SCLA | Sustainable Cities Latin America

Arequipa
August 26-29, 2019

Key technology enablers for 5G in smart cities

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PQ-2 CNPq

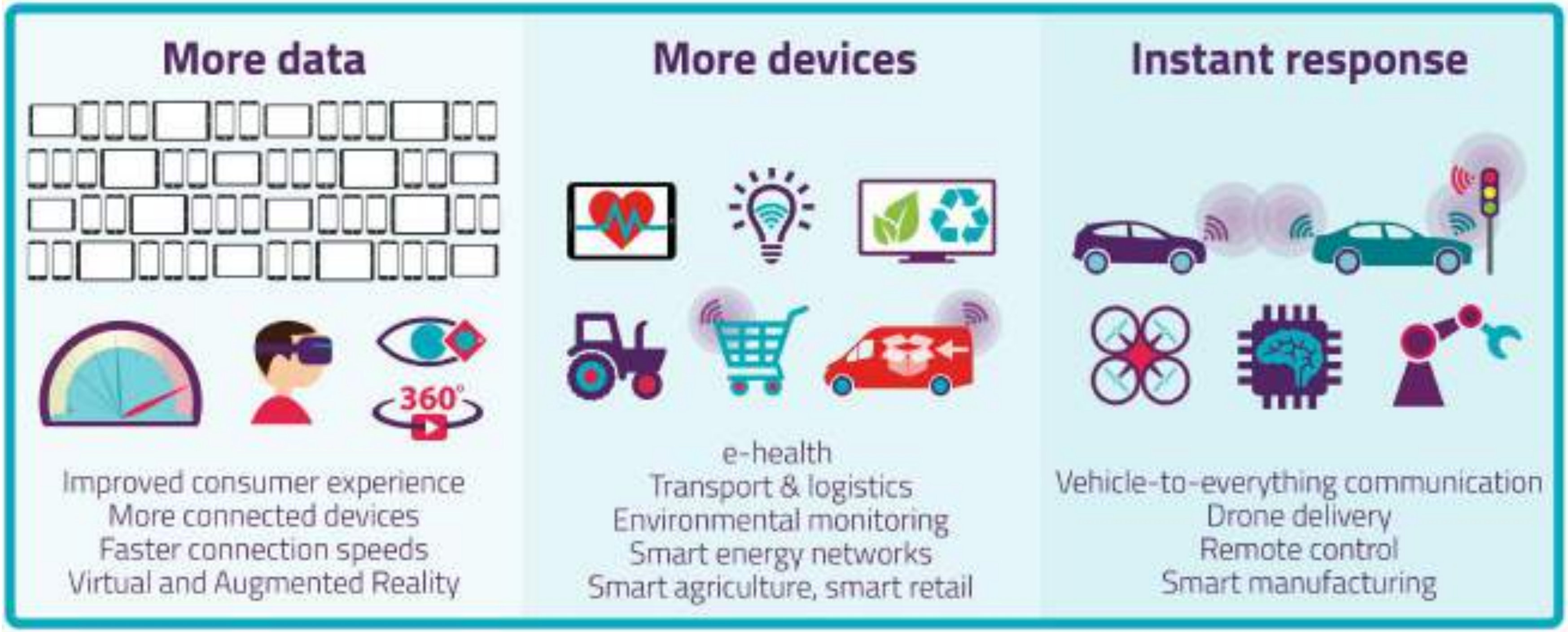
Research Group o Future Internet Service and Applications

Agenda

- Introduction to 5G
- Main 5G Technology Enablers
  - Cloudification
  - Softwarization
  - Virtualization
  - Slicing
- Usecase
- Concluding Remarks

Outlook 

5G



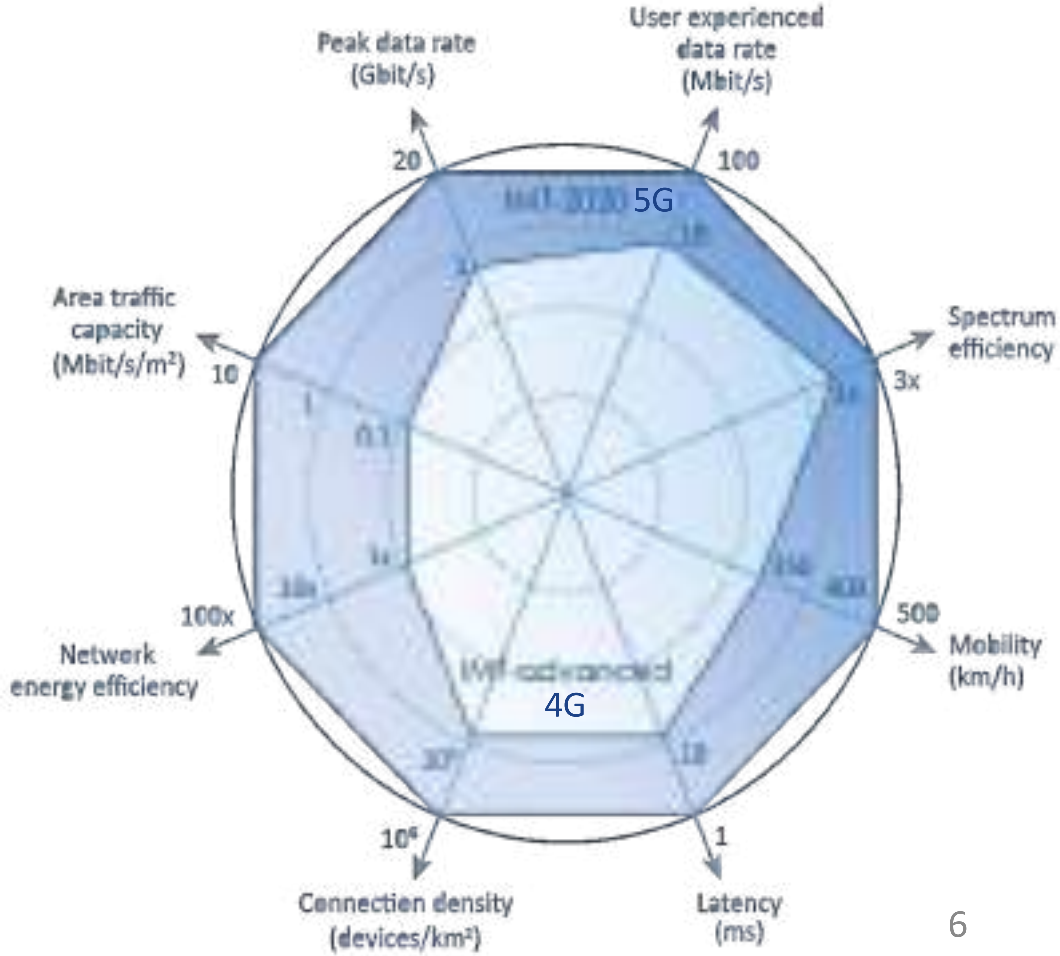
More data
360°
Improved consumer experience
More connected devices
Faster connection speeds
Virtual and Augmented Reality
More devices
e-health
Transport & logistics
Environmental monitoring
Smart energy networks
Smart agriculture, smart retail
Instant response
Vehicle-to-everything communication
Drone delivery
Remote control
Smart manufacturing

What is 5G?

- Mobile data **traffic is rising rapidly** mostly **due to video streaming**.
- **Growing number of connections at large-scale**.
- **Internet of Things** will require networks that must handle **billions more devices**.
- With a growing number of mobiles and increased data traffic both mobiles and networks need to **increase energy efficiency**.
- Network operators are under pressure to **reduce operational expenditure**, as users get used to flat rate tariffs and don't wish to pay more.

https://www.etsi.org/technologies/5g

Comparison of key 4G with 5G capabilities according to ITU-R M.2083



https://www.etsi.org/technologies/5g

What are the Main Usage Scenarios of 5G?

Enhanced Mobile Broadband (eMBB) to deal with hugely increased data rates, high user density and very high traffic capacity for hotspot scenarios as well as seamless coverage and high mobility scenarios with still improved used data rates

Massive Machine-type Communications (mMTC) for the IoT, requiring low power consumption and low data rates for very large numbers of connected devices

Ultra-reliable and Low Latency Communications (URLLC) to cater for safety-critical and mission critical applications

key capabilities required in Numbers

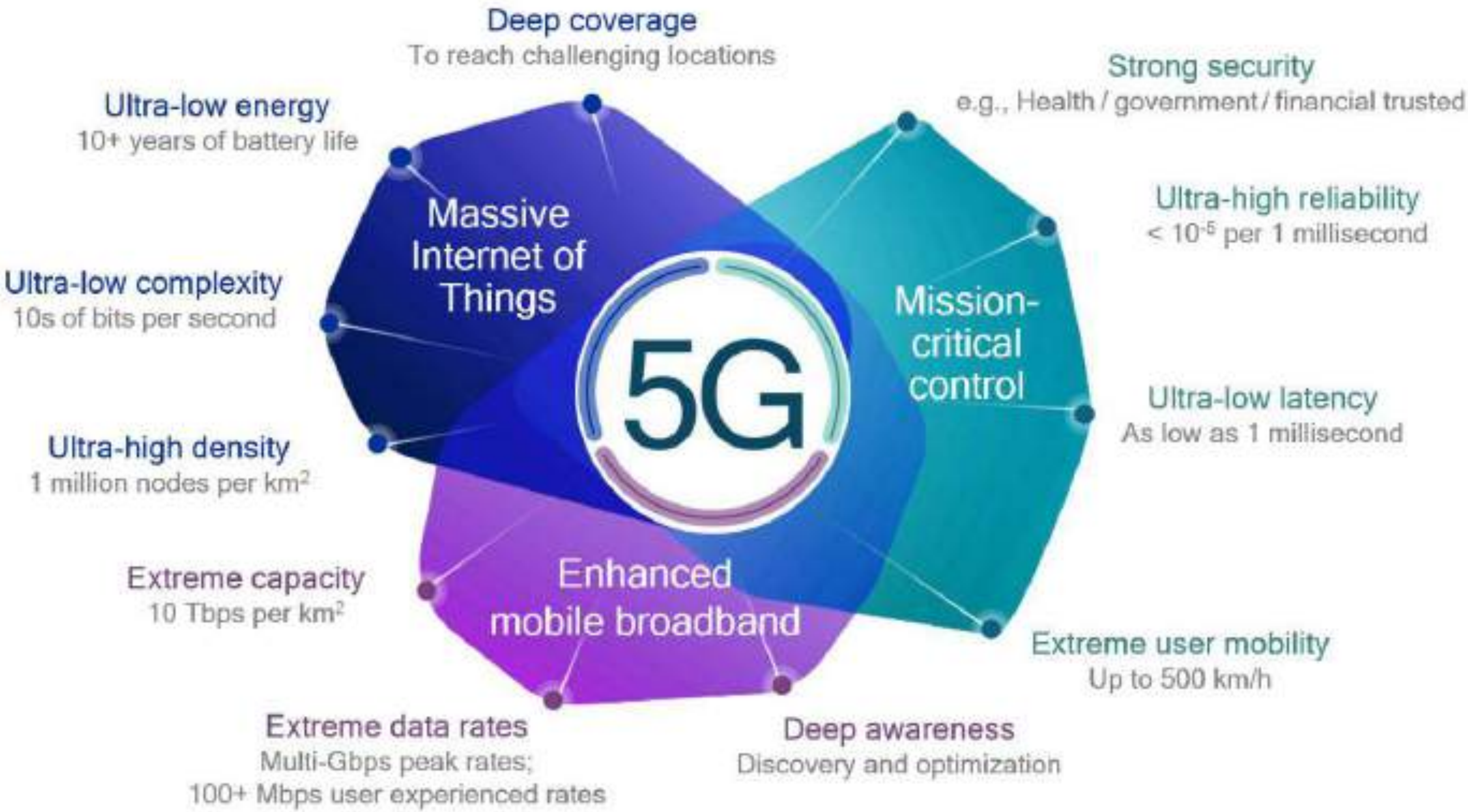
The minimum requirements:

- for peak data rate::
  - Downlink: 20 Gbit/s
  - Uplink: 10 Gbit/s
- for peak spectral efficiencies:
  - Downlink: 30 bit/s/Hz
  - Uplink: 15 bit/s/Hz
- user plane latency (single user, small packets):
  - 4 ms for eMBB
  - 1 ms for URLLC
- control plane latency (idle => active):
  - 10-20ms

Other requirements:

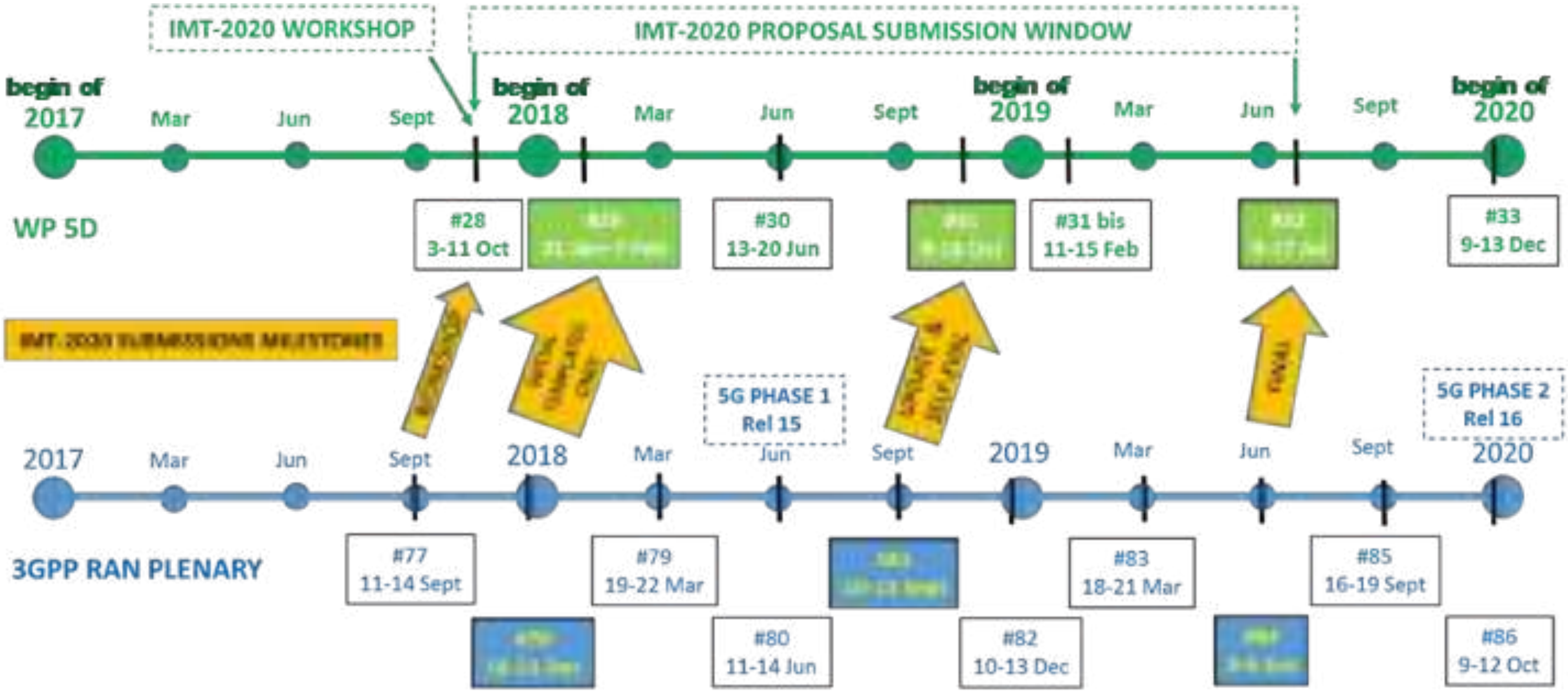
- maximum aggregated system bandwidth:
  - at least 100 MHz, up to 1GHz in higher frequency bands (above 6GHz)
- mobility:
  - up to 500km/h in rural eMBB

https://www.etsi.org/technologies/5g

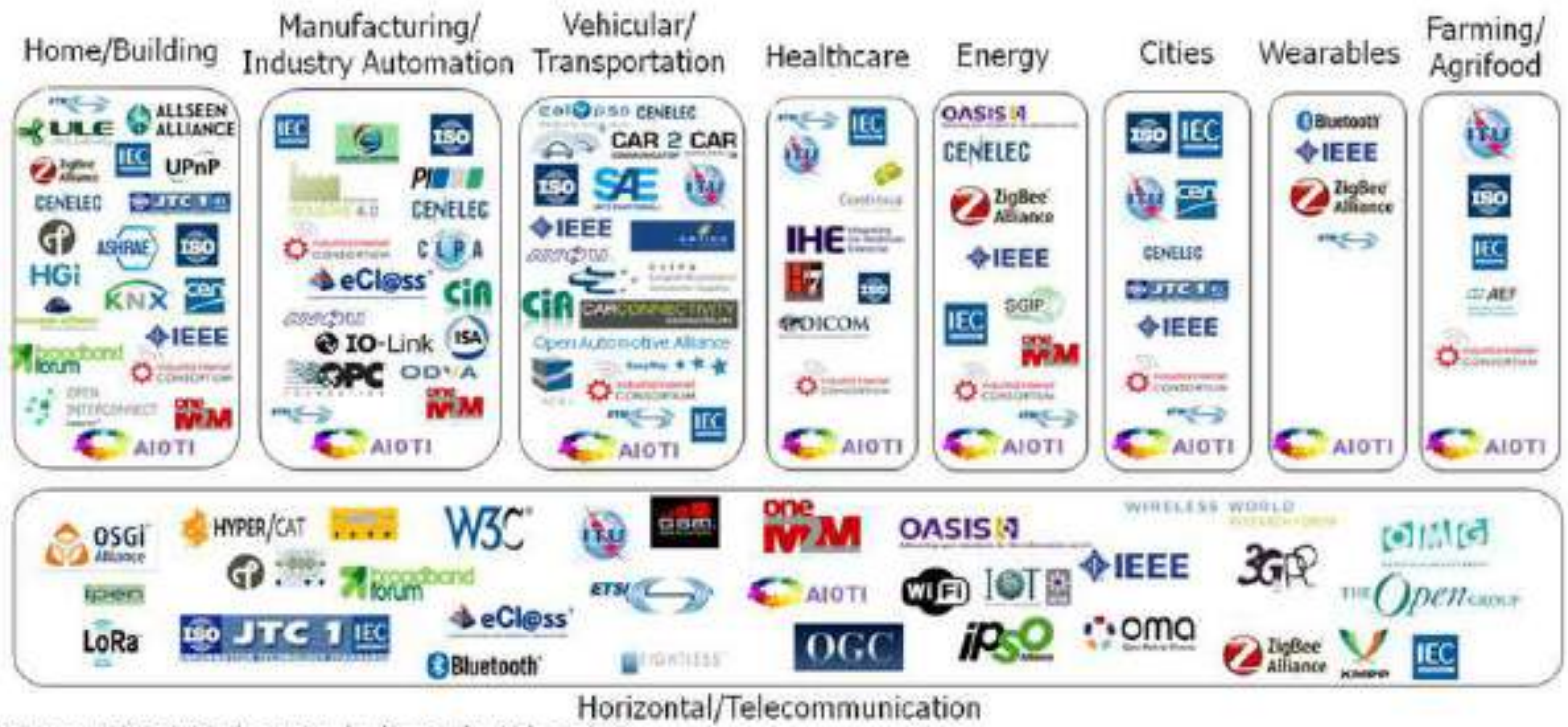


Deep coverage
To reach challenging locations
Strong security
e.g., Health / government / financial trusted
Ultra-low energy
10+ years of battery life
Ultra-high reliability
< 10^-5 per 1 millisecond
Ultra-low complexity
10s of bits per second
Massive Internet of Things
5G
Mission-critical control
Ultra-low latency
As low as 1 millisecond
Ultra-high density
1 million nodes per km²
Extreme capacity
10 Tbps per km²
Enhanced mobile broadband
Extreme user mobility
Up to 500 km/h
Extreme data rates
Multi-Gbps peak rates;
100+ Mbps user experienced rates
Deep awareness
Discovery and optimization

When it will be ready?



Who is working on 5G?

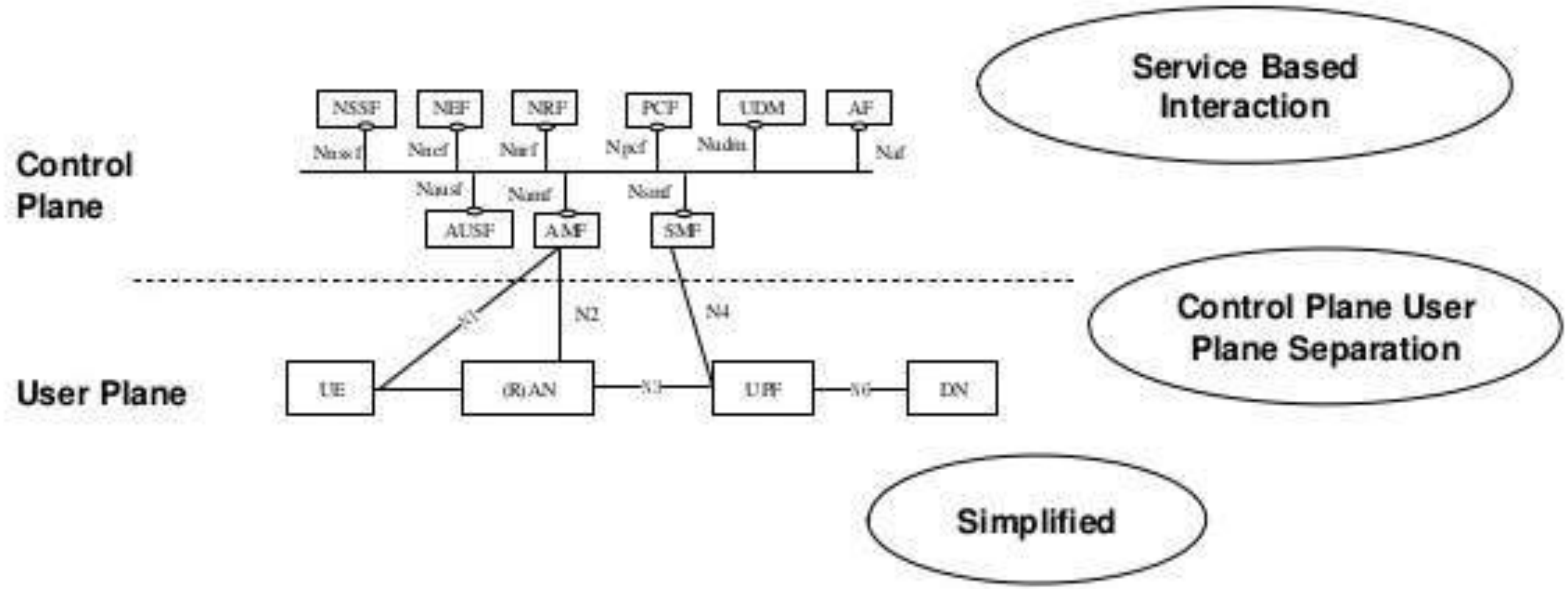


Source: AIOTI WG3 (IoT Standardisation) – Release 2.0

Where to find the corresponding 5G specifications?

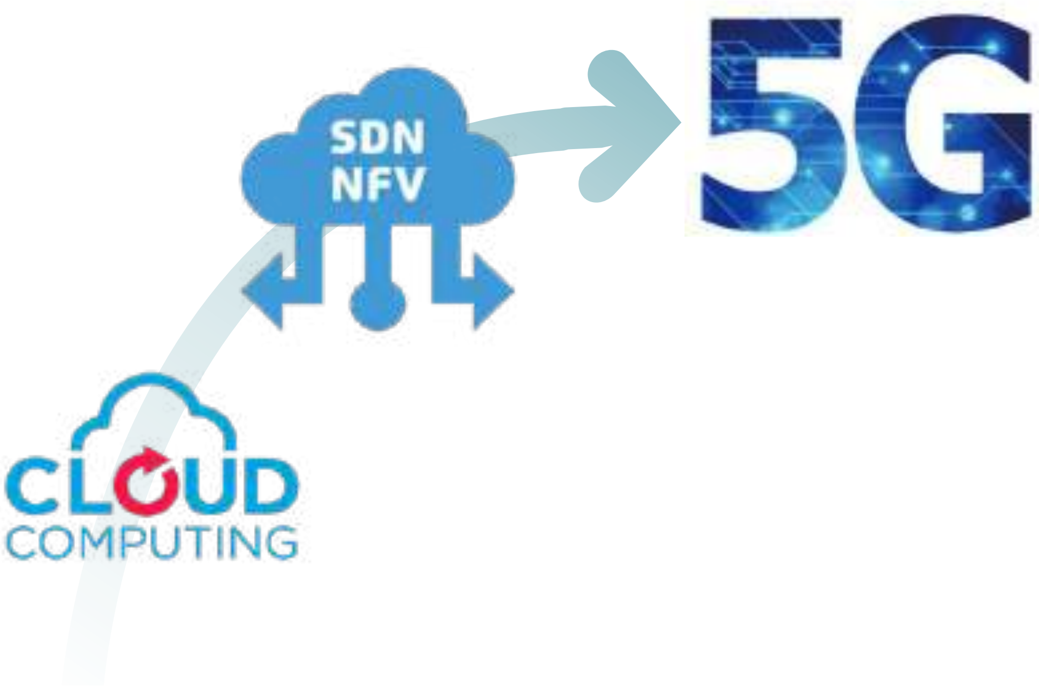
- A list of all 5G related specs (incl. core network and system aspects)
  http://www.3gpp.org/DynaReport/21205.htm
- Radio related specifications addressing only NR: 38 series specifications.
  http://www.3gpp.org/DynaReport/38-series.htm
- Radio related specifications addressing only LTE: 36 series specifications.
  http://www.3gpp.org/DynaReport/36-series.htm
- Radio related specifications addressing aspects affecting both LTE and NR: 37 series specifications.
  http://www.3gpp.org/DynaReport/37-series.htm
- Service requirements for next generation new services and markets: 3GPP TS 22.261.
  http://www.3gpp.org/DynaReport/22261.htm
- System Architecture for the 5G system (stage 2): 3GPP TS 23.501.
  http://www.3gpp.org/DynaReport/23501.htm
- Procedures for the 5G System (stage 2): 3GPP TS 23.502.
  http://www.3gpp.org/DynaReport/23502.htm
- NR; NR and NG-RAN Overall Description (stage 2): 3GPP TS 38.300.
  http://www.3gpp.org/DynaReport/38300.htm
- NR; Multi-connectivity; Overall description (stage 2): 3GPP TS 37.340.
  http://www.3gpp.org/DynaReport/37340.htm
- NG-RAN; Architecture description: 3GPP TS 38.401.
  http://www.3gpp.org/DynaReport/38401.htm

5G System Architecture



TS 23.501 System Architecture for the 5G System, Stage 2 (Release 15)

Habilitadores Tecnológicos: tendências além de camadas de comunicação



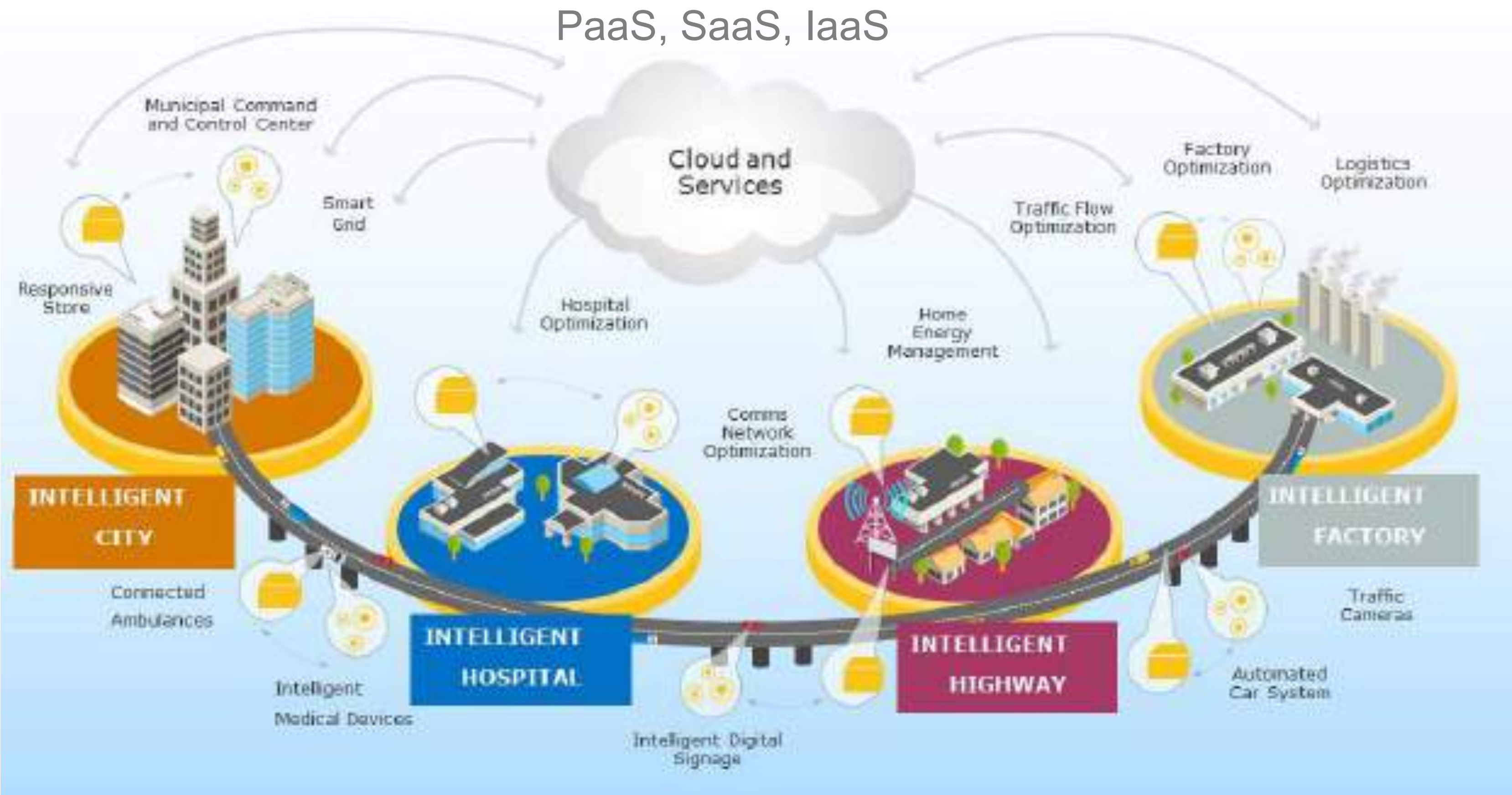
- Integration of different Technologies (beyond physical layer)
  - Following actual trends...
- Complex radio environments
  - C-RAN, microcells
- Decoupling between infrastructure, network, computing and service
  - Softwarization: SDN, NFV, virtualization (cloud e edge computing)
- Multitenancy
  - Different flavors of providers and interrelations
  - Service slicing: **deep virtualization** (cloud and network)

Enabling Technologies for 5G Success

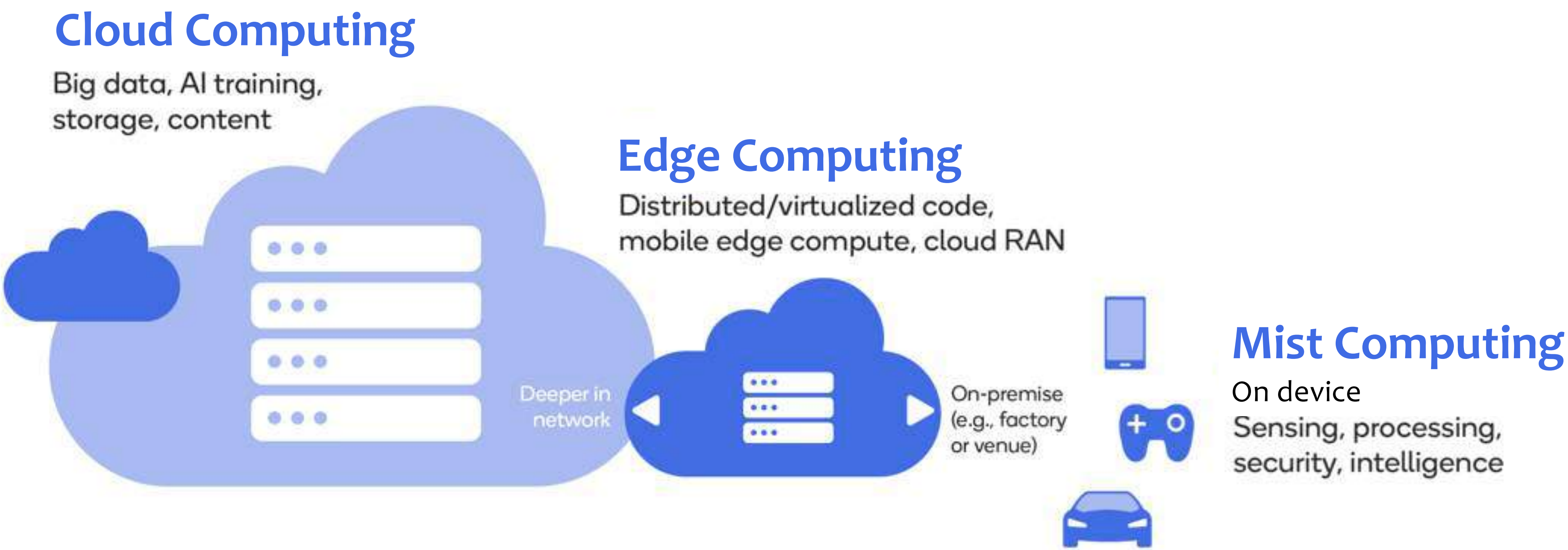
Evolutionary components of current generations of mobile networks under a unifying umbrella; and

Revolutionary components that will enable energy and spectral efficiency and new resiliency (i.e., responsive, auto-manageable QoS/QoE, secure, survivable, traffic and disruption tolerant) for services to everyone and everything (applications and machines).

Cloudification

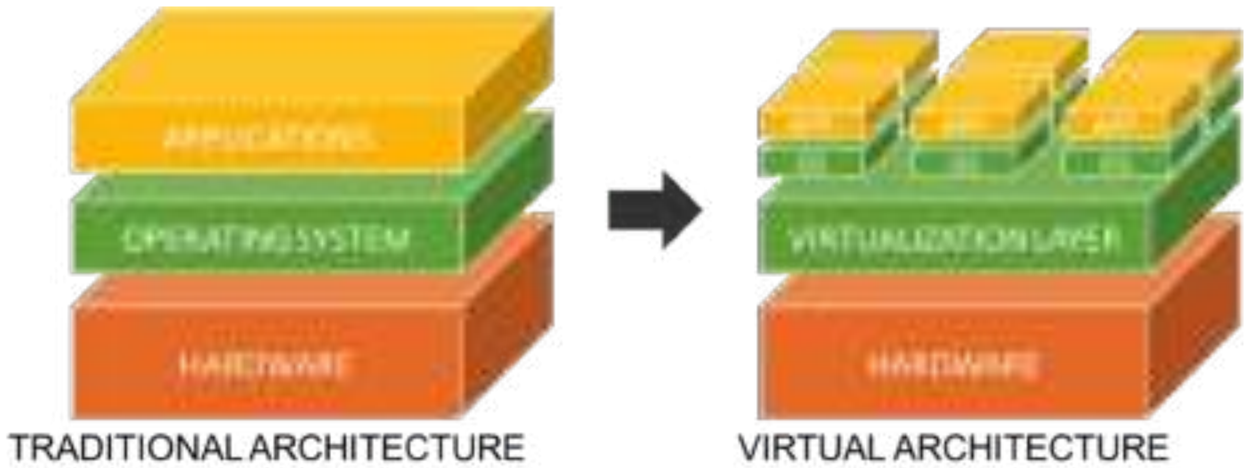


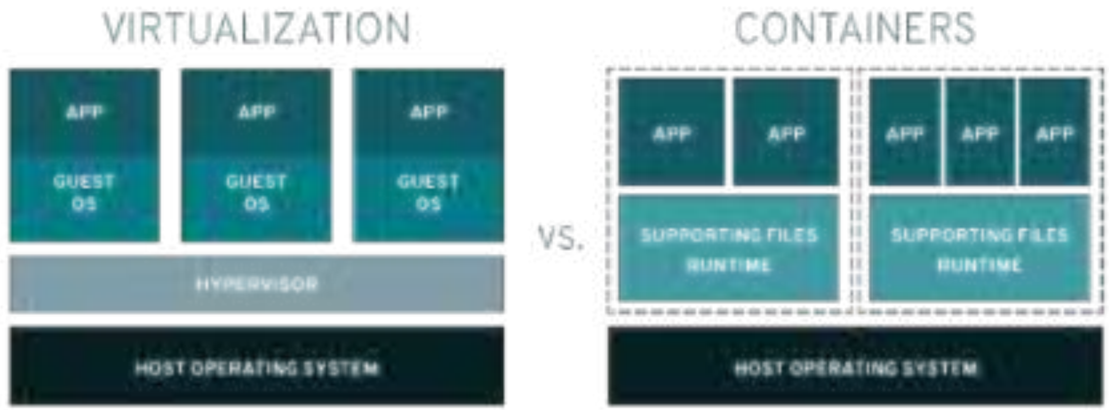
Evolution of Cloudification



Virtualization

the process of running a virtual instance of a computer system in a layer abstracted from the actual hardware

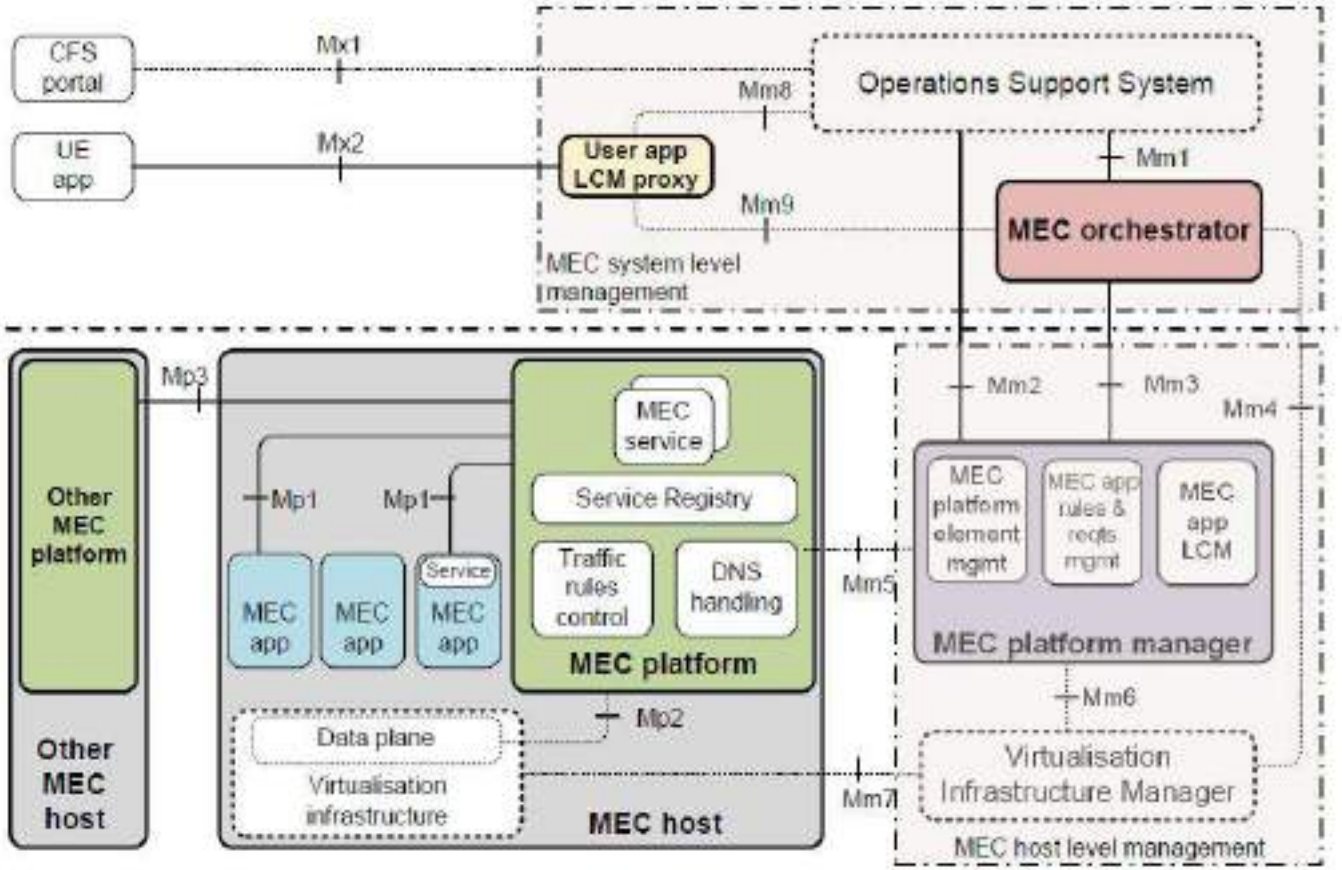




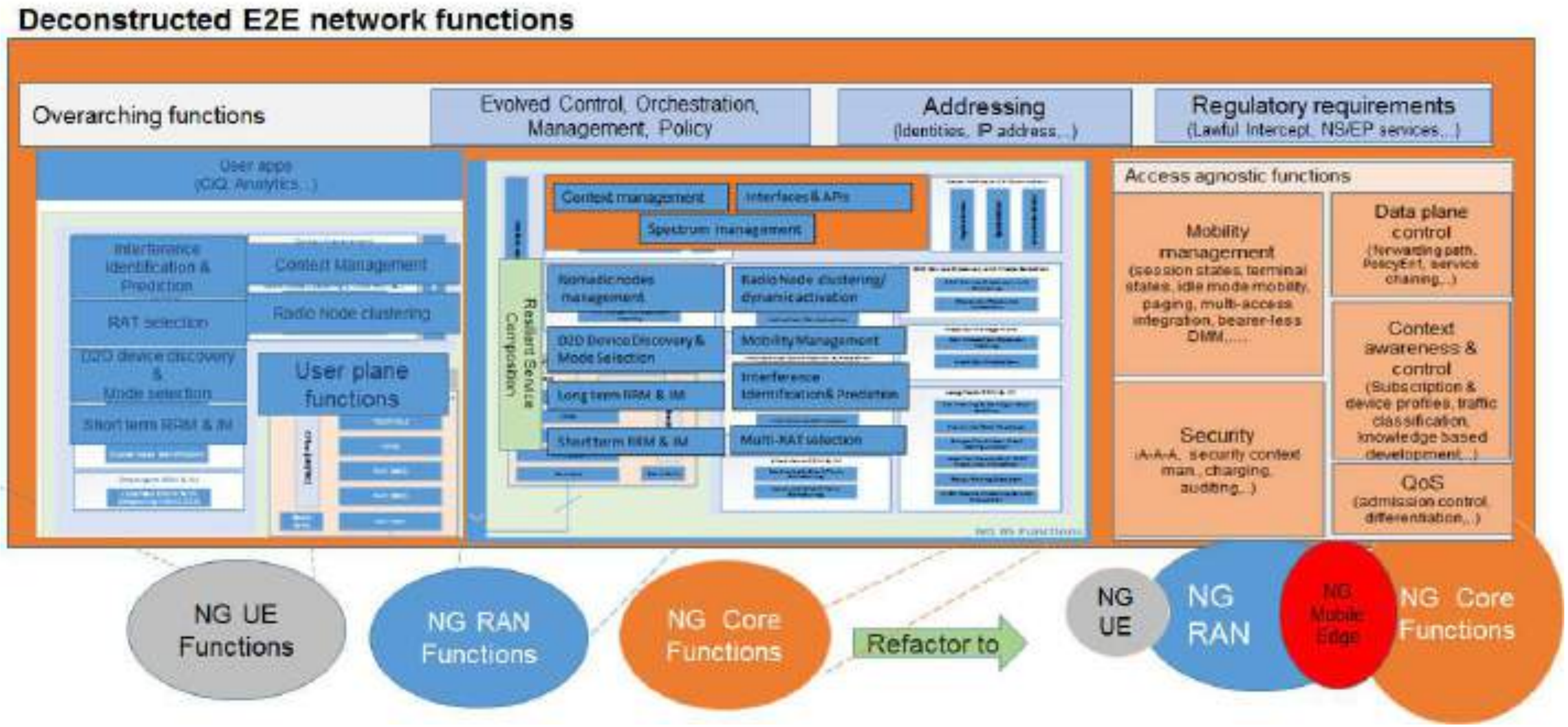
MANO


Storage Domain
Network Domain
Application Provisioning
Monitoring
Lifecycle Management
Compute Domain
Change Management
Orchestration Engine
Orchestration
Service Desk
Private cloud
Traditional IT
docker
Chef
Azure

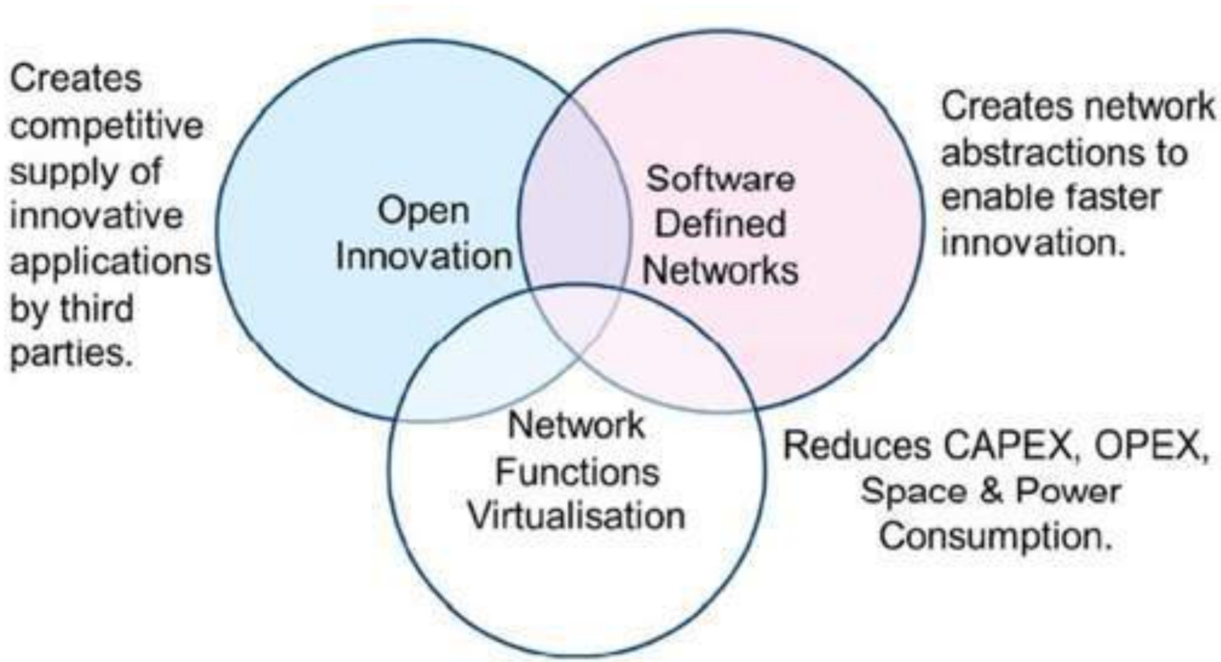
STSI's Multi Access Edge Computing (MEC) Proposal Overview



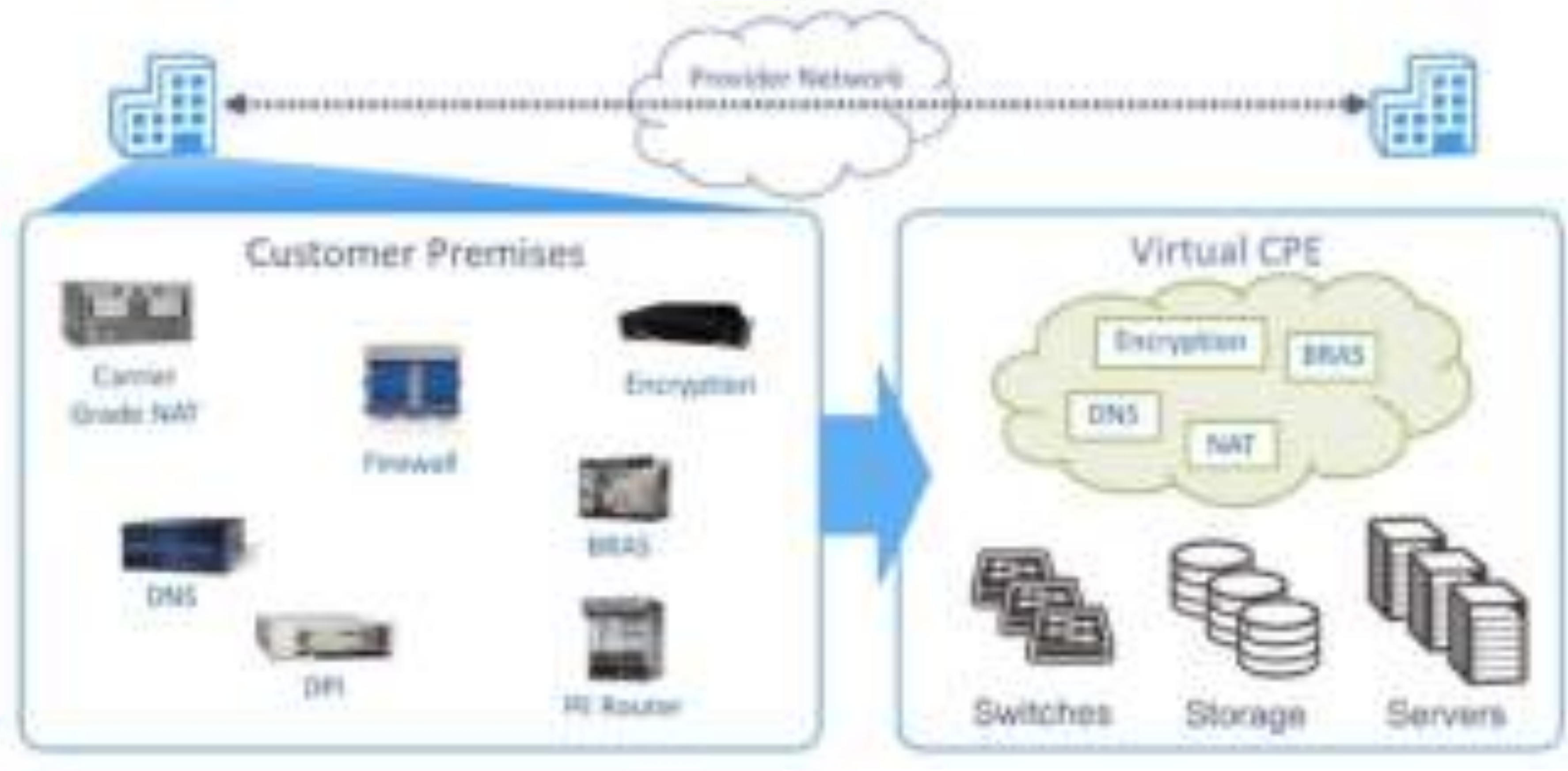
ETSI’s Open Mobile Edge Cloud (OMEC) Vision



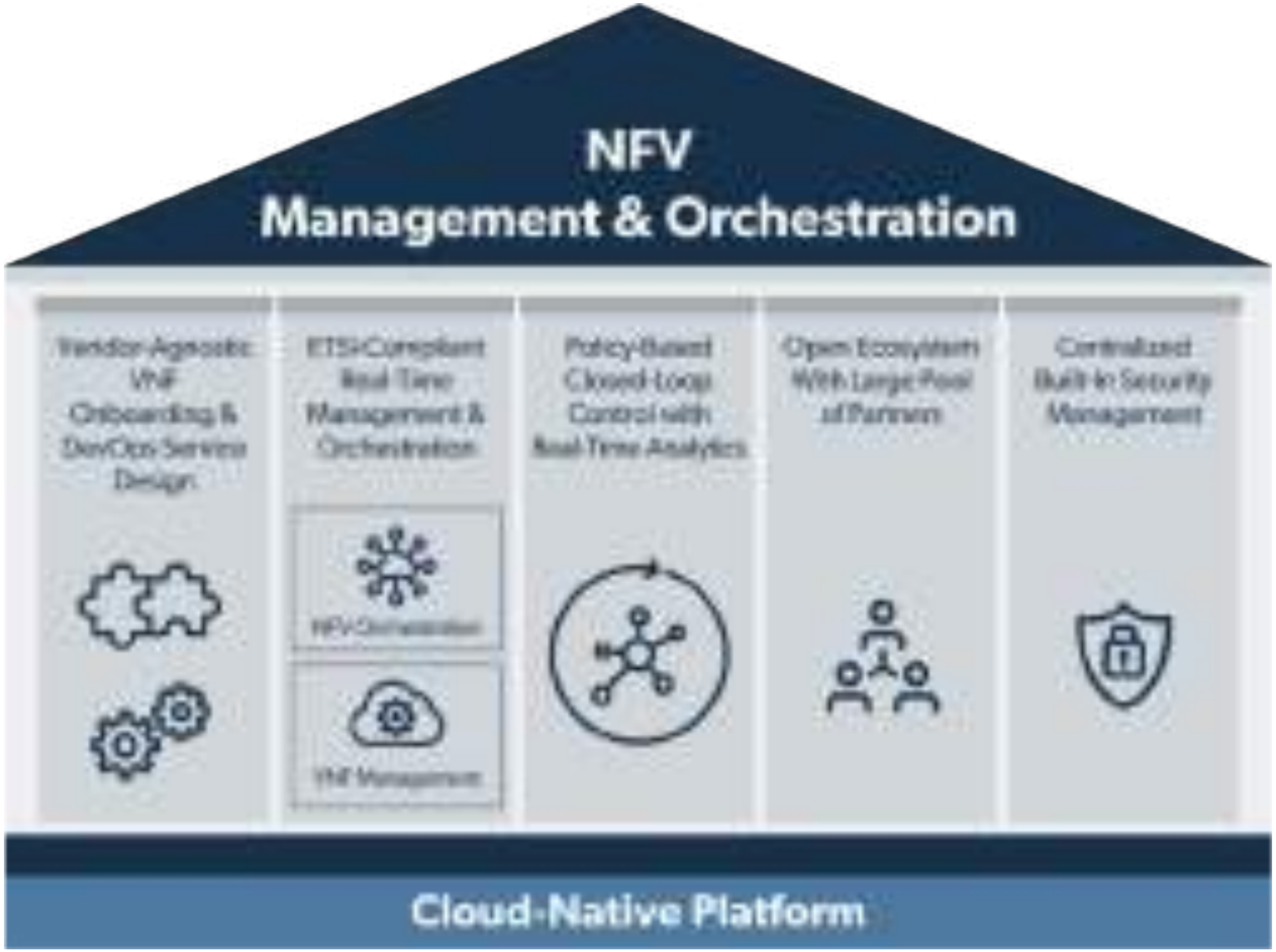
NFV + SDN = Softwarization



NFV: from hardware to virtual machines

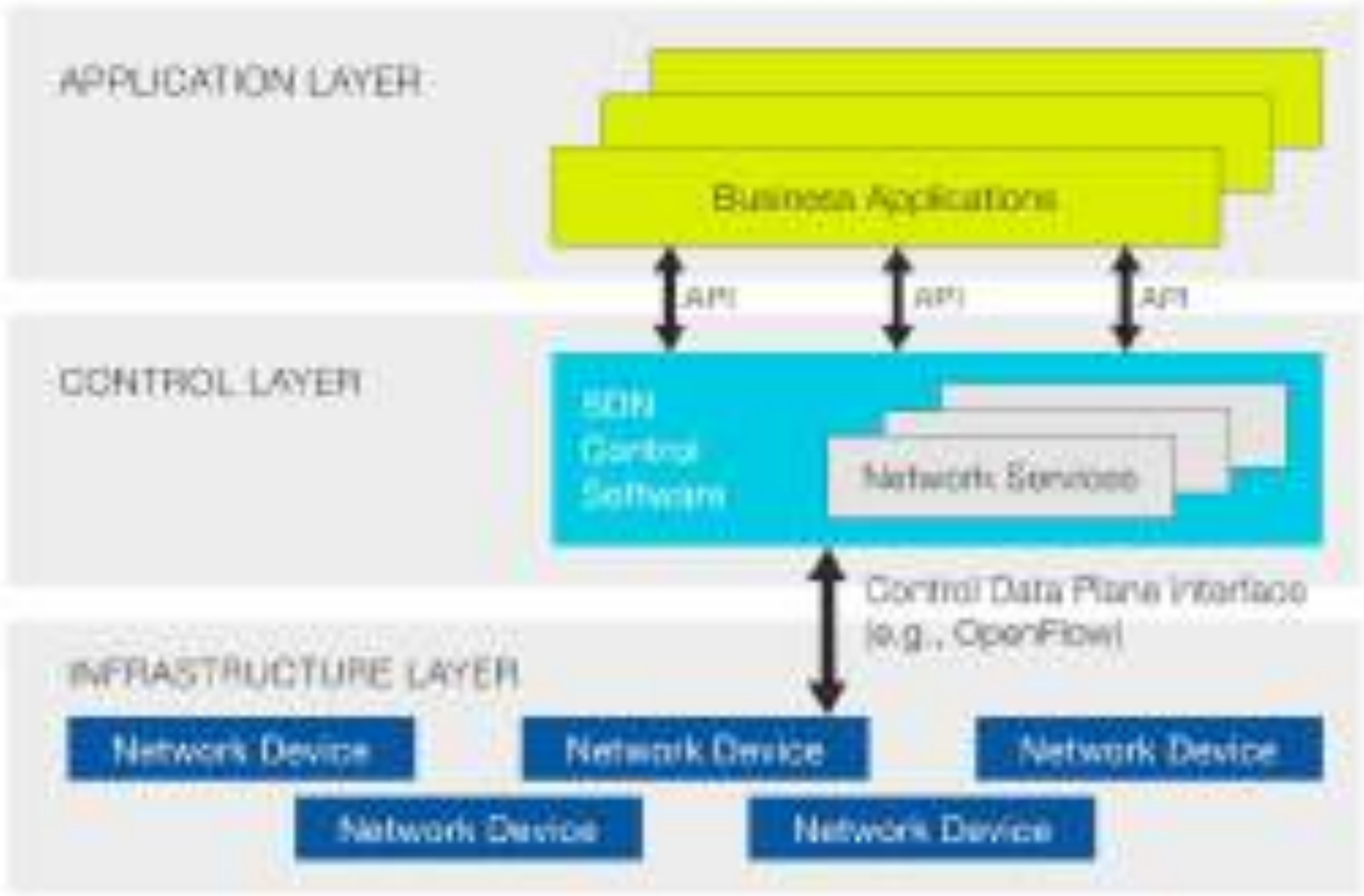


NFV: MANO

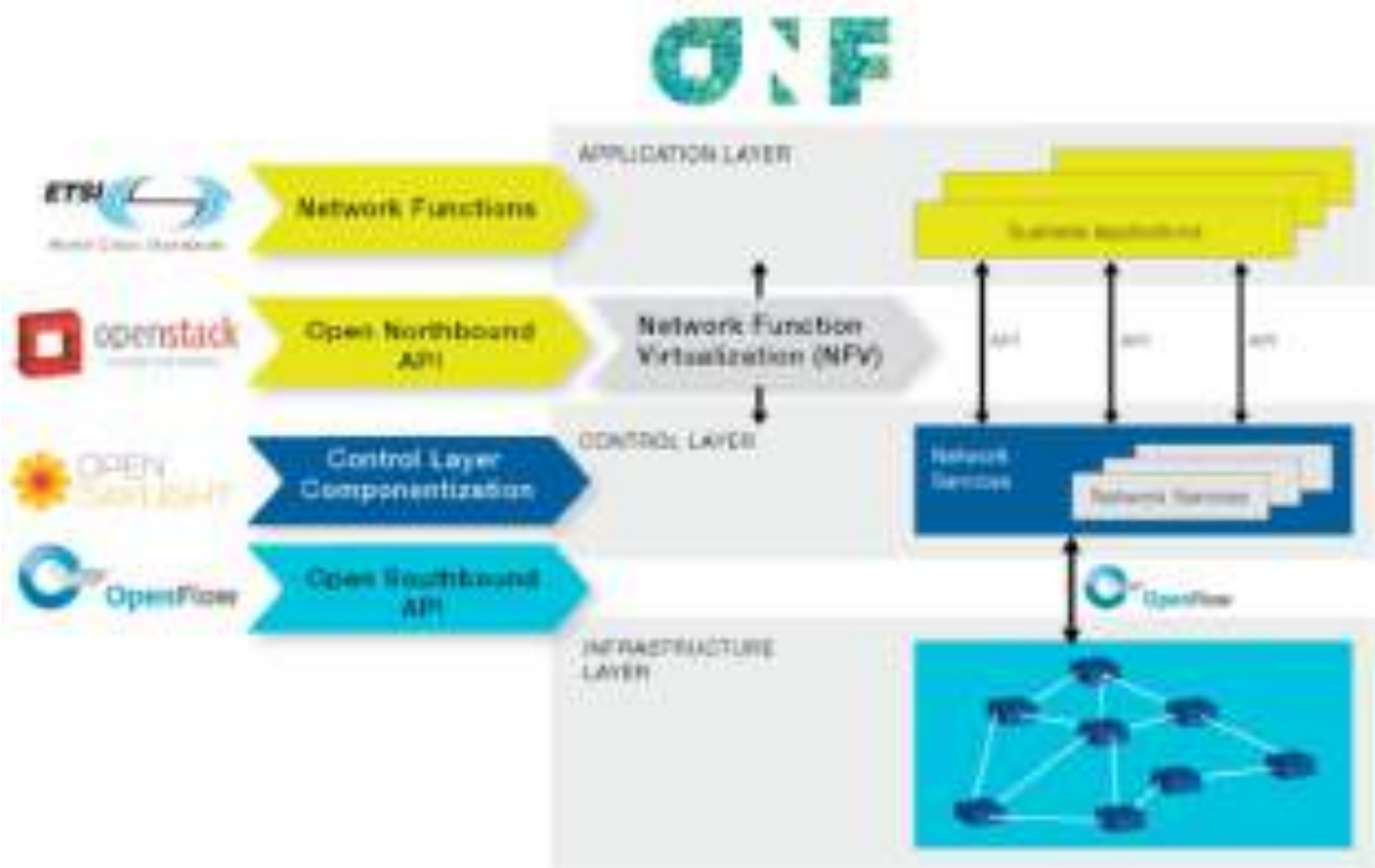


NFV
Management & Orchestration
Vendor-Agnostic VNF Onboarding & DevOps Service Design
ETSI-Compliant Real-Time Management & Orchestration
Policy-Based Closed-Loop Control with Real-Time Analytics
Open Ecosystem With Large Pool of Partners
Centralized Built-In Security Management
Cloud-Native Platform

SDN

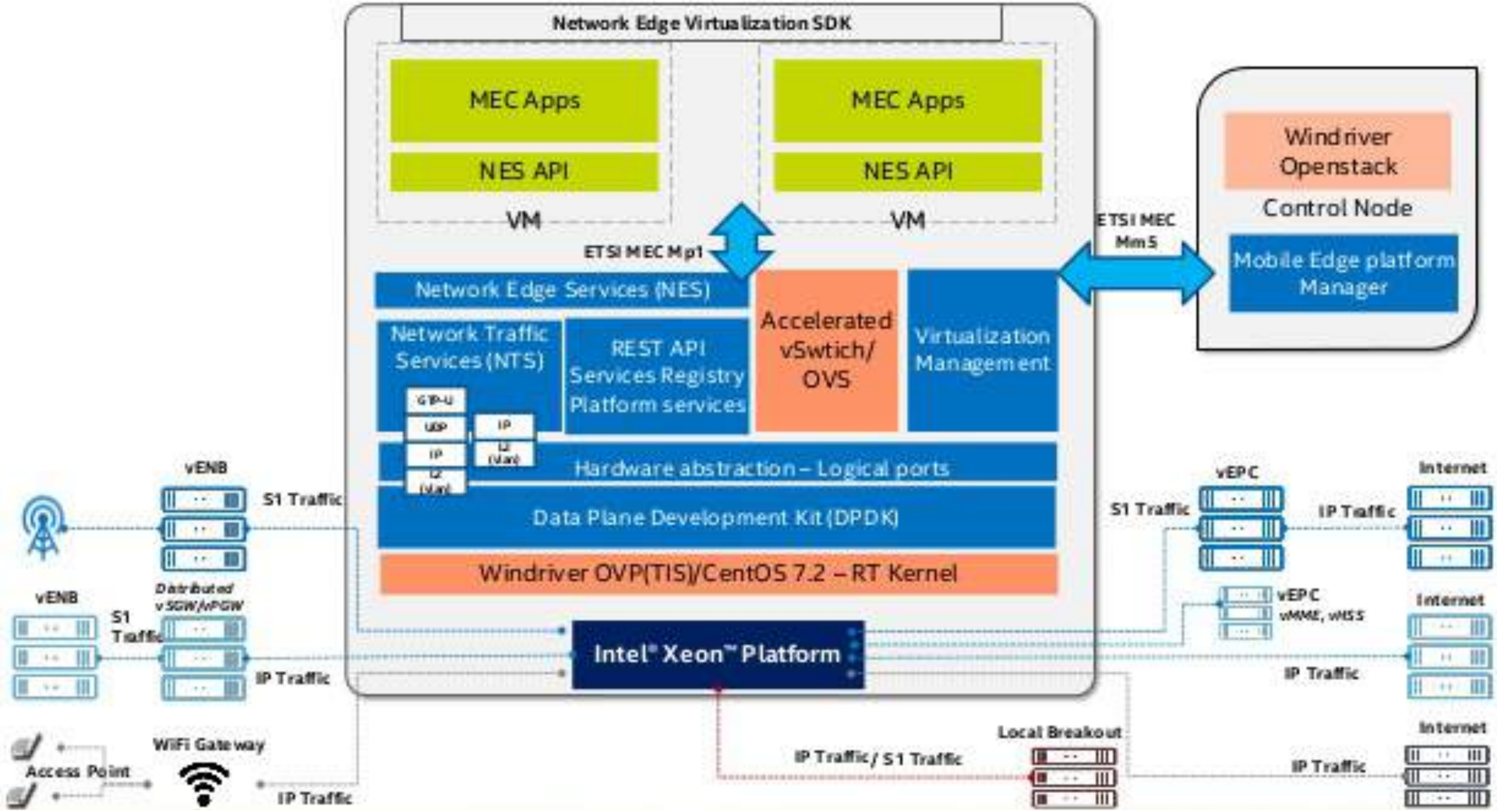

APPLICATION LAYER
Business Applications
API
API
API
CONTROL LAYER
SDN
Control
Software
Network Services
Control Data Plane interface
(e.g., OpenFlow)
INFRASTRUCTURE LAYER
Network Device
Network Device
Network Device
Network Device
Network Device

SDN/NFV


ONF
APPLICATION LAYER
Network Functions
Open Northbound API
Network Function Virtualization (NFV)
Control Layer Componentization
Open Southbound API
CONTROL LAYER
INFRASTRUCTURE LAYER
openstack
OpenFlow
API
API
API
Network Services
Network Services
OpenFlow

NFV + SDN


Virtual Infrastructure
Management
NFV
Infrastructure
SDN Equipment
High-Density Servers
High-Performance Storage
Carrier-Grade
Hypervisor
Foundation for
Any NFV
Deployment
Support for
Distributed
Architecture
Fully
Virtualized
Data Center


Network Edge Virtualization SDK
MEC Apps
NES API
VM
MEC Apps
NES API
VM
ETSI MEC Mp1
Network Edge Services (NES)
Network Traffic Services (NTS)
GTP-U
UDP
IP
L2 (Vlan)
IP
L2 (Vlan)
REST API Services Registry Platform services
Accelerated vSwtich/ OVS
Virtualization Management
Hardware abstraction – Logical ports
Data Plane Development Kit (DPDK)
Windriver OVP(TIS)/CentOS 7.2 – RT Kernel
Intel® Xeon™ Platform
ETSI MEC Mm5
Windriver Openstack
Control Node
Mobile Edge platform Manager
vENB
S1 Traffic
vENB
S1 Traffic
Distributed vSGW/vPGW
IP Traffic
Access Point
WiFi Gateway
IP Traffic
IP Traffic / S1 Traffic
Local Breakout
vEPC
S1 Traffic
IP Traffic
Internet
vEPC
vMME, vHSS
Internet
IP Traffic
Internet
IP Traffic

Slicing

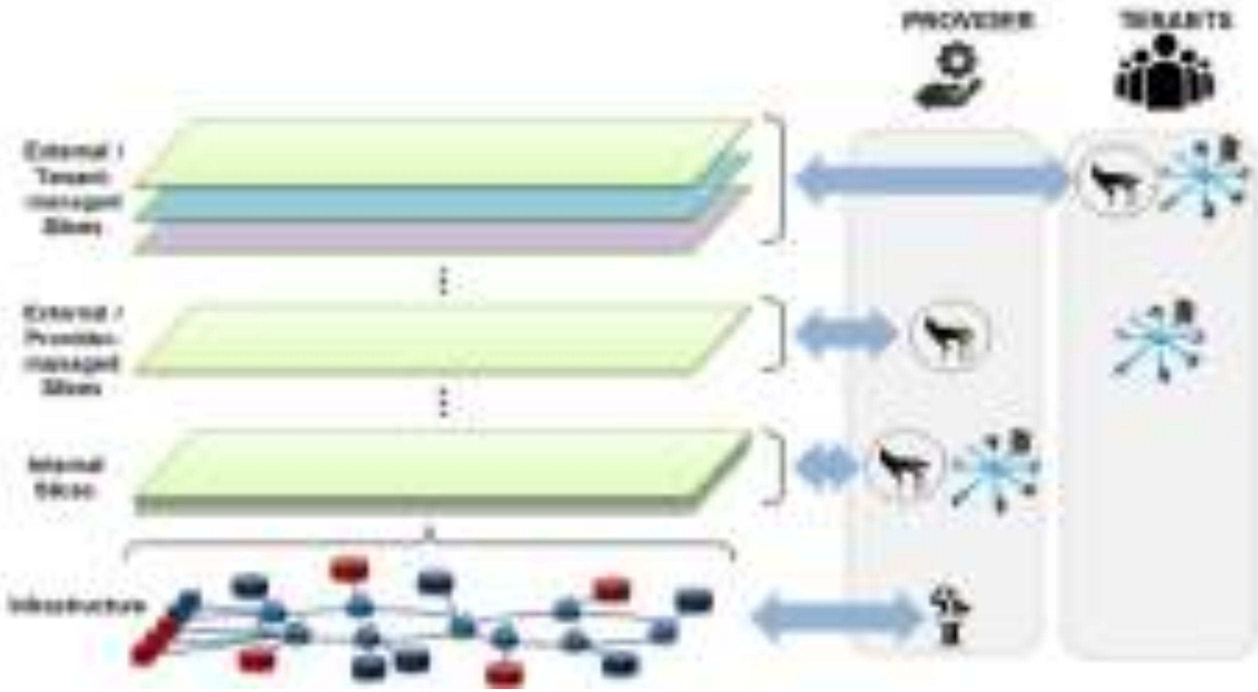
Partition the physical infrastructure in different logical for multitenancy service provisioning

Main benefits:

- Customization
- Independency
- Isolation
- Systematic control

Types:

- Network Slicing
- Cloud Slicing

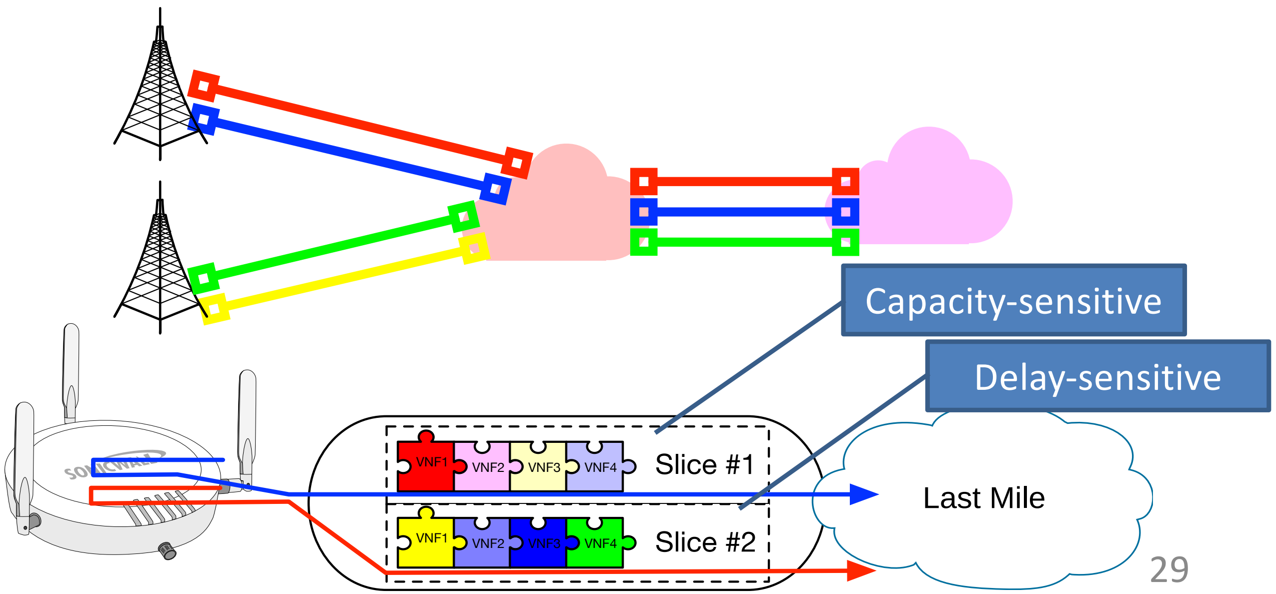


Network Slicing: Network as a Service

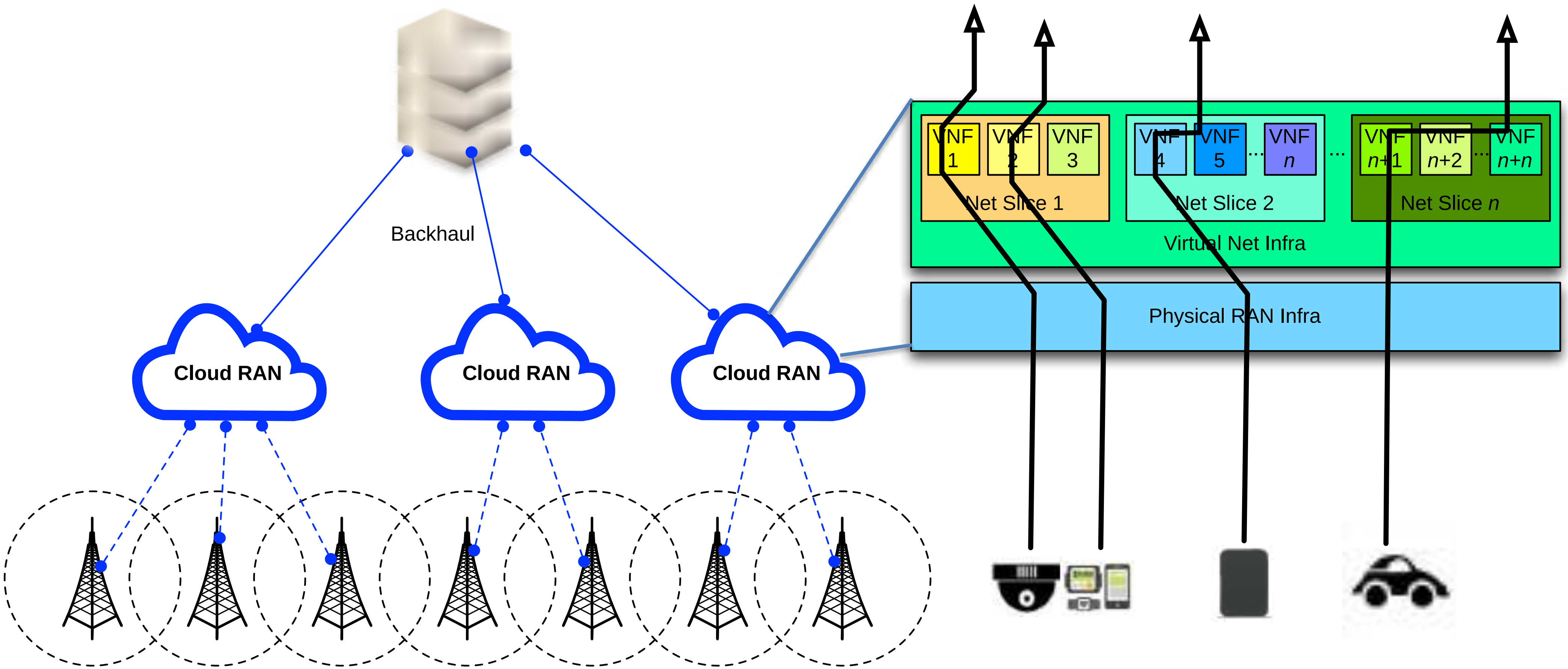
Network physical infrastructure partitioning

Deployment through the combination of:
- Softwarized substrate,
- Fine-granularity definitions
- High distribution of data centers (specially in the edges)

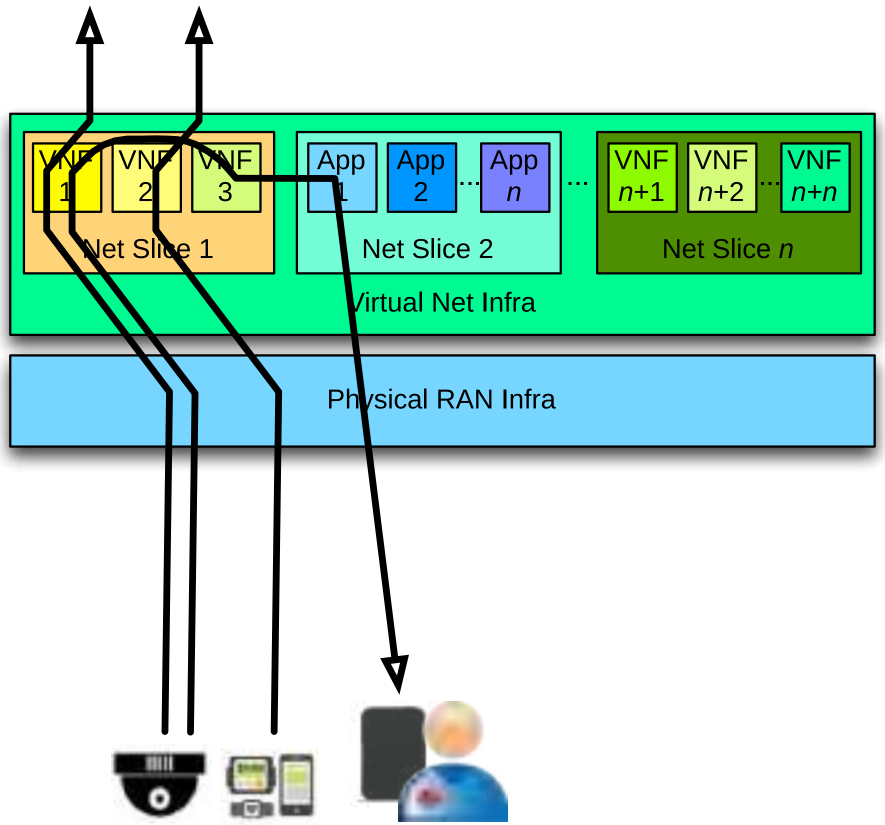
NS são:
- Self-contented
- Mutually isolated
- Manageable and programmable
- Multisservice support
- Multitenancy
- Significantly diferente from traditional VPNs or virtual networks, and traffic engeneeging

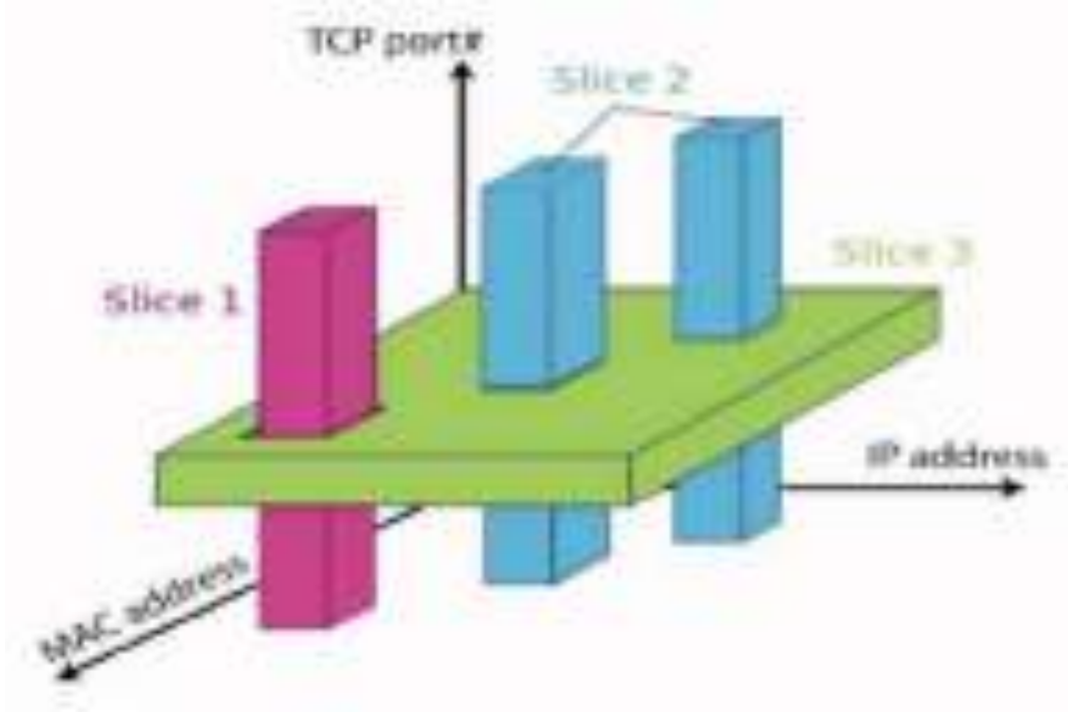


Network Slicing: Network as a Service

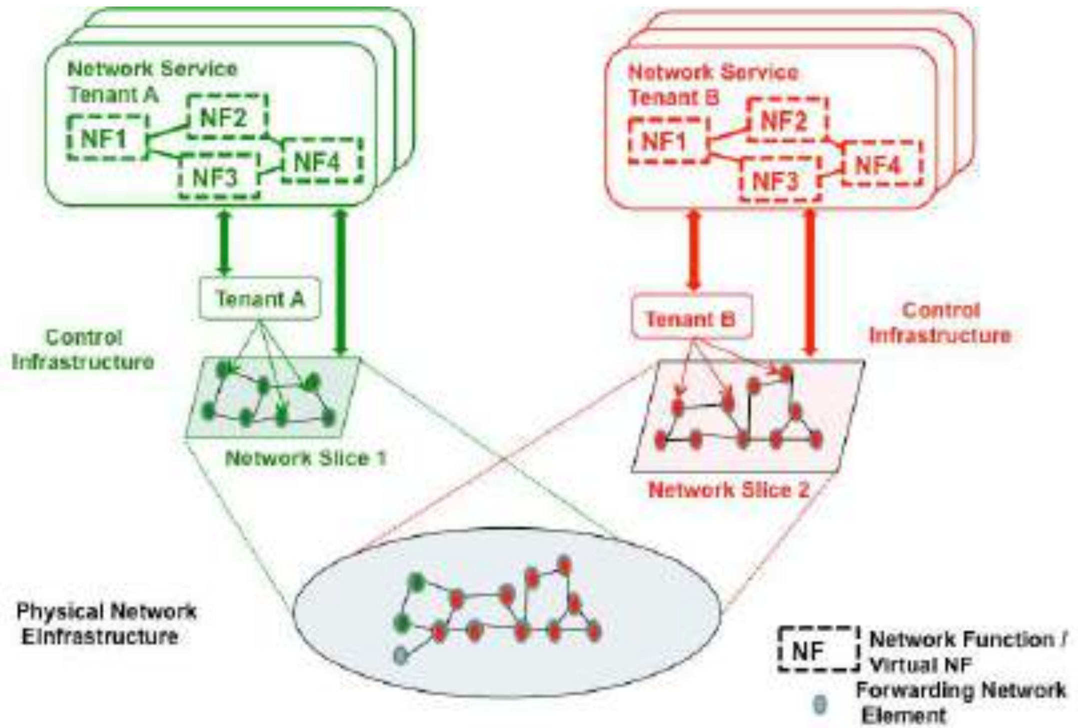


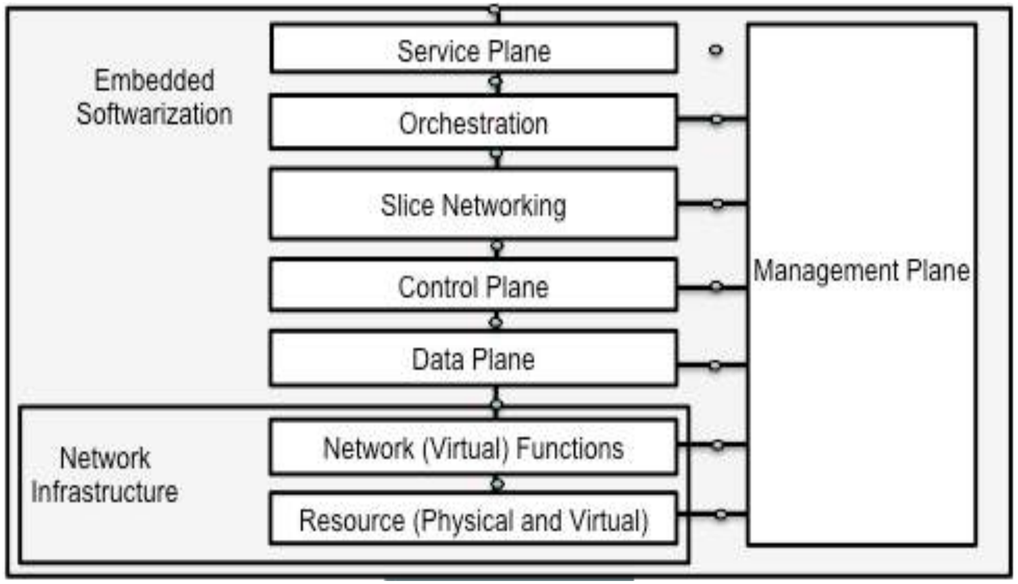
Network Slicing: Net/App as Service



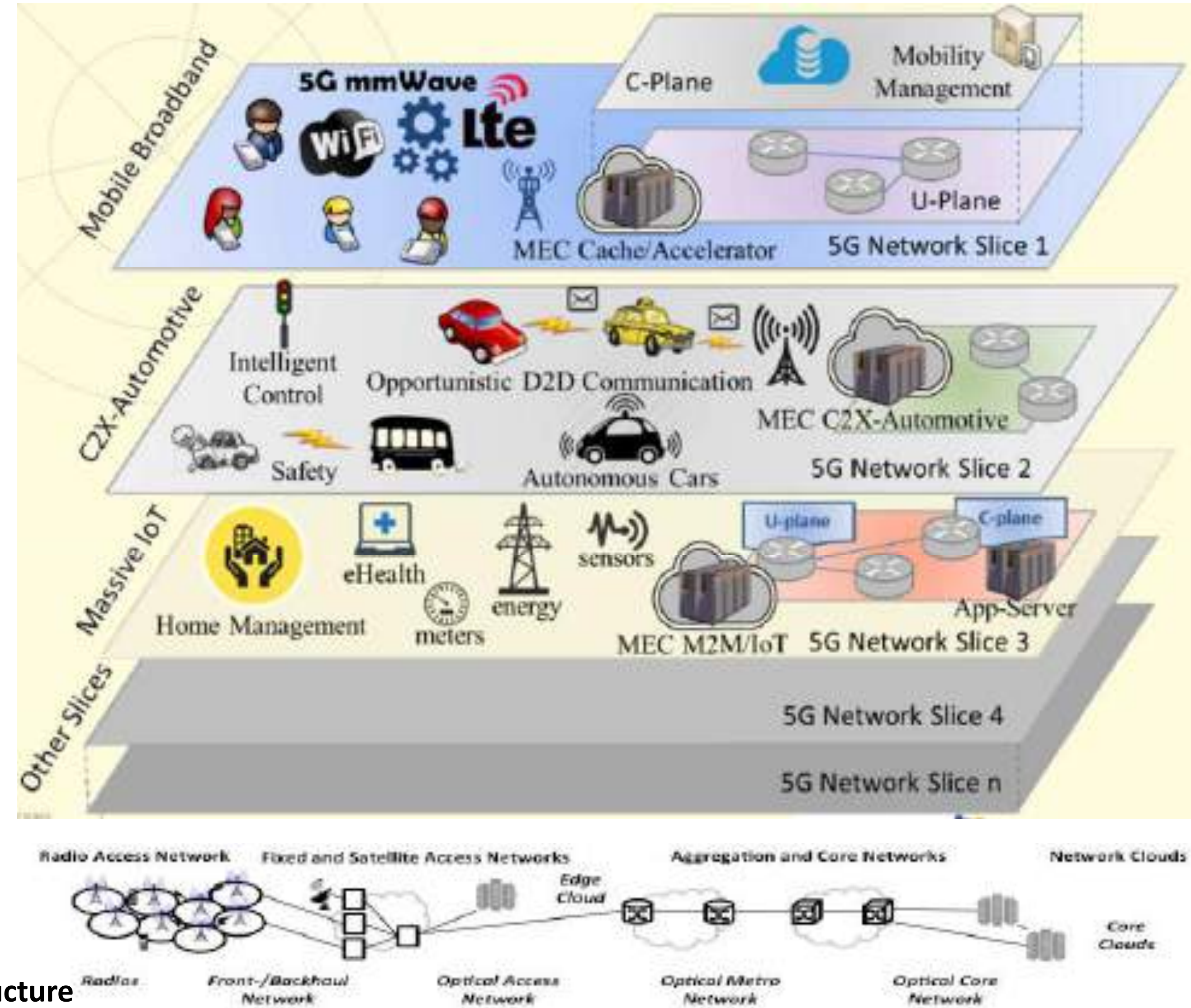


Network Slicing: 5G PPP View





Fonte: 5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0



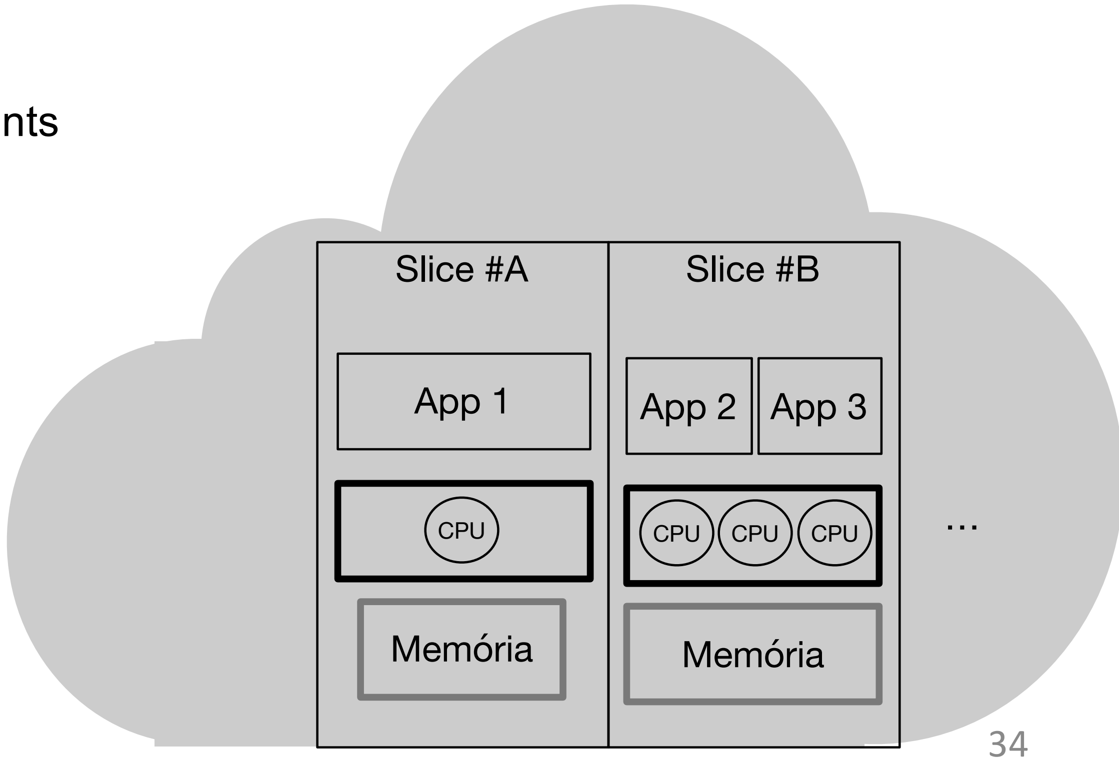
Infrastructure

Cloud Slicing

Cloud physical infrastructure partitioning

Characteristics:

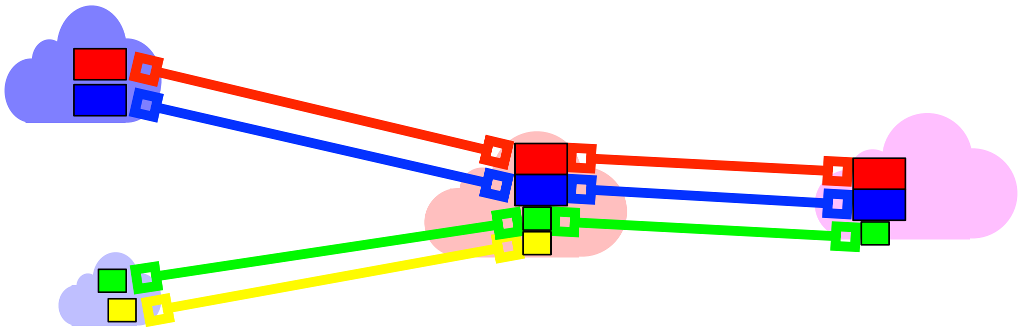
- High-isolation level between slices
- Pre-stablished resources
- Real time elasticity management
- Infrastcuture complexity is transparente for clients
- CAPEX/OPEX



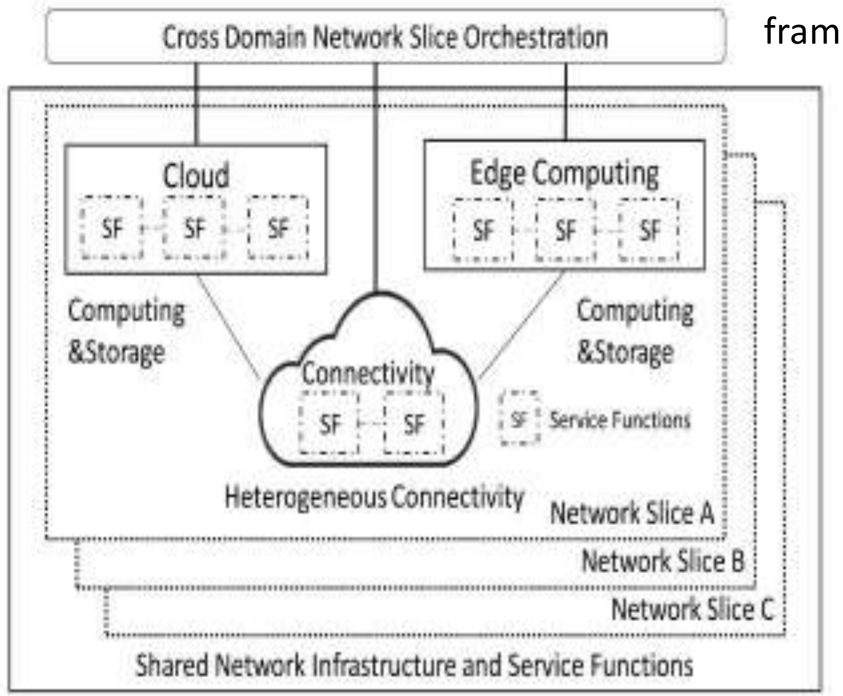
Network-Cloud Slicing

Coupled partitioning of network and cloud physiscal infrastructures

Benefits:
- Resources dedicated and isolated in a end-to-end view
- Tenants can have customized level of slice provisioning
- New business models



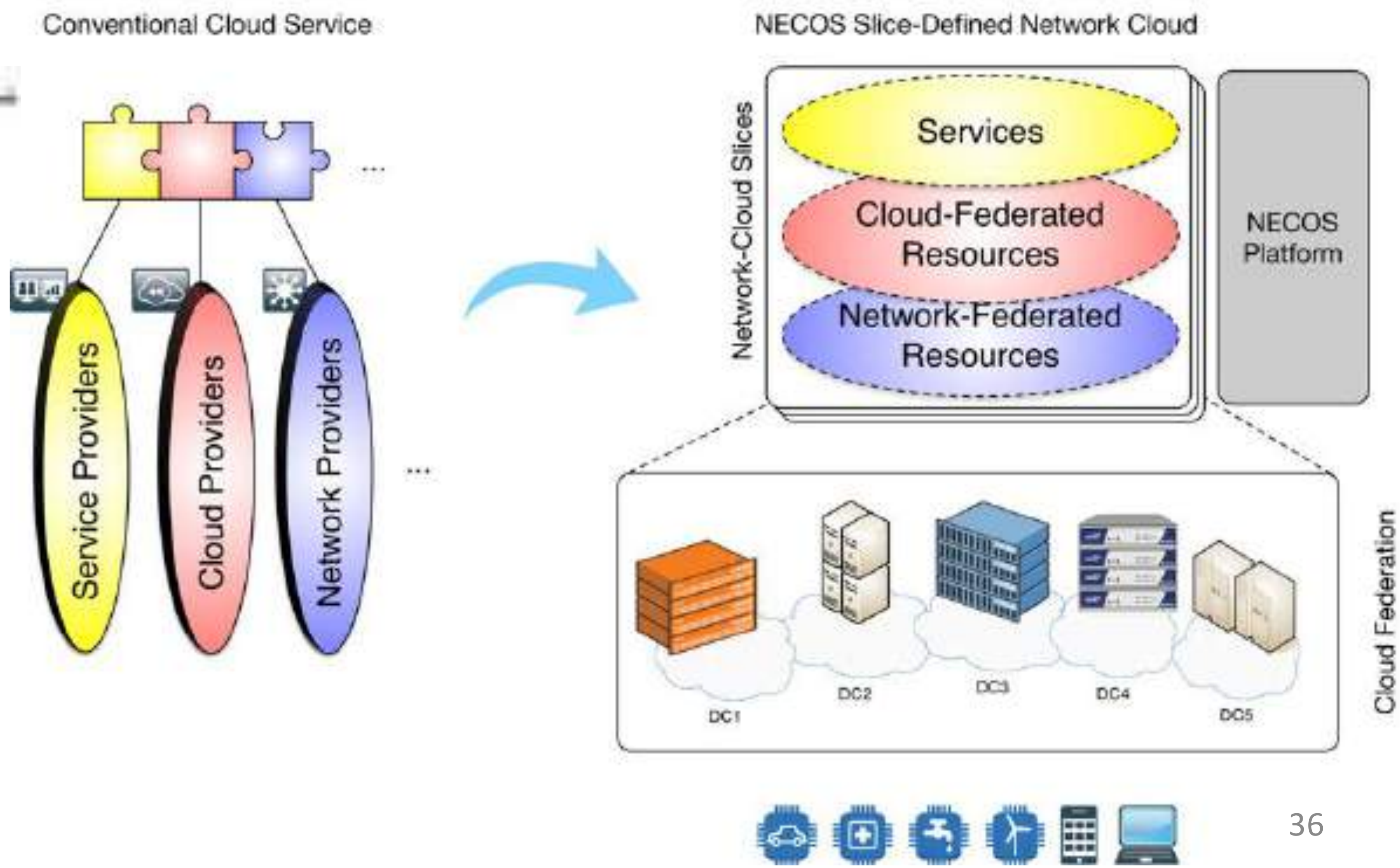
IETF proposed framework



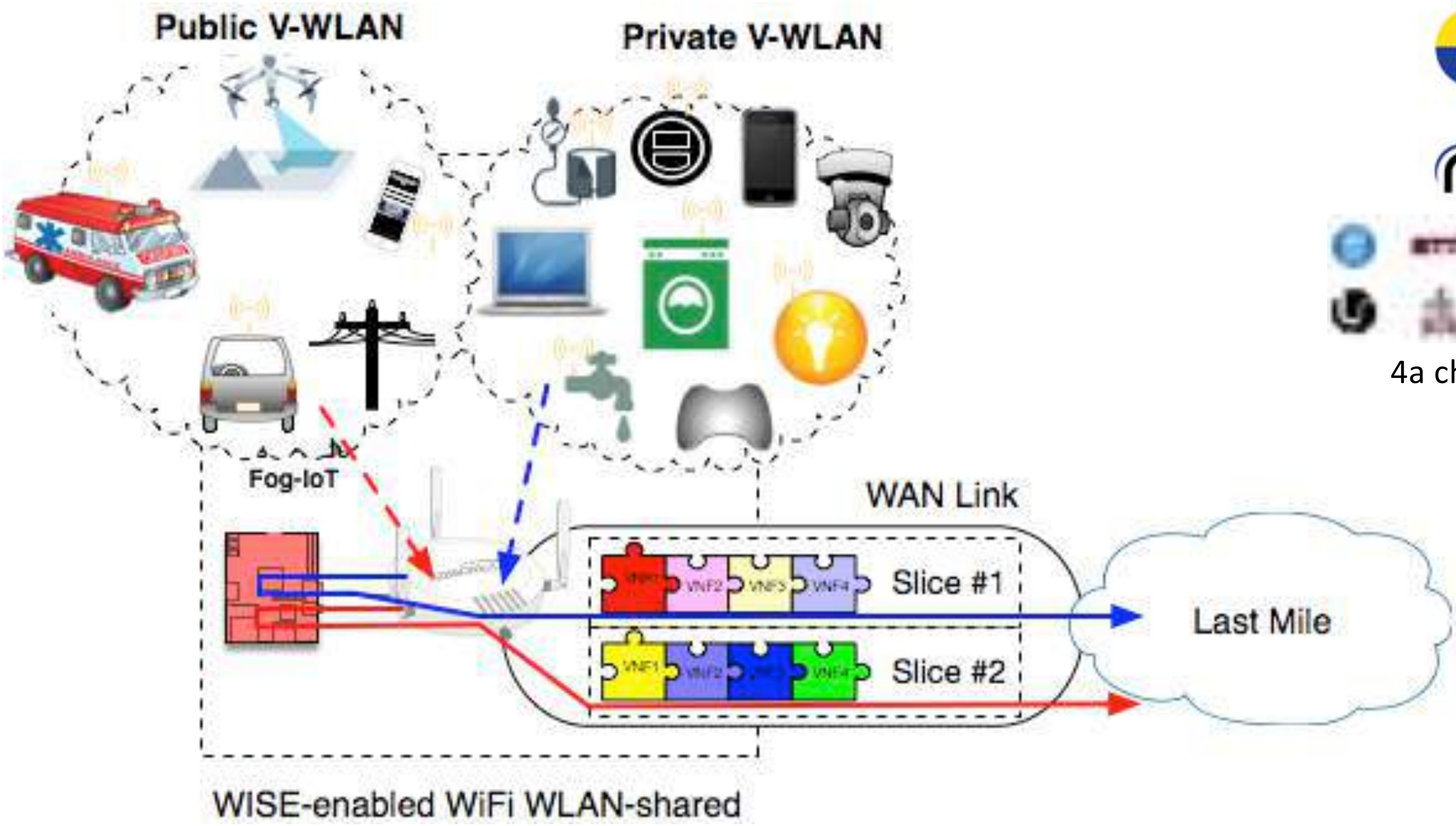
Novel Enablers for Cloud Slicing

4a chamada colaborativa EU-BR

http://www.h2020-necos.eu



Usecase: NECOS-supported WISE



necos

4a chamada colaborativa
EU-BR

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Thanks, questions?

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