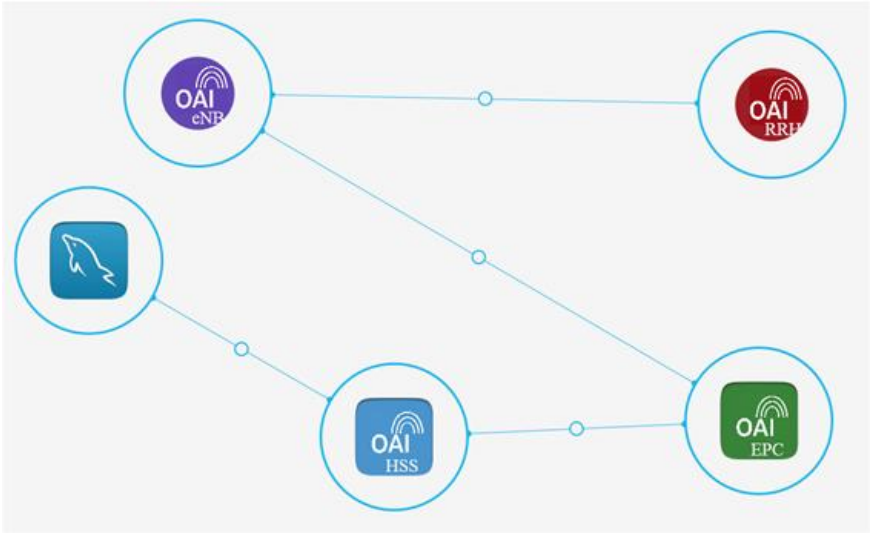
EURECOM

Sophia Antipolis

OPEN AIR INTERFACE



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EURECOM, Communication System Department

Agenda

- **Intro to OAI Alliance -> Raymond (5 mins)**
- **OAI Initiatives on Next Gen Fronthaul - > Raymond (10 mins)**
- **OAI Initiatives on NFV/SDN - > Navid (10 mins)**

A bit about EURECOM and OAI Software Alliance

- **EURECOM is a private non-profit research center in Sophia Antipolis France**
- **Launched the OpenAirInterface software Alliance in 2014 to foster innovation and collaboration in air interface technologies**
  - RAN : open-source 3GPP LTE (Rel 11) implementation, evolution towards 5G when specified
  - CN : open-source LTE Enhanced Packet Core (EPC)
  - Deployable on generic PC and ARM architectures with off-the-shelf (e.g. National Instruments/Ettus RF hardware) and commercially-deployable RF solutions
- **Research / Industry collaboration through open-source**
  - PoC demonstrators for architectural exploration phase of 5G

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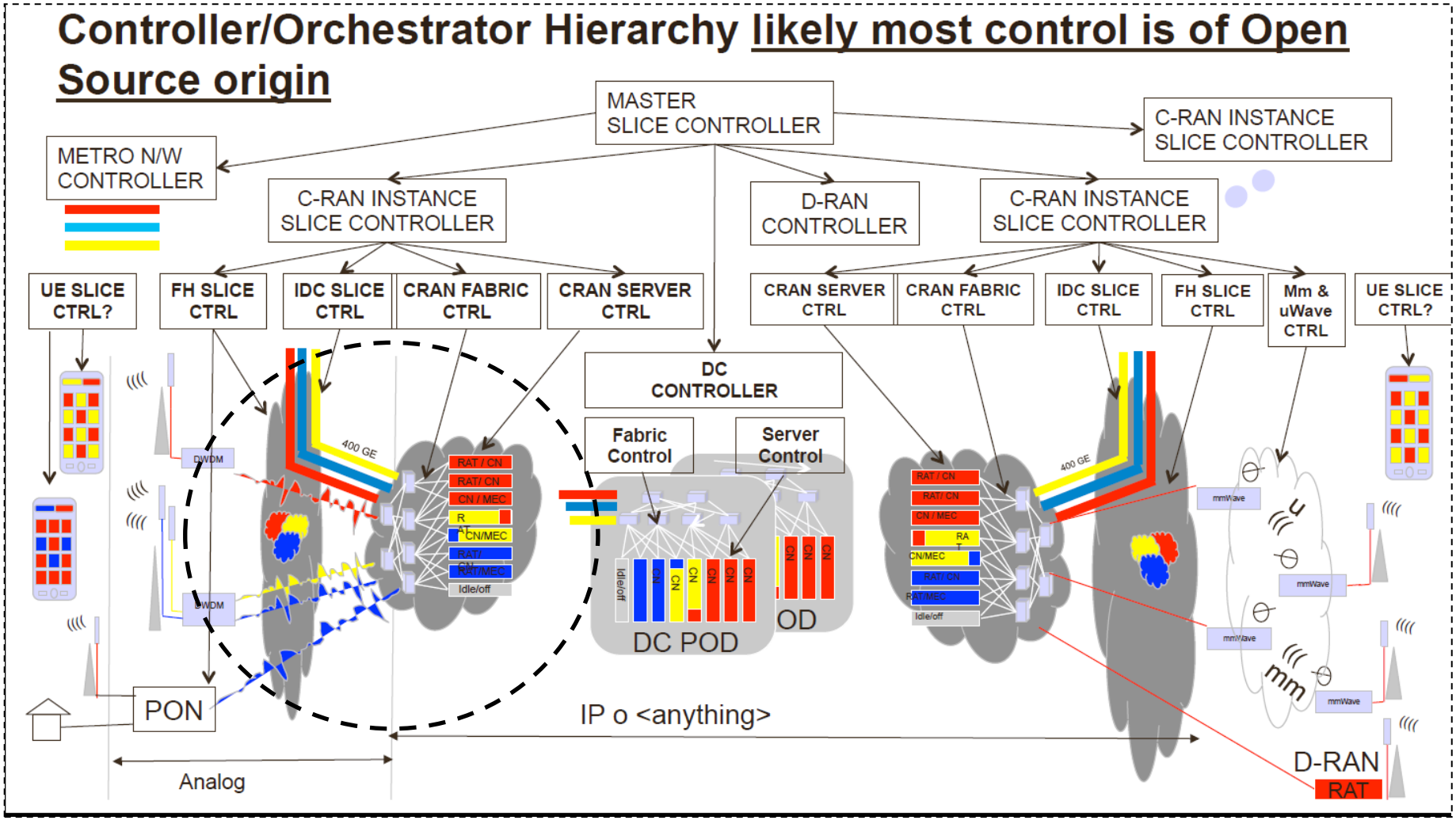
OpenAirInterface Software Alliance Project 4

- **Short-term goal: “Manual” for up to 50 RRUs and BBU pool**
  - align with ITU/NGFI/3GPP architectures for fixed network and data center RAN/CORE
- **Replication of this test network globally to carry out PoCs / Research in the following areas:**
  - Network Slicing
  - Study split of PHY – RRH (IEEE NGFI P1914.x, NGMN, specs)
  - Interface with commercial RRHs over CPRI
  - Orchestration of BBU pool in Intel/ARM based cluster using automated virtualization tools
  - Address real-time, HW abstraction issues when running future RAN in containers and KVM.
  - Work closely with other open source groups (OSM, JuJu, OpenStack, OpNFV and ONOS)
  - make it replicable (open-access to technology) and based on current OAI RAN and EPC
    - Interoperable with
      - COTS UEs
      - Commercial EPC
  - Evolve towards 5G as 3GPP progresses (below 6 GHz access)
  - Generic cloud computing equipment (**Intel/ARM**)
  - 100% open-source

Reference Platform for 3GPP/IEEE/ETSI/NGMN Based on Open Source tools (OAI + others) + Proprietary HW/SW IP Blocks

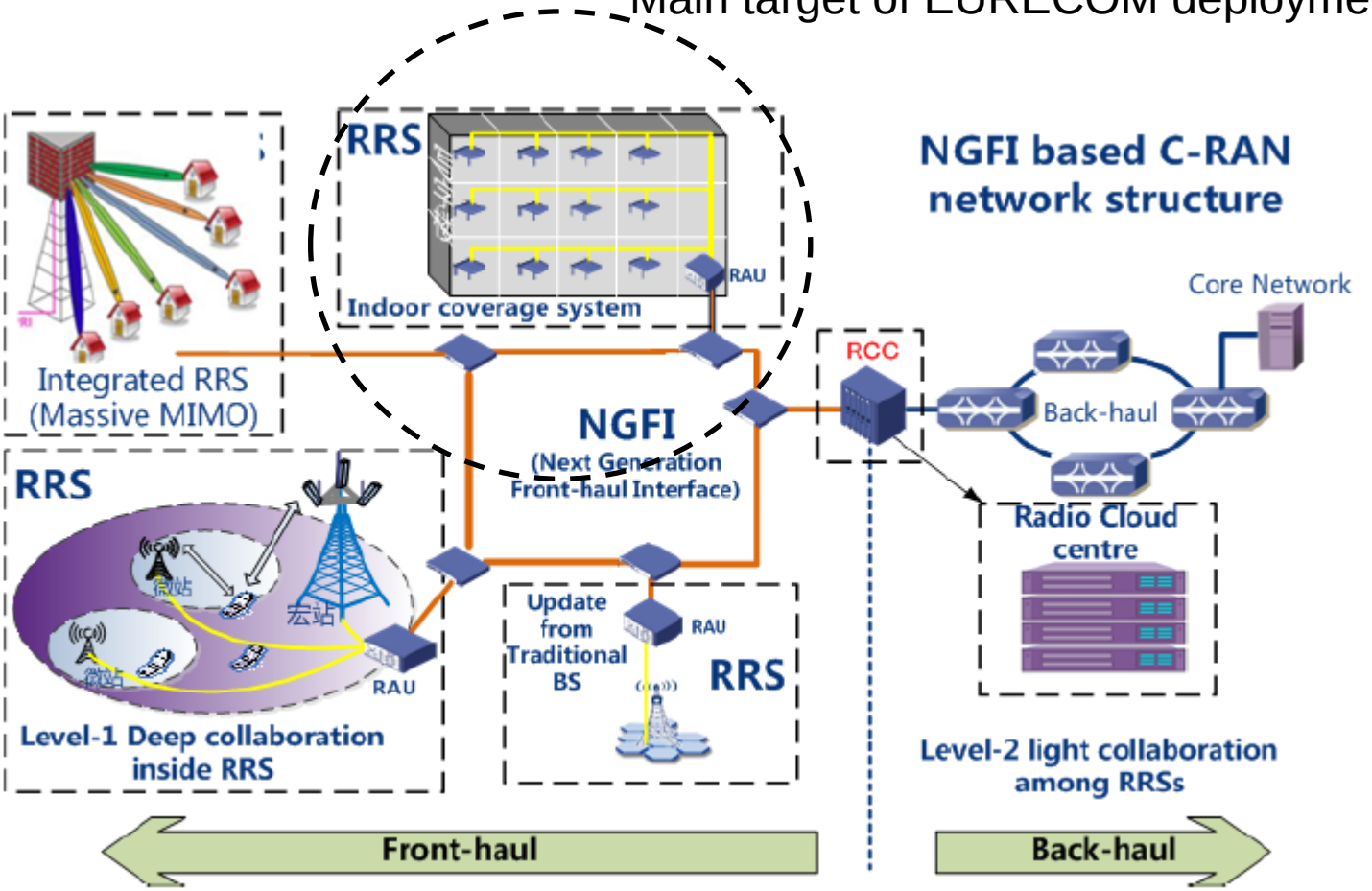
ITU IMT2020 FG Vision



Source: https://www.itu.int/en/ITU-T/Workshops-and-Seminars/itu-ngmn/Documents/Abstracts_and_Presentations/Peter-Ashwood-Smithv2.pdf

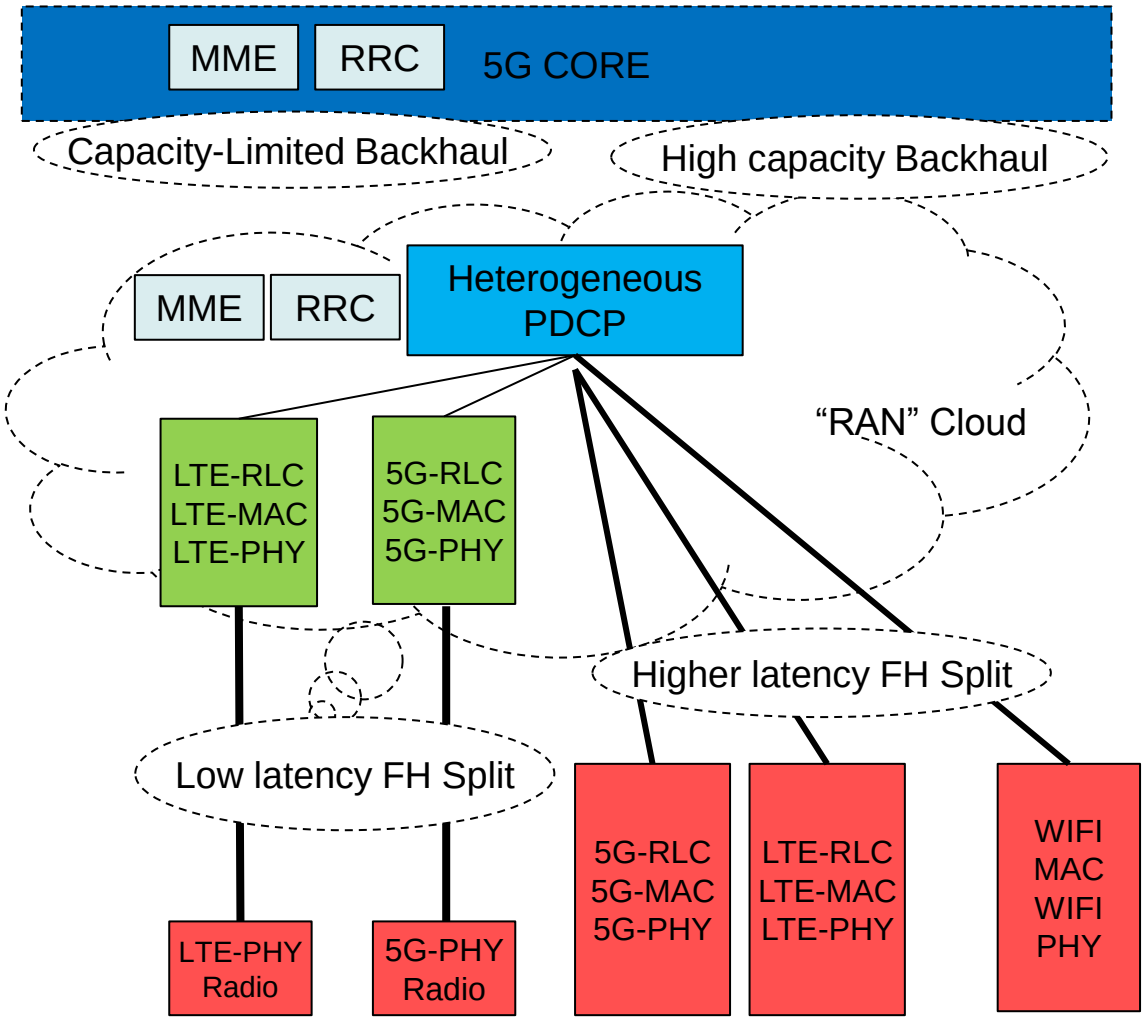
NGFI – Fronthaul Vision

Main target of EURECOM deployment



Considered RAN Splits in 3GPP evolution

- **Fronthaul**
  - Lowlatency FH
  - Highlatency FH



NGFI fronthaul splits today in OAI

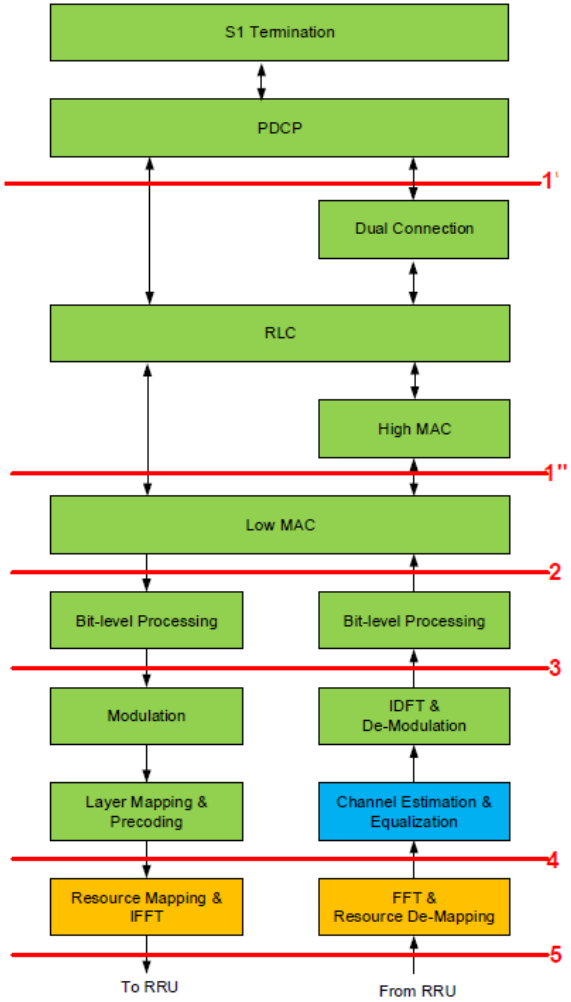
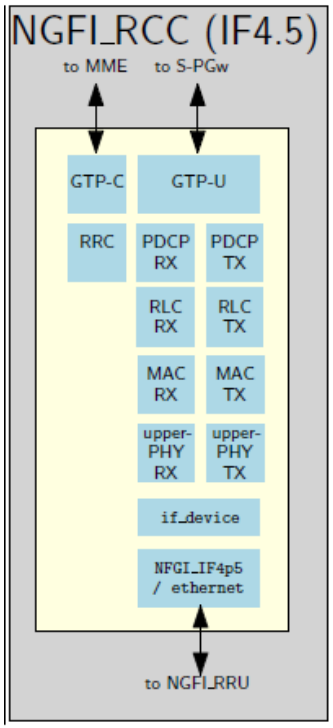
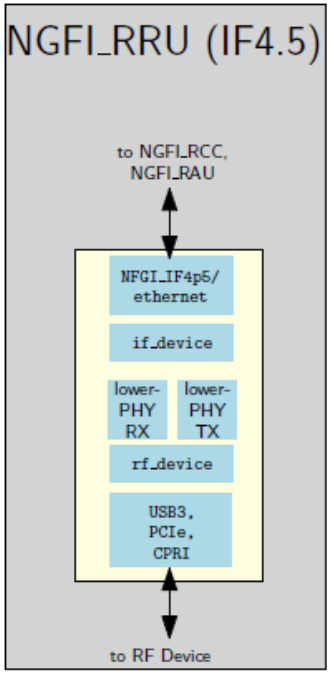


Figure 3-1: Division Plans for the RCC-RRS Interface

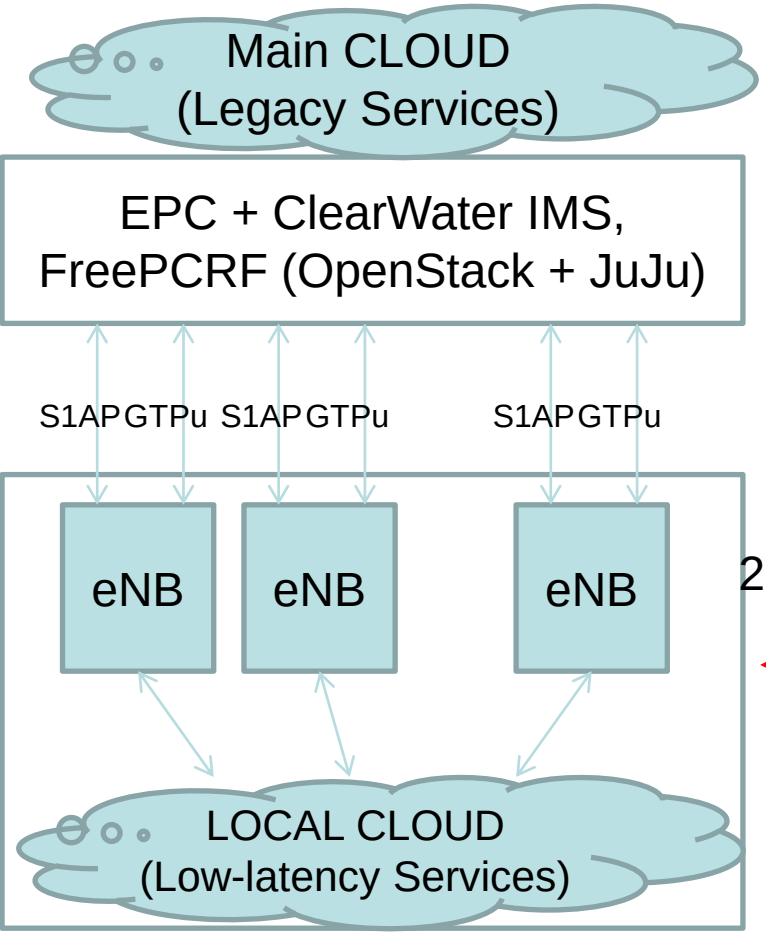
Current OAI implementation (RRU/RCC) supports either

- 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
  - mixed IF1" / IF4.5
  - IF1' for "super-PDCP"



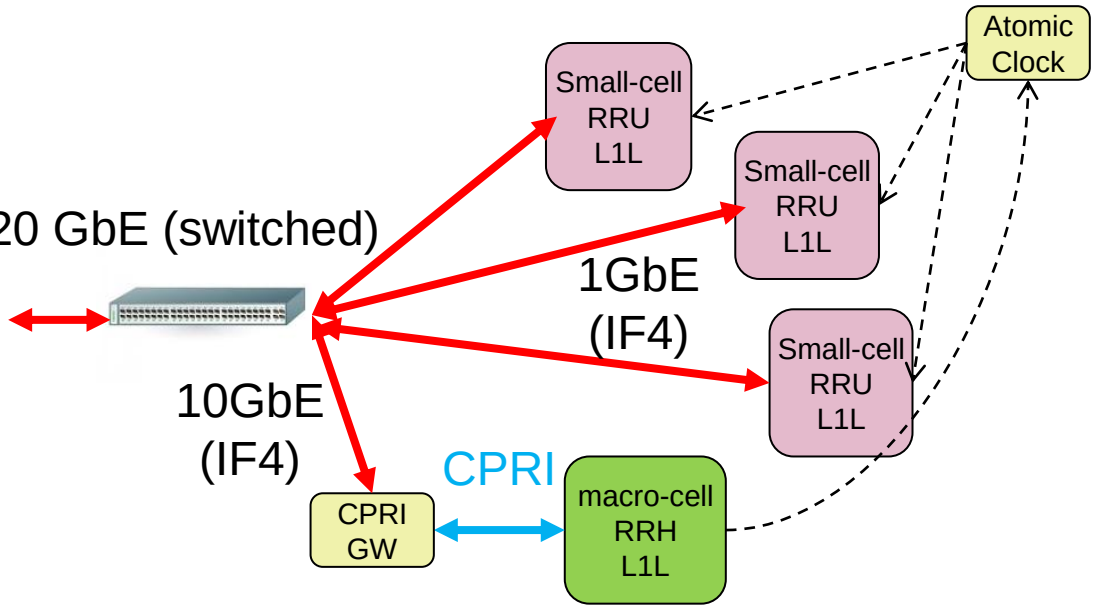


EURECOM RRH to Datacenter Architecture



Some issues

- Distributed computation
- Cheap synchronization
- Loosening of control/user-plane coupling
- Real-time I/Q over Eth links (copper, low-cost fiber)



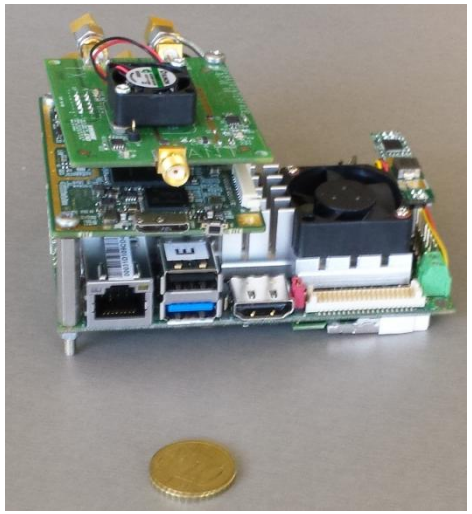
CRAN Equipment

- **Deployment of CRAN playground at EURECOM**
  - 50 Low cost RRU
  - Dense servers x86-64 Xeon (today)
  - Optical (10/20/100 GbE) and copper (1 Gbe) distribution

RCC/RAU (COTS Intel Server Technology)

Example Radio Cloud Processing units

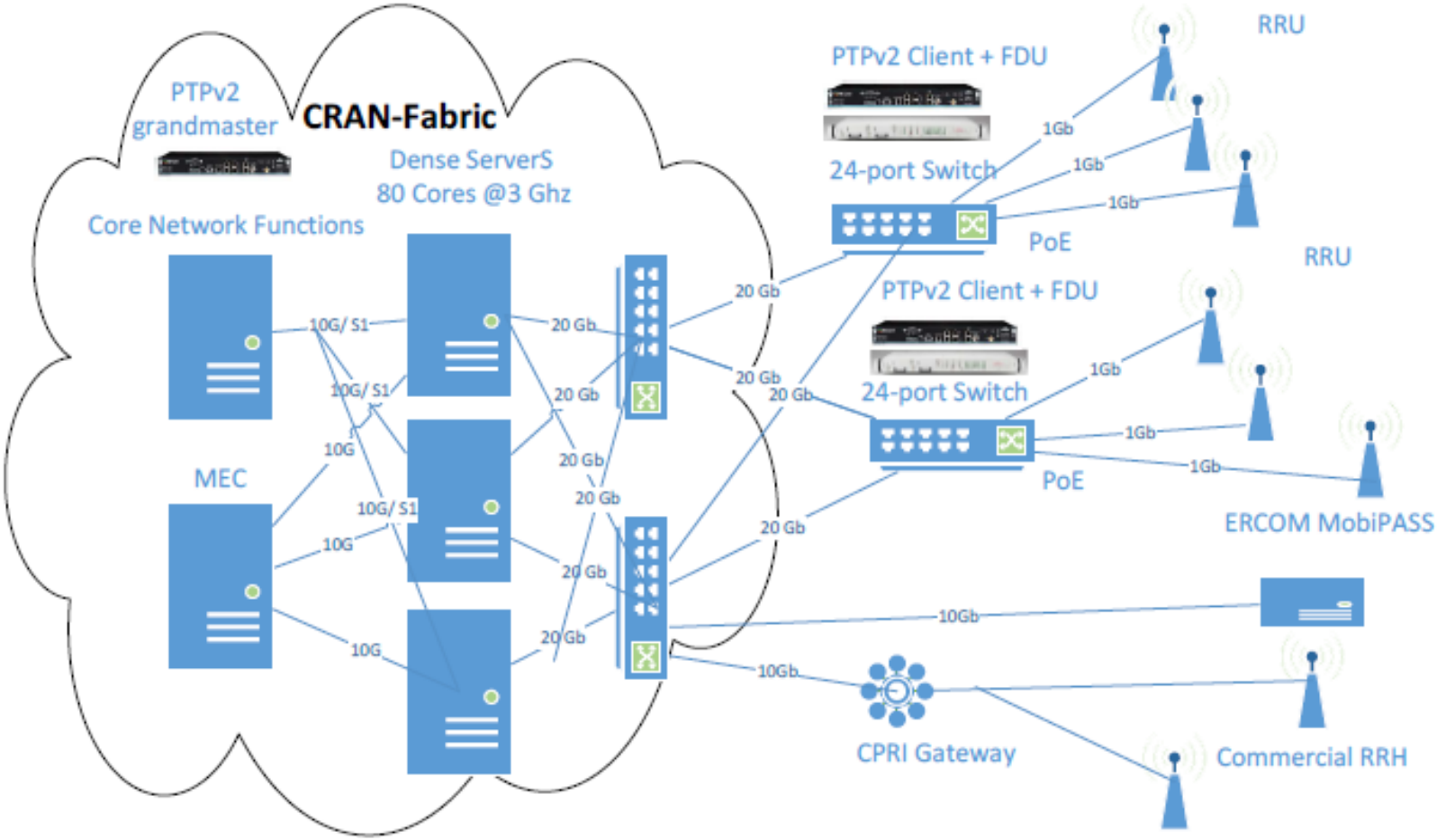
RRU



RRUs (Experimental)

- **Band 7(FDD),38 (TDD),42/43 (TDD)**
  - Up to 25 dBm output
  - 20 MHz BW
  - 1 or 2 antennas per RRU
  - <1000 euros / RRU
- **Pico-ITX form factor (100mm x 72 mm)**
  - Intel Atom E3845 or X7-8300, <10W TDP
  - PoE from aggregation switch
  - 10 MHz reference from clock distribution at aggregation switch
  - 1GbE front-haul per RRU
    - MIMO/MU-MIMO done via multiple RRU

Targetted Indoor deployment (1 outdoor RRH)



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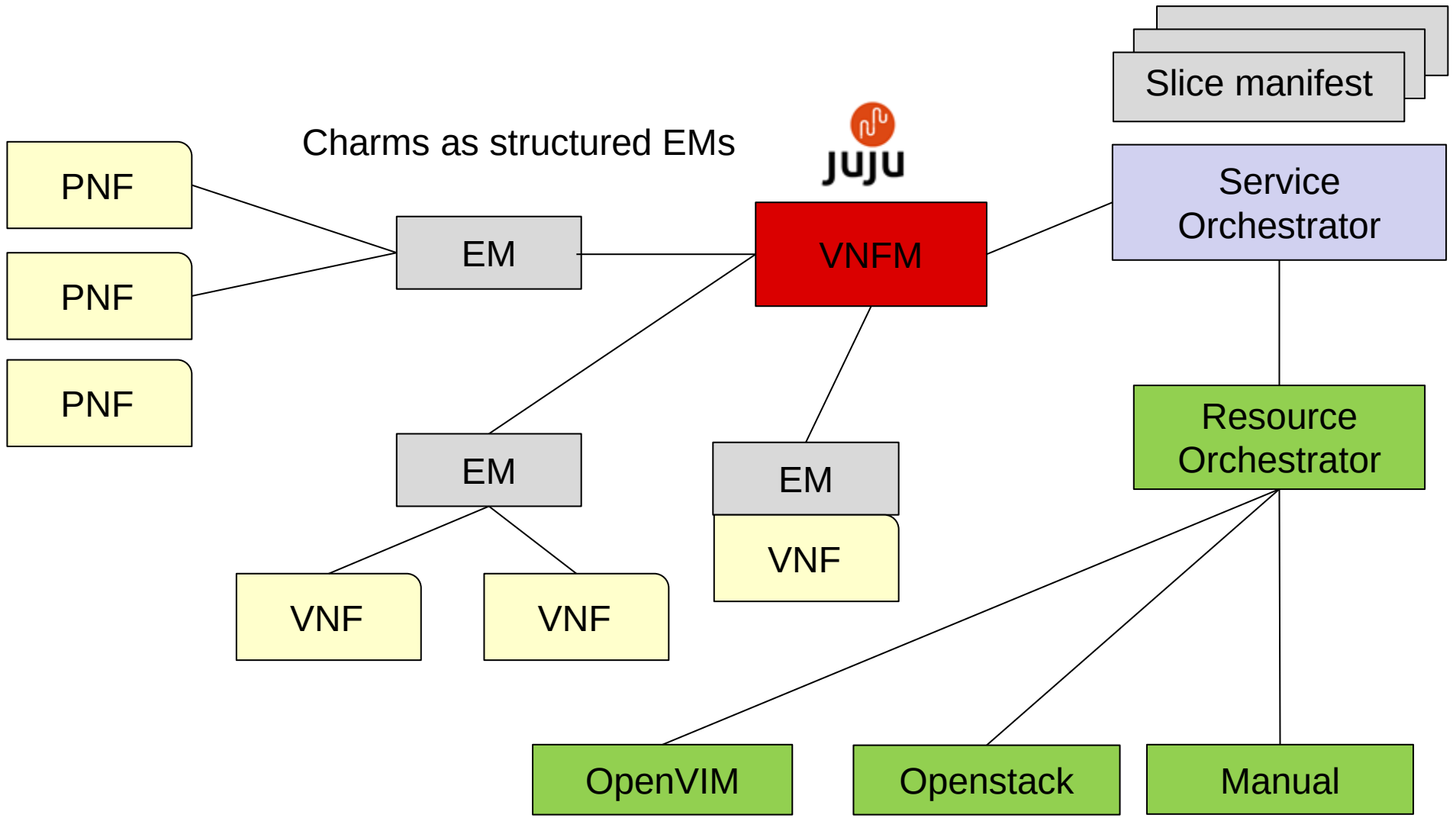
NFV and OSM


Slice manifest
Charms as structured EMs
juju
PNF
PNF
PNF
EM
VNFM
Service Orchestrator
EM
EM
Resource Orchestrator
VNF
VNF
VNF
OpenVIM
Openstack
Manual

Service level modeling

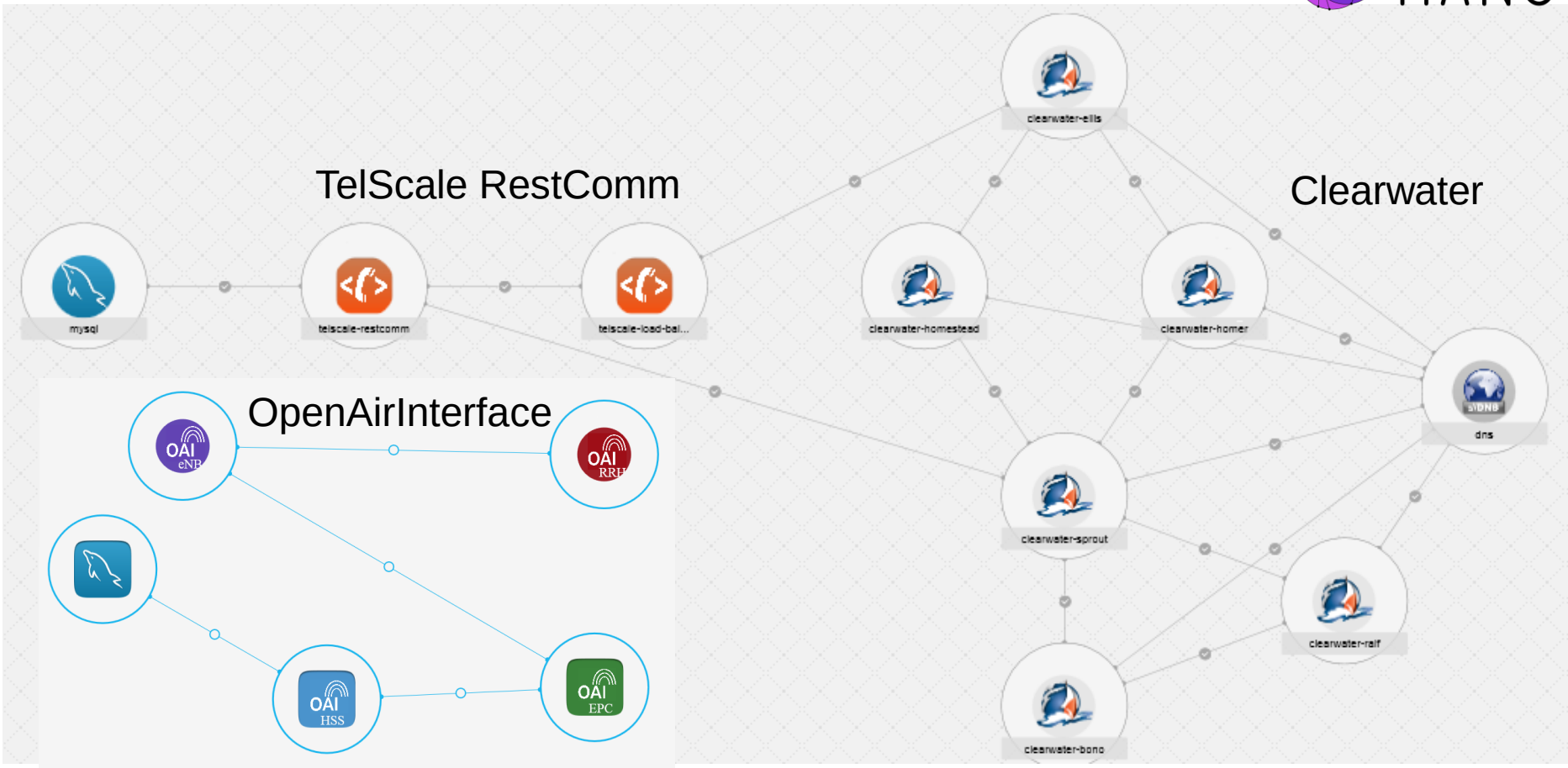
- **Requirements for modeling**
  - design an abstract network slice for a particular use-case
  - Identify the data models and interfaces across the network functions
  - Standardize reference network slice templates
    - capex/opex considerations

- **Service layer encapsulates**
  - VNF image and descriptor
  - Configuration
  - Connection points
  - Two distinct lifecycles
    - Service
    - Relationships
  - Health and monitoring parameters
  - Resources and constraints
  - Upgrade

- **Service template defines**
  - Service descriptor
  - Input Parameters
  - Configuration primitives
  - Relationships/dependencies
  - Resources and constraints
  - Units (number of instances)
  - Machine (physical or virtual)

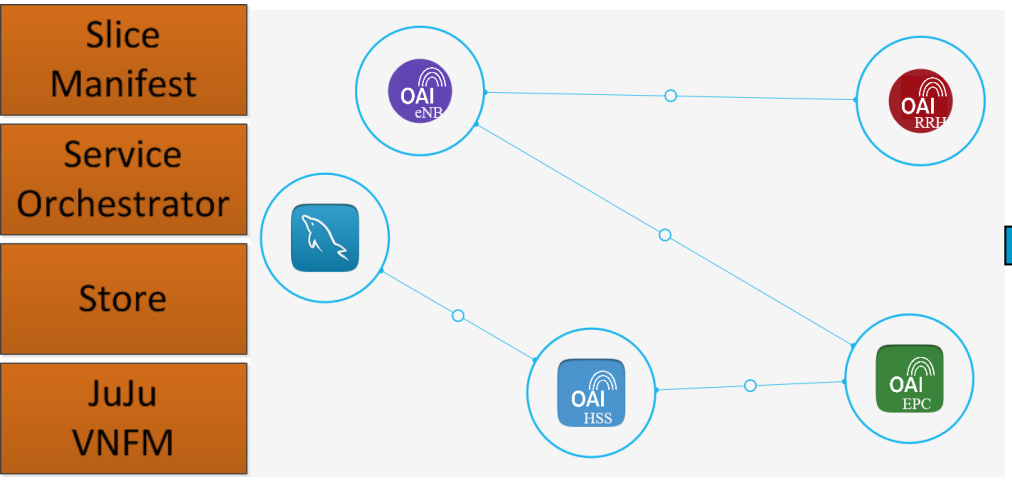
Rapid Service Chaining

Open Source MANO



- **rapidly build voice, video, WebRTC, USSD, SMS, fax and rich messaging applications over LTE**

Service modelling and template definition

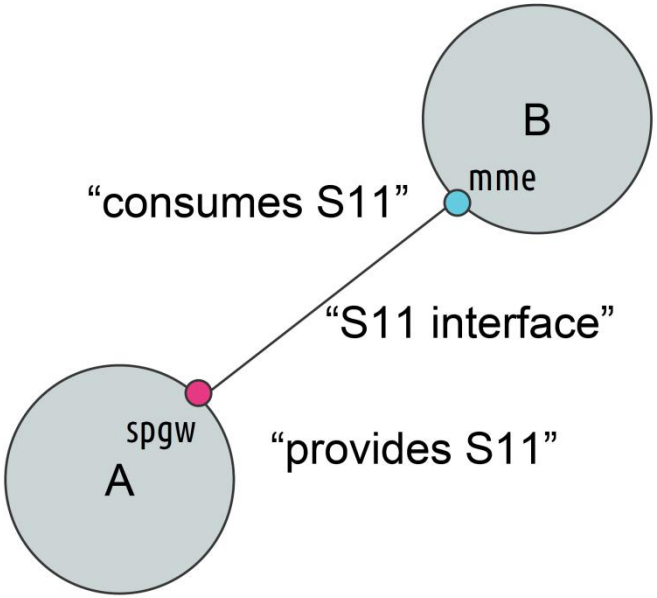


series: trusty
services:
"**oai-enb**":
charm: "cs:~navid-nikaein/trusty/oai-enb-14"
num_units: 1
options:
N_RB_DL: 50
downlink_frequency: 2680000000L
eutra_band: 7
rrh_active: "yes"
uplink_frequency_offset: "-120000000"
to:
- "0"
"oai-epc":
charm: "cs:~navid-nikaein/trusty/oai-epc-22"
num_units: 1
annotations:
"gui-x": "353"
"gui-y": "267"
to:
- "kvm:oai-dnb/0"
relations:
- - "oai-enb:epc"
- "oai-epc:epc"
- - "oai-hss:db"
- "mysql:db"
- - "oai-epc:hss"
- "oai-hss:hss"
machines:
"0":
series: trusty
constraints: "arch=amd64 cpu-cores=4 mem=15951 root-disk=8192"

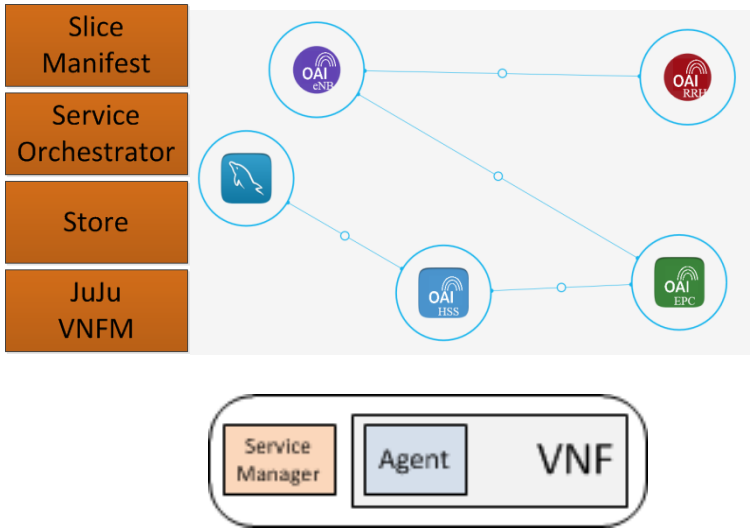
- **Template defines the slice manifest**
- **Orchestrator logic applied through a EM able to change the service template definition on the fly**
  - Reliability and scalability (scale in/out)
- **Charms as structured element manager to drive the app lifecycle**
- **JUJU is a generic VNFM**

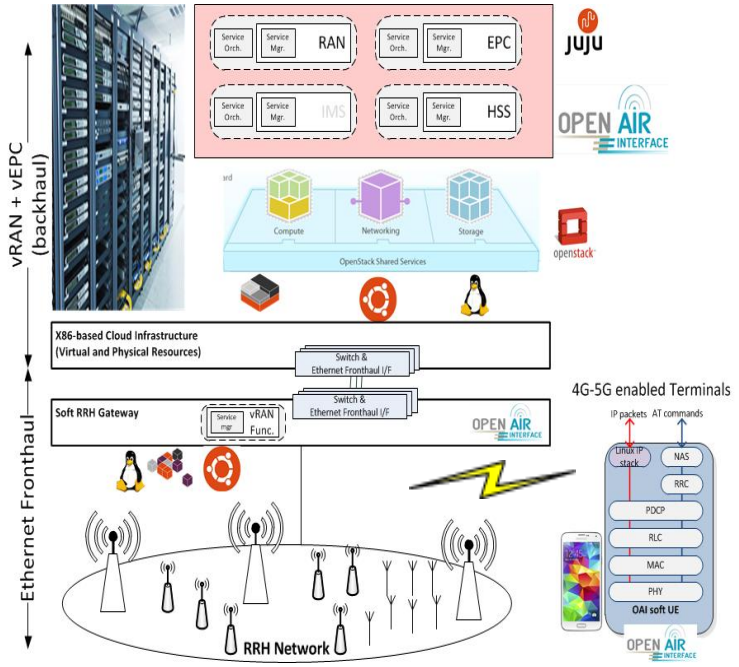
Applications? Units? Charms ?

- **Application is spanning across a set of machines**
- **There are two units of this app with their respective configuration file**
- **Charm acts a structured EM driven by juju**
  - Lifecycle
  - Scale
  - Integration
  - configuration



Deployed CRAN NFV Service Template Juju



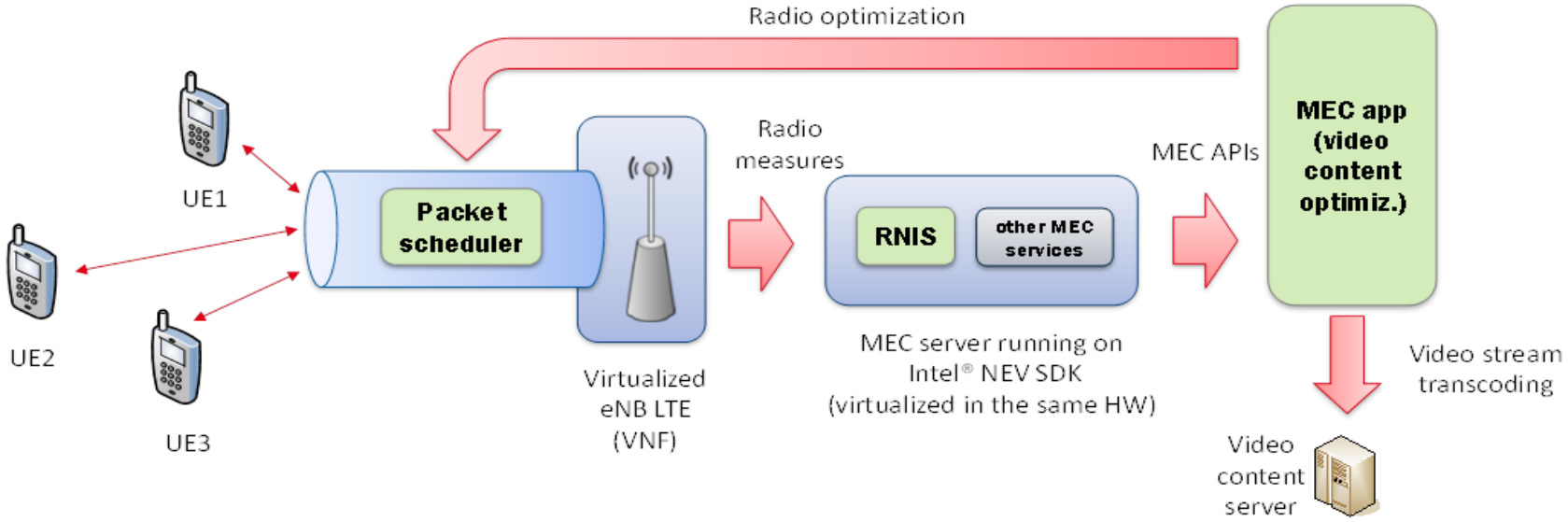


KPI	Unit	KPI measurements
Clean Installation	Time(s)	600 seconds
Configuration	Time(s)	4 seconds
Disposal	Time(s)	< 1 seconds
Service upgrade duration	Time(s)	122-300 seconds

ETSI MEC PoC - RAVEN

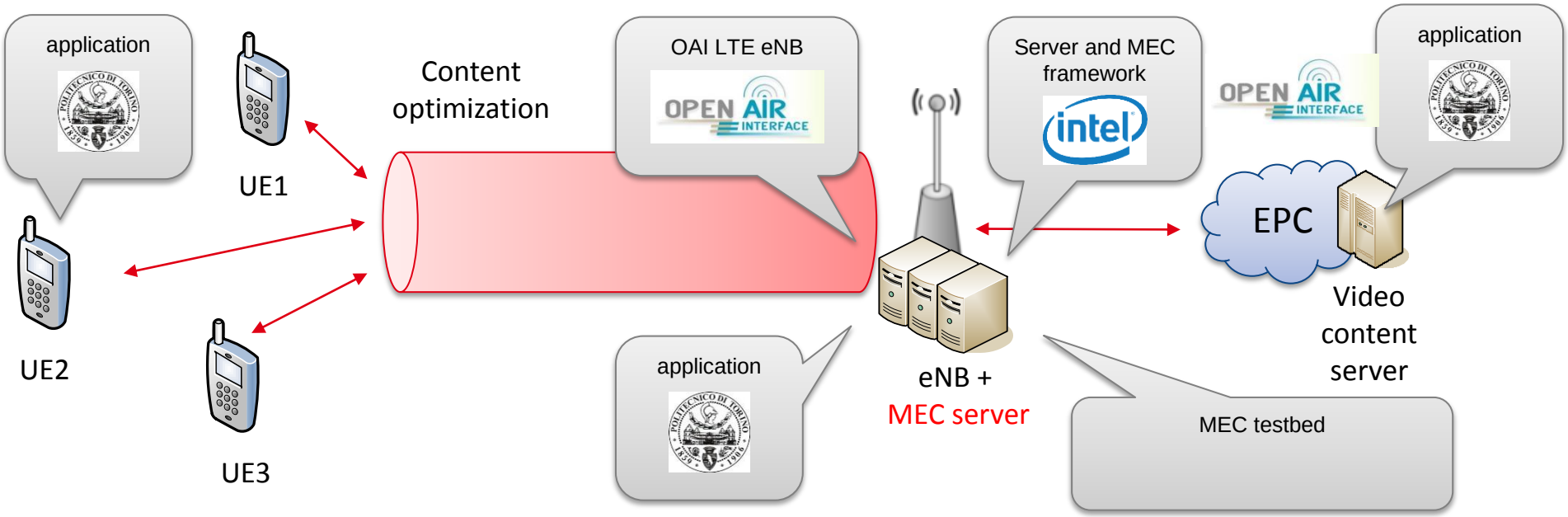
"Radio aware video optimization in a fully virtualized network"

- **This PoC (accepted by ETSI) is about Radio aware video optimisation application implemented in a fully virtualized network, under the collaboration between TIM, Intel, Eurecom and Politecnico di Torino.**
- **see http://mecwiki.etsi.org/**



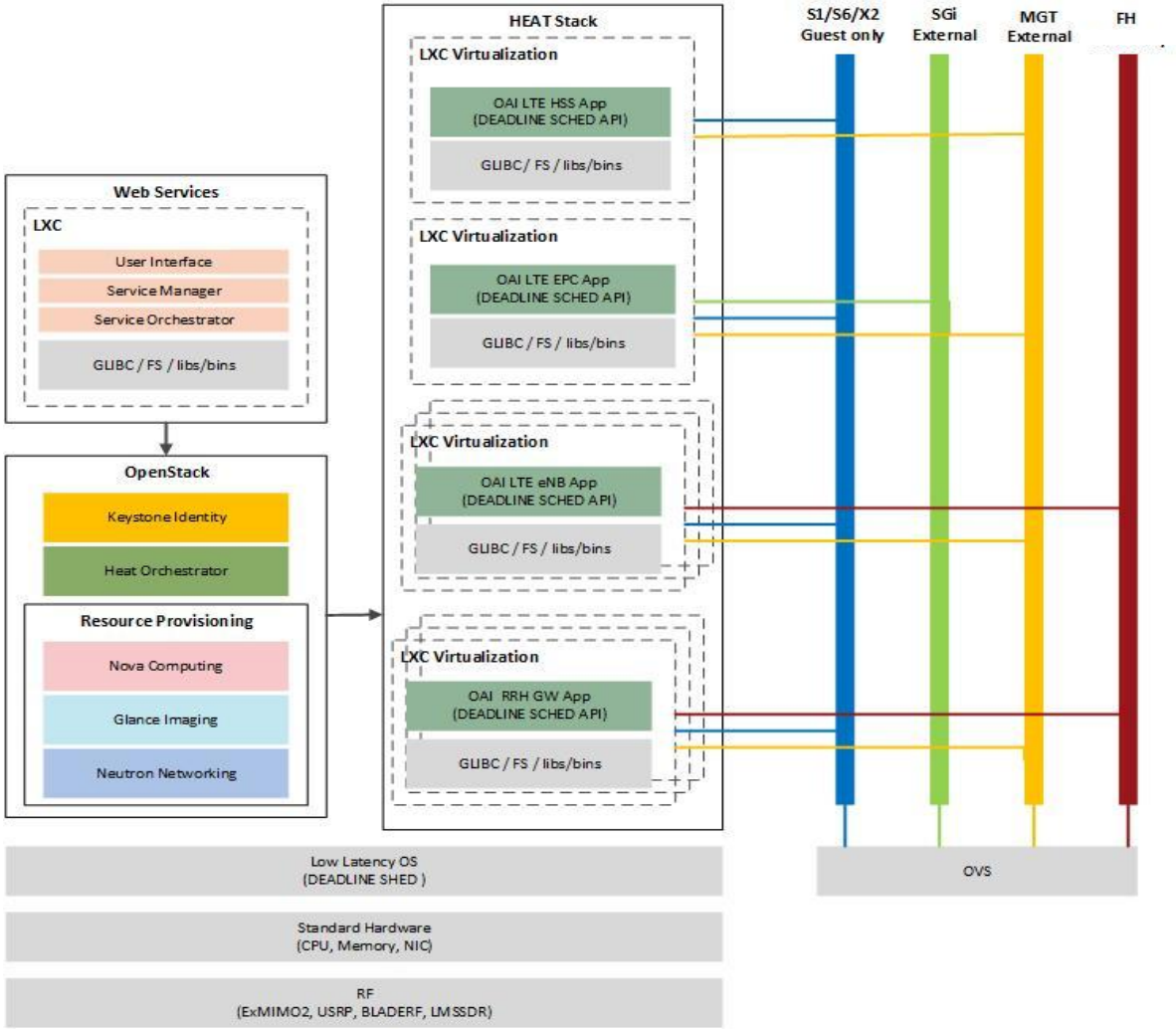
RAVEN PoC

- **Multiple demonstration has been planned including MWC 2017**
- **Alternative architecture (e.g. more convenient location of the video content server, …) can be evaluated, for example in order to compare different deployment options (and related performances**
- **Input to the standards**

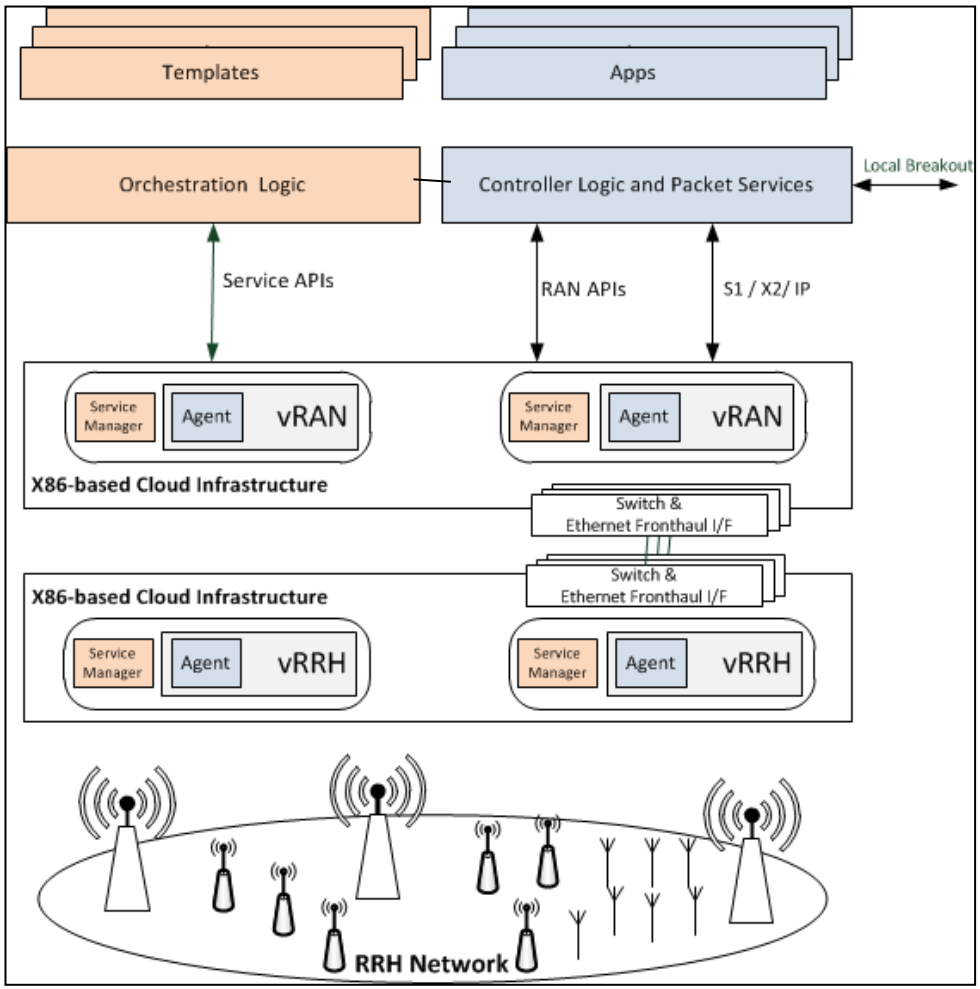


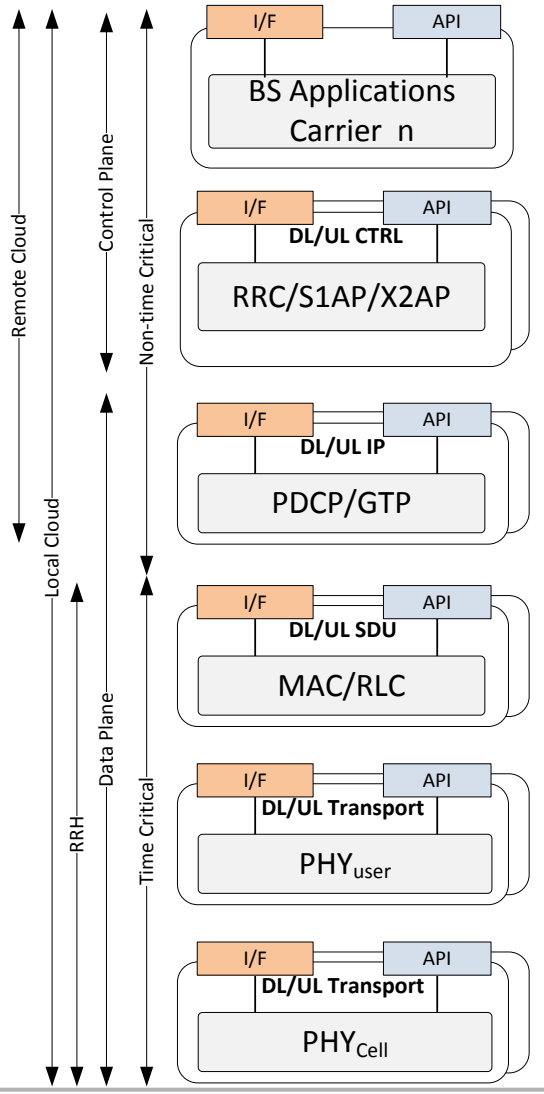
LTEaaS
Openstack and Heat Orchestrator

- **Three components**
  - web service
  - OpenStack
  - Heat stack
- **Heat Template describes the virtual network deployment**
  - Deployment Lifecycle
- **Linux Container**
- **Open vSwitch**
- **Low latency kernel**
- **RF frontend HW**



Overall Approach to software-defined 5G





Liaisons with other bodies

- **Currently**
  - Regular interactions with
    - **ETSI NFV ISG**
    - **ETSI MEC ISG – PoC#3 , RAVEN**
    - NGMN
  - 3GPP
    - Regular discussions with TSG RAN,SA,CN
  - ITU
    - Discussions with ITU-T FG-IMT-2020, ITU-T focus group looking into the wireline requirements for 5G
  - 5GPPP
    - Several users of OAI in 5GPPP projects (e.g. EURECOM, Nokia, Telecom Italia)
  - OpNFV
    - OAI as an upstream project + OpNFV Functest
      - ☞ (demo @ OpNFV Summit 2016, Berlin)
  - OSM
    - OAI as an upstream project (OAI is member)
  - ONOS
    - Discussions planned in coming weeks

Conclusion

- **OAI is all software, all IP, and open**
- **Integrated tools for a complete experiment life-cycle**
- **Flexibility to architect, instantiate, and configure the network components (at the edge, core, or cloud)**
  - E.g. The network can be packed into a single commodity server/PC or virtualized as a cloud service
- **Rapid prototyping of 3GPP compliant and non-compliant use-cases**
  - E.g. Software-define networking or mobile edge services
- **We are launching alliance projects around Fronthaul splitting/Orchestration/Slicing -> Join US!!**

Demo

- https://youtu.be/UUAMknoRJ0g

JOIN US!

- http://www.openairinterface.org

- **Backup Slides**

OAI/ITU-T FG on Wireline Collaboration

- **Study different aspects of Network Slicing**
- **Collaborate with Open Source Projects (OAI, Open-O, etc) for PoCs**
- **Key aspects of study:**
  - Performance of RAN within containers, KVM, etc
  - Real-time support in containers + KVM
  - Access to HW Resources (USB, PCIe)
  - Low latency transport over Ethernet
  - Synchronization issues over Ethernet
  - Study different types of Base-and split between BBU/RRH
- **There is also interest to extend this work towards UE**

Challenges in running OAI in Containers/VM (Docker, LXC, KVM)

- **Real-time support in containers + KVM**
- **Access to HW Resources (USB, PCIe)**
- **Low latency transport over Ethernet**
- **Integration with High Performance SoC platforms for heavy number-crunching (for ex. Turbo Decoder)**
- **Study different types of Base-band split between BBU/RRH**
- **Orchestration framework that guarantees real-time HW requirements**

Running OAI in Containers + KVM

- **Evaluate RT performance when running in Containers + KVM**
- **Orchestration solutions based on JuJu, OpenStack + other solutions**