Evolution of OAI Software for Data Center Deployments

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EURECOM

Unleashing the potential of open-source in the 5G arena
Background

- 3GPP access network is evolving towards a 3-tier network
  - CU => DU => RRU
  - CU is envisaged to cover an area of 100-200 km radius
  - DU is envisaged to cover an area of 10-20 km radius
  - RRU covers < 2km radius

- DU will be a data center for **centralized radio signal processing**

- Indoor networks (DAS)
Considered RAN Splits in 3GPP evolution

- **Fronthaul/Midhaul**
  - Low latency FH
  - High latency FH

Evolution of Telecom and Open-Source
Indoor/outdoor

IWF

5G Layer 2

5G Layer 1

Outdoor Layer 1 fronthaul
(high-speed, low latency)

Radio cloud in
Central office with
Indoor/outdoor IWF

Indoor-outdoor
mobility

Local breakout Data-center
and DAS

Indoor Layer 2 fronthaul to
Public network
(medium speed, medium latency)
Indoor Data Center

Layer 2 fronthaul to public networks

MEC

Indoor Data Center

Indoor break-out virtualized network

DU L1

Layer 2

Radio access unit with L1 functional split

op3

op2

op1

Indoor 802.11x remote radio unit with L2 interconnect

Indoor remote radio unit with L1 functional split

DU L1

RRU 4G/5G

RRU 4G/5G

RRU 4G/5G

RRU 4G/5G

RRU 802.11x

RRU 802.11x

RRU 802.11x

Op1

Op2

Op3
How OAI is evolving to address this

- Until now isolated “monolithic” elements
  - EPC (MME,HSS,S+PGW)
  - eNB
  - UE

- Now infrastructure components prepared for data-center deployments
  - vEPC (OpenStack, Docker, KVM)
  - Radio Cloud Center (RCC) (RRC,PDCP), virtualizable
  - Radio-Access Unit (RAU) (RLC/MAC,L1-high), virtualizable but better as PNF
  - RRU (L1-low), PNF

- RAU can be in the same data-center as RCC (e.g. for indoor)

- All components under control of global orchestrator

- Main contributors/users in this effort
  - Nokia Bell Labs (software architecture, fronthaul interfaces, testing)
  - Cisco UK (small-cell forum compatibility)
  - Fujitsu Labs Tokyo (expected contributions on LTE RAN)
  - Facebook/Radisys (vEPC component)
  - III (RCC/RRU testing)
  - BCOM (vEPC component, NB-IoT RAN components)
  - NTUST (NB-IoT RAN components)
  - Several 5GPP projects and their users in the community (e.g. TIM)
Current vRAN Roadmap (partially done for LTE)

OAI Functional Splits

OSS/BSS/MEC

Radio-Cloud Center (RCC)  Radio-Access Unit (RAU)  Remote Radio-Unit (RRU)
NGFI splits

Current OAI implementation (RRU/RAU/RCC) supports either
- IF5 time-domain fronthaul (> 1 GbE required)
- IF4.5 split (FFTs) (280 Mbit/s/antenna port fronthaul – 20 MHz carrier) per carrier/sector

Under development
- IF2 via NFAPI
- IF1’ for CU-DU soon
RRU/RAU

- OAI current lower-layer functional split
  - a network of radio units (L1-low)
  - a precoding function and switching function
  - Regular (virtualized) eNB functions

Example: RAU with NGFI_IF1pp xhaul (MACPHY split) northbound, NGFI_IF4p5 fronthaul southbound, 2 vCell logical interfaces (2 L1/L2 instances, or 1 L2 instance and 2 CCs), 4 RRU with NGFI_IF4p5
Splits under construction in OAI Community

- vEPC
- MEC
- RRC
- PDCP
- LTE-RLC
- LTE-MAC
- LTE-L1H
- RAU
- RCC

Network Protocols:
- IF1'/UDP or raw
- IF1'/UDP or raw (Nokia)
- IF2/UDP or raw (N-FAP – Cisco)
- IF4.5/UDP or raw

- 802.11 MAC PHY
- LTE-RLC
- LTE-MAC
- precoder
- RRU

(Radio Access Unit (vCell Precoder))

(Nokia)
EURECOM Deployment (1 outdoor RRH)
A bit on synchronization

- PTPv2 grandmaster in RAU
- PTPv2 clients in distribution switches to regenerate 10 MHz (PPS if needed) from GPS source behind RAU
- Distribution of 10 MHz to RRU
- Over-the-air (TDD) between RRU for frame synch
- Note in a commercial solution, PTPv2 would go all the way to the RRU and clock synchronization would be rederived in each RRU
  - No off-the-shelf solution for everyday users
RRU – Bill of Materials

- **SISO (20 MHz, 1GbE Fronthaul)**
  - UPBoard (100$)
  - USRPB200-mini (500$ in quantities)
  - PA/LNA/Switch (100$)
  - PoE+ module (50$) => 750$

- **2x2 (20 MHz, 2 GbE Fronthaul)**
  - UpBoard2 (200$)
  - LimeSDR (300$ in quantities)
  - PA/LNA/Switch (200$)
  - PoE+ modules (100$) => 800$
Prototype RRU
Indoor/Outdoor Deployment at EURECOM (Jan. 2017)
Projected SophiaTech Campus Deployment

- **Collaboration around OAI technologies on SophiaTech Campus**
  - EURECOM (Open5GLab) + INRIA (R2Lab)

- **Showcase**
  - Centralized RAN and MEC
    - Antenna processing
    - RAN slicing
    - Indoor-outdoor coordination
    - RAN/CN Orchestration
    - Multi-tenancy
  - Optical/wireless technologies
  - 2.6/3.5 GHz TDD
  - eMBB and eMTC
  - 802.11 convergence
Conclusions

We want people to take this, experiment and enrich in a community-driven effort

- Contribute to the software
- Replicate the hardware
- Integrate with other hardware
- Use for PoC demonstrators (5GPPP and other project programs)