Newsletter

OAI 2023 WINTER EDITION

Joint OSC/OSFG-OAI Workshop: E2E Reference Designs for O-RAN

The Joint OSC/OSFG-OAI Workshop: End-to-End Reference Designs for O-RAN was held from November 14th to November 15th at the Northeastern University Innovation Campus in Burlington, MA. We thank you all for attending such a large number!

More information on page 6.

Upcoming events

- OAI Webinars: January 2024
- MWC Barcelona: February 2024

We are delighted to bring you the latest edition of our OAI Winter Newsletter, packed with exciting updates, achievements, and the latest events.

As we navigate through this journey together, our community continues to thrive and evolve, and we're thrilled to share the highlights with you.

If you want more information about OAI RAN, Core, and OAM, keep reading!

OAI Team

Reem Bahsoun
OAI RAN Group

Welcome to our new teammate !

New Members

Strategic Members

ERICSSON

Canonical

Associate Members

MAXEYE TECHNOLOGIES

Flying River

Secmotic smart inside

VVDN TECHNOLOGIES

OAI RAN

F1 & E1 Improvements

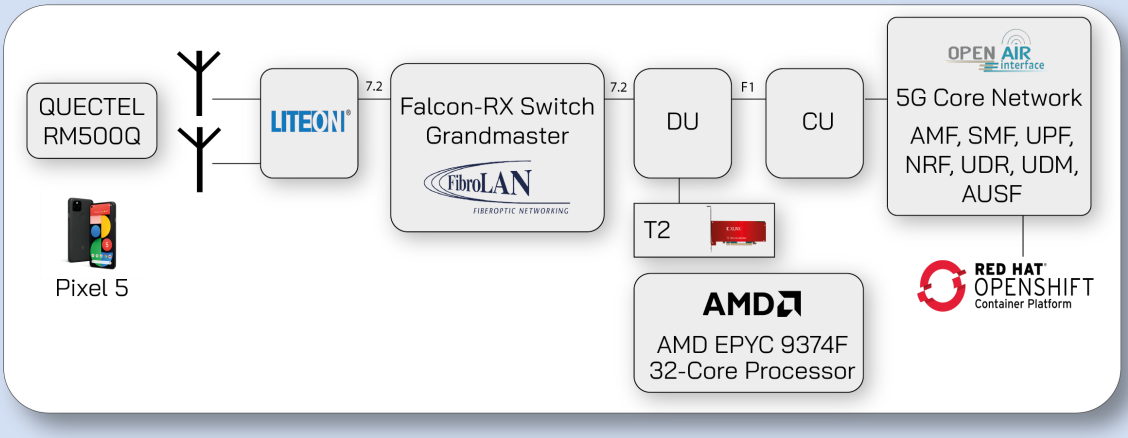
The improvements of the 3GPP F1 and E1 interfaces, separating the distributed unit (DU) from the centralized unit/control plane (CU-CP) and centralized unit/user plane (CU-UP), have advanced considerably this year. As part of this work, usability has been refined when configuring such a split RAN, e.g., the configuration has become easier. Also, we refactored code to use these interfaces internally at the gNB, i.e., even in non-split mode, to make its operation more stable. Finally, as an outcome of cleanup efforts, we could add the support of multiple DUs at one (CU-CP), as well as multiple CU-UPs at one CU-CP. The former will be the bottom line to implement F1 handover, and the latter can be used to achieve slice differentiation, e.g., to implement different forwarding behavior per slice, where one CU-UP handles one specific slice.

Status on UE Improvements

A declared goal of the team at OpenAirInterface is to allow the OAI UE to interoperate with commercial third-party gNBs. While the OAI UE is not there yet, a number of important milestones have been taken recently towards enabling such interoperability. Precisely, we fixed some performance problems which finally allowed us to complete random access with Nokia gNB. An ongoing effort is to clean up the code in order to facilitate the implementation of future features. Also, a number of other features have been worked on, such as UL/DL 2x2 MIMO, which can already be tested with the OAI gNB. Finally, the team has received code contributions for sidelink, which should be generally available next year.

OAI T2 & 7.2 Demo at the O-RAN F2F Meeting in Phoenix, AZ

At the O-RAN F2F meeting (see page 7), we showcased a demo of the OAI RAN integrating the O-RAN 7.2 Fronthaul, the AMD T2 Accelerator card, and the 3GPP F1 midhaul split. A LITEON O-RU is connected to the OAI O-DU, which leverages the open fronthaul interface (FHI) library (E release) from the O-RAN Software Community. LDPC encoding at the DU during DL processing and decoding during the UL processing is offloaded to the T2 HW accelerator card, lowering the requirements on the CPU. The DU is further connected to the OAI O-CU via F1. Tests were done using a 100MHz bandwidth, SCS 30kHz, and MIMO 2x2. This reference implementation creates the opportunity for a wide range of O-RAN compatible radio units to be tested and deployed through OAI, such as LITEON, Benetel, and VVDN.



Aerial Integration

The first version of the integration of the Nvidia Aerial Layer 1 Inline Accelerator (DU-low) and OAI Layer 2 and above (DU-high and CU) is finally available on OAI's public GitLab repository (see branch Aerial_Integration). It allows users in possession of the necessary hardware (Nvidia A100 GPU and GX-6 NIC or converged A100X or AX800, as well as a Foxconn O-RU) to set up a complete O-RAN compatible hardware-accelerated 5G system. The integration uses the FAPI interface from the Small Cell Forum, and it is the first time OAI shows interoperability with a third-party Layer 1 implementation. The platform paves the way for highly scalable O-RAN deployments, as Layer 1 can support multiple cells on the same accelerator card. It is also an ideal platform for next-generation research as it is ready to integrate AI/ML-type algorithms. The branch is currently under integration into the development branch and the OAI CI system and will be part of the next release 2.1 in January 2024.

OAI CORE NETWORK

SPGW Refactoring and Integrating Simple_switch Mode Beside eBPF Mode within the OAI New UPF

Since our implementation of OAI-SPGWU-Tiny as UPF has limited throughput capacity, we worked on the sources and refactored its implementation. In the new release 2.0, we unveil a new UPF version that embeds two deployment modes: the Simple-Switch mode and eBPF-XDP mode.

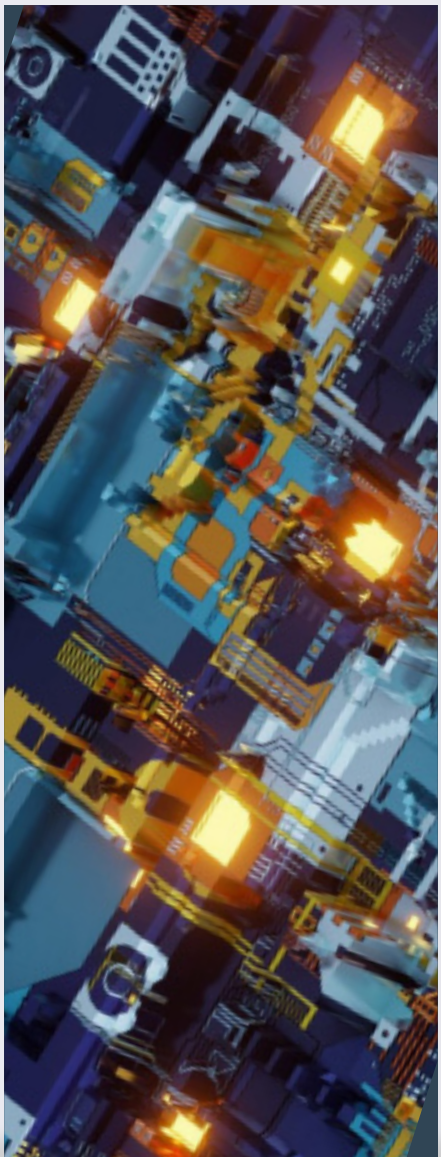
Simple-Switch Mode: We reused the code from OAI-SPGWU-Tiny to perform several UPF features. The purpose of using this mode is twofold: to demonstrate the functioning of the entire OAI 5G setup (RAN & CN), and to enable some functionalities not yet implemented within the eBPF-XDP deployment mode.

eBPF-XDP Mode: The main goal of using this mode is to achieve high throughput and UPF performance. This first release of UPF (v2.0.0) offers basic features, including PDRs and FARs. In upcoming versions, we will implement new features such as QERs, BARs, and URRs. To activate this mode, you must enable the eBPF datapath variable within the UPF configuration file.

We refactored the entire code of OAI-SPGWU-Tiny to have a common code for both modes, including different protocols' implementation, the entire N4 server and its PFCP implementation, and the 3GPP implementation of various information elements.

UPF Release & UPF Features (SDF Implementation, PFCP Handeling QoS, QER eBPF Implementation)

On the one hand, the UPF interacts with the SMF via the PFCP protocol on the N4 interface. On the other hand, it forwards user traffic between Access and Data Networks over N3 and N6 interfaces. These two main functions are implemented within two layers: the Management layer and the Datapath layer.



Management layer: The Management layer is a user-space library responsible for PFCP session management. It implements the CRUD functions to create, update, and delete a PFCP session and manages the eBPF program lifecycle.

Datapath layer: It embeds the two deployment modes: Simple-Switch and eBPF-XDP modes. When the eBPF-XDP mode is enabled, the datapath layer is a kernel space layer based on eBPF and XDP technologies. It treats the traffic as fast as possible by making decisions on each packet at the NIC level, determining whether it will be passed to the next stage, dropped for some reason, or redirected to another interface.

The SMF manages QoS enforcement during PDU session establishment or modification in the Data Network. The UPF in the Data Network maps QoS flows to N3 GTP-U tunnels. The SMF collaborates with UDM and PCF, extracting QoS parameters from PCC Rules provided by PCF. If there is no existing QoS flow, the SMF creates one, binding PCC rules to QoS flows and associating them with the QoS profile, rules, and PDR. Each QoS flow gets a QFI, and each rule receives a unique identifier within the PDU session.

In this context, we have implemented the first SDF solution using < protocol type, port, source IP, destination IP > as filters. In addition, we are improving the scope of the Management Layer, especially the PFCP library, to include the management of QoS.

Release of NWDAF

We are excited to announce the release of OAI-NWDAF, a fully 3GPP-compliant NWDAF built on an efficient microservices-based architecture. OAI-NWDAF is designed to enhance the delivery of 3GPP-defined use cases and provide comprehensive network insights.

OAI-NWDAF offers a suite of core services, including:
1) Network Performance Information: Delivers metrics such as the number of UEs and PDU sessions.
2) UE Communications Statistics: Provides information about uplink and downlink data volumes of UEs.
3) UE Mobility Information: Tracks UE mobility across the network.
4) NF Load: Gains insights into the load and resource utilization of NFs.

OAI-NWDAF goes beyond basic network monitoring by leveraging machine learning for abnormal traffic detection. This machine learning-based service provides OAI-NWDAF clients with the probability of abnormal traffic for a given list of UEs. This service enables the proactive identification of network anomalies, ensuring an optimal user experience.

Code Quality Improvement

Improving the code quality of the OAI CN Network Functions (NFs) was one of our key activities while working on the 2.0.0 release. Over the last few years, the OAI codebase has consistently grown, and although we focused on maintaining high quality, refactoring is essential for keeping code maintainable, readable, scalable, and testable. For example, we moved common code to a Git submodule, which is shared by all NFs to implement the Do-Not-Repeat-Yourself (DRY) pattern. Additionally, we modernized and simplified many parts of the code to improve readability and maintainability, easing the onboarding of new contributors. Apart from that, we provided various bug fixes to make OAI CN stable and robust. Finally, we are working on integration tests based on the well-established Robot Framework to further improve the existing automated testing framework. We will continue with our refactoring and stabilization efforts in future releases to provide a high-quality, production-ready 5GC.

OAI CN V2.0.0

After a bit of delay, we are finally releasing version `2.0` of the OpenAirInterface 5G Core Network. We chose to fully increment the major release version because:
- We are moving to a YAML-based configuration scheme and some Network functions are no longer backward-compatible with the previous CONF scheme.
- We are also obsoleting the maintenance and support `openair-spgwu-tiny` in favor of « oai-UPF ».
- All tutorials/helm charts are now using « oai-UPF ».

Additional tutorials have been added to showcase:
1) A traffic steering example vs a traffic redirection example
2) How to use a Mongo-DB instead of mysql for User Subscription management
3) eBPF implementation

More details are in the release notes.

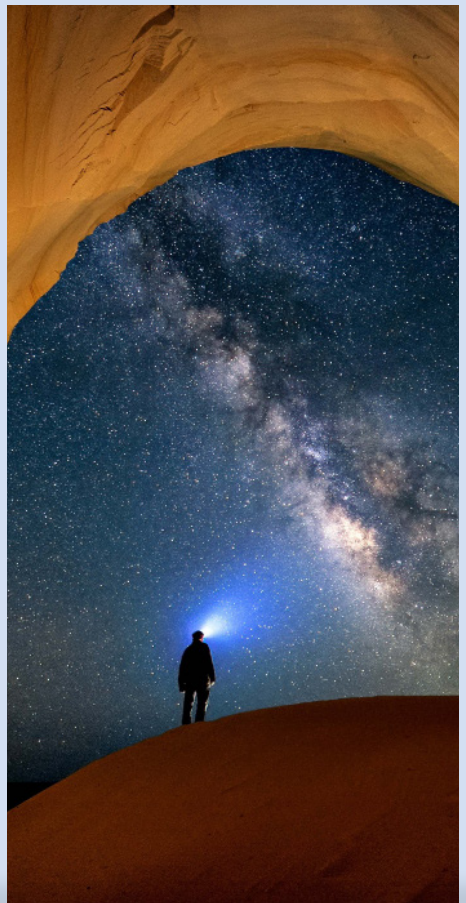
MongoDB Support

Thanks to the flexible design of UDR, capable of supporting multiple underlying database systems, we now offer MongoDB as an alternative to the MySQL database system. As a document database with native JSON support, MongoDB is perfectly suited for storing both structured data (where the structure is defined in 3GPP specifications) and unstructured data (where the structure is not defined in 3GPP specifications). MongoDB can handle high volumes and can be horizontally or vertically scaled to accommodate large data loads. Therefore, we have also adopted MongoDB as the database system for the UDSF network function, which will soon be integrated into the OAI 5GCN ecosystem.

FlexRIC News

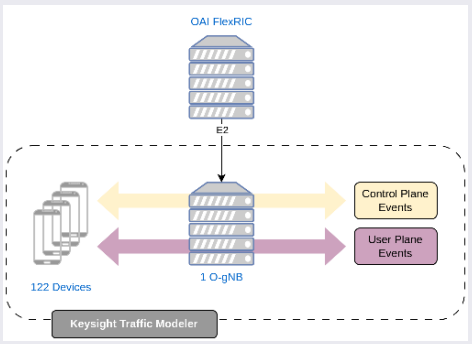
We are pleased to announce that FlexRIC 2.0 has been released. In addition to the existing multi-vendor, multi-RAT, multi-language, multi-agent, and multi-xApp features, FlexRIC has now become multi-version. Using compile-time flags and following zero-cost abstractions, you can now build FlexRIC with E2AP v1.01/2.03/3.01, O-RAN KPM v2.01/v2.03/v3.00, and RC v1.03. Furthermore, FlexRIC's nearRT-RIC has successfully undergone testing with different RAN Emulators, such as Keysight's RICtest. The E2 Agent has also been tested against other nearRT-RICs, including TIM nearRT-RIC and OSC RIC, significantly enhancing the stack's robustness in diverse events.

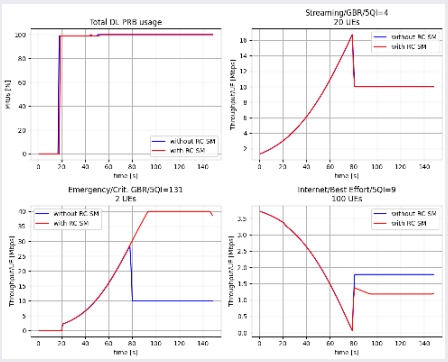
A thread pool has been added to the nearRT-RIC, notably enhancing its scalability. Lastly, the project has grown to approximately ~75 Kloc, and CTest has been integrated into the already rich testing toolbox to maintain its high-quality code base.



Demonstrating QoS Use Case Using Keysight RICtest and FlexRIC

The primary objective is to enhance the Quality of Service (QoS) in high-traffic scenarios, particularly focusing on two UEs during emergency situations with a GBR requirement of 40 Mbps. The approach involves leveraging the KPM SM Report Service, where the RIC monitors and assesses the cell's congestion and throughput for UEs categorized into distinct classes such as Streaming, Best Effort, and Critical GBR. Simultaneously, the RC SM Report Service captures and archives DRB information for all UEs. In the event that Emergency UE throughput exceeds 10 Mbps, the RC SM Control Service, facilitated by the xApp, intervenes to optimize QoS attributes. This strategic intervention ensures that critical UEs receive a guaranteed requirement of 40 Mbps. The proposed methodology, through the integration of KPM and RC SMs, provides a targeted and adaptive solution to address QoS challenges during emergencies and maintain communication integrity for critical UEs in high-traffic conditions.





O-RAN F2F Meeting in Phoenix, AZ

In this October's O-RAN face-to-face meeting in Phoenix, the team showed integration of the OAI RAN with the O-RAN Software Community's (OSC) near-RT RAN Intelligent Controller (RIC). Specifically, this demo aims at improving the Quality-of-Experience (QoE) of a user playing the online game slither.io in a 5G network through the near-RT RIC. The 5G system consists of the OAI CU and DU, connected to the OSC RIC. Because the online game is a delay-sensitive application, it is directly affected when the cell has a high load, becoming unresponsive. To overcome this issue, a custom QoE xApp is deployed over the OSC RIC. It uses the O-RAN KPM service model to monitor RAN packet delay. When the latency at the RLC surpasses a threshold, we use the RAN Control service model to create a new radio bearer, preferentially scheduling traffic of the game and improving its QoE.

O1 Demo, What is New?

We demonstrate a prototype of the O-RAN O1 interface in the OpenAirInterface (OAI) stack. We deploy the OAI 5G O-DU and O-CU together with our proposed O1 adapter. A Service Management Orchestrator (SMO) manages the O-DU via the O1 interface. The SMO is implemented through an ONAP-based non-RT RIC, which monitors and manages the O-DU component via the SDN Controller (SDNC with SDN-R feature set). In the demo scenario, if the O-DU load is high, ONAP receives an alarm notification through the O-RAN-specified Virtual Event Stream (VES) format and leverages the SDNC to reconfigure the cell bandwidth of the O-DU on the fly to provide better service to the user. Conversely, the SMO scales down the bandwidth of the O-DU when it is not needed.

OAI EVENTS

O-RAN Global PlugFest Fall 2023

In November, OpenAirInterface participated via EURECOM in the Fall O-RAN Global European PlugFest. At the end of this event, we successfully presented one test scenario done in partnership with Keysight: « Keysight RICTest interoperability over E2 interface using OAI FlexRIC demonstrating QoS use case ». The goal of the scenario was to improve QoS in high-traffic scenarios for 2 UEs in emergency situations (Crit. GBR). Using KPM SM Report Service, RIC observes the congestion of the cell, the throughput for UEs belonging to different classes, streaming/GBR, internet/Best Effort, and emergency/Crit. GBR. When we use the RC SM Report Service, the xApp investigates and stores the DRB information for all UEs. If the cell is congested and the Emergency UE throughput reaches 10 Mbps using RC SM Control Service, the xApp optimizes the QoS attributes. In this manner, critical UEs have the guaranteed resources even in the high-traffic scenario. This test scenario allows us to enhance the user's QoS based on the current resource usage. It demonstrates end-to-end near real-time RIC monitoring and control features (use of O-RAN Service Models: KPM v02.01 and RC v01.03) and makes possible the interoperability on E2 interface between Keysight RAN simulator and OAI FlexRIC stack.

MWC Las Vegas 2023

In August, we participated in the Mobile World Congress Las Vegas as an O-RAN virtual booth. The demonstration proposed is «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 implement the end-to-end cellular network employing OAI CN, OAI CU, OAI DU, and FlexRIC—an O-RAN-compliant nearT-RIC. Our initiative involves initiating the online game slither.io, an application sensitive to latency, and subsequently generating resource-intensive flows through iperf3, all sharing the same radio bearer. The game experiences unresponsiveness as packets are treated uniformly, leading to a significant decline in Quality of Experience (QoE). To address this challenge, we leverage the capabilities of the near-RT-RIC and an associated application. Utilizing KPM SM, we monitor the packet sojourn time within the default radio bearer. When the latency in the RLC buffer exceeds the threshold, we employ RC SM to govern the E2 nodes, thereby establishing a new radio bearer. This strategic approach ensures traffic flows from distinct applications (such as greedy and time-sensitive) traverse separate radio bearers, ultimately enhancing the QoE.

Joint OSC/OSFG-OAI Workshop

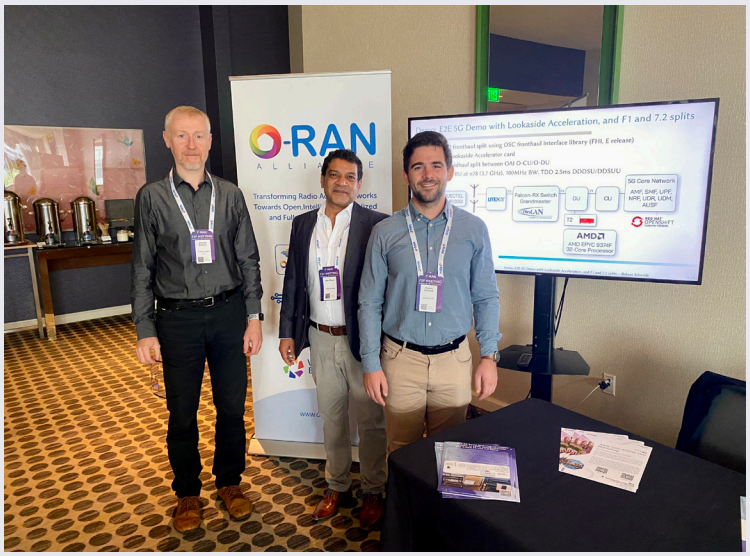
We are excited to share the success of the Joint OSC/OSFG-OAI workshop: End-to-End Reference Designs for O-RAN, held in collaboration with the Institute for the Wireless Internet of Things and the Open6G Center at Northeastern University Innovation Campus, Burlington, MA, on November of this year.

The O-RAN Software Community (OSC) and the OpenAirInterface Software Alliance (OSA) embarked on a dynamic collaboration, generously supported by the O-RAN Open Source Focus Group (OSFG). Together, we aim to unveil end-to-end showcases of the O-RAN architecture, leveraging open source components developed by our communities. The workshop showcased recent advancements and served as a platform to explore ways to strengthen collaboration further. Discussions revolved around the seamless sharing of code between OSC and OSA, and the establishment of a robust methodology for maintaining continuously integrated, delivered, and tested O-RAN reference designs.

O-RAN F2F Meeting in Phoenix, AZ

In October, we attended the O-RAN face-to-face (F2F) meeting in Phoenix, AZ, United States. On this occasion, we presented three demos in the main hall of the event. These demos are based on the latest OAI work and integrate code components from OSC and OAI. The demo titles are:

1) End-to-End 5G Demo featuring Lookaside Acceleration of LDPC Encode/Decode and O-RAN F1 and 7.2 Splits
2) Improving QoE using OSC nearRT-RIC and OAI 5G RAN, leveraging O-RAN E2 KPM and RC SMs
3) 5G RAN Management through an SMO/non-RT RIC via the O1 Interface



Participate in the OAI Meetings:

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