



Evolution of Telecom and Open-Source

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

Some visions of 5G and beyond

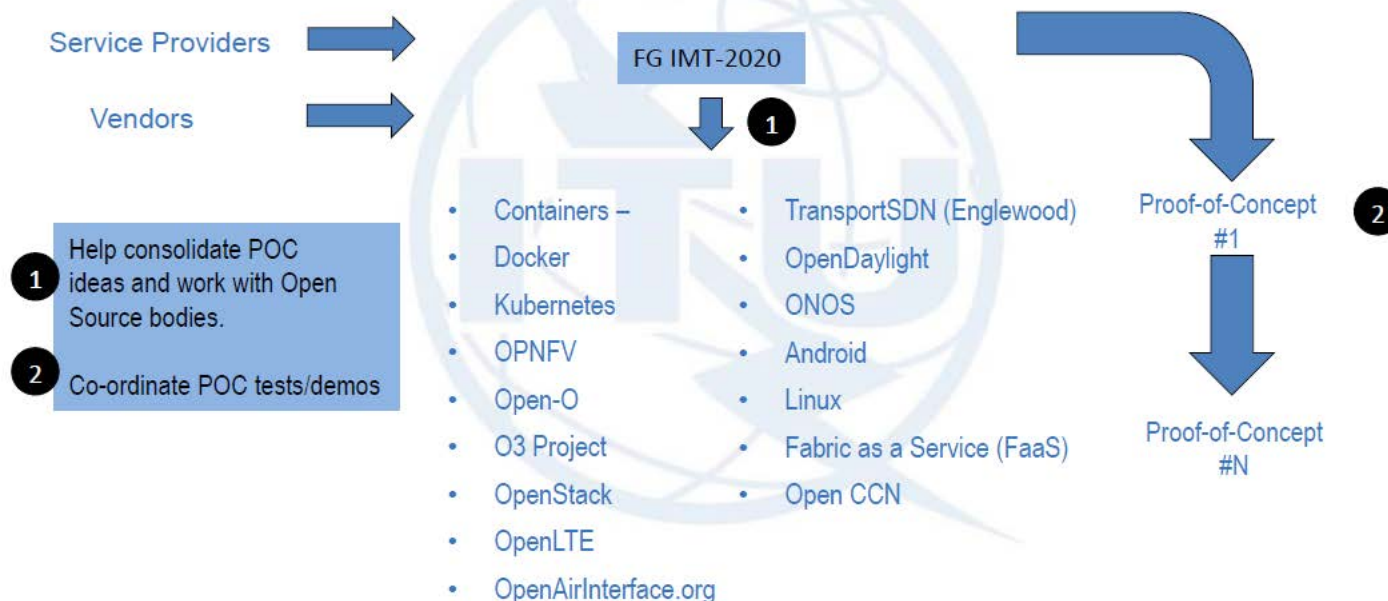
- **5G and beyond is not only New Radio and verticals**
- **It is also evolution in computing for wireless networks**
 - Central offices becoming data-centers (see CORD / M-CORD projects in USA as an example)
 - High-performance fronthaul networks for distributed computing
 - Fixed network to support advanced radio
 - Centralized computing and storage using
 - More general-purpose equipment (Intel servers)
 - More and more software technologies from cloud-computing (NFV,SDN,MEC, etc.) jointly with radio signal processing
 - Applicable to lesser extent for existing and evolving 4G radio
- Fusion of Information and Cellular technologies

Scrambling to federate the open-source communities

- **Increased interest in understanding (managing?) the role of open-source communities by**
 - **ITU Focus Group on IMT-2020 (SG13) : mandate completed**
 - the standardization expert group responsible for future networks, cloud computing and network aspects of mobile communications. new mandate includes the exploration of demonstrations or prototyping with other groups, notably the open-source community
 - ☞ Extension for ITU-T Focus Group on network aspects of 5G
 - ☞ Group instructed to work with open source communities
 - ◆ “Influencing and taking advantage of their work” part of its mandate
 - **ETSI (ETSI Summit on Standardization and Open Source, Nov. 17 2015)**
 - **NGMN (Joint ITU-NGMN Alliance Workshop “Open Source and Standards for 5G”, May 26th 2016)**
- **Main issue: patent-pool licensing**

ITU-Vision for Open-source and 5G

2016: Collaboration with Open Source initiatives



Evolution #1 : Reducing Vendor Lockin

EE Looks To Open Source Networks For 5G And Rural 4G

Steve McCaskill, April 27, 2016, 10:36 am

BROADBAND

CARRIERS

M2M

NETWORK MANAGEMENT

NETWORKS

VOIP

[LTE](#) [LTE ADVANCED](#) [NETWORK TECHNOLOGIES](#)

Lime and Canonical support EE's radical new approach to 4G coverage

Even before its acquisition by BT, the UK's largest mobile operator, EE, was taking some innovative approaches to solving the country's issues of poor rural coverage. In response to government pressure, including the threat of mandatory roaming, the MNOs have been paying long-overdue attention to patchy coverage in remote areas, and as part of BT, EE's efforts may also help to support universal broadband initiatives.



2 MAY, 2016

BY CAROLINE GABRIEL

Evolution #2 – FB and Google

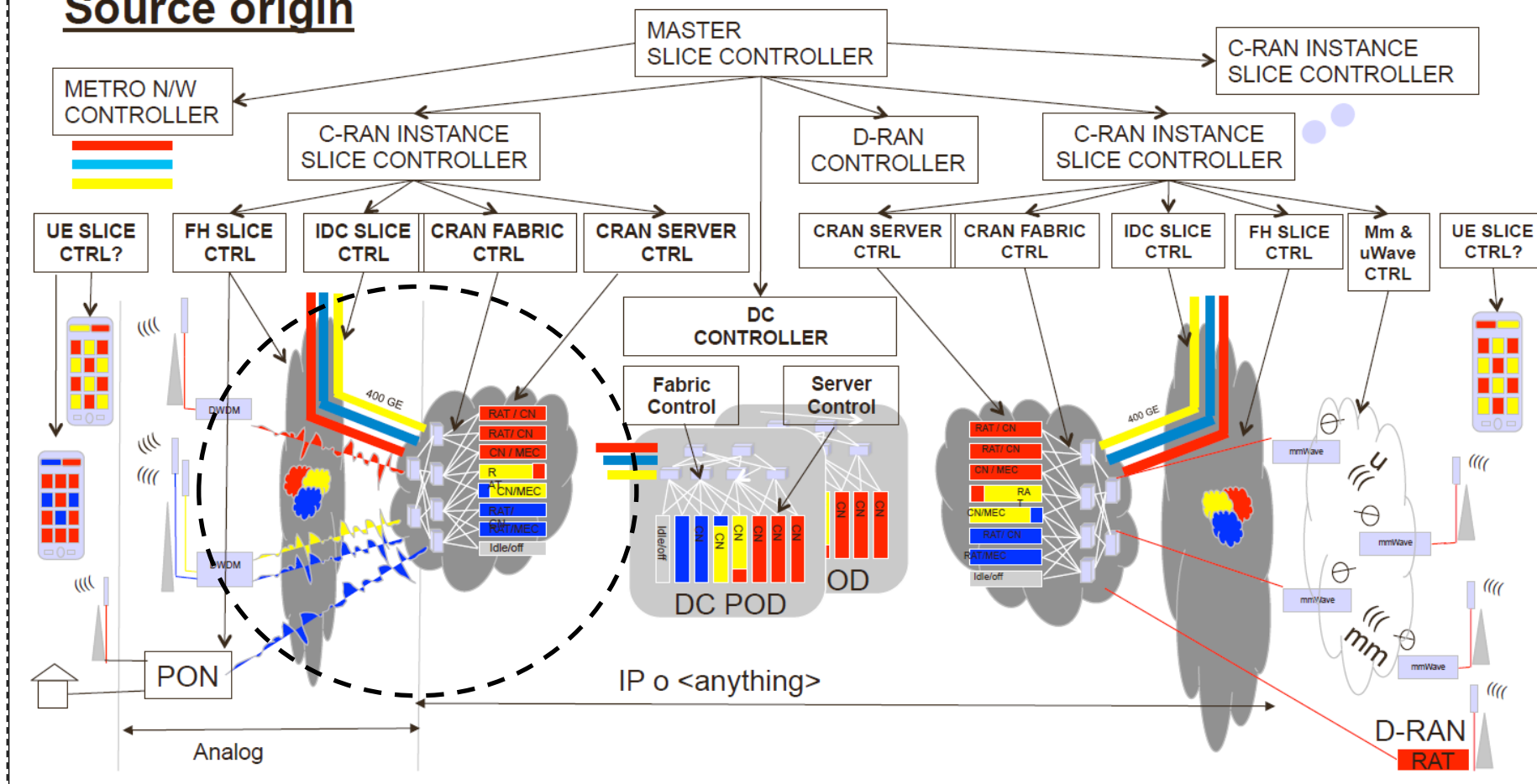
- <https://telecominfraproject.com/>
- Value-chain of Telecom is under siege and may become very different because of this.
- Google and openCORD

Recent ITU/NGMN Workshop

- **Where : Qualcomm headquarters in San Diego**
- **Agenda**
 - Technical, how-to work with open-source, where it plays a role, etc.
 - Non-technical:
 - Are standards and open-source licensing regimes compatible?
 - Should open-source licenses be pre-defined or left open for negotiations?
 - Which is more efficient, open-source or patent-pool licenses?
 - Patent ambush: threats and mitigations.

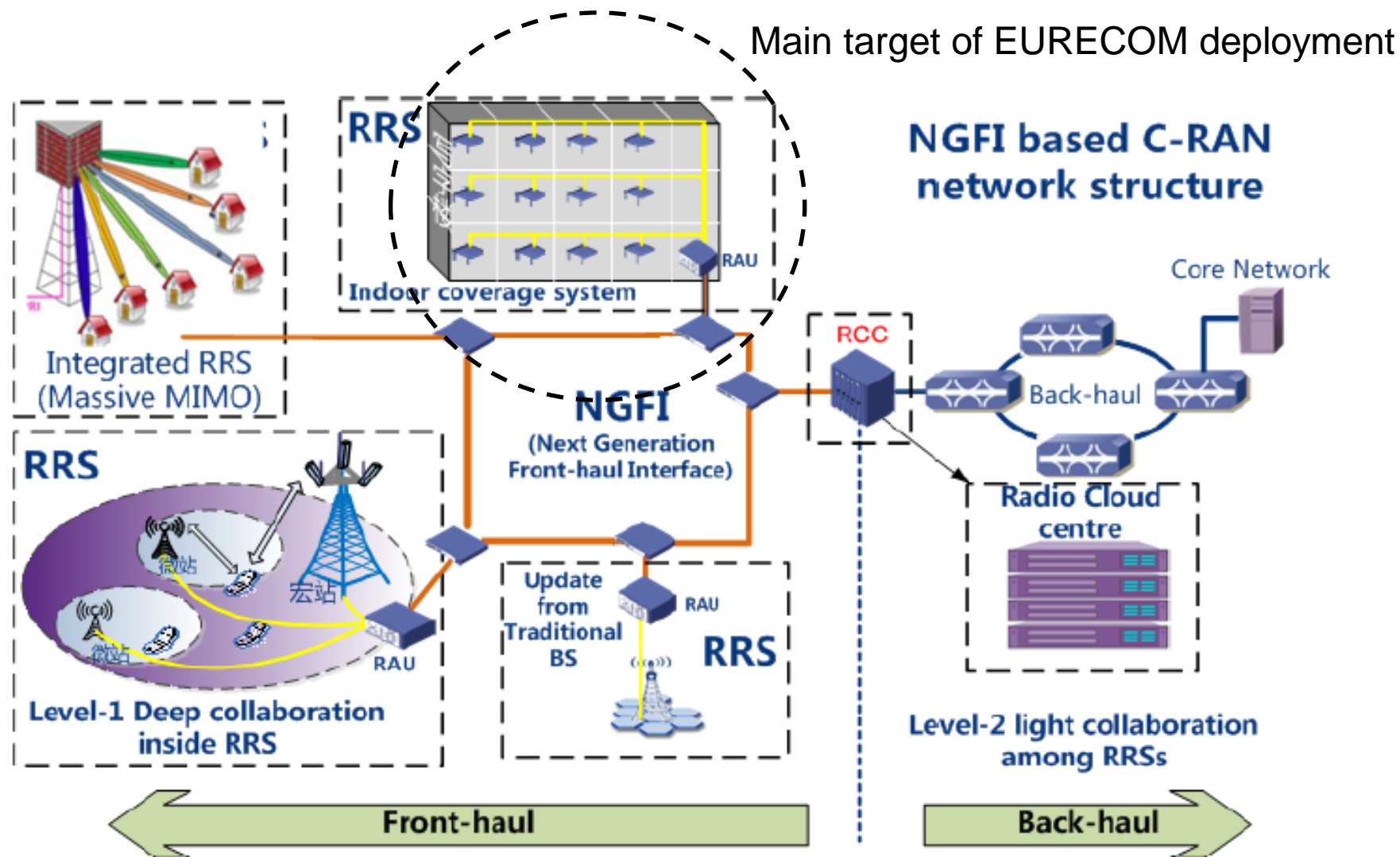
ITU IMT2020 FG Vision

Controller/Orchestrator Hierarchy likely most control is of Open Source origin



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

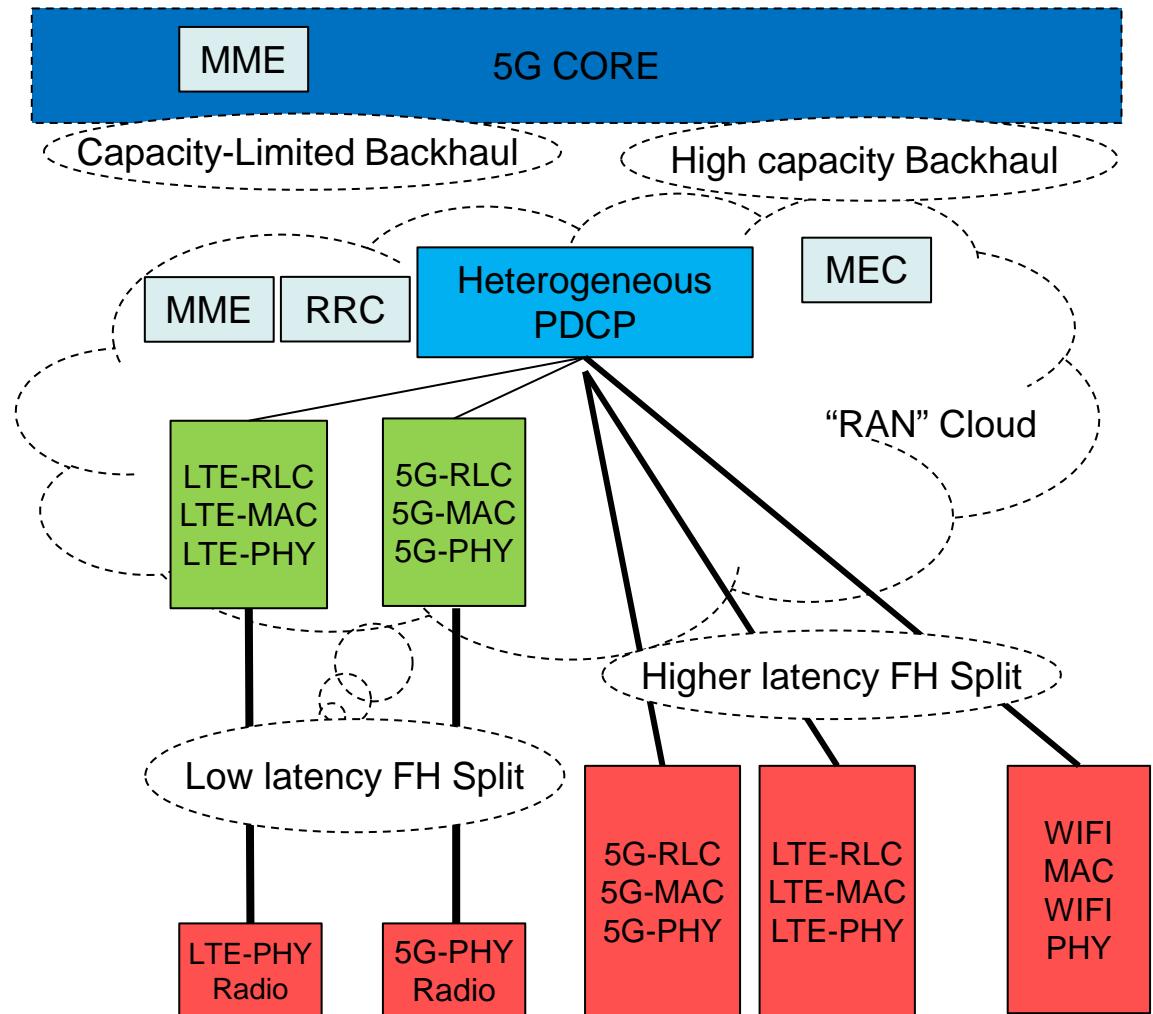
NGFI (IEEE 1914) – Fronthaul Vision



Considered RAN Splits in 3GPP evolution

■ Fronthaul

- Lowlatency FH
- Highlatency FH



SDN/NFV

■ Benefits of SDN/NFV

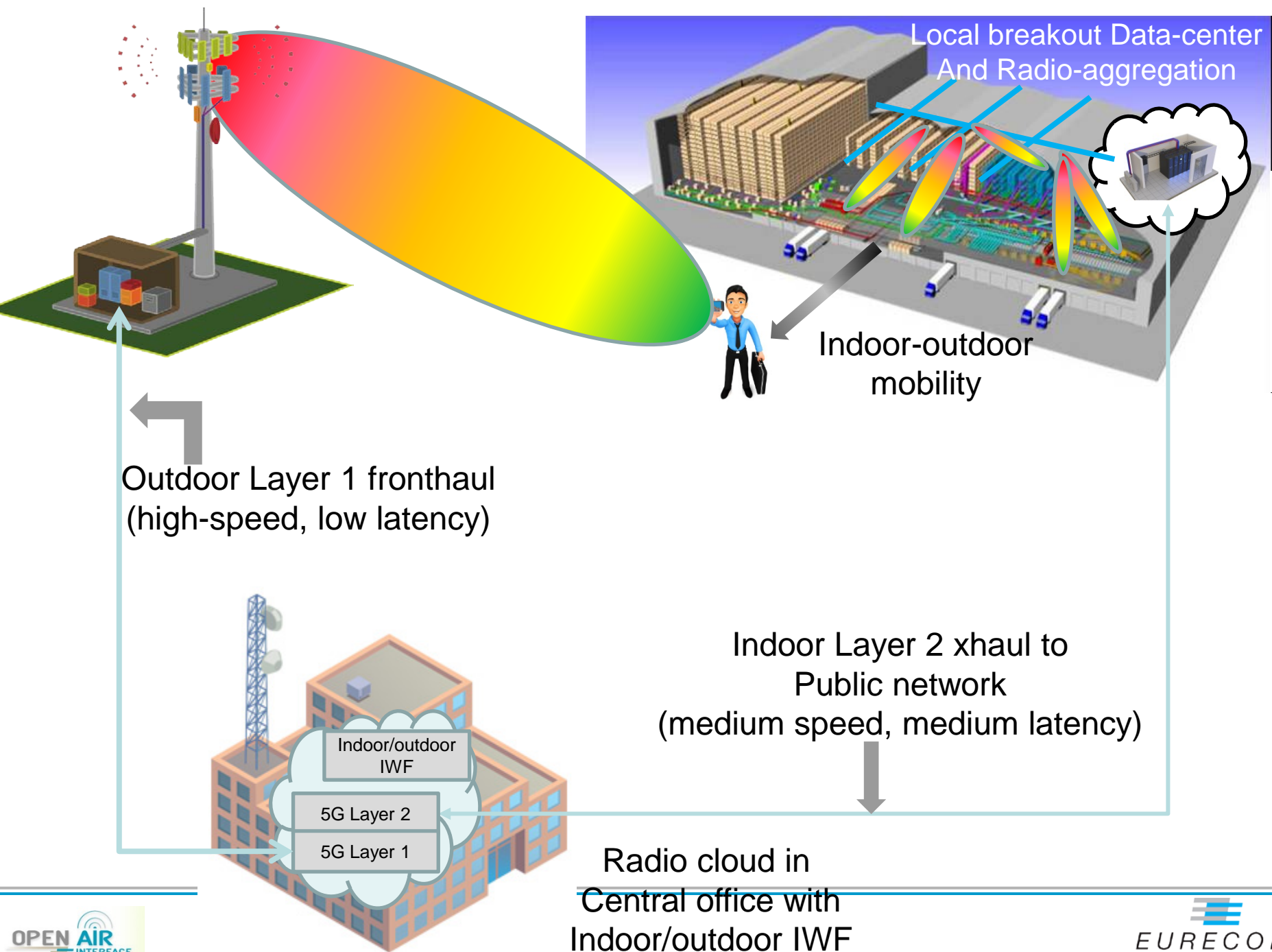
- Making the Telecom Network an interconnection of many “Apps”
- Tailored deployments for vertical industries
- Commodity servers

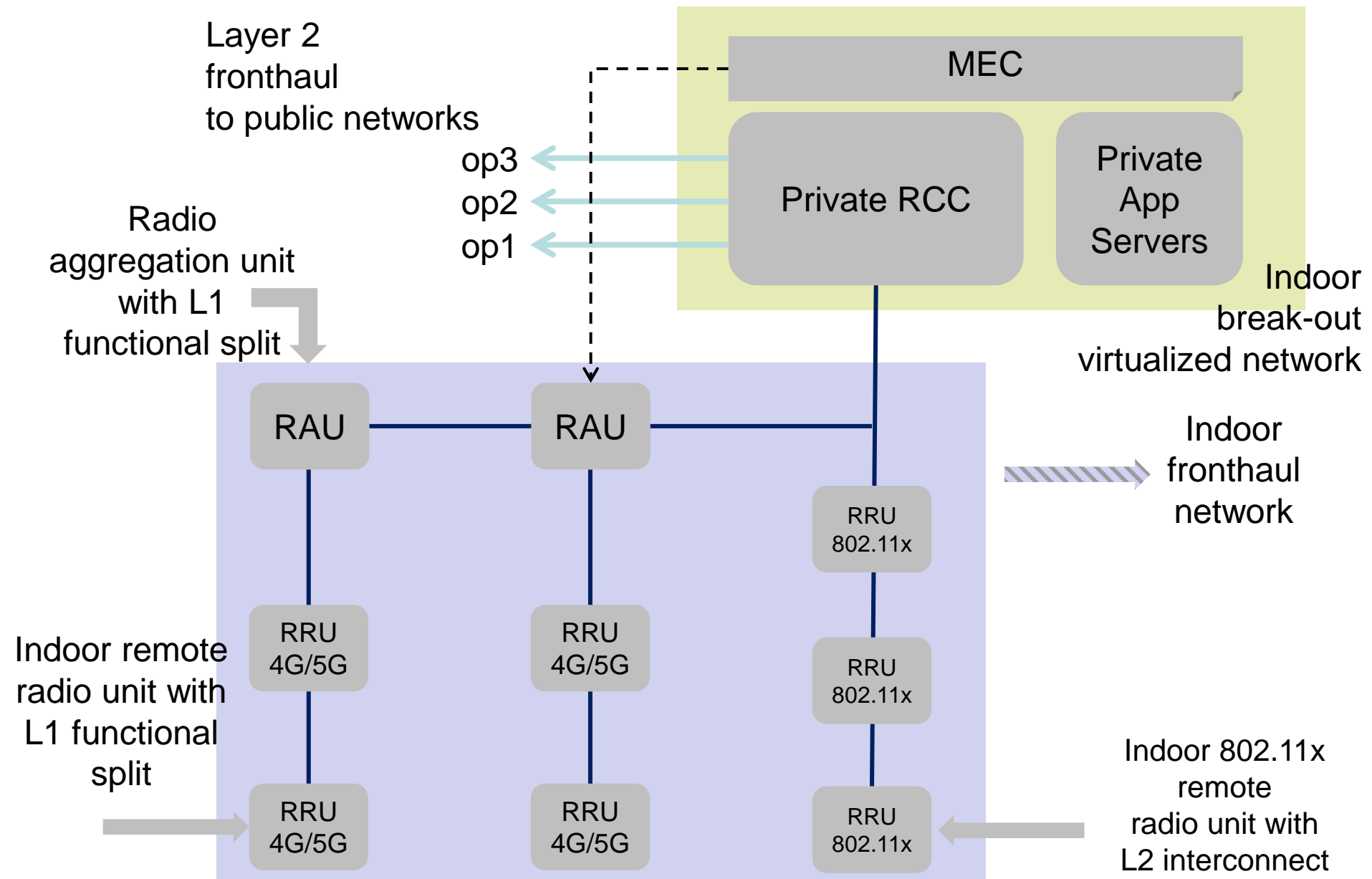
■ Challenges for NFV

- Real-time processing in access-layer
 - 1ms for 4G
 - 200µs for 5G, but possibilities for higher latency too
- Software licenses

■ Challenges for SDN

- Diving deeper into the access-layer using SDN/slicing concepts for fine-grain control of radio network
 - MAC scheduling
 - Dynamic radio network topology (virtual cells)
 - Multi-RAT on mutualized hardware (4G, 5G, WIFI, LWA)
 - Multi-tenancy on mutualized hardware
 - Private/public traffic on mutualized hardware
- managing time-scales (latency critical vs. delay-tolerant)





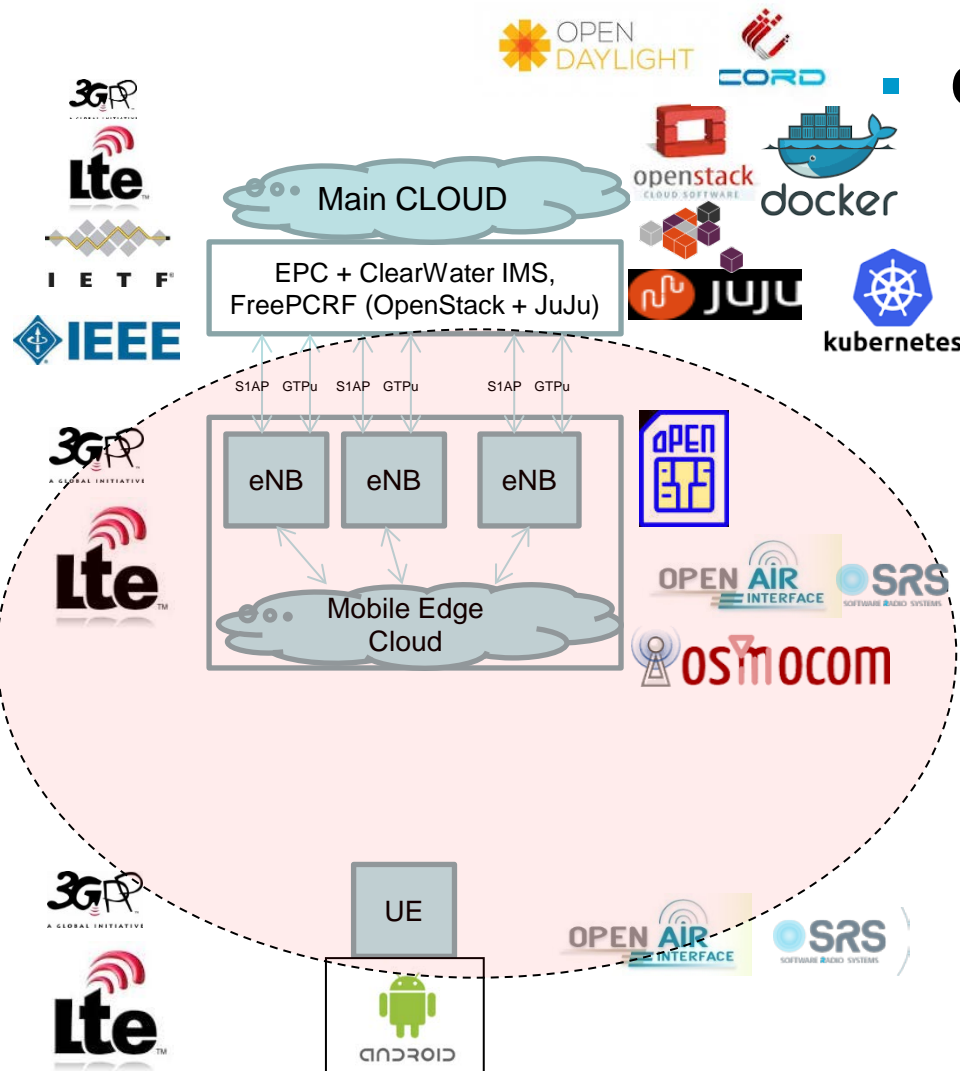
A note on real-time for SDN/NFV

- **4G L1/L2 is possible in real-time on pure x86-64 now (Xeon v3/v4)**
 - Even low-latency kernel is ok, 100 μ s jitter
 - Deadline scheduler ($\geq 3.14.10$ kernel) better, tens of μ s
 - 4G L1 feasible even on kvm/docker, but to be avoided, better as PNF with RTOS
 - 4G L2 no real issue, can be virtualised easily
- **5G will be more challenging**
 - Process scheduling requiring an order of magnitude better determinism
 - Control of HW accelerators coupled with x86/ARM GPP in real-time processing chain
 - Data plane physical networking (10-100 Gbit/s), CRAN fabric (interprocessor communications)
- **Real-time controllers will also be necessary for MAC scheduling and more advanced PNF control (e.g. virtual cell formation, CoMP) : see FLEXRAN MWC17 demo (Canonical stand)**

Commoditization of 3GPP Radio Systems and Open-Source : OAI Software Alliance

- **Today it is feasible to put a fully-compliant 4G eNodeB and EPC in a commodity x86 or ARM-based computer (or data center for a pool of eNodeBs)**
 - Emergence of “radio”-hackers in addition to commercial vendors
 - OAI Alliance
 - launched in 2014 as a “Fond de Dotation”
 - 3GPP strategic members in 2015-2017 (Orange, TCL-Alcatel, Ercom, Nokia)
 - Many associate members (B-COM, INRIA, IMT, TNO, III, Rutgers WINLAB, U. Washington, BUPT, etc.)
- **Coupling this with an open-source community makes for a very disruptive technology for the onset of 5G**
 - What we’re building
 - Community of individual developers, academics and major industrials embracing open-source for 5G
 - What we hope to become
 - A strong voice and maybe a game-changer in the 3GPP world
 - ☞ Real impact from “the little guys” on 3GPP systems

Bringing open-source into the RAN

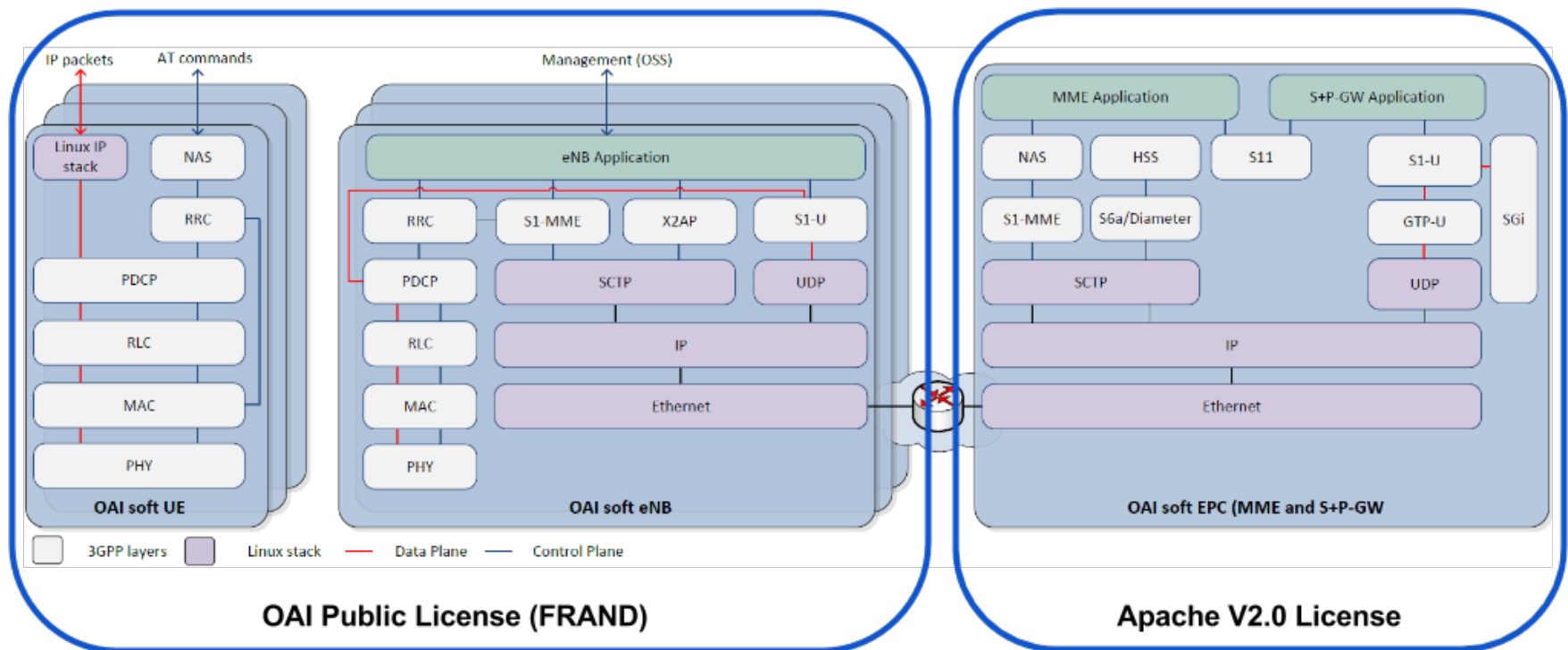


Challenges for 4.5G/5G

- FRAND License for open-source
 - Allow 3GPP members to contribute to open-source and still perceive royalties
 - Compatible with
 - ☞ academic/research/prototyping use
 - ☞ commercial use in devices, data centers and testing equipment
 - Approval by Alcatel-Lucent, Orange, TCL and Ericsson (observer)
- Community coexistence/synergy with standardization process
 - Use of open-source in prototyping phase of 5G
 - Open-source community following 3GPP process
 - Community representation in 3GPP via OSA

OSA Licensing Model

- FRAND License allows committing software with patent rights into OSA and still keep licensing rights -> Inline with 3GPP fair use licensing policy
- We aim to work closely with ETSI on implications of open-source for licensing/certification
- Future 5G Core Network developed within eNB/UE repository will inherit FRAND license

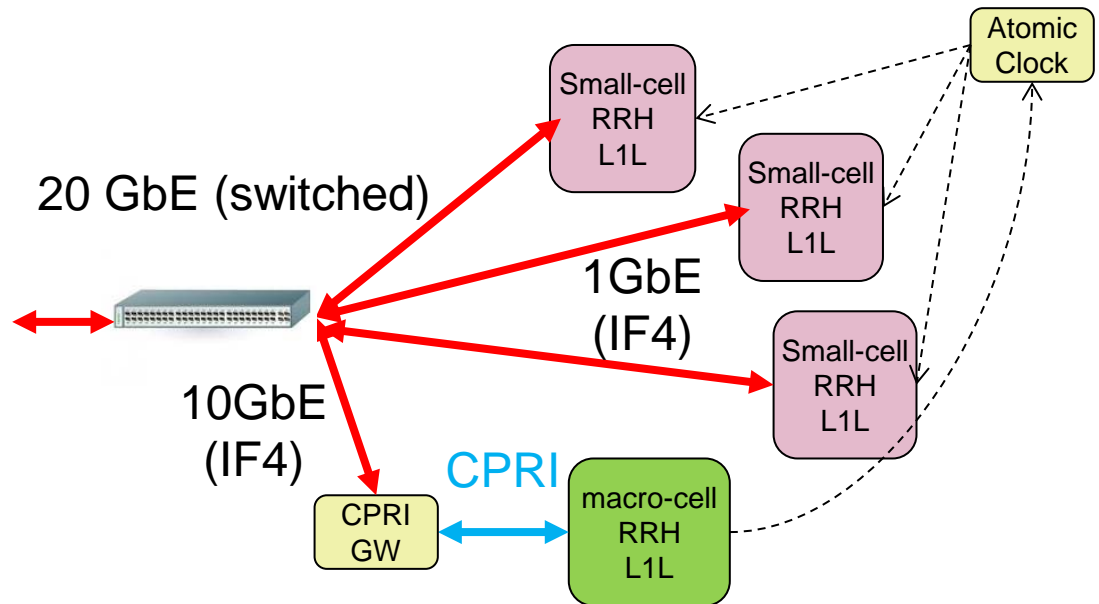
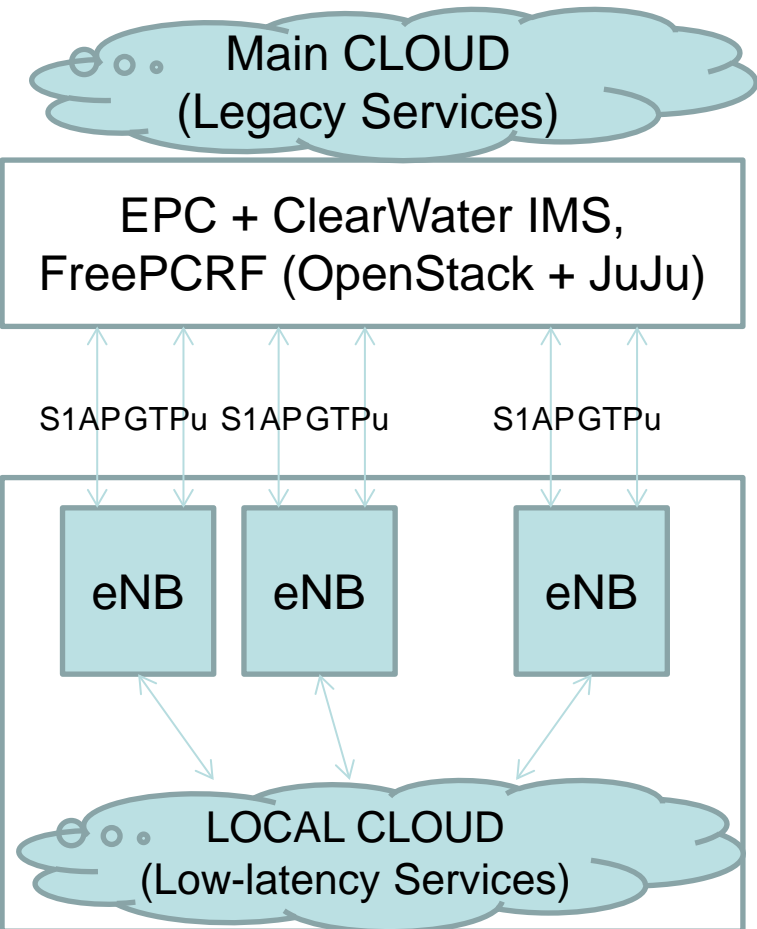


EURECOM RRH to Datacenter Architecture

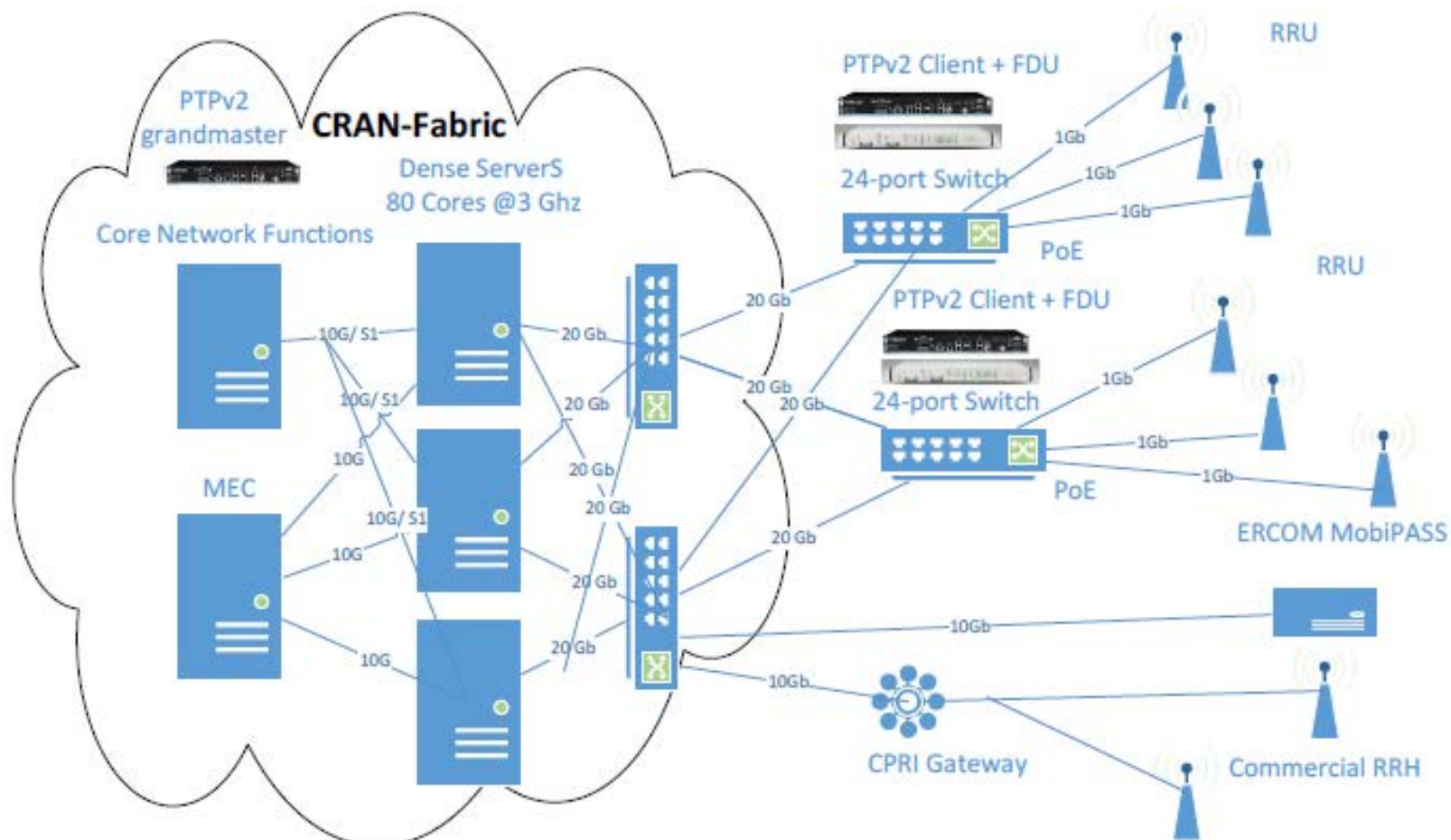


Some issues

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



EURECOM Deployment (1 outdoor RRH)



Conclusions

- **Open-source methodology is coming to telcom => community-driven effort, primarily prototyping and experimenting with SDN/NFV concepts down to the radios**
 - Traditional telco operators + vendors
 - New players (FB, Google)
 - Academics / public research
- **Work with open HW/SW in labs**
 - Contribute to the software
 - Replicate the hardware
 - Integrate with other hardware
 - Push to standards bodies (e.g. ITU, ETSI, 3GPP) and upstream in other communities (e.g. OPNFV, OSM)
 - Use for PoC demonstrators (5GPPP and other project programs)