



# Review Open Call SME

## F4Fp-09-M08

### 5GFed experiment

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Remote Review

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# 5GFed

Integration and testing  
of 5G NR  
OpenAirInterface in the  
Fed4FIRE+ federation

IRIS (TCD) and CityLab (imec) testbeds

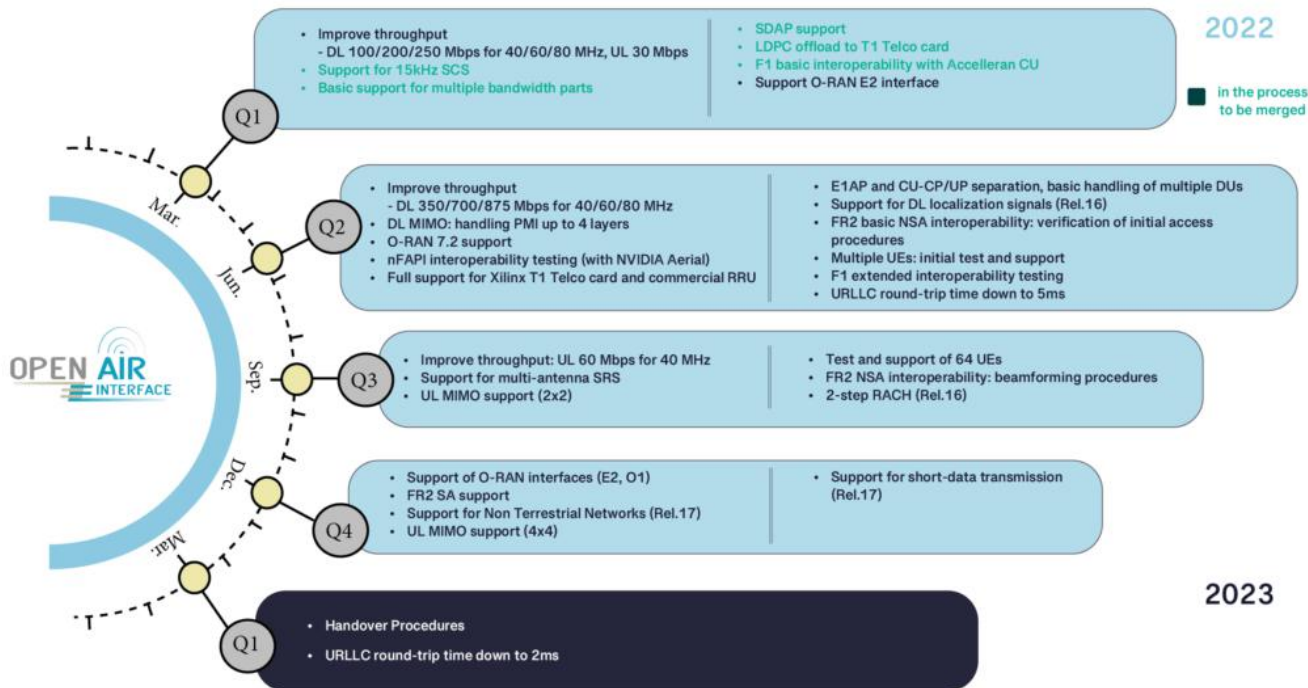
# Concept and Objectives

- The practical experimentation with 3GPP networks has been historically reserved exclusively to network equipment vendors and telecommunication operators, primarily due to high equipment costs and licensing constraints.
- In recent years, the state of play has been changing with the advent of open source 3GPP stacks based on increasingly more affordable Software Defined Radio (SDR) systems.
- In this context, OpenAirInterface (OAI) emerges as an open-source initiative that provides a reference implementation of 5G gNB, User Equipment (UE), and 5G core network (5GC), standard compliant with 3GPP NR Release 15 and that runs on general purpose x86 computing platforms along with off-the-shelf SDR hardware platforms like USRPs.



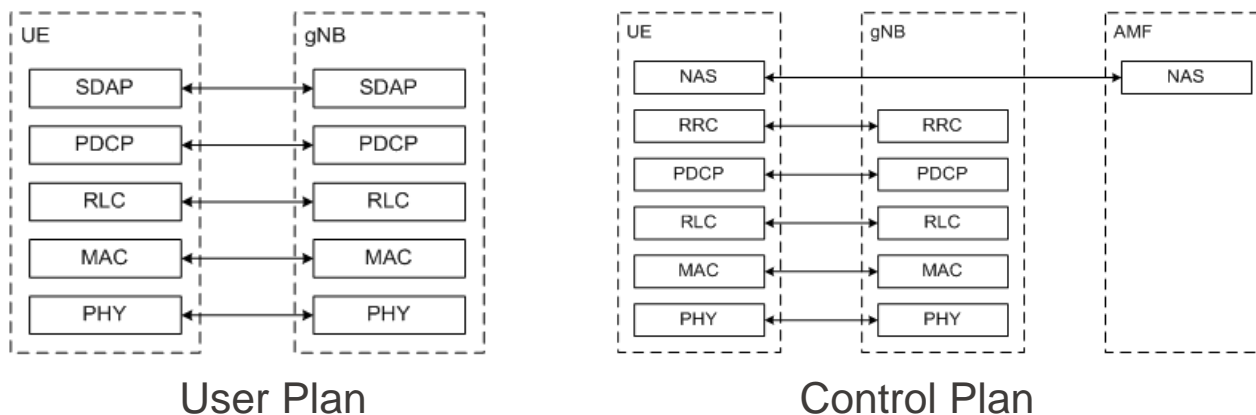
# Concept and Objectives

- OAI RAN roadmap.

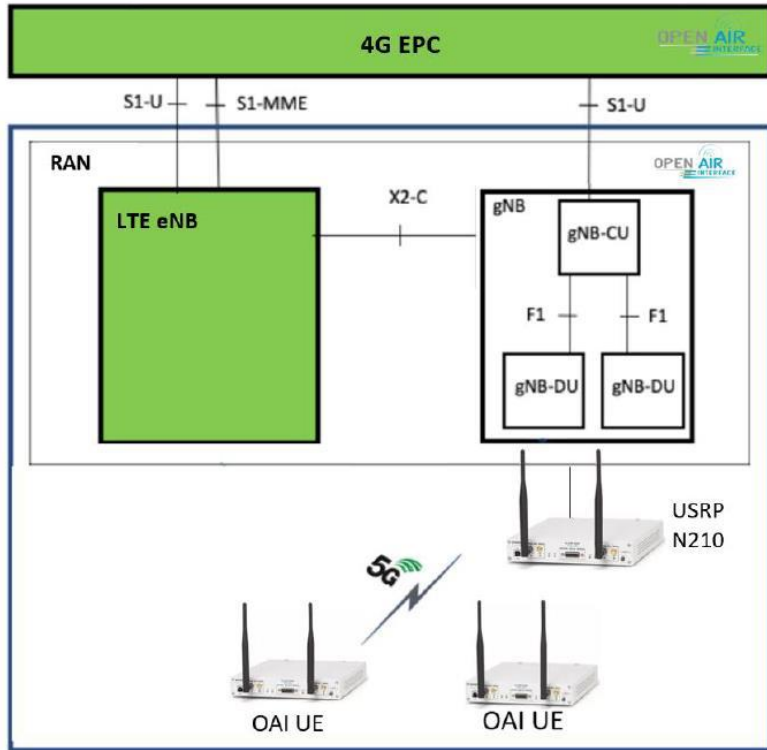


# Concept and Objectives

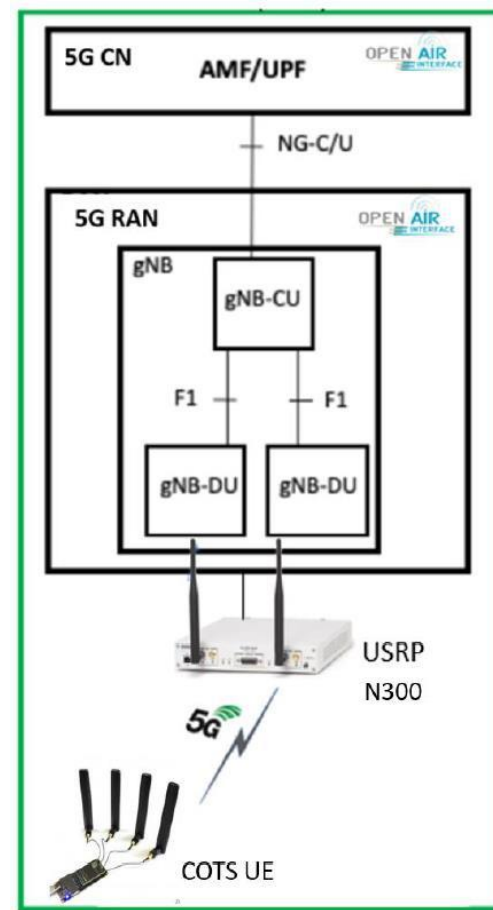
- The OAI code can be adapted to different use cases and deployment and new functionality can be implemented, making it an ideal platform for both industrial and academic research on 3GPP networks.
- The main objective of the 5GFed experiment is to integrate and test the latest OAI 5G NR standard-compliant implementation within two Fed4FIRE+ testbeds: IRIS (TCD) and CityLab (imec).**



# Concept and Objectives



Setup1: 5G NSA with USRPs



Setup 2: 5G SA with COTS 5G UE

# Project results

- End-to-end implementation of OAI 5G NR in the IRIS testbed
- Interoperability test between OAI gNB and COTS UE (Quectel RM500Q).
  - TDD configuration, 30kHz SCS (Subcarrier Spacing)
  - Downlink configurations: 256 QAM max, 60 MHz bandwidth (162 PRB), single layer
  - Uplink configurations: QPSK max, 60MHz bandwidth (162 PRB), single layer
  - iPerf UDP between OAI CN5G and QUECTEL RM500Q



# Project results

- End-to-end implementation of OAI 5G NR in the IRIS testbed (TCD)

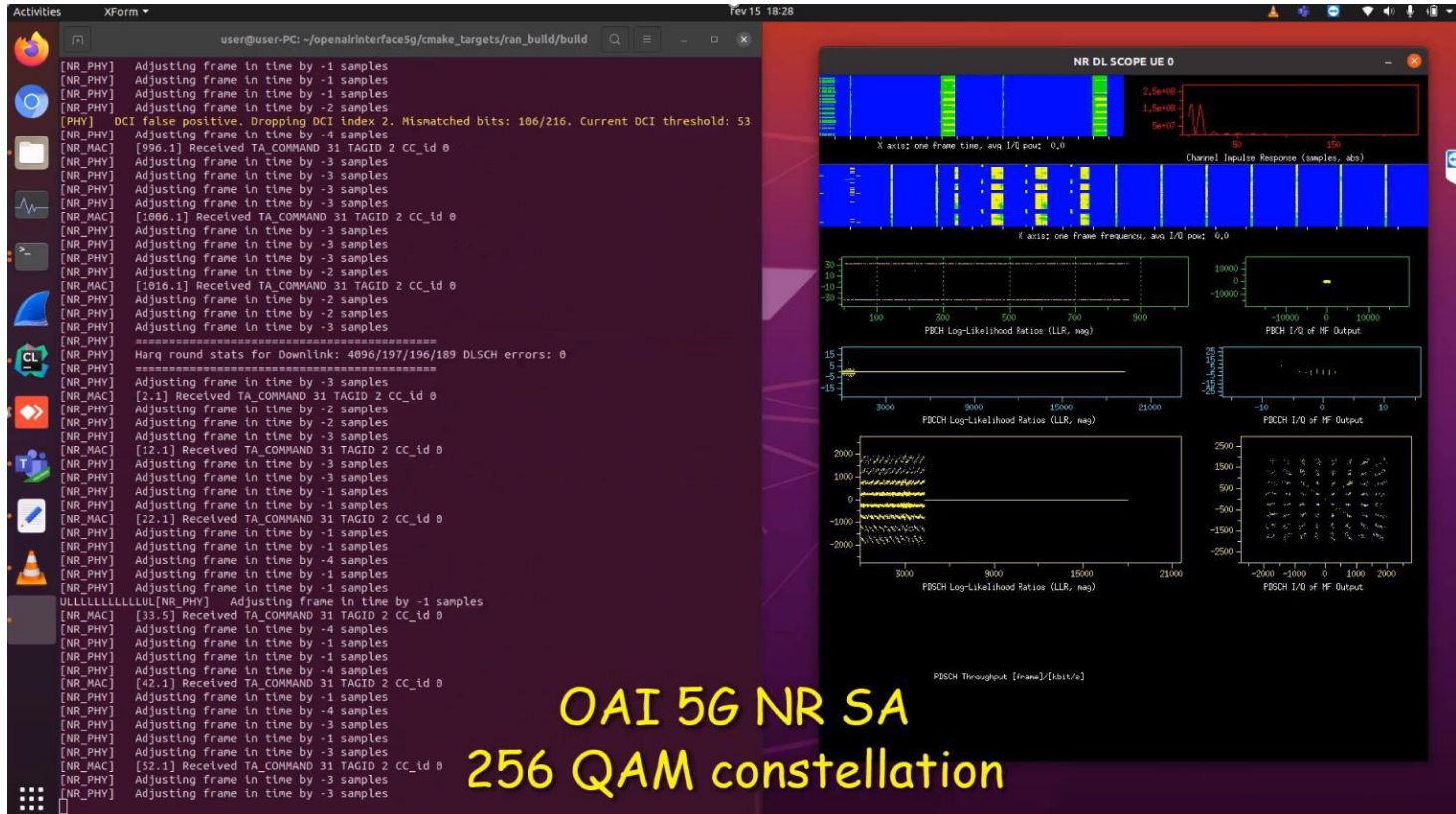
The screenshot displays a terminal window with several sections:

- gNB:** Shows network statistics for the gNB, including IP addresses, round trip times, and bytes received/sent. It also displays the number of bad RUCCH received and frame slots.
- gNB ↔ CN5G:** A central section showing the connection between the gNB and the CN5G network.
- Open Air Interface:** A section showing the Open Air Interface (OAI) configuration and status, including the IP address (12.1.1.2) and port (5802).
- Performance Metrics:** A table showing network performance metrics, including ID, Interval, Transfer, Bandwidth, and Delay. The table shows a peak transfer rate of 201 Mbytes/sec and a bandwidth of 201 Mb/s.

ID	Interval	Transfer	Bandwidth	Delay	Loss
0.0-1.0	sec	137 Mbytes	137 Mb/s	0.070 ms	12/16841 (0.27%)
1.0-2.0	sec	23.6 Mbytes	108 Mb/s	0.007 ms	14/16841 (0.083%)
2.0-3.0	sec	24.0 Mbytes	201 Mb/s	0.003 ms	7/17120 (0.041%)
3.0-4.0	sec	24.0 Mbytes	201 Mb/s	0.094 ms	30/17135 (0.18%)
4.0-5.0	sec	24.0 Mbytes	201 Mb/s	0.100 ms	7/17120 (0.041%)
5.0-6.0	sec	24.0 Mbytes	201 Mb/s	0.113 ms	15/17120 (0.088%)
6.0-7.0	sec	24.0 Mbytes	201 Mb/s	0.104 ms	15/17105 (0.088%)
7.0-8.0	sec	24.0 Mbytes	201 Mb/s	0.101 ms	7/17120 (0.041%)
8.0-9.0	sec	23.9 Mbytes	200 Mb/s	0.105 ms	16/17054 (0.094%)
9.0-10.0	sec	23.9 Mbytes	200 Mb/s	0.087 ms	30/17106 (0.18%)
10.0-11.0	sec	24.0 Mbytes	201 Mb/s	0.110 ms	15/17120 (0.088%)
11.0-12.0	sec	24.0 Mbytes	201 Mb/s	0.105 ms	15/17120 (0.088%)
12.0-13.0	sec	23.9 Mbytes	200 Mb/s	0.089 ms	61/17892 (0.30%)
12.0-13.0	sec	7 datagrams	received out-of-order		
13.0-14.0	sec	24.0 Mbytes	201 Mb/s	0.084 ms	15/17120 (0.088%)



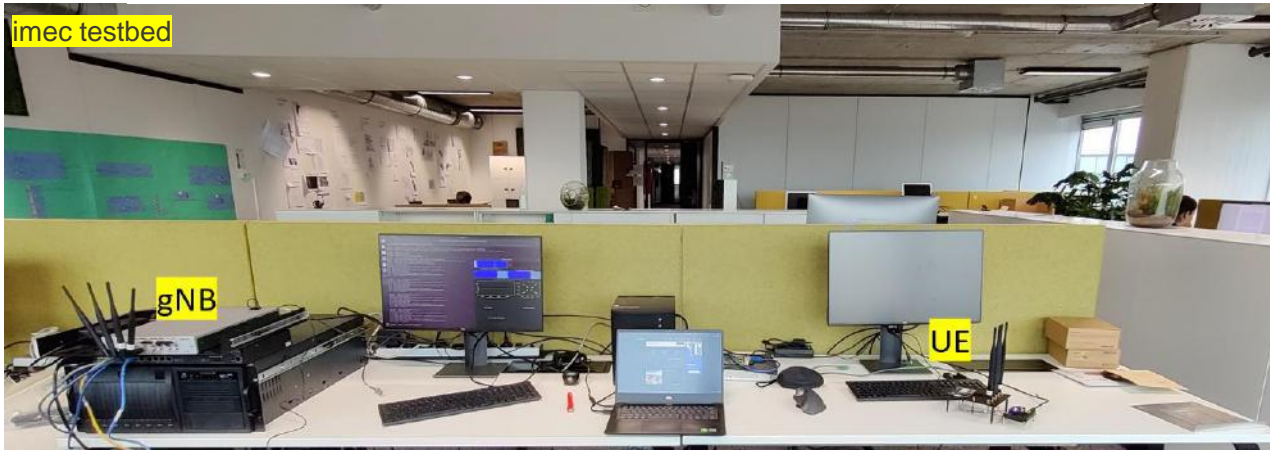
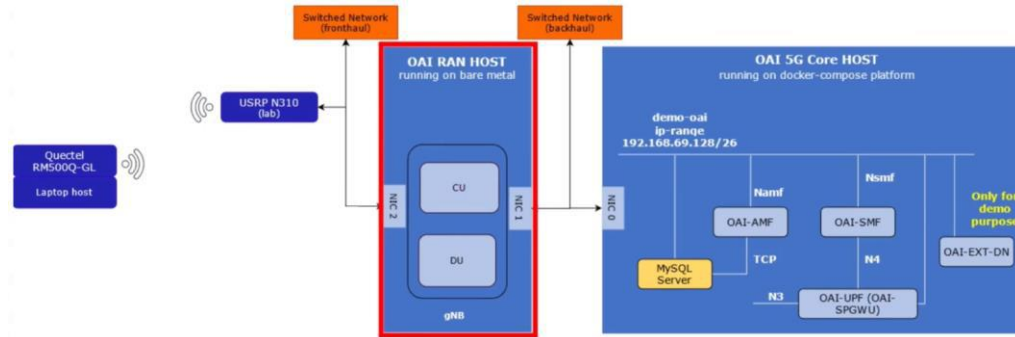
# Project results



OAI 5G NR SA  
256 QAM constellation

# Project results

- End-to-end implementation of OAI 5G NR in the testbed CityLab (imec).



# Project results

- Indoor testing @ imec



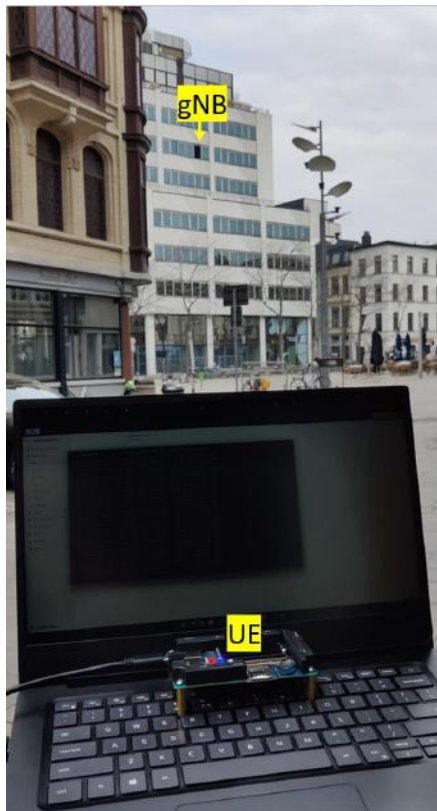
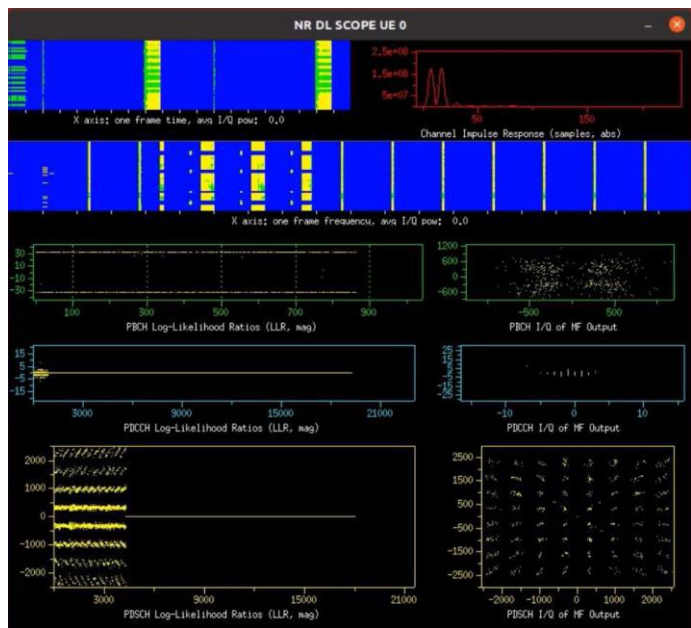
Configuration	Bandwidth [MHz]	DL throughput [Mbit/s]
SISO	40	123
SISO	60	188
MIMO 2x2	40	184
MIMO 2x2	60	240



5G NR SA indoor testing using MIMO 2x2, 60 MHz bandwidth and reaching DL 240 Mbps.

# Project results

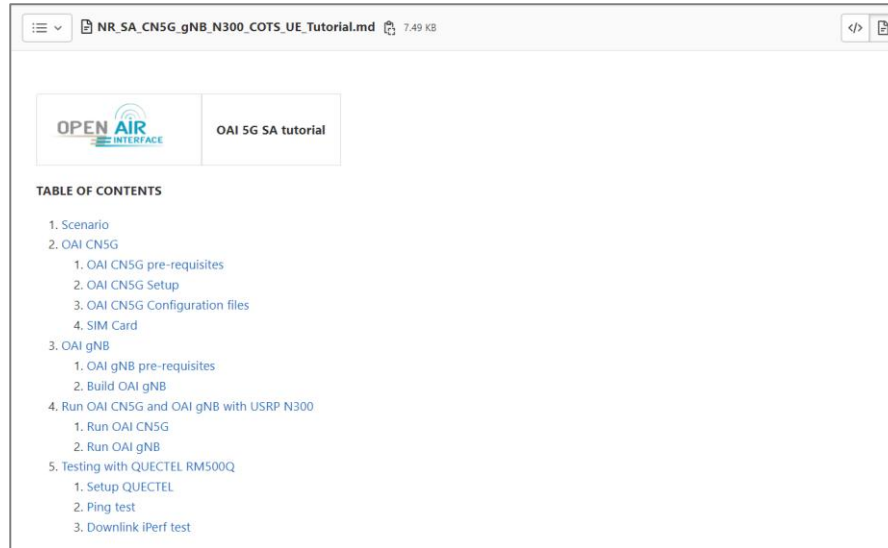
- Outdoor testing @imec



5G NR SA outdoor testing using MIMO 2x2, 60 MHz, 95 m LOS, reaching DL 58 Mbps and UL 4 Mbps.

# Project results

Allbesmart has published a tutorial to allow the OAI community to replicate the 5GFed experiment. The tutorial is available in the gitlab repository from EURECOM.



The screenshot shows a GitLab repository page for a file named "NR\_SA\_CN5G\_gNB\_N300\_COTS\_UE\_Tutorial.md" (7.49 KB). The page header includes the "OPEN AIR INTERFACE" logo and the title "OAI 5G SA tutorial". Below the header is a "TABLE OF CONTENTS" section with the following items:

- 1. Scenario
- 2. OAI CN5G
  - 1. OAI CN5G pre-requisites
  - 2. OAI CN5G Setup
  - 3. OAI CN5G Configuration files
  - 4. SIM Card
- 3. OAI gNB
  - 1. OAI gNB pre-requisites
  - 2. Build OAI gNB
- 4. Run OAI CN5G and OAI gNB with USRP N300
  - 1. Run OAI CN5G
  - 2. Run OAI gNB
- 5. Testing with QUECTEL RMS00Q
  - 1. Setup QUECTEL
  - 2. Ping test
  - 3. Downlink iPerf test

# Business impact

- Fed4FIRE+ has provided a unique opportunity for Allbesmart to have access to state-of-art Software Defined Radio (SDR) testbed infrastructure.
- This experiment helps us to speed up our developing and testing phase and position the company as a player in the emerging market of 5G open-source solutions.
- This experiment has allowed us to mature the technology sufficiently to offer it to our commercial partners and to approach potential new partners for proof-of-concept testing and trials.
- Allbesmart wants to leverage its OAI deep expertise to provide consultancy services on OAI implementations of 3GPP 5G NR protocol stack to accelerate 5G product development and innovations.

# Business impact



- Thanks to this experiment, IRIS and CityLab testbeds will be able to provide end-to-end 5G open-source implementation for protocol testing, contributing to the sustainability of the Fed4FIRE+ project.

# Feedback

- A very good point is that in OC projects the level of administrative burden for experimenters is very low compared with other H2020 projects.
- Excellent support from TCD and imec teams.
- The documentation available was sufficient to run the experiment.
- We aim to build on top of this experiment and strength the collaboration with TCD (Open Ireland testbed) and imec on open-source solutions for 5G and beyond.





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**MANY THANKS TO FED4FIRE+  
AND TO  
THE TCD AND IMEC TEAMS !**

**[WWW.FED4FIRE.EU](http://WWW.FED4FIRE.EU)**