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2016 Spring Semester Seminar

Mobile Edge Caching with SDN

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Outline

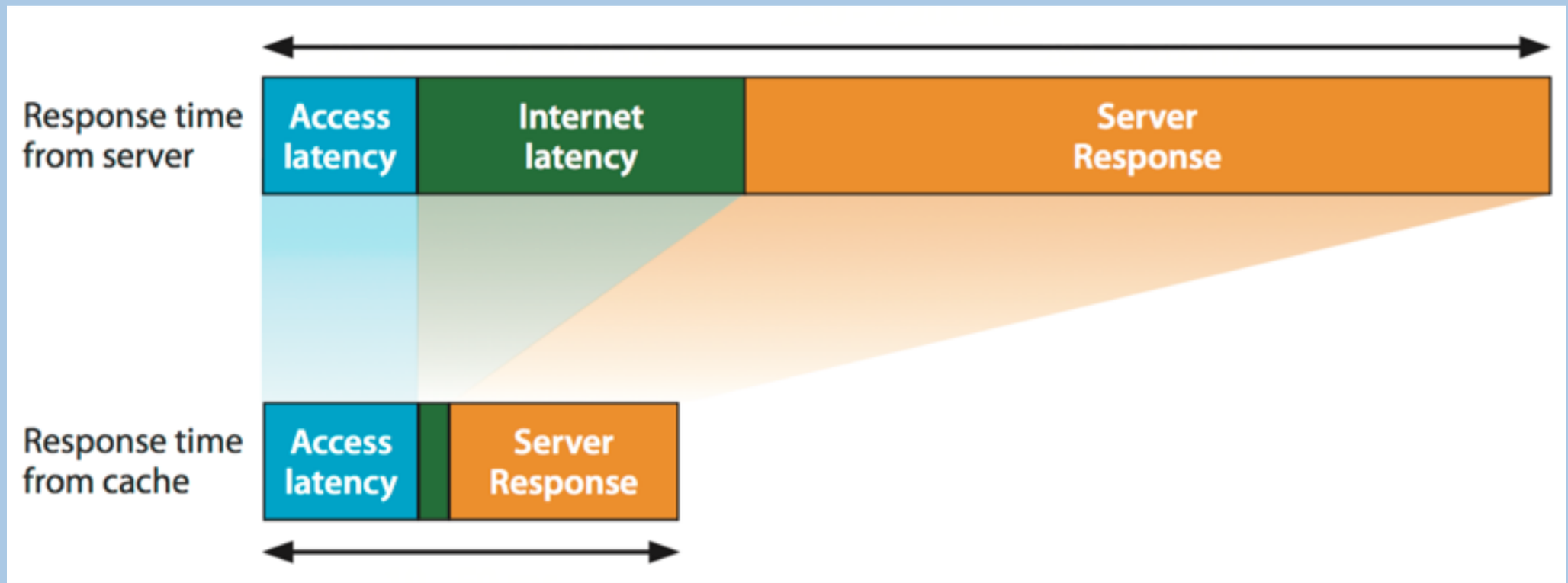
- Introduction and Motivation
- Overall Architecture
- Design and Functionalities
- Research Challenges
- Evaluation Test Beds

Introduction and Motivation

> Motivation for Mobile Edge Caching:

➡ Huge traffic growth in mobile networks.

➡ Intuitively, keeping content close to end users improves performance and reduces bandwidth consumption in the network's core.



Introduction and Motivation

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> Exploring the benefits:

➡ User: much better experienced quality of the network and potential for battery consumption savings.

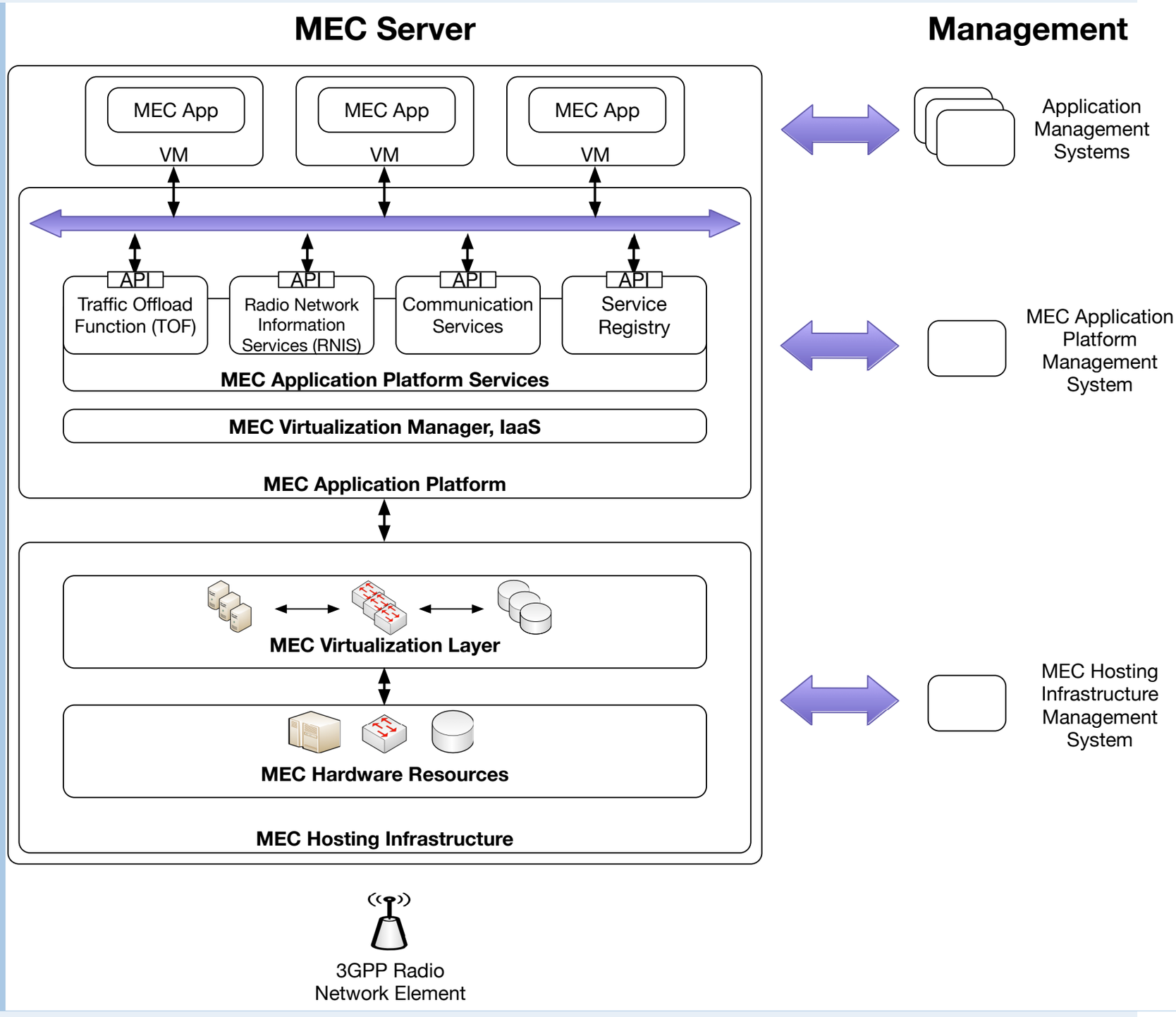
➡ Mobile Network Operator: higher network scalability and potential for tremendous cost savings. How?

- Caching improves OpEX by reducing total throughput, and improves CapEX by reducing peak bandwidth required.
- Maximum savings: up to 36%.
- Difference between L2 and L1 caching: about 10%.

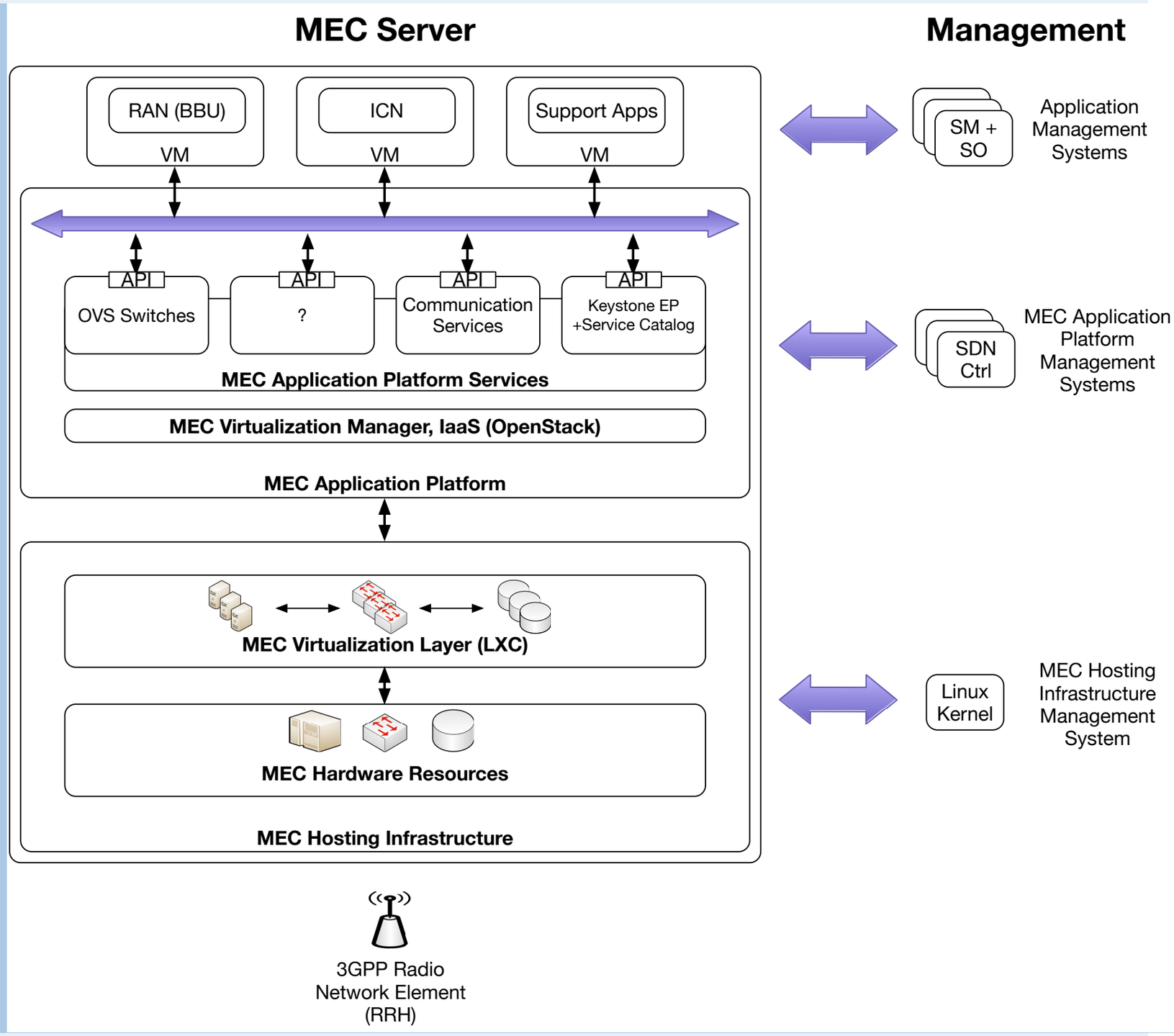
Requirements

- Compliance with standards and industry specifications:
  - ➡ 3GPP
  - ➡ ETSI
- Leverage new technologies and concepts:
  - ➡ Virtualization + cloud orchestration
  - ➡ Mobile Edge Computing
  - ➡ Software-Defined Networks
  - ➡ Cloud Radio Access Networks
  - ➡ Information-Centric Networking
- Integrate and go past simulation:
  - ➡ Architecture and framework to have all the components working together.
  - ➡ Have a working Proof of Concept.
  - ➡ Evaluate and demonstrate the PoC in existing test beds.

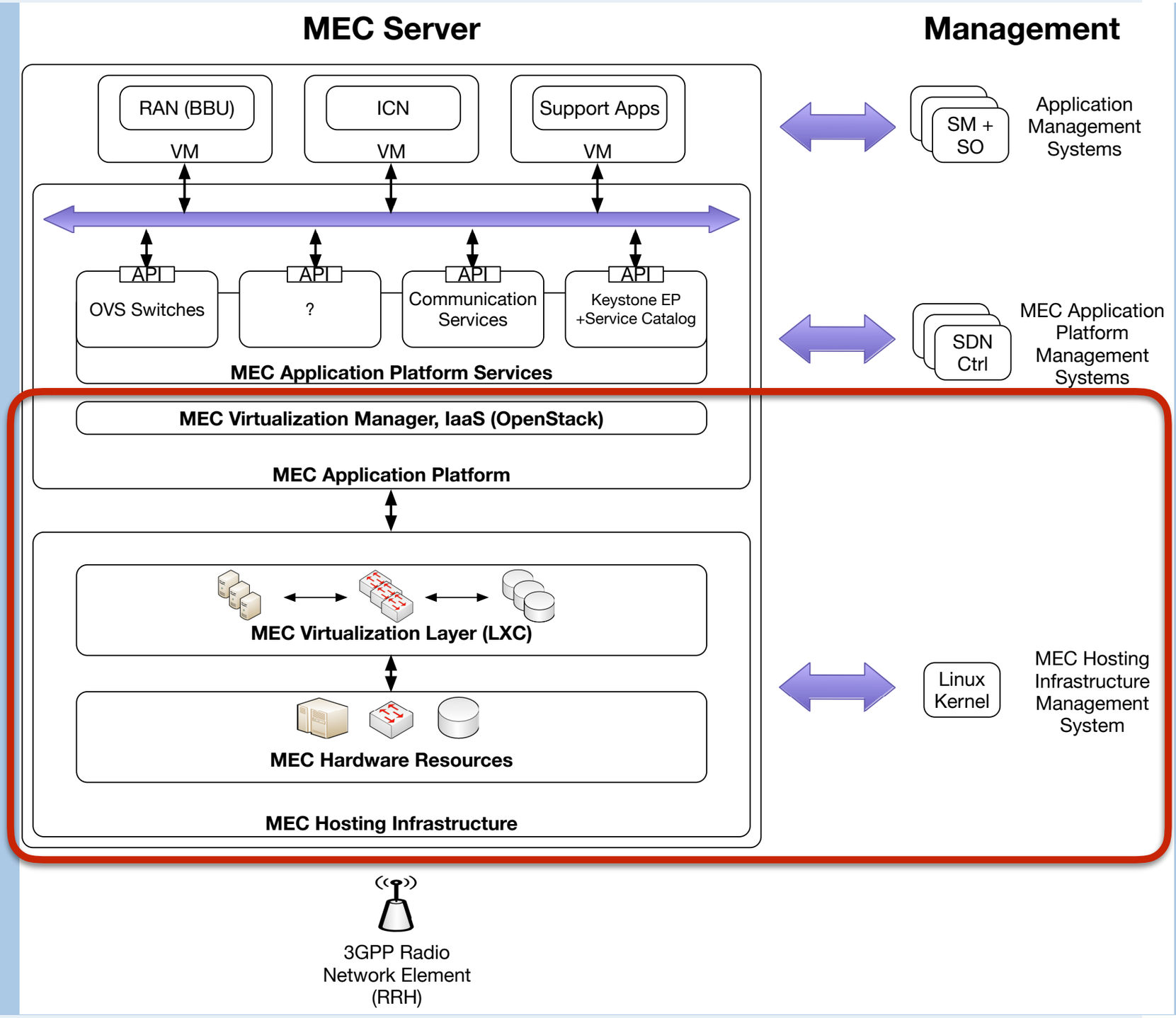
ETSI Architecture



Proposed ETSI-Compliant Architecture



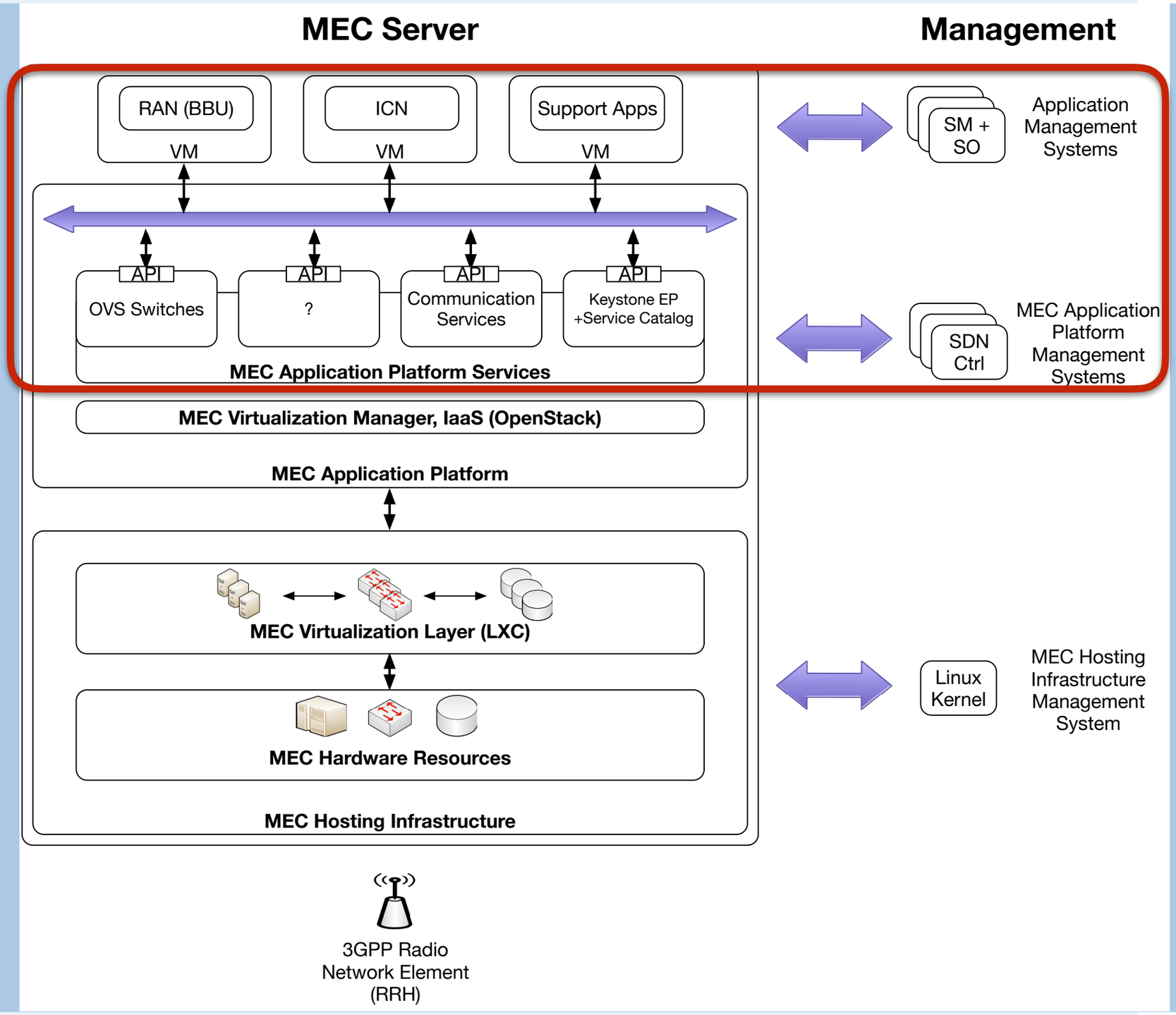
Proposed ETSI-Compliant Architecture



Design

- > Application Platform
  - ➡ Virtualization Manager
    - OpenStack (Infrastructure as a Service)
    - Includes multiple modules, e.g. Nova, Neutron, Heat
    - A logical split between controller and compute functions is usually taken into account
  - ➡ Controller Nodes
    - Orchestration, dashboards, monitoring, network management, etc.
    - Most setups only need 1 controller per DC, but a clustered approach can be used for redundancy.
  - ➡ Compute Nodes
    - Direct access to HW resources. With LCX containers and low-latency Linux kernel, more demanding applications can be supported.
    - Any number of compute nodes may exist at a micro DC.

Proposed ETSI-Compliant Architecture



Design

- Application Platform Services
  - ➡ OVS Switches
    - SDN-enabled virtual switches to connect applications and other components.
  - ➡ Communication Services
    - Enable communication between different applications at an API level.
  - ➡ Keystone
    - Catalogue of all available applications and their endpoints, i.e. where all the applications need to register to be found.

Design

- Applications
  - ➡ RAN (BBU)
    - Virtualized LTE base stations.
    - Cloud orchestrated, deployed and scalable on demand.
  - ➡ ICN
    - Application that supports deploying and scaling ICN routers on demand.
    - Routers process traffic from eNBs and provide a seamless caching platform.
  - ➡ Support Apps
    - Other applications, such as analytics/monitoring and specific charging functionalities.

Research Challenges

> SDN-based traffic forwarding

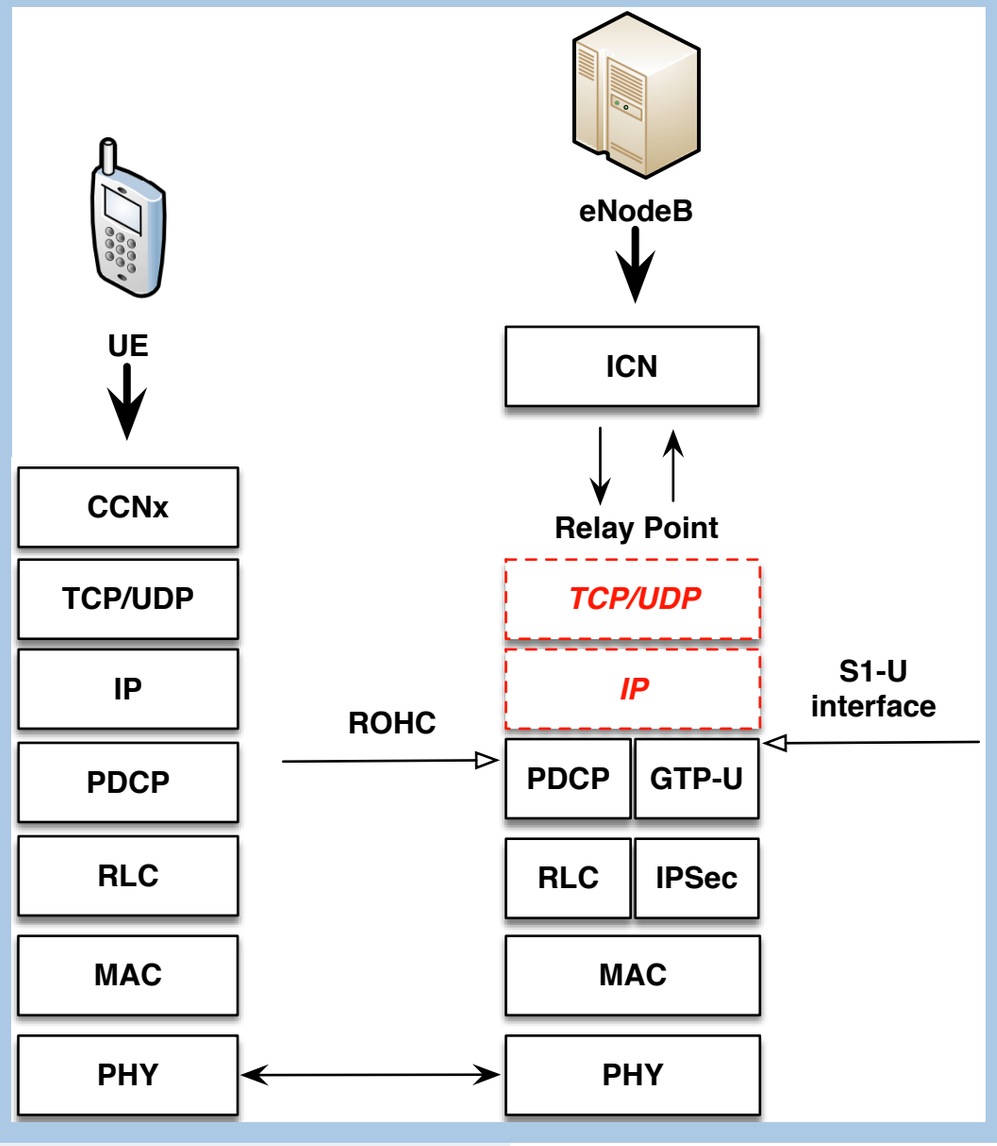
➡ Managed by SDN Controller, can be integrated with OS Controller.

➡ Mapping between GTP-U and S1 interfaces:

- Multiple tunnels between eNBs and the EPC.
- How to map? N:M? N:N?

➡ Traffic forwarding between eNBs and ICN:

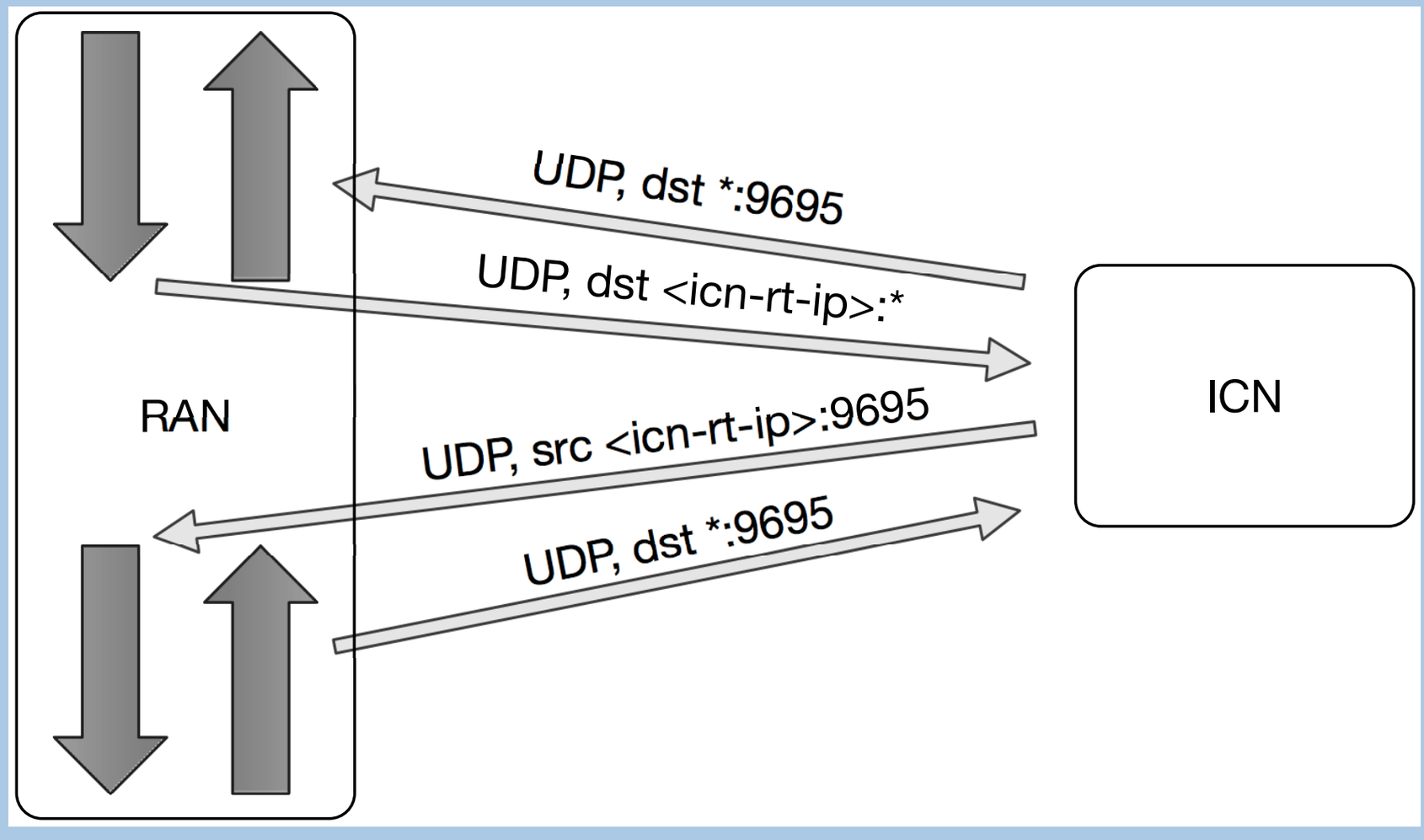
- Where to get the traffic?



> SDN-based traffic forwarding (cont.)

➡ Traffic forwarding between eNBs and ICN:

- How to redirect traffic and inject it back?



Research Challenges

- SDN-based traffic forwarding (cont.)
  - ➡ Traffic forwarding between eNBs and ICN:
    - How to map between eNBs and ICN routers?
    - Caching is important: multiple ICN routers must share the cache to make maintain efficiency. May be done with repository.
- ICN Scalability
  - ➡ How to scale?
    - If cache needs to be maintained, one option is to scale out and sync repositories.
    - Mapping between routers and repositories may be N:M.

Research Challenges

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- 3GPP Compliance
  - ➡ Lawful Interception
    - Can only be guaranteed if traffic always flows through the EPC.
  - ➡ Charging
    - Within the EPC. What if content is cached? ICN or eNB need to interact with EPC and report.
- Handovers
  - ➡ What happens to the flows?
  - ➡ Shall they be redirected for a while? Or should a FMC approach be triggered?

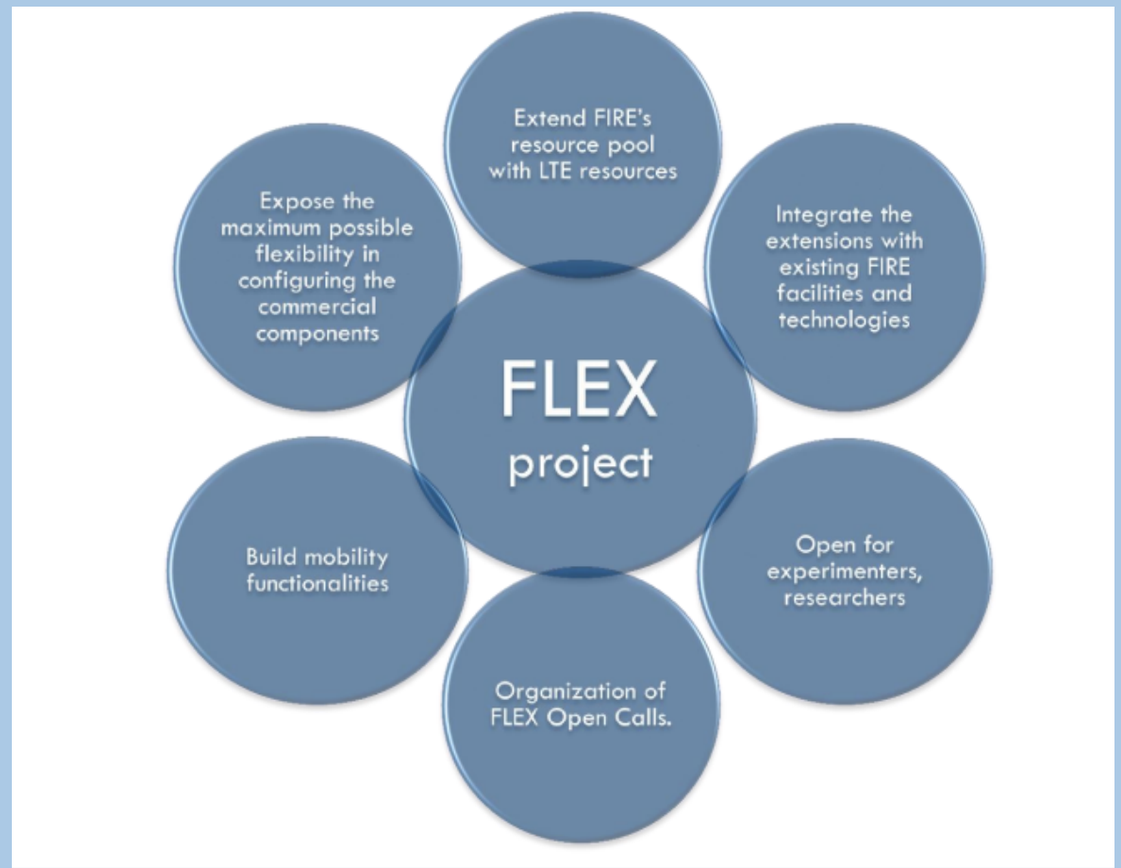
Where does it fit?

> FLEX: FIRE LTE Testbeds for Open Experimentation:

➡ EU FP7 Project.

➡ Duration: 36 Months (Starting from Jan 2014).

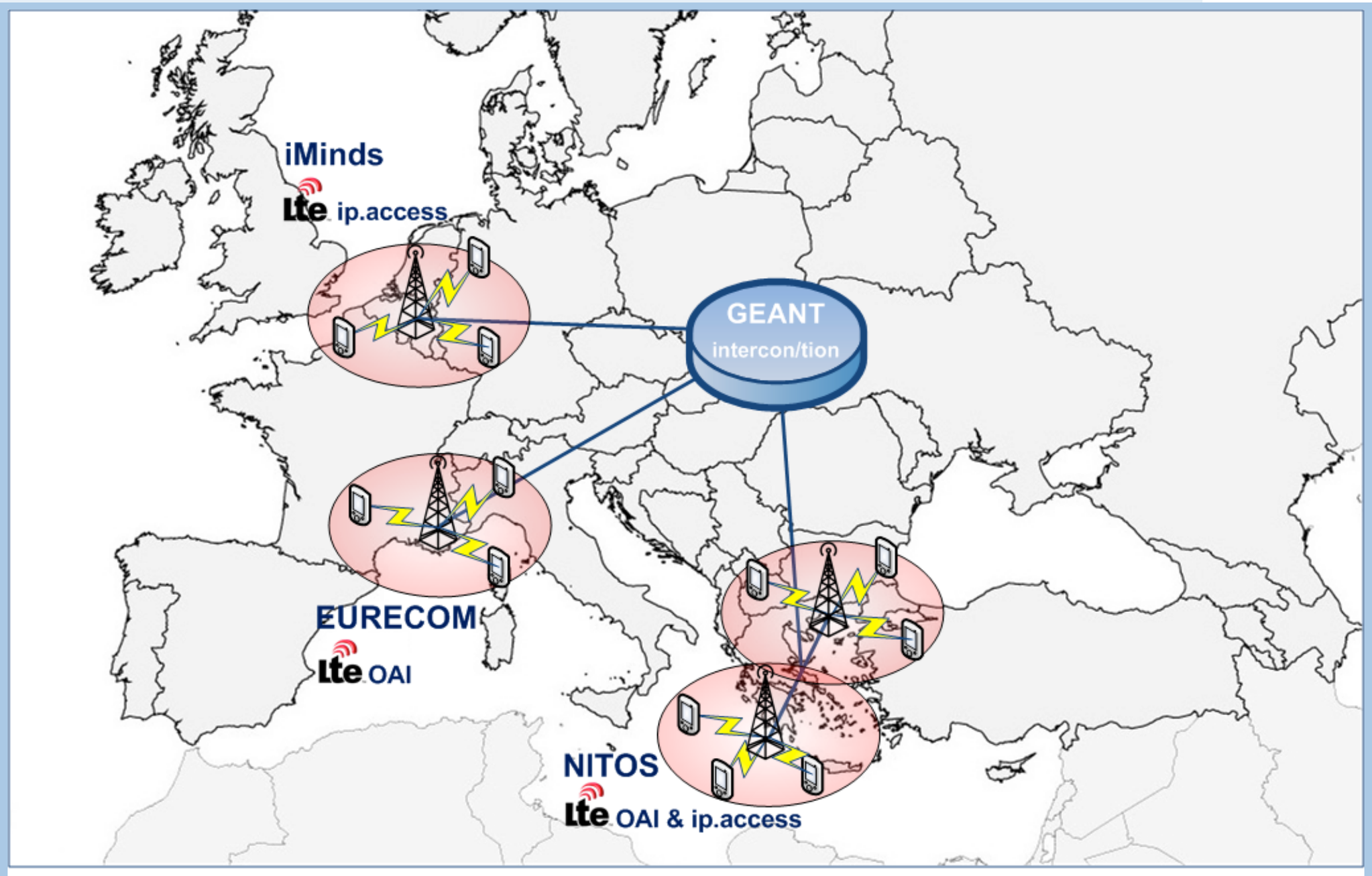
➡ UNIBE joining April 1st for 9 months. Main contributor: Eryk Schiller.



Test Beds

- Two main different setups will be developed for the creation of operational LTE test beds:
  - ➡ Setup 1: Based on commercial equipment
    - SIRRAN EPC
    - ip.access cellular equipment
    - commercial UE
  - ➡ Setup 2: Open Source components
    - OpenAirInterface core network
    - OpenAirInterface eNodeB
    - OpenAirInterface/commercial UE

Test Beds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NITOS
Lte OAI & ip.access

Q&A - Discussion