GRUPO DE TECNOLOGÍAS
DE LA INFORMACIÓN

Redes 5G

como activadoras de IoT en la industria
10-5-19

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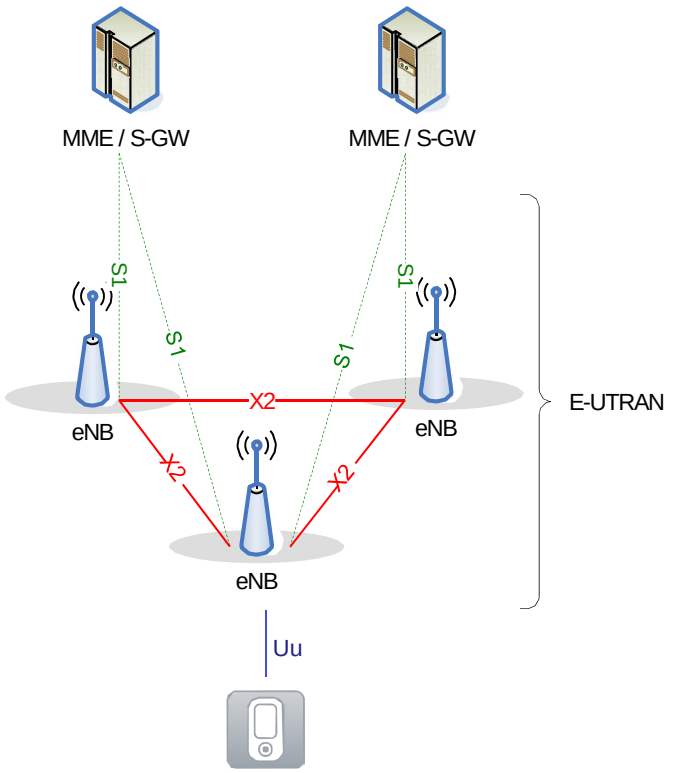
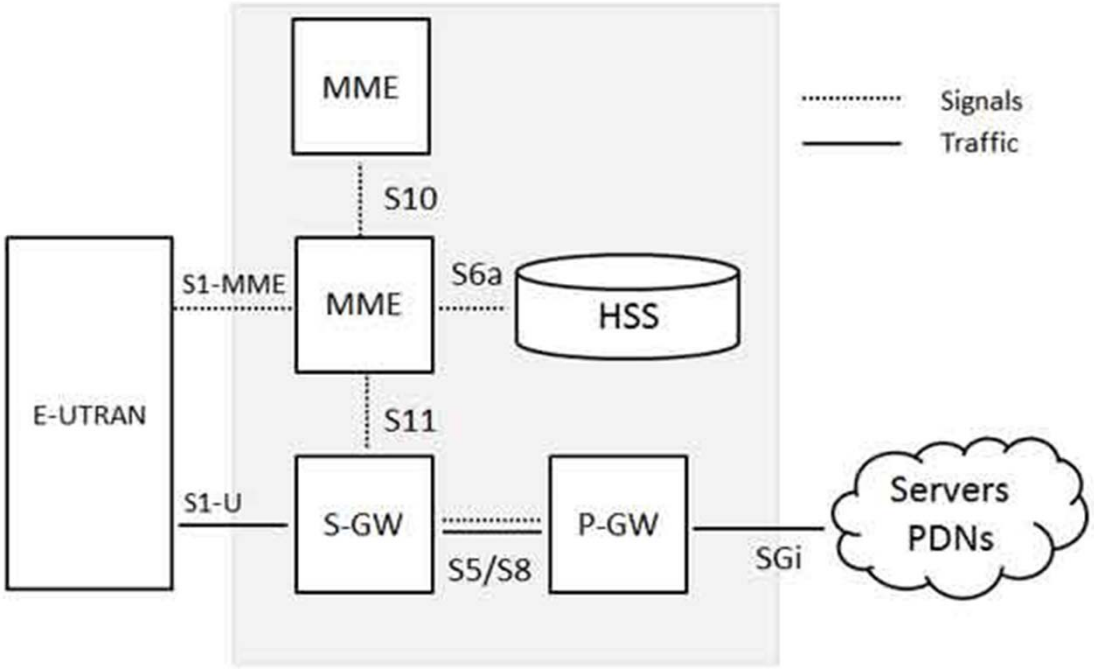
Antecedentes: Arquitectura LTE 4G

- UE (User Equipment). Terminal de usuario junto con el “universal subscriber identity module” (USIM).
- E-UTRAN Access Network: Versión mejorada de la red de acceso UMTS (UMTS Terrestrial Radio Access Network).
- EPC, Core Network (Evolved Packet Core). Red de transporte solo IP.



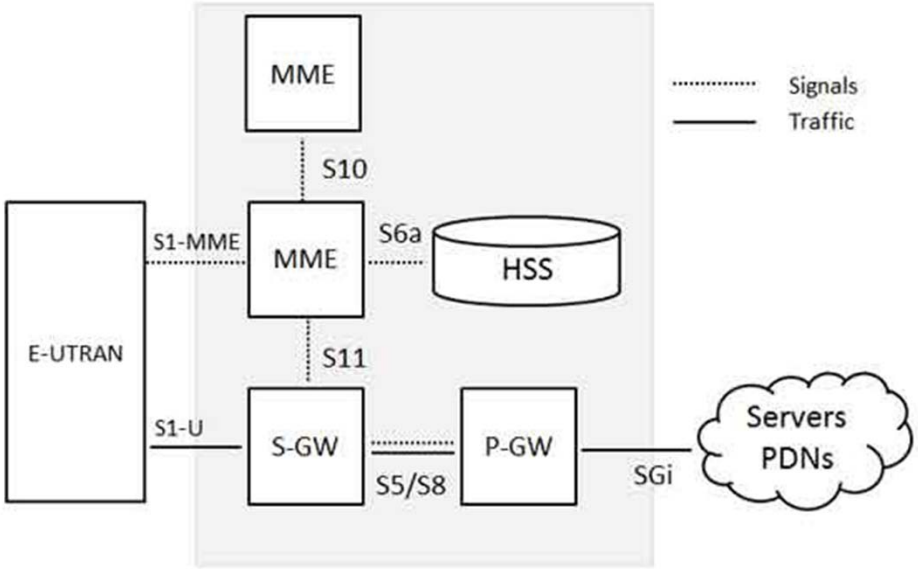
Antecedentes: Arquitectura LTE 4G (cont.)

- Elementos principals:
  - P-GW (Packet data network GateWay). Conecta el EPC a las redes externas (por ejemplo, Internet). Las redes externas se identifican con un Access Point Name (APN).
  - S-GW (Serving GateWay). Un router entre un grupo de UEs y un P-GW.
  - MME (Mobility Management Entity). Elemento de plano de control que gestiona la movilidad de los terminales.
  - HSS (Home Subscriber Server). Base de datos con información de los usuarios.

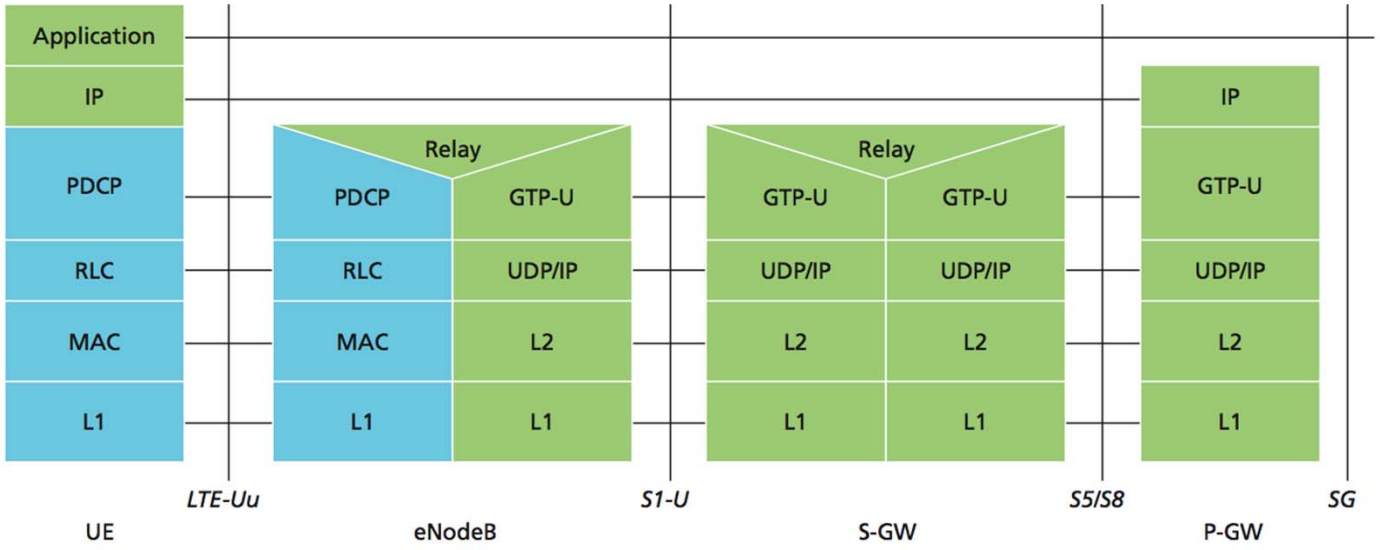


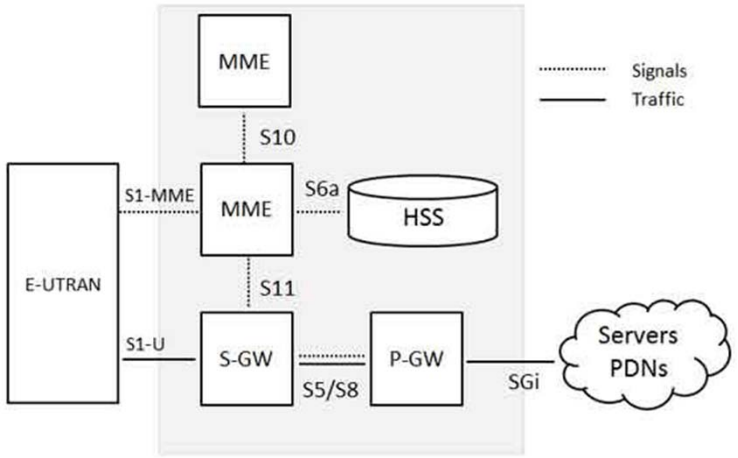
Antecedentes: Arquitectura LTE 4G (cont.)

- Interfaces principales
  - S1-MME: Entre la estación base (in the access network) y el MME. Tráfico de control.
  - S1-U: Entre la estación base y el S-GW. Tráfico de datos (usuario).
  - S5: Entre el S-GW y el P-GW Si están en la misma red (incluso el S-GW y el P-GW pueden ser el mismo dispositivo).
  - S8: Entre el S-GW y el P-GW si están en redes diferentes.
  - Sgi: Interfaz IP

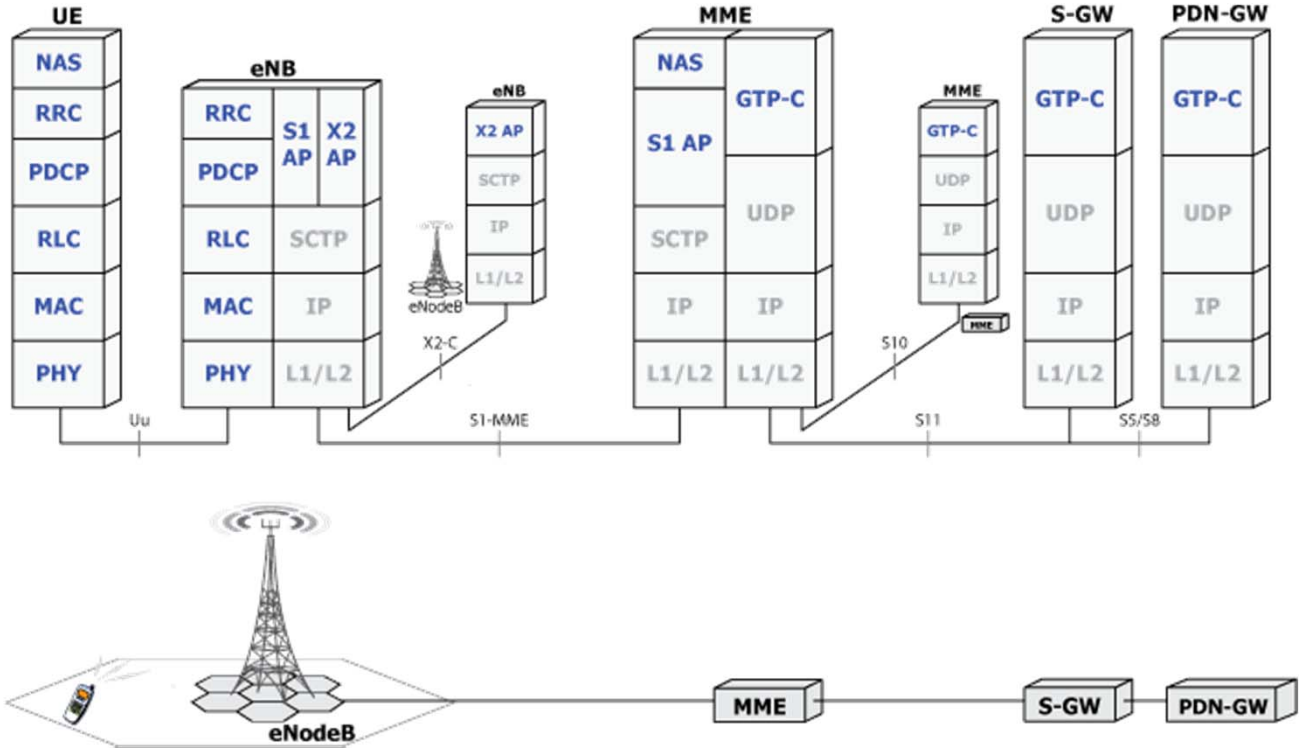


Protocolos en LTE (cont.): Plano de datos



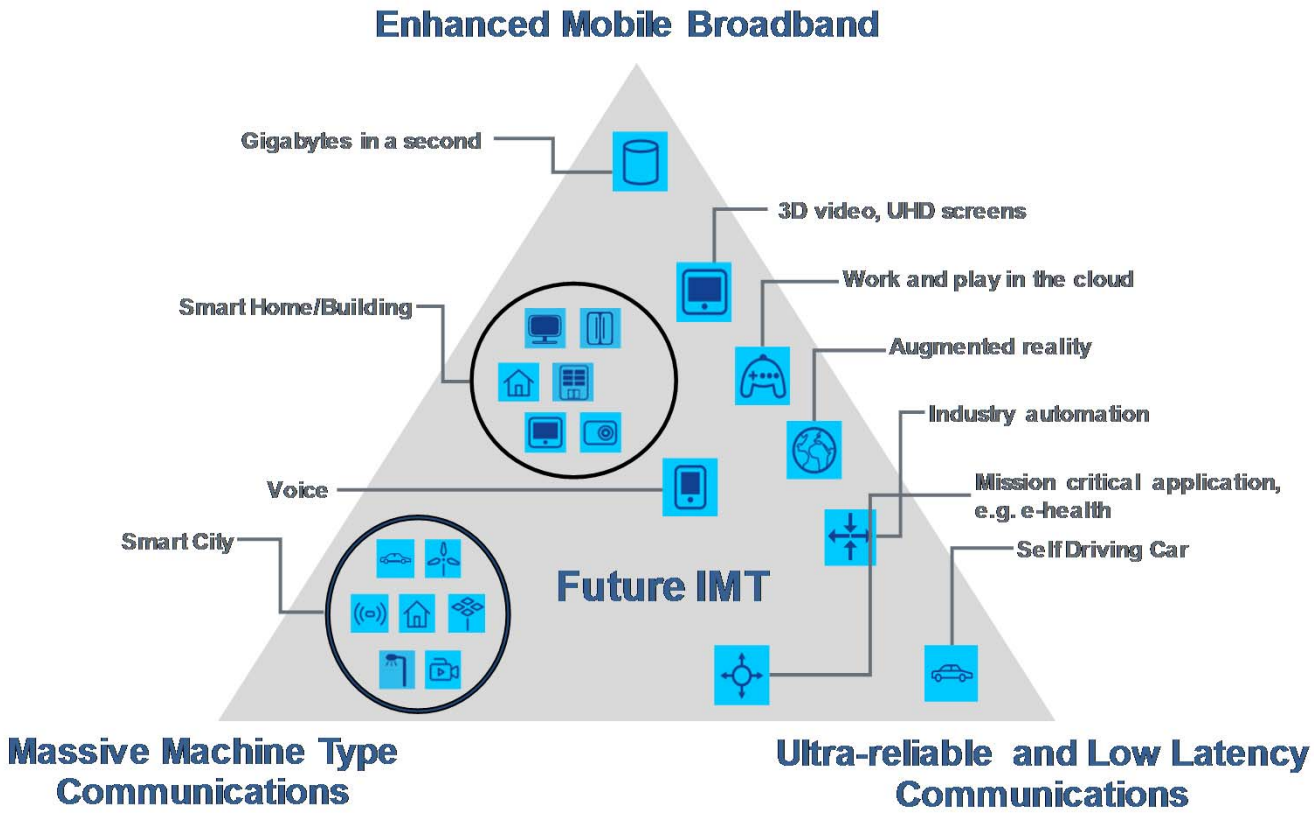


Protocolos en LTE (cont.): Plano de control



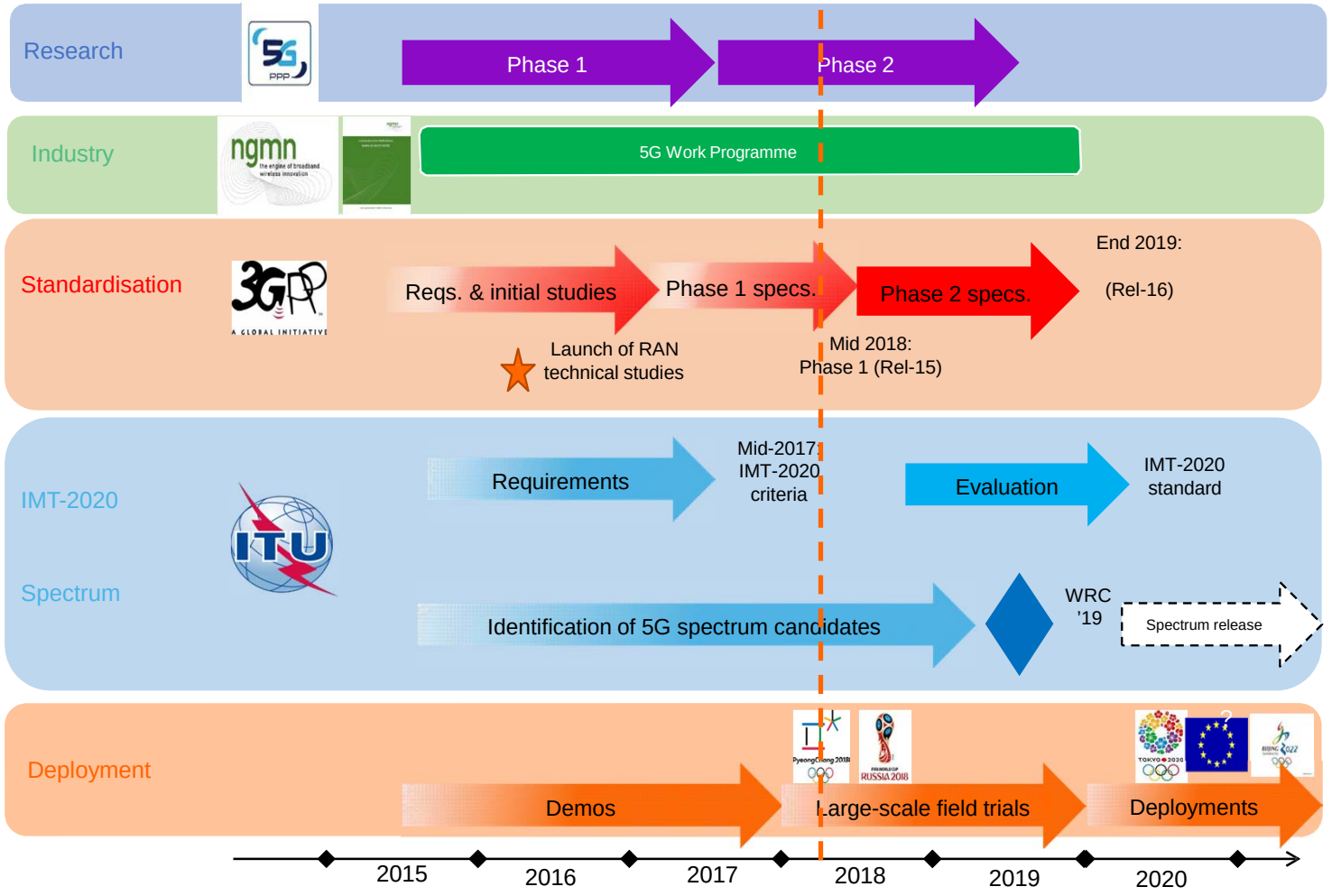
Introducción a 5G

5G: Casos de Uso



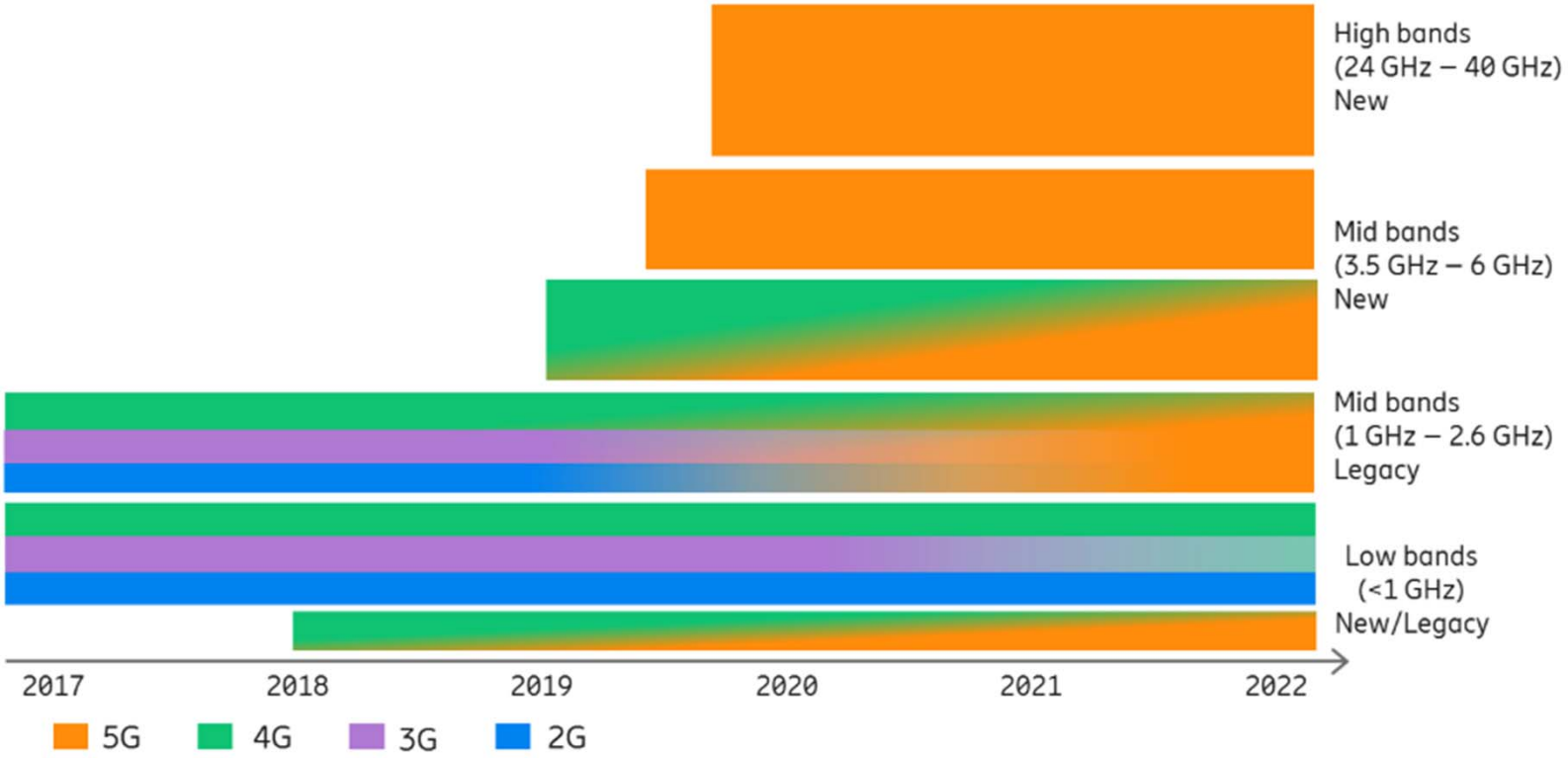
Source: ITU

5G: Plazos

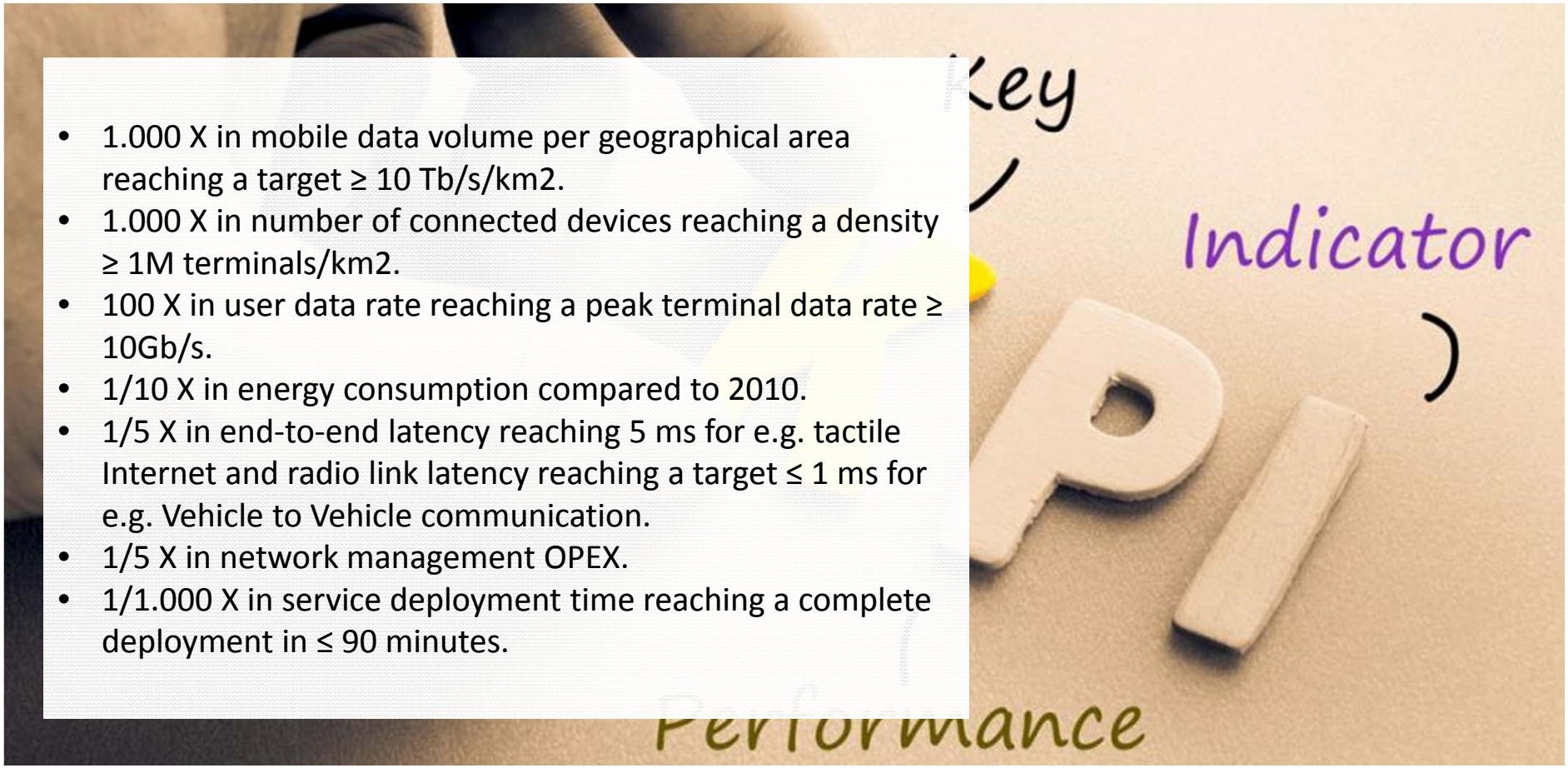


Source: orange

5G: Frecuencias

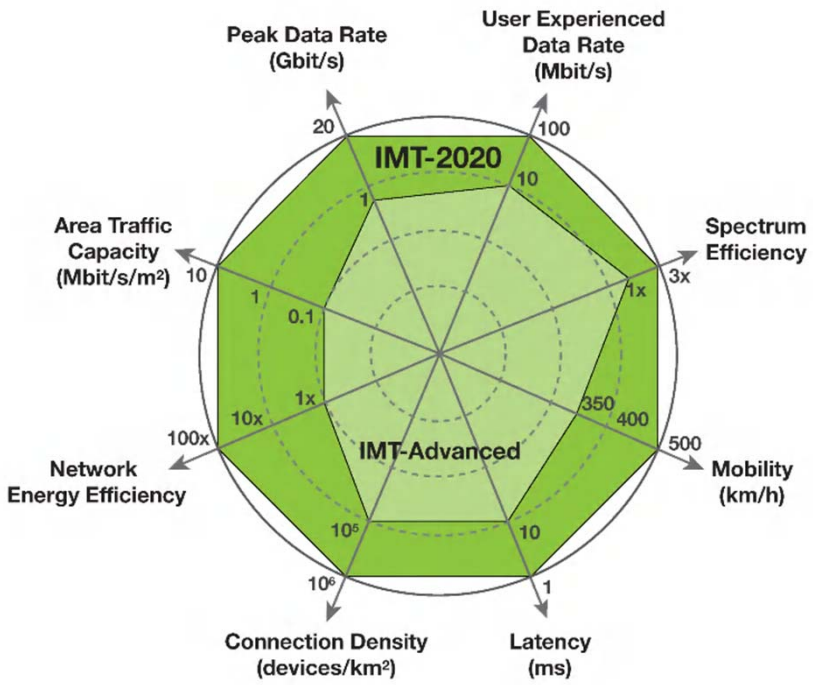


5G KPIs

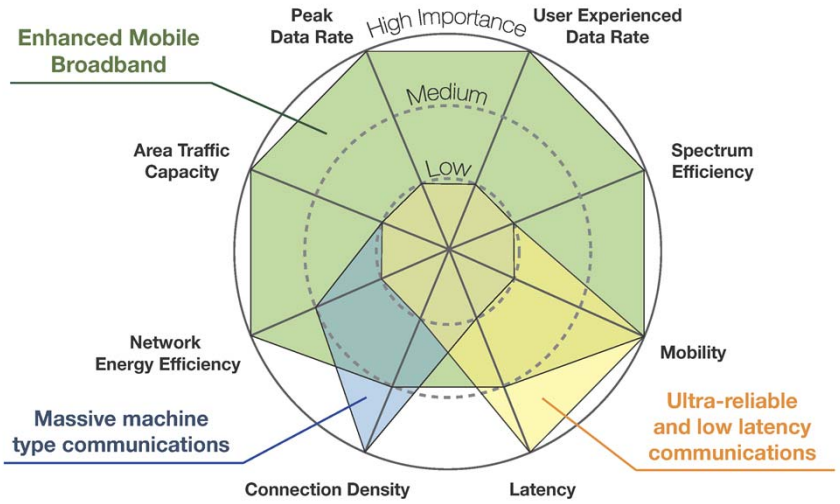


- 1.000 X in mobile data volume per geographical area reaching a target ≥ 10 Tb/s/km2.
- 1.000 X in number of connected devices reaching a density ≥ 1M terminals/km2.
- 100 X in user data rate reaching a peak terminal data rate ≥ 10Gb/s.
- 1/10 X in energy consumption compared to 2010.
- 1/5 X in end-to-end latency reaching 5 ms for e.g. tactile Internet and radio link latency reaching a target ≤ 1 ms for e.g. Vehicle to Vehicle communication.
- 1/5 X in network management OPEX.
- 1/1.000 X in service deployment time reaching a complete deployment in ≤ 90 minutes.

5G: Capacidades



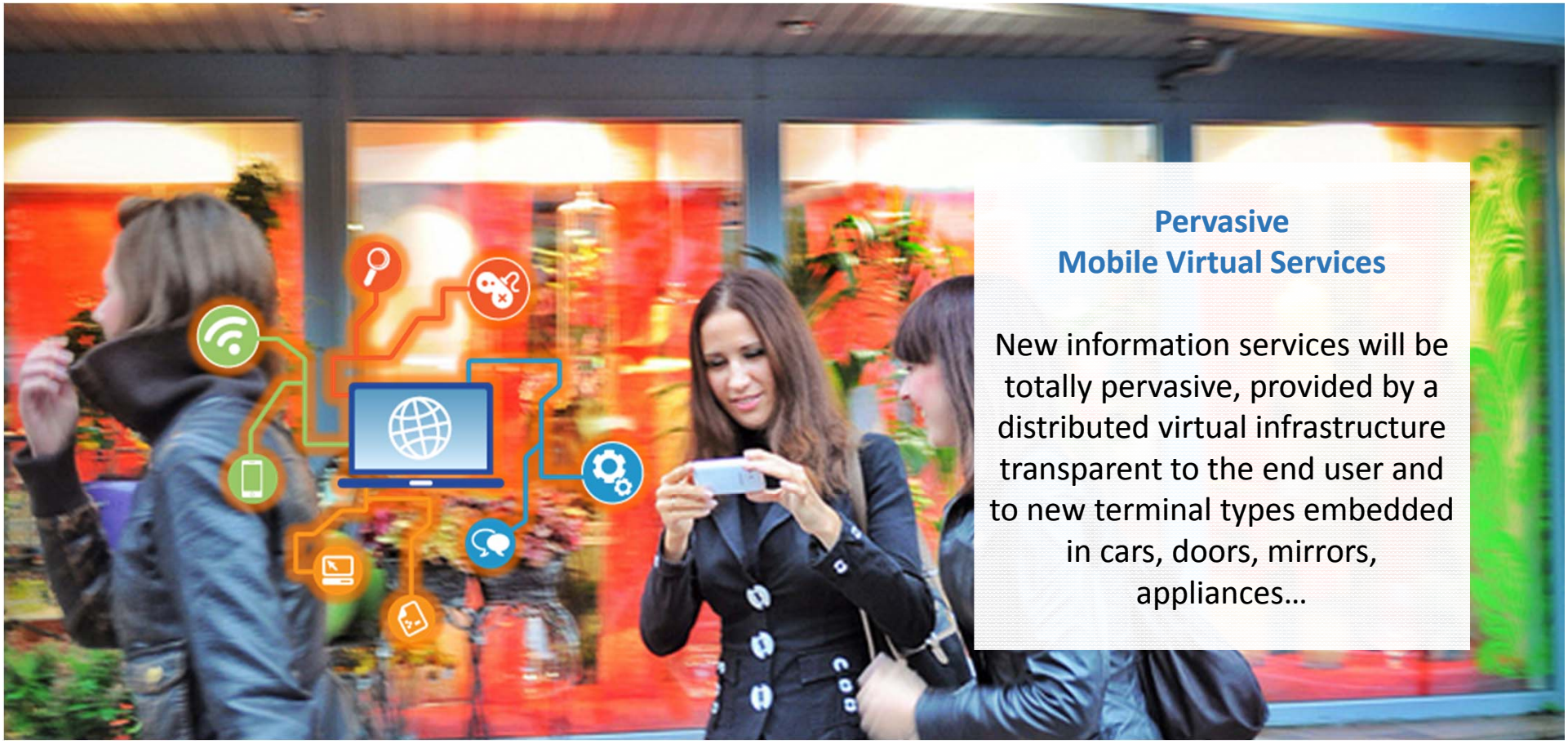
Enhancement of key capabilities from IMT-Advanced to IMT-2020



The importance of key capabilities in different usage scenarios

Source: ITU

5G: Un nuevo contexto



Pervasive
Mobile Virtual Services

New information services will be totally pervasive, provided by a distributed virtual infrastructure transparent to the end user and to new terminal types embedded in cars, doors, mirrors, appliances…

Pervasive Mobile Virtual Services (II)

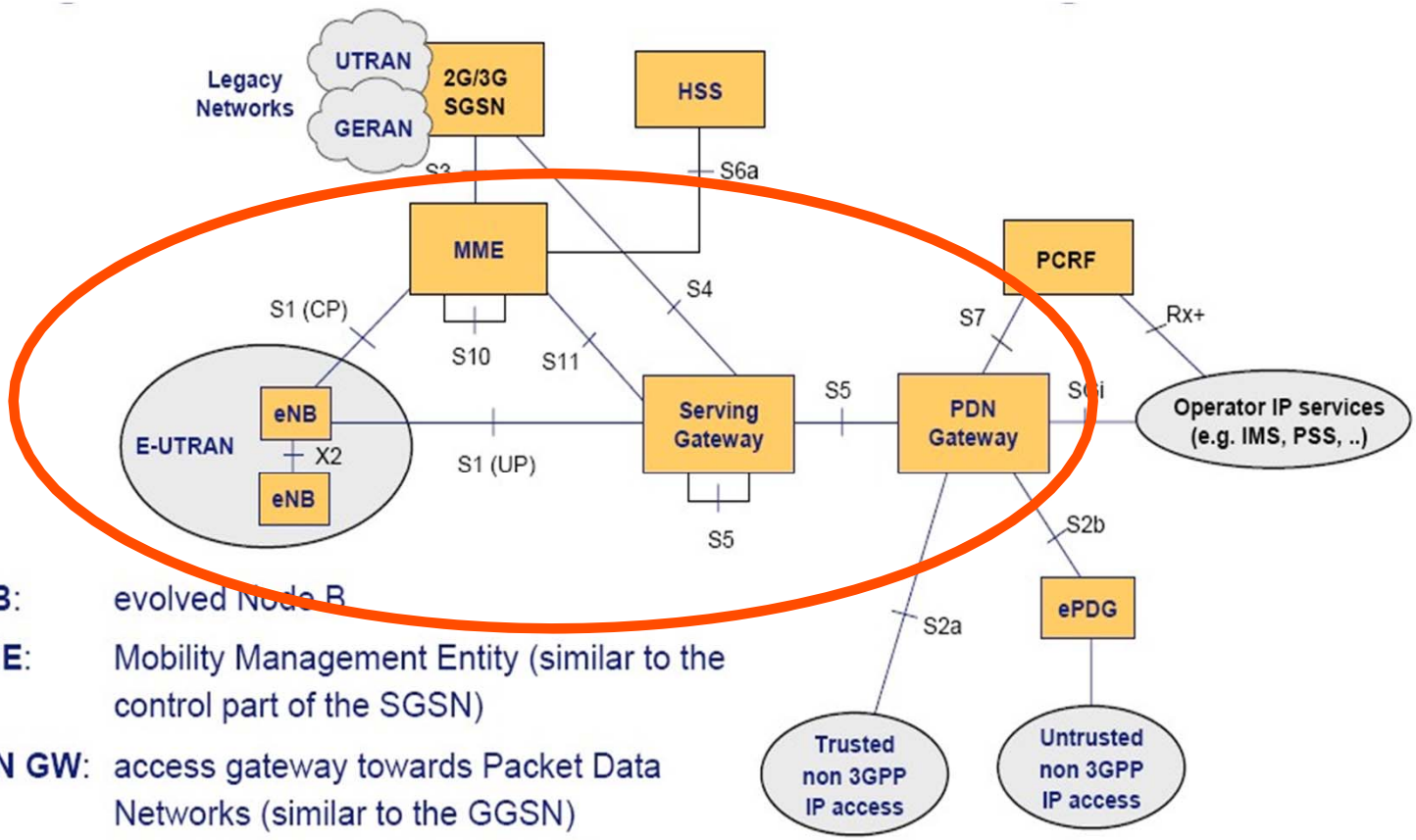
- Complex service model: not just transporting packets end-to-end (service driven architecture).
  - Adapted to the different verticals (Industry 4.0, connected vehicle, security, etc.)
  - Incorporate computing and storage services.
- Take advantage of new technologies:
  - Mobile edge computing (MEC).
  - Network function virtualization (NFV).
  - Software defined networks (SDN).
- Address new challenges:
  - Explosion of the Internet of Things (IoT).
    - More terminals.
    - Broader range of requirements:
      - New network control solutions for authentication, naming, addressing…
  - Offer QoS under SLAs.
    - Latency, bandwidth, power consumption…

Pervasive Mobile Virtual Services (III)

- New radio developments.
  - More spectrum.
  - Disperse (frequency bands).
  - Multi RAT.
  - New developments: mmWave, massive MIMO, beam steering.
  - Need for a Single Radio Controller (SRC).
- New optical developments.
  - Satisfy backhaul requirements.
  - C-RAN.

5G: Retos y Nuevas Tecnologías

Repasando: LTE



eNB: evolved Node B

MME: Mobility Management Entity (similar to the control part of the SGSN)

PDN GW: access gateway towards Packet Data Networks (similar to the GGSN)

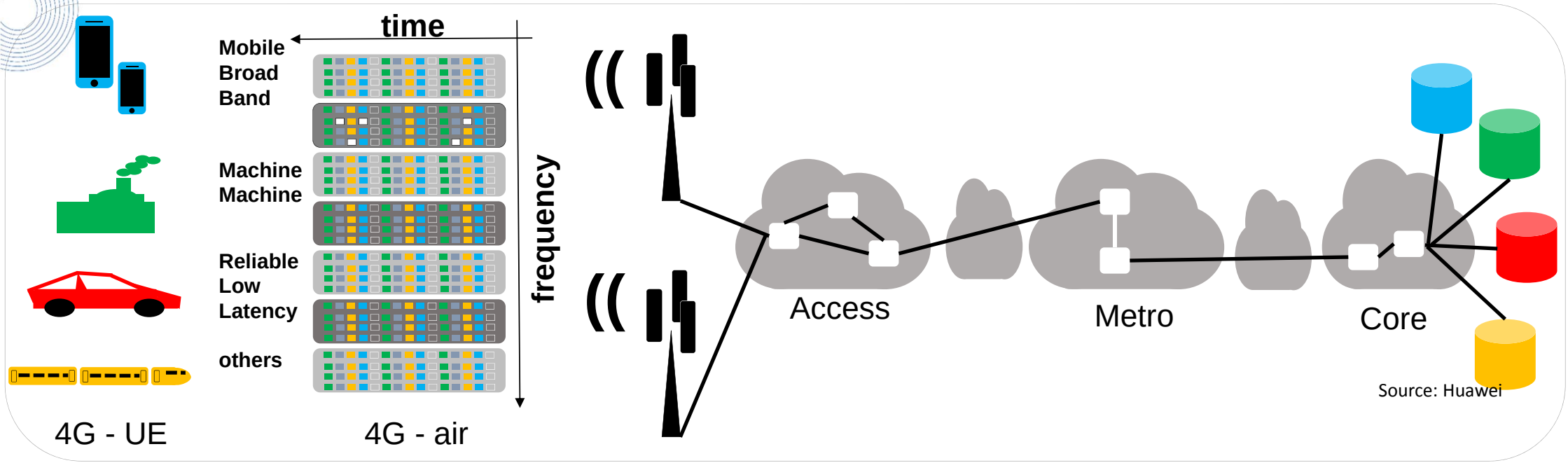
SGi: interface towards Internet/Intranet (equivalent to Gi interface in GPRS)

5G: Retos

- Support a wide variety of **business models.**
  - Multiple use cases. New focus on enterprise markets. Multi-vendor integration.
- **Flexibility** with service on demand.
  - Adapt the architecture to the services.
  - Separate User Plane and Control Plane.
- Adapt in real-time to **dynamic** traffic changes.
  - Essential to make it possible to satisfy the KPIs.
- Manage network **complexity.**
  - Automation is essential. It will not be posible to deploy or configure services manually.
- Enable an **open** services **ecosystem.**
  - The Core Network should become a platform.
- Network **security and privacy.**
  - Support authentication for both IMSI-based and non IMSI-based identities
- Be **eco**-friendly.

Source: Nokia, Ericsson, own

Limitaciones de LTE



Multiple Applications

Different QoS requirements

Same air interface for every application +

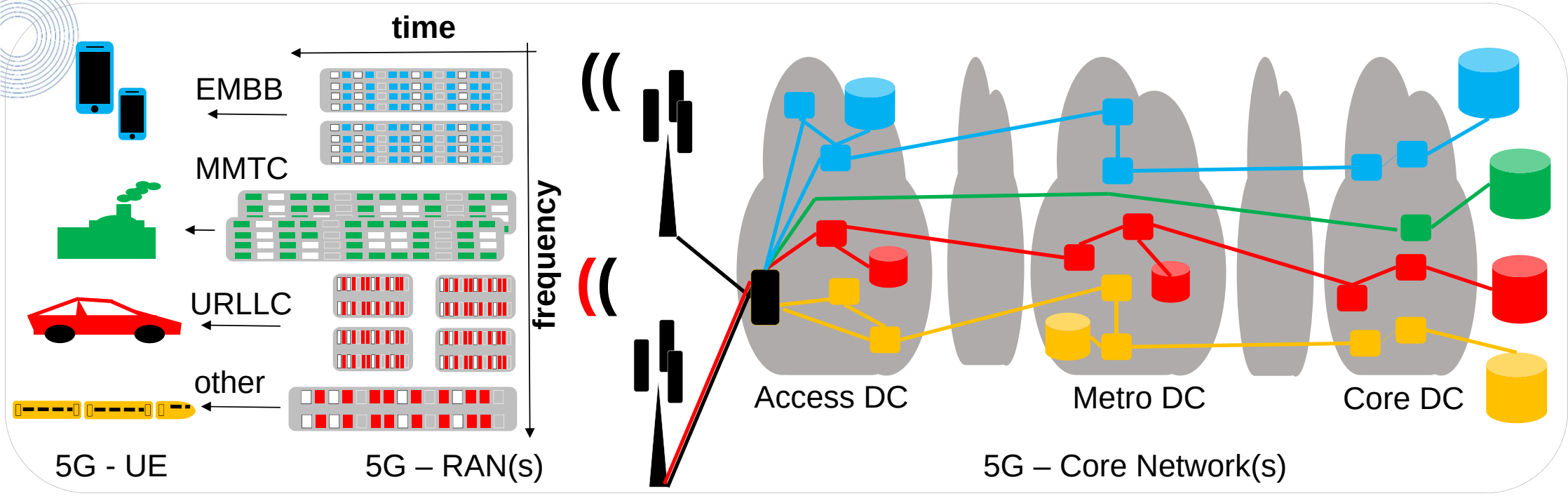
Air interface controls most of QoS +

= COMPROMISES

Same authentication +
Same mobility +
Same reliability +
Same delay +
Same QOS +

= COMPROMISES

5G: Solución. Network Slicing (I)



- High bandwidth for MBB
- Low delay/reliability for URLLC
- No reservations for MMTC
- Room for other services

- High bandwidth for MBB/content near UE
- Low delay/reliability for URLLC /dedicated BW
- No reservations for MMTC
- New dynamic services

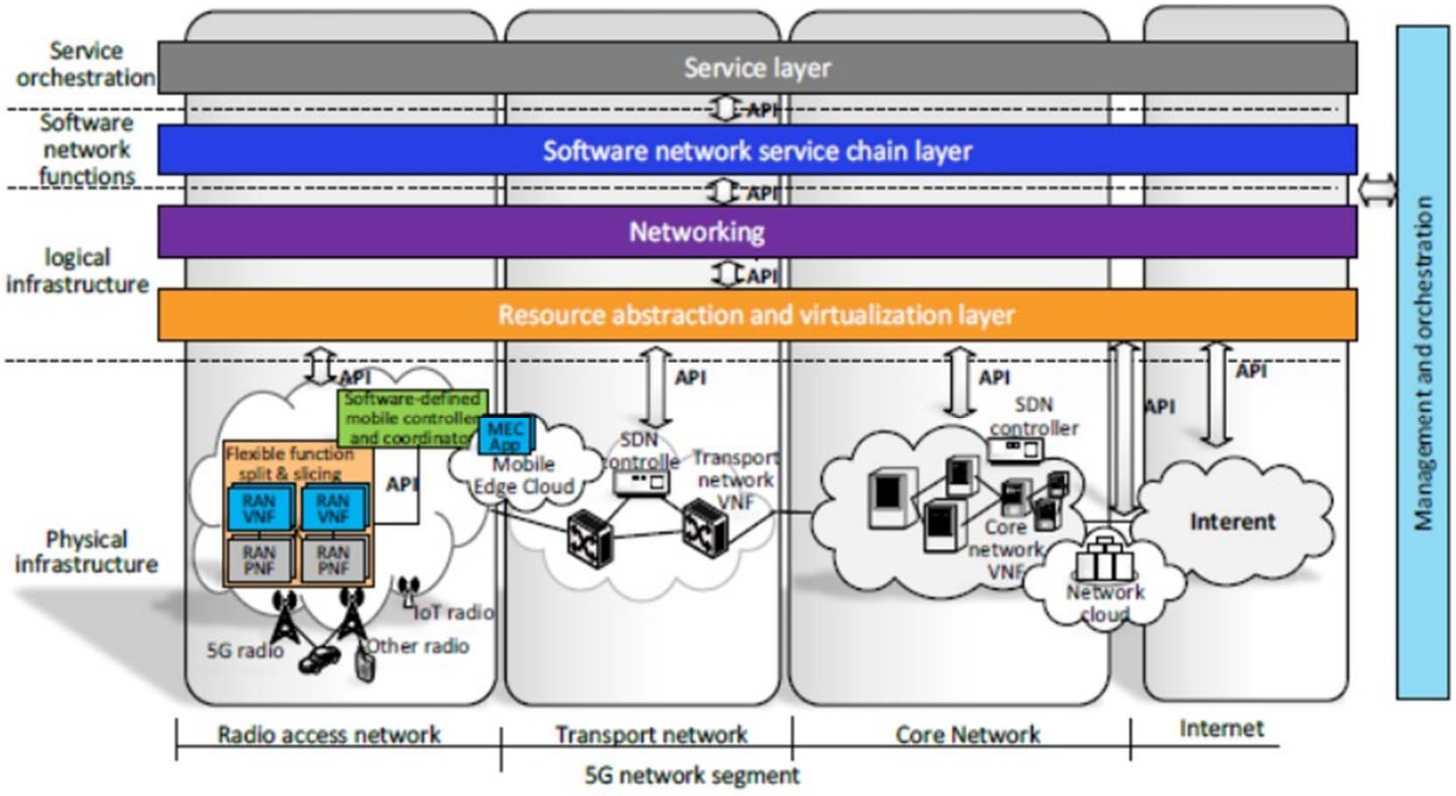
Source: Huawei

5G: Solución: Network Slicing (II)

Network slice is a **logical network** serving a defined **business purpose** or **customer**, consisting of **all** required network resources **configured** together. It is created, changed and removed by management functions.

- Logical network managed by a provider.
- Enabler for services, not a service.
- Mobile and fixed.
- Resources may be physical or virtual, dedicated or shared.
- Independent/”Isolated” but may share resources.
- May integrate services from other providers, facilitating e.g. aggregation and roaming.
- May include management functions and possible exposure of control/management to customer.

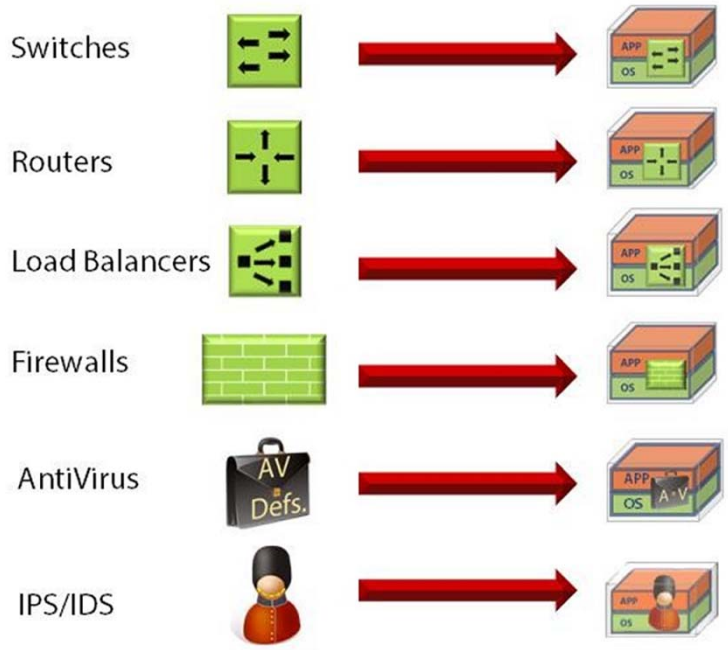
5G: “Softwarización”



Source: 5GPPP

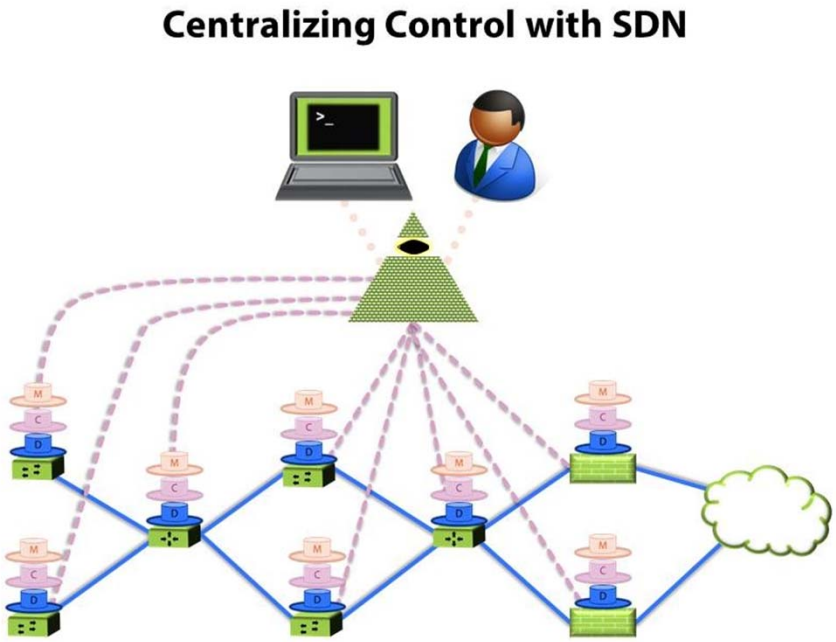
Tecnologías (I): NFV

- NFV: Network Function Virtualization
  - Implement traditional physical network equipment in software and run it in a Virtual Machine



Tecnologías (II): SDN (I)

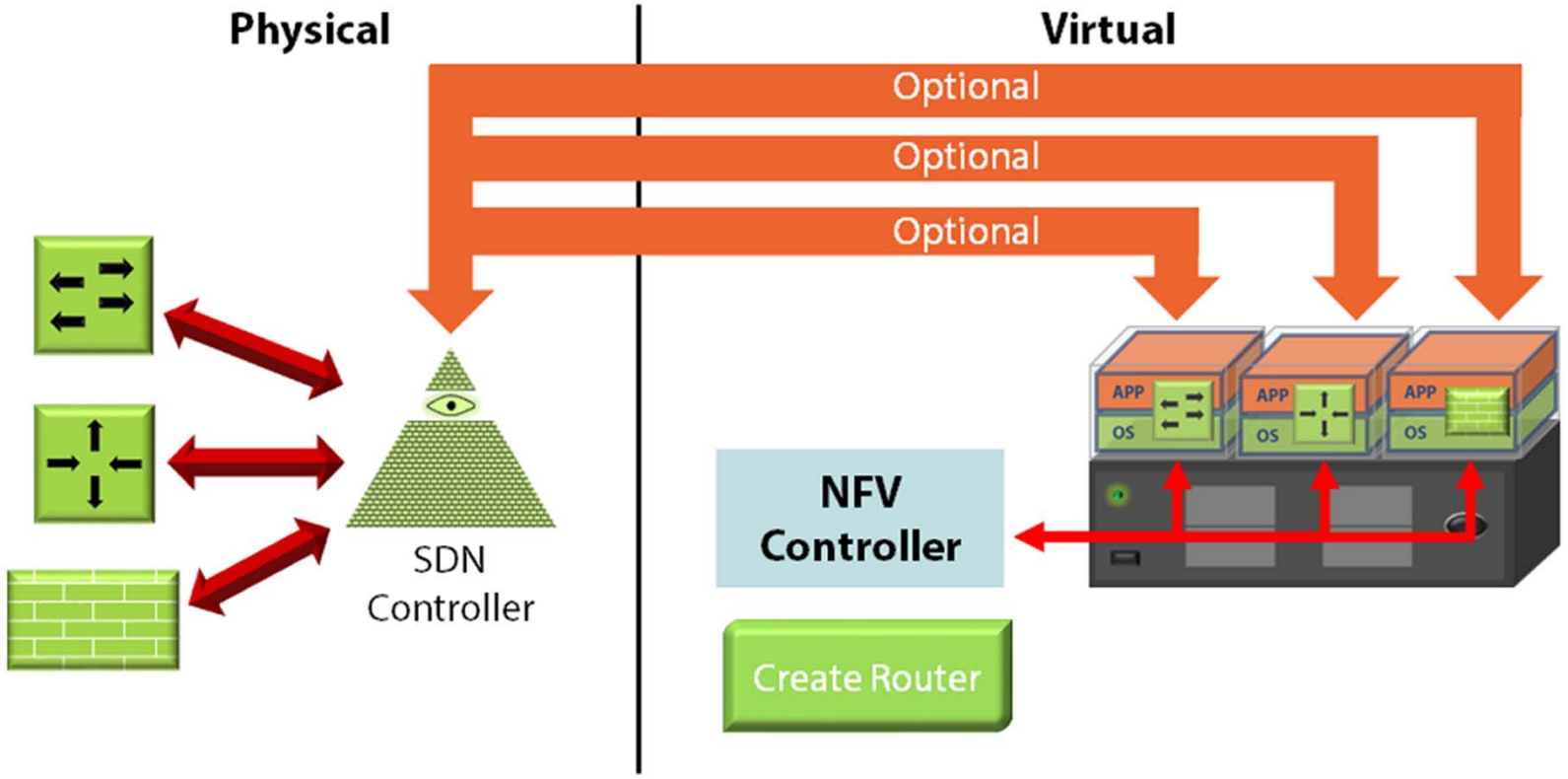
- SDN (Software Defined Networking)
  - Separate the control and forwarding plane, and centralize the control



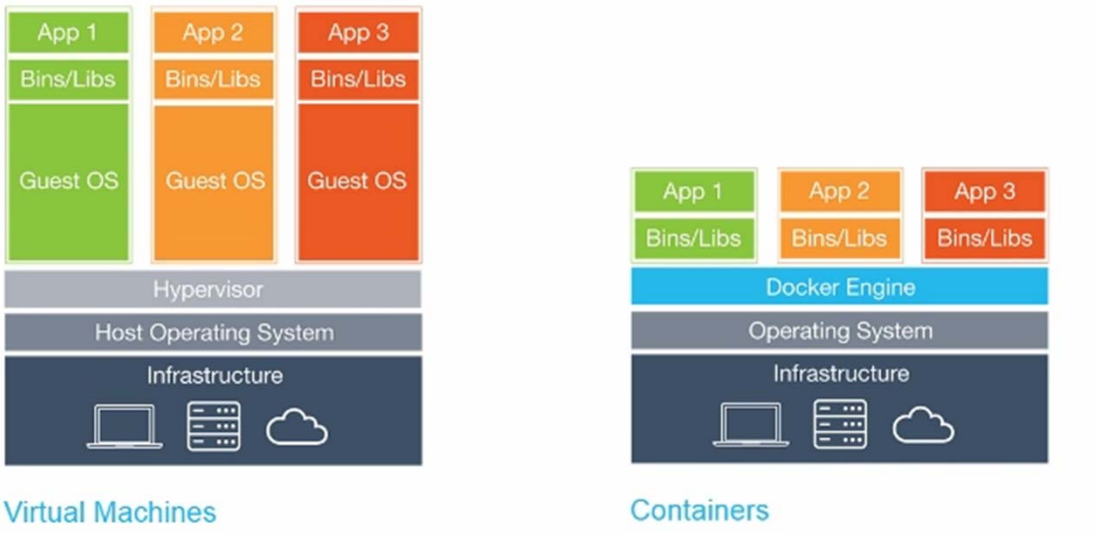
Tecnologías (II): SDN (II)

- Directly programmable:
  - Control decoupled from forwarding functions and centralized.
- Agile:
  - New rules can be define dynamically.
- Centrally managed:
  - Network intelligence is centralized in controllers that maintain a global view of the network.
- Programmatically configured:
  - Automatic SDN programs can decide in real-time (using rules, artificial intelligence, etc.)
- Open standards-based and vendor-neutral:
  - Standard interfaces and APIs.

Tecnologías (III): SDN y NFV



Tecnologías (IV): Arquitectura de micro-servicios

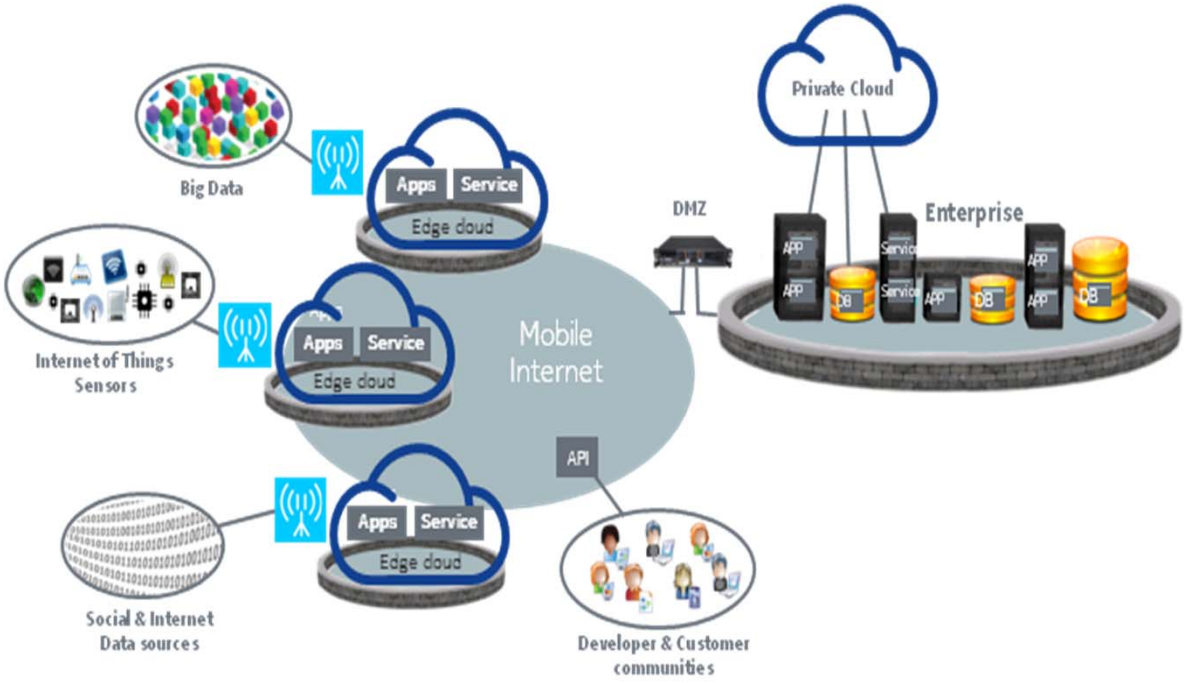


Micro-services provide a suitable environment for 5G core networks:

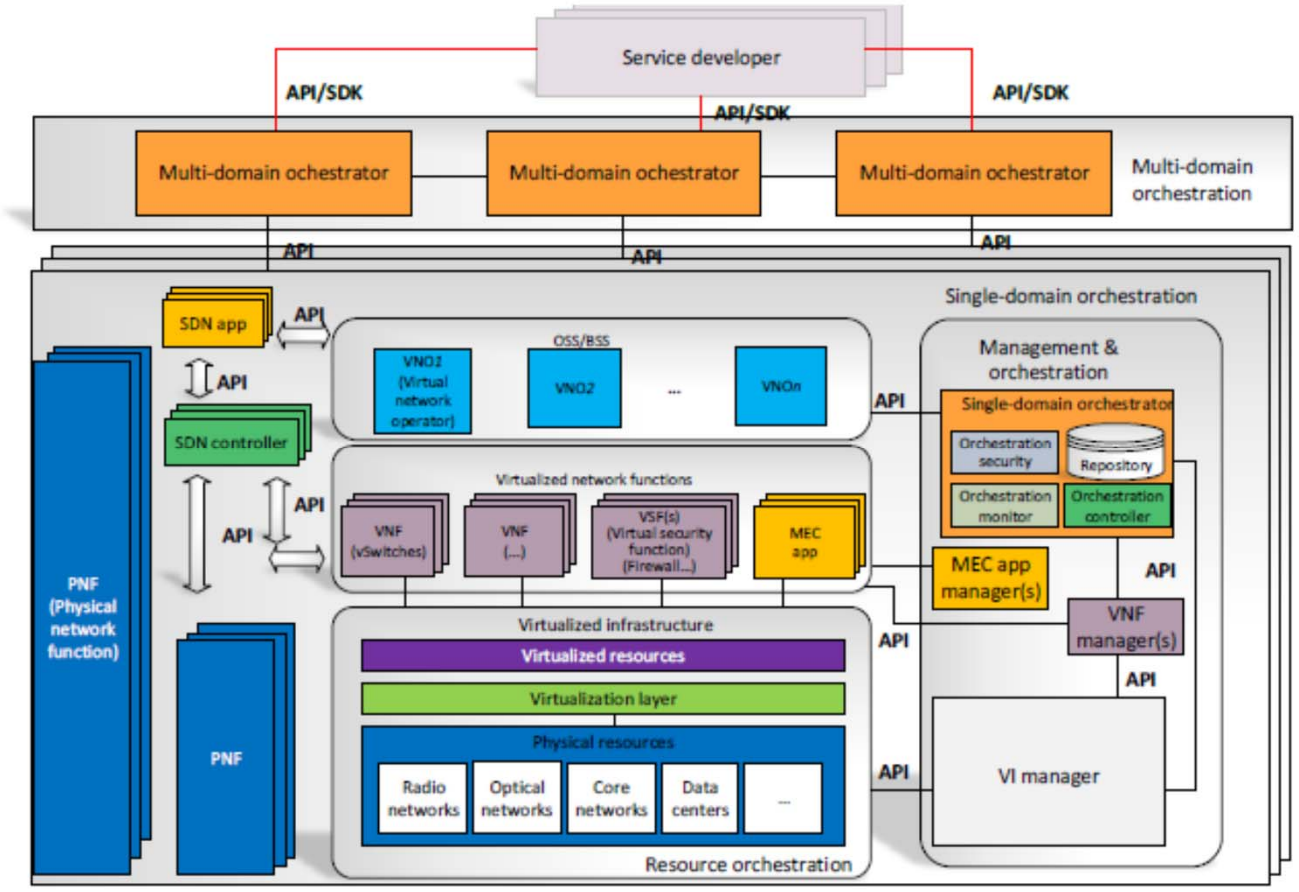
- Technical advantages:
  - Efficiency.
  - Stability.
  - Easy scalability.
  - Easy deployment.
- Business advantages:
  - Reduced time to market.
  - Reduced CapEx and OpEx.
  - Shared infrastructure among operators.

Tecnologías (V): MEC

- MEC (Mobile Edge Computing)
  - Move the applications close to the subscribers/users/terminals.



Tecnologías (VI): Orquestación (ETSI MANO)

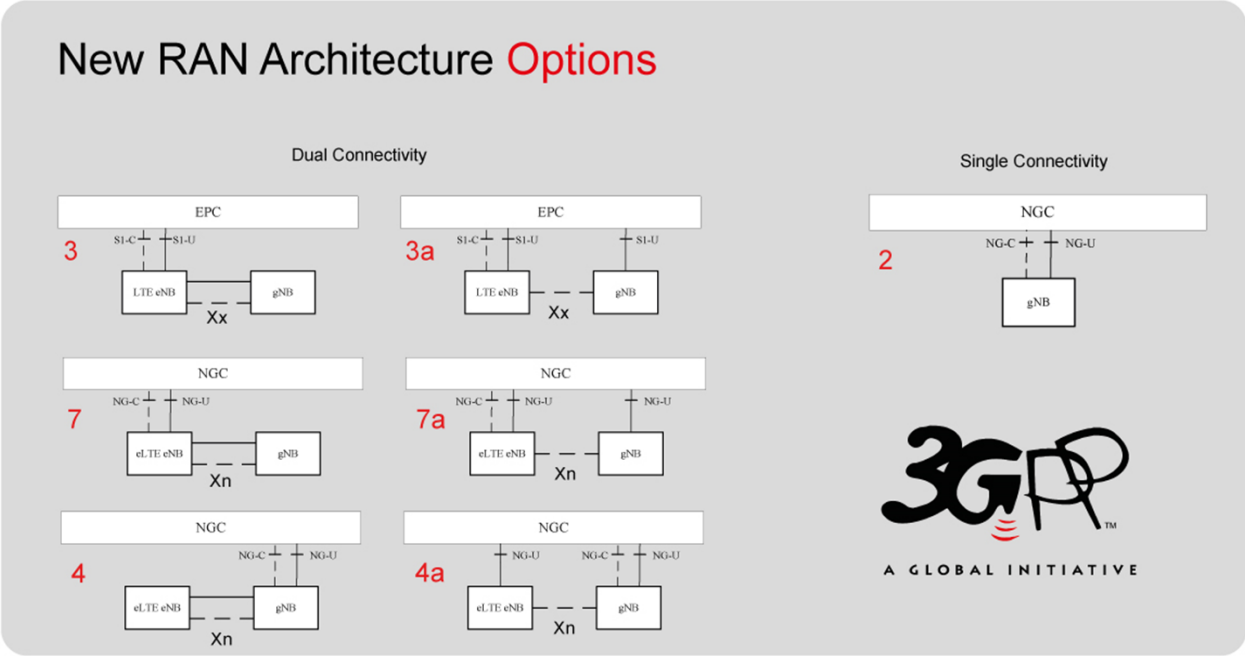


Source: 5GPPP

5G: Arquitectura

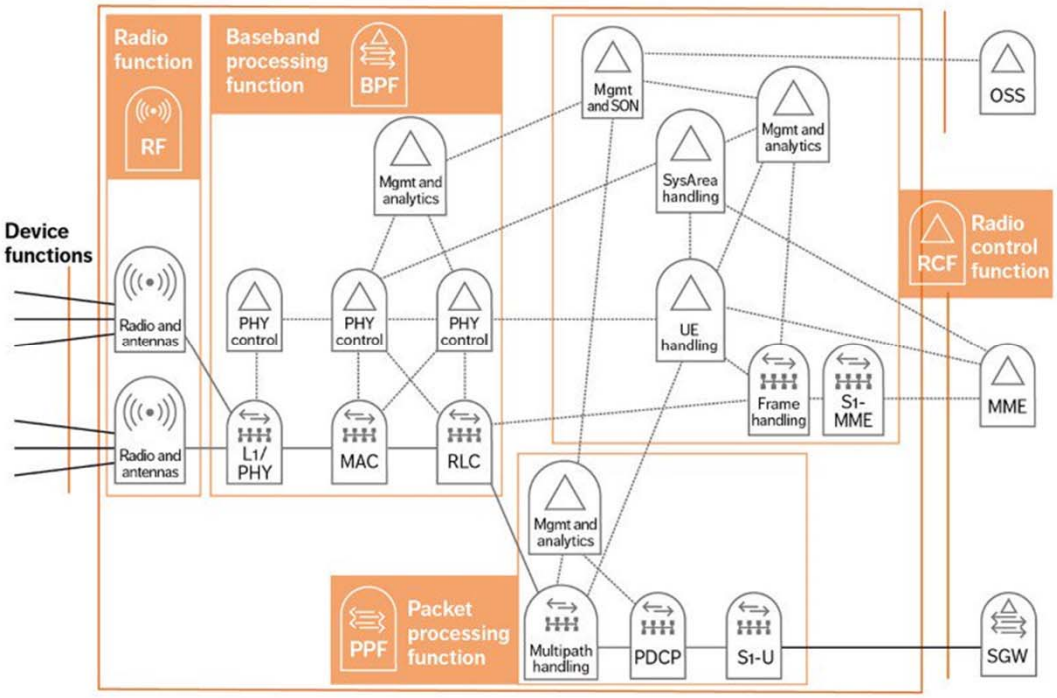
Arquitectura RAN (I): De 4G a 5G

- NSA 5G NR, or Non-Standalone 5G New Radio was recently approved
- **Non-Standalone (NSA) 5G NR** will utilize the existing LTE radio and core network as an anchor for mobility management and coverage while adding a new 5G carrier.
  - **Standalone (SA) 5G NR** implies full user and control plane capability for 5G NR, utilizing the new 5G core network architecture also being done in 3GPP.
    - Aprobada recientemente (2018)



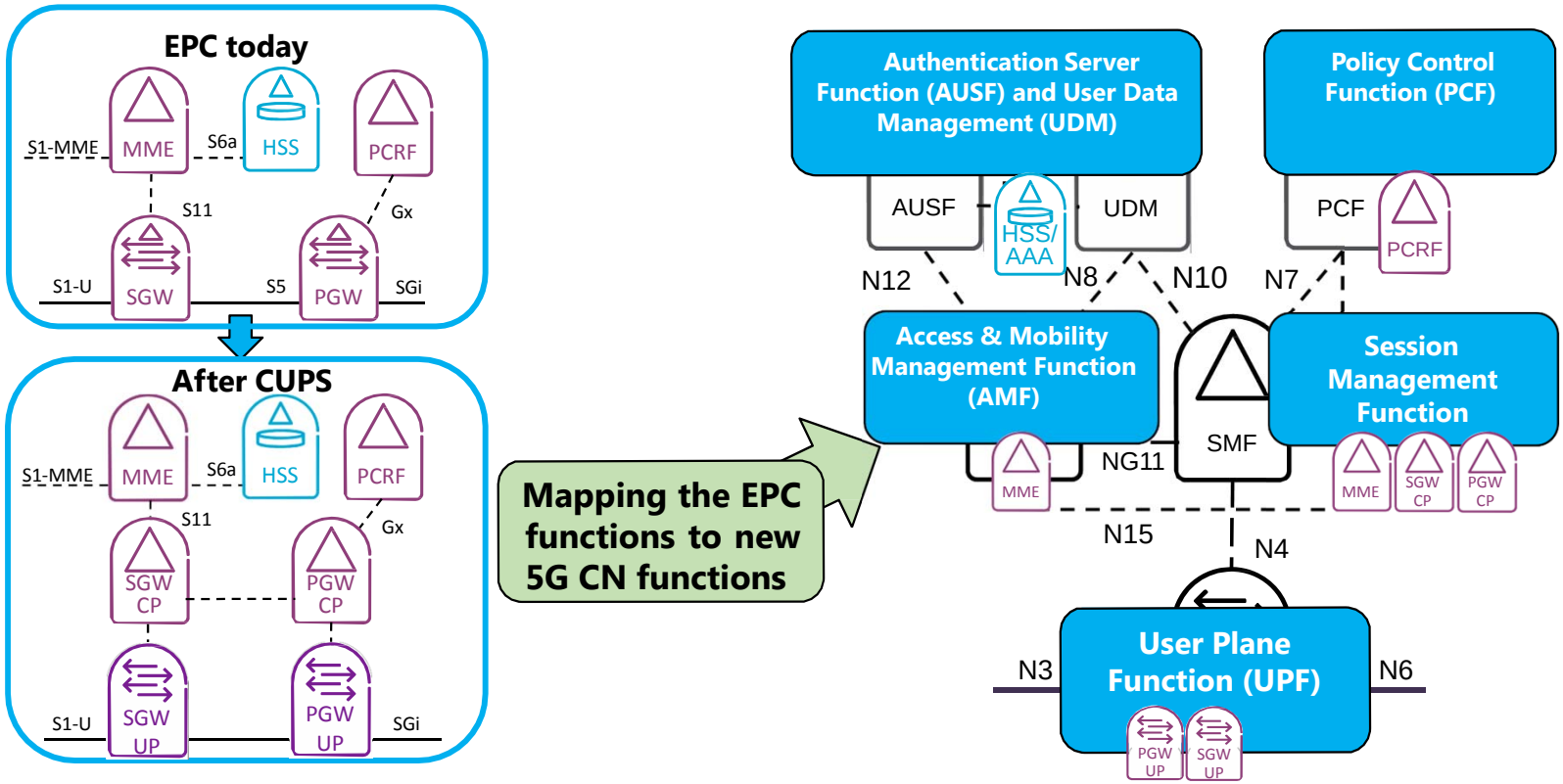
Arquitectura RAN (II): “Logical splits” (I)

- The requirements for 5G also make necessary a change in the internal RAN architecture in order to gain a number of capabilities:
  - Seamless Radio Resource Management.
    - A user should receive the best combination of any radio beam.
  - Functional split.
    - Separation of UP and CP.
    - Split RAN functions.
  - Dynamic and software-defined RAN.
    - Configure, scale logical nodes through software commands.
  - Deployment flexibility.
    - Deploy and configure the RAN with maximum spectrum efficiency and service performance regardless of the site topology, transport network characteristics, and spectrum scenario.
      - Split RAN into logical nodes.



Source: Ericsson

Arquitectura Core (I): Cambios respecto a 4G



CUPS: Control and User Plane Separation

Source: ITU

Arquitectura Core (II): “Service Based Architecture (SBA)”

- 5G is defined as a “Service Based” architecture.
  - There are two representations, but Network functions within the 5GC Control Plane shall only use service-based interfaces for their interactions.

Figure 4.2.3-1 depicts the non-roaming reference architecture. Service-based interfaces are used within the Control Plane.

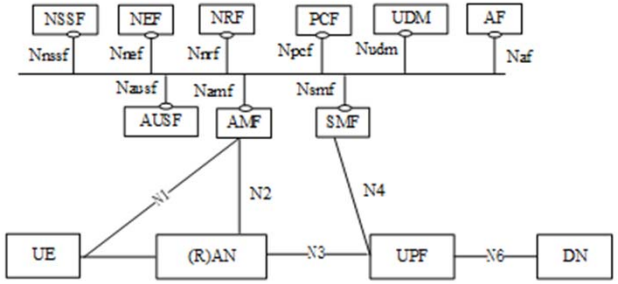
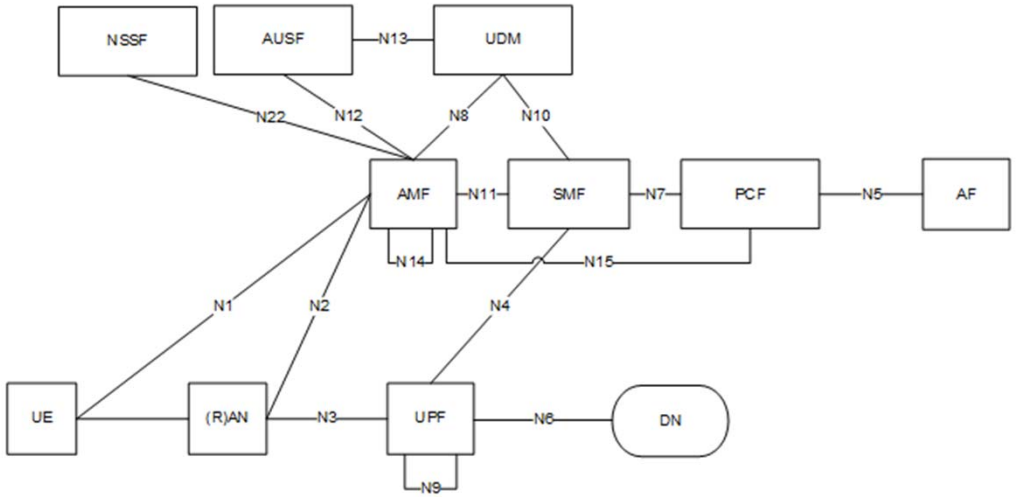


Figure 4.2.3-1: 5G System architecture

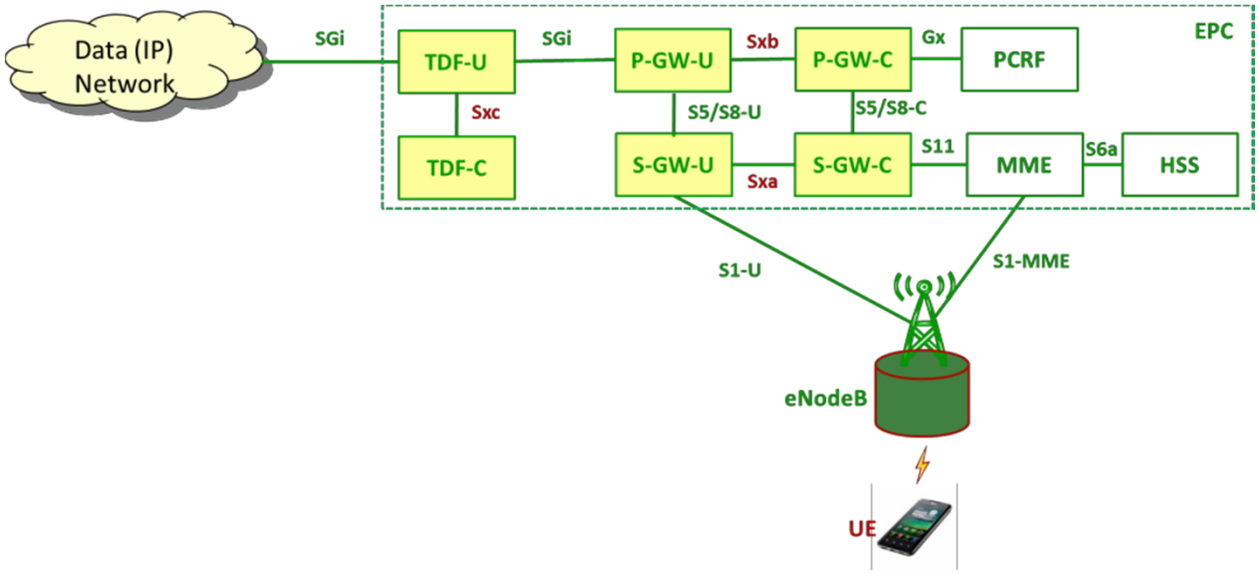
Figure 4.2.3-2 depicts the 5G System architecture in the non-roaming case, using the reference point representation showing how various network functions interact with each other.

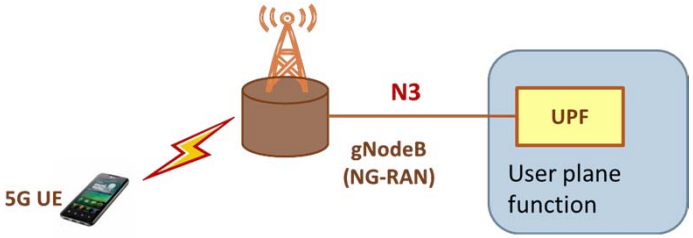


Authentication Server Function (AUSF)
Core Access and Mobility Management Function (AMF)
Data network (DN), e.g. operator services, Internet access or 3rd party services

Network Exposure Function (NEF)
NF Repository Function (NRF)
Policy Control function (PCF)
Session Management Function (SMF)
Unified Data Management (UDM)
User plane Function (UPF)
Application Function (AF)
User Equipment (UE)

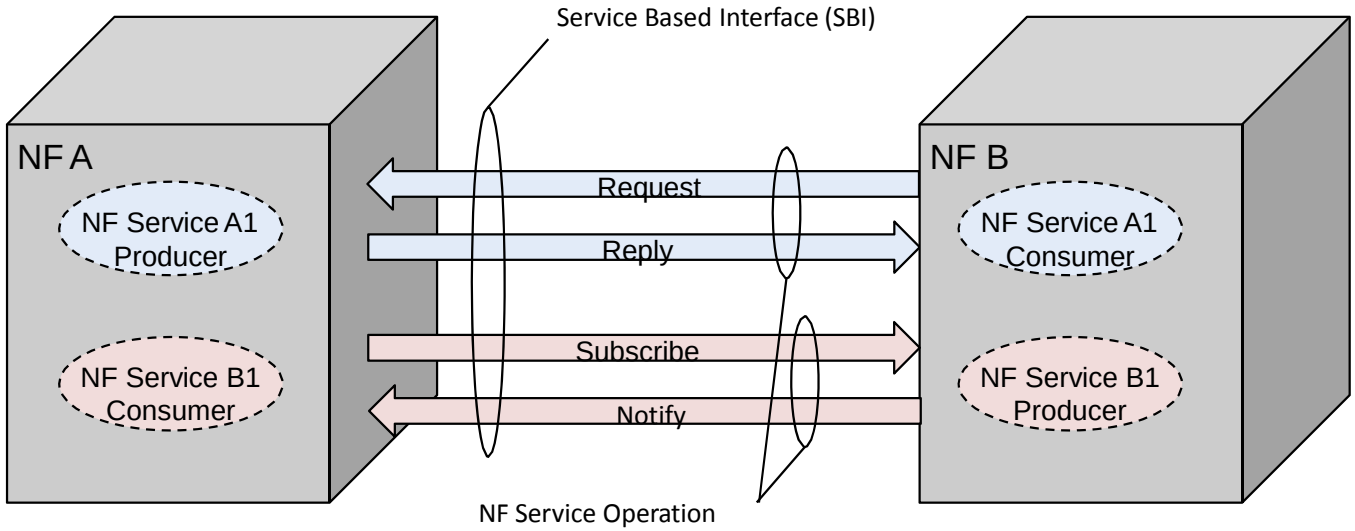
Core Architecture (III): SBA (II)





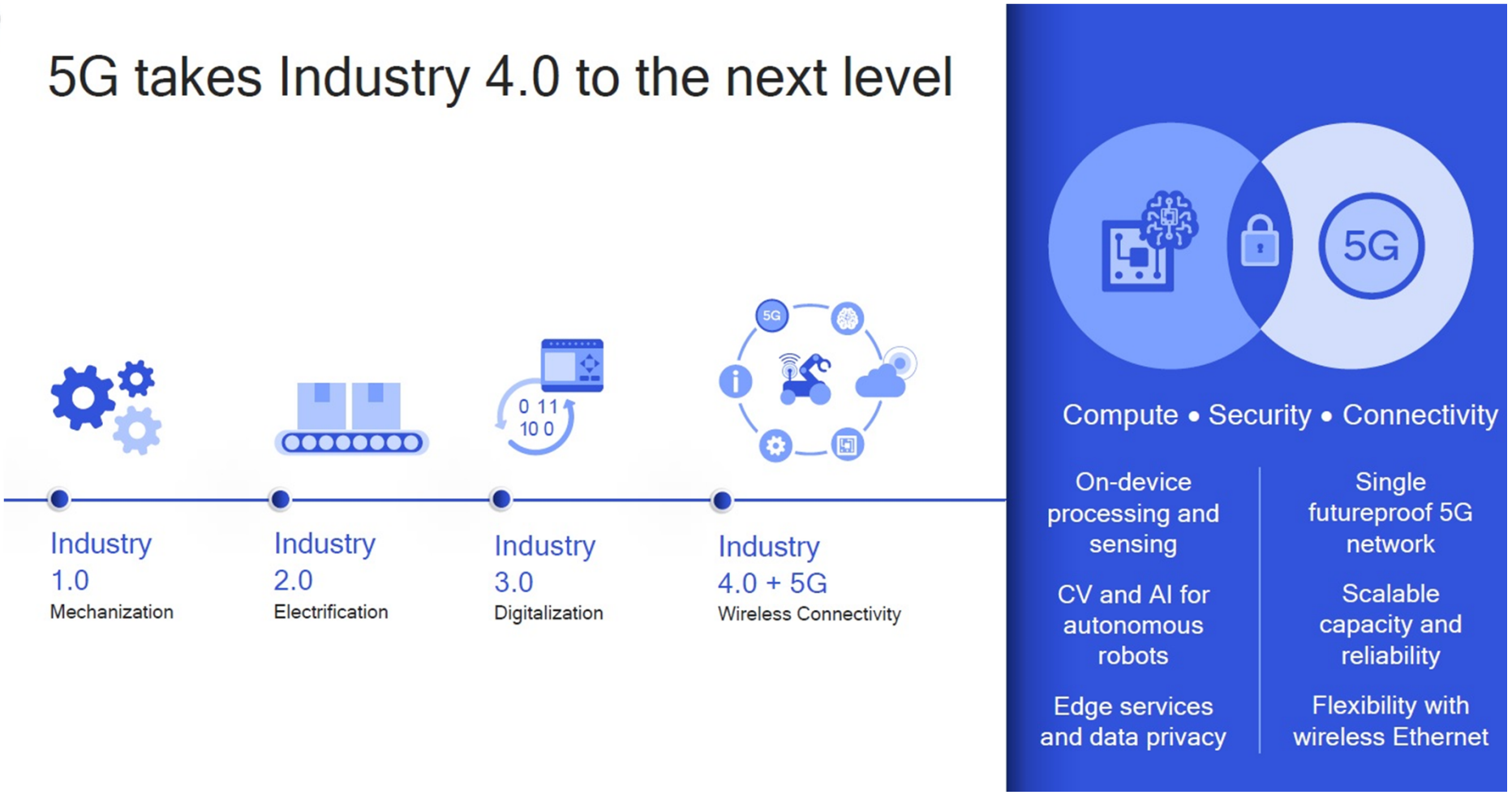
Arquitectura Core (IV): "Service Based Interface”

- A Control Plane Network Function can provide one or more NF Services.
- A NF Service consist of operations based on either a request-response or a subscribe-notify model.
- Common control protocol using e.g. HTTP based API, replacing protocols like e.g. Diameter



5G: IoT industrial
(fuente: Qualcomm)

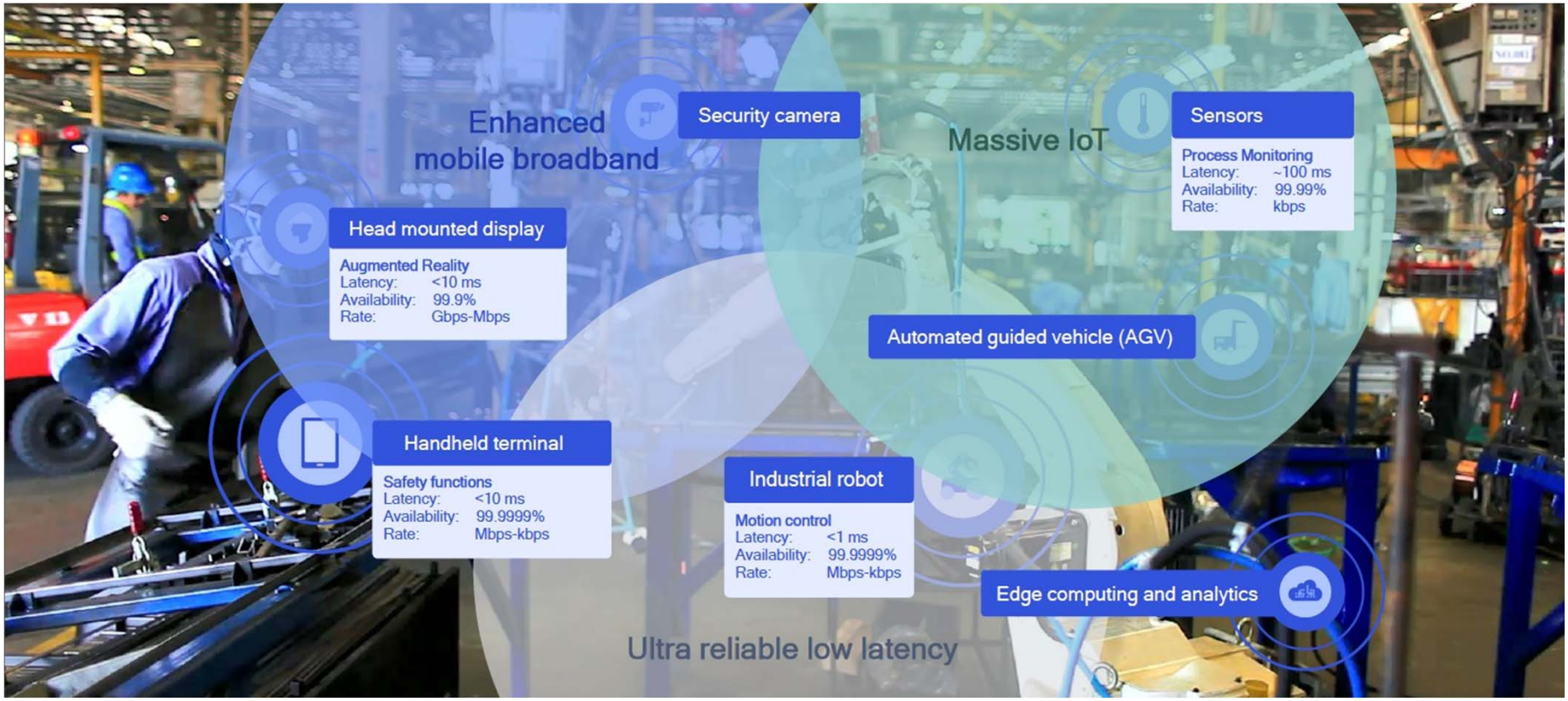
5G para la Industria



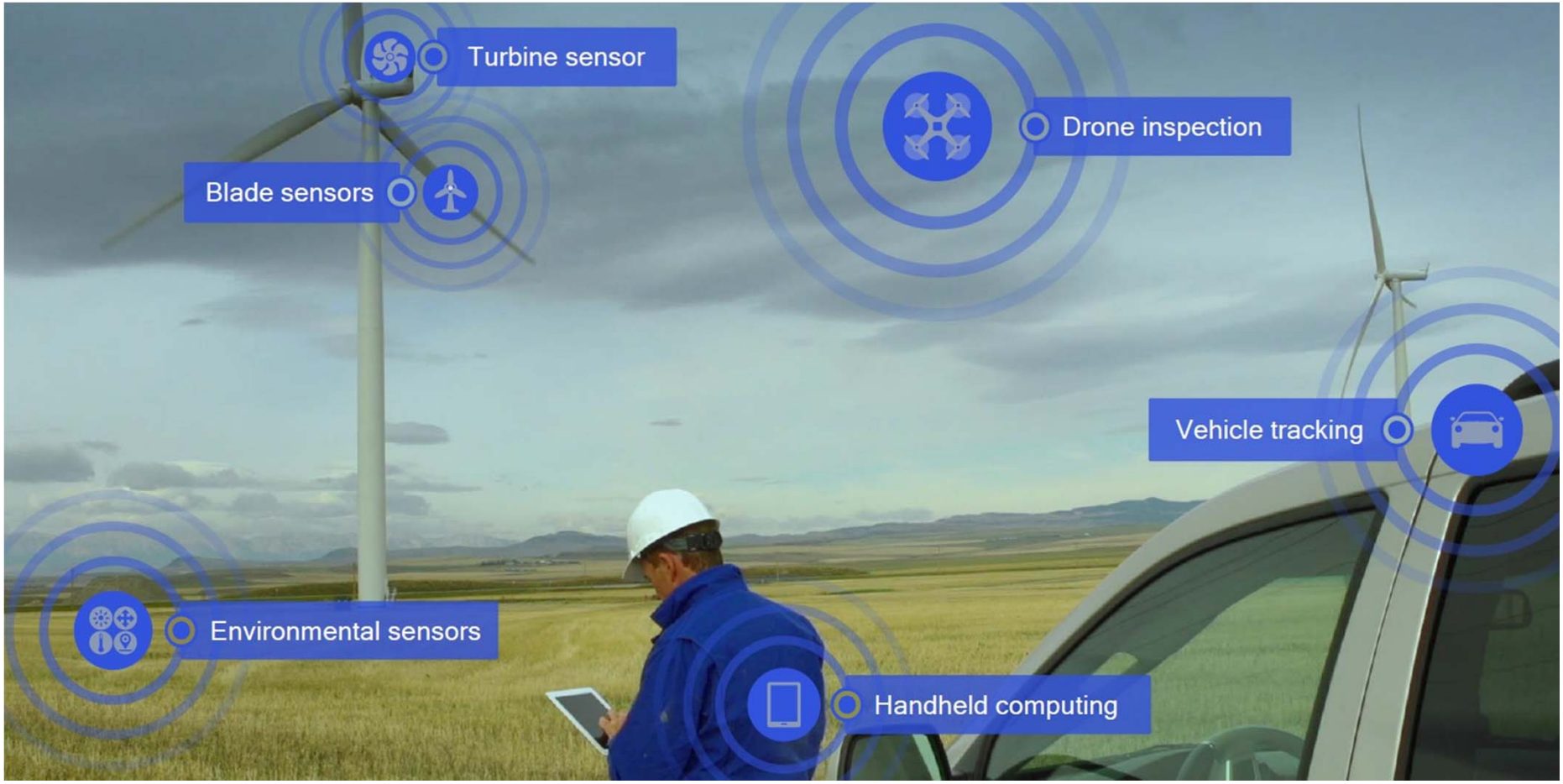
Campos de aplicación

Nuestro entorno: puertos

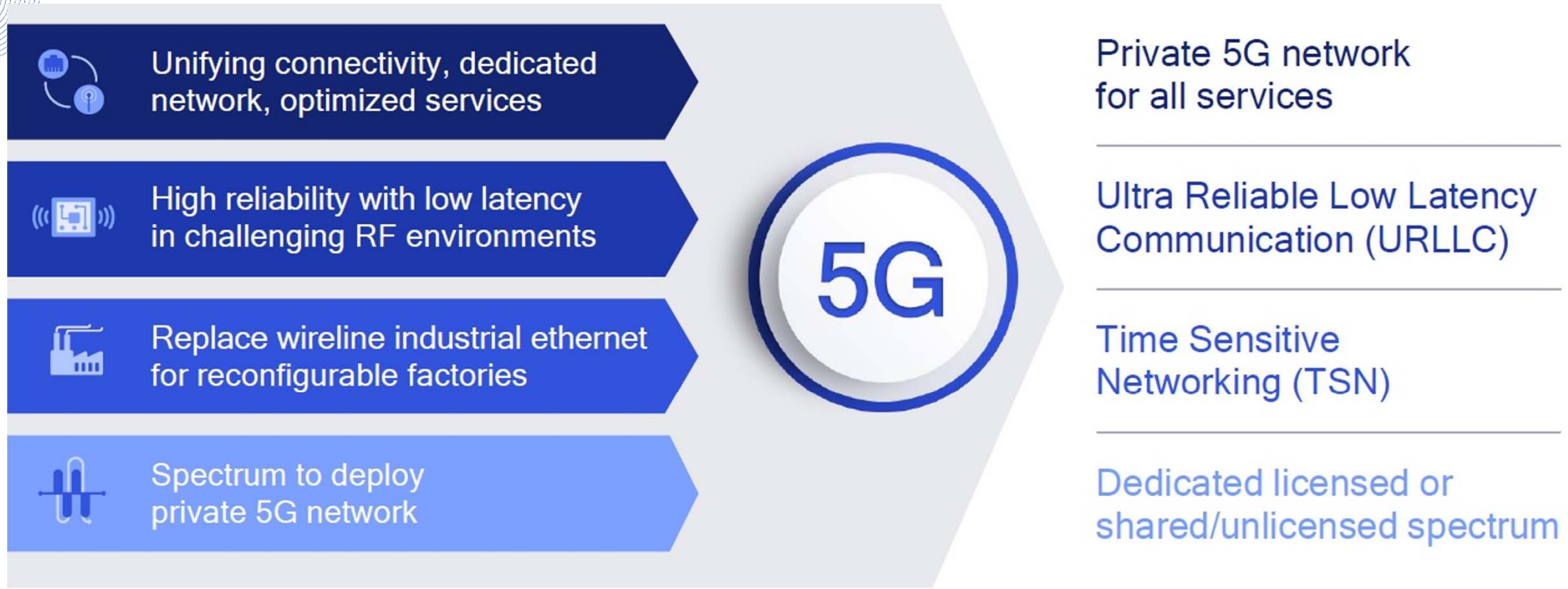
Nuestro entorno: fabricación



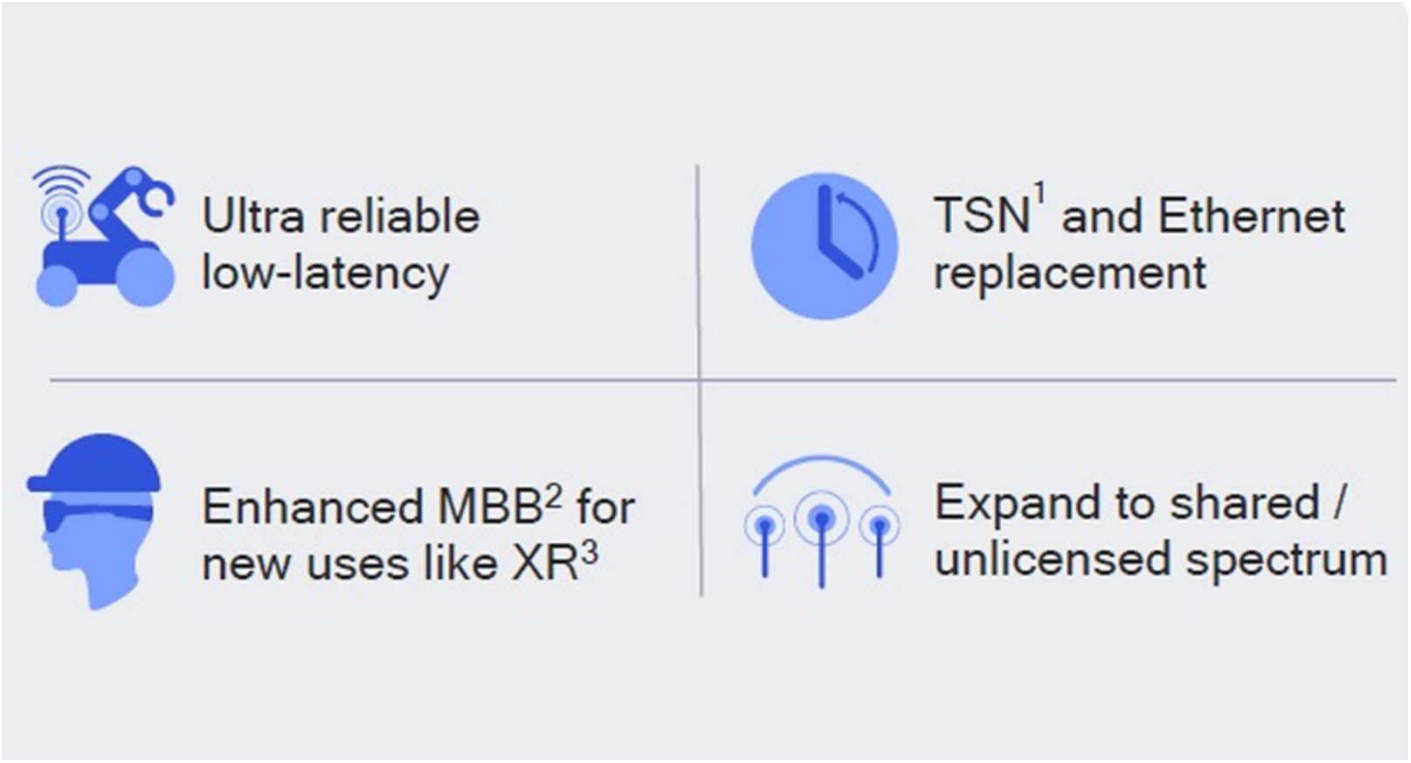
Nuestro entorno: energía



Diseño de 5G industrial



Diseño de 5G industrial (cont.)



Diseño de 5G industrial: URLLC y CoMP

URLLC

Ultra Reliable Low Latency Communication

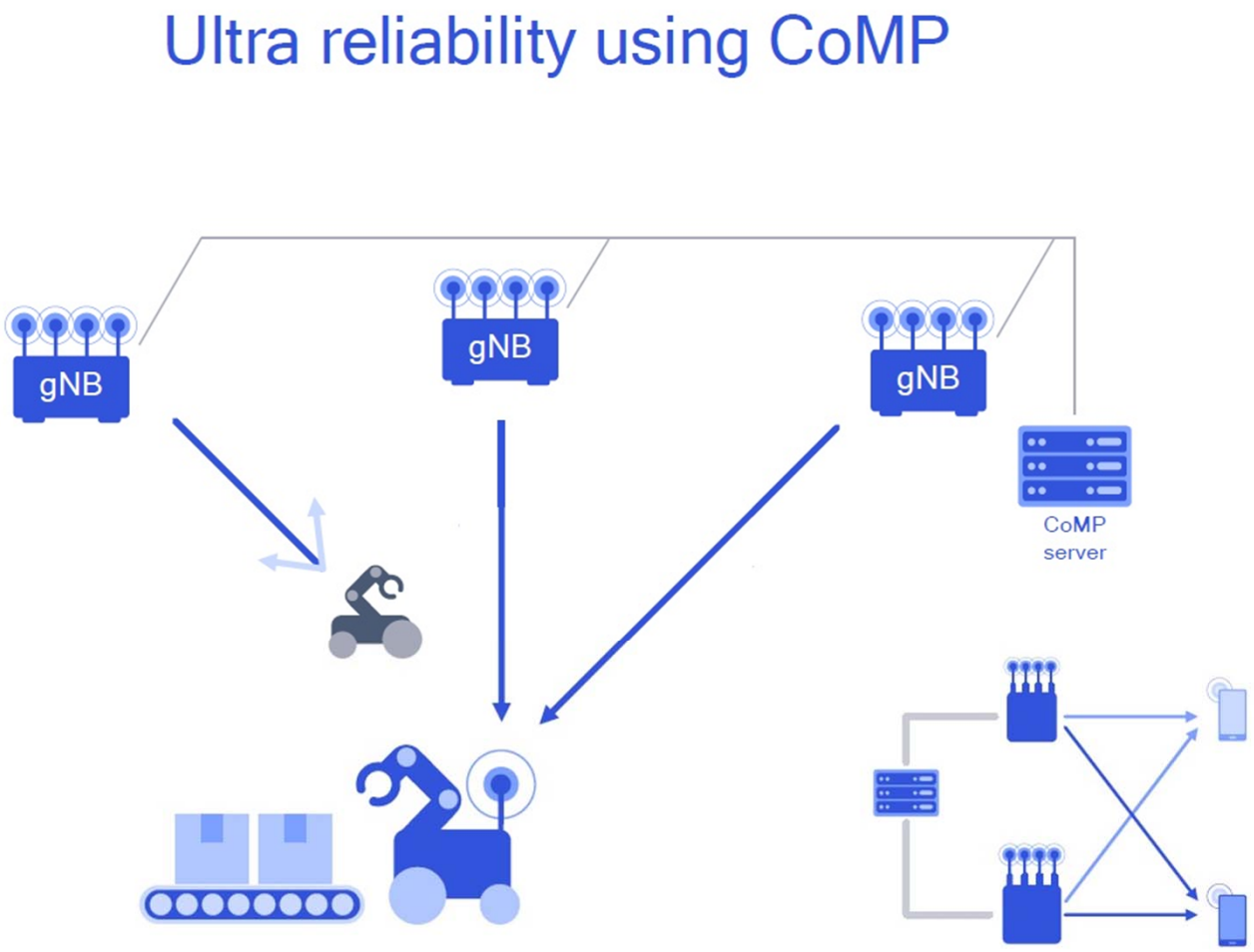
99.9999% reliability[1]

Spatial diversity is essential

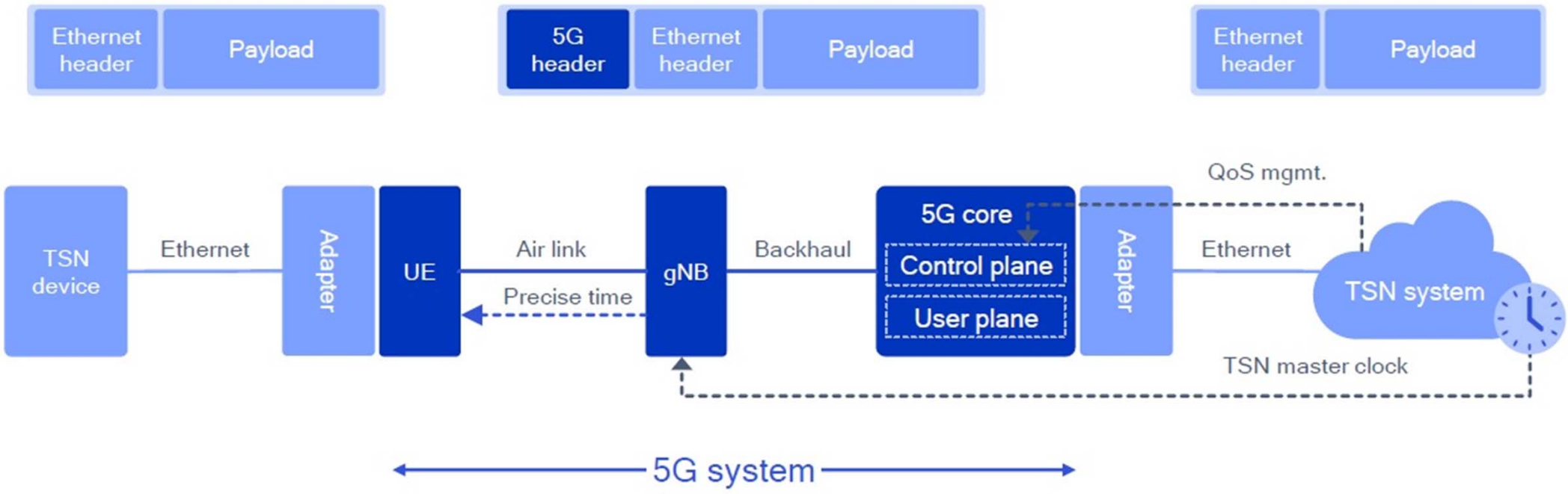
- Coordinated multi-point (CoMP) provides spatial diversity with high capacity
- CoMP enabled with dense deployment of small cells with high bandwidth backhaul

Other diversity limited

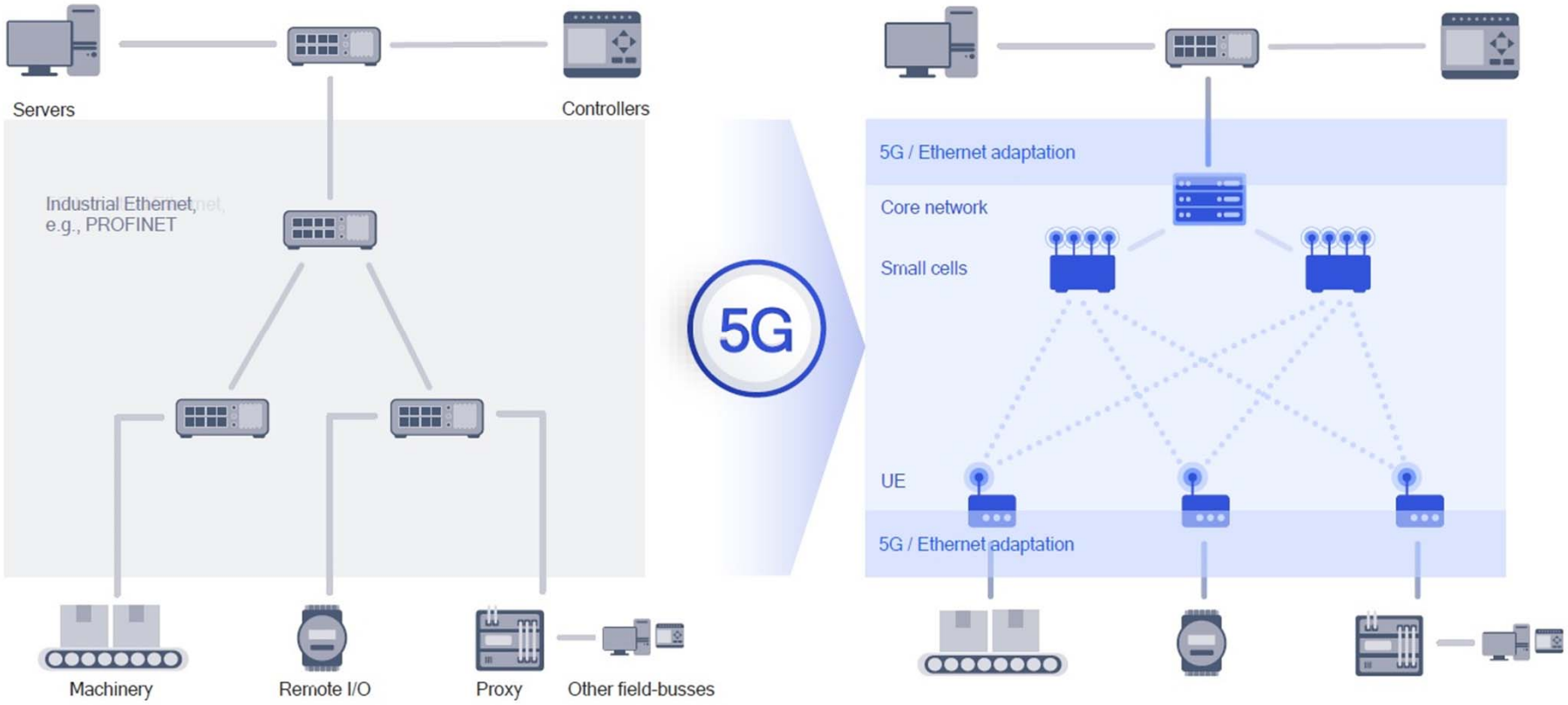
- Frequency diversity does not address RF blockage/shadowing
- Time diversity limited as ultra low latency dictates timing



Diseño de 5G industrial: URLLC y TSN



Diseño de 5G industrial: 5G WLAN

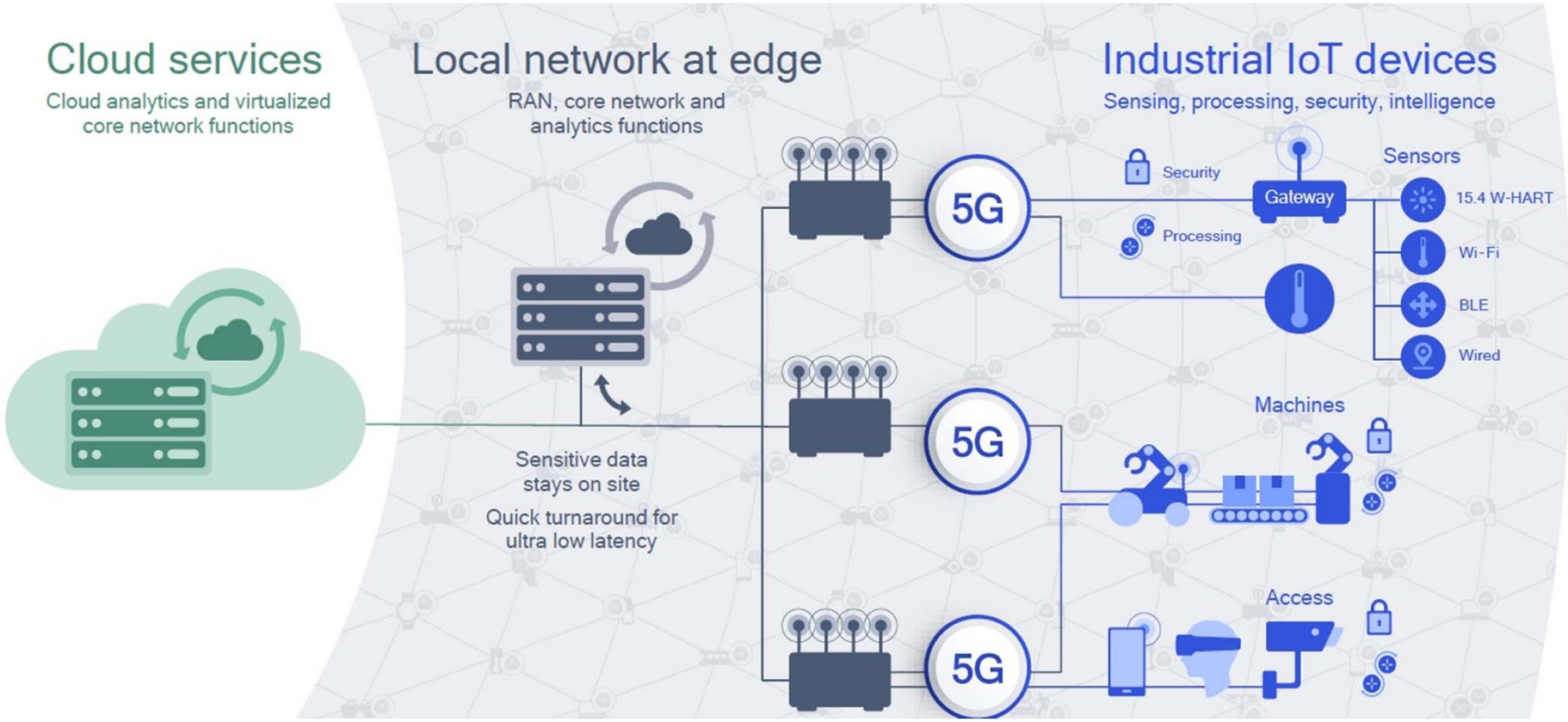


Diseño de 5G industrial: espectro sin licencia

Unlicensed/shared spectrum

3GPP Rel-16 adds support for unlicensed spectrum (5G NR-U) including standalone operation; can support URLLC services in non-public locations controlled by tenant/owner

Diseño de 5G industrial: MEC



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5G como activador de IoT

¡Gracias!

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