     sport     = 45012
     dport     = 80
     len       = 25
     chksum    = 0x7ab
###[ Raw ]###
        load      = b'username_password'

Sending Packet from UE1...
Packet sent successfully.
*** Sending Username and Password using IPSec ***
Packet:
###[ IP ]###
  version   = 4
  ihl       = 5
  tos       = 0x0
```

```
Sending Packet from UE1...
Packet sent successfully.
*** Sending Username and Password using IPSec ***
Packet:
###[ IP ]###
  version   = 4
  ihl       = 5
  tos       = 0x0
  len       = 56
  id        = 1
  flags     =
  frag      = 0
  ttl       = 64
  proto     = esp
  chksum    = 0xf121
  src       = 192.187.3.254
  dst       = 192.187.3.253
  \options  \
###[ ESP ]###
     spi       = 0x222
     seq       = 1
     data      = afd40050001907ab757365726e616d655f70617373776f7264010111

Sending Packet from UE1...
Packet sent successfully.
(.venv) mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ |
```

Verification of ipsec deployment:

```
mani@Mani:/mnt/c/Users/manim/5gpro/5gproject$ sudo tcpdump -i any esp
[sudo] password for mani:
tcpdump: data link type LINUX_SLL2
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on any, link-type LINUX_SLL2 (Linux cooked v2), snapshot length 262144 bytes
17:05:01.994742 br-d126afdd556f Out IP 192.187.3.254 > 192.187.3.253: ESP(spi=0x00000222,seq=0x1), length 36
17:05:01.994874 veth14d4175 Out IP 192.187.3.254 > 192.187.3.253: ESP(spi=0x00000222,seq=0x1), length 36
```