Newsletter

OAI 2023 SUMMER EDITION

Spring 2023 OAI Hands-On Workshop

In May, the OSA conducted the Spring 2023 OAI Hands-On Workshop, a two-day on-site workshop, in the OAI premises at EURECOM (Sophia Antipolis). During these two days, the experts walked the participants through the evolution of the OAI software during the past year. The workshop allowed the participants to attend training sessions on the different OAI project groups, witness the end-to-end O-RAN showcase (as an account of the OAI vision of what a Super Wireless Blueprint (SWBP) should look like), investigate how to leverage in-line and look-aside hardware acceleration for high performance 5G and xG, discover other active OAI projects like soft UE, near-RT RIC and xApps, SMO readiness of the stack, and many more topics. We also demonstrated how OpenAirInterface has made significant strides in becoming a reference implementation for the 3GPP and O-RAN specifications.

We thank all the participants of this Spring edition of the OAI workshop, and we hope to see you in the next OAI Workshop!

Welcome to our latest edition of the OAI newsletter! We are pleased to bring you the most exciting updates, insights, and developments from the last six months. In this edition, we delve into the latest news of each OAI Project Group (OAI RAN, OAI CN, and OAI OAM) and we will explore the events where OAI left its marks. Whether you're a technology enthusiast, a business professional, or simply curious about the future of 5G connectivity and innovation, this newsletter is your go-to source for all things OAI.

New Members

AMANTYA

DELL

NTT DATA

JVCKENWOOD

Associate Members:
Dell Technologies, Amantya, NTT Data Corp., Jvckenwood Corporation

Important coming dates:

1. Next webinar: September 2023
2. Next workshop: 14-15 November 2023
3. Mobile World Congress Las Vegas 2023: September 2023
4. O-RAN Global PlugFest Fall 2023

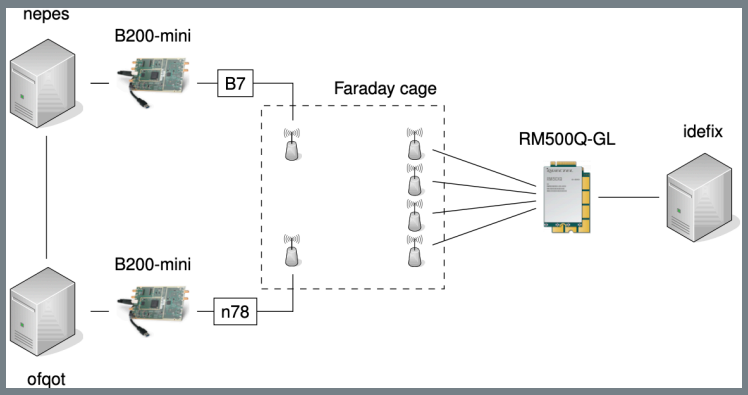
OAI RAN

Release 2.0 in the Master Branch

We are happy to share that a new release of OAI RAN is now available. This is OAI v2.0!
Rel 2.0 reflects a shift in our feature-release methodology that has come about as a result of significant investment in testing. The release updates the master branch which contains the latest 5G NR SA features that were under development and testing for several months.
The OAI team intends to release quarterly upgrades in the master branch in the future. Find out more in the official release notes here.

RAN CI

Did you ever wonder how OAI tests its software and what runs the CI environment? In the last years, the CI team built up many tests. Specifically in the RAN, there are build tests for different platforms, physical simulators for various 4G and 5G channels, end-to-end simulator tests with the RFsimulator and L2simulator, and various over-the-air/radio-based tests, notably using USRPs and an AW2S radio unit. As the next step, we will extend this with more tests for O-RAN radio units, the T2 offload card, and commercial gNBs interoperating with the OAI UE.
For more information, you can have a look at doc/TESTBenches.md in the repository to learn more.



T2 integration into CI and in the OAI RAN

OAI is currently integrating the AMD T2 Telco Accelerator Card, which plays a crucial role in offloading the computationally demanding task of LDPC encoding and decoding operation. This offloading capability effectively reduces the CPU load and accelerates the processing of the receiver and transmitter chains in the L1. At the same time, the CI team works on the integration of the T2 Card in our CI system, to continuously ensure good behavior of the gNB, quickly detect new problems and severely limit the apparition of regressions in our evolving code base. Especially with several UEs simultaneously connected to the gNB and heavy data traffic, the use of the T2 Card fully proves its usefulness.

F1 Handover

No cellular implementation is complete without the possibility to perform handovers, where a UE transitions from a source to a target base station in an ideally seemless way. Up until recently, the OAI RAN implementation lacked such functionality. A first merge request is open to address this shortcoming. In the targeted scenario, one Centralized Unit (CU) connects to two Distributed Units (DU) using the F1 split; one UE can do a handover between these two DUs using the RFsimulator. Following the instructions in the merge request, you can perform handovers on your own machine without radio, all using OAI software!
The feature has been developed in the context of the 5G-LEO EU project that aims to facilitate the research of Non-Terrestrial Networks (NTN).

OAI UE

OAI UE has been historically used mostly as a tool to test OAI gNB with which it can be interfaced both in simulation and with RF boards.
This year, OSA has started a project to improve the OAI UE, and test it with commercial gNBs. At this point, the OAI UE can synchronize, decode SIBs (SIB1 and others) and complete RA with a commercial gNB. Work is ongoing to improve the capability of the UE to provide UL feedback with the delay required by a commercial gNB, the major limitation to achieving full connection. At the same time, the set of features implemented in the UE is continuously expanded to be in line with what is configured by the commercial gNBs.

Multi-UE integration in the CI

Handling multiple users is a fundamental requirement of any cellular network implementation. Therefore, ongoing efforts focus on enhancing the gNB's management of several UEs. Recently, many bugs related to UEs have been fixed. Automation of multi-UE testing allows the detection of problems quickly and promotes better system stability while at the same time enabling the development of new features. For this reason, the CI team is integrating the testing of multiple UEs into our CI system. The testbench consists of the OAI gNB with an AW2S radio unit and Amarisoft UE Simbox, a UE simulator allowing the simulation of multiple UEs. Currently, we test five UEs connected simultaneously. We strive towards connecting around twenty UEs, all of them performing heavy data traffic while sharing resources in a fair manner.

OAI CORE NETWORK

Development and Integration of the OAI UPF based on eBPF to the OAI Core Network

We are developing a new version of OAI-UPF that will support enhanced eBPF and XDP as a data path solution. It will also use the OAI-SPGWU-TINY Simple Switch-based data path as an optional data path support. eBPF will provide the UPF a high performant data path. The first release of UPF will use the new YAML based configuration mechanism and it will support multiple UE PDNs. In future releases, we plan to add features such as Quality of Service and uplink classifiers.

Improving Code Quality of 5G Core

One of the main objectives for the last six months was to improve the code quality of 5G CN, to make it stable and robust. To do it, we improved different Network Functions. In AMF, we refactored and provided bug fixes for the two most important and complex libraries, namely NAS and NGAP. In SMF, we fixed the implementation of Service Request procedure required by many COTS UEs and improved error handling by sending a PDU Session Reject whenever an error occurs. Apart from this, we did a lot of code refactoring, introduced common sub-modules in each NF to manage the common code of all the network functions. Our aim is to reduce the feature development time and for this we are focusing on simplifying the code base of all the Core Network functions. In future releases, we will keep removing duplicated code with a clear focus on stability. We recently introduced YAML based configuration for core network functions and moved our tutorials to HTTP/2.

Release of the OAI CN Version 1.5.0 & 1.5.1

Six months after completing the v1.4.0 version we released v1.5.0. The aim of this version was to improve the number and the quality of our tutorials, the user experience, the Core Network functions, and the Docker images (picture 1). The second release, v1.5.0 (picture 2) primarily focuses on fixing bugs, especially Service Request Handling. We are also releasing the container images for Docker-Hub on an Ubuntu-20 base and no longer supporting Ubuntu-18. All these new features, bug fixes, and improvements are essential to us and allow the OAI code users to get the smoothest experience possible.

OPEN AIR interface

COTS UE List

- Iphone 14/14 pro
- Huawei P40/P40 pro
- OnePlus 8/9/Nord (ac2003)
- Google Pixel 5/6
- OnePlus Nord 2
- Corsscall Core Z5
- Fritzbox 6850
- Oppo Reno7 Pro
- Quectel (RM500Q-GL, RM520-GL, RM502Q-AE)
- SIMCOM_SIM8200EA-M2

Major Bug Fixes

- Fix Service Request Handling (Service Type: Signalling)
- Fix to support up to 5000 PDU sessions
- Fix N2 Handover
- Fix HTTP/2 deployments

picture1

picture 2

User Experience

- Continuous effort to improve the quality of our tutorials
- Creation of new tutorials
- Simplification of the Docker-Compose files
- OAI Core & OAI gNB tested with multiple COTS-UE and modules

CN Functions

- Public Release of the PCF network function: supporting uplink classifier with N7 interface (SMF, UPF, PCF). The PDU session now can be established using PCC rules
- Stabilizing 5G Core Network by providing various fixes for all the network functions

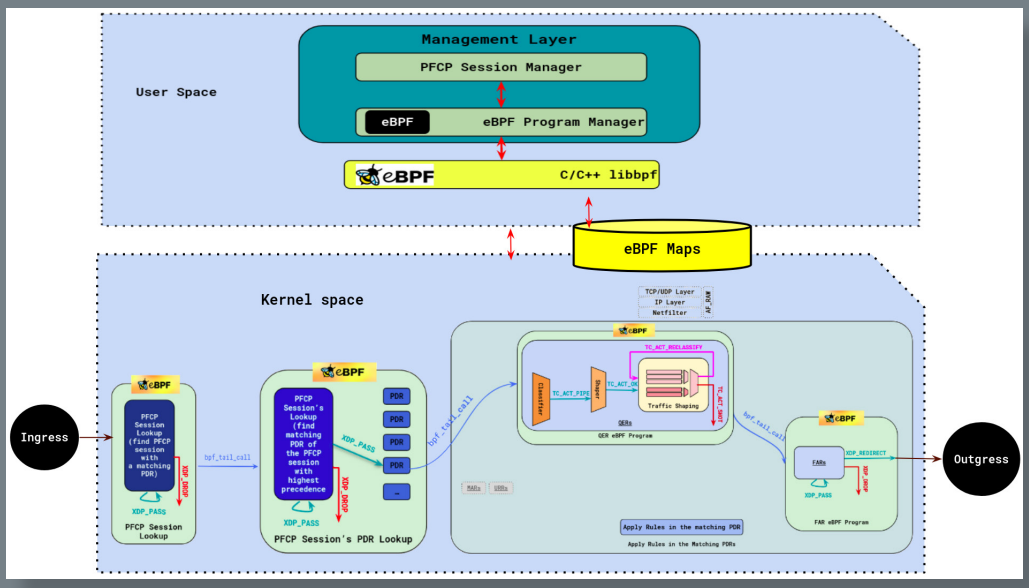
Docker Images

- The next releases will be on an Ubuntu-22 base image

The New YAML Way of Configuring Core Network Functions

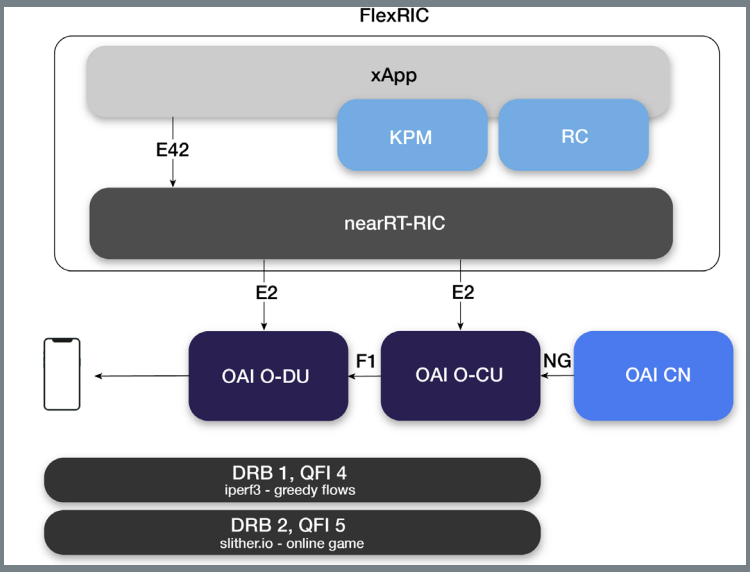
We have identified the need to ease the use of OAI 5G-CN. The existing way of configuring the NFs was overly complicated and not transparent to the users. Therefore, we decided to create a new configuration framework, which reads the configuration from YAML files mounted inside the Docker containers. For simple 5GC setups, it is enough to create one file to configure all the NFs. We will continue to improve the configuration files and add more easy-to-use configuration options.

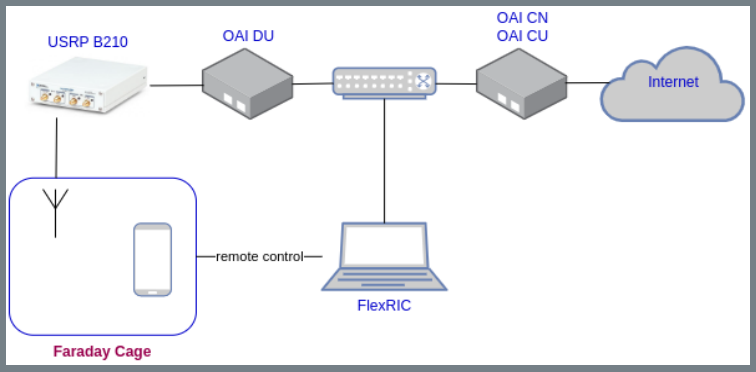
Coming Next: QoS



The OAI 5GC version 1.5 already supports a default Non-GBR QoS flow. For the next release, we plan to implement multiple QoS flows per PDU session with support for Non-GBR and GBR QoS flows. We will implement the policy framework according to 3GPP TS 23.503 and focus on end-to-end QoS covering SMF, UPF, and PCF. For QoS management inside the UPF, it will rely on eBPF. Indeed, we will use the TC additionally to the QDISC (queueing discipline) to create multiple queues. Queue Discipline will schedule packet transmission orders and prioritization within the queues. There are various QDISC options available in Linux: Token Bucket Filter (TBF) and Hierarchical TBF (HTB). HTB classifies traffic upon reception, based on specific criteria (e.g., source/destination IP address, port number, or protocol), into multiple classes or queues with their own token bucket filter, rate limits, burst sizes, and priorities. Whilst Traffic Shaping controls and limits the rate of outgoing traffic from NIC. The shaper utilizes token bucket algorithms (i.e., HTB) to transmit packets when sufficient tokens are available. If there are not enough tokens, the packet may be delayed or buffered until sufficient tokens become available.

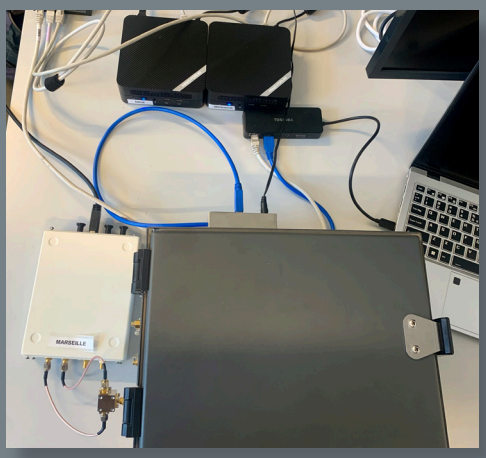
OAI Operations and Maintenance (OAM)





FlexRIC Demo at the O-RAN F2F Meeting in Osaka, Japan

Thanks to the recent developments made within the OAM group, the team was able to showcase a demo at the O-RAN F2F meeting in Osaka, Japan: "Improving QoE using O-RAN compliant nearRT-RIC, KPM v03.00 and RC v01.03 SMs in an online multiplayer game". In this demo, we deploy the end-to-end cellular network with OAI CN, OAI CU, OAI DU, and FlexRIC, an O-RAN-compliant nearRT-RIC. We launch the online game slither.io, a latency-sensitive application, and then generate greedy flows, using iperf3 that share the same radio bearer. Since the packets are treated equally, the game becomes unresponsive and the QoE drops significantly. To overcome this issue, we take advantage of nearRT-RIC and an associated xApp. We use KPM SM to monitor the packet sojourn time in the default radio bearer. When the latency at the RLC buffer surpasses the threshold, we use RC SM to control the E2 nodes by creating a new radio bearer. In this manner, traffic flows belonging to different applications (i.e., greedy and time-sensitive) are sent through separate radio bearers, improving the QoE.



E2 Agent and OAI SMs

E2 Agent is officially merged with OAI. To build it, you need to add the --build-e2 flag when building OAI. The E2 Agent remains, as previously, highly decoupled so it can be smoothly deployed in other scenarios. The E2 Agent API is unbloated with four function calls and function pointers to handle SMs events. Additionally, KPM upgraded to v3, and all the mandatory messages described in the standard are implemented. In addition, all the encoding and decoding mandatory messages for the acclaimed RC 1.03 are achieved. It is an important milestone: FlexRIC is the first open-source project that fully implements all the mandatory messages required by O-RAN, fostering the open-source community. We also added asynchronous event handling in the E2 Agent, enabling aperiodic events (e.g., UE connection) to be handled smoothly. In this way, we are closer to providing full support to xApps, as they may require subscribing to asynchronous events using the RC SM and acting accordingly.

Next steps:

There are more than 1000 variables specified in KPM v3. For the moment, we fill the variables with random values. If you are interested in one specific variable, do not hesitate to contact us or push a MR that will allow the whole community to benefit from it.

Work has continued to develop the Cell Configuration and Control Service Model and E2AP v2 and v3. Moreover, we also plan to start giving experimental support to RIC CONTROL Services 1 and 2 (i.e., Radio Bearer control and Radio resource allocation control) shortly.

OAI EVENTS

Mobile World Congress Barcelona 2023 & MoU with the O-RAN Alliance

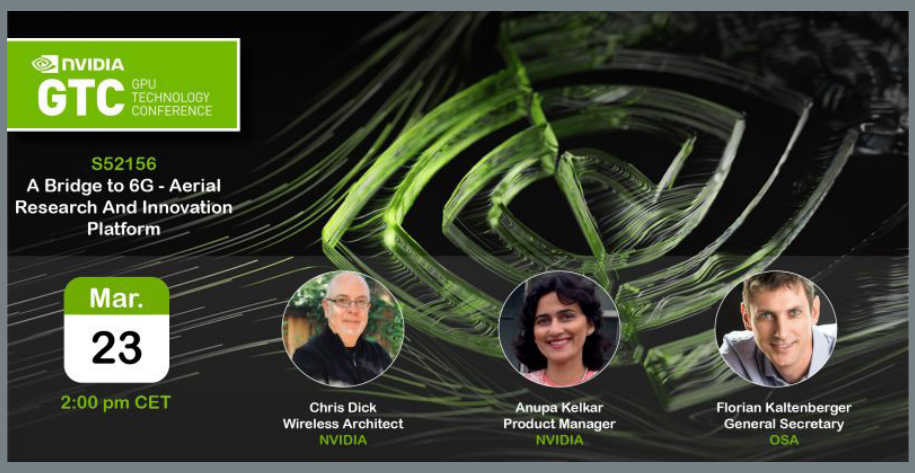
In MWC Barcelona 2023, the OSA showcased online and on-site demos. The online was done in collaboration with our strategic partner NVIDIA: "GPU Accelerated 5G Virtual RAN with NVIDIA Aerial SDK and OAI". The demo was on interoperability of the OAI-Aerial integrated platform with Foxconn Technology 7.2 split O-RU and OTA connectivity with UEs from Quectel and Oppo. The on-site demo «O-RAN 7.2 Open Fronthaul Support in OpenAirInterface» showcased the OSC fronthaul library integration with the full OAI stack including OAI L1 (High Phy) and L2/L3.

During the event, O-RAN and OSA signed an MoU for collaboration. The collaboration objective is to roll out an O-RAN-compliant open-source wireless platform. The announcement was made in a stage talk by Alex Choi, president of the O-RAN Alliance.

NVIDIA 2023 GPU Technology Conference (GTC)

In March, the OSA and NVIDIA gave a talk at the NVIDIA 2023 GTC. This session, entitled "A Bridge to 6G - Aerial Research and Innovation Platform." conducted by the NVIDIA and OAI experts, introduced the ARC platform. They highlighted the platform vision and use cases of early adopters, outlined the C/C++ network programmability, provided OAI ISV gNB and CN overview, and did a deep dive into specific ML examples that have the potential to jumpstart great innovation.

This collaboration is designed to provide a solution to the multiple needs of different profiles of users: allowing researchers to simulate prototype-benchmark optimizations, algorithms, and innovations rapidly in a deployed Over-the-Air NR standards-compliant high-performance operational network and more.



O-RAN nGRG Workshop

During June, OpenAirInterface participated alongside its strategic partner NVIDIA in the O-RAN nGRG Workshop in Osaka, Japan. Lopamudra K. of NVIDIA and Irfan Ghauri from OAI highlighted the joint work between OAI and NVIDIA through a presentation on "NVIDIA ARC with OAI L2+ for Next Generation Innovation".

2023 Open RAN Workshop in Taiwan

In February, we gave our perspective on the innovation opportunities enabled by Open RAN concepts and open source availability at the 2023 Open RAN Workshop in Taiwan. This talk was entitled: Open RAN and OpenAirInterface - A Marriage of Stars.

Hannover Messe 2023

In April, Robert Schmidt, our OAI RAN expert, showcased a demo at the Hannover Messe 2023 in Germany entitled "O-RAN 7.2 Open Fronthaul Support in OpenAirInterface".

The demo leverages the OAI software stack and an O-RAN-compliant RU from VVDN Technologies to realize an application throughput of 600 Mbps.

Spring O-RAN Global European Plugfest

In the occasion of the Spring O-RAN Global Eureopean Plugfest, the OAI team decided to work closely with LITE-ON to produce a test scenario named «End-to-end testing of LITE-ON O-RU with O-DU/O-CU using COTS UE.». Thank to this test, the O-RAN 7.2 Fronthaul split integration has been completed in the OAI stack.

O-RAN F2F Meeting in Osaka, Japan

In June, The OAI team attended the O-RAN F2F meeting in Osaka, Japan. During one week, we showcased two demos based on the latest OAI work in compliance with the O-RAN specifications.

The first demo "Improving QoE using O-RAN compliant near RT-RIC, KPM v03.00 and RC v01.03 SMs in an online multiplayer game» focused on near Real-time RIC".

The second demo "End-to-End Over-the-Air 5G Demo with OAI CU-DU and LITE-ON O-RU interoperability over O-RAN 7.2 Fronthaul using the OSC Interface (FHI) Library" showcased the 7.2 fronthaul library integration with the full OAI stack including OAI L1 (High Phy) and L2/L3, and running on AMD CPU.

Participate in the OAI Meetings:

- OAI External Developer Meetings:
  - Asia Time Zone on every odd weeks
  - Americas Time Zone on every even weeks