

IETF-118

Intent-Based Network Management Automation Project

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5G Testbed Architecture



IETF 118 Prague
4-10 November 2023

IETF-118 NMRG Hackathon Project

Professors:

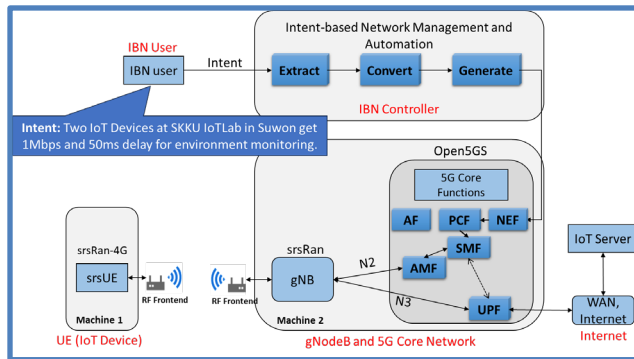
- Jaehoon (Paul) Jeong (SKKU)
- Yiwen (Chris) Shen (SKKU)
- Younghan Kim (SSU)

Researchers:

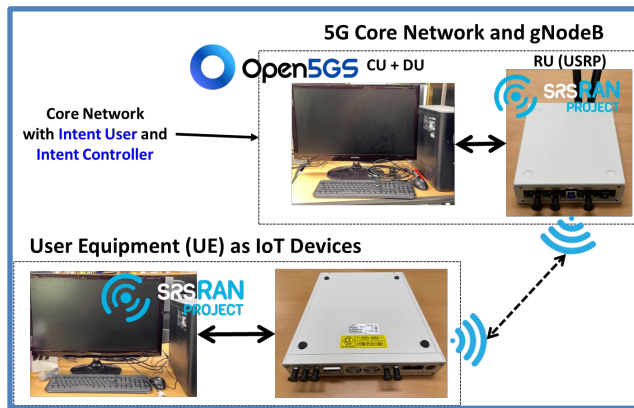
- Jung-Soo Park (ETRI)
- Yunchul Choi (ETRI)

Students:

- Yoseop Ahn (SKKU)
- Mose Gu (SKKU)



SKKU 5G Testbed



What to pull down to set up an environment

- OS: Ubuntu 22.04
- Desktop for srsUE
- Desktop for gNodeB and 5G core
- USRP for UE
- USRP for gNodeB

Construction of Testbed

1. Install Open5gs, srsRAN22.04, MongoDB, and the dependencies
2. Modify Open5gs configuration (AMF and UPF)
3. Modify srsRAN22.04 configuration (enb.conf and rr.conf)
4. Add SIM information (imsi, key, and opc) on both Open5GS and srsUE
5. Create the TUN device with the interface name ogstun
6. Run Open5GS, gNodeB, and srsUE

Objective

- IBN User sends a configuration file to 5G Core Network.
- 5G Core Network changes its internal policy according to the configuration file.

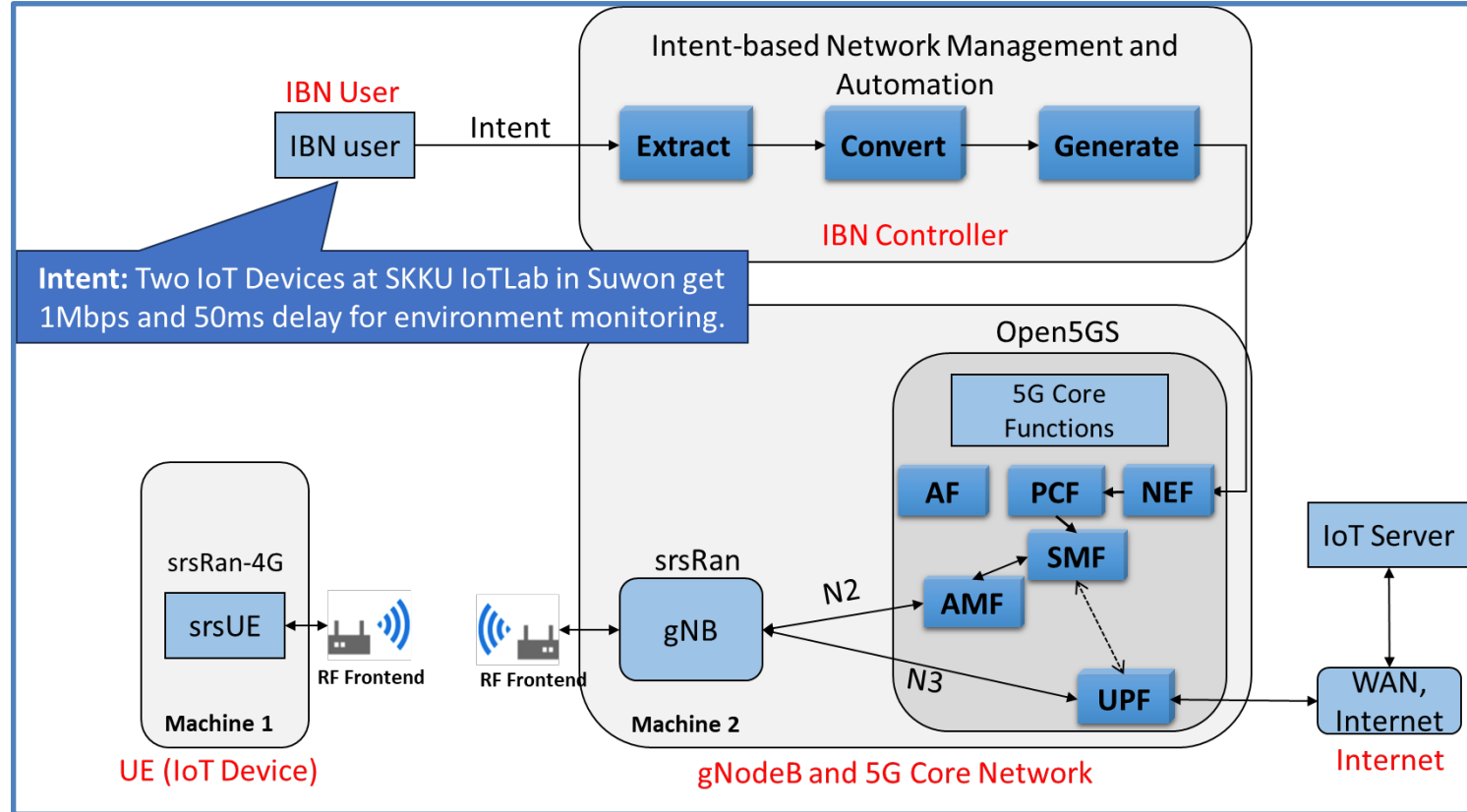
Future Work

- 5G Framework for Intent-Based Network Management Automation such as Intent Translation and Closed-loop Control
- Natural Language Processing (NLP)-based Intent Translation and Configuration File Generation

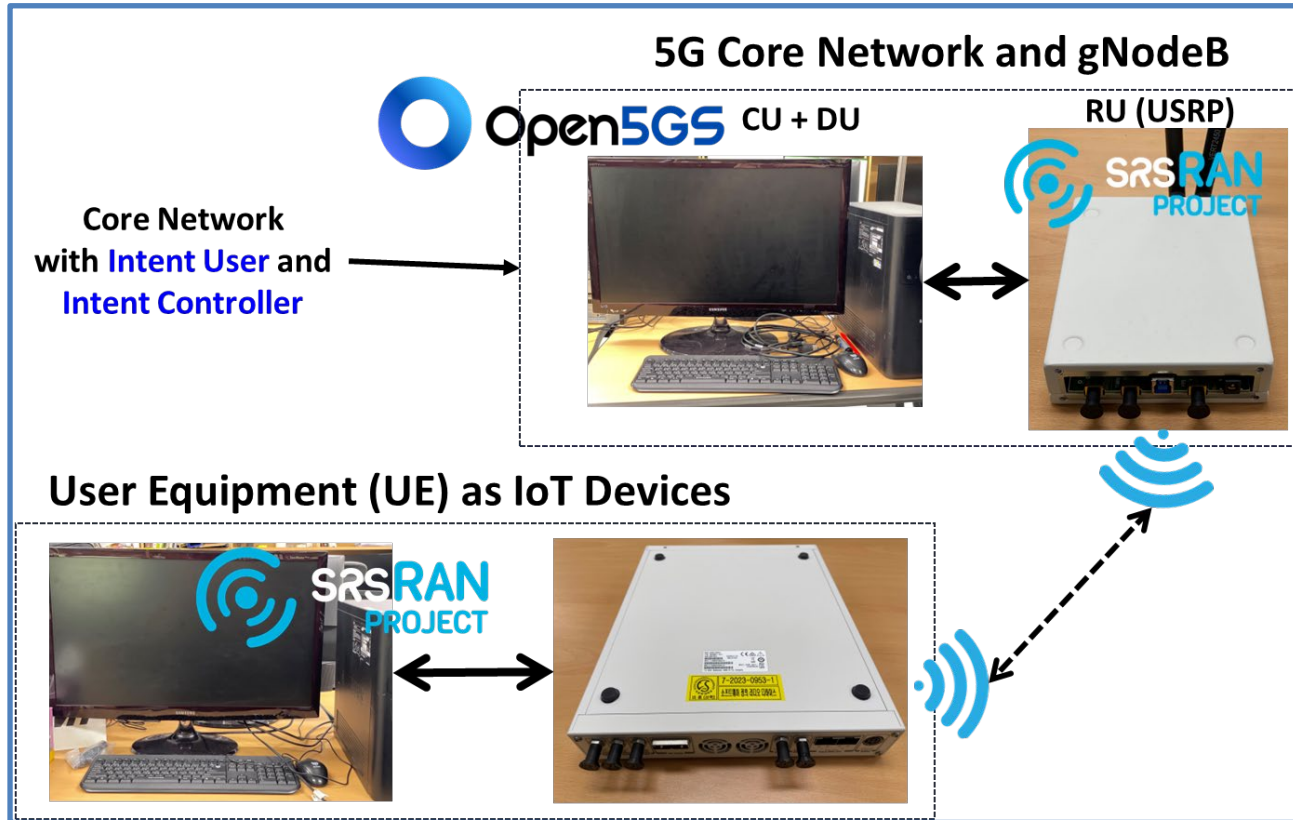
Hackathon Plan

- Goal in this hackathon project
 - To make a 5G Network Testbed for 5G Intent-Based Network Management Automation.
 - We install Open5GS, srsRAN22.04, MongoDB and all the dependencies.
 - Configuration for 5G Networks
 - To configure the IP addresses of AMF and UPF and add USIM information on Open5GS
 - To configure enb.conf and rr.conf files on srsRAN based on the information on Open5GS
 - Make a communication between a UE and a RAN with USRP devices.

Intent-Based Network Management Automation in 5G Networks



SKKU 5G Network Testbed



What got done (1/2)

- Both USRP devices can communicate with each other while Open5GS main functions (e.g., AMF, UPF, and SMF) are working.
- We could check the bandwidth and communication speed while both USRP devices are communicating with each other.

What got done (2/2)

USRP1

```
iotlab@iotlab: ~  
libjs-highlight.js  
Use 'sudo apt autoremove' to remove it.  
The following NEW packages will be installed:  
  iperf  
0 upgraded, 1 newly installed, 0 to remove and 44 not upgraded.  
Need to get 121 kB of archives.  
After this operation, 315 kB of additional disk space will be used.  
Get:1 http://kr.archive.ubuntu.com/ubuntu jammy/universe amd64 iperf amd64 2.1.5+dfsg1-1 [121 kB]  
Fetched 121 kB in 2s (65.1 kB/s)  
Selecting previously unselected package iperf.  
(Reading database ... 251172 files and directories currently installed.)  
Preparing to unpack .../iperf_2.1.5+dfsg1-1_amd64.deb ...  
Unpacking iperf (2.1.5+dfsg1-1) ...  
Setting up iperf (2.1.5+dfsg1-1) ...  
Processing triggers for man-db (2.10.2-1) ...  
Processing triggers for ufw (0.36.1-4ubuntu0.1) ...  
iotlab@iotlab: ~$ iperf -c 172.16.0.2  
-----  
Client connecting to 172.16.0.2, TCP port 5001  
TCP window size: 85.0 KByte (default)  
-----  
[ 1] local 172.16.0.1 port 50160 connected with 172.16.0.2 port 5001
```

Send messagea to the USRP2 using iperf.

5G Core Network and gNodeB

USRP2

```
iotlab@iotlab: ~  
Reading state information... Done  
iperf is already the newest version (2.1.5+dfsg1-1).  
0 upgraded, 0 newly installed, 0 to remove and 35 not upgraded.  
iotlab@iotlab: ~$ iperf -s -i 1  
-----  
Server listening on TCP port 5001  
TCP window size: 128 KByte (default)  
-----  
[ 1] local 172.16.0.2 port 5001 connected with 172.16.0.1 port 50160  
60  
-----  
ID      Interval      Transfer      Bandwidth  
1] 0.0000-1.0000 sec 1.12 MBytes 9.37 Mbits/sec  
1] 1.0000-2.0000 sec 1.57 MBytes 13.2 Mbits/sec  
1] 2.0000-3.0000 sec 1.87 MBytes 15.6 Mbits/sec  
1] 3.0000-4.0000 sec 2.20 MBytes 18.5 Mbits/sec  
1] 4.0000-5.0000 sec 1.83 MBytes 15.3 Mbits/sec  
1] 5.0000-6.0000 sec 1.87 MBytes 15.7 Mbits/sec  
1] 6.0000-7.0000 sec 1.85 MBytes 15.5 Mbits/sec  
1] 7.0000-8.0000 sec 2.51 MBytes 21.1 Mbits/sec  
1] 8.0000-9.0000 sec 2.13 MBytes 17.8 Mbits/sec  
1] 9.0000-10.0000 sec 2.18 MBytes 18.3 Mbits/sec  
1] 10.0000-10.8177 sec 1.75 MBytes 18.0 Mbits/sec  
1] 0.0000-10.8177 sec 20.9 MBytes 16.2 Mbits/sec
```

Receive messages from the USRP1 using iperf.

User Equipment (UE) as IoT Devices

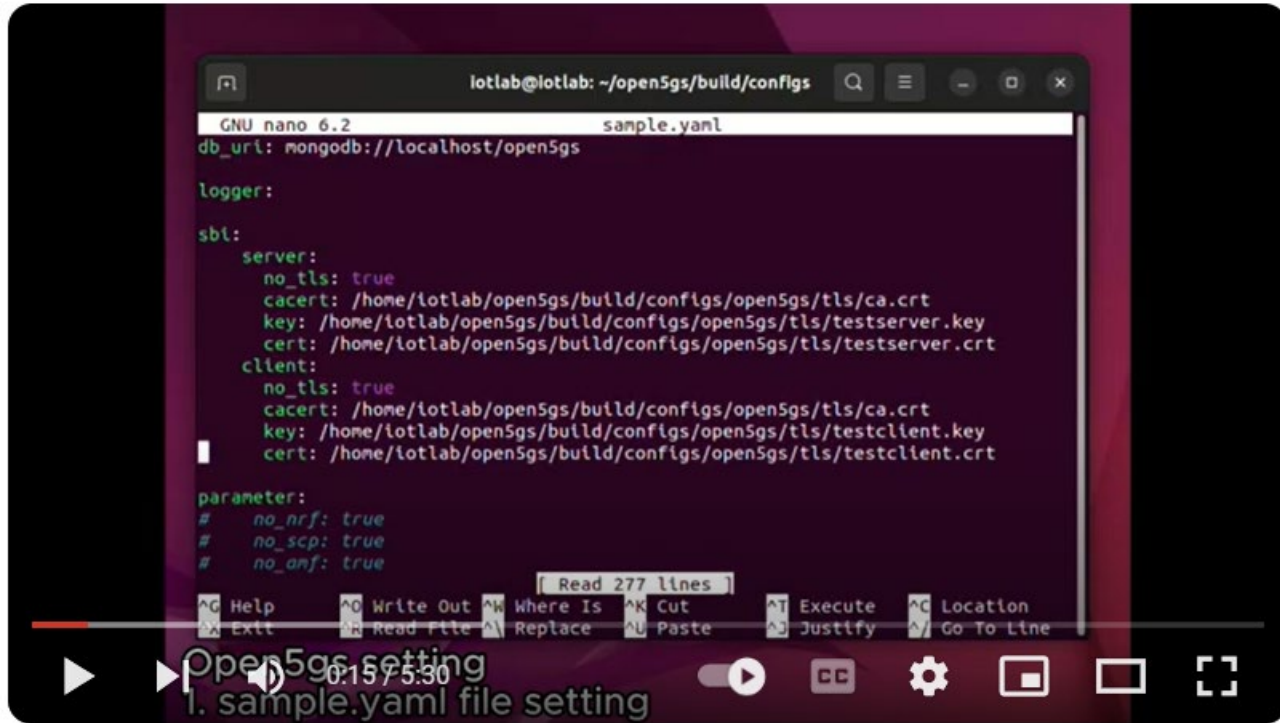
Open Source

URL: <https://github.com/jaehoonpauljeong/Intent-Based-Network-Management-Automation/tree/main>

The screenshot shows the GitHub repository page for 'Intent-Based-Network-Management-Automation' by user 'jaehoonpauljeong'. The repository is public and has 0 stars, 0 forks, and 2 watchers. The main branch is 'main' with 1 branch and 0 tags. The repository contains 5 commits, with the most recent being 'ahrjs124 Update and rename Open5gs setting.txt to Open5gs, srsRAN, srsUE setti...' 10 minutes ago. The repository includes a README.md file, which is currently displayed. The README.md file contains the title 'Intent-Based-Network-Management-Automation' and a description: 'This is the Intent-Based Network Management Automation in 5G Networks.' Below the description is a diagram titled '5G Core Network and gNodeB'. The diagram shows a 'Core Network with Intent User and Intent Controller' connected to an 'Open5GS CU + DU' (represented by a computer monitor) and an 'RU (USRP) SRSRAN PROJECT' (represented by a hardware device). The diagram also shows 'User Equipment (UE) as IoT Devices' connected to the RU. The diagram is a block diagram showing the components of a 5G network and their interconnections.

Demonstration in YouTube (1/2)

URL: <https://www.youtube.com/watch?v=DSxbhpWRval>



Open5gs(5gc) + srsRAN22.04 + srsUE demo (USRP B210)

Demonstration in YouTube (2/2)

URL: <https://www.youtube.com/watch?v=DSxbhpWRval>

USRP1

Open5gs (5gc)

```
iotlab@iotlab: ~/srsRAN
[INFO] [B200] Performing register loopback test...
[INFO] [B200] Register loopback test passed
[INFO] [B200] Asking for clock rate 23.040000 MHz...
[INFO] [B200] Actually got clock rate 23.040000 MHz.
RF device 'UHD' successfully opened

==== eNodeB started ====
Type <t> to view trace
Setting frequency: DL=2680.0 Mhz, UL=2560.0 Mhz for cc_ldx=0 nof_prb=50
RACH: tti=3541, cc=0, pci=1, preamble=1, offset=43, temp_crtti=0x46
RACH: tti=3541, cc=0, pci=1, preamble=3, offset=1, temp_crtti=0x47
RACH: tti=3541, cc=0, pci=1, preamble=6, offset=7, temp_crtti=0x48
SCHED: Could not transmit RAR within the window (RA=3541, Window=[3544, 3554], R
RA=3560
RACH: tti=3561, cc=0, pci=1, preamble=43, offset=43, temp_crtti=0x49
RACH: tti=3561, cc=0, pci=1, preamble=45, offset=1, temp_crtti=0x4a
RACH: tti=3561, cc=0, pci=1, preamble=48, offset=7, temp_crtti=0x4b
Disconnecting rnti=0x47.
Disconnecting rnti=0x46.
Disconnecting rnti=0x48.
Disconnecting rnti=0x4b.
Disconnecting rnti=0x49.
Disconnecting rnti=0x4a connected
User 0x4a connected
```

SRSSEN



USRP2

```
root@iotlab: ~/config/srsran
[INFO] [B200] Initialize CODEC control...
[INFO] [B200] Initialize Radio control...
[INFO] [B200] Performing register loopback test...
[INFO] [B200] Register loopback test passed
[INFO] [B200] Performing register loopback test...
[INFO] [B200] Register loopback test passed
[INFO] [B200] Asking for clock rate 23.040000 MHz...
[INFO] [B200] Actually got clock rate 23.040000 MHz.
RF device 'UHD' successfully opened
Waiting PHY to initialize ... done!
Attaching UE...

Found Cell: Mode=FDD, PCI=1, PRB=50, Ports=1, CP=Normal, CF0=
0.1 KHz
Found PLMN: Id=00101, TAC=7
Random Access Transmission: seq=3, tti=3541, ra-rnti=0x2
Random Access Transmission: seq=45, tti=3561, ra-rnti=0x2
RRC Connected
Random Access Complete. c-rnti=0x4a, ta=1
Network attach successful. IP: 172.16.0.2
Software 'Radio Systems RAN (SrsRAN)' 26/10/2023 4:51:59 TZ:0
```

SRSUE

User Equipment (UE) as IoT Devices

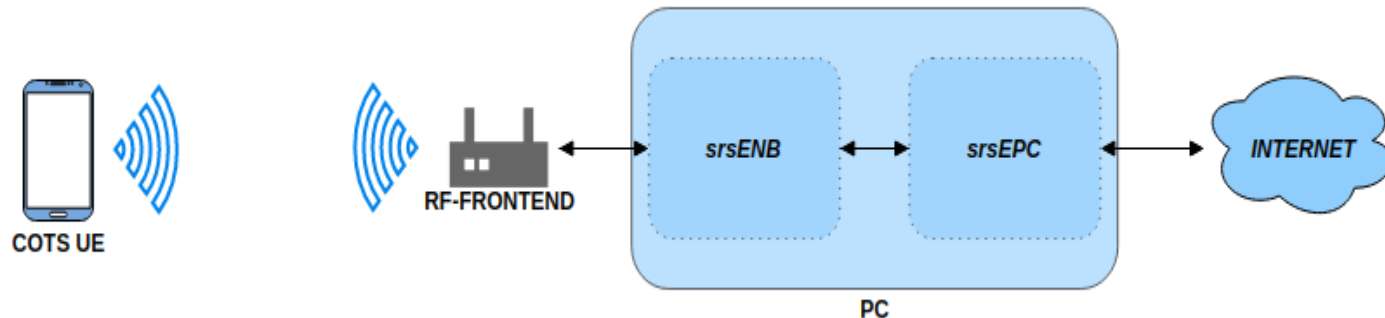
5G Core Network and gNodeB

What we learned

- We learned the main structure of the Open5GS for the communicate between two USRP devices.
- We learned the following:
 - The setting of the configuration between Open5GS and srsRAN
 - How to make a communication through Open5GS and srsRAN using USRP devices.

Next Step

- We aim to configure and connect a 5G-capable COTS UE to a 5G SA network using the srsRAN-Project gNB and a 3rd-party 5G core network.
- We will implement and demonstrate an Intent-Based Network Management Automation in 5G Networks.



Wrap Up

Hackathon Team

- **Professors:**
 - Jaehoon (Paul) Jeong (SKKU)
 - Yiwen (Chris) Shen (SKKU)
 - Younghan Kim (SSU)
- **Researchers:**
 - Jung-Soo Park (ETRI)
 - Yunchul Choi (ETRI)
- **Students:**
 - Yoseop Ahn (SKKU)
 - Mose Gu (SKKU)
 - Nobuo Aoki (NII)

Hackathon Team Photo

