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Master Thesis:
Mobile Edge Caching

Ehsan Farhadi
Supervisor: Eryk Schiller
Pr. Torsten Braun

Communication and Distributed Systems
Universität Bern

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Outline

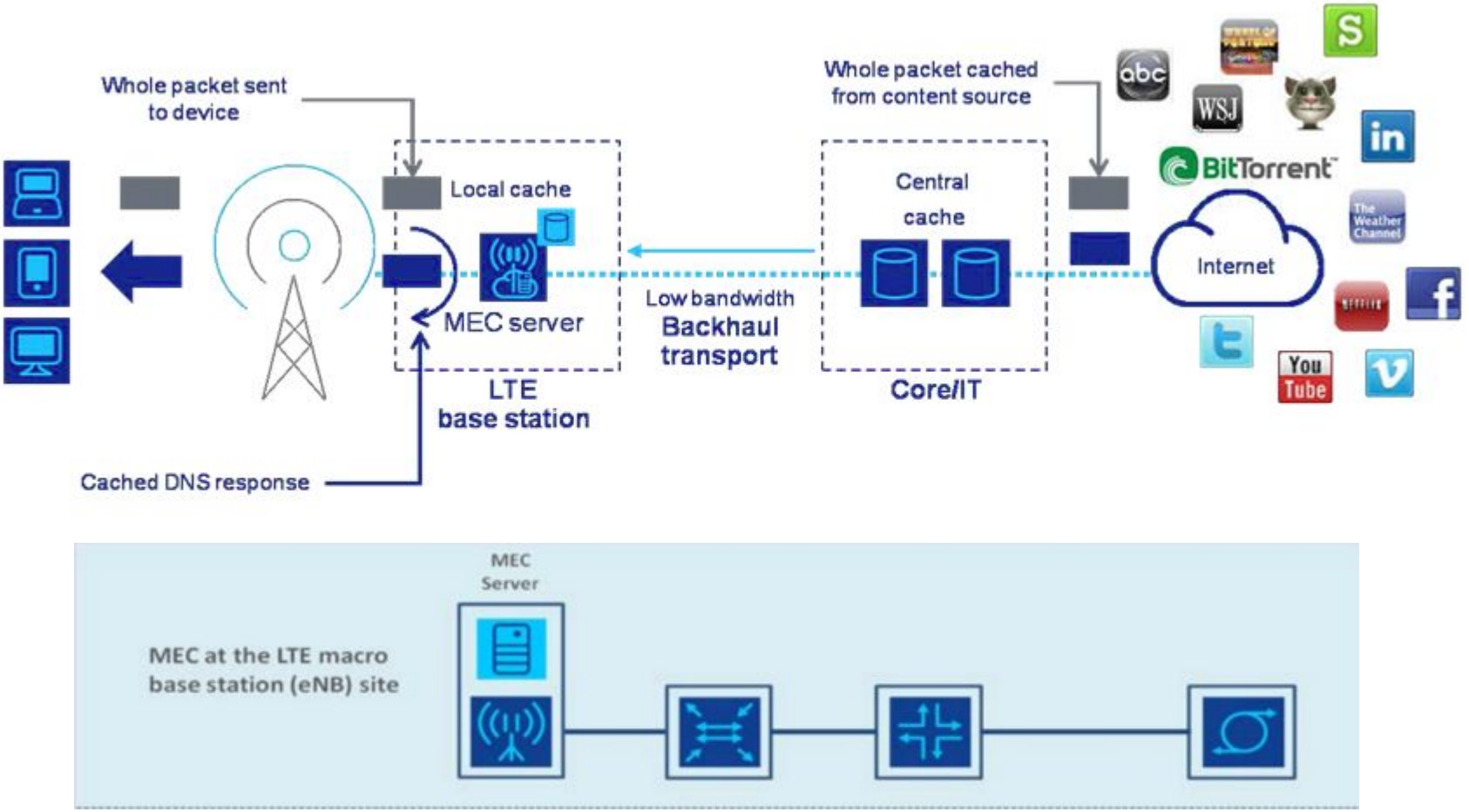
- Introduction and Motivations
- Goals and objectives
- Tasks
- Proposed Architecture

Mobile Edge Computing

"Service on the edge of the cellular network"

- Due to Dramatic growth in mobile traffic
  - By smartphone users
  - By machines
- And capabilities of new technologies (like virtualization, SDN)
- Characteristics:
  - On-Premises
  - Proximity
  - Lower latency
  - Location awareness
  - Network context information

Mobile Edge Computing



Mobile Edge Computing architecture

Mobile Edge Caching

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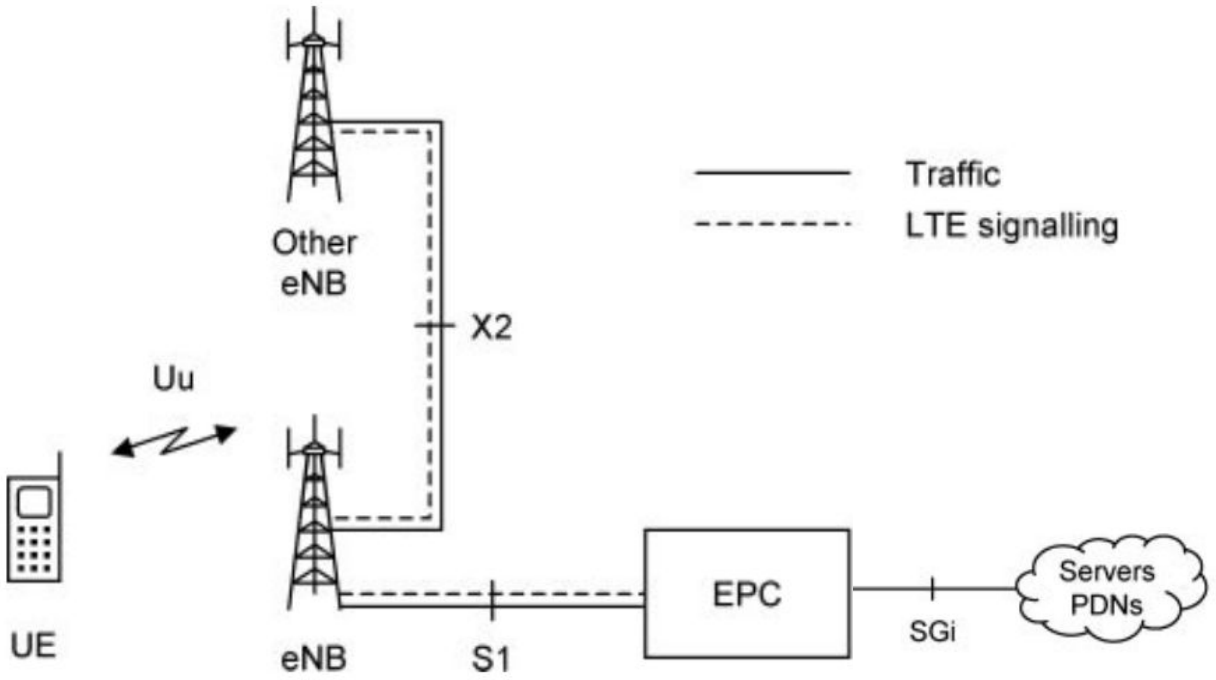
- Heavy traffic load on mobile networks
  - Content caching: reduce backhaul capacity requirements by up to 35%
  - DNS caching: reduce webpage download time by 20%[1]
- Benefits for end user:
  - better experience and quality of network
- Benefits for Mobile network Operator:
  - higher network scalability
  - Caching improves OpEX by reducing total throughput, and improves CapEX by reducing peak bandwidth required[2]
  - Maximum savings: up to 36%[2]

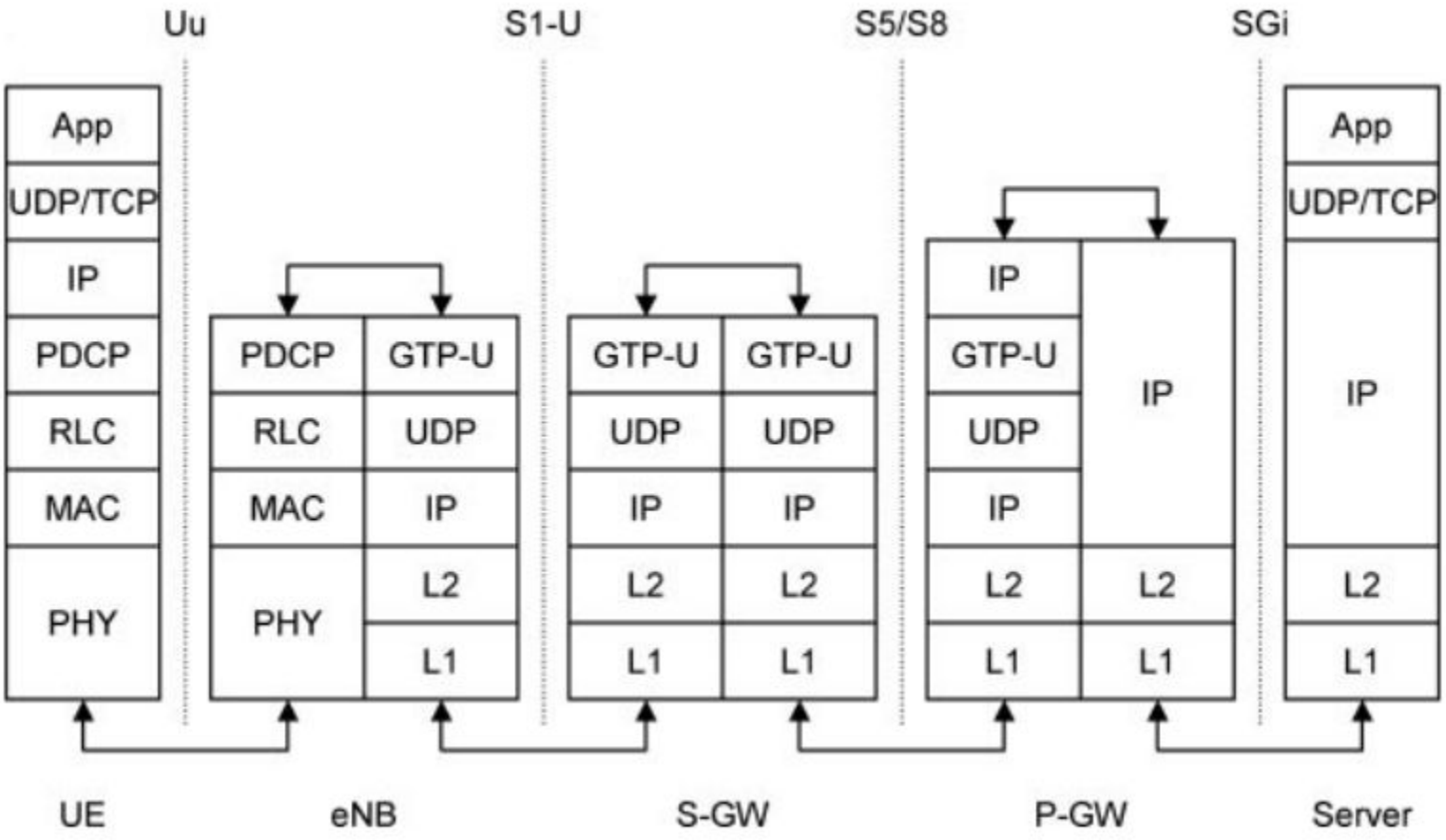
1 “Mobile-Edge Computing” - Introductory Technical Whitepaper
2 “The Business Case for Caching in 4G LTE Networks” - Whitepaper

LTE Architecture



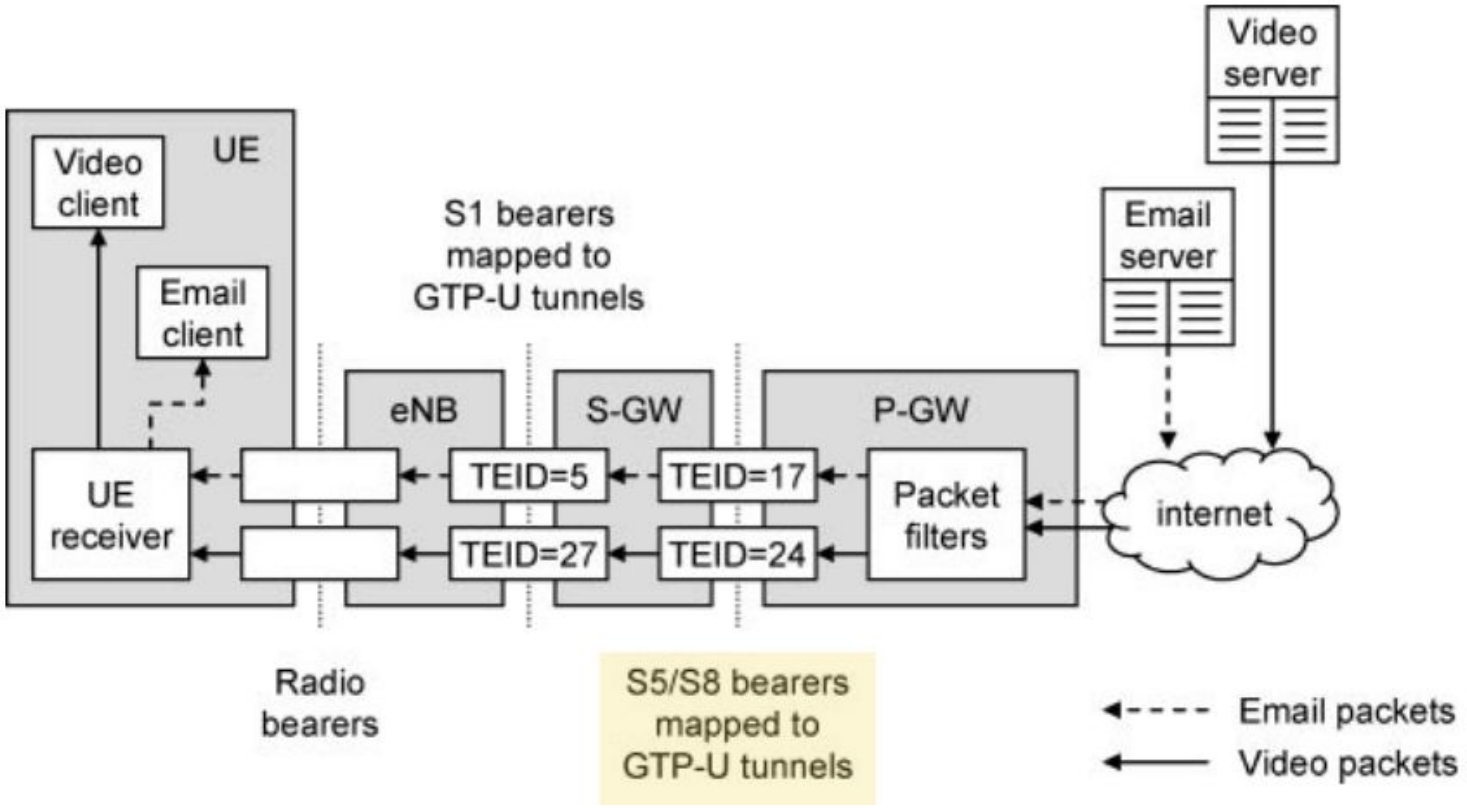
Architecture of the evolved UMTS terrestrial RAN

LTE Protocol stacks



Protocol stacks used to exchange data between mobile and an external server

GTP Tunneling



Implementation of tunneling in the downlink, based on GTP

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.

Objective

Set up a MEC server approximate to eNB with caching capabilities using

1. Identify the KPIs, critical metrics for the execution of EDGE caching.
2. Implement components, to provide the required functionality for EDGE caching.
3. Perform use-case studies, and select valuable verticals for our experiments.
4. Integrate the whole system, and provide the studies on the selected verticals.
5. Refine the system based on the experiments performed.
6. Address the final remarks on the architecture using the experience from experiments.

Tasks

- Setup OpenStack
- Setup and modify OpenAirInterface
- Setup and Configure Open vSwitch
- Setup, Integrate and configure Opendaylight
- Add CCNx (ICN based caching) component

OpenStack

- Open source software for creating private and public clouds
- Deploy VMs and other instances that handle different tasks, for managing a cloud environment on the fly
- Components:
  - **Nova:** is the primary computing engine
  - **Neutron:** provides the networking capability
  - **Heat:** is the orchestration component
  - ...

OpenAirInterface

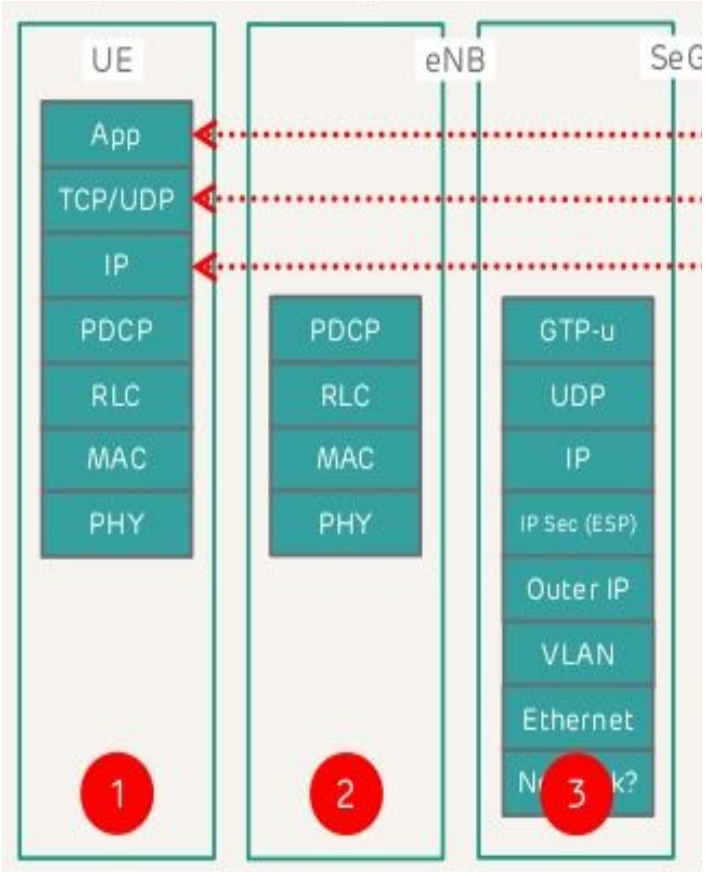
> Open-source (hardware and software) wireless technology platforms for deployment of mock network with high level of realism

- User equipment (UE)
- eNodeB (eNB)
- Core network (EPC)

OpenAirInterface

- Current architecture of OpenAirInterface:
  - Receiving packet from UE, relaying it and encapsulate it and GTP-U packet and sent to S-GW
  - GTP-U: Multiple tunnels between eNBs and the EPC per UE
  - Therefor, no caching available

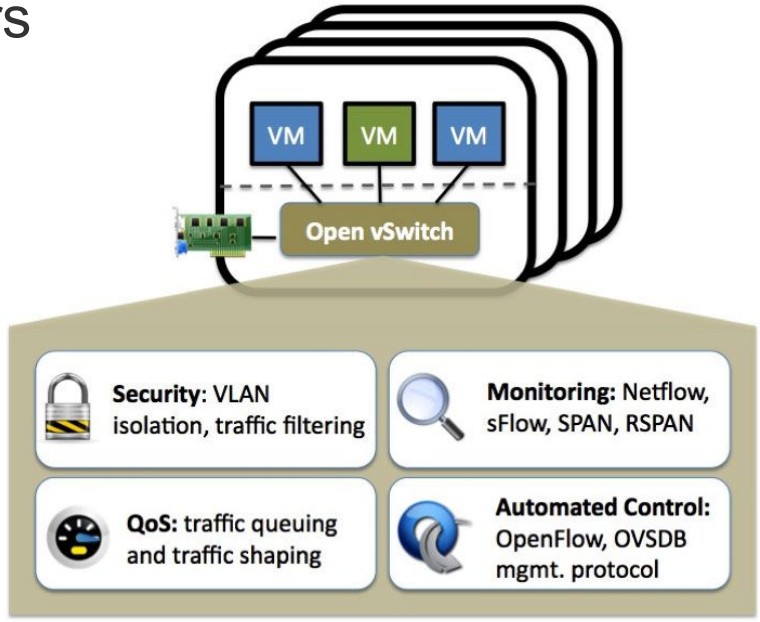
    At the edge



Open vSwitch

- open-source distributed virtual multilayer switch
- provide a switching stack for hardware virtualization environments
- Open vSwitch is meant to be controlled and managed by third party controllers

➥OpenDayLight



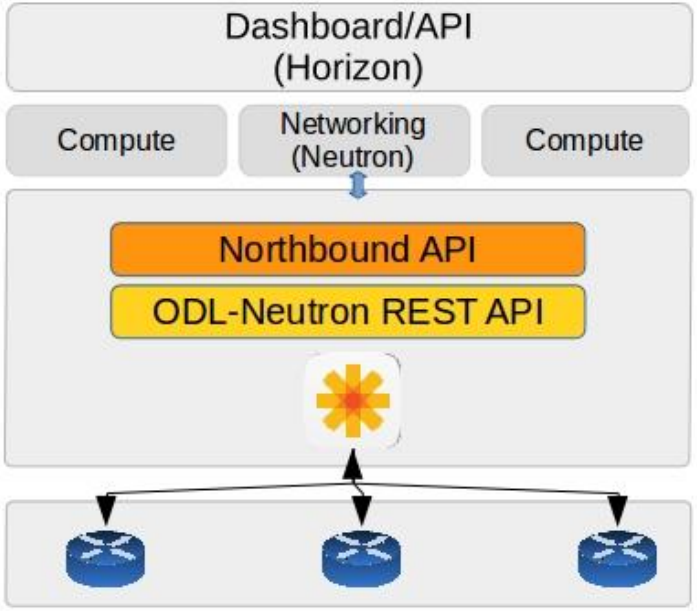
Open vSwitch

- Current OVS does not support GTP
- We are going to either:
  - patch OVS with existing solutions on the internet

  or:
  - Configure OVS to provide routing for GTP packets

Opendaylight

- Open source project. Accelerate the adoption of SDN and create a solid foundation for NFV
  - Open source framework and platform for SDN
- Control Open vSwitch



CCNx

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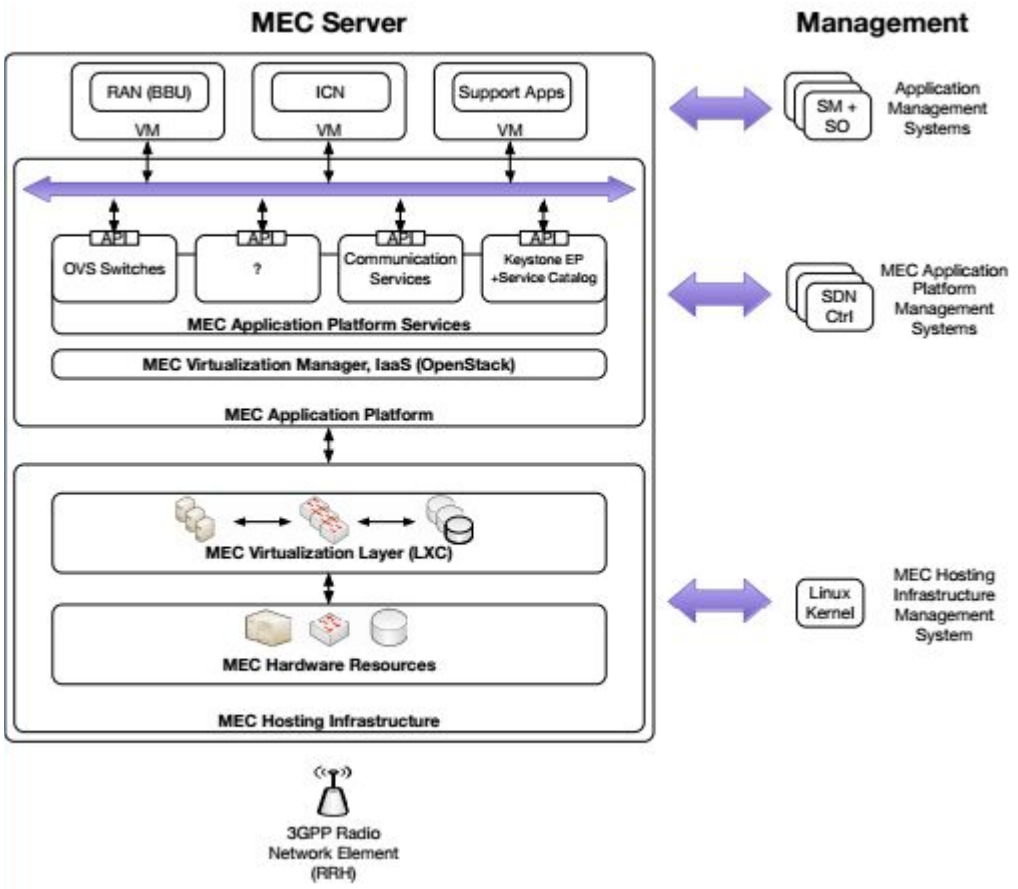
- Content-Centric Networking is a network architecture
  - Routes and delivers named pieces of content at the packet level of the network
  - CCN's security model focuses on explicitly securing the content itself, instead of securing endpoints or connections
  - enabling automatic and application-neutral caching in memory wherever it's located in the network
- We will use Andre's CCNx implementation

Proposed Architecture

Proposed by Andre Gomez.

- OVS Switches
- Communication Services
- Keystone

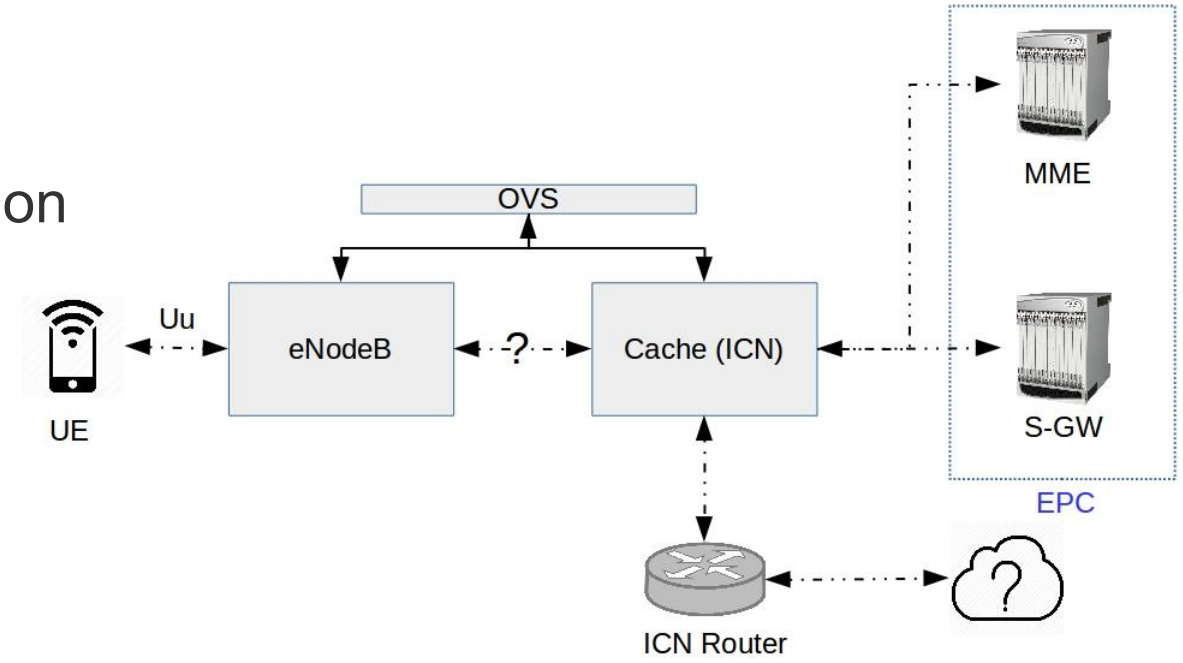
- RAN (BBU)
- ICN
- Support Apps



Proposed Architecture

How to apply?:

- Billing
- Traffic shaping
- Lawful interception



Proposed Architecture

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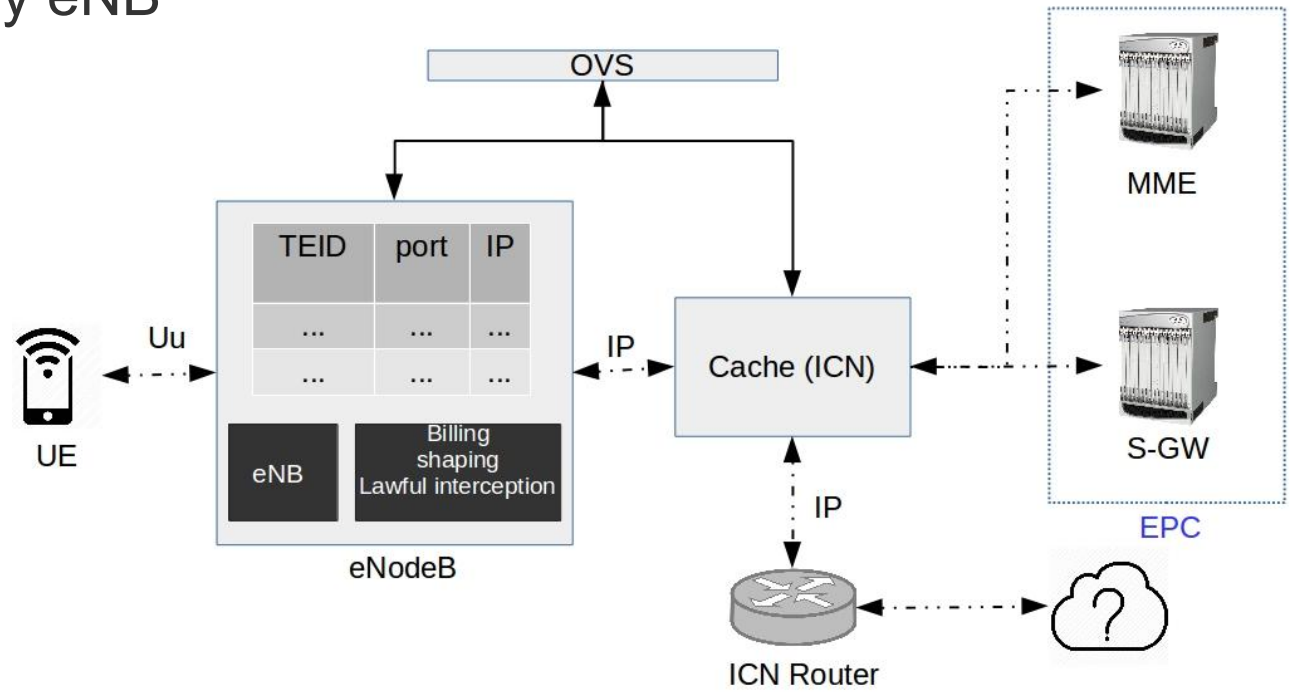
Option 1: Modify eNB



Proposed Architecture

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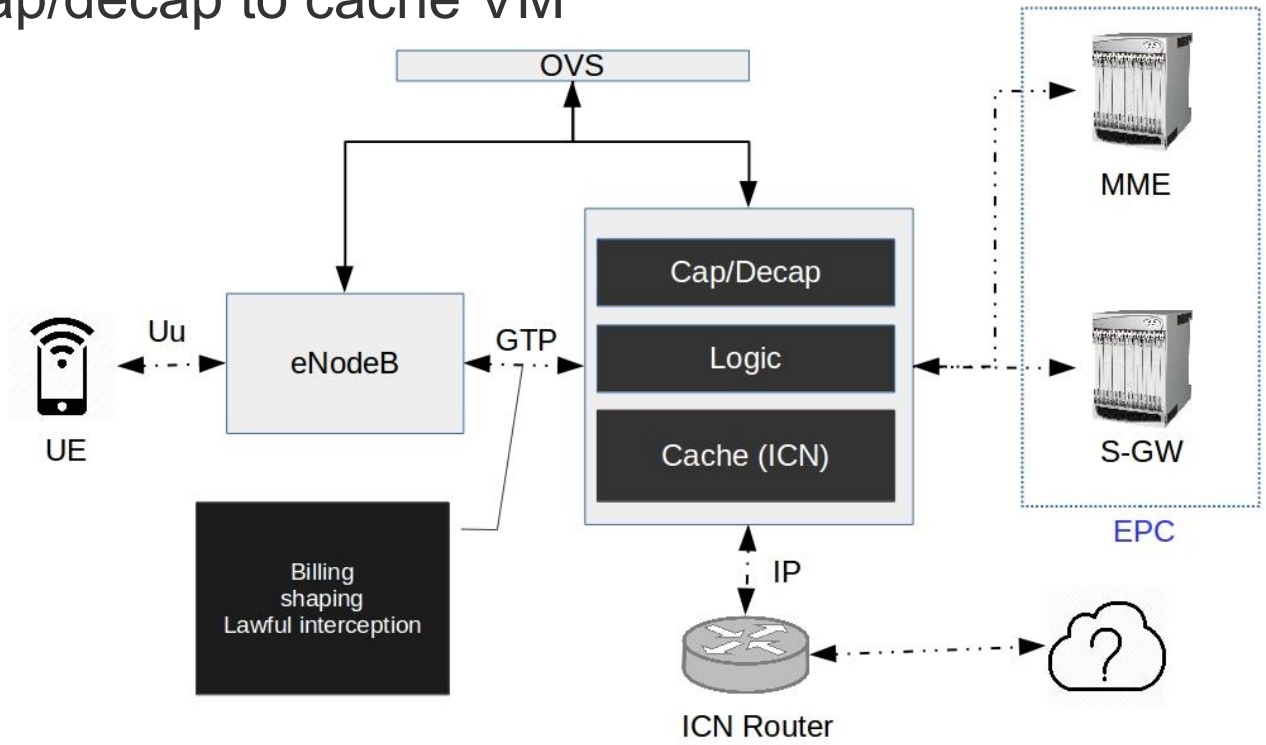
Option 2: Add cap/decap to cache VM



Proposed Architecture

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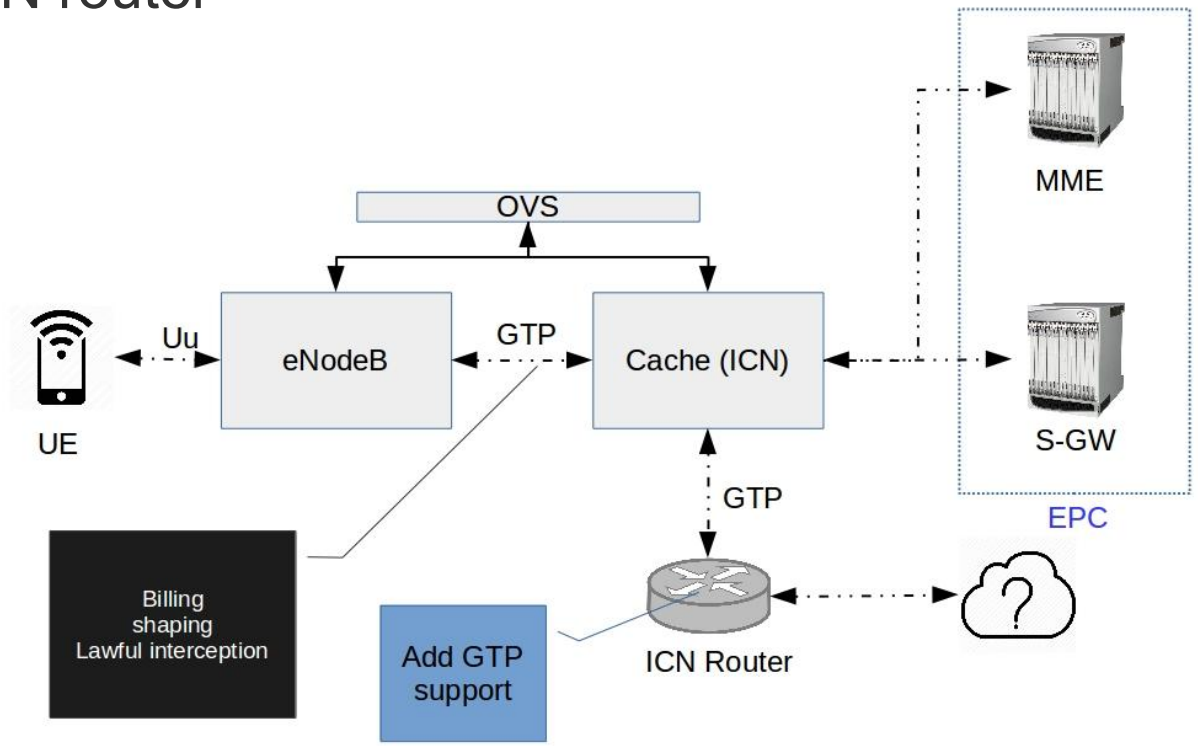
Option 3: Modify ICN router

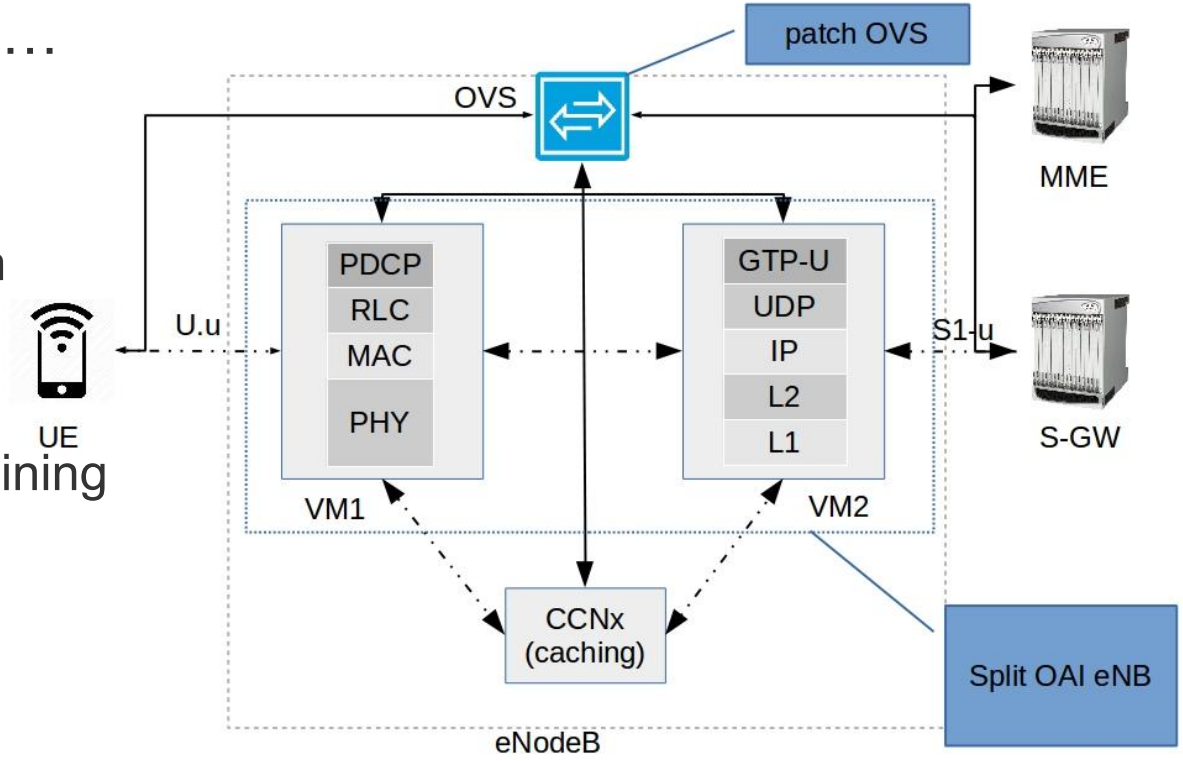


Proposed Architecture

Later Implementations…

Facilitate:
composition/decomposition

By
> SDN/NFV function chaining



FLEX project

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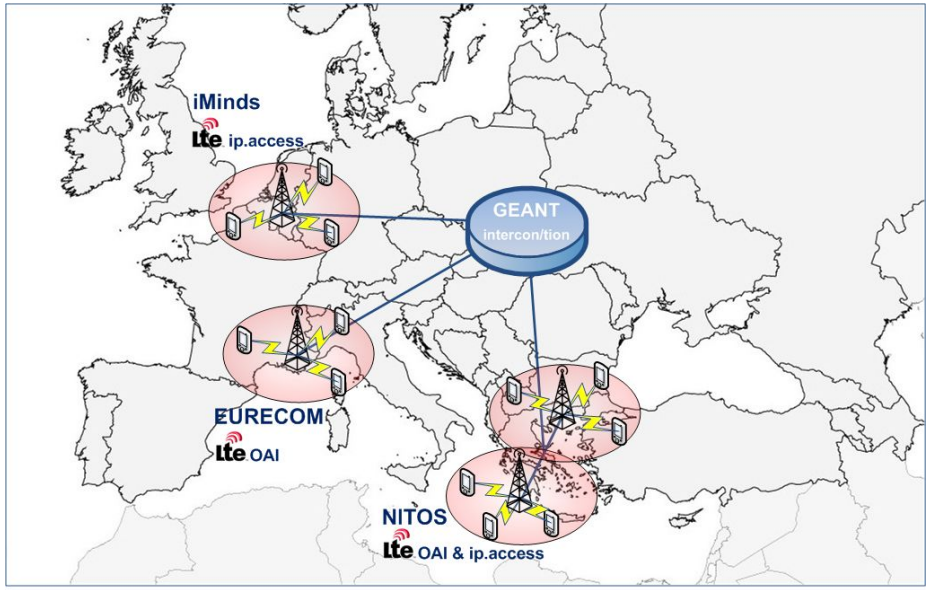
After testing our architecture on local local testbed. We can implement it on:

- FLEX: FIRE LTE testbeds for open experimentation
- EU FP7 Project.
- Since jan 2014
- UNIBE joining for 9 months
- Main contributor
  - ErykSchiller



Q&A- Discussion