OpenAirInterface (OAI): A flexible open-source 4G/5G SDR Platform

Giovanni Rigazzi
Andrea Tassi

Summary

- Introduction
- Popular SDR platforms
- OAI Software and Hardware platforms
- 5G experimentations
- Next steps
- Demo: multimedia streaming over OAI LTE

OAI Software Alliance

OAI = open source 3GPP radio systems (EUTRAN + EPC)

Harmonising **two key objectives**:

1. Bringing academia <u>closer to complex real-world systems</u>
2. Designing <u>open-source tools</u> to develop a common R&D framework for rapid PoC designs

Launched in **2014** and joined by major industrial players (Alcatel-Lucent, Orange) in **2015**

SDR platforms

- **SORA**: hybrid SDR platform , partially open-source, supports 802.11 a/b/g/n 4x4 MIMO, no interoperability with COTS, cost $8000
- **WARP**: programmable SDR platform supporting 802.11, capable of operating with COTS WiFi devices, cost $6000
- **OpenLTE**: open-source 3GPP LTE implementation (GNU Radio + USRP), signal processed offline via Octave, limited developer community, cost $2000
- **LTEENB**: commercialised by Amarisoft, support LTE rel. 8 with FDD and core network emulation, cost $2,000
- **Nutaq PicoSDR**: MIMO waveform development platform for communications between 300 MHz and 3.8 GHz, cost $11000
- **NI LabView + USRP RIO**: FPGA-based SDR with IEEE 802.11 and LTE application frameworks, cost £20,000

OAI platform

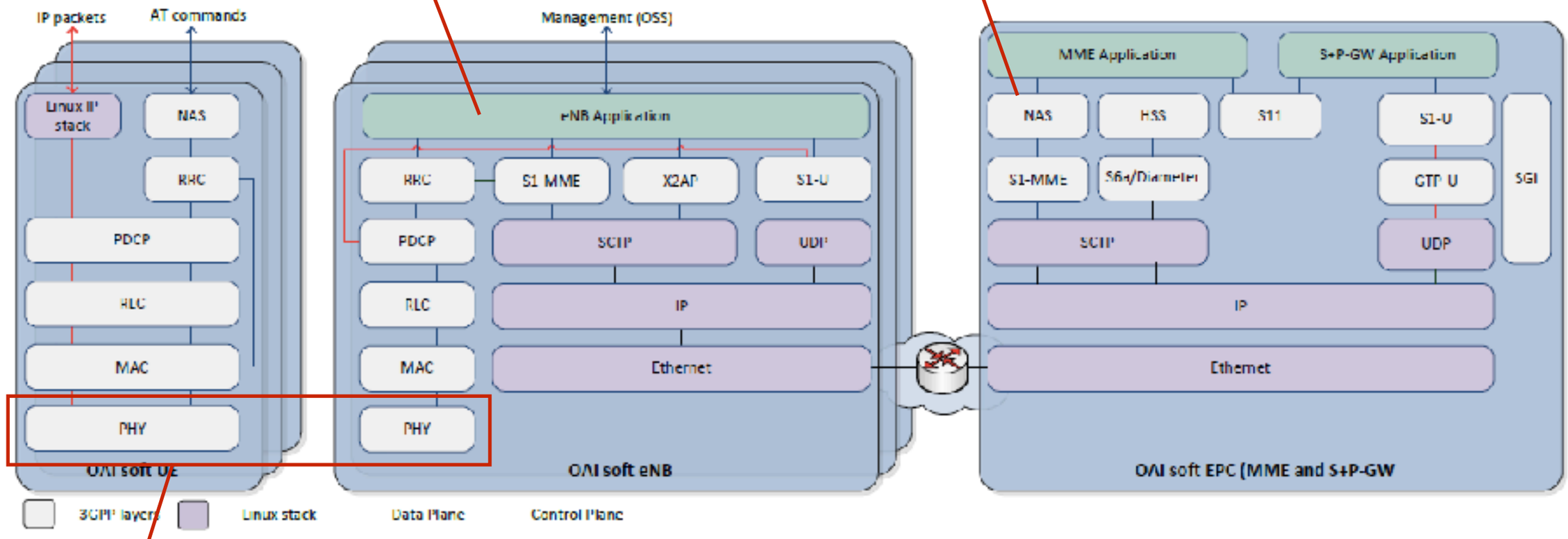
- **Flexible** platform for an open LTE ecosystem
- Typical emulator set-up: **base station** (OAI eNB), **terminal** (OAI UE) and **core network** (OAI EPC)
- Transceiver functionality achieved via a **SW radio front-end** connected to a host computer for processing
- Written in **standard C** and optimised for different **real-time Linux platforms** and **architectures** (Intel x86 and ARM)
- Comes with a collection of **bult-in tools**, including soft monitoring (softscope) and debugging tools, protocol analyser, performance profiler, etc.

SW Platform

Channel-aware proportional scheduling
Fully-reconfigurable protocol stack
Integrity check and encryption
IPv4 and IPv6 support

NAS integrity and encryption using AES and Snow3G algorithms

UE procedures handling: attach, authentication, service access, radio bearer establishment



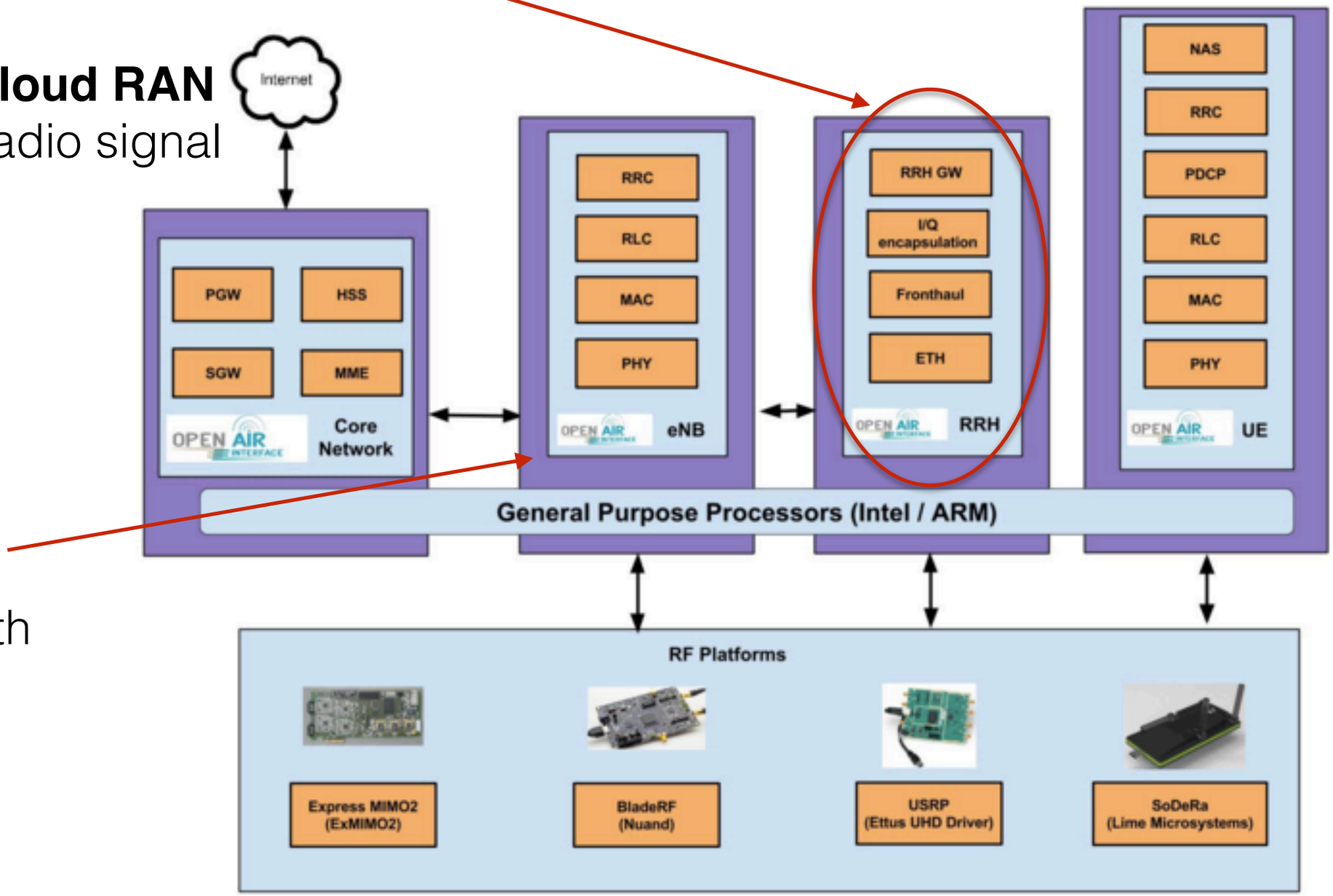
LTE Rel 8 compliant + subset of Rel 10, FDD/TDD in 5,10, 20 MHs, TX mode
SISO and MIMO 2x2, all DL/UL channels supported, HARQ
Highly optimised base-band processing (including a turbo decoder)

HW Platform

OAI Remote Radio Head

- Passive server of I/Q samples waiting for incoming BBU client connections
- **Enabler for cloud RAN**
- Transport of radio signal over Ethernet

The eNB is a client able to initiate a connection with the RRH



Multiple configurations

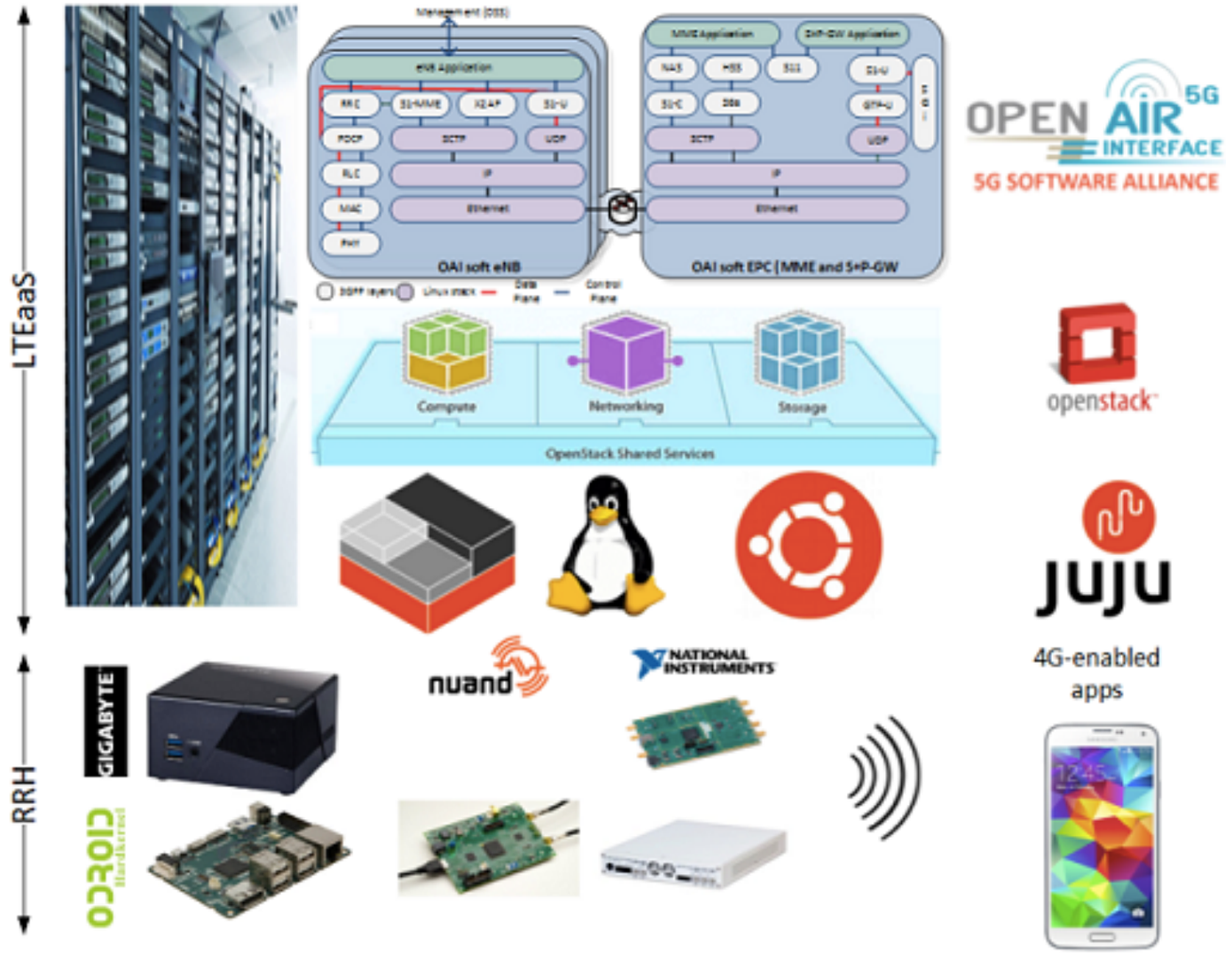
- COTS UE ↔ COTS eNB + OAI EPC
- COTS UE ↔ OAI eNB + COTS EPC
- COTS UE ↔ OAI eNB + OAI EPC
- OAI UE ↔ OAI eNB + OAI EPC
- OAI UE ↔ OAI eNB + COTS EPC
- OAI UE ↔ COTS eNB + COTS EPC

Successful tests with COTS UEs (Huawei E392, E398u-1, Bandrich 500), test equipments (CMW500) and commercial EPC (Ericsson)

5G experimentation

Softwarisation of Networks

- Cloud-native 5G networks
- Network Orchestration (OpenStack, Juju)
- Network programmability (slicing)



What's in the works?

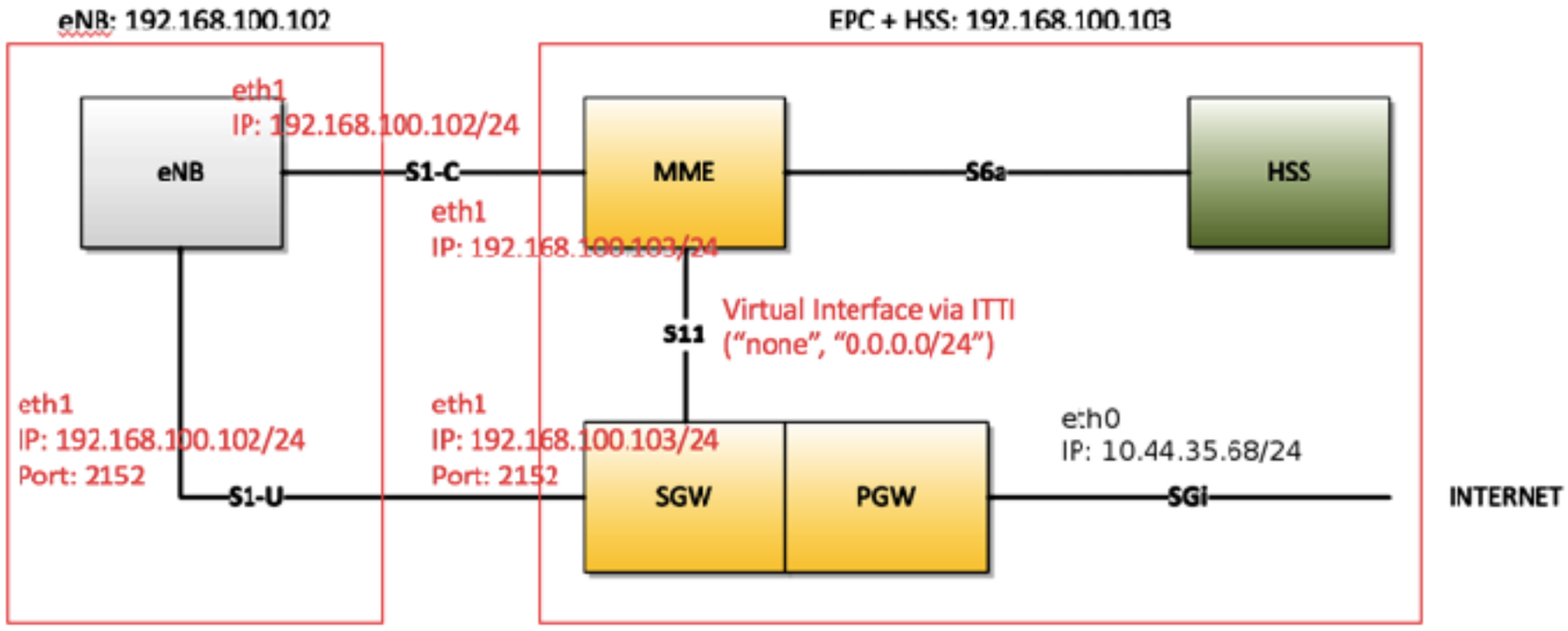
- Charting a path 4G to 5G via **open-source policy**
  - Working with **new carrier candidates**, short-packet low-latency carriers, contention-based access
  - **VRAN, NFV, MEC** architectures
    - Rapidly deployable EPC/eNB
- Ready-to-use on **commodity hardware** (Eurecom ExpressMIMO2, NI/Ettus USRP, …)
- **Multi-architecture support**: x86, ARM, NXP (Freescale)
- Enhancing current 4G implementation (CA, handover, …)
- Separation of EPC elements for **cloud deployment**
- **New entities**: eRRH (Ethernet-based remote radio heads), cloudification of RAN and EPC

References

- http://www.openairinterface.org/
- OAI Gitlab server:
    - https://gitlab.eurecom.fr/oai/openairinterface5g (eNB and UE)
    - https://gitlab.eurecom.fr/oai/openair-cn (EPC)
- Mailing list
    - openair5g-user@lists.eurecom.fr
    - openair5g-devel@lists.eurecom.fr
    - openaircn-user@lists.eurecom.fr
    - openaircn-devel@lists.eurecom.fr

OAI LTE Testbed Setup

- **UE USIM card configuration**
  - Programmable USIM card + USIM card reader + USIM programmer SW (e.g., PySIM)
  - Relevant info needed (operator key, tracking area code, IMSI, etc.)
- **Optimised Ubuntu kernel settings**
  - disable C-state from BIOS
  - disable CPU frequency scaling
  - install low-latency kernel
- **Calibration of UE and eNB**
  - Attenuation set to get UE RX power between -75 and -95 dBm



OAI LTE Testbed Setup

OAI EPC

VLC media server

ubuntu

Low-latency kernel

Ethernet

OAI eNB

USB

OPEN AIR INTERFACE

USRP B210

Intel Mini-PC NUC
Core i7-6770HQ

RF cables coupled with 40 dB attenuators

COTS UE

VLC media client