Network Store: Exploring Slicing in Future 5G Networks

Navid Nikaein, Romain Favraud (EURECOM, France);

Eryk Schiller, Islam Alyafawi, Zhongliang Zhao, Torsten Braun (University of Bern, Switzerland);

Kostas Katsalis, Donatos Stavropoulos, Thanasis (University of Thessaly, Greece).

7th September, 2015

Economics of mobile are changing

- **Softwarization and Commoditization**
  - Software implementation of network functions on top of GPP with no or little dependency on a dedicated hardware
    - Full GPP vs. accelerated vs. system-on-chip
  - Programmable RF
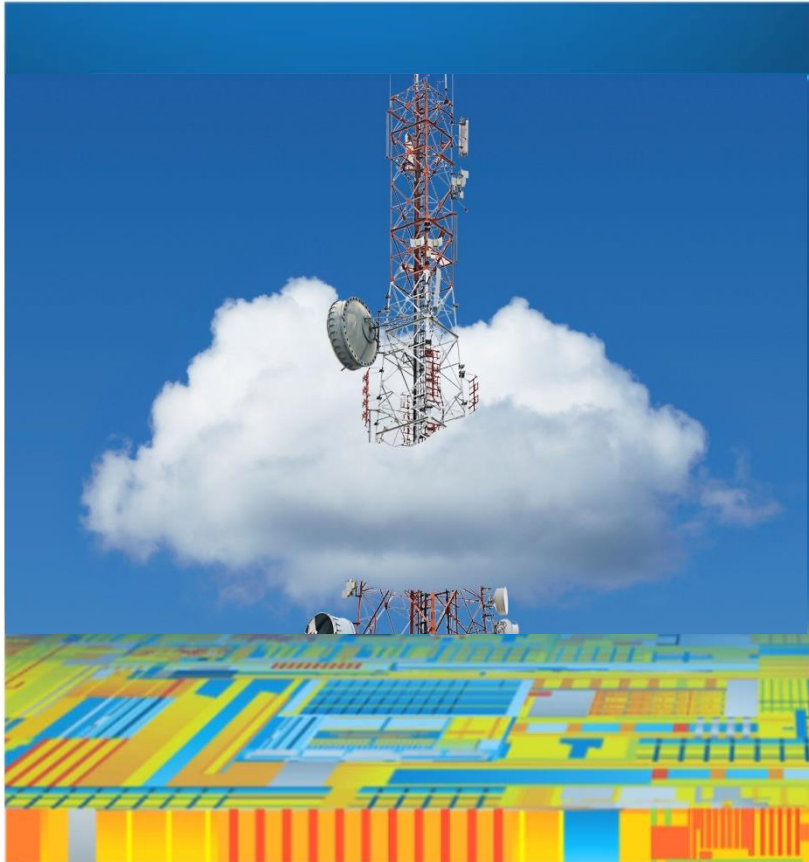
- **Virtualization and Cloudification**
  - Execution of network functions on top of virtualized computing, storage, and networking resources controlled by a cloud OS.
  - Share I/O resources among multiple guests

- **Realtime OS/Virtualization**
  - Low latency radio application (scheduling latency)

Network slicing
Softwarization and Commoditization

Network slicing
virtualization and cloudification

- **Mircoservice Architecture and NFV**
  - Loosely coupled, reusable, composable, stateless, and discoverable
  - Function refactoring
  - Mapping 1:1, 1:N, N:1, N:2, etc. (mindful about SW complexity)
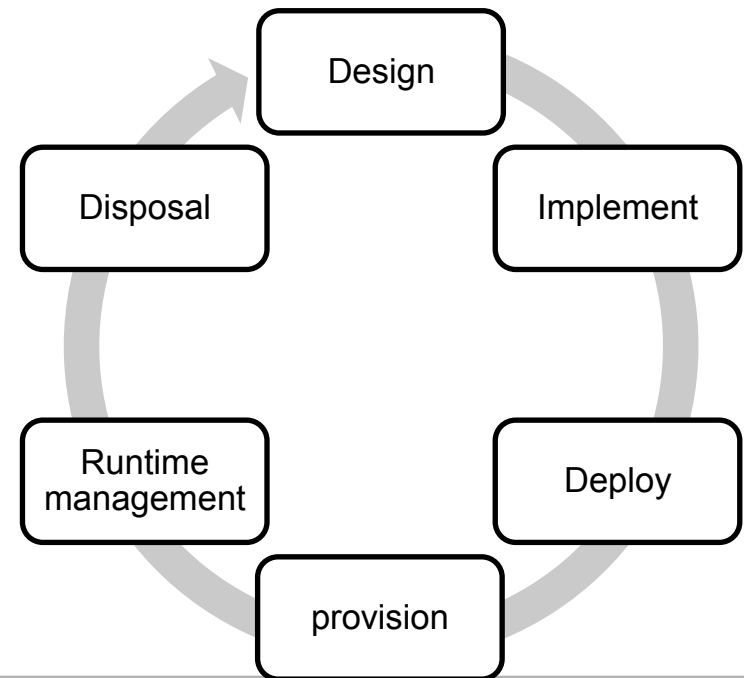
- **Scalability**

- **Reliability**
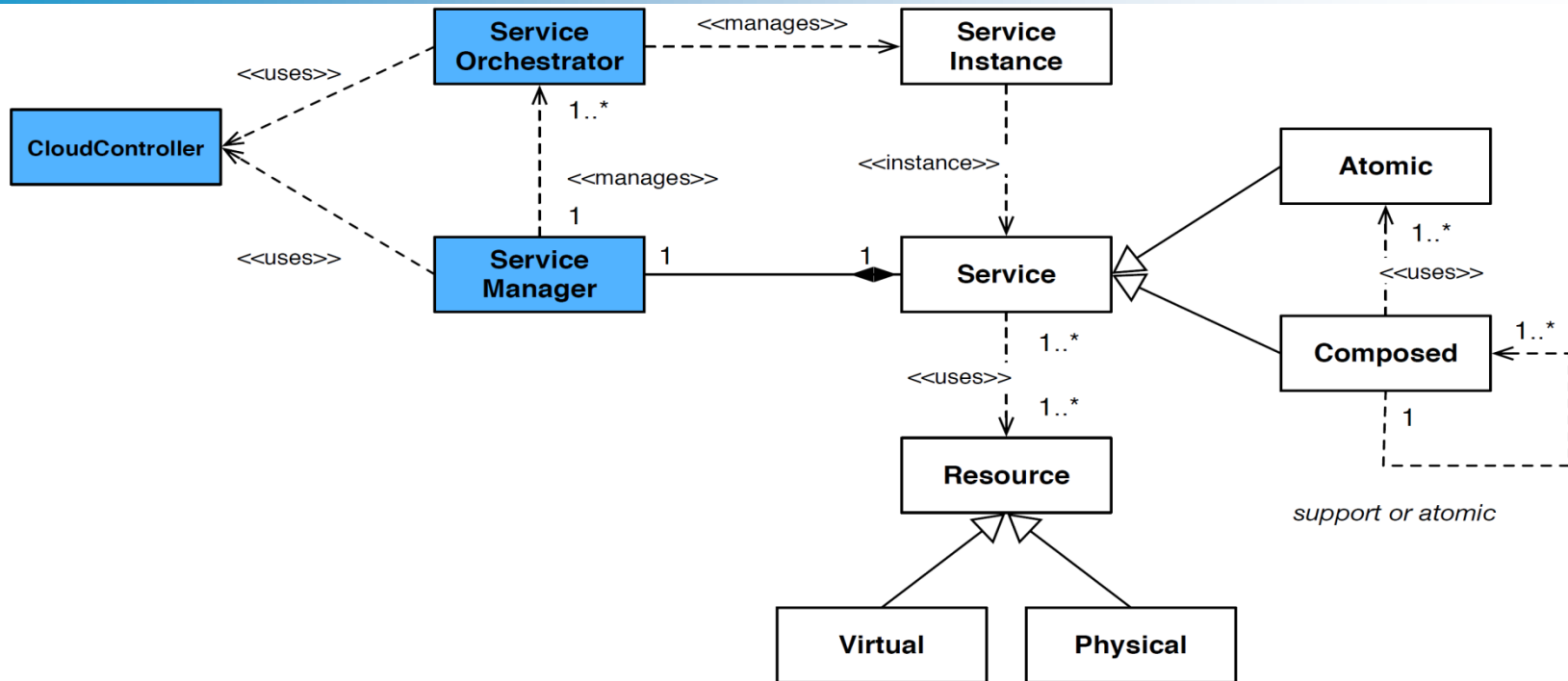
- **Placement**

- **Multi-tenancy**

- **Real-time edge service**

- **Life-cycle managements**

Network Slicing
Service entity

- **Atomic Services**
  - IaaS : compute, storage, network
  - PaaS: Application, and components

- **Support Services**
  - DNSaaS, MaaS, and CDNaaS

- **Composed Service**
  - RANaaS
   - ☞ PHYaaS
    - ☞ MACaaS
  - EPCaaS ...

Network Slicing Programmability

- **Separation of control plane from data plane and SDN**
  - Distinct logical networks over a shared infrastructure
  - Unified control plane (mindful about c-plane protocols and configuration)
  - Dedicated data plane

- **Isolation without performance degradation**
  - Consistency Availability and Partition tolerance (CAP) conjecture

- **Runtime programmable control layer based on the abstraction**
  - MAC/PHY modeling and abstraction
  - Time-critical and non-time-critical RAN control plane

Network Store

- **Cloud, NFV, and SDN technologies allow vertical network architecture to be broken down into blocks**
  - ➢ Chain and compose adequately configured network functions, network applications, and underlying cloud infrastructures
  - ➢ Map and place them onto the infrastructure resources and assign target performance metrics
  - ➢ Program and scale them according to a particular business application scenario

- **Network store allows creation of service bundle for each network slices through digital distribution platforms**

Network store and slice concept

Entertainment Slice

IoT /Smart grid Slice

eHealth/Public safety Slice
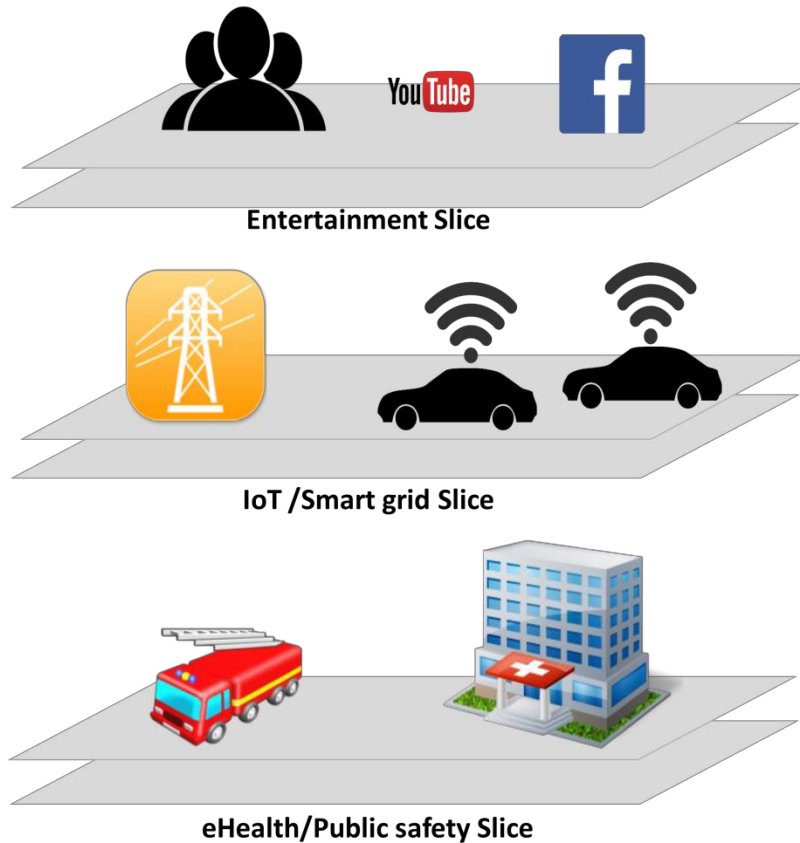
Business Layer

User and industry business applications

Network Function and Application Store

Service Layer

Network Applications	Network Applications
Unified Management and Orchestration	
Network Functions	Network Functions
Dedicated User Plane	Dedicated User Plane

Cloud Infrastructure Layer

RRH

Network

Storage
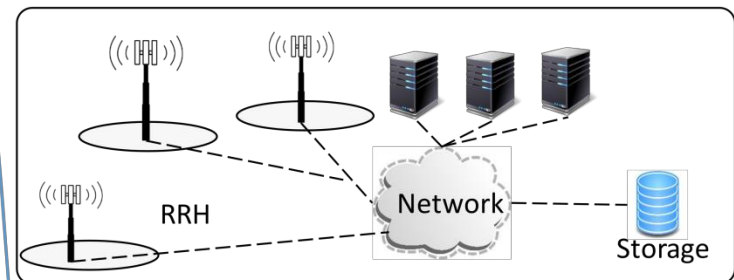
Network store and slice concept
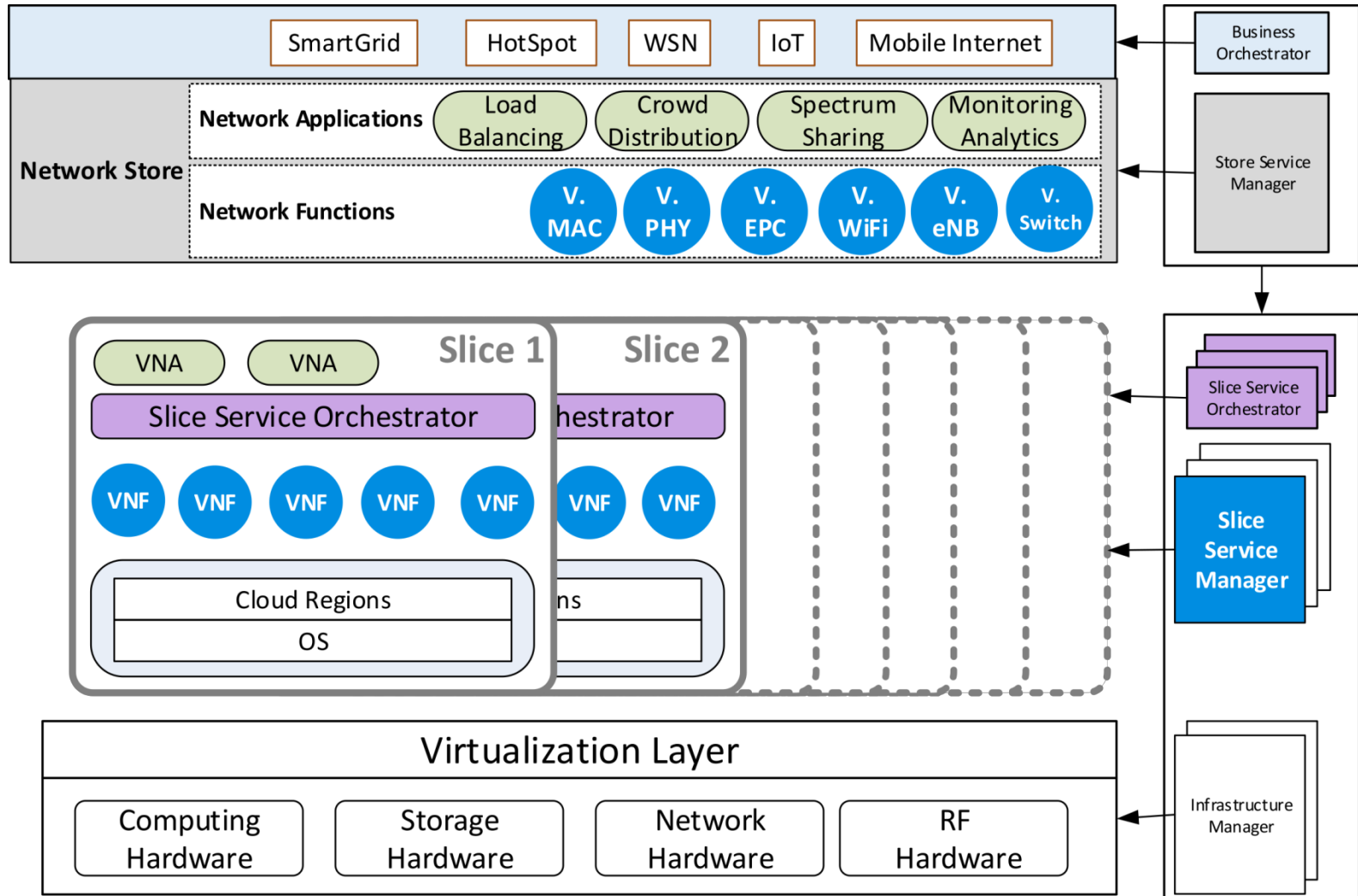
LTEaaS realtime prototype

- **Three components**
  - ➤ web service
  - ➤ OpenStack
  - ➤ Heat stack

- **Heat Template describes the virtual network deployment**
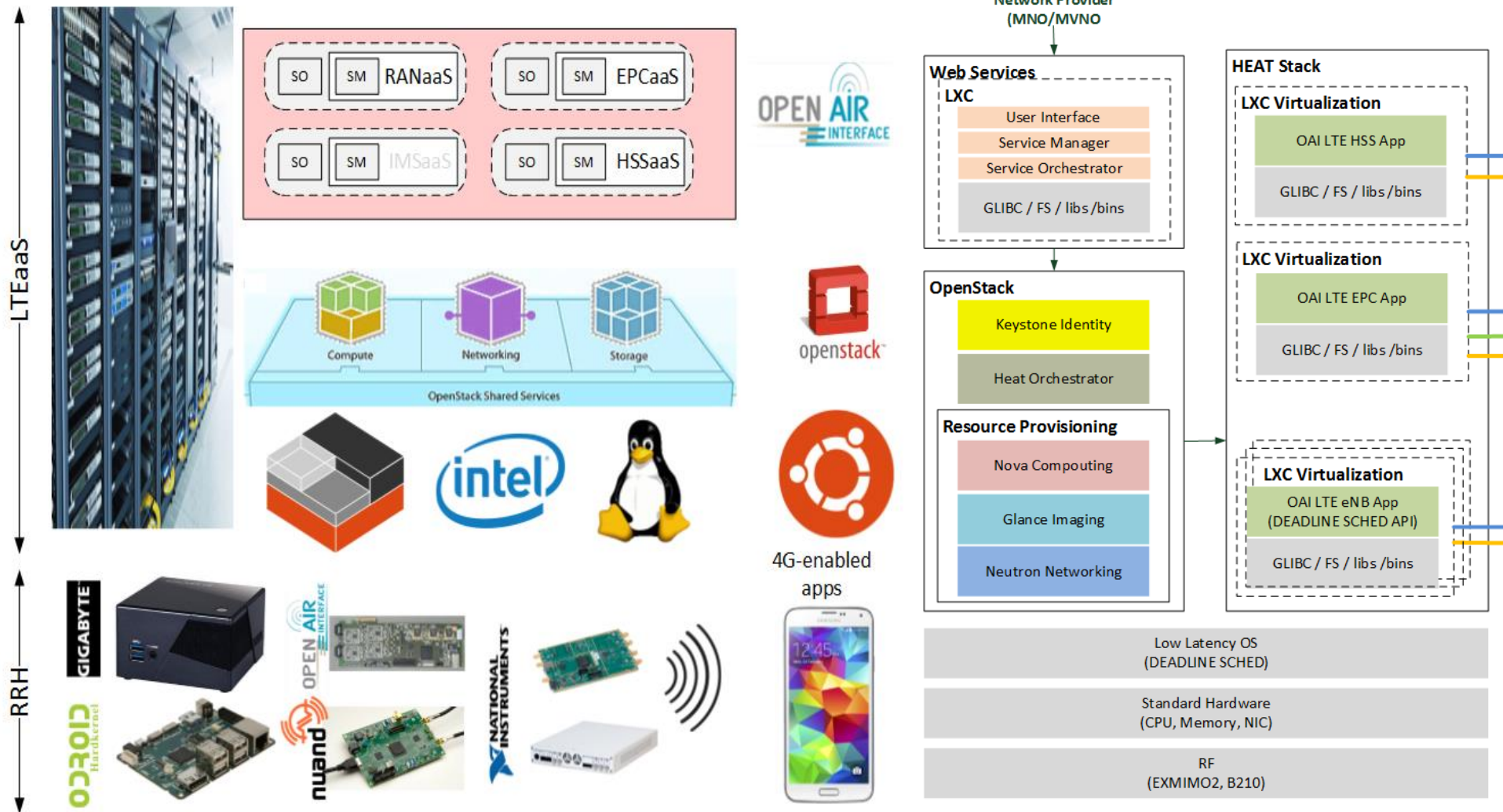
- **Linux Container**

- **Open vSwitch**

- **Low latency kernel**

- **RF frontend HW**

Network Provider
(MNO/MVNO)

Web Services
- LXC
  - User Interface
  - Service Manager
  - Service Orchestrator
  - GLIBC / FS / libs /bins

OpenStack
- Keystone Identity
- Heat Orchestrator
- **Resource Provisioning**
  - Nova Compouting
  - Glance Imaging
  - Neutron Networking

HEAT Stack
- **LXC Virtualization**
  - OAI LTE HSS App
  - GLIBC / FS / libs /bins
- **LXC Virtualization**
  - OAI LTE EPC App
  - GLIBC / FS / libs /bins
- **LXC Virtualization**
  - OAI LTE eNB App (DEADLINE SCHED API)
  - GLIBC / FS / libs /bins

S1/S6/X2 Guest-only
SGI External
MGT External

Low Latency OS
(DEADLINE SCHED)

Standard Hardware
(CPU, Memory, NIC)

RF
(EXMIMO2, B210)

OVS

# LTEaaS realtime prototype
Setup

LTEaaS prototype

- **OAI EPC and HSS VNF**

- **OAI eNB VNF: a deadline critical application (8ms HARQ RRT)**
  - ➢ Eurecom EXMIMO 2 radio frontend
  - ➢ FDD band 7 SISO mode
  - ➢ 10 MHz channel bandwidth (50 PRBs).
  - ➢ Downlink MCS27 and uplink MCS16
  - ➢ Only 4 uplink sub-frames (SFs) are granted by the eNB
    - – SF #0, 1, 2 and 3, allowing UL transmission to occur in SF # 4, 5, 6, 7.
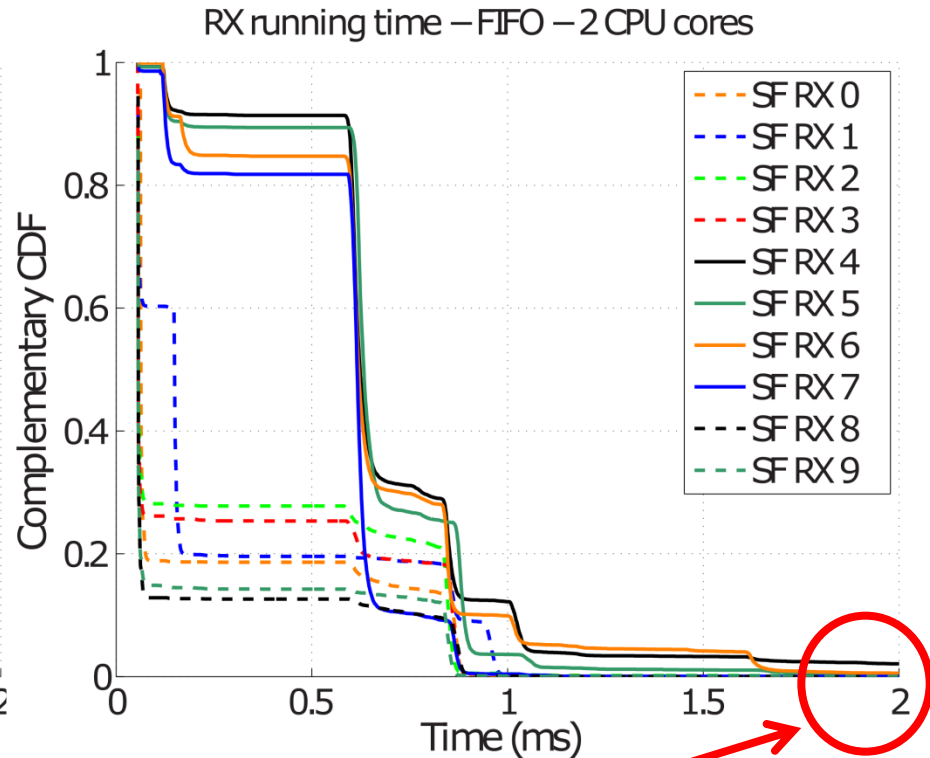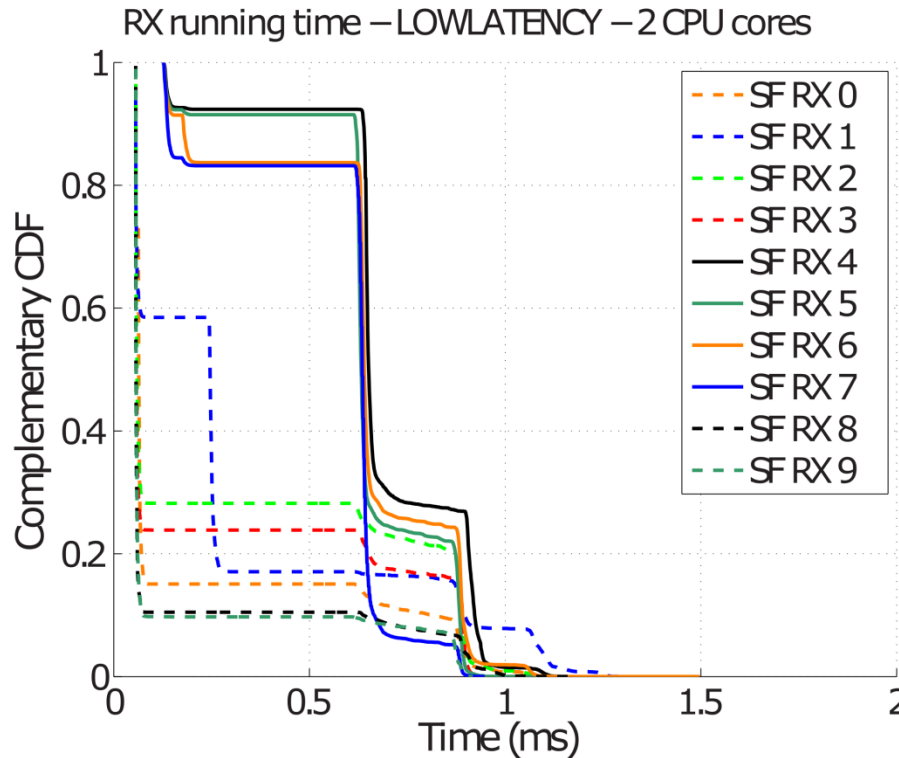   - – Full uplink traffic
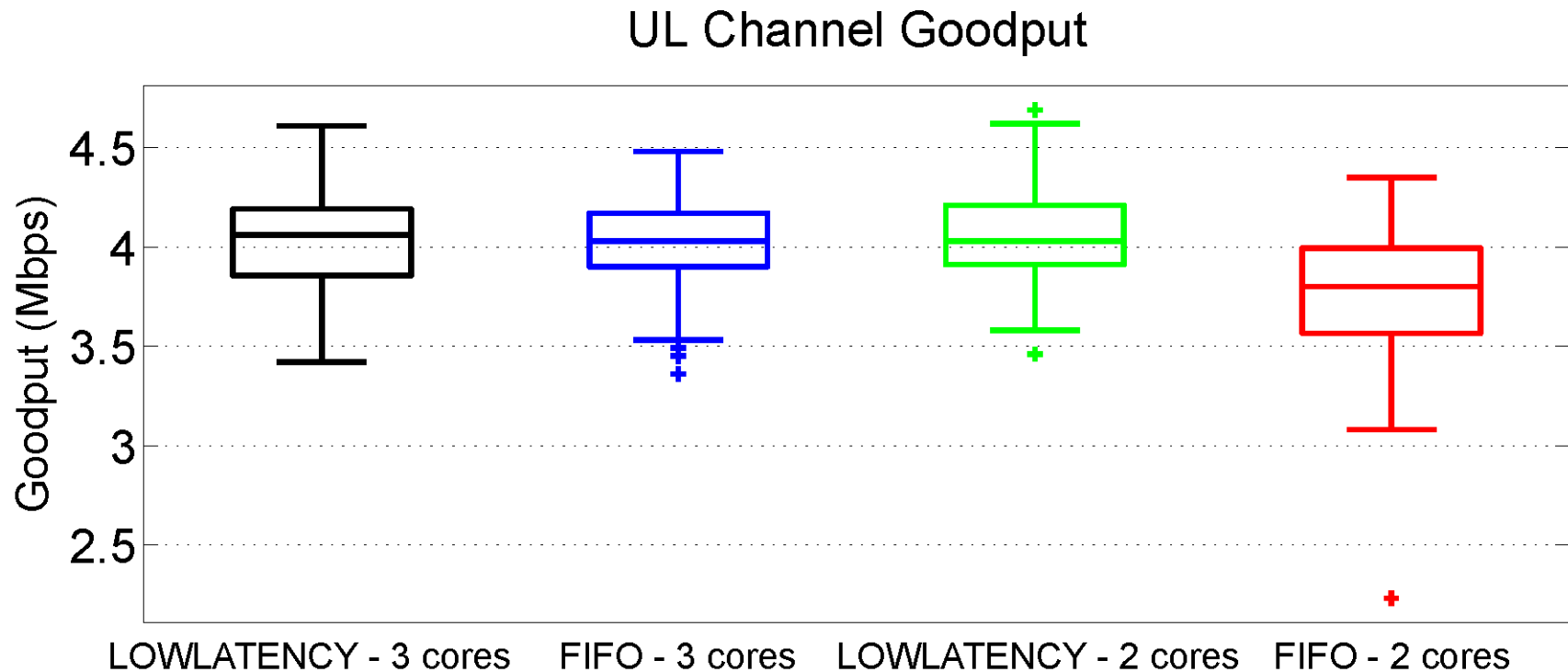
OAI LTE softmodem (L1/L2/L3) Processing

3Cores
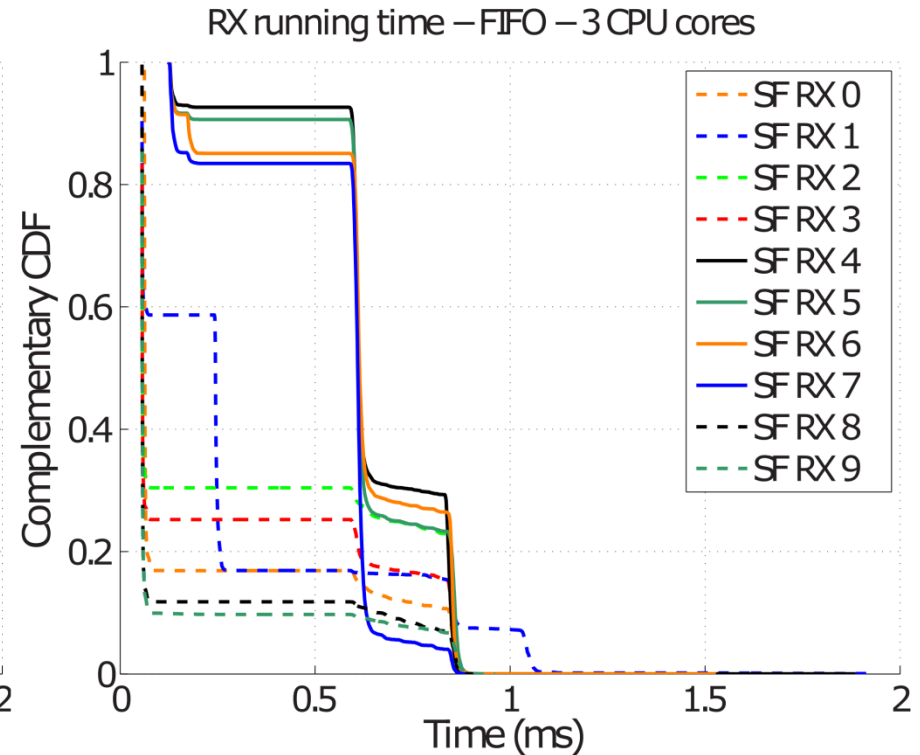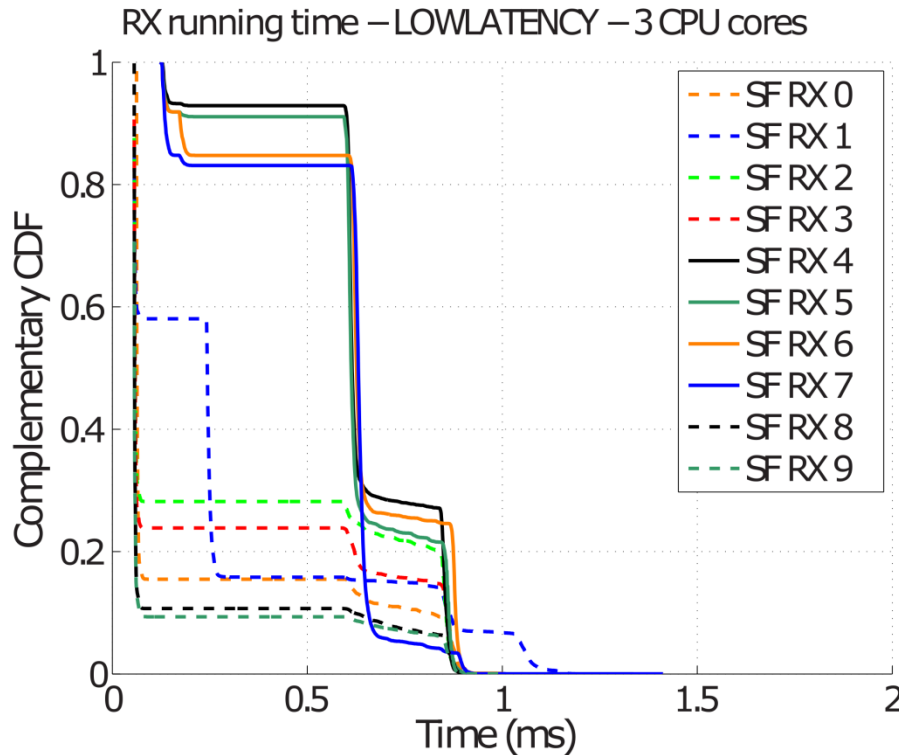
OAI LTE softmodem (L1/L2/L#) Processing
2Cores

Impact of OS and CPU on the LTE softmodem UL performance

UL Channel Goodput

Conclusion

- **5G system is more than a communication technology**
  - ➢ It is also a business helper and value creation

- **Network abstraction is needed to compose and chain network functions and applications, and map the resulted service bundle to the underlying cloud infrastructure**

- **Network slices and stores are key to deliver differentiated network service offerings optimized for each and every use case, application and user**