MOBISLICE / 5GNETApp Workshop (in IEEE SDN-NFV 2018)

5G-ready Network Applications Development and Orchestration over Network Slices with Mobility Support

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SDN-based End-to-End Flow Control in Mobile Slice Environments

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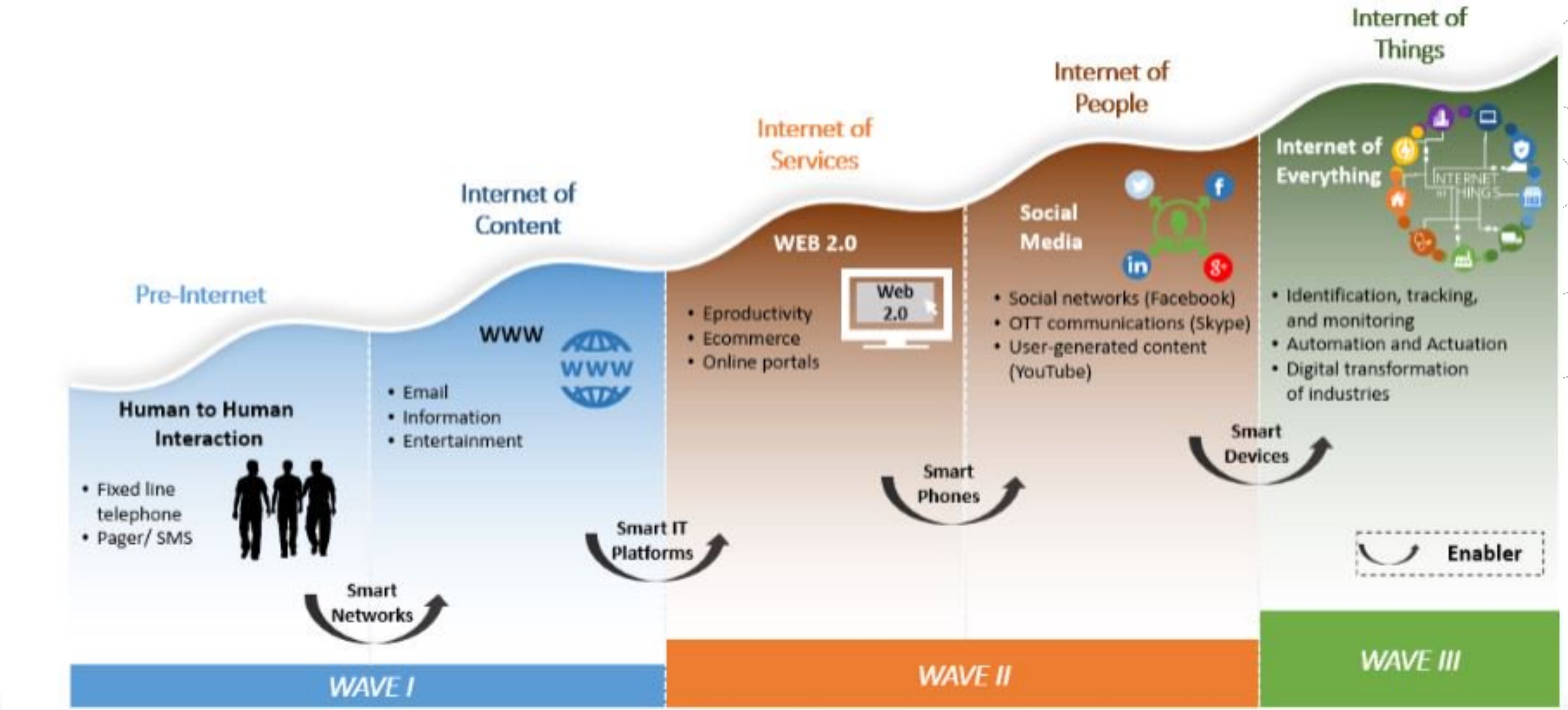
Outline

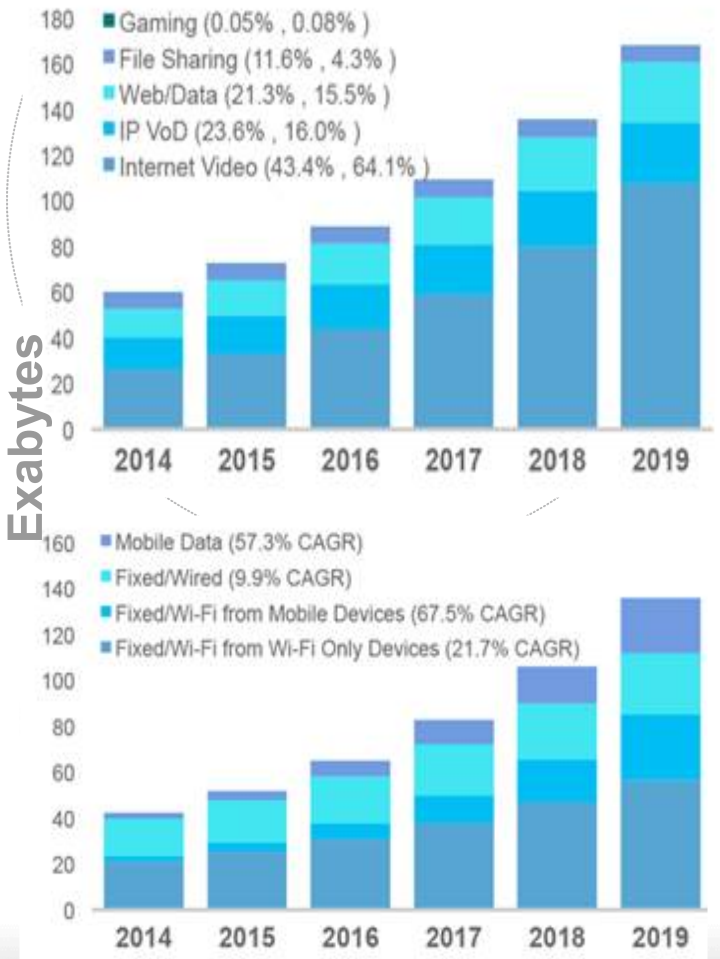
1. Motivation & Objectives
2. Main Goal of the framework
3. Framework architecture
4. Signalling procedure
5. Results
6. Conclusion

Motivation: **Internet evolution**



Motivation: Why Mobility?

- **IP video traffic** will account for **80 percent of traffic by 2019**.
- The implications of video growth are difficult to overstate. With video growth, Internet traffic is **evolving from** a relatively steady stream of traffic (characteristic of P2P) to a **more dynamic traffic pattern**.
- By 2019, wired devices will account for 19 percent of Internet traffic, and **Wi-Fi and mobile devices will account for 81 percent of Internet traffic**. In 2014, wired devices accounted for less than half of Internet traffic, at 39 percent.



[1]http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/VNI_Hyperconnectivity_WP.html

Motivation: Why Mobility?

- Users consuming video on smartphones;
- Smartphones are able to exploit **multiples wireless technologies while on the move;**

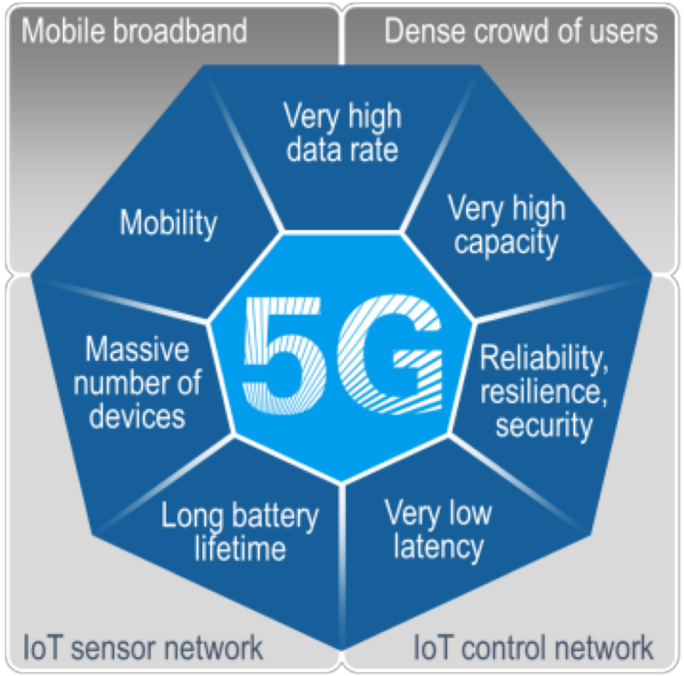
↓

- Opportunity for **offloading** and better **traffic adaptation**

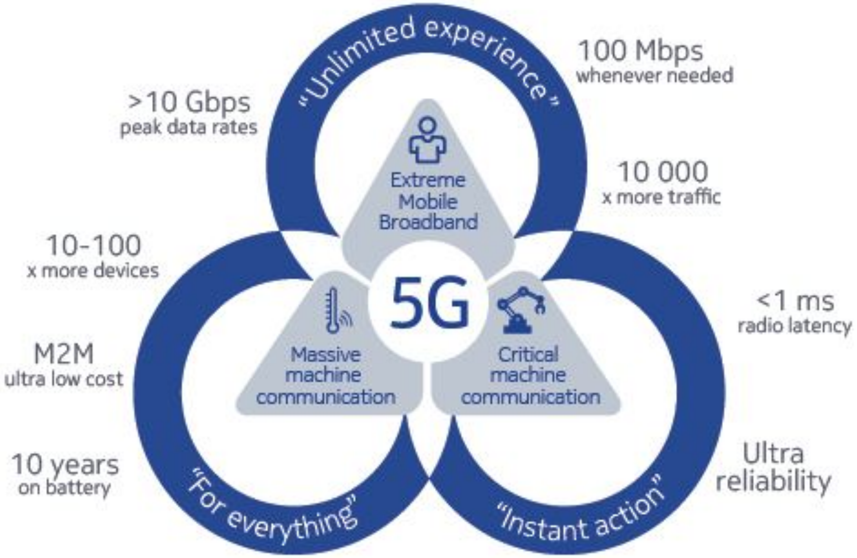
↓

- Currently we have several mobility architectures coupled with other protocols (eg. OPMIP)

Motivation: **5G Requirements**

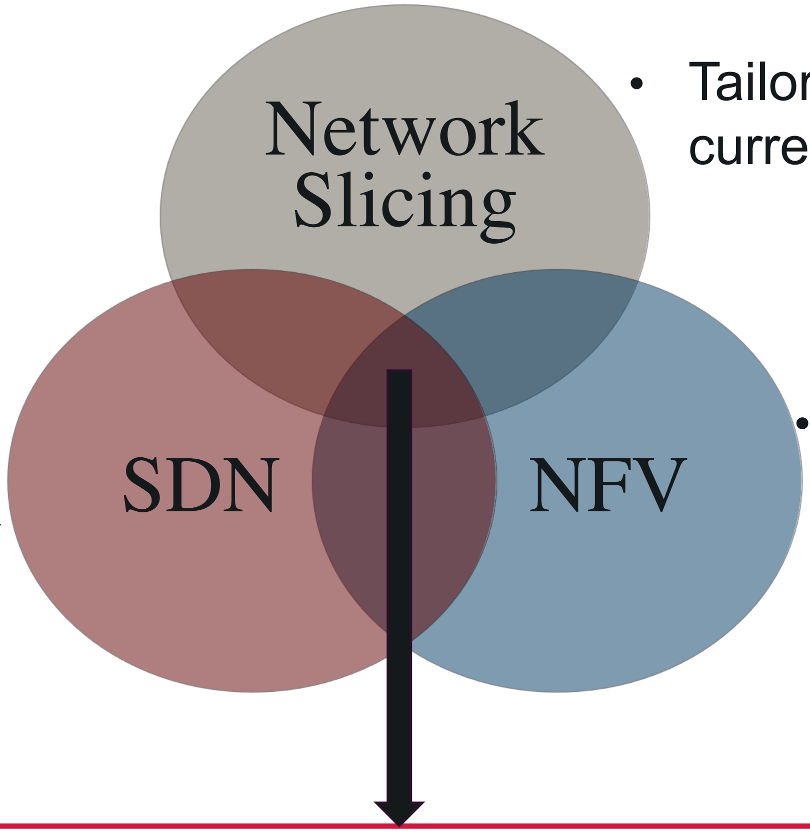


[2]https://www.rohde-schwarz.com/us/solutions/wireless-communications/5g/5g-fundamentals/5g-fundamentals_229439.html



[3]http://next-generation-communications.tmcnet.com/topics/industries/articles/419508-5gs-mission-critical-objectives.htm

Key enablers



- Tailor the network to the current traffic requirements

- flexibility
- (re)configurability

- Network functions installed (e.g., MME) into VMs on a data center

provide abstract mechanisms that support **flow-based mobility management** in an access technology-independent deployment, while **tailoring the network** to the use case requirements

Main Goal

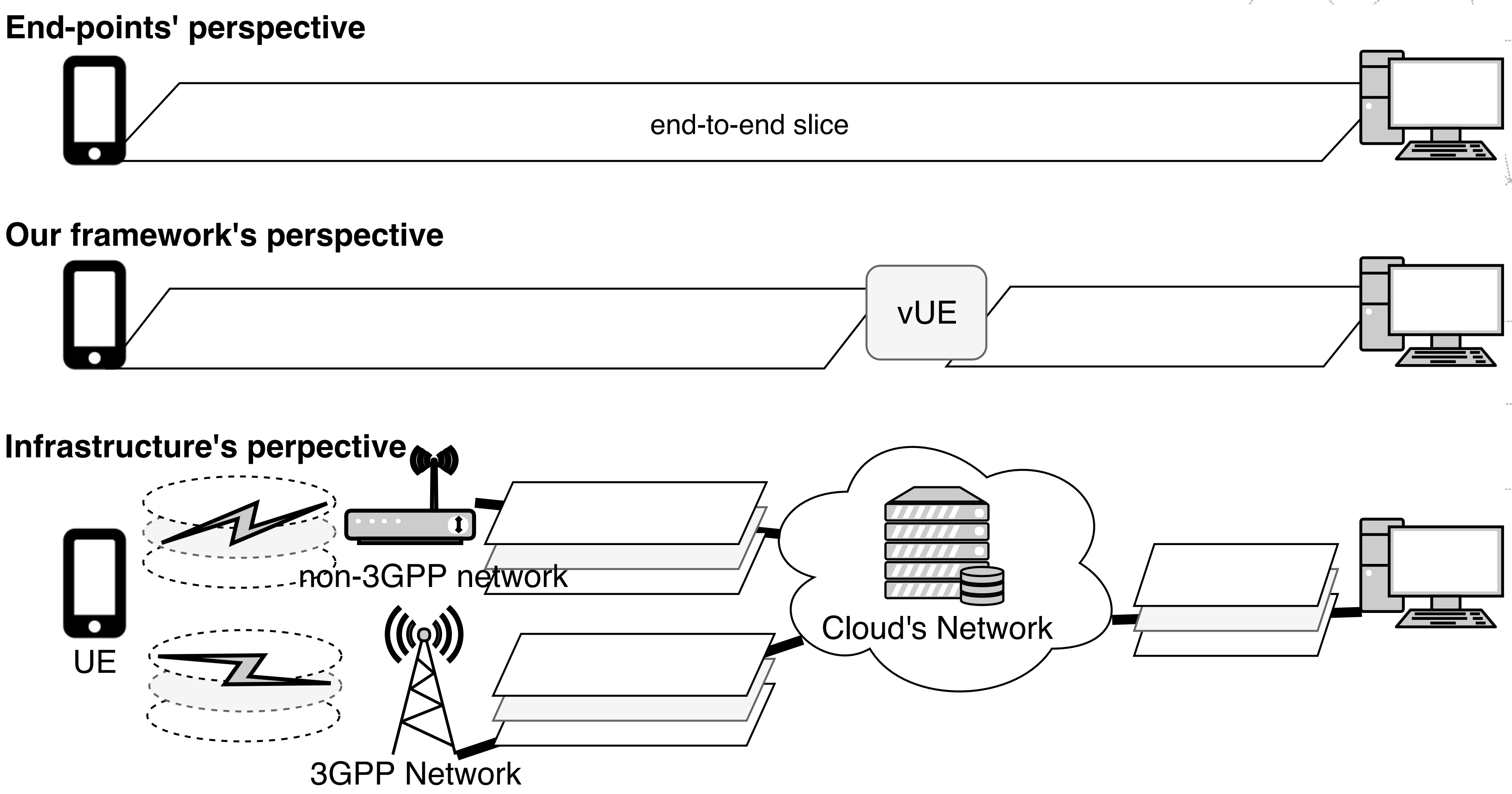
- Users consuming video on smartphones;
- Smartphones are able to exploit **multiples wireless technologies while on the move;**

- Opportunity for **offloading** and better **traffic adaptation**

- Currently we have several mobilit… …res coupled with other protocols (eg. OPM…

OpenFlow

Proposal Overview



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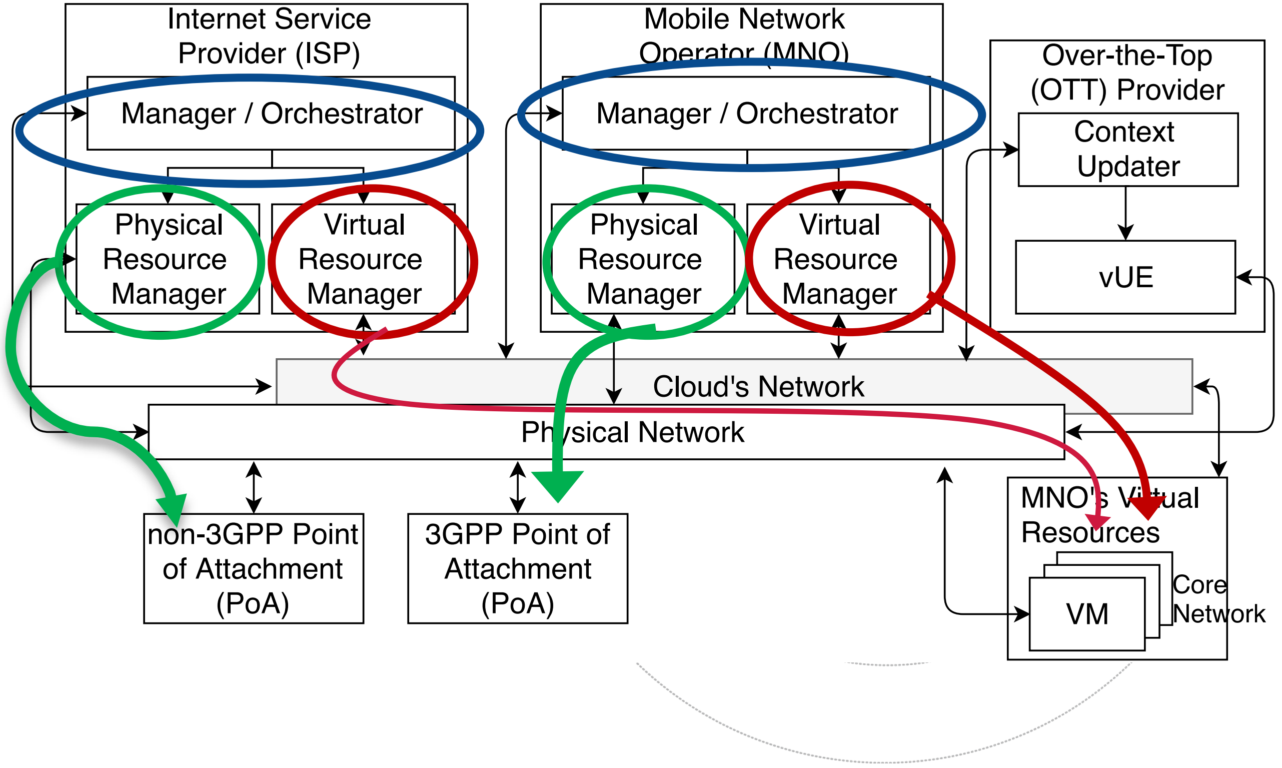
Architecture (1)

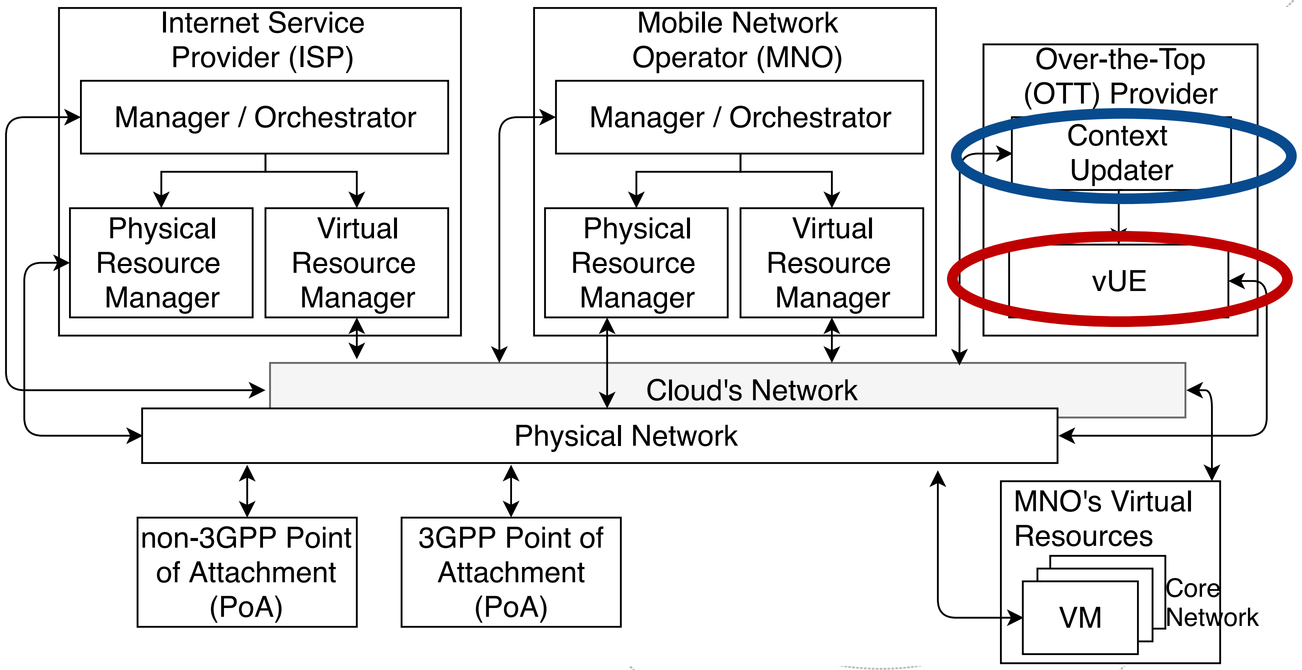


- ***Orchestrator***
  - interoperate with its SDN resource elements (via Physical and/or Virtual Resource Manager);
  - communicate with OTT providers through northbound APIs;

- ***Physical Resource Manager***
  - Instantiates and manages PHYSICAL network functions (PNFs) for E2E slices;

- ***Virtual Resource Managers***
  - Instantiates and manages VIRTUAL network functions (VNFs) for E2E slices;

Architecture (2)



- ***Context Updater***
  - For managing vUEs;
  - Receives messages from other network entities/functions about the UE's context (e.g., (dis)connection from the network);
  - Instantiates and/or updates the respective vUE;
  - Communicates with the orchestrator of the telecommunication providers;

- ***Virtual UE***
  - Makes connectivity decisions on behalf of its physical counterpart;
  - Assists the SDN controller for flow handovers over heterogeneous networks;
  - Acts as an anchor for mobility procedures;

High level sequence diagram

When the UE attaches to the 3GPP network

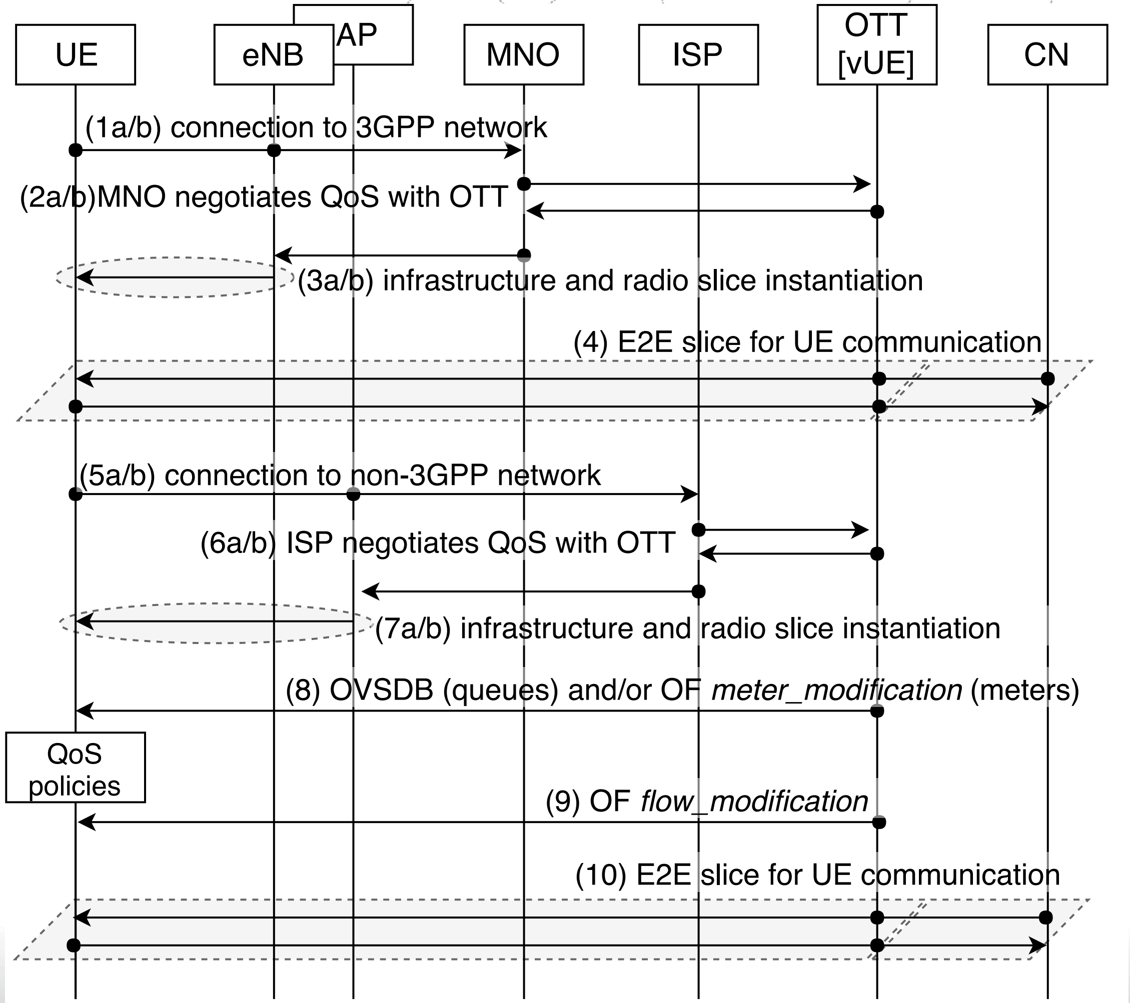
- the OTT (through the vUE's context updater) requests a network slice to the MNO.

When the UE connects to a non-3GPP PoA

- the ISP and the OTT establish the slice requirements for the UE, with the former instantiating a slice for the UE, allowing the OTT (via the vUE) to dynamically manage the UE's flows

E2E QoS

- the vUE dynamically applies flow-based QoS policing in its physical counterpart by SDN interfaces (OpenFlow and/or OvSDB)



Implementation and Deployment

- **3GPP network**
  - OpenAirInterface (OAI) enhanced with SDN interfaces;
  - Virtualised in an in-house OpenStack (Ocata) data-centre;
- **non-3GPP network**
  - Hostapd (IEEE 802.11n at 5GHz)
  - dynamically creates an overlay access network (by instantiating a new SSID).
- **User equipment**
  - Open vSwitch (OvS) bridge per network interface

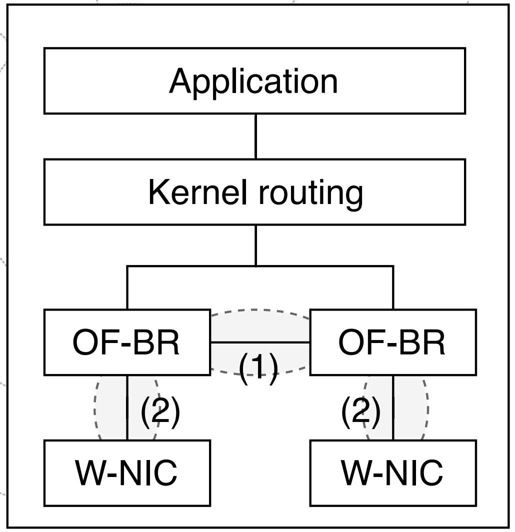


Fig. 4: UE architecture.
(1) patch-port;
(2) physical port.

Evaluation and Discussion: *Wi-Fi slice throughput impact*

- **UE without E2E QoS (Fig. 5)**
  - the bandwidth is divided by both networks, independently of the slice requirements; -> 50Mbps per slice
  - The resulted bandwidth per slice is divided per UE's active flows, disregarding the flows characteristics; -> 10Mbps per flow
- **SDN-based UE with E2E QoS (Fig. 6)**
  - the OTT is able to dynamically establish the traffic bandwidth to each UE, and consequently, its slice.
  - This allows to establish the dynamic bandwidth elasticity of UE and slices.

by reducing the bandwidth in one slice, the other' slice is able to consume the remaining bandwidth, allowing slice elasticity.

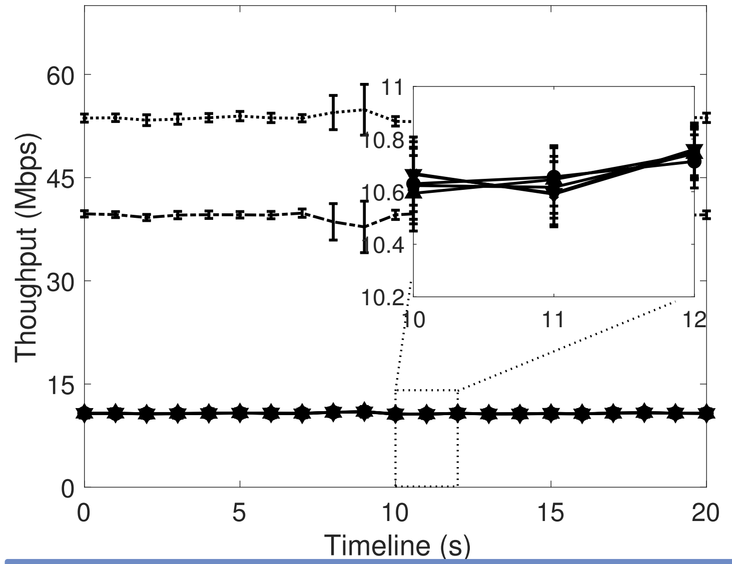


Fig. 5: UE without E2E QoS

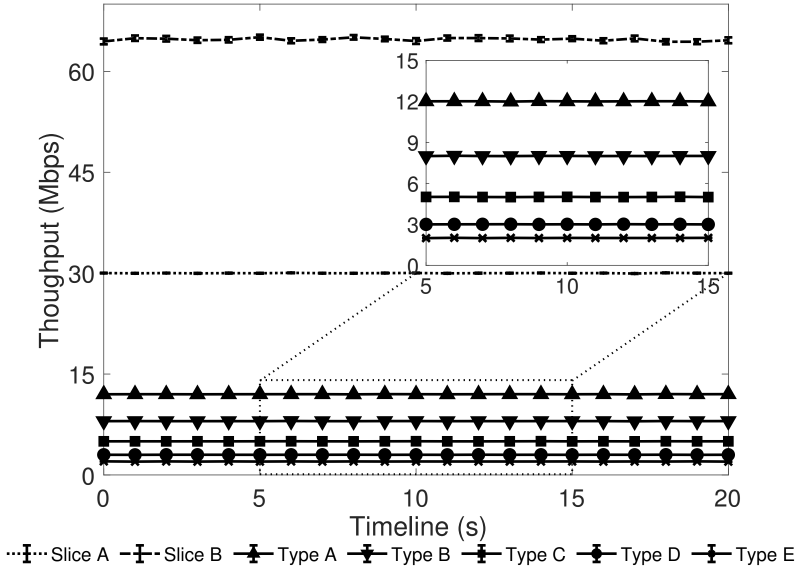


Fig. 6: SDN-based UE with E2E QoS

Evaluation and Discussion: *Signalling impact*

- **OpenFlow Flow Meter**
  - QoS policing
  - easier to create and modify at the runtime
- **OVSDB**
  - Traffic shaping
  - rigid and created out of band or by specific protocols
  - More overhead and delay
- **OpenFlow Flow Modification**
  - to apply the QoS policies, the flow requires to be redirected to the flow meter and/or QoS queue

With OVSDB, the SDN controller and OvS bridge exchange information about the bridge status before and after the QoS creation

Table 1: Signalling Impact

Function	**Protocol**	**Data overhead**	**Delay**
Flow meter	OpenFlow	164 bytes	7 ms
QoS and Queues	OvSDB	6914 bytes	59.10 ms
Flow redirection	OpenFlow	236 bytes	5 ms

Conclusion

- The use of the vUE enables the network to preserve the necessary information about the UE's medium access to the network, enabling the Controller to adapt the building blocks of the network to each kind of access technology used by the UE;
- Dynamic management of the UE's traffic flows;
- Independent of the network access technology;
- The mobility process for a cross-technology handover becomes agnostic to the wireless access technology.

Thank you!

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