V-RAN & Network Slicing – IEEE 5G Berlin Summit slides

presented by Divya Chitimalla

Slides from..

- 5G experimental activities in Flex5Gware project focus on RAN virtualization - Dario Sabella (Telecom Italia)

- Orchestrating and composing slices within 5G networks - Key to the programmable world - Hannu Flinck (Nokia)

- Network Slicing in 5G - Hans J. Einsiedler (T Mobile)

The path toward a fully virtualized network

Motivation for mobile operators

Scenario

- Exponential increase in mobile traffic volume (forecast: 1000-fold increase by 2020).
- This traffic will be unevenly distributed in time and space, due to the nature of mobile broadband connections.

Operators needs

- Network deployment evolution should adapt to this demand by providing the required coverage, capacity and QoS (Quality of Service). More attention to energy efficiency and operational costs (CAPEX./OPEX)

Emerging trends

- progressive usage of cloud technologies (traditionally born within IT market) applied to other business sectors (i.e. telco market), and in particular for mobile networks evolution.
- Telecommunication market is already moving progressively toward virtual implementations of EPC, and recently operators are considering with increasing attention the centralization (C-RAN) and virtualization (NFV) of mobile networks functionalities in a standard IT platform.

Benefits

- This will result also in an highly efficient network, able to provide the needed system throughput by taking care of costs and utilization efficiency, and also energy efficiency and sustainability of the mobile network evolution.
- All these aspects are currently carefully evaluated by operators, in the view of future network deployments, suitable for additional revenue generating services.

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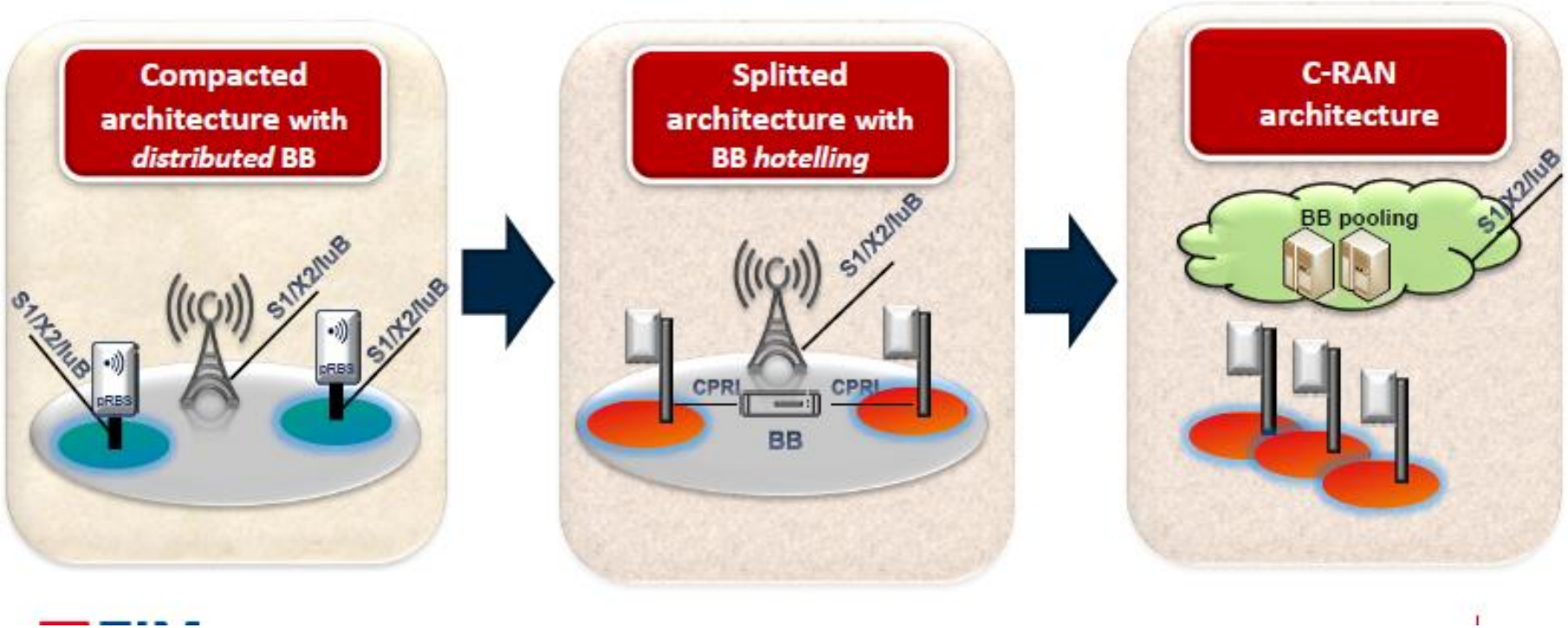
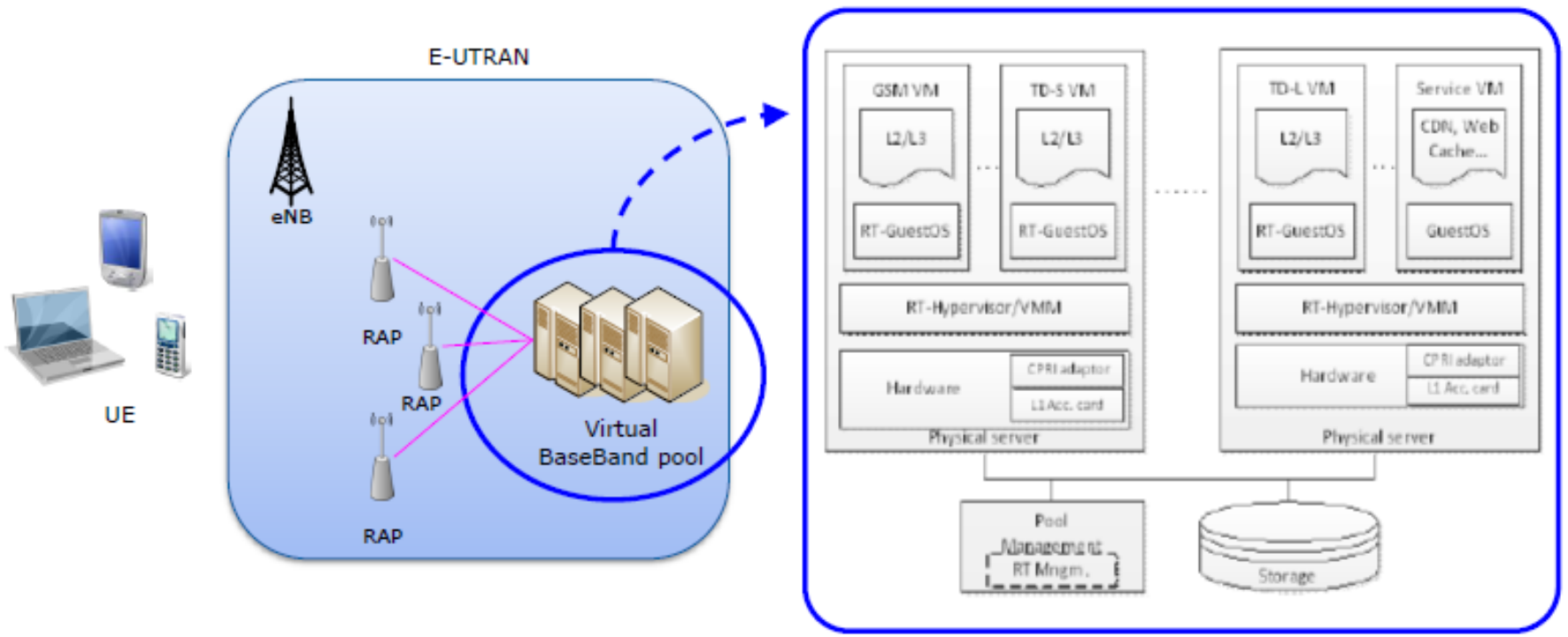
C-RAN evolution path ...

- Compacted architecture consists in Baseband unit and Radio unit joint in same module.
- A splitted architecture (with BB unit and Radio unit in different modules) can be seen as a first centralization step toward C-RAN architecture.
- In C-RAN architecture baseband resources shared (pooled) across RRUs.



… toward virtual RAN

- In this phase, virtualization (on general purpose HW) enables the abstraction from a particular Operating System. This is usually done by an "hypervisor". Some functionalities are executed running as Virtual Machines (VMs). Examples of VMs in CRAN environment are represented by single RATs or by sub-systems of the protocol stack of a RAT.
- Virtualization approach of RAN functionalities should follow the general ETSI NFV framework.

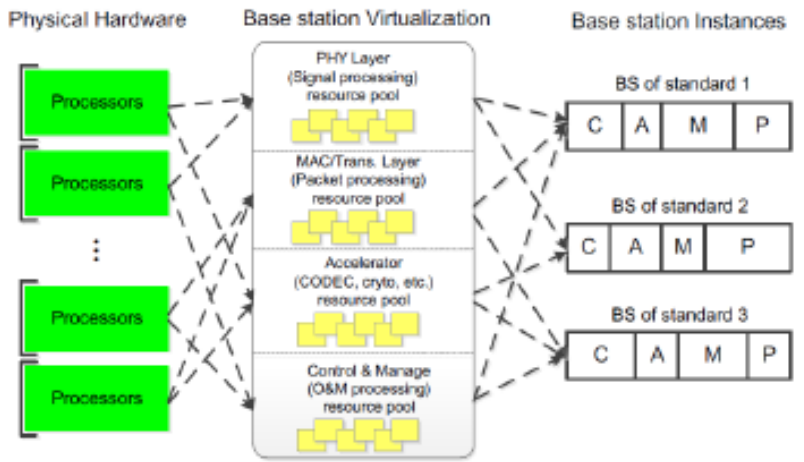


virtual RAN: advantages for the operator

vRAN got all the C-RAN advantages and add the followings (due to usage of GPP HW, i.e. General Purpose Hardware):

- the operator can dynamically allocate processing resources within a centralized baseband pool to different virtualized base stations and different air interface standards

- HW and SW totally decoupled for both, cost and management
- simpler inter-vendor interoperability
- cost reduction to manage, maintain, expand and upgrade the base station



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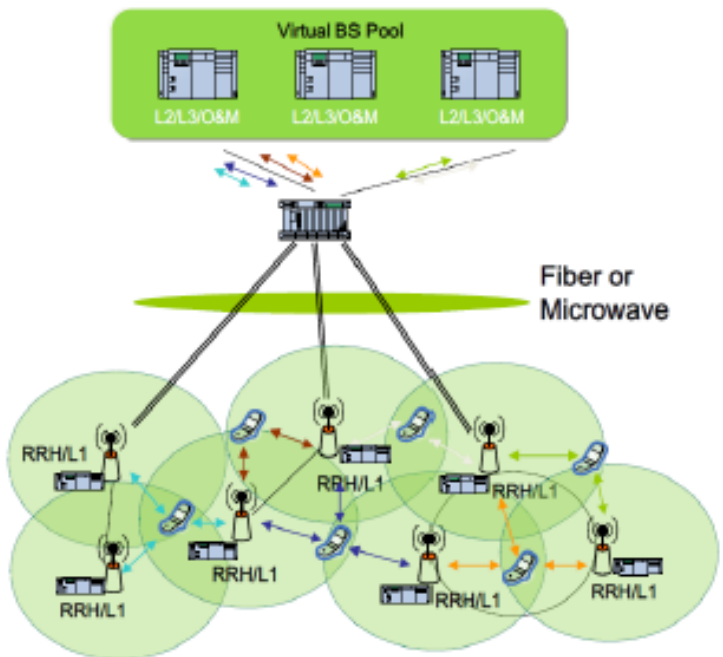
virtual RAN: implementation issues

- In general, in order to satisfy realtime needs given by radio systems, it may be difficult to implement all eNBs protocol stack on general purpose HW: in these cases some functionalities (typically PHY layer) are implemented on dedicated HW.

- In any case, full RAN centralization implies the usage of Fiber (with high capacity but also most expensive).
- If this cable infrastructure is not available, partial RAN centralization solutions should be evaluated.

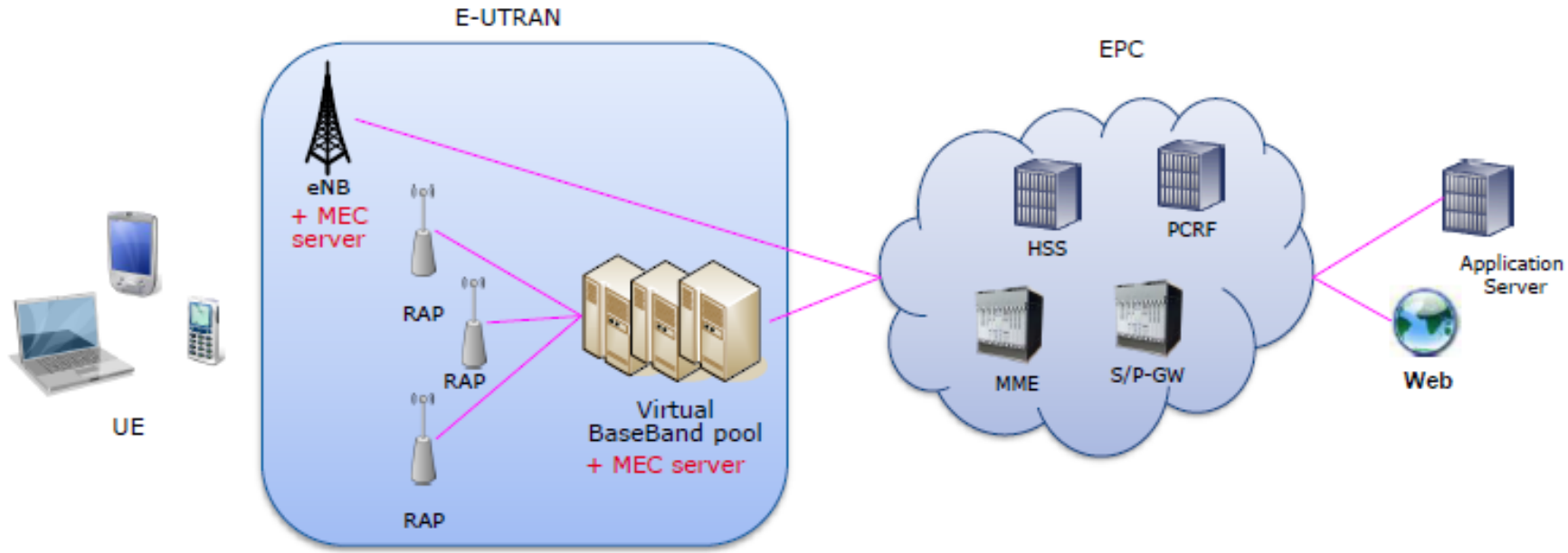
(e.g. the approach of iJOIN project).



Network evolution toward 5G

The need for Mobile edge computing

- Mobile edge computing (MEC) permits to extend cloud platform for applications to the edge of the network (e.g. Base Stations), in order to improve the user experience (also thanks to the standardization of proper measurements and network APIs).



- This view is not in contrast with C-RAN architecture: MEC will add flexible decentralization and proper dynamic instantiation of applications, in close proximity to terminals (that are also empowered with additional capabilities through computation offloading).

TIM proof-of-concept in Flex5Gware

Name of the PoC (in collaboration with UniPisa):

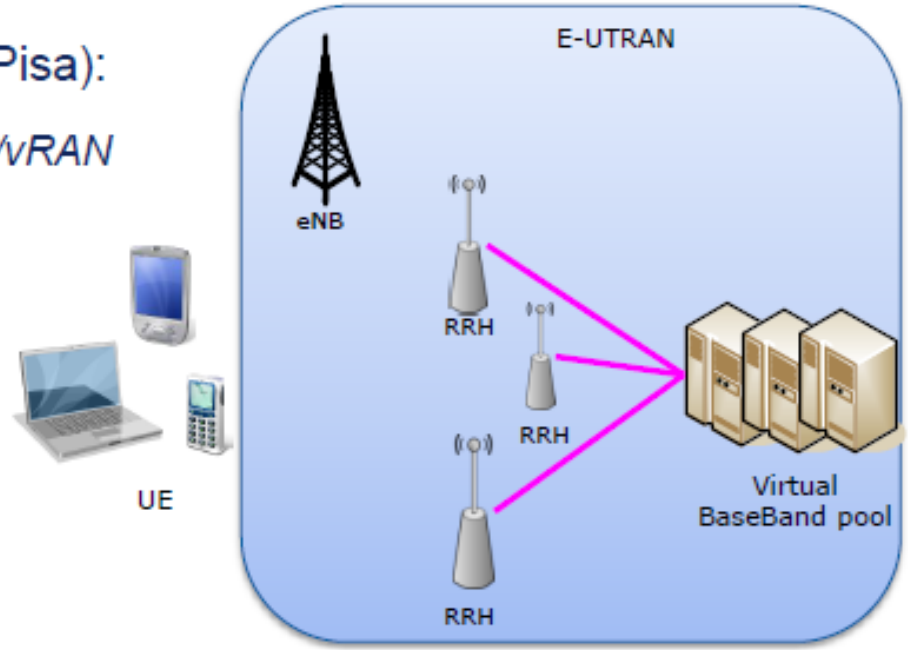
- *Flexible resource allocation in CRAN/vRAN platform*

Goal:

- design and evaluation of flexible SW solutions in 5G networks for centralized RAN environments, through virtualization of BSs

Main ideas:

- vRAN/CRAN scenario
- PoC with phones/dongles



Features:

- BBU pool allocation algorithms,
- constrained RRH activation patterns,
- energy-efficiency maximization, resource allocation, robustness and reliability, using SotA optimization techniques to strike the best trade-offs between performance and energy, scale vs. resources

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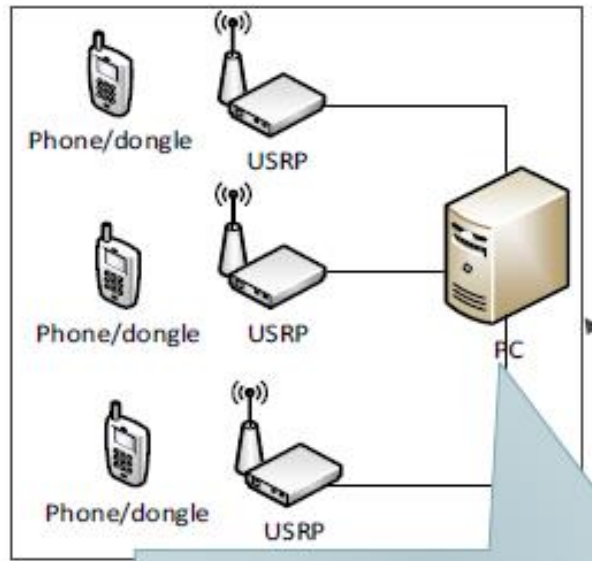


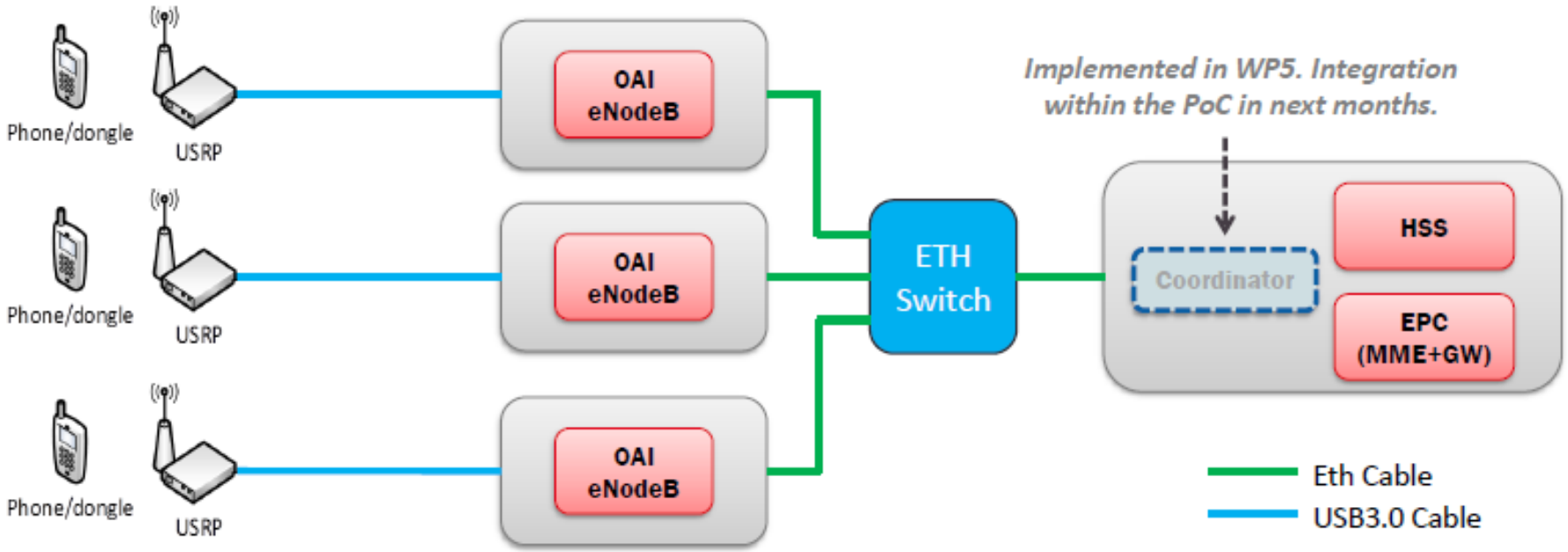
C-RAN/vRAN server used for the BBUs allocation. The BBUs control the RRHs (Micro and Macro). It contain also a Coordinator and the Intelligent Programs as developed in WP5.

The surrounding noise will be generated with additional LTE node (acting as intercell interference generator).

- **Macro cells sites are placed considering an hexagonal grid (assuming 3 sectors per site);**
- **Two Micro cells per Macro sector**

TIM proof-of-concept in Flex5Gware

- Testbench defined. First evaluations planned according to the target KPIs



Target KPI	Related Use Case(s)	Comment
Energy Consumption (NRG)	Dynamic Hotspots 50+ Mbps Everywhere	% of Energy saving in comparison with the solution where all the hotspots are transmitting.
User data rate (UDR)	Dynamic Hotspots 50+ Mbps Everywhere	User/cell edge Throughput (comparison with and without CoMP technique).
Flexibility, versatility, re-configurability (FVR)	Dynamic Hotspots 50+ Mbps Everywhere	Time requested to adapt the system to a change of network configuration (switch on/off of one or more cells and reallocation of the resources).

- Flex5Gware project (5G PPP) is focused on implementation of key HW and SW building blocks, targeting flexible, efficient and reconfigurable HW/SW platforms, experimental activities and proof-of-concepts on 5G.
- Architecture evolution from operator perspective (starting from C-RAN toward virtual RAN) should move toward a fully virtualized network, including the addition of mobile edge computing technologies.
- TIM is realizing a proof-of-concept on vRAN in CRAN environment.

- Flex5Gware will show its PoCs during a final event at the end of the project.
- Cross-project demonstrations will be hosted as well as Flex5Gware PoCs during the final demonstration event (Turin, June 2017).

- *Telecom Italia will host the Flex5Gware demonstration activities, thanks to the presence of TILAB facilities and TI Test Plant in Turin, as already done in the past for the EARTH project demonstrator.*

TIM

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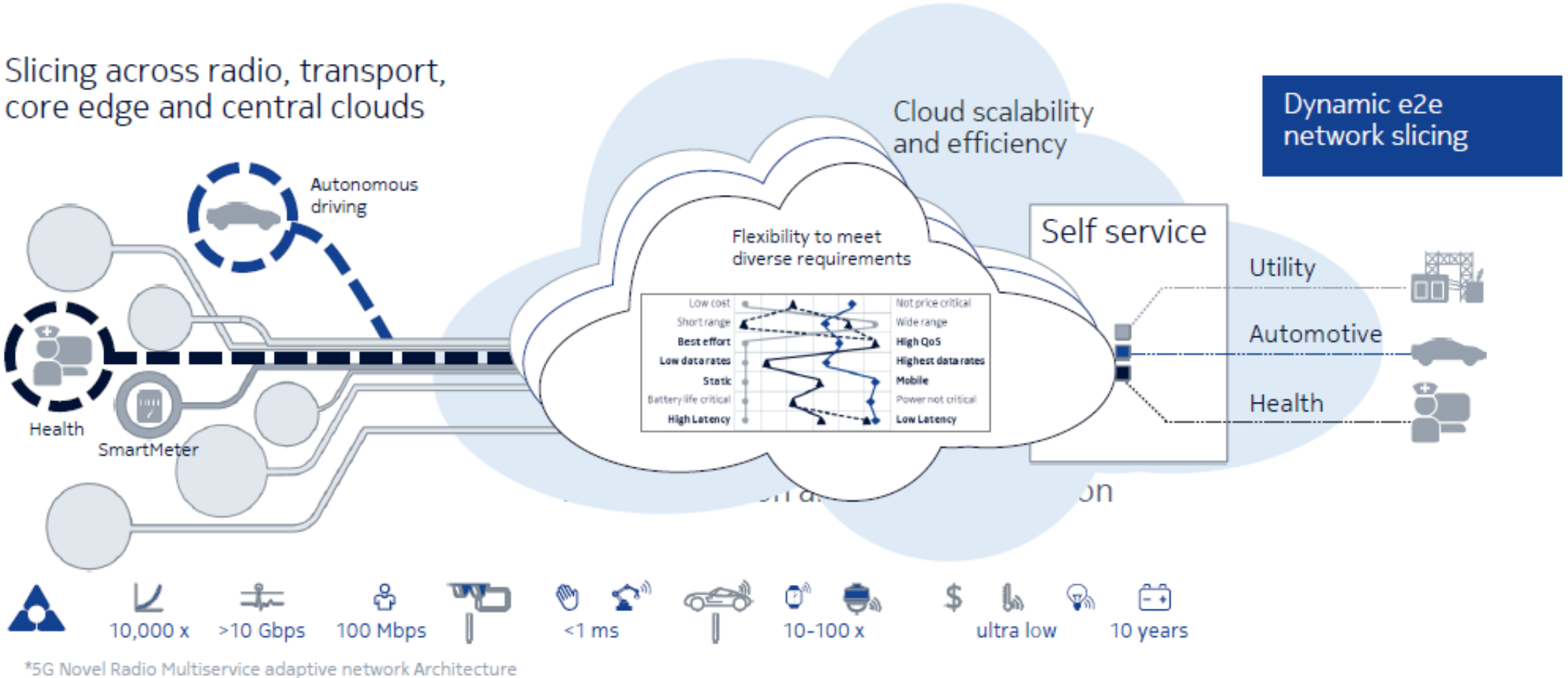
Nokia - Orchestrating and composing slices within 5G networks - Key to the programmable world

Agenda

- Motivation for Network Slicing
- Network slicing is not only 5G, what is possible today?
- Key topics in Network Slicing
  - Management and orchestration
  - Composing slices from network functions
  - Slice selection
  - Architectural impact to core and RAN

Network Slicing | Optimized service delivery for heterogeneous use cases
Multiple independent instances on one physical network



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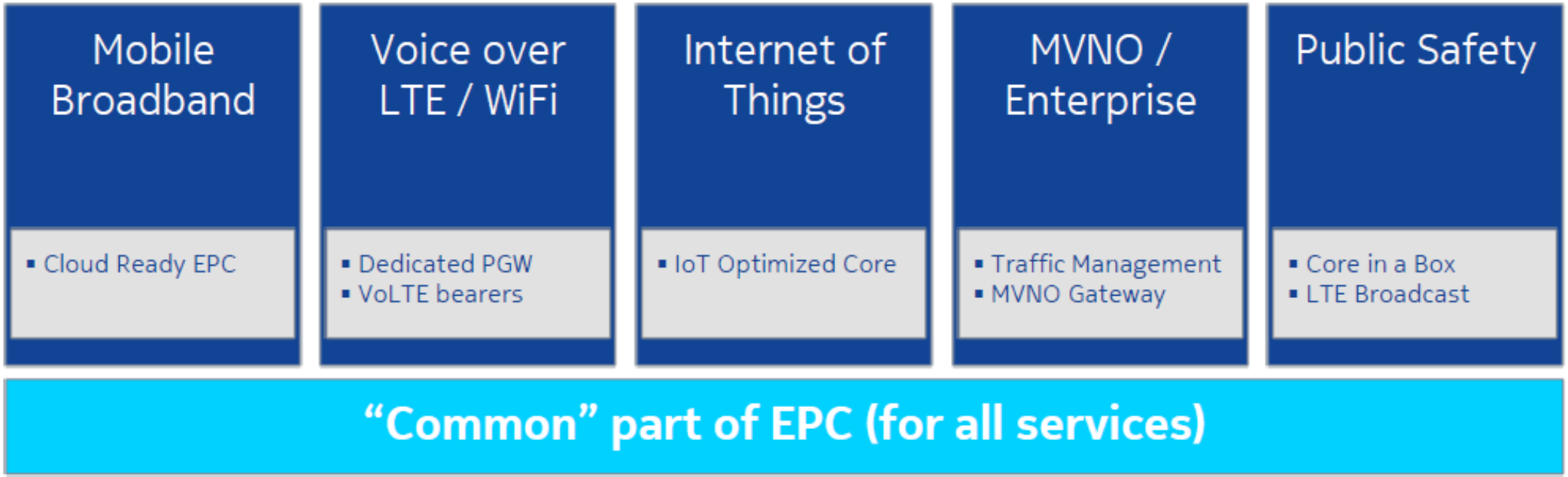
EPC with Business Verticals
New Service Introduction, Cloud Transformation, Overlay deployment



... implementing already network slicing to a certain extent ...

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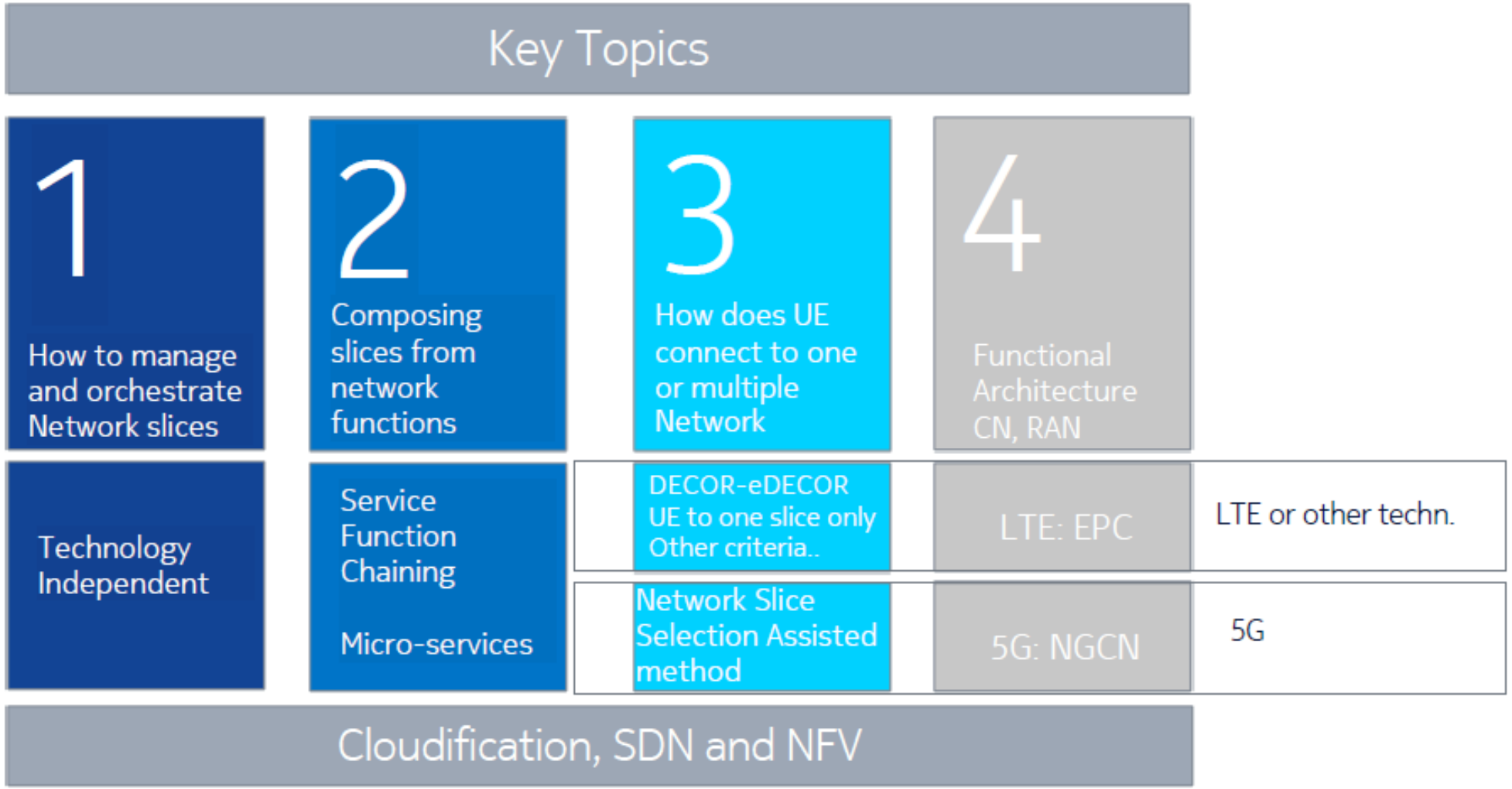
Key topics in Network Slicing



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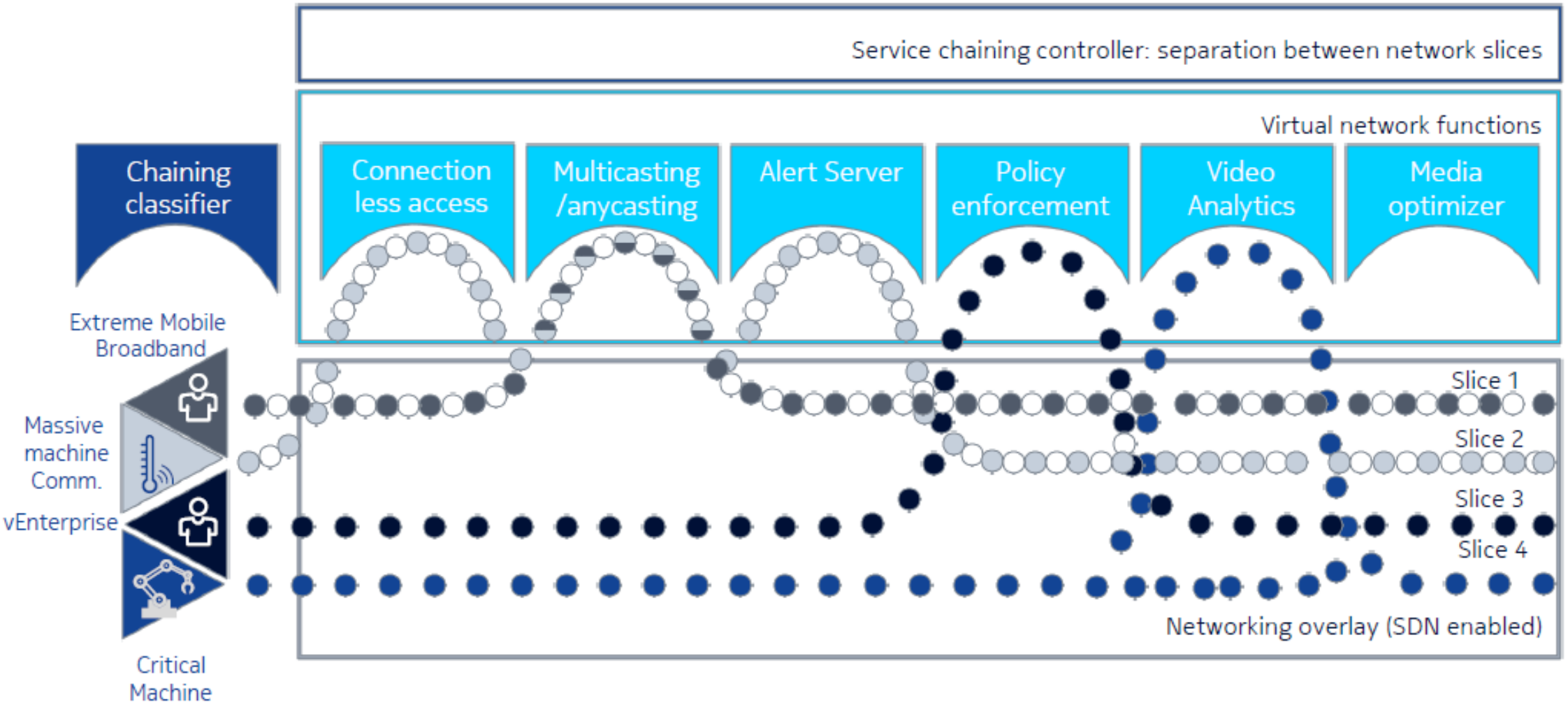
Composing a slice as service chain of network functions



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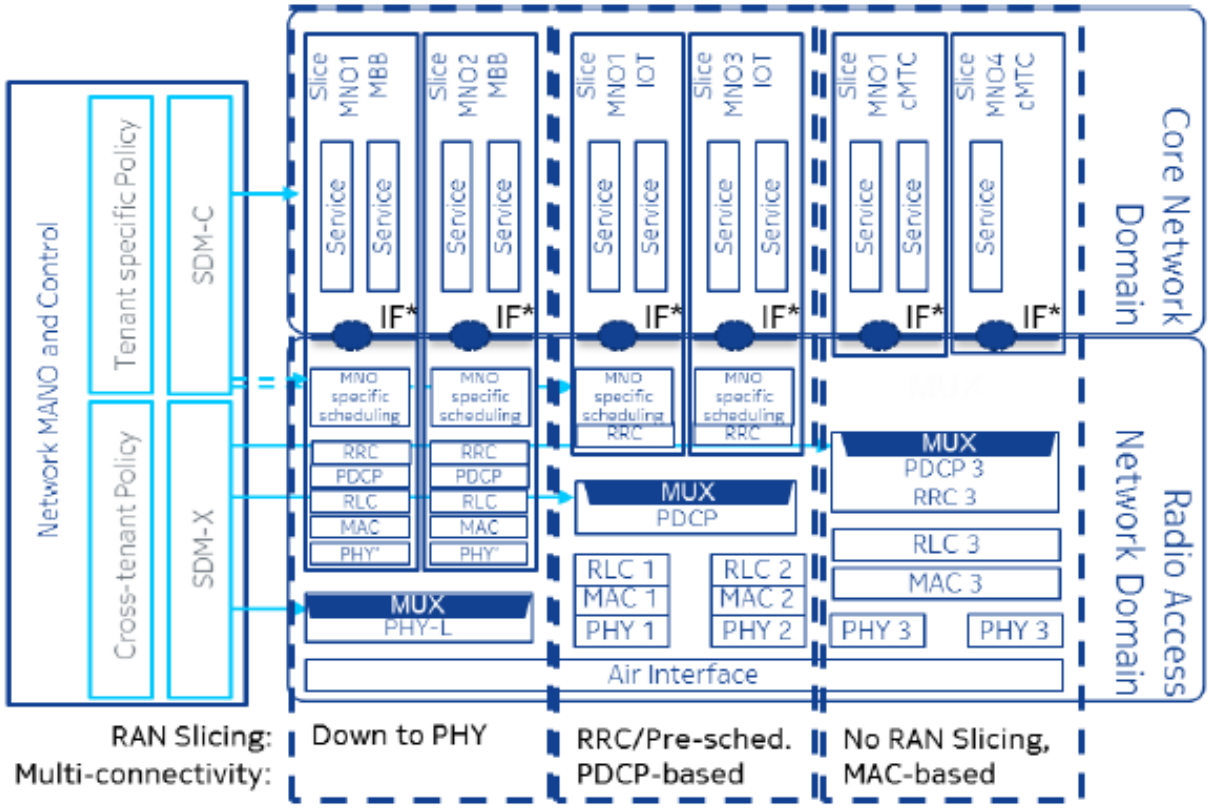
Options in slicing RAN (EU-project Norma)

- Slicing down to within PHY.
  - With slice-individual MC of any kind
  - But RAT design needs to support it to be efficient (5G only)
- RRC Slicing + PDCP MC.
  - Slice-individual data layer (RAN L123) adaptation/customization through MC
  - With per slice RRC additional customization through QoS scheduling
- No RAN slicing + MAC MC.
  - At least parts of RRC need to be shared across slices
  - Very limited/no chance for customization
  - Most straight forward 5G evolution of the current (4G) RAN sharing architecture of 3GPP DECOR



Source: P. Rost *et al.*, "Network Slicing to Enable Scalability and Flexibility in 5G Mobile Networks", submitted to IEEE Communication Mag., September 2016.

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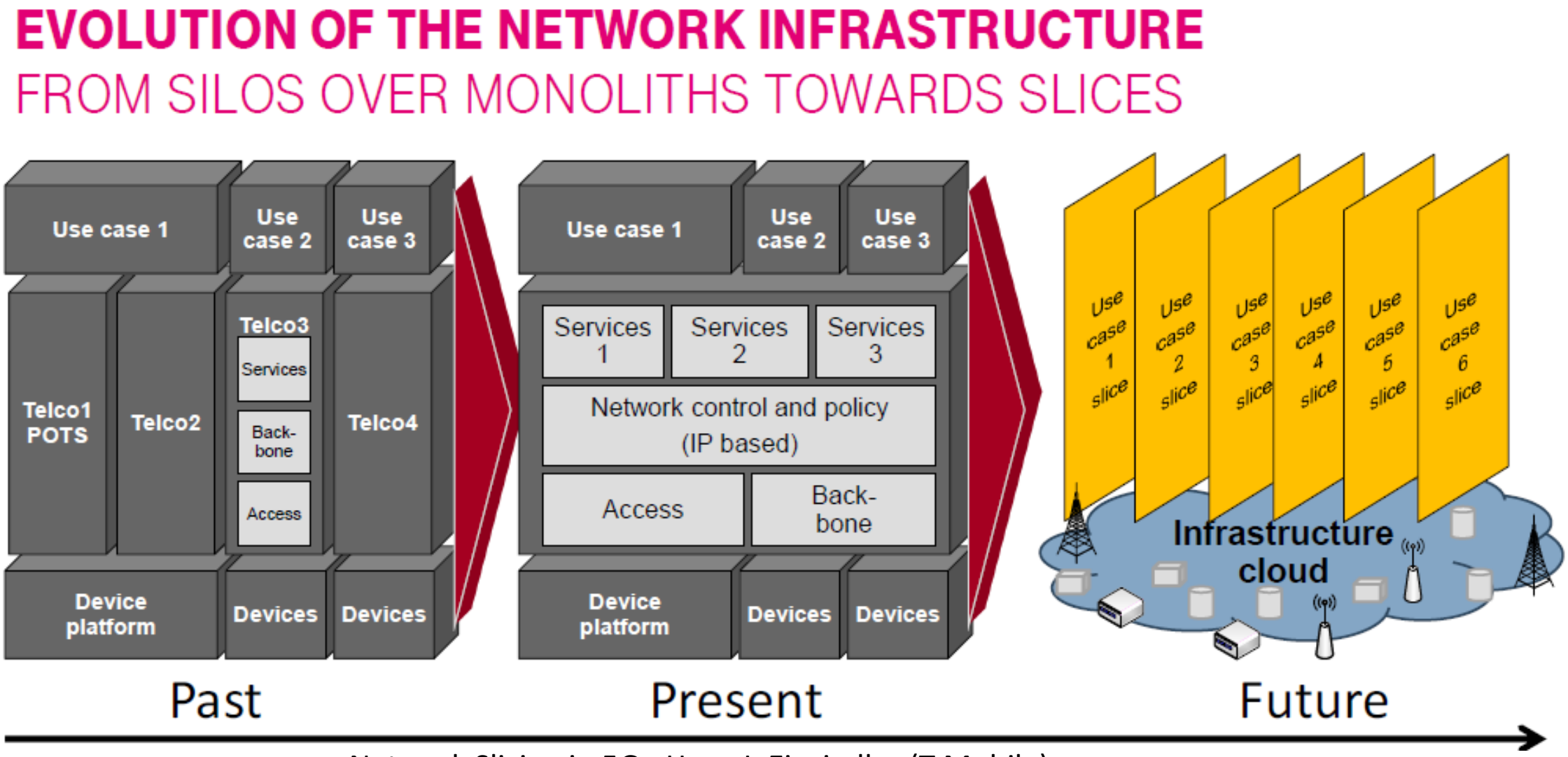
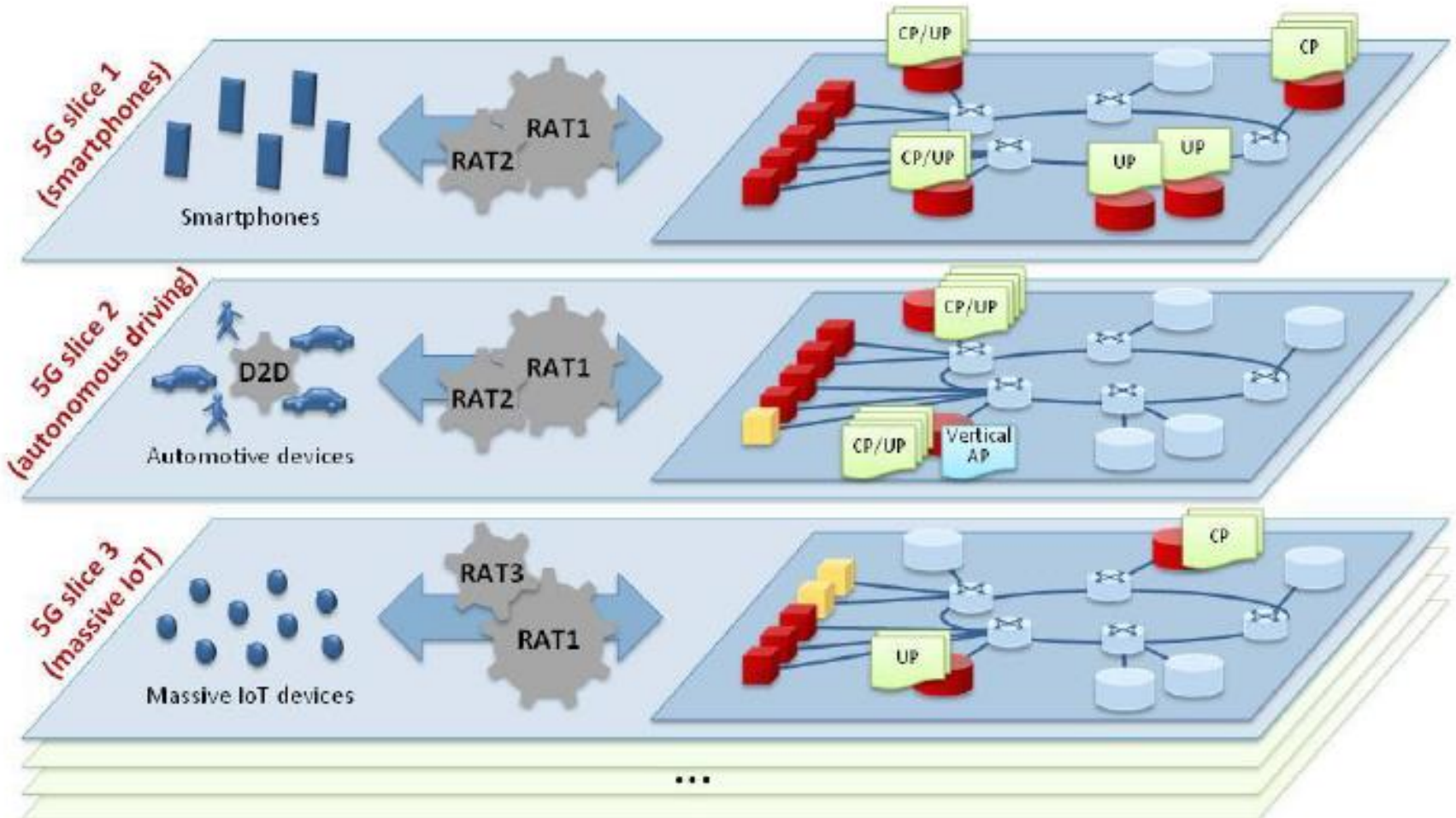


USE CASES MAPPED TO NETWORK SLICES

REQUIREMENTS WILL DEFINE THE NETWORK SLICES



RAT= Radio Access Technology; CP = Control Plane; UP= User Plane; AP= Access Point; IoT= Internet of things; D2D = Device to Device

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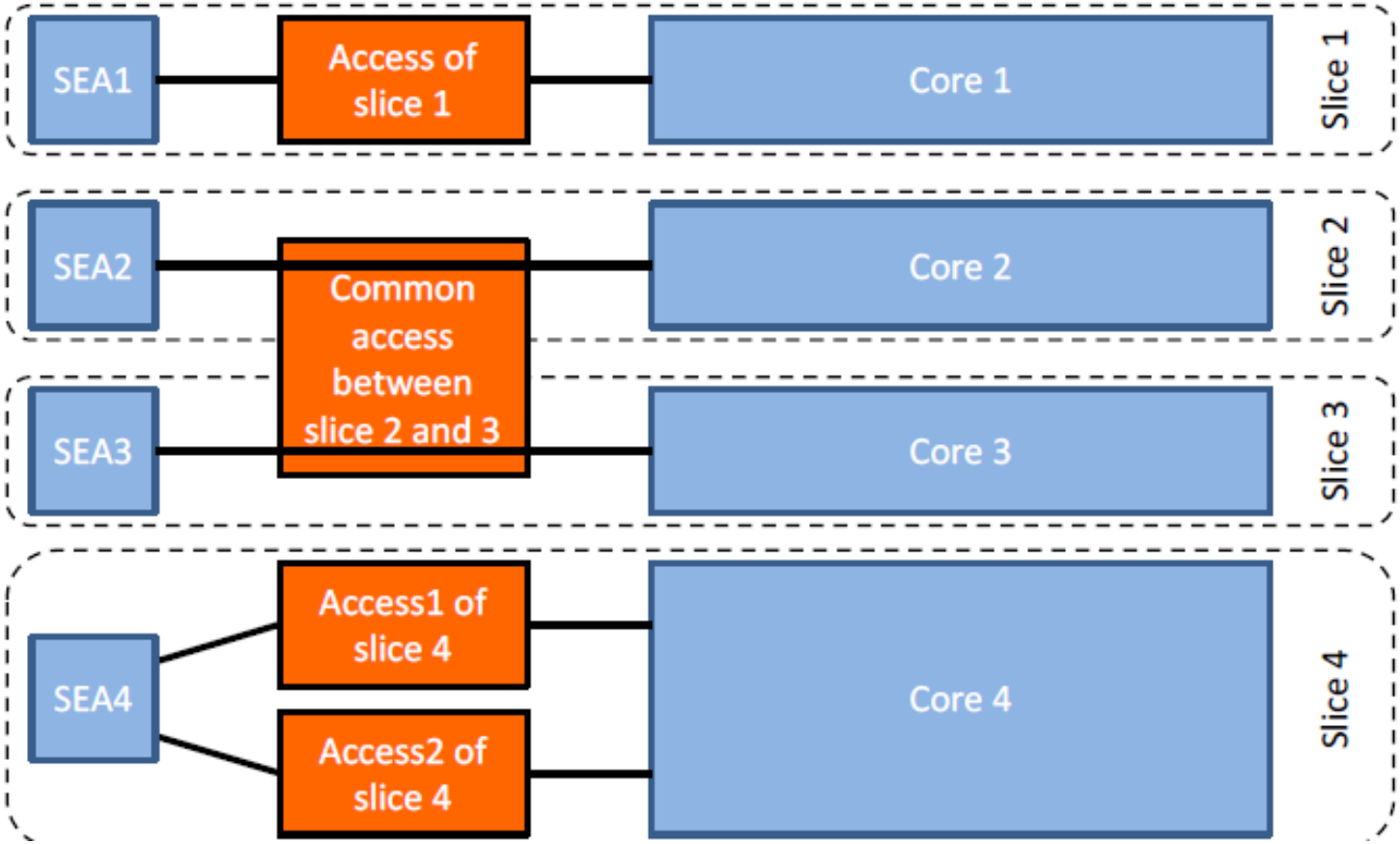
SLICES – A SERVICE DRIVEN APPROACH

NEW VIEW ON NETWORKING - ESPECIALLY ON THE END-SYSTEMS

- Different possibilities to implement slices
- End systems (terminals) are part of the slice
- 3GPP and ETSI expression User Equipment (UE) misleading therefore new expression needed – proposal: Service End-point Agent (SEA)



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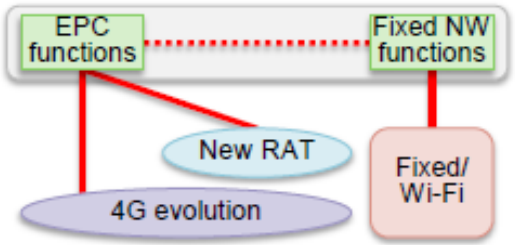
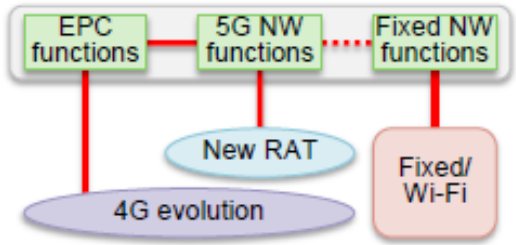
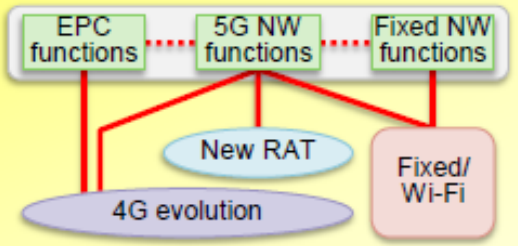
WHERE ARE WE NOW?

THREE OPTIONS – WHICH IS THE RIGHT ONE?

	Option 1	Option 2	Option 3
			
Pros	• No changes to 4G RAN • No need for revolutionary 5G NW functions design	• No changes to 4G RAN • 5G NW functions/ new RAT design can be optimized to fully benefit from new technologies (e.g., virtualization)	• 5G NW functions/ new RAT design can be optimized to fully benefit from new technologies (like virtualization) • Solves mobility issues of option 2 • Provides a sound migration path
Cons	• Tied to the legacy paradigm for all the use cases (which may be expensive)	• New design could only be utilized where there is new RAT coverage • Potential signalling burden due to mobility if the new RAT does not provide seamless coverage	• Impact on 4G RAN to support connections to EPC functions and 5G NW functions

NW Network
EPC Evolved packet core
RAN Radio access network

Defined interface/ reference point
Potential interface/ reference point

CONCLUSION

5G WILL BE A MODULAR PLUG AND PLAY INFRASTRUCTURE

- **Modular and flexible network architecture: No one-size-fits-all approach**
- **Virtual networks/network slices depending on use case requirements**
- **Context awareness will offer the possibility to optimize the infrastructure and the services**
- **ID management will be important not only to address the customer/end-system, it will also address the interconnection to the slice, the service execution environment**
- **End-systems become part of the network slice through Service End-point Agent (SEA)**

➔ **Future telecommunication infrastructure will be**

- **modular,**
- **software driven,**
- **access agnostic,**
- **virtualized, and**
- **sliced**

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Thank you :D