REDES DE QUINTA GENERACIÓN
Curso básico
Módulo 4

CePETel

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TEMARIO

MODULO 1
La evolución histórica de las redes móviles. 2G/3G/4G.
Rol de 3GPP en la standarización.
Redes 4: LTE y EPC.
Conceptos heredados de LTE. Conceptos específicos de 5G.

MODULO 2
Motivadores para el despliegue de una red 5G. Por dónde empezar.
Concepto de Dual Connectivity.
Los terminales: Bandas, road map, chipsets. Impacto en la estrategia de despliegue.
La red de Acceso: Bandas, aspectos de propagación, ancho de banda.
El Núcleo: arquitectura a alto nivel.

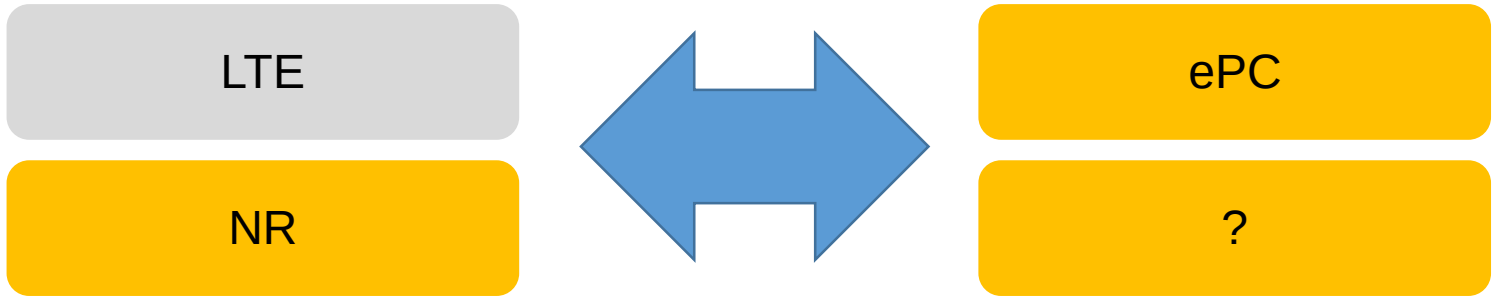
MODULO 3
Arquitectura NSA. Visión de alto nivel.
Opciones de interconexión.
Planificación de red 5G inicial. Casos de uso.
DSS.Conceptos, posibles aplicaciones.

MODULO 4
Arquitectura SA. Visión de alto nivel.
Principales Desafíos de SA..
Impacto de 5G en IMS y servicios de tiempo real.

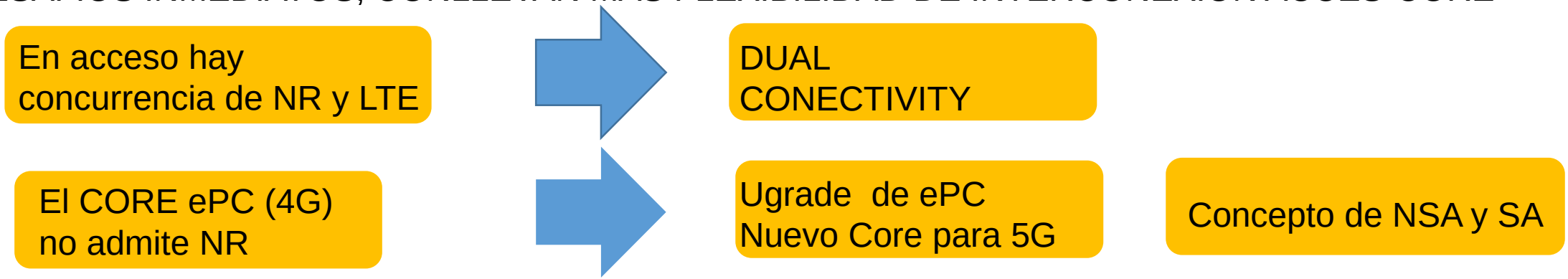
LTE & EPC

CONSIDERACIONES DE ALTO NIVEL SOBRE LA CONEXIÓN AL CORE

El modelo NSA, se basa en la dual connectivity y en el Core ePC



DESAFÍOS INMEDIATOS, CONLLEVAN MAS FLEXIBILIDAD DE INTERCONEXIÓN ACCES-CORE



A diferencia de 4G, en las redes 5G, el acceso y el Core pueden evolucionar independientemente. Las estaciones 4G y 5G se conectan a cada Core respectivamente, sin embargo, con las adecuaciones necesarias, es posible utilizar “Dual Conectivity” para mejorar los tiempos de despliegue y utilizar infraestructura pre existente, permitiendo de ese modo una evolución mas suave.
En 5G aparecen además los conceptos de NSA y SA asociados a lo anterior

ARQUITECTURA STAND ALONE CONSIDERACIONES SOBRE EL CORE

CONSIDERACIONES DE ALTO NIVEL SOBRE LA CONEXIÓN AL CORE

El modelo SA, se basa en una arquitectura nueva

NSA, se apoya sobre el ePC pre-existente para lo cual, para poder interconectarse con NR se requieren adecuaciones (ePC+)

Non-Standalone (NSA) NR: During this phase, NR is expected to utilize the existing LTE Radio Access Network (RAN) and Core Network (CN) functionalities accordingly modified to handle the addition of a new 5G carrier targeting late 2018 (early 2019) NR NSA deployments.

SA , podría considerarse como el modelo objetivo si no existiera LTE, sin embargo la convivencia con LTE implica retos

Standalone (SA) NR: In this phase, a full set of CP and Upnfunctionalities will be specified to fully exploit the 5G capabilities driven by the ITU targets. Furthermore,3GPP will also specify a new CN architecture for 5G enabling new features such as network slicing.With the completion of the second phase, NR will be able to operate with a full set of 5G capabilities without the need of the LTE co-existence.

Modelo Puro: NR, modelo real: NR + eLTE
Unico Core: NGC

ROL DE EDGE COMPUTING

Examples:

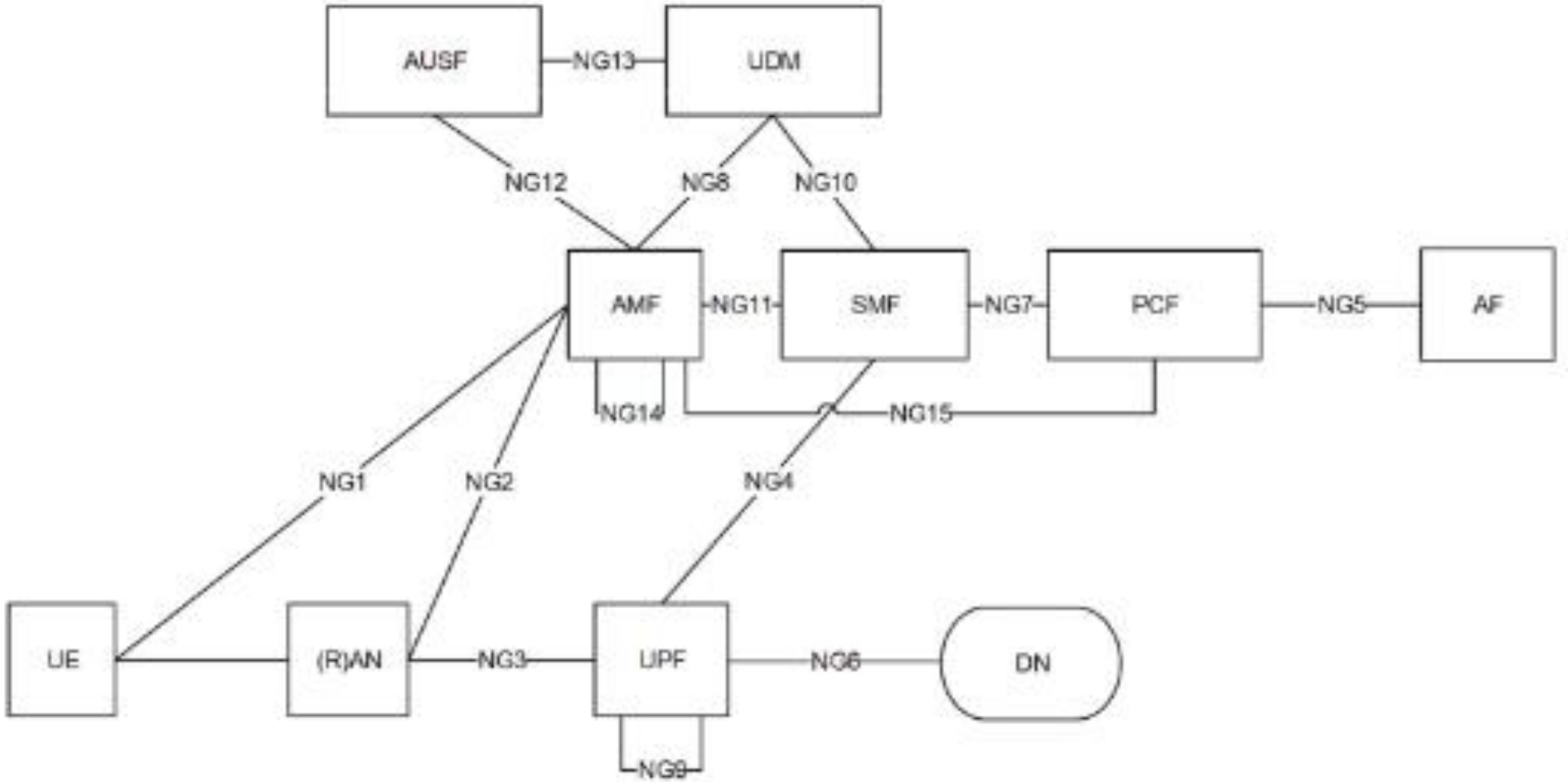
- Road Side Units for V2X Applications (Latency)
- Content Delivery Networks for On-Demand Services (Core Offload)

Examples:

- Used for Control / Capacity Architectures
- Densification Architectures – e.g. Campus, Airports, Business / Residential / Leisure (Parenting Multiple Cells)

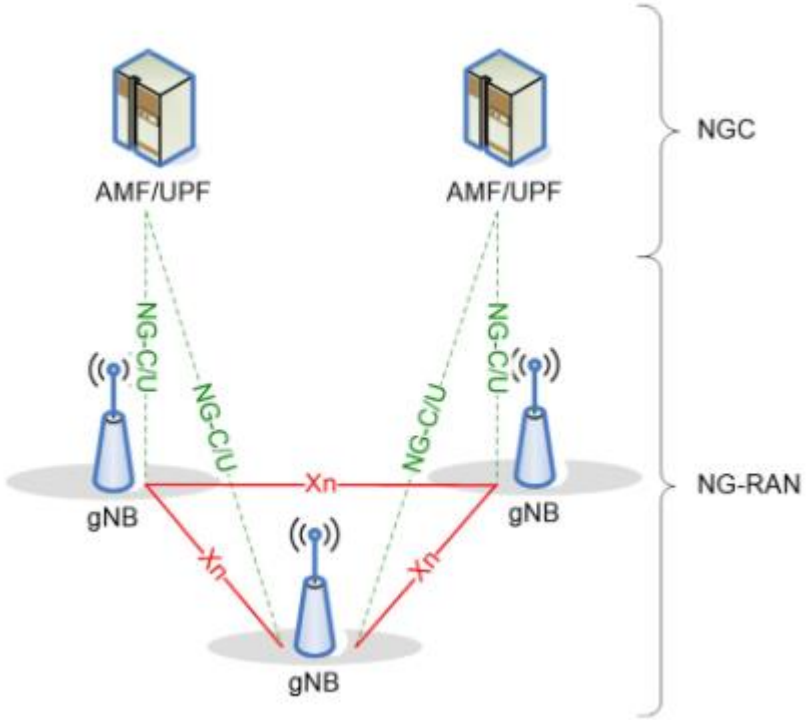
Llevamos el Acceso al Core o el Core al Acceso?

ESTRUCTURA DEL NGC- PUNTOS DE REFERENCIA



5G STANDALONE NETWORKING

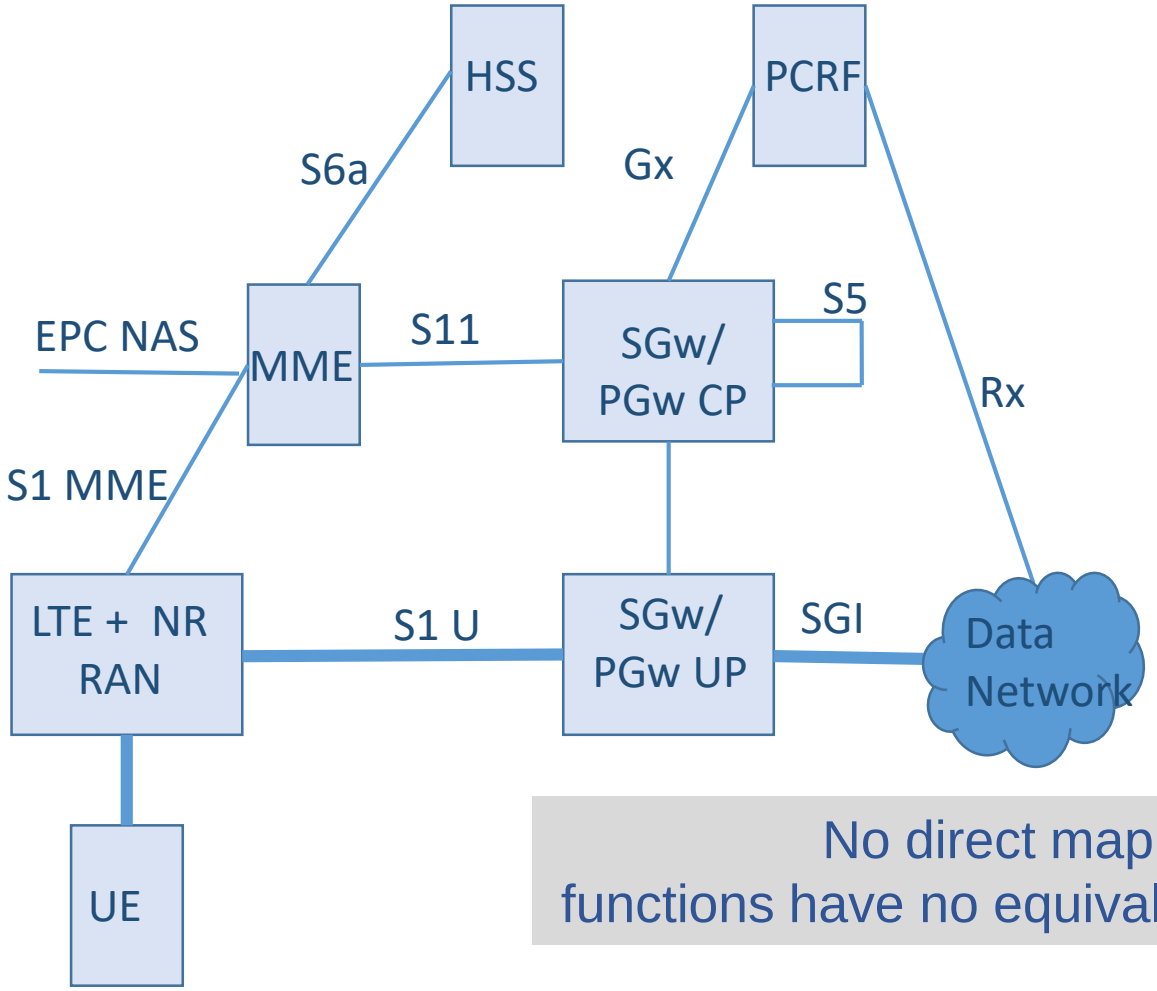
PLANO DE CONTROL



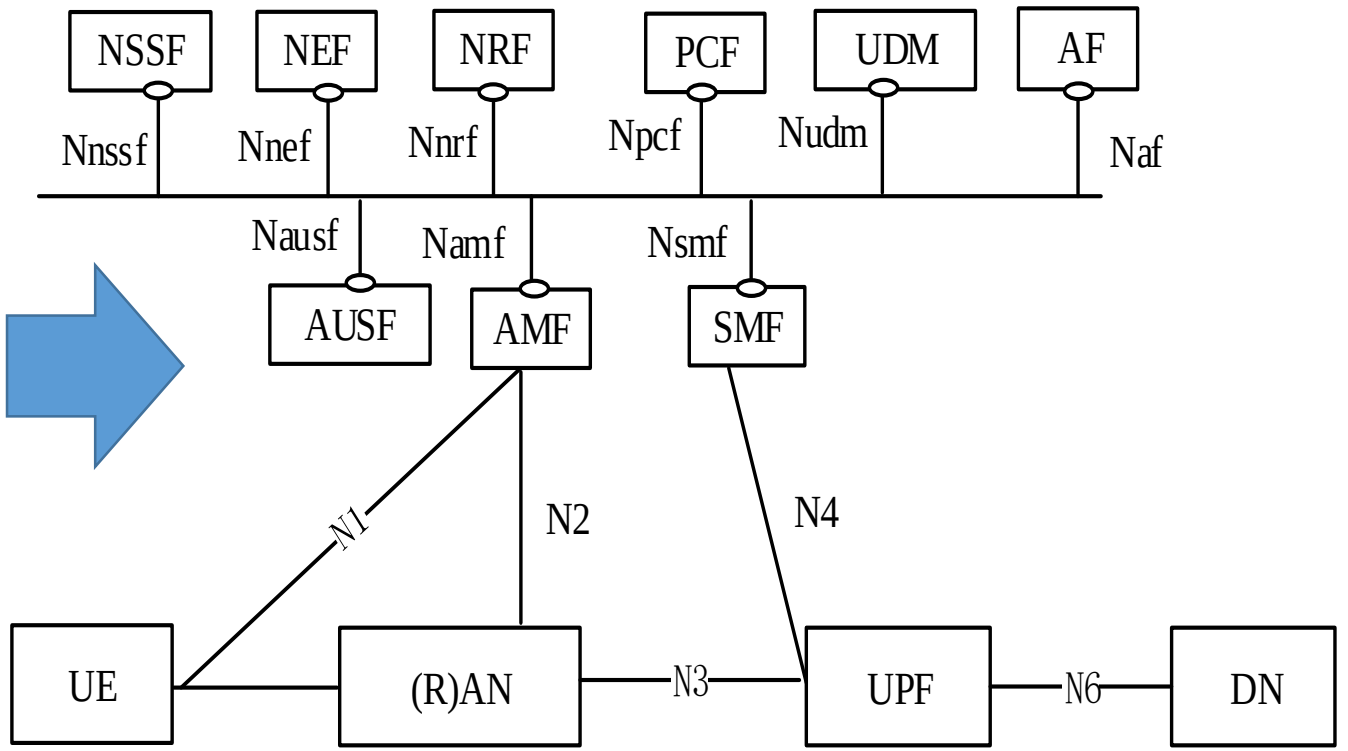
En un escenario de 5G networking, el core cambia radicalmente si se lo compara con el EPC.
En la definición del NGC, el networking 5G tiene las siguientes características:

- La red usa tecnologías de virtualización NFV y SDN (también Contenedores), para desacoplar las funciones lógicas de HW
- Basandose en la arquitectura EPC se hace una separación profunda entre User plane y Control Plane
- Diseño modular de las funciones lógicas, Implementando Ntework Slicing

ARQUITECTURA SA DE ALTO NIVEL



Arquitectura SBA (Service Based Architecture)



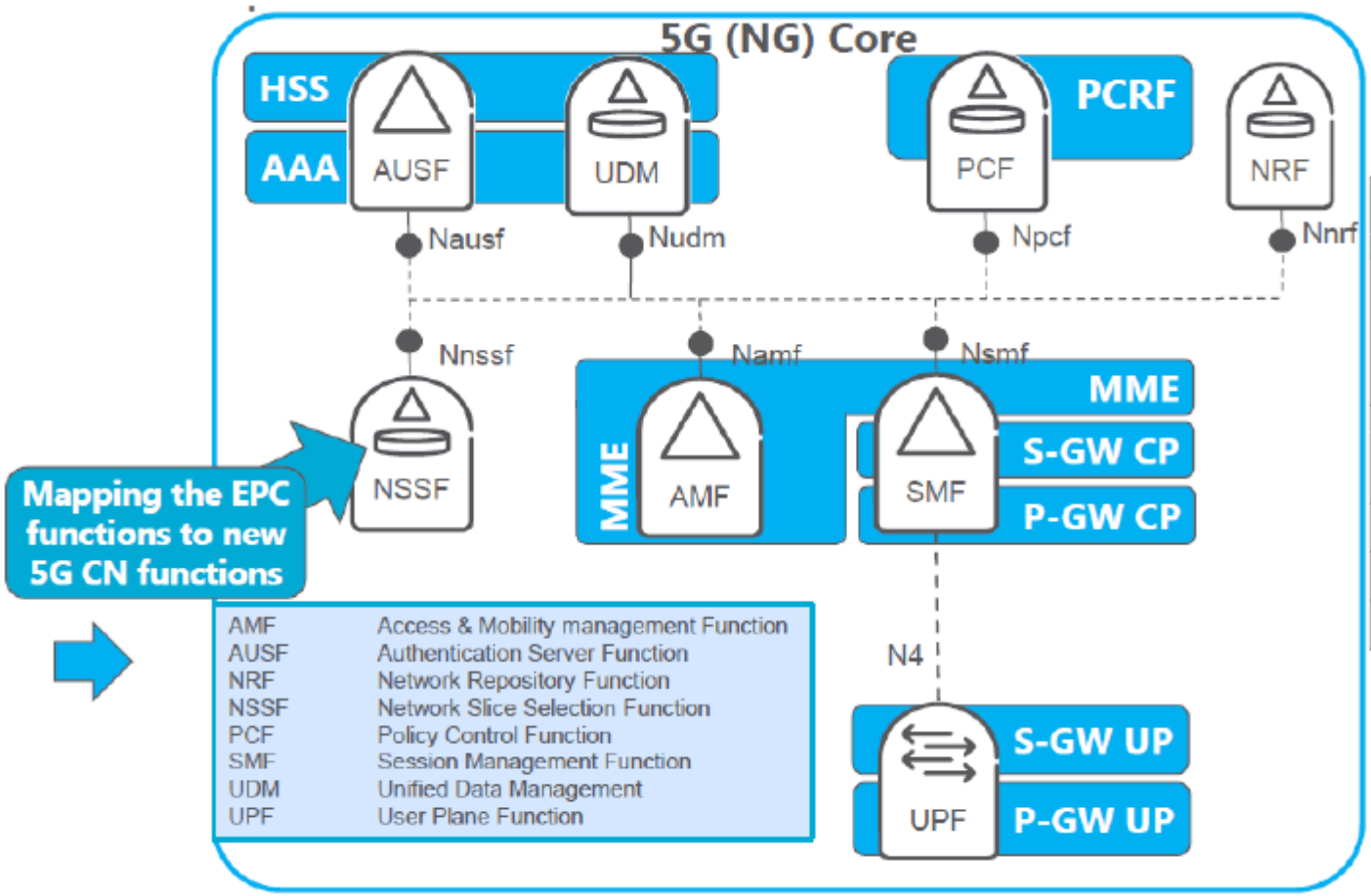
No direct mapping as new functions have no equivalence in ePC

Split the CP and UP in PGw
Support of 5G data rate
Support of 5G RAT and suscription

ENTIDADES DE NGC

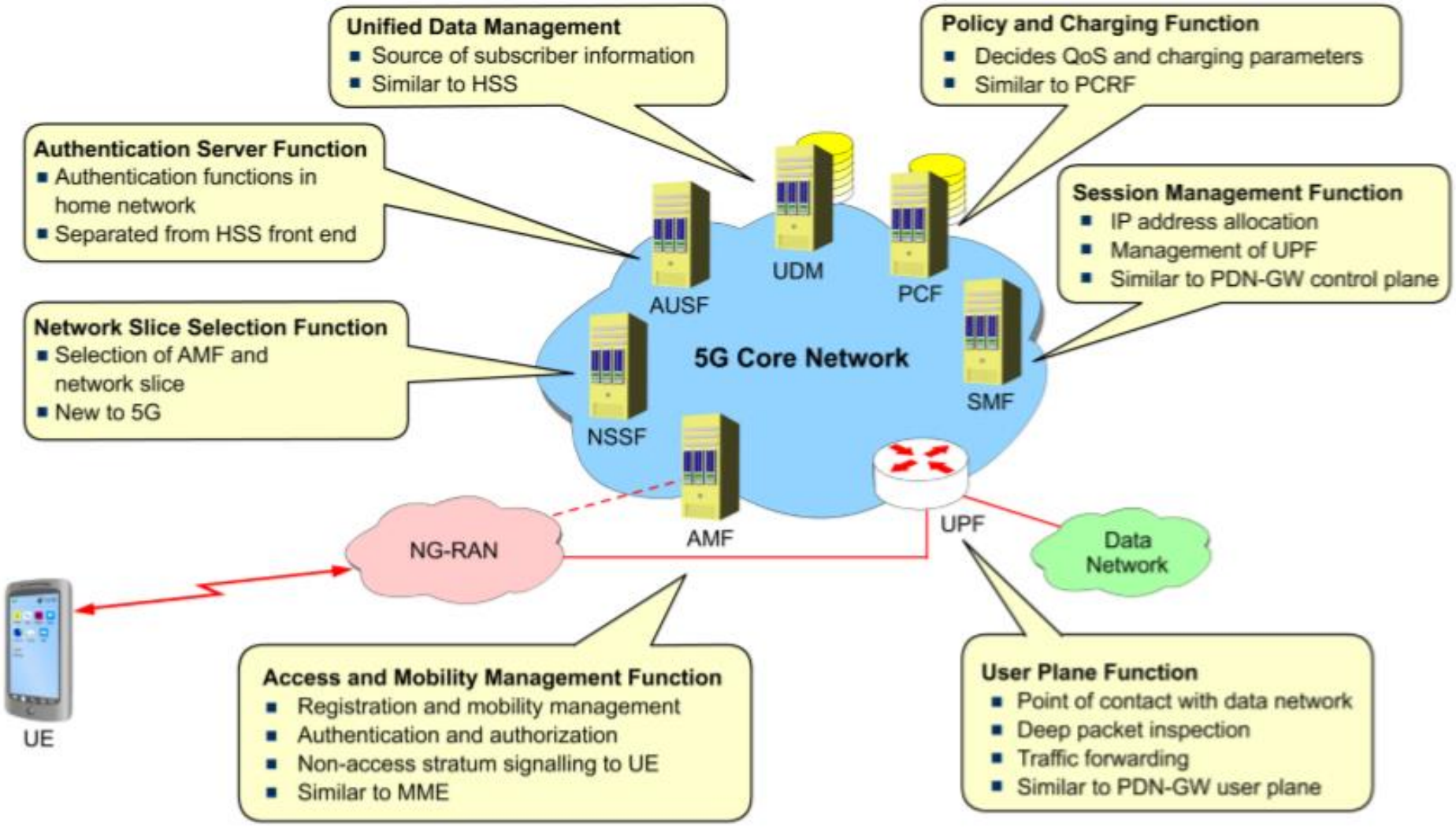
AMF Access and Mobility Management Function. Which is an enhancement of the current MME able to perform dynamic selection of slicing and packet data gateway for use cases associated to MEC (mobile Edge Computing).
SMF. Session Management Function. The PGW is split in UPF (user plane) and SMF (control plane). SMF will be able to perform dynamic UPF selection for supporting the MEC concept.
NRF Network Repository Function. By adopting a service oriented architecture new discovery and authorization capability is required for the different module to access each other.
AUSF Authentication Server Function. New authentication functions used in order to support non SIM based devices.
NSSF. Network slicing function. Required in order to enhanced slice selection
UDM Unified Data Management. Stores subscriber data and profiles. Similar to an HSS in 4G, but will be used for both fixed and mobile access in 5G Core.
PCF Policy Control function. Provides a policy framework incorporating network slicing, roaming and mobility management. Equivalent to PCRF in 4G
UPF：User plane Function.
DN：Data network.
SDSF: Structured Data Storage Network Function .
UDSF: Unstructured Data Storage network function.
UDM：Unified Data Management.
AF： Application Function.

MAPEO DE FUNCIONES DE EPC A NGC



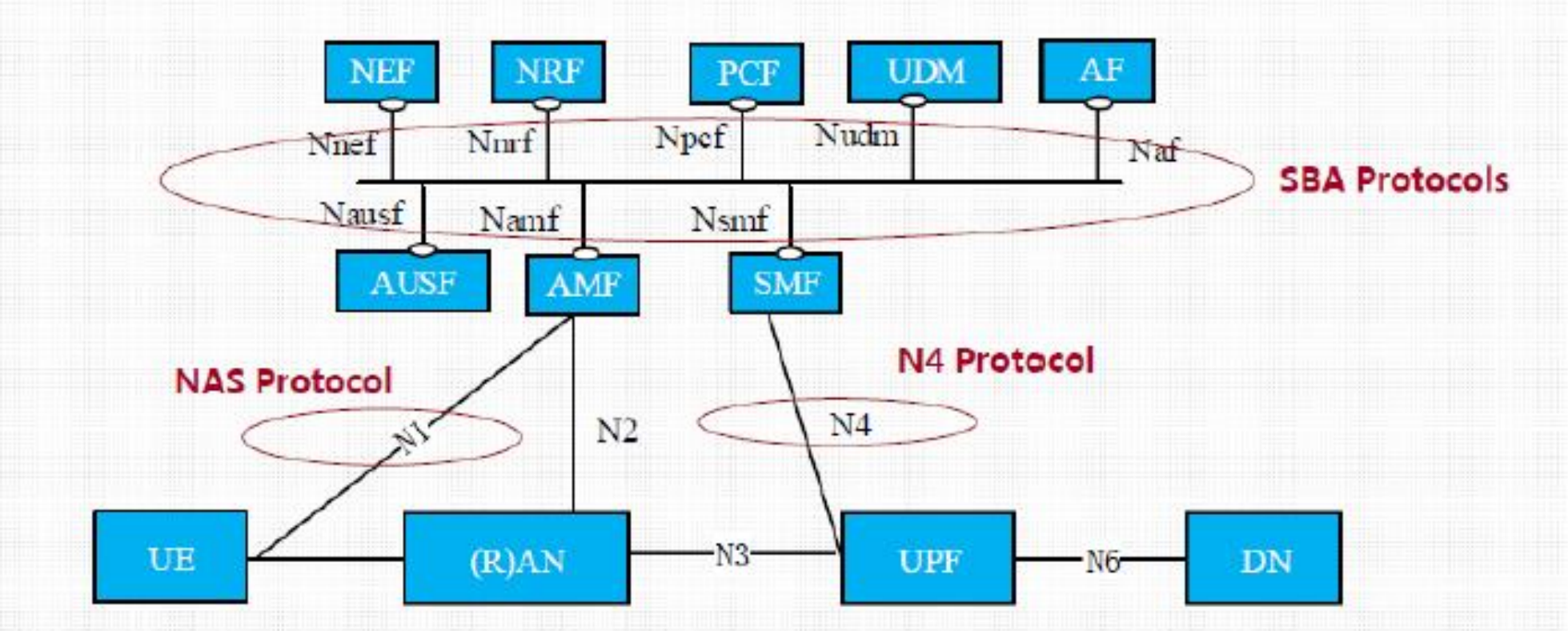
EPC NE function		Corresponding NGC NF
MME	Mobility management	AMF
	User authentication	AUSF
	Session management	SMF
PDN-GW	Session management	
	User plane data forwarding	UPF
SGW	User plane data forwarding	
PCRF	QoS policy and charging rules	PCF
HSS	User profile database	UDM

MAPEO DE FUNCIONES DE EPC EN NGCN AL CORE



PROTOCOLOS

SBA architecture is moving to a Service Oriented Architecture (SOA) approach where control functions will communicate via HTTP 2.0 and APIs based on YAML (Yet another marking Languaje) and JSON (Java Script Object Notation).



PROTOCOLOS

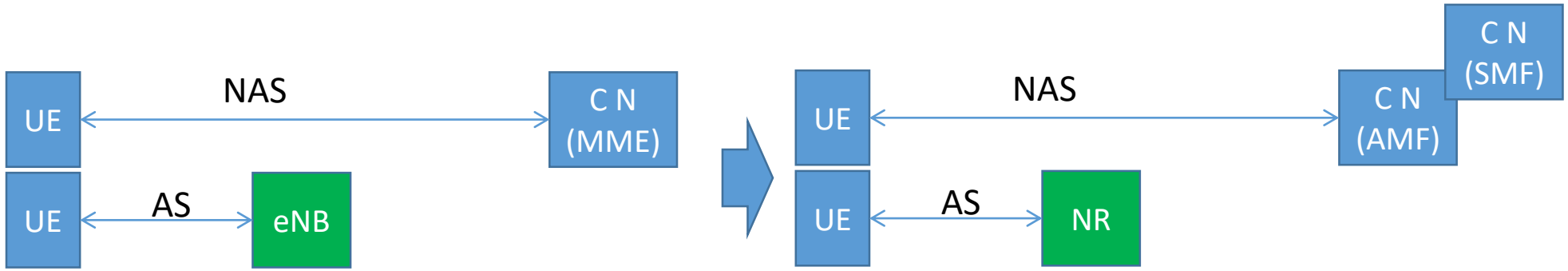
SBA architecture is moving to a Service Oriented Architecture (SOA) approach where control functions will communicate via HTTP 2.0 and APIs based on YAML (Yet another marking Languaje) and Json (Java Script Object Notation).

Key Issue	Selected Protocol
Architecture Style	Restful
Interface Definition Language	OpenAPI 3.0.0
Serialization Protocol	JSON
Application Layer Protocol	HTTP 2.0
Transport Layer Protocol	TCP

SBA Protocols: Are based on RESTFUL (Representational state transfer) APIS. Transport is still TCP.
QUIC (Quick UDP Internet Connections) usage is left for study in Rel 16.

PROTOCOLOS

NAS PROTOCOLS: NAS handles the UE access to the network



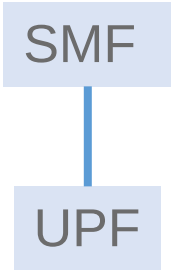
NAS over EAP-5G

NAS over PPOE

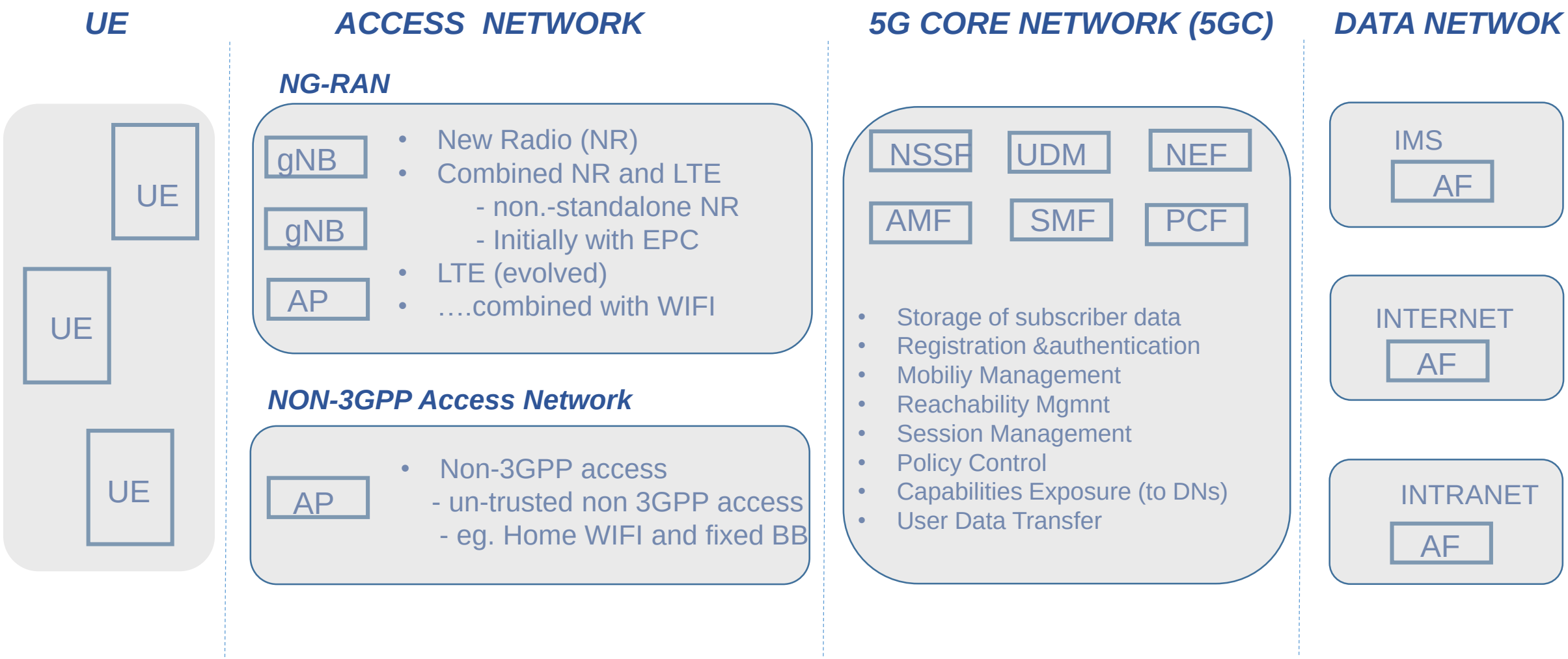
NAS over IP

PROTOCOLOS

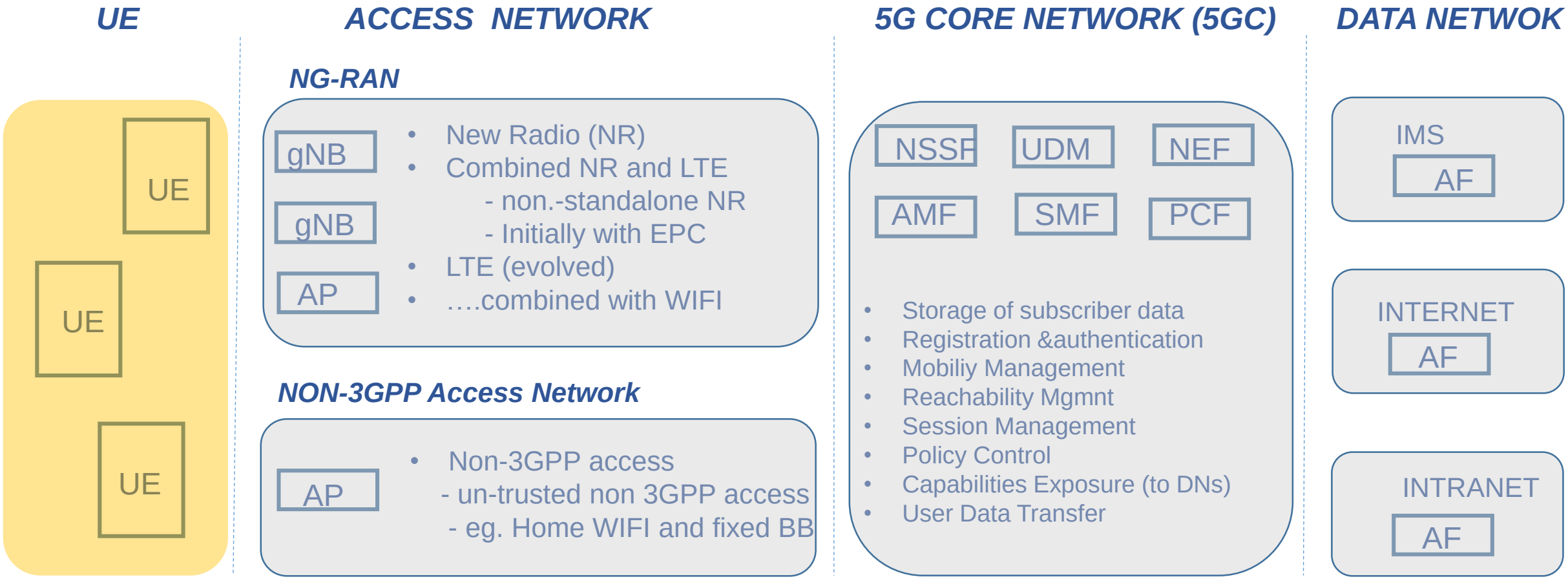
N4 protocols. N4 is the interface binding the control plane and user plane of the 5G packet gateway. 3GPP defines the usage of the Packet Forwarding Control Protocol (PFCP) for the communication between the control and user plane elements affected by CUPS (Control and User Plane Separation). In addition, it is planned to reuse PFCP, with some enhancements, in the interface N4. The user plane is done via extension of GTP U (over UDP).



5G SYSTEM (5GS)



5G SYSTEM (5GS)



- **Smartphones**
- **Pads/tables**
- **"Things"/Gateways**
- **"5G Router" (FWA)**

Smartphones

- Very mobile
- Lots of data
- eMBB

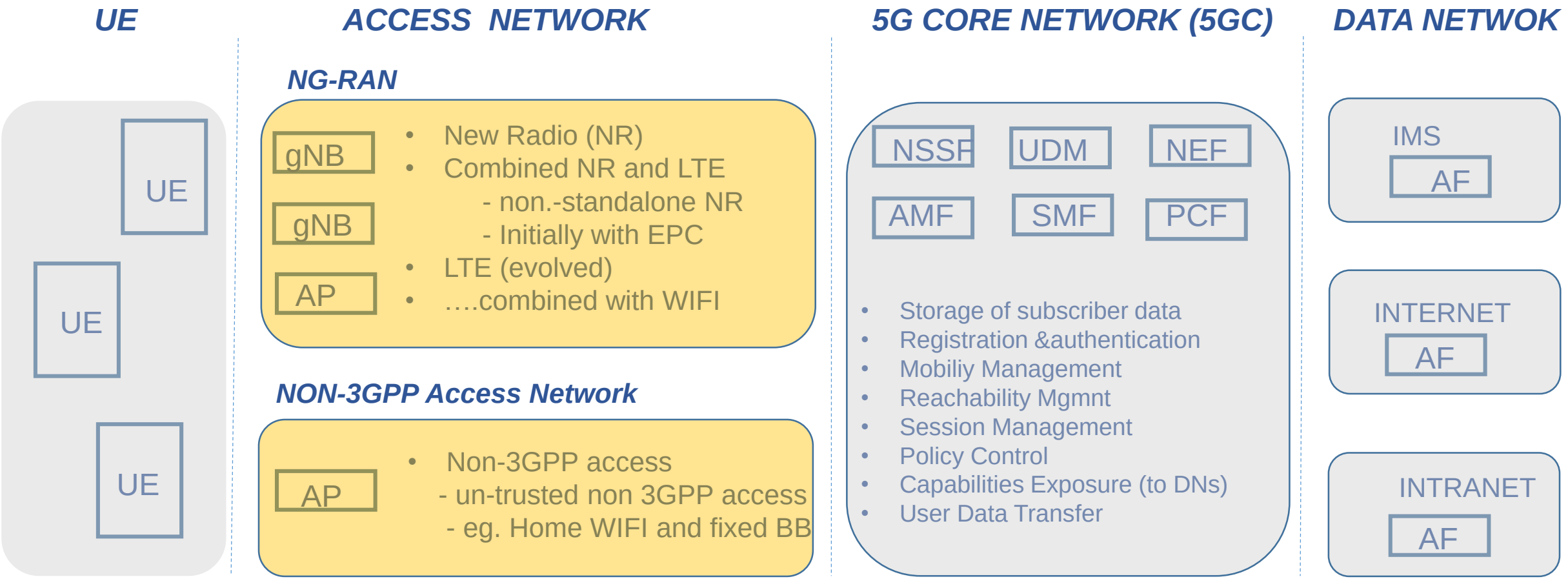
Meters

- Stationary
- Not much data
- mMTC

Vehicle to X

- May be critical
- Possible D2D
- URLLC

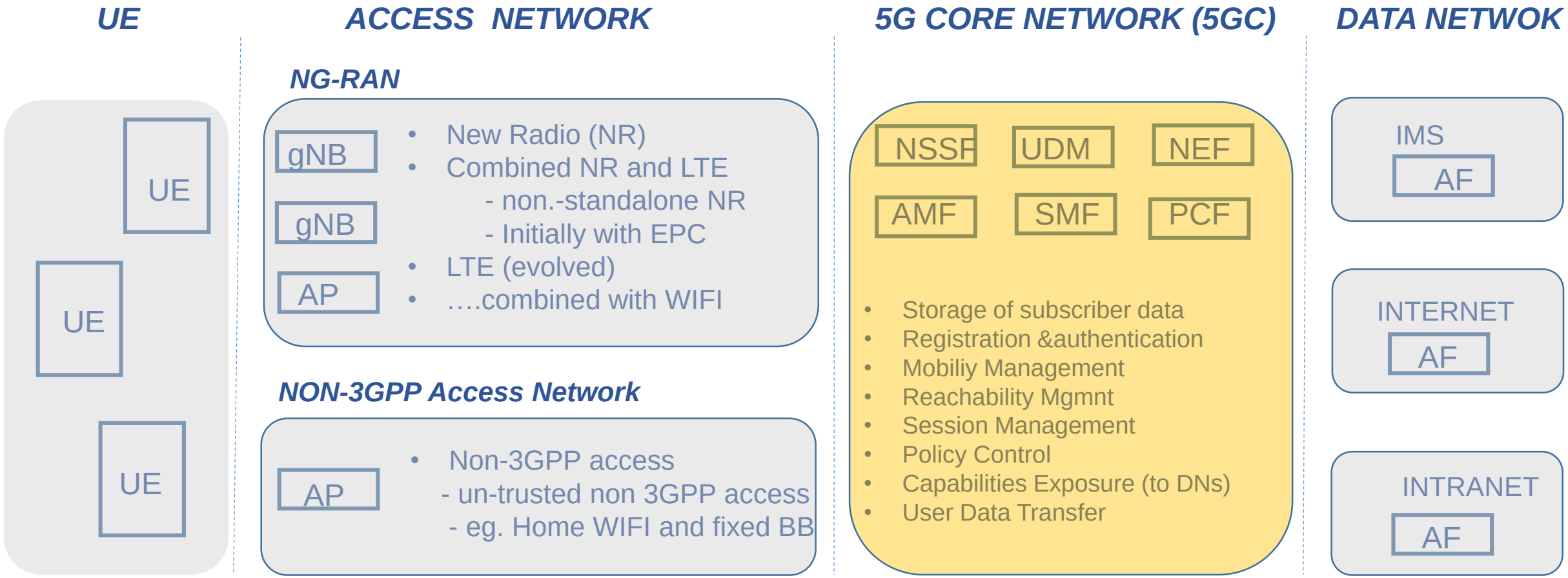
5G SYSTEM (5GS)



NG-RAN Features

- New frecuency spectrum
  - -Traditional fq ranges (<6 GHz)
  - - High: 6- 100 GHz fq-bands
- Use of nunicensed spectrum (LAA)
- New Radio (NR), still OFDM
- Carrier Aggregation, Massive MIMO
- Tight integration with E-UTRA (e.g Dual Connectivity)
- Integration with WIFI (LWA)

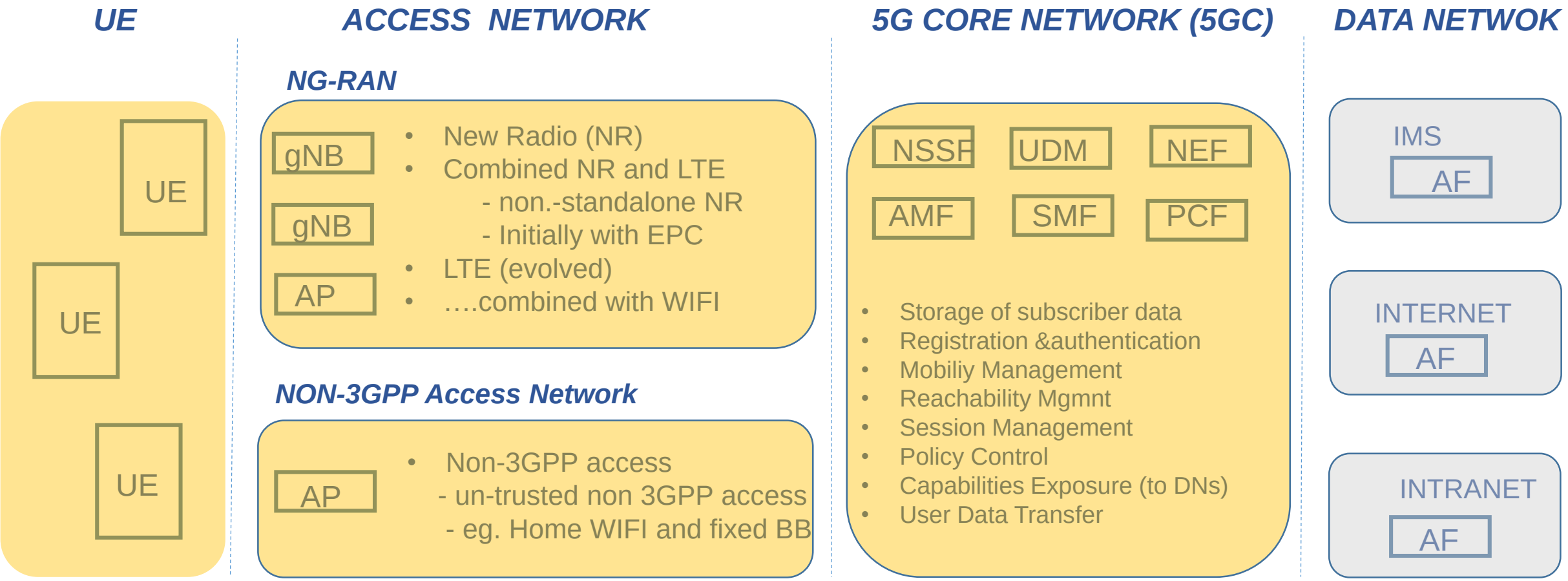
5G SYSTEM (5GS)



5G Core Features

- VNFs in Central and Distributed Data Centers
- Clear Separation of CP and UP functions (CUPS)
- Closer integration with Network possible
- More flexibe UP paths
- Service-Based architecture

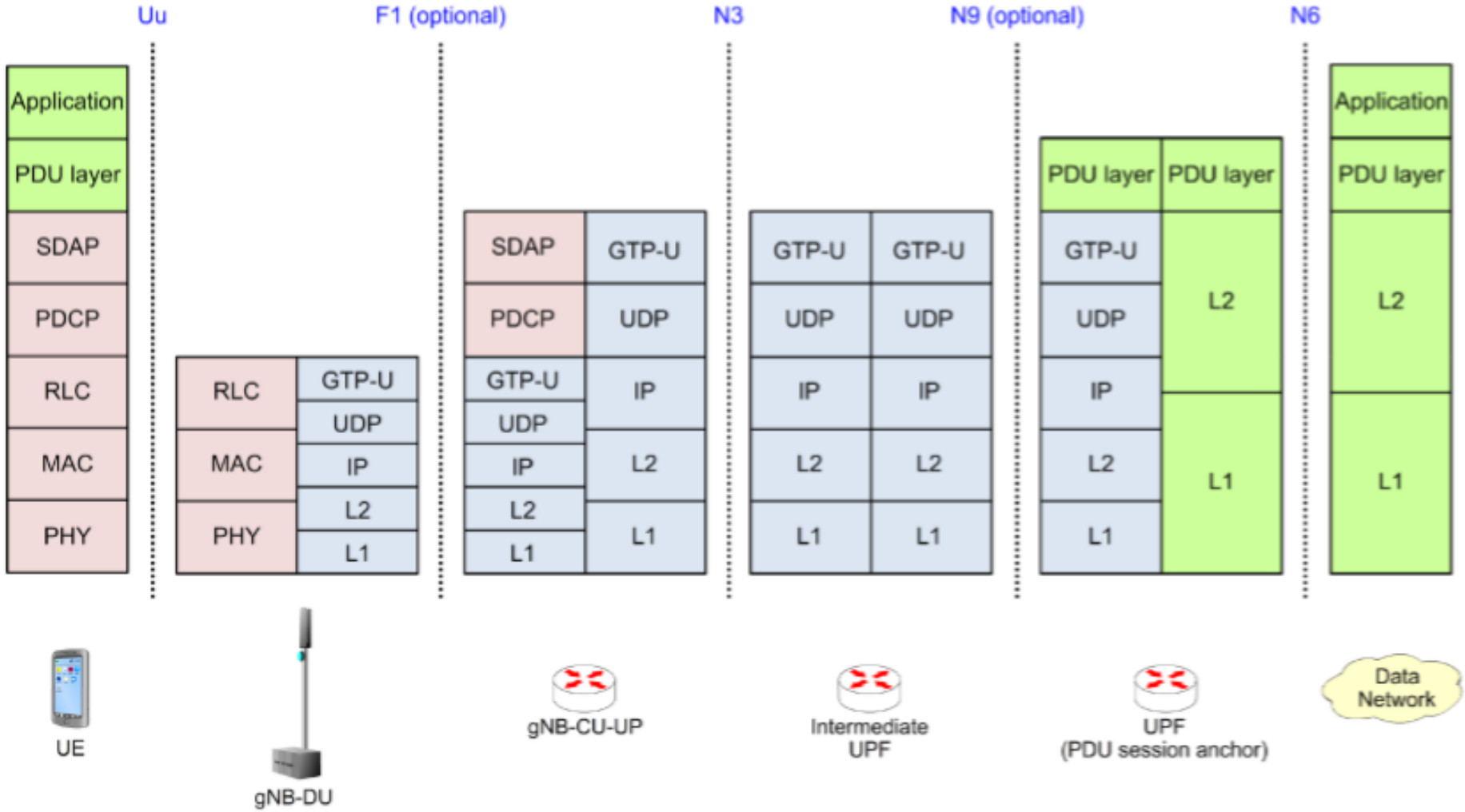
5G SYSTEM (5GS)



5G System Features

- Network Function Virtualization (NFV)
- Software-Defined Networking (SDN)
- Network Slicing (using NFV and SDN)
- Multi-Access Edge Computing (MEC)
- Automation and Orchestation
- Support for (enhanced) MBMS
- For IPV4 , IPV6, Ethernet, and “unstructured” traffic

5G USER PLANE PROTOCOL STACK



La interfaz F1 es un caso especial no siempre implementado

5G CORE NETWORK PROTOCOLS- 3GPP EVOLUTION

ISUP/MAP/INAP
TCAP
SCCP
MTP3
MTP2
MTP1
Stack SN7

SEÑALIZ APP DIAMETER /HTTP2
TRANSPORTE SCTP/ TCP
RED IP
ENLACE ENLACE
FÍSICA FÍSICA

IP based

Example: "Update Location"

Aligned with Virtualisation & Uses a Service Based Architecture

2G	3G	4G	5G
Update Location	Update Location	Update Location	Update Location
MAP	MAP	S6a	N8 / JSON
TCAP	TCAP	Diameter	HTTP/2
SCCP	SCCP	SCTP	TCP
MTP	SIGTRAN	IP	IP
Stack SN7		IP based	

La interfaz F1 es un caso especial no siempre implementado

IDENTIDADES- SUPI AND GPSI

SUPI
Subscription Permanent Identifier

- Identidad única Global para cada subscriber 5G
- Solo usado dentro de sistemas 3GPP
- Contiene dirección de la red home

Ejemplos de formatos

- IMSI
- NAI (basado en IMSI)
  IMSI@operator.com

GPSI
Generic Public Subscription Identifier

Subscription Permanent Identifier

- Identidad de subscripción 5G, usada fuera de sistemas 3GPP.
- También pued ser usado dentro de sistemas 3GPP

Ejemplos de formatos

- MSISDN
- Identificar externo)
  username@realm

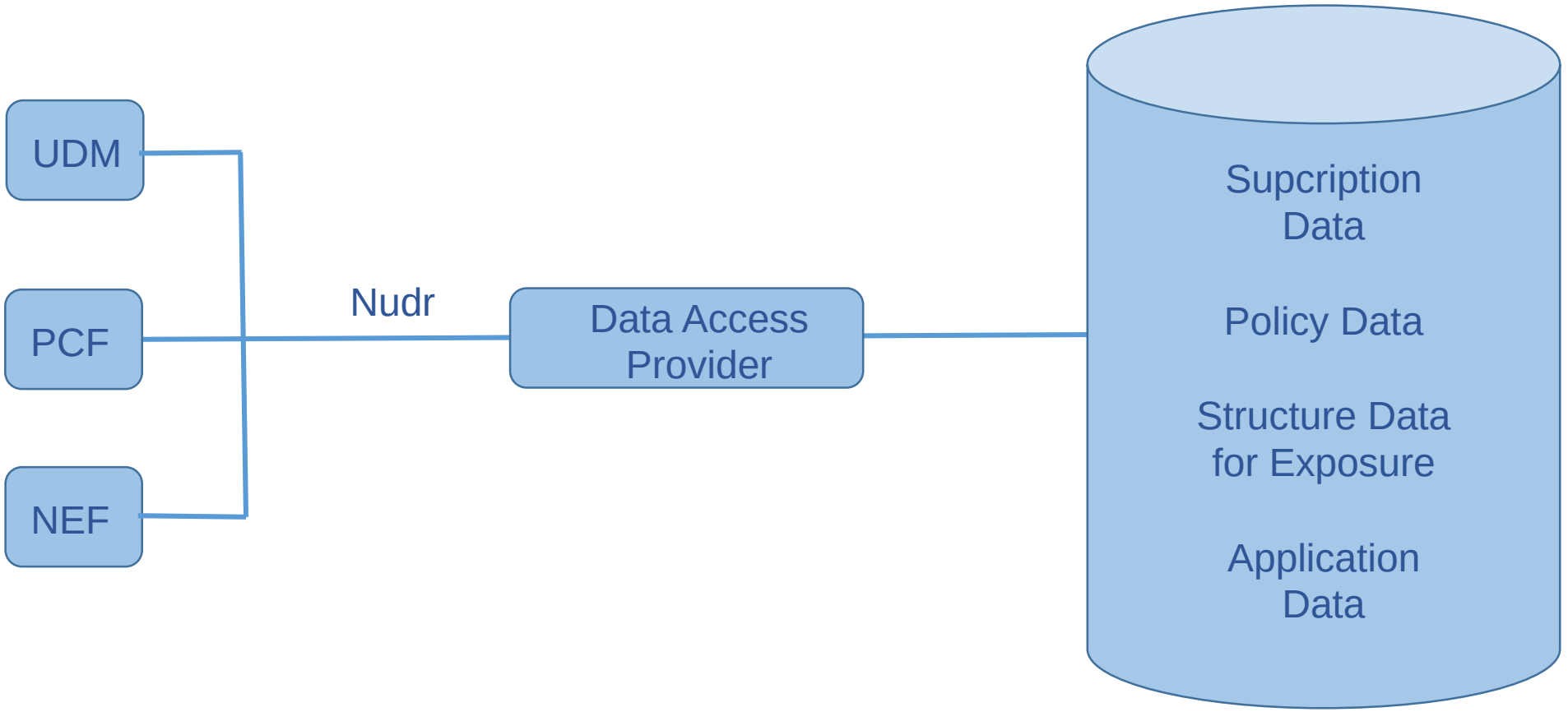
Para interworking con el EPC, SUPI debe estar basado en IMSI

SUCI
Subscription Concealed Identifier

- Versón “secreta” de SUPI, creada por el UE o USIM
- Identidad única Global para cada subscriber 5G
- El UDM hace la traducción entre SUCI y SUPI

El propio sistema 3GPP traduce entre SUPI y GPSI

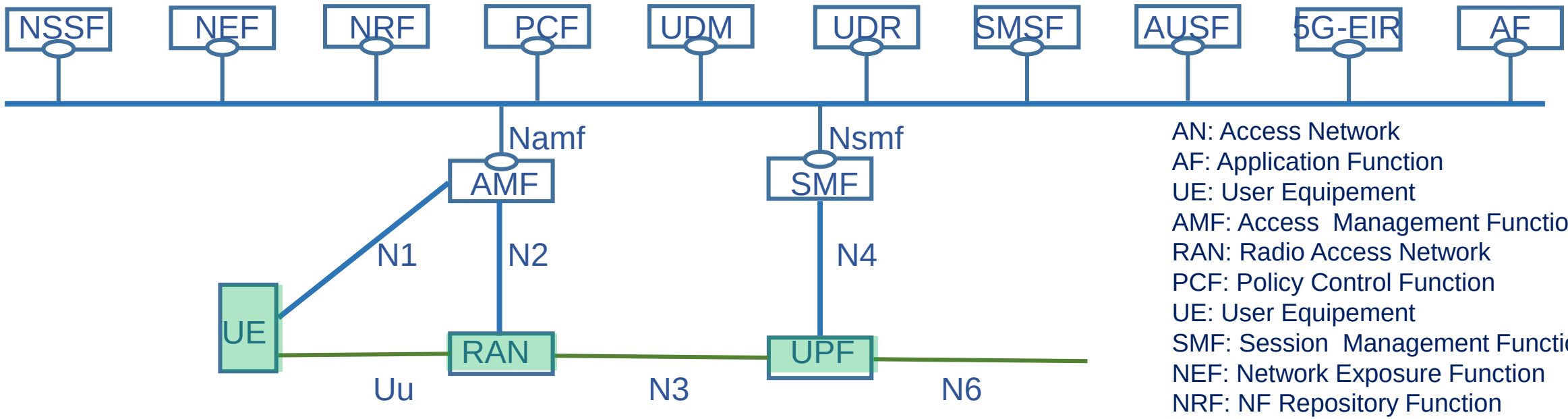
UDR- USER DATA REPOSITORY



Ref.: TS.23.501

SERVICE-BASED ARCHITECTURE

Las funciones del Control Plane (C) en el Sistema 5G son basadas en SBA.
Cada funcionalidad del sistema es llevada a cabo por una serie de NF que proveen servicios a otras NFs autorizadas a acceder a sus servicios



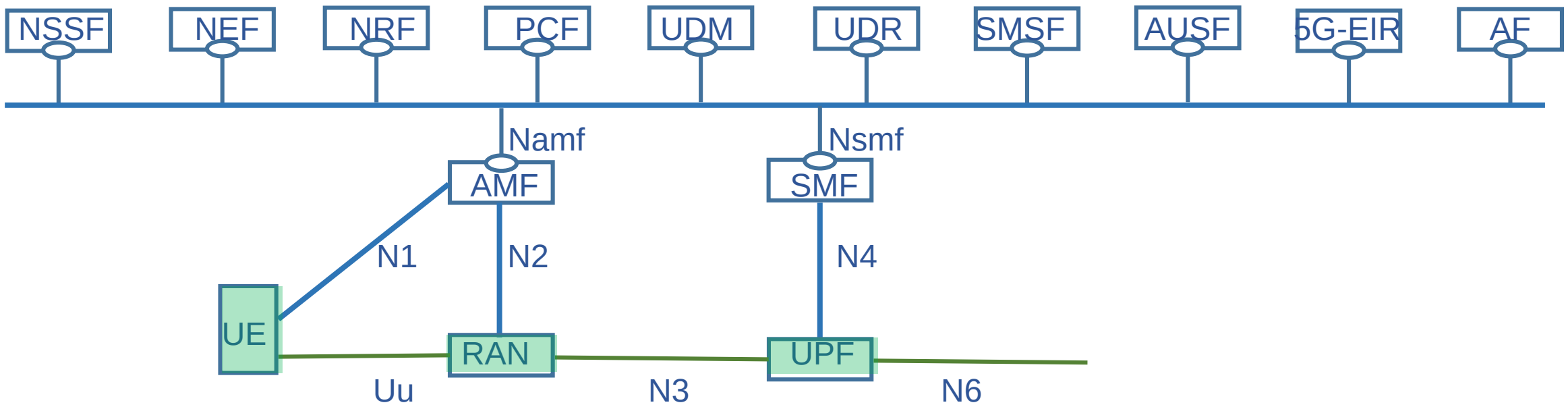
AN: Access Network
AF: Application Function
UE: User Equipement
AMF: Access Management Function
RAN: Radio Access Network
PCF: Policy Control Function
UE: User Equipement
SMF: Session Management Function
NEF: Network Exposure Function
NRF: NF Repository Function
NF: Network Function
AUSF: Authentication Server Function.
EIR: Equipment Identity Register
IMEI: International Mobile Equipment Ider
PEI: Permanent Equipment Identifier
RAT: Rado Access Technology

UDM: User Data Management}
UDR: User Data Repository
NSSF: Network Slice Selection Function
UDSF: Un structured Data Storage Function
UPF: User Plane Function

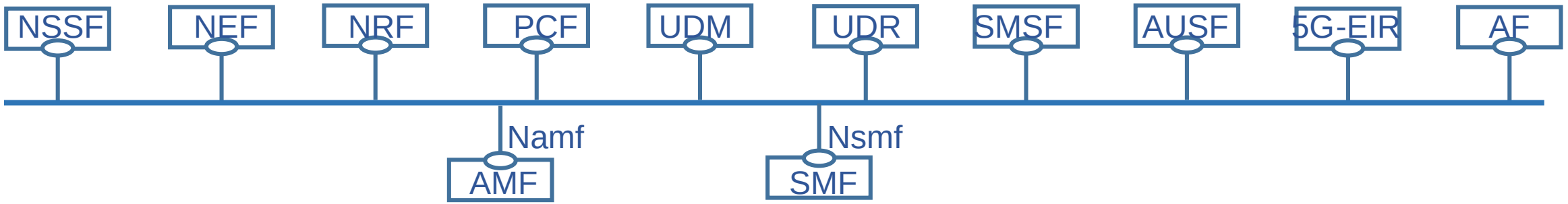
Ref.:
TS.23.501
TS.23.502
TS.29.500
TS.33.501

SERVICE-BASED ARCHITECTURE

Una ***NF*** es un tipo de capacidad expuesta por un ***NF Service Producer*** a otra NF autorizada, llamada ***NF Service Consumer***, a traves de una Service Based Interface
Un ***NF Service*** puede soportar uno o mas ***NF Service Operation(s).***



USO DE HTTPV2 EN SERVICE-BASED ARCHITECTURE



Service Operations (examples):
- Request
- Get
- Create
- Update
- Subscribe / Unsubscribe
- Registration
- Notify
- .....

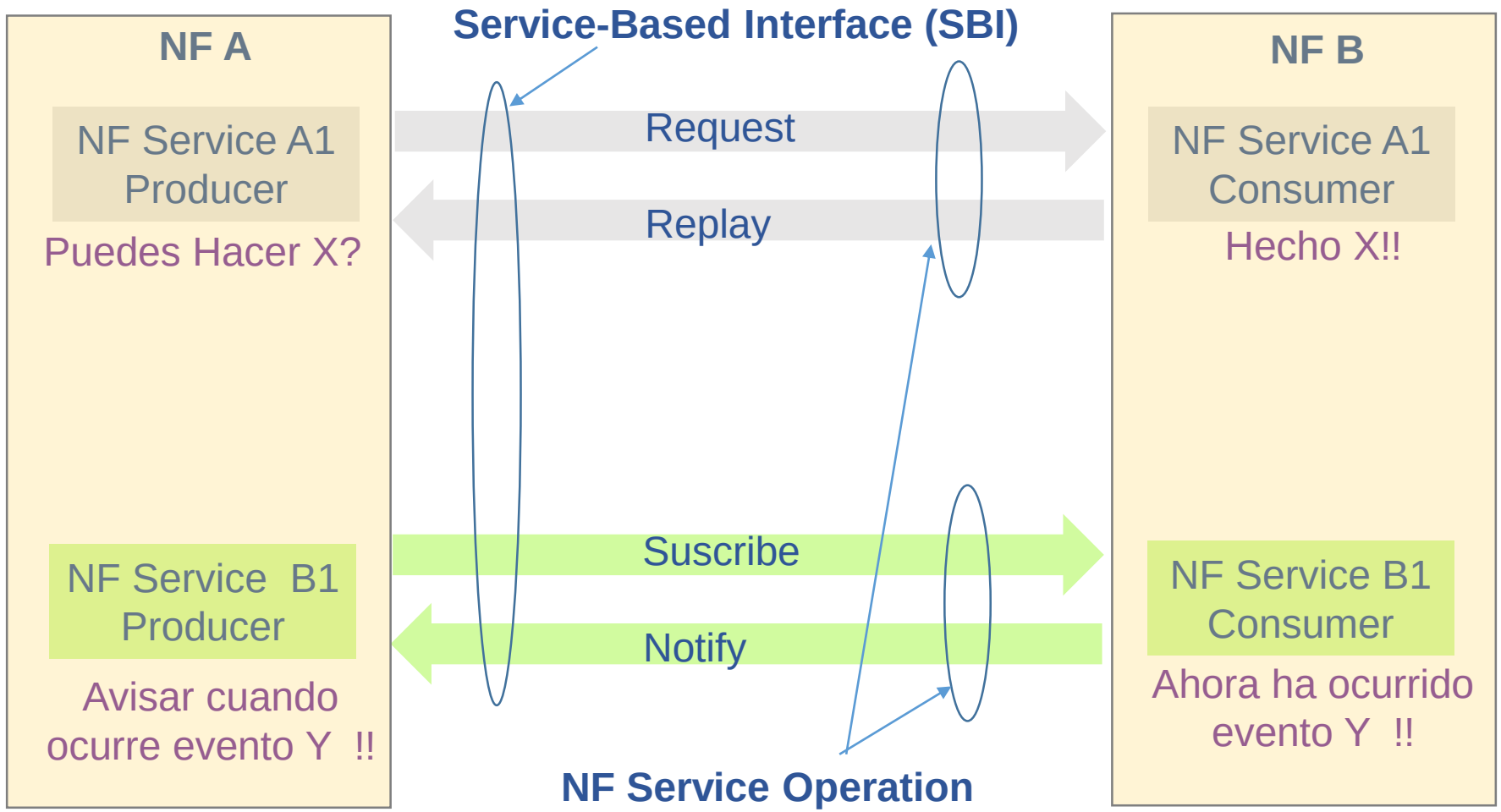
HTTP methods:
GET
POST
PATCH
...

Application
HTTP/2
TCP
IP
L2
L1

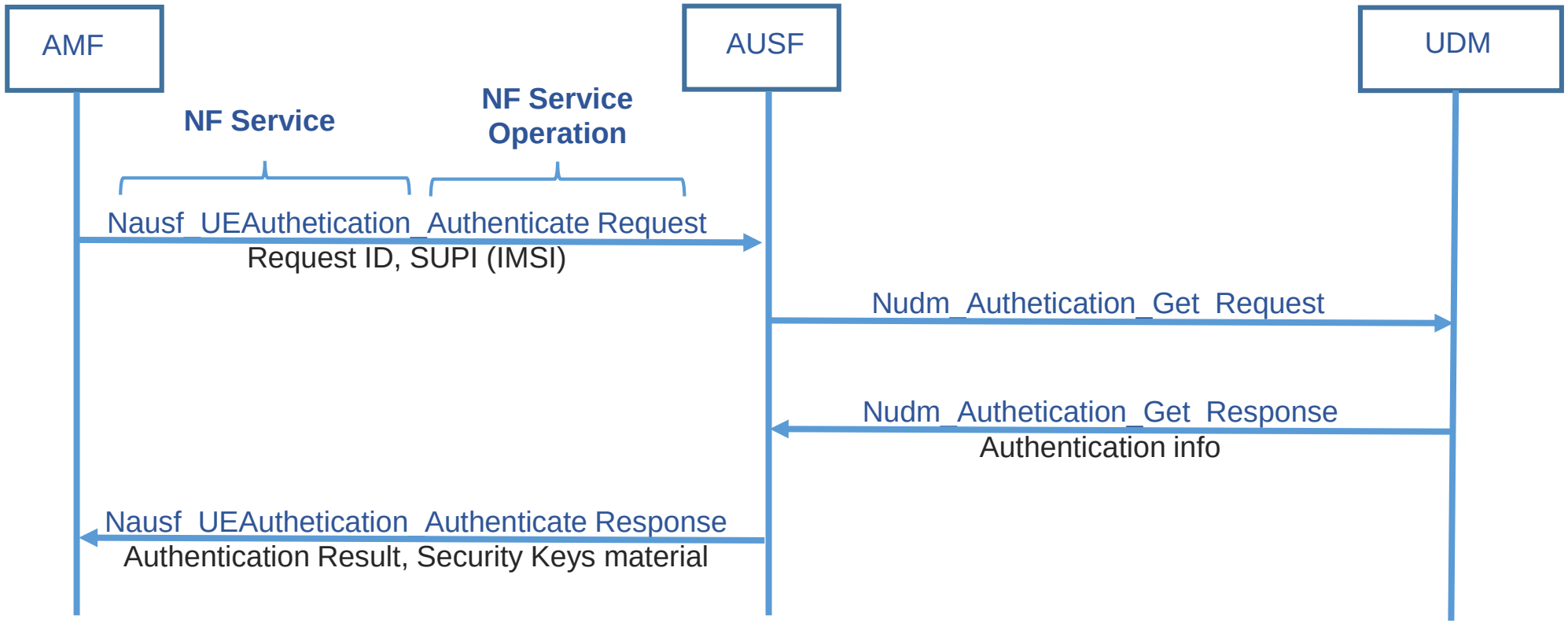
HTTP/2 (RFC 7540)

The JavaScript Object Notation (JSON) format as described in IETF RFC 7159 shall be used as serialization protocol.

REQUEST-REPLAY VS SUSCRIBE-NOTIFY



EJEMPLO- AUTENTICACIÓN DEL UE



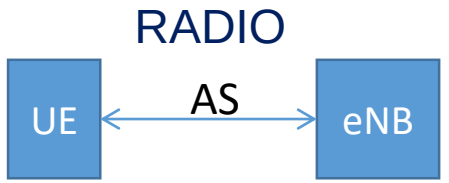
ALGUNOS PROCEDIMIENTOS DE CONTROL EN LTE Y 5G

Muchos procedimientos definidos en LTE siguen siendo válidos en 5G

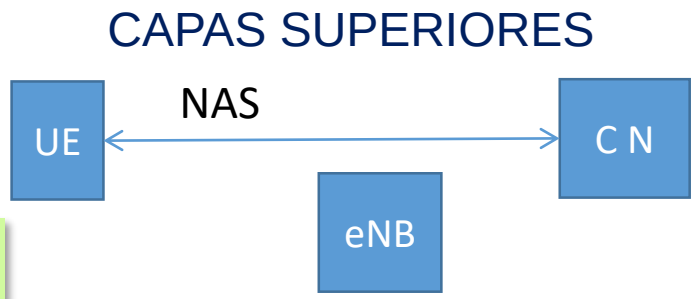
CONTROL PROTOCOLS

AS &NAS

Control Plane of the Access Stratum (AS) handles radio specific functionalities.



The AS interacts with the Non-Access Stratum (NAS), also referred to as the 'upper layers'.
-Public Land Mobile Network (PLMN) selection
-tracking area update
-Paging
-Authentication
-Evolved Packet System (EPS) bearer establishment, modification and release.



The applicable AS-related procedures largely depend on the Radio Resource Control (RRC) state of the User Equipment (UE).
-RRC_IDLE
-RRC_CONNECTED.

AL REFERIRNOS A RADIO: RRC

RRC State

UE in RRC_IDLE.

Cell selection and reselection.

The cell (re)selection process takes into account the priority of each applicable frequency of each applicable Radio Access Technology (RAT), the radio link quality and the cell status (i.e. whether a cell is barred or reserved).

An RRC_IDLE UE monitors a paging channel to detect incoming calls, and also acquires system information.

The System Information (SI) mainly consists of parameters by which the network (EUTRAN) can control the cell (re)selection process.

SI: System Information

SIB: System Information Blocks

UE In RRC_CONNECTED.

E-UTRAN allocates radio resources to the UE to facilitate the transfer of (unicast) data via shared data channels (PDSCH).

To support this operation, the UE monitors an associated control channel (PDCCH) used to indicate the dynamic allocation of the shared transmission resources in time and frequency.

The UE provides the network with reports of its buffer status and of the downlink channel quality, as well as neighbouring cell measurement information to enable E-UTRAN to select the most appropriate cell for the UE. These measurement reports include cells using other frequencies or RATs.

The UE also receives SI, consisting mainly of information required to use the transmission channels. To extend its battery lifetime, a UE in RRC_CONNECTED may be configured with a Discontinuous Reception (DRX) cycle.

CONTROL PROTOCOLS

RRC

RRC → E-UTRAN-→controls the UE behaviour in RRC_CONNECTED.
RRC also includes the control signalling applicable for a UE in RRC_IDLE, namely paging and SI.
Functionality related to Multimedia Broadcast/Multicast Services (MBMSs) are also related to RRC.

The RRC protocol supports the transfer of *common* NAS information (i.e. NAS information which is applicable to all UEs) as well as *dedicated* NAS information (which is applicable only to a specific UE).
In addition, for UEs in RRC_IDLE, RRC supports notification of incoming calls (via paging).

SI: System Information

SIB: System Information Blocks

CONTROL PROTOCOLS

RRC (CP) FUNCTIONAL AREAS

System information handles the broadcasting of SI, which includes NAS common information. Some of the system information is applicable only for UEs in RRC_IDLE while other SI is also applicable for UEs in RRC_CONNECTED.

RRC connection control covers all procedures related to the establishment, modification and release of an RRC connection, including paging, initial security activation, establishment of Signalling Radio Bearers (SRBs) and of radio bearers carrying user data (Data Radio Bearers, DRBs), handover within LTE (including transfer of UE RRC context information), configuration of the lower protocol layers, access class barring and radio link failure.

SI: System Information

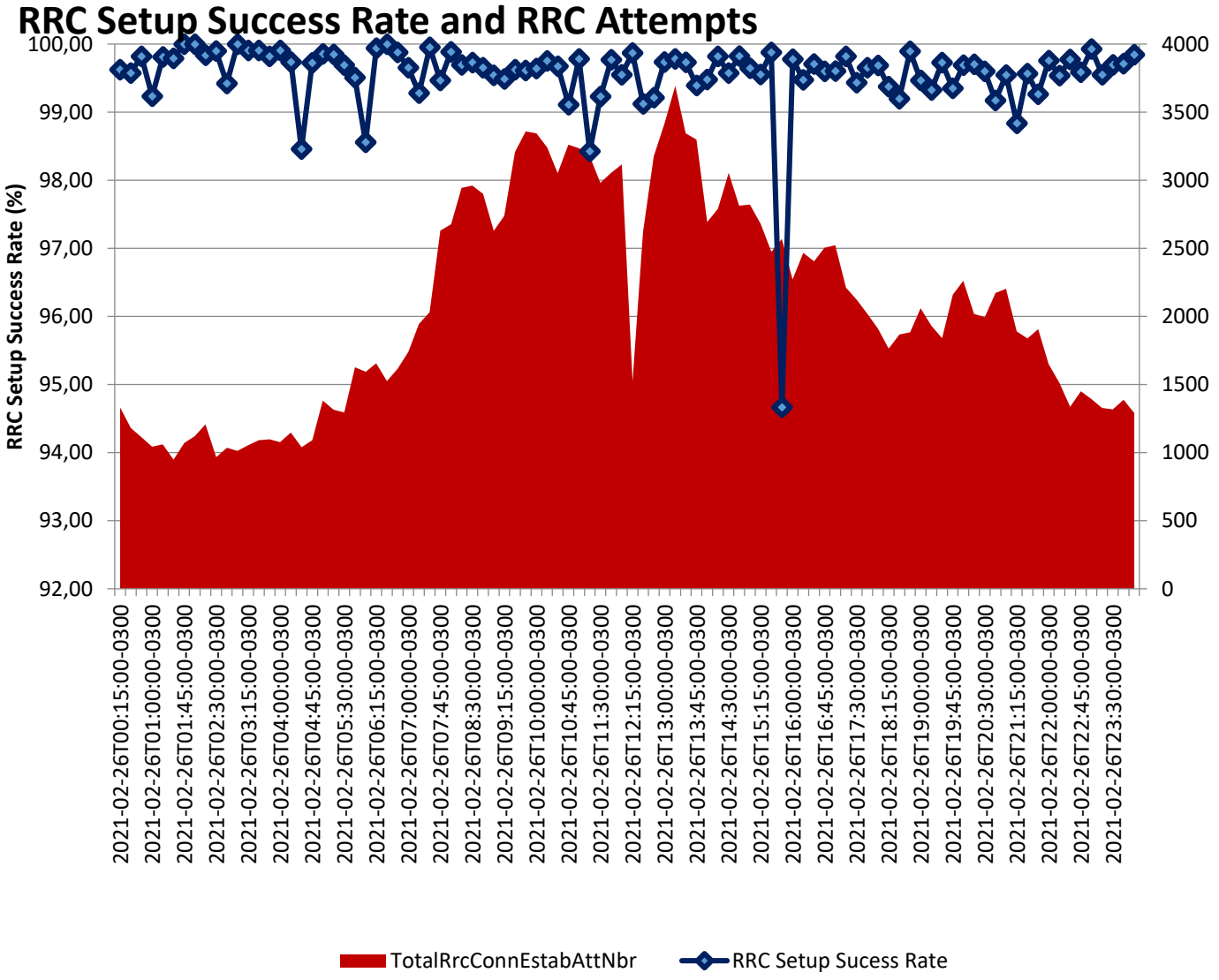
SIB: System Information Blocks

Network controlled **inter-RAT mobility** includes handover, cell change orders and redirection upon connection release, security activation and transfer of **UE RRC context** information.

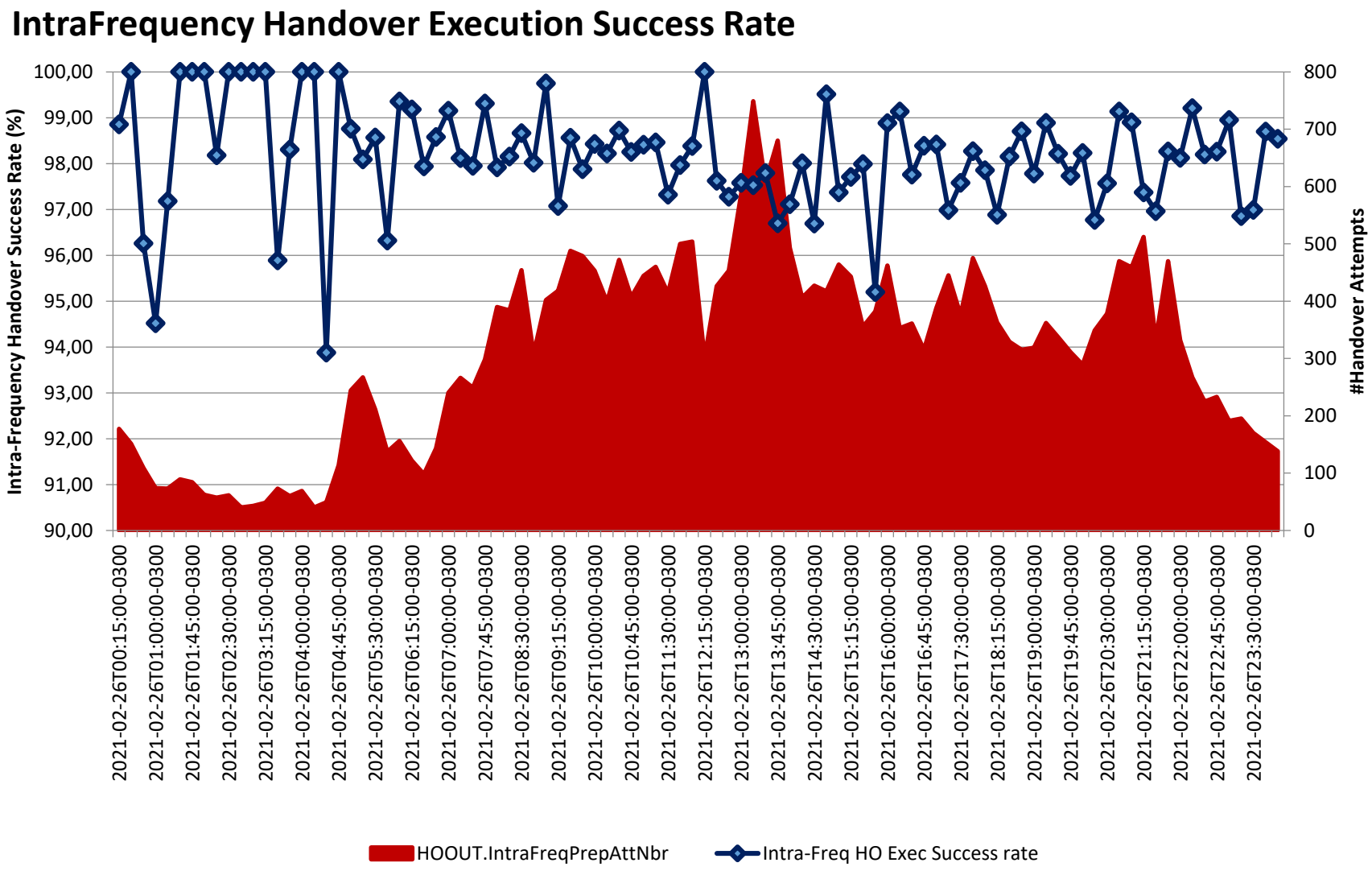
Measurement configuration and reporting for intra-frequency, inter-frequency and inter-RAT mobility, includes configuration and activation of measurement gaps.

Miscellaneous functions including, for example, transfer of dedicated NAS information and transfer of UE radio access capability information.

CONTROL PROTOCOLS (ejemplos)



CONTROL PROTOCOLS (ejemplos)



CONTROL PROTOCOLS

RRC FUNCTIONAL AREAS

Dedicated RRC messages are transferred across SRBs, which are mapped via the Packet Data Convergence Protocol (PDCP) and RLC layers onto logical channels – either the Common Control CHannel (CCCH) during connection establishment or a Dedicated Control CHannel (DCCH) in RRC_CONNECTED.

System Information and Paging messages are mapped directly to logical channels – the Broadcast Control CHannel (BCCH) and Paging Control CHannel (PCCH) respectively.

Common Control CHannel (CCCH)
Dedicated Control CHannel (DCCH)

SRB0 is used for RRC messages which use the CCCH, SRB1 is for RRC messages using DCCH, and SRB2 is for the (lower-priority) RRC messages using DCCH which only include NAS dedicated information.

All RRC messages using DCCH are integrity-protected and ciphered by the PDCP layer (after security activation) and use Automatic Repeat reQuest (ARQ) protocols for reliable delivery through the RLC layer. The RRC messages using CCCH are not integrity-protected and do not use ARQ in the RLC layer.
It should also be noted that the NAS independently applies integrity protection and ciphering.

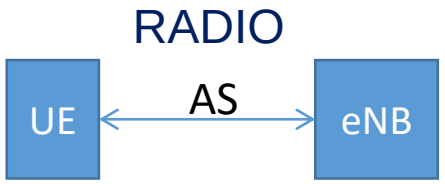
For control information for which low transfer delay is more important than reliable transfer (i.e. for which the use of ARQ is inappropriate due to the additional delay it incurs), MAC signalling is used provided that there are no security concerns (integrity protection and ciphering are not applicable for MAC signalling).

CONTROL PROTOCOLS

SIBs

SI: System Information

SIB: System Information Blocks



System information is structured by means of System Information Blocks (SIBs), each of which contains a set of functionally-related parameters. The SIB have been divided in types:

The Master Information Block (MIB), includes a limited number of the most frequently transmitted Parameters which are essential for a UE's initial access to the network.

- System Information Block Type 1 (SIB1), which contains parameters needed to determine if a cell is suitable for cell selection, as well as information about the timedomain scheduling of the other SIBs.
- System Information Block Type 2 (SIB2), which includes common and shared channel information.
- SIB3–SIB8, which include parameters used to control intra-frequency, inter-frequency and inter-RAT cell reselection.
- SIB9, which is used to signal the name of a Home eNodeB (HeNBs).
- SIB10–SIB12, which include the Earthquake and Tsunami Warning Service (ETWS) notifications and Commercial Mobile Alert System (CMAS) warning messages.
- SIB13, which includes MBMS related control information

CONTROL PROTOCOLS

SIBs

The SIBs are described in 3GPP TS 25.331

MIB (Master Information Block) -- SIB scheduling information and MNC/MCC network identities

SIB1 : The system information block type 1 contains NAS system information as well as UE timers and counters to be used in idle mode and in connected mode.

SIB2 : The system information block type 2 contains the URA identity.

SIB3 : The system information block type 3 contains parameters for cell selection and re-selection.

SIB4 : The system information block type 4 contains parameters for cell selection and re-selection to be used in connected mode.

SIB5 : The system information block type 5 contains parameters for the configuration of the common physical channels in the cell.

SIB6 : The system information block type 6 contains parameters for the configuration of the common and shared physical channels to be used in connected mode.

SIB7 : The system information block type 7 contains the fast changing parameters UL interference and Dynamic persistence level.

SIB8 : The system information block type 8 contains static CPCH information to be used in the cell.

SIB9 : The system information block type 9 contains CPCH information to be used in the cell.

SIB10 : The system information block type 10 contains information to be used by UEs having their DCH controlled by a DRAC procedure.

SIB11 : The system information block type 11 contains measurement control information to be used in the cell.

SIB12 : The system information block type 12 contains measurement control information to be used in connected mode.

SIB13 : The system information block type 13 contains ANSI-41 system information.

SIB14 : Only for TDD

SIB15 : The system information block type 15 contains information useful for UE-based or UE-assisted positioning methods.

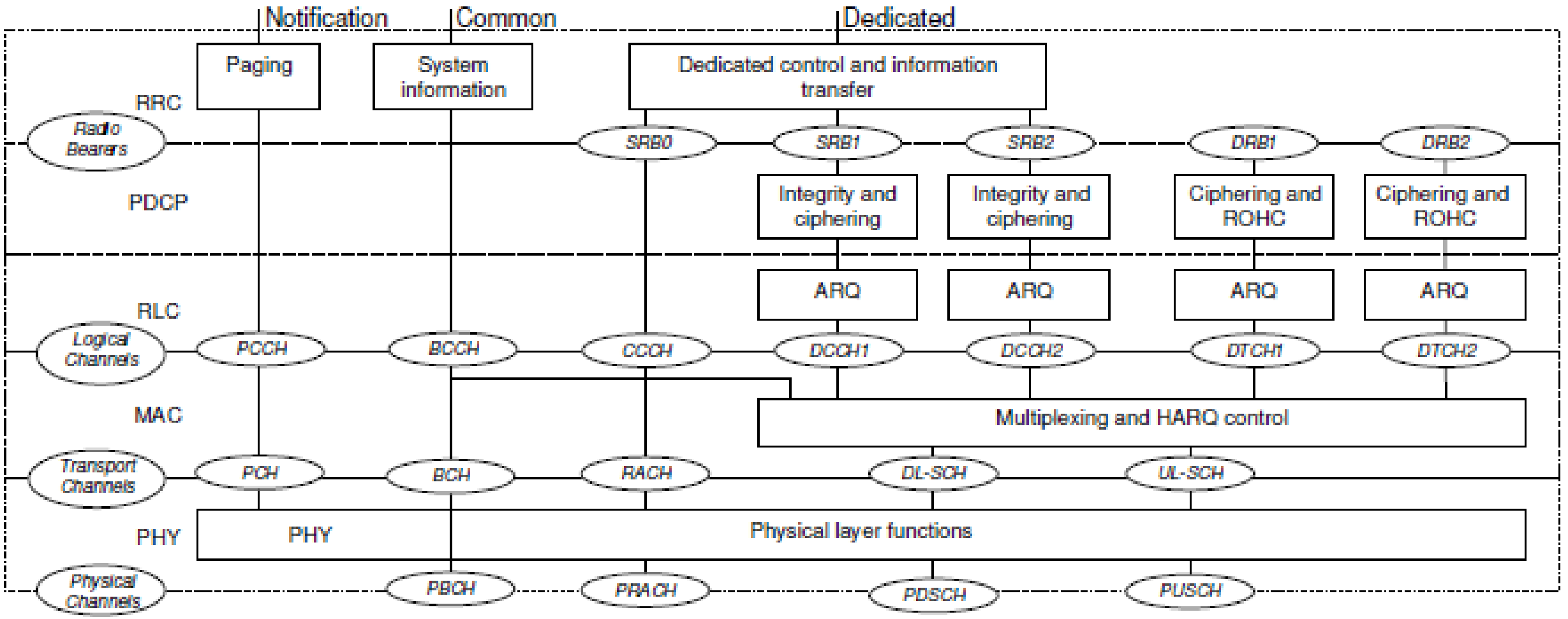
SIB16 : The system information block type 16 contains radio bearer, transport channel and physical channel parameters to be stored by UE in idle and connected mode for use during handover to UTRAN.

SIB17 : Only for TDD

SIB18 : The System Information Block type 18 contains PLMN identities of neighbouring cells to be considered in idle mode as well as in connected mode.

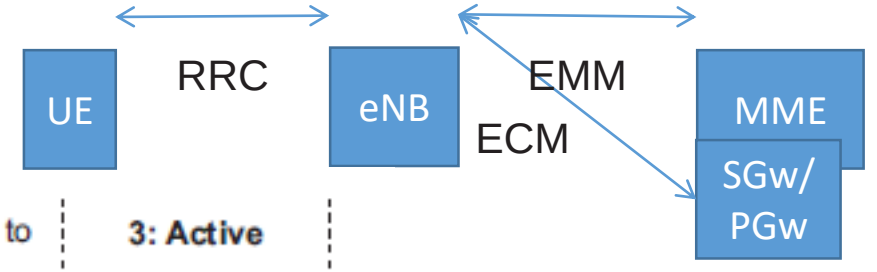
CONTROL PROTOCOLS

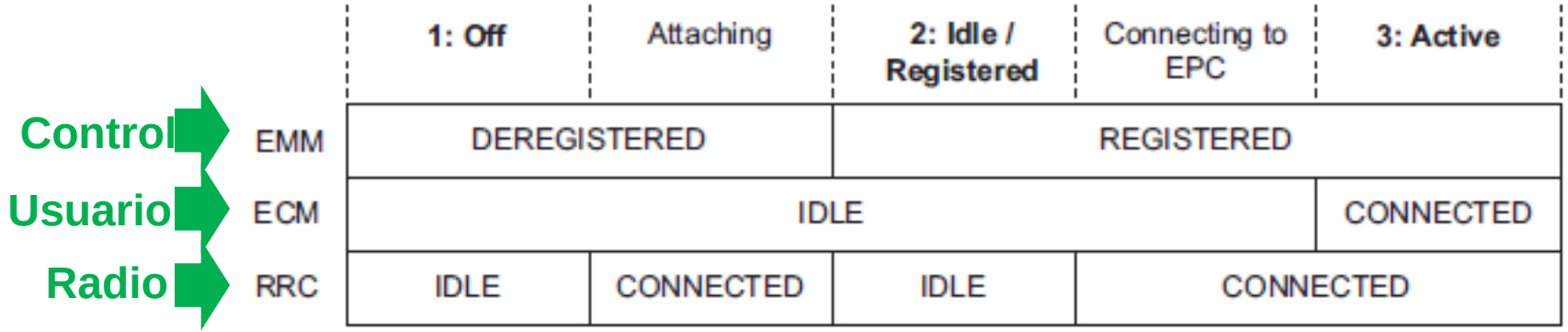
SIBs & Radio Architecture



CONNECTION MANAGEMENT EN LTE

Connection Establishment and Release





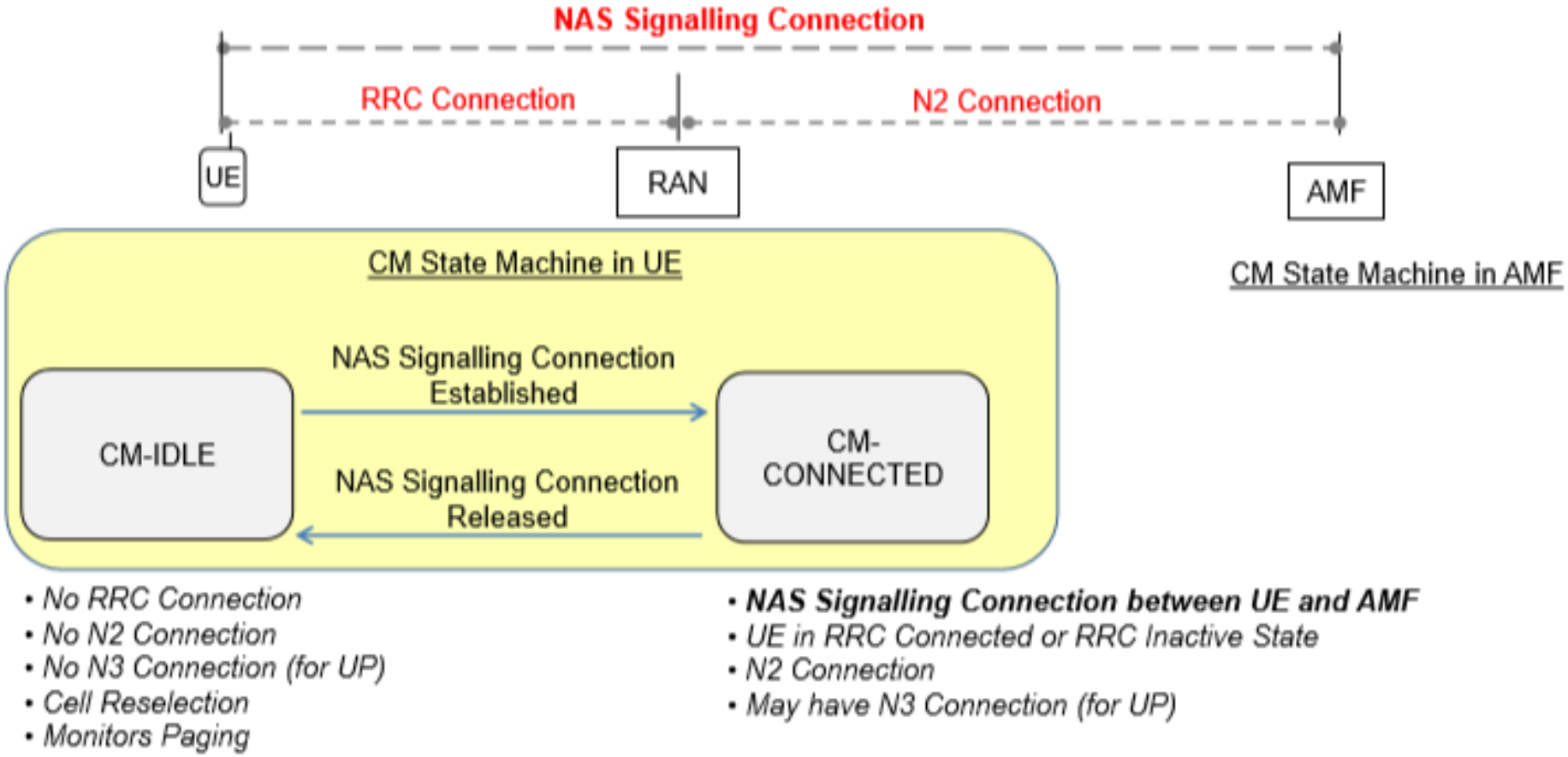
Two levels of NAS states reflect the state of a UE in respect of connection establishment:

The EPS Mobility Management (EMM) state (EMM-DEREGISTERED or EMMREGISTERED) reflects whether the UE is registered in the MME.

The EPS Connection Management (ECM) state (ECM-IDLE or ECM-CONNECTED) reflects the connectivity of the UE with the Evolved Packet Core.

Los UEs tipicamente estan en modo ECM-CONNECTED cuando están activos. El paso de ECM-IDLE a ECM-CONNECTED lleva unos 100 ms. Entonces, los terminals asociados a transmisiones intermitentes de datos no necesitan estar en ECM-CONNECTED si el servicio tolera ese delay. Estar en modo IDLE ahorra batería

CONNECTION MANAGEMENT (CM) EN 5G

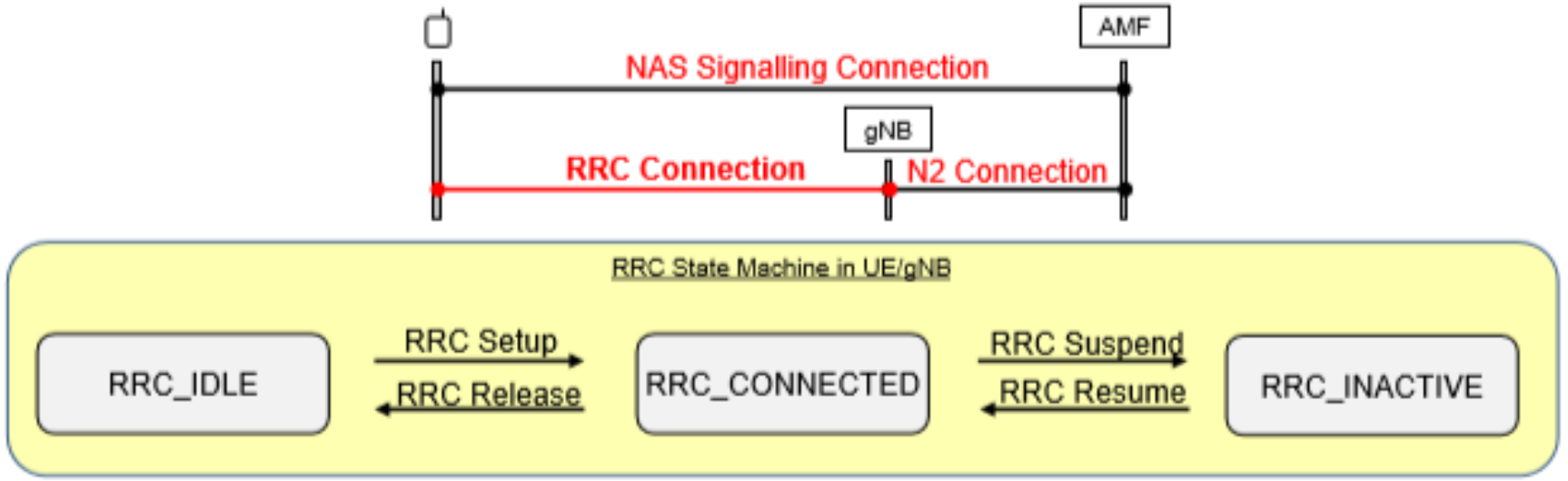


AMF admite dos estados CM para el UE

CM para accesos 3GPP

CM para accesos non-3GPPy

RADIO RESOURCE CONTROL (RRC) STATE EN 5G

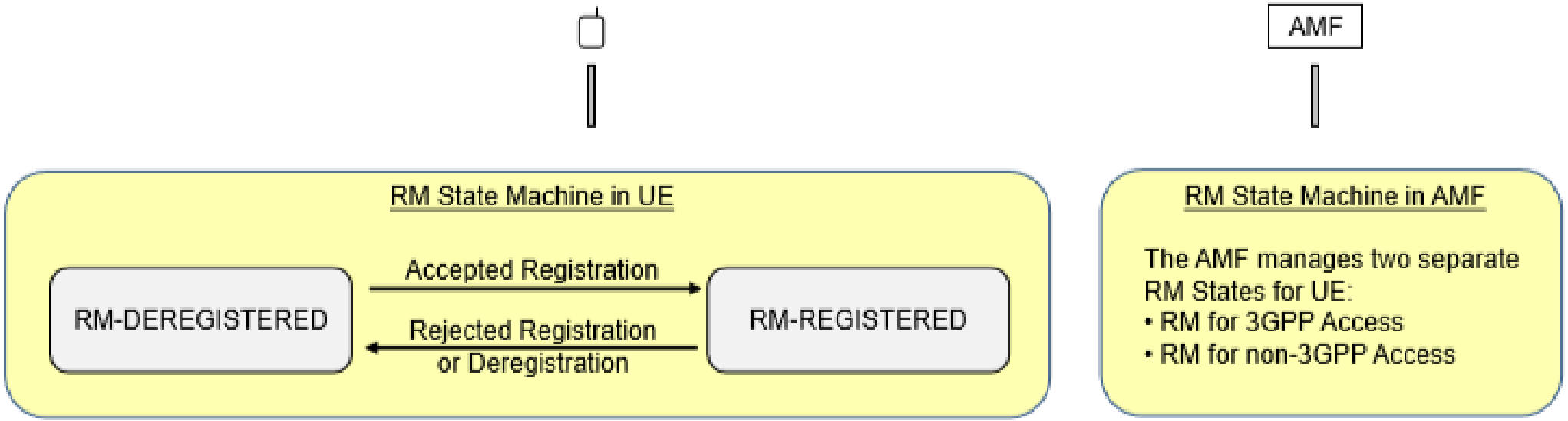


UE is not known in RAN
- *UE reads (and can request) System Information*
- *Cell re-selection by UE*
- *Tracking Area Update procedure if UE enters new TA*
- *Paging initiated by 5GC*
- *Paging area managed by 5GC*
- *DRX for CN paging configured by NAS*

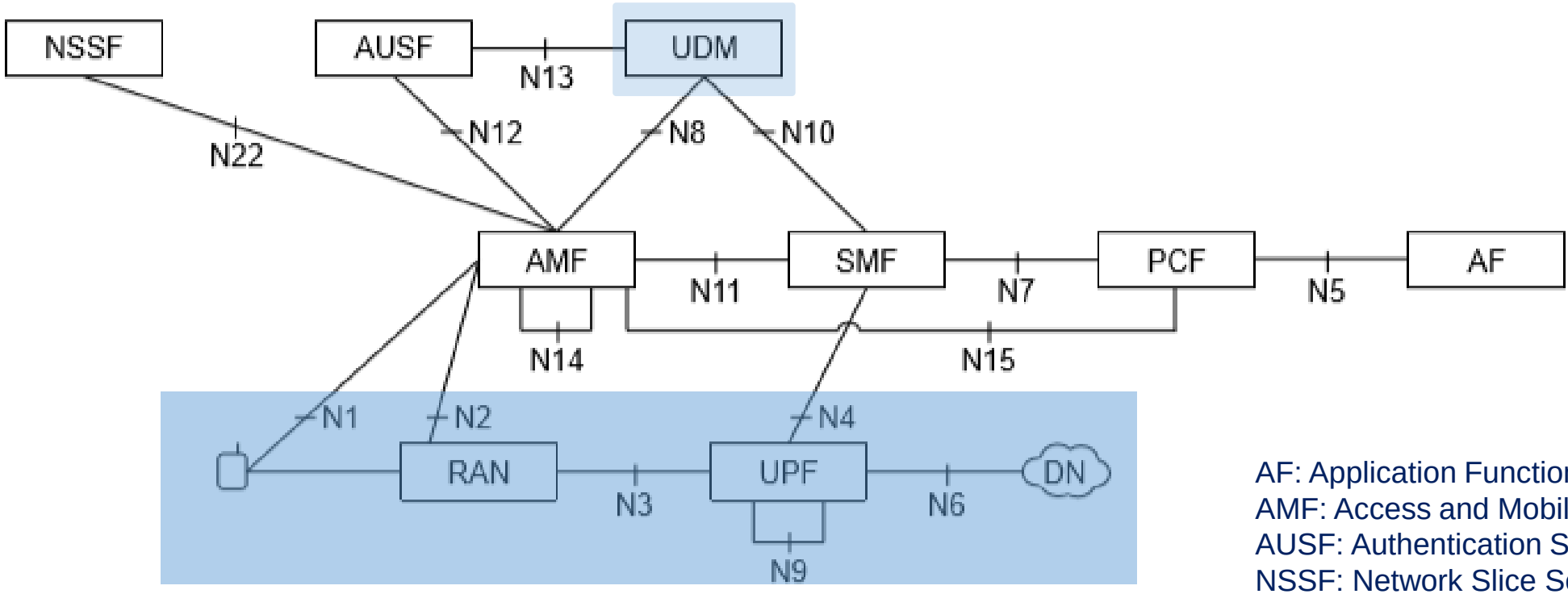
UE has an RRC connection
- *NG-RAN – 5GC connection (both C/U-planes) established for UE (CM-CONNECTED state)*
- *NG-RAN knows cell which the UE belongs to*
- *Transfer of UP data to/from the UE*
- *Network controlled mobility including measurements*
- *Cell level mobility (Handovers) or Beam level mobility*

UE AS context is stored in at least one gNB (last serving) and UE
- *NG-RAN – 5GC connection (both C/U-planes) established for UE*
- *RAN-based notification area (RNA) managed by NG-RAN*
- *UE reads (and can request) System Information*
- *Cell re-selection by UE → RNA Update procedure if UE enters new RNA*
- *Paging initiated by NG-RAN (RAN paging)*
- *DRX for RAN paging configured by NG-RAN*

REGISTRATION MANAGEMENT EN 5G

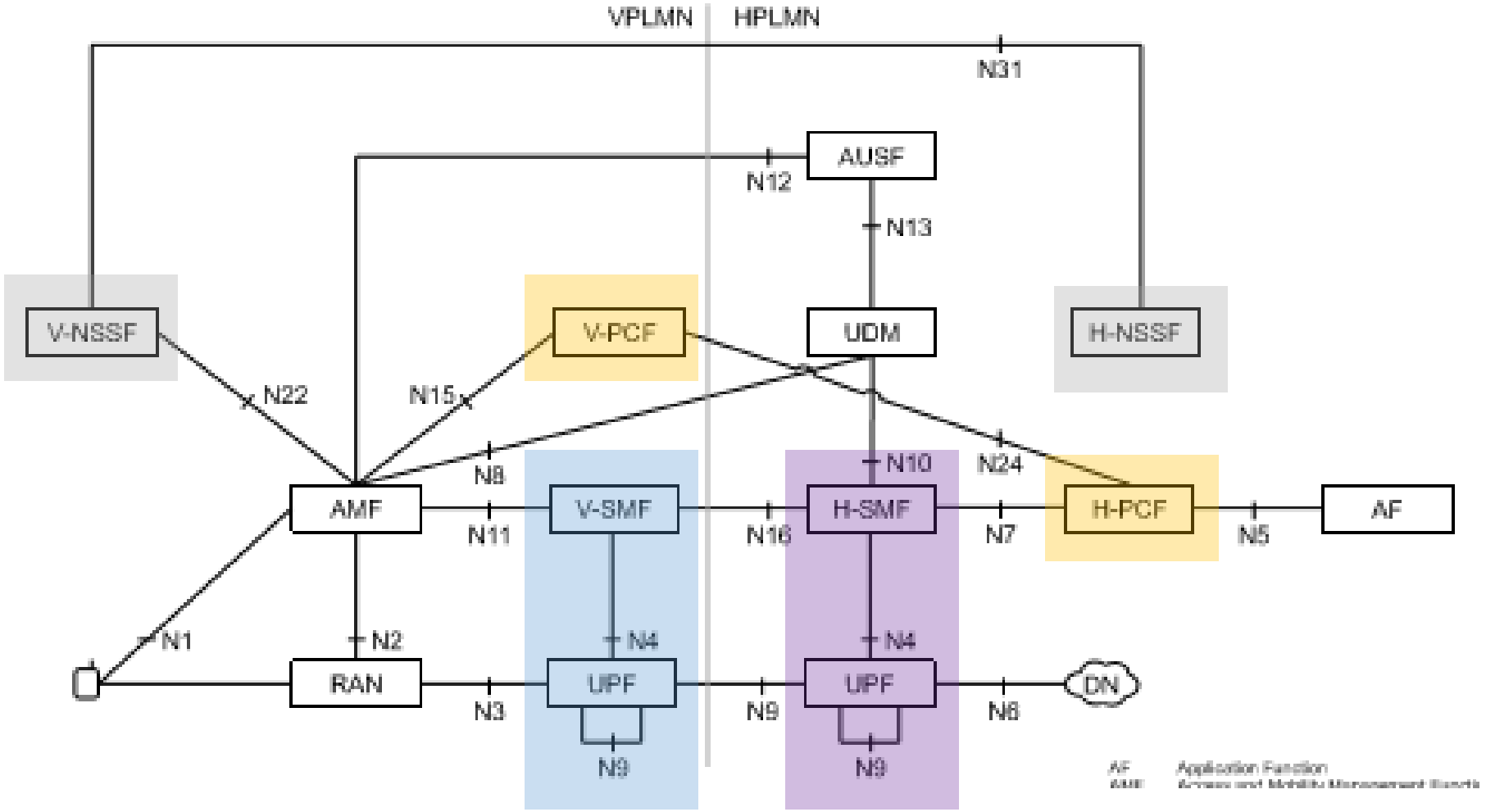


5G REPRESENTACIÓN DE PUNTOS DE REFERENCIA

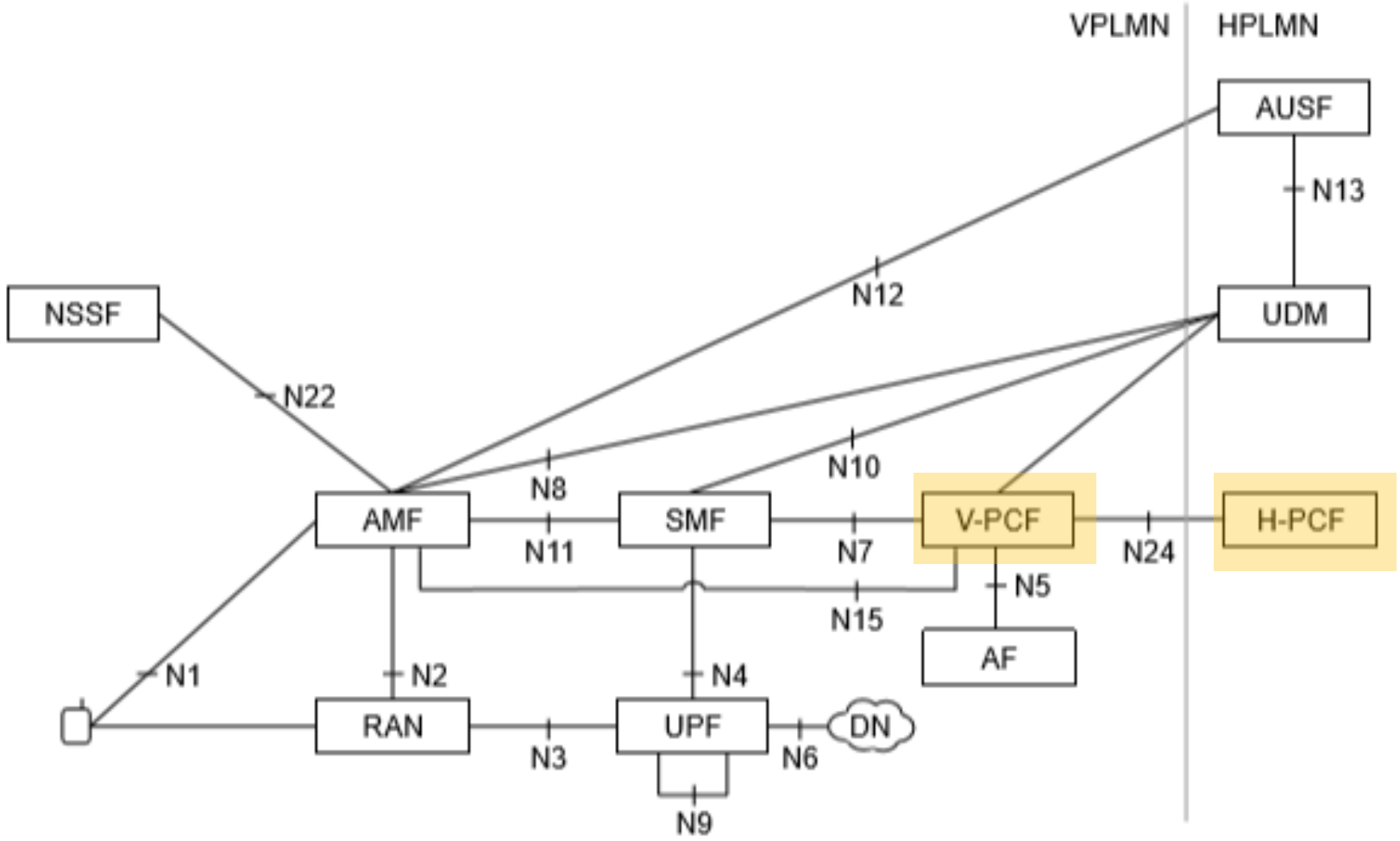


AF: Application Function
AMF: Access and Mobility Management Function
AUSF: Authentication Server Function
NSSF: Network Slice Selection Function
PCF: Policy Control Function
RAN: Radio Access Network
SMF: Session Management Function
UDM: Unified Data Management
UPF: User Plane Function

5G REPRESENTACIÓN DE PUNTOS DE REFERENCIA, HOME ROUTING

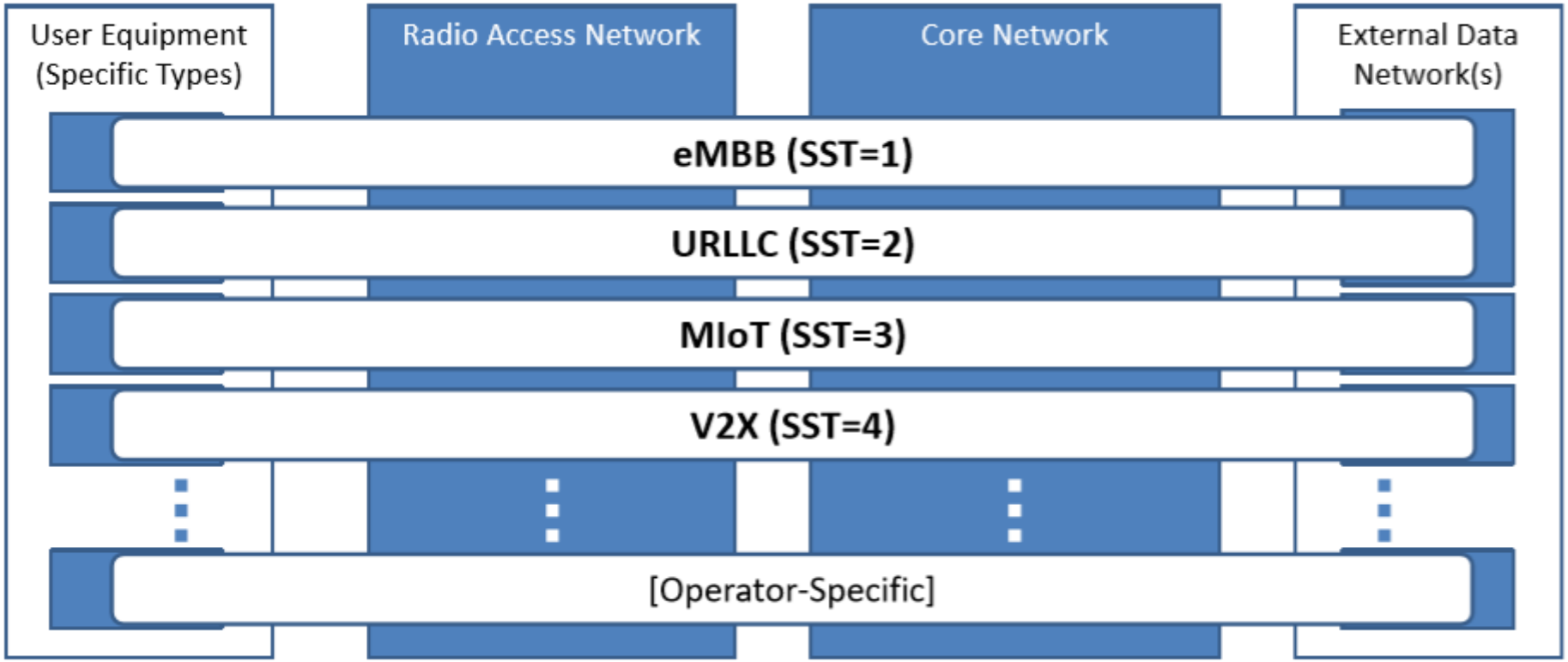


5G REPRESENTACIÓN DE PUNTOS DE REFERENCIA, LOCAL BREAKOUT



NETWORK SLICING

5G NETWORK SLICING



Referencia 3GPP TS 23.501 V16.1.0 (2019-06)

NETWORK SLICING

slice management functions

Full automation of network slice management, NFV Management & Orchestration functions (NFV-MANO) need to be complemented and interwork with slice management functions.

Operation Support System

Slice management could be regarded as a particular Operations Support System (OSS) functional area which needs to be standardized on top of NFV. This includes specifying a mechanism for mapping network slice requirements onto Network Services capabilities.

Network slice as a logical network

According to 3GPP, a Network slice is a logical network serving a defined business purpose or customer, consisting of all required network resources configured together.

NETWORK SLICING

La primera clasificación que surge al considerer un mecanismo que ofrezca una porción de la red de acuerdo al tipo de servicio (eso es en esencia el Network Slicing), es pensar justamente en las tres categorías de servicios:
eMBB (Enhanced Mobie Bradband), URLLC (Ultra-Reliable Low Latency Communication), y mMTC (Massive Machine Type Communication)

SST = 1, eMBB (enhanced Mobile Broadband)
Slice suitable for the handling of 5G enhanced Mobile broadband, useful, but not limited to the general consumer space mobile broadband applications including streaming of High Quality Video, Fast large file transfers etc. It is expected this SST to aim at supporting high data rates and high traffic densities as outlined in Table 7.1-1 "Performance requirements for high data rate and traffic density scenarios" in TS 22.261

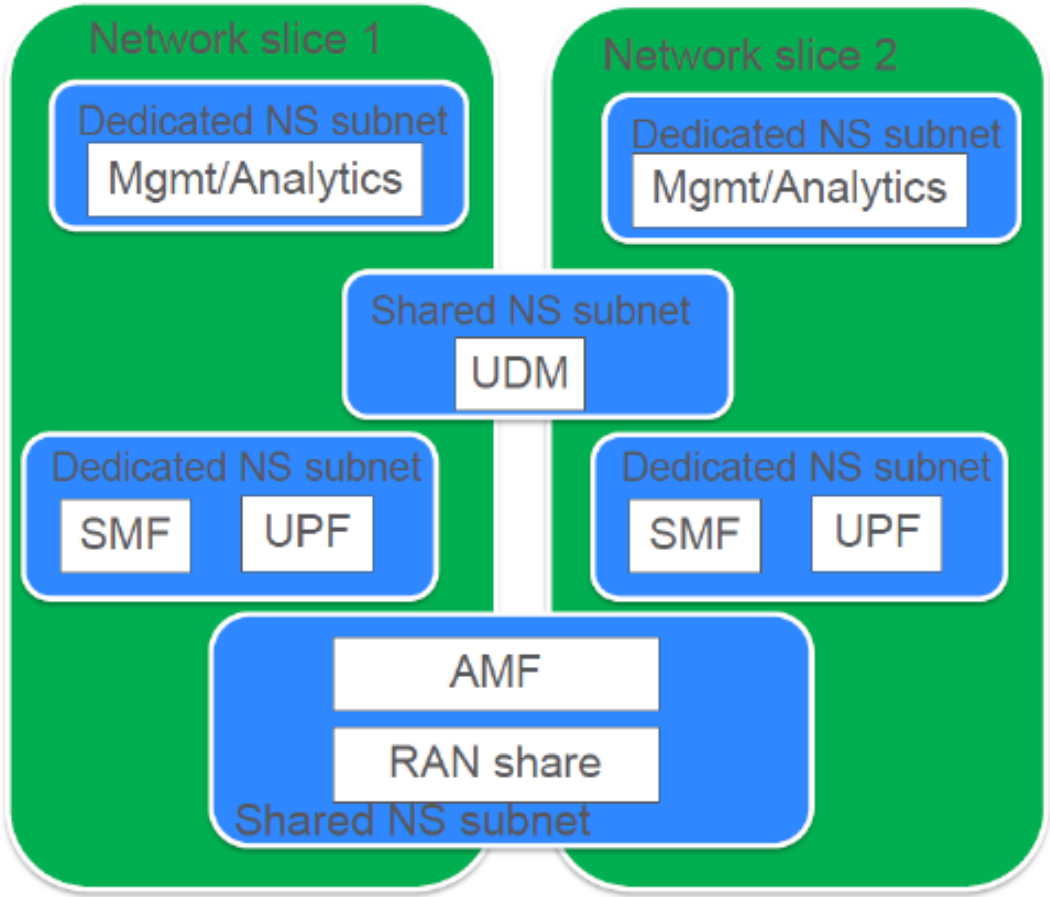
SST = 2, URLLC (Ultra-Reliable Low Latency Communication)
Supporting ultra-reliable low latency communications for applications including, industrial automation, (remote) control systems. This SST is expected to aim at supporting the requirements in Table 7.2.2-1 "Performance requirements for low-latency and high-reliability services." in TS 22.261 related to high reliability and low latency scenarios

SST = 3, MIoT (Massive IoT), mMTC (massive Machine Type Communication)
Allowing the support of a large number and high density of IoT devices efficiently and cost effectively.

Characteristics of Network Slicing

- 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

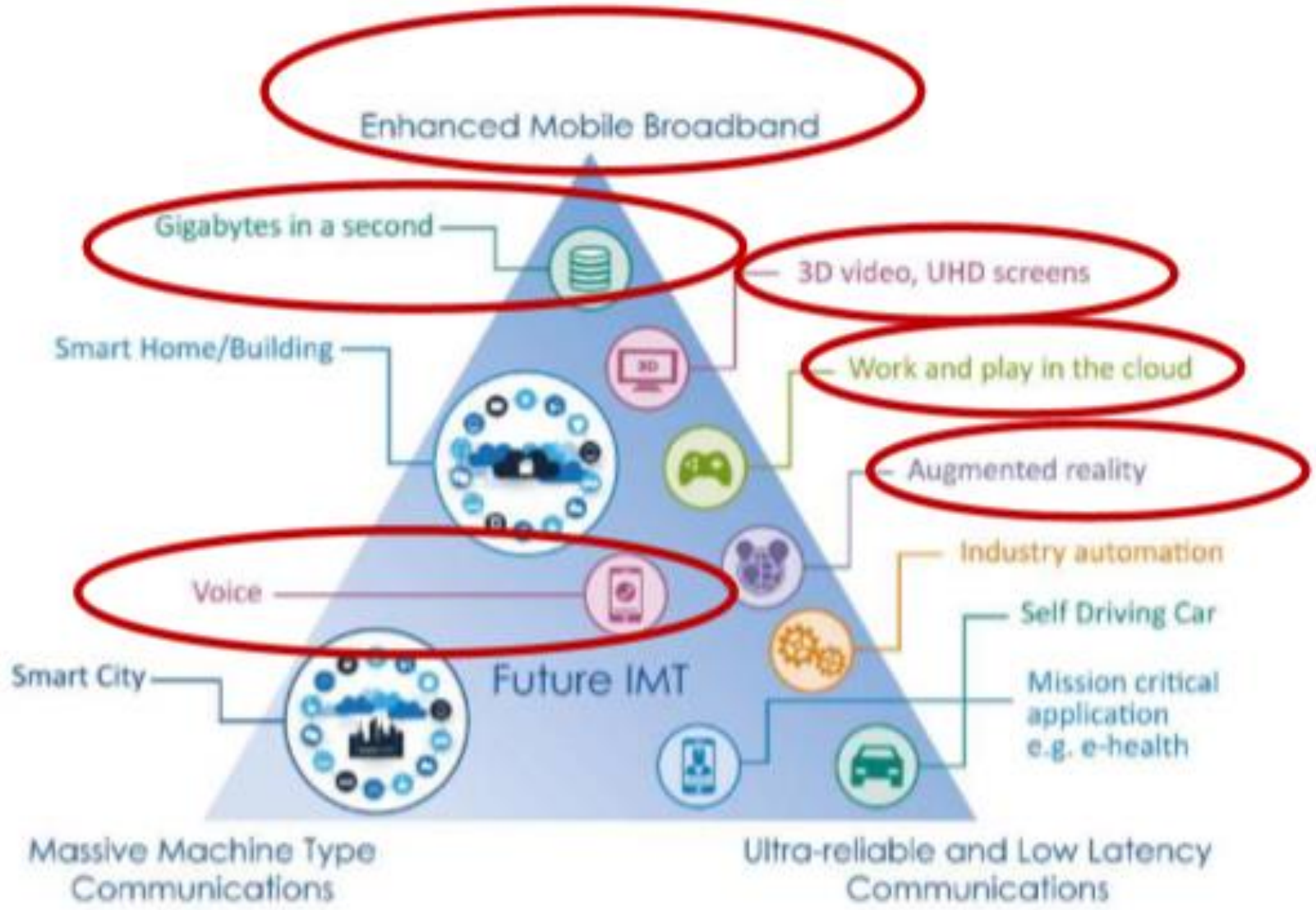
NETWORK SLICING SUBNET



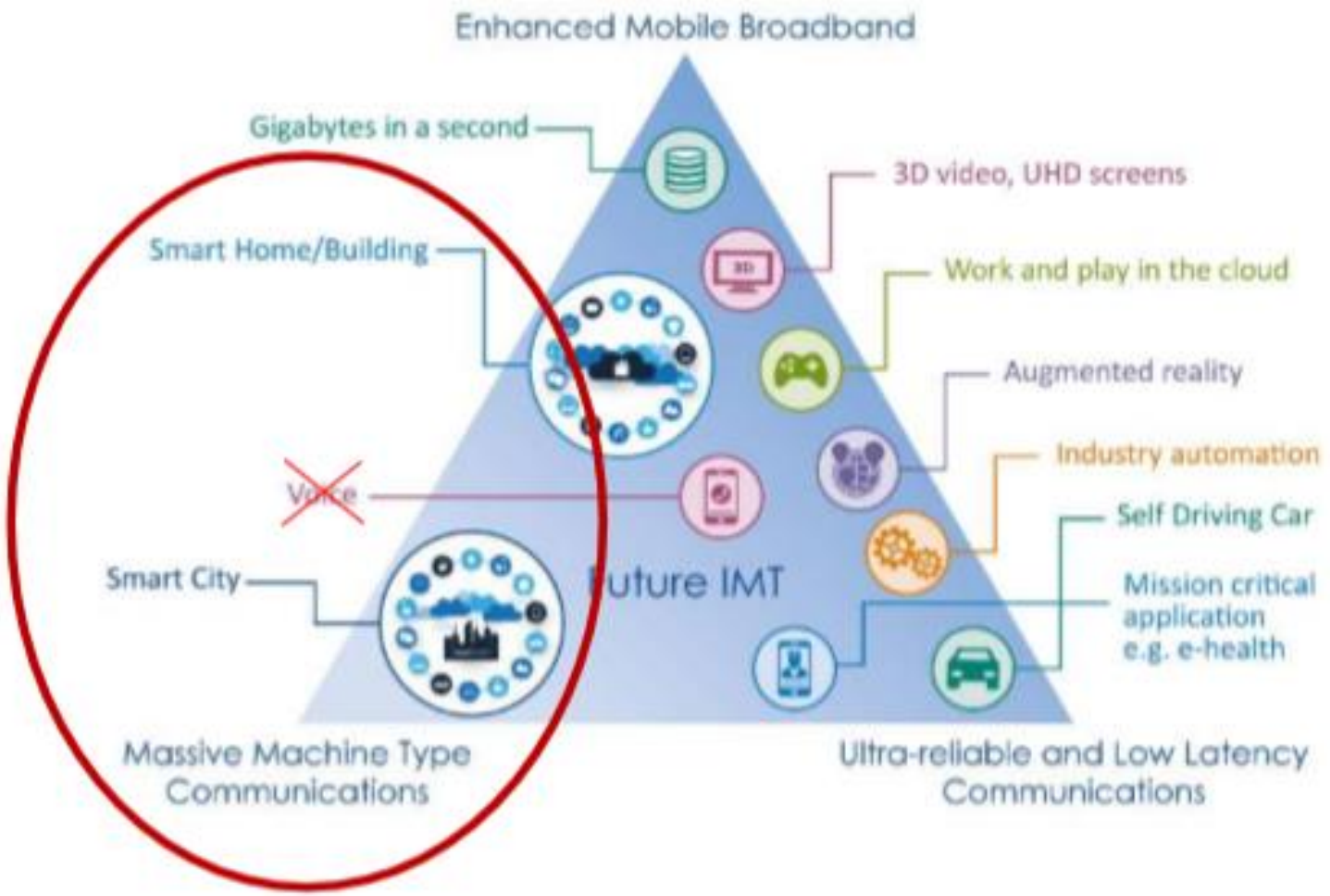
Network slice subnet is a constituting part of one or several network slices, consisting of a set of network resources configured together. It is created, changed and removed by management functions.

- Unlike network slices, network slice subnets do not serve a business purpose of their own, only as a member of a network slice
- Network slice subnets can be dedicated to a network slice or shared by several
- Network slice subnets may have other network slice subnets as its constituting parts
- Network slice subnets are formed because there is a need to life cycle them as a separate entity, or to enable sharing of network functions across network slices

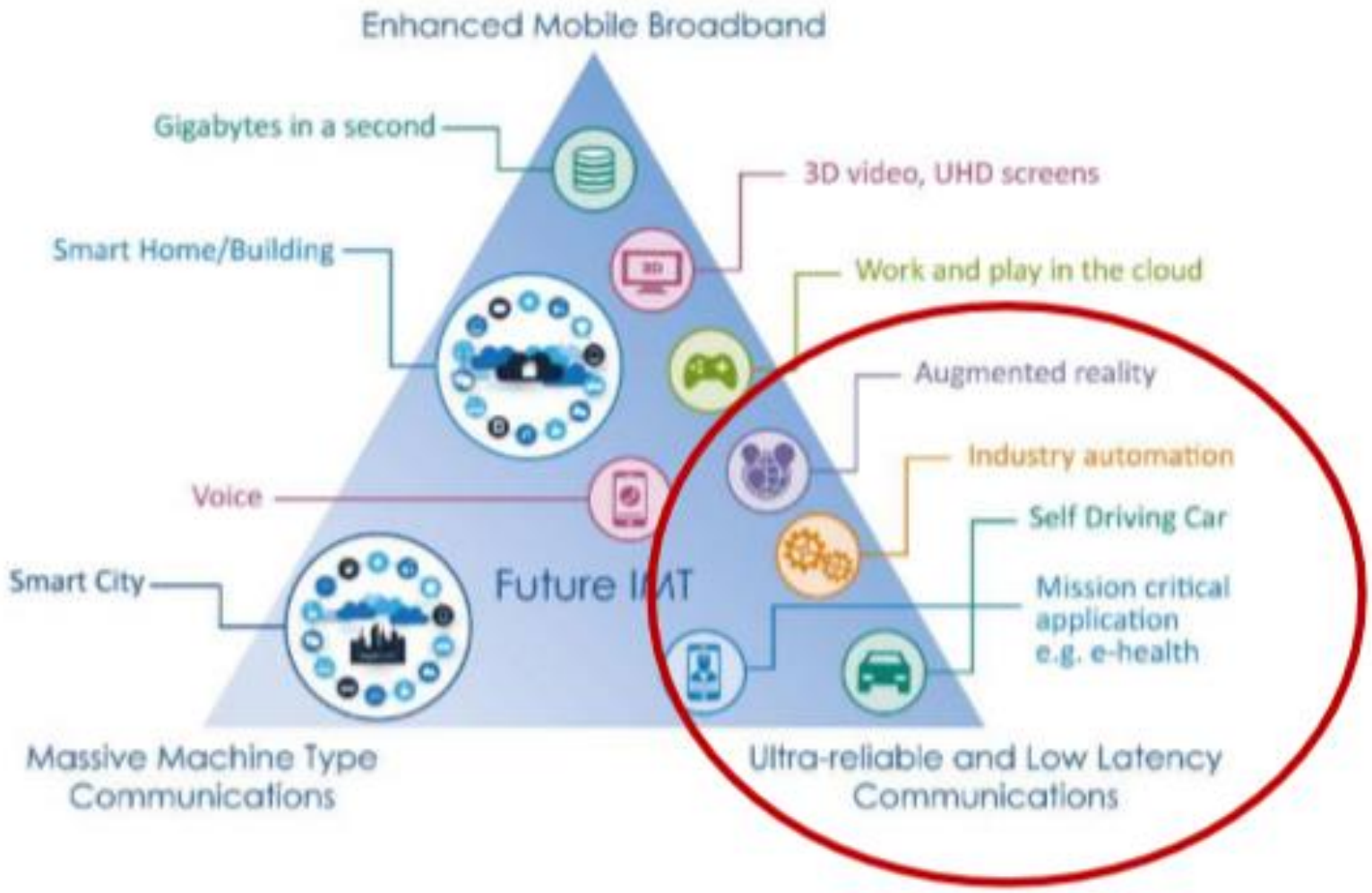
NETWORK SLICING - eMBB



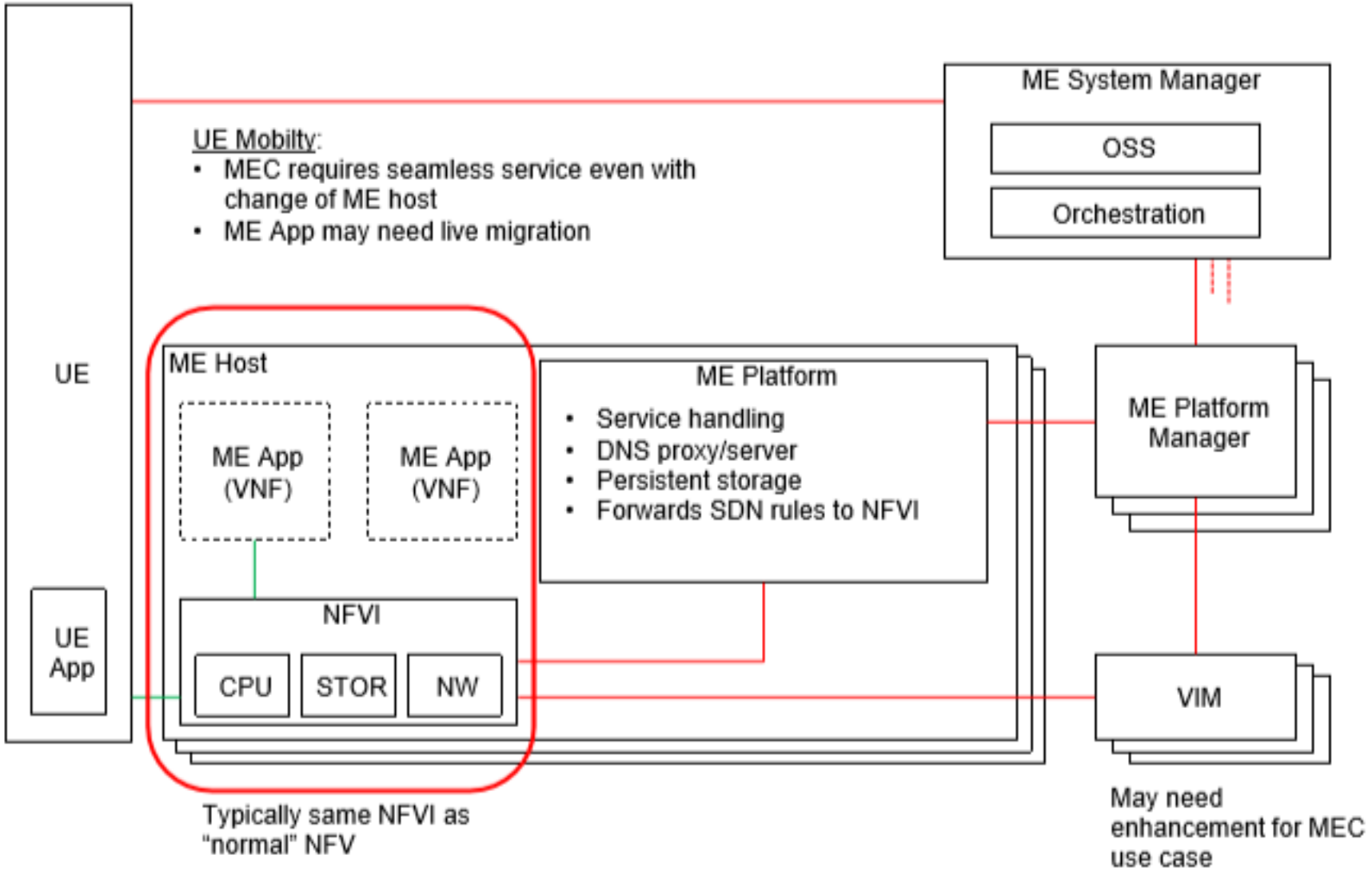
NETWORK SLICING - mMTC



NETWORK SLICING – Ultra-Reliable and Low Latency Communication

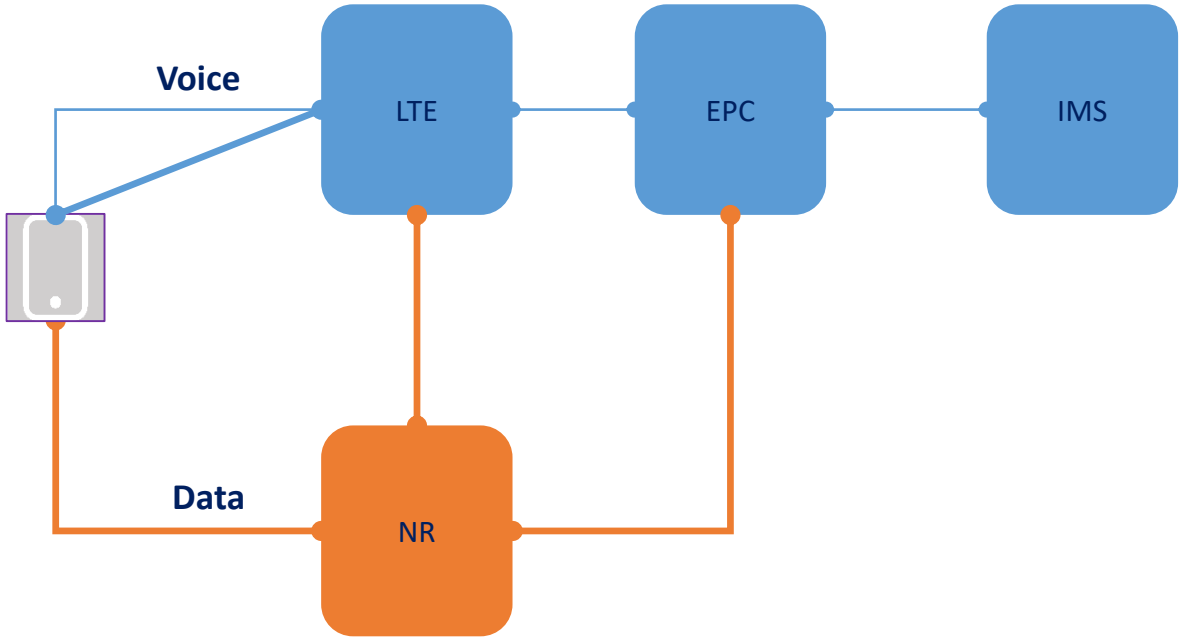


MEC (Mobile Edge Computing)



VOICE STEPS IN 5G

Step 1: EN-DC - Option 3x



Service Continuity:

- Standard 4G VoLTE behavior.
- Standard SRVCC.
- Standard CSFB.

Availability:

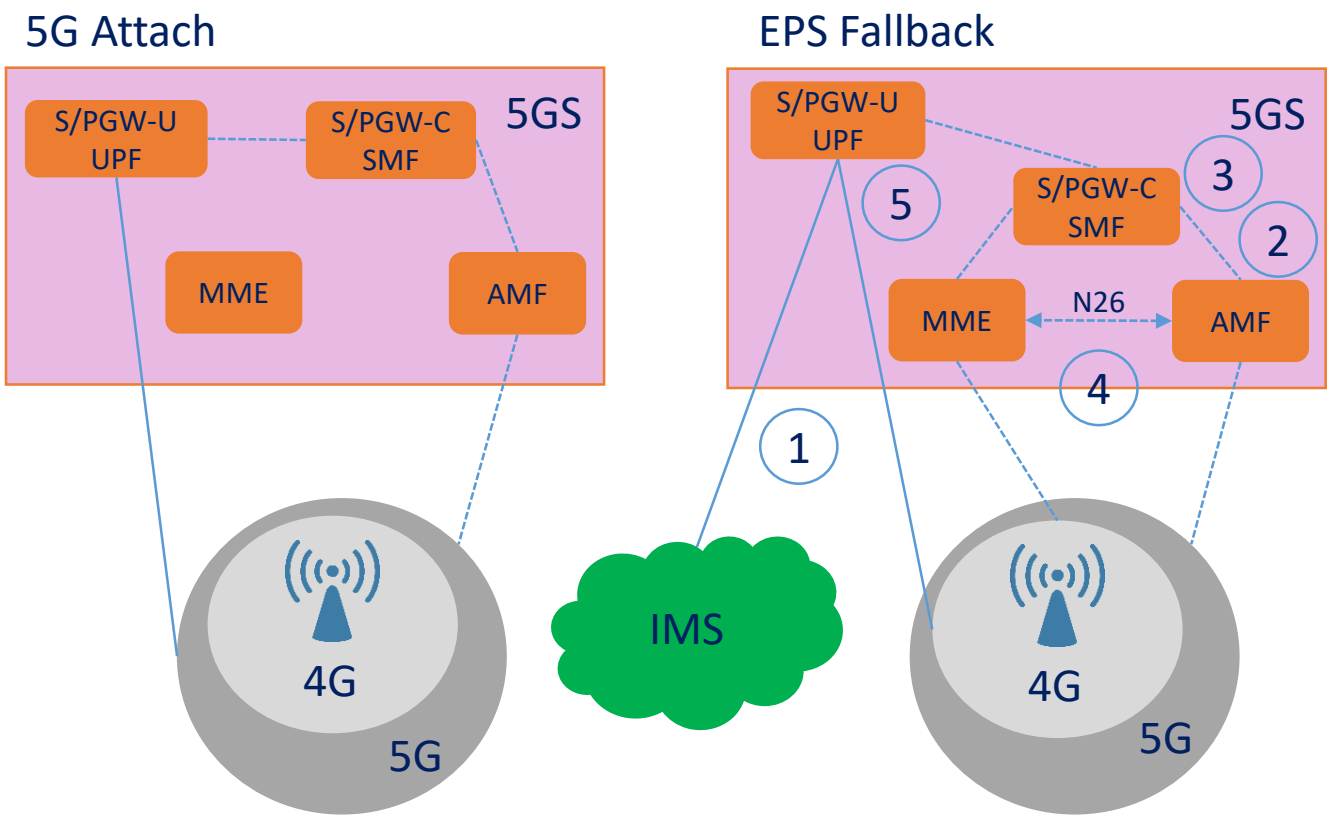
- IMS: GA.
- RAN: GA.
- Core: GA.
- Terminals: GA.

Considerations:

- NSA scenarios.
- Voice in LTE (VoLTE), while NR is used as data boost.
- IMS is not aware, there is no impact.

VOICE STEPS IN 5G

Step 2: EPS Fallback – phase 1 for Option 2



Considerations:

- First SA scenarios.
- New radio is used mainly for data, but during call establishment, both data and voice go to 4G.
- IMS is impacted in terms of parametrization (SW upgrades).

Process

1) IMS voice session establishment and QoS are initiated.
2) Network initiated a PDU session modification to setup QoS with PCF and cancelled it because of a RAN trigger of doing EPS Fallback.
3) RAN release: RAT change and inform to PCF.
4) AMF passes the session to MME towards N26 interface.
5) The session is anchored in S/PGW-U+UPF. The mapping of QoS flow characteristics between 5G and 4G is done by S/PWG-C+SMF.

Service Continuity:

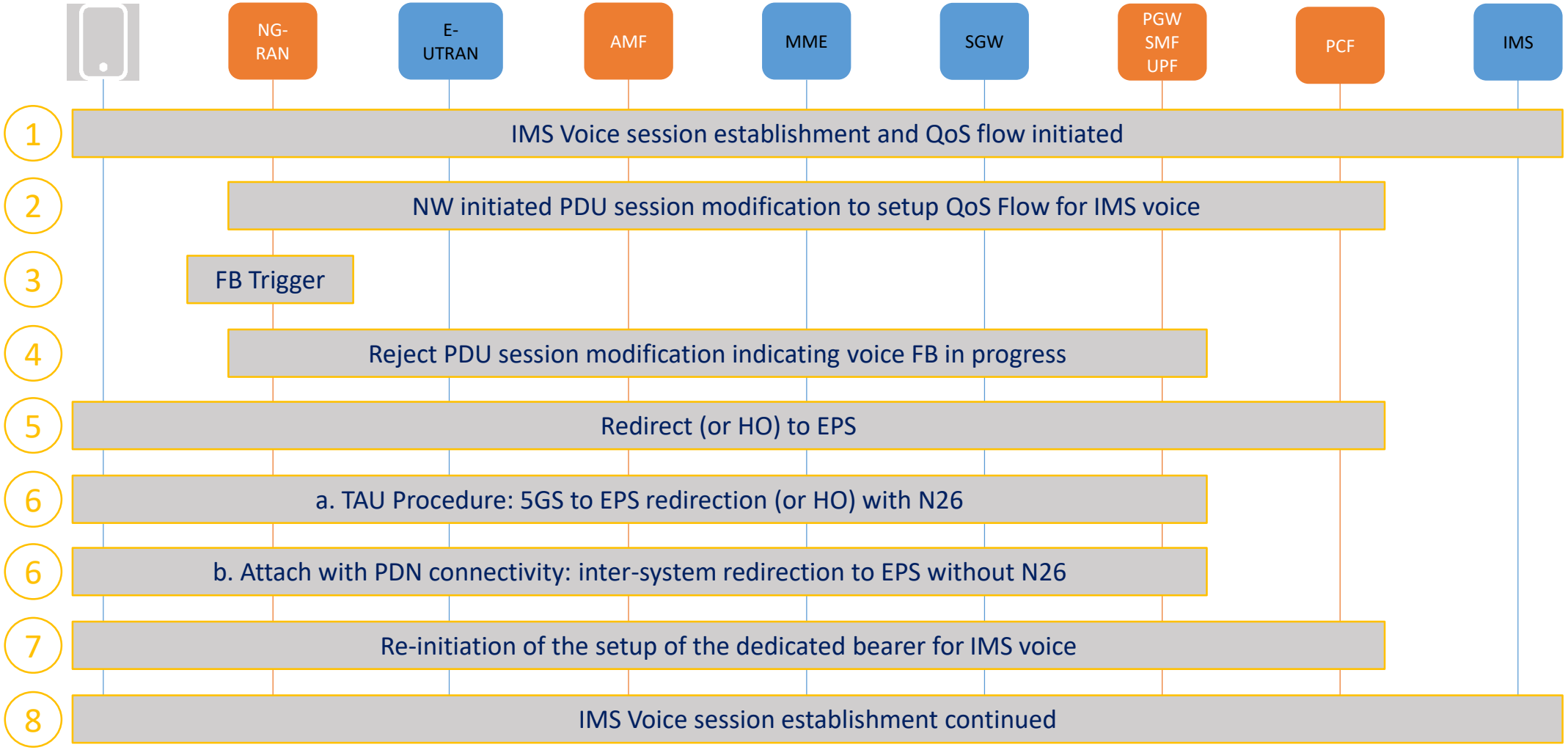
- Standard SRVCC.
- CSFB could not be done during EPS Fallback. This means need to have VoLTE totally performant on the same coverage

Conclusions:

- It is mandatory for vendors to support N26 interface or combo element MME+AMF.
- It is mandatory for vendors to have both combo elements S/PGW-U+UPF and S/PGW-C+SMF.
- RAN and terminals dependency.

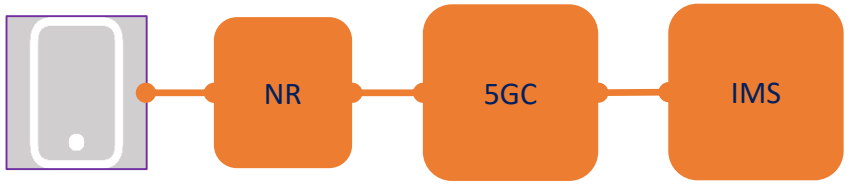
VOICE STEPS IN 5G

Standard Call Flow



VOICE STEPS IN 5G

Step 3: VoNR - phase 2 for Option 2



Considerations:

- Objective SA scenarios.
- Voice and Data go through NR.
- IMS is impacted to support NR/5GC registration.
- NR has to be dimensioned for VoNR usage.
- Terminals have to be ready for VoNR usage.

Availability:

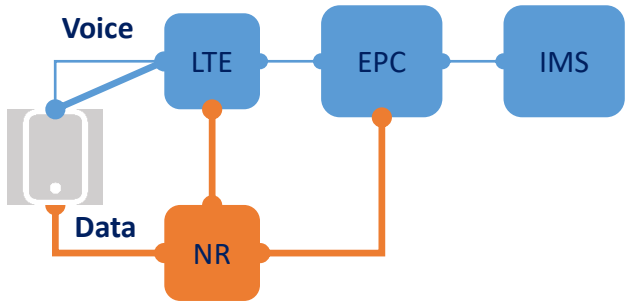
- IMS: Q2 2019.
- RAN: Q2 2020.
- Core: Q2 2020.
- Terminals: Q1 2020.

Service Continuity

- When there is lost of coverage, IRAT HO is done to move data and voice to 4G, similar to a standard HO nowadays.
- SRVCC directly from 5G to 3G is being standardized in release 16.
- CSFB directly from 5G to 3G is not going to be standardized.
- There is the same dependency as EPS Fallback with combo elements and N26 interface.

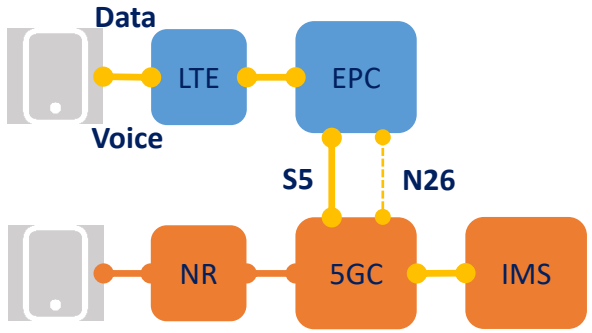
Summary of Steps

EN-DC



- NSA scenarios: option 3x.
- Voice in LTE (VoLTE), while NR is used as data boost.
- IMS is not aware, there is no impact.
- Codecs are also the same as VoLTE.

EPS Fallback



- First SA scenarios: option 2.
- New radio is used mainly for Data, but during call establishment, both Data and Voice go to 4G.
- IMS is impacted in terms of parametrization.
- Codecs are also the same as VoLTE.

VoNR

- Objective SA scenarios: option 2.
- Voice and Data go through NR.
- IMS is impacted to support NR/5GC registration.
- NR has to be dimensioned for voice usage.
- Use of EVS codec is mandatory.

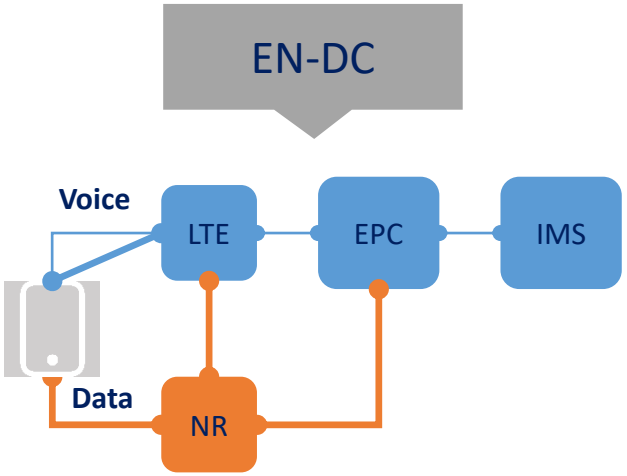
VOICE STEPS IN 5G

Terminals roadmap

	Date
Option 3x	Q2 2019
Option 2	Q2 2020

- No details on voice support by OEM on those options yet.
- Specific questionnaire with several scenarios was sent to OEM in accordance to Telefónica strategy for 5GC. Responses are estimated for September.
- This aspect is critical to assess which voice option should Telefónica implement first i.e. EPS Fallback or directly VoNR.
- Apparently, there would be devices supporting the three voice scenarios covered (EN-DC, EPS FB & VoNR) coexisting in the same time and network might need to support all.

Summary



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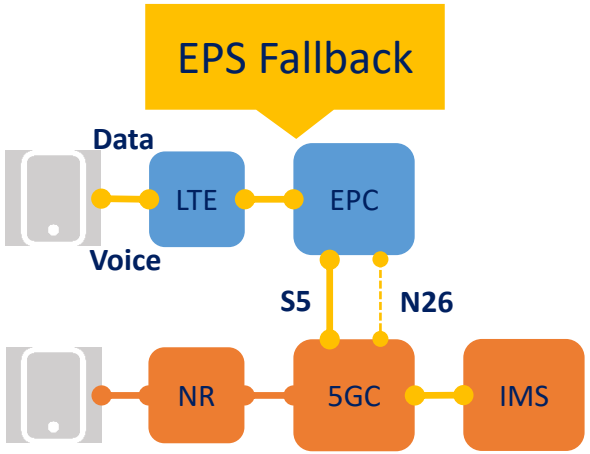
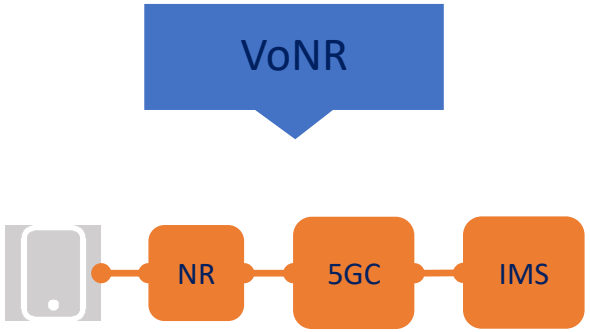
- Codecs are also the same as VoLTE.



- First SA scenarios: option 2.
- New radio is used mainly for Data, but during call establishment, both Data and Voice go to 4G.
- IMS is impacted in terms of parametrization.
- Codecs are also the same as VoLTE.



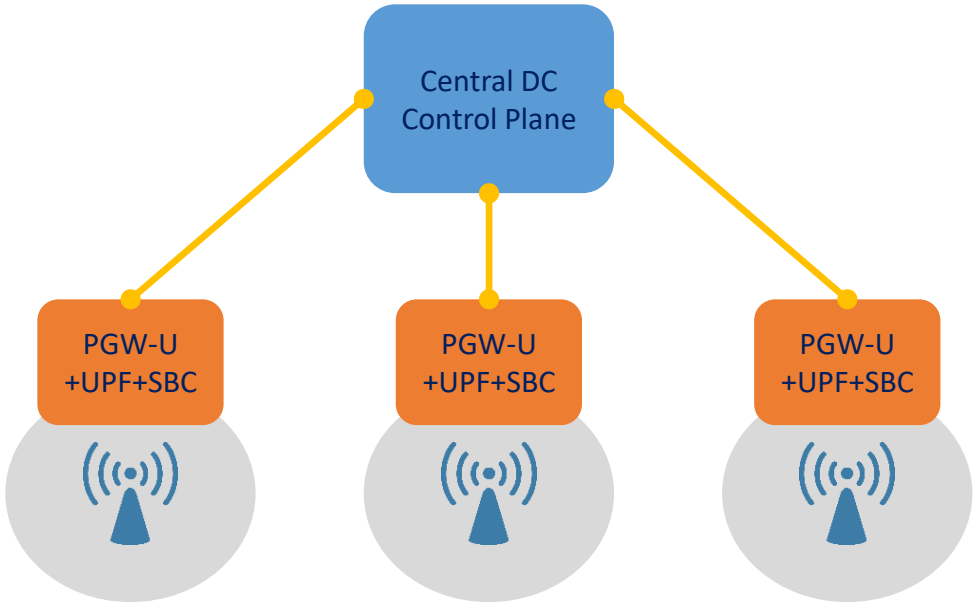
- Objective SA scenarios: option 2.
- Voice and Data go through NR.
- IMS is impacted to support NR/5GC registration.
- NR has to be dimensioned for voice usage.
- Use of EVS codec is mandated by standard, AMR optional.

- Operartors should go directly to VoNR – as much as possible- if RAN and OEM are ready by mid 2020, pushing Nokia and the OEM.
- Apparently, there might be simultaneously devices that support all these three scenarios – this is yet under investigation.
- For EPS fallback to work properly, Telefónica needs to assure that VoLTE is deployed in the same areas we provide 5G coverage. Until 5G SRVCC is standardized , for securing VoNR seamless mobility to 4G and 3G/2G we need also VoLTE coverage.
- For VoNR, Telefónica needs to push AMR support mandatorily de facto in all devices supporting EVS to avoid transcoding.

NEW MULTIMEDIA SERVICES

AR/VR

- IMS Sessions for Augmented Reality and Virtual Reality services such as online courses, remote professional assistance (e.g. car repair, drone control), virtual meetings, gaming.
- Architecture:
  - Bring the media as close as possible to the RAN.
  - Rendering and transcoding closer than media anchoring and stream, if possible.
  - Control plane in central DC.
  - This brings having a SBC in the same nodes where we have a PGW-U+UPF (all media together).



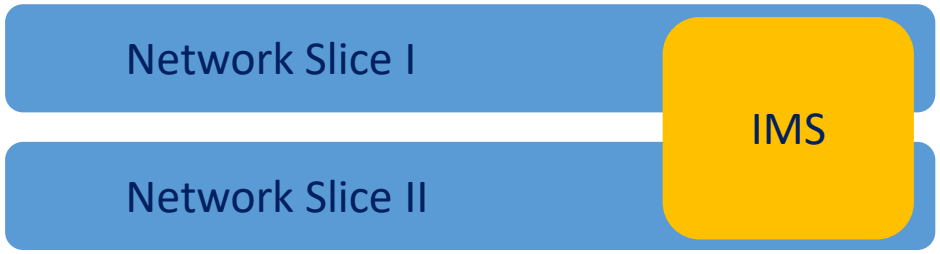
- Media SBC impact: more BW.
- Split SBC mandatory in Signalling and Media.
- New codecs will require to scale our platforms:
  - EVS and H.265 are mandatory for VoNR → Need to avoid transcoding.
- AR/VR is not ready and under standardization, vendor's answer are TBD or 2022.

- AR/VR: under evaluation by vendor. Different options:
  - New MTAS – ZTE.
  - Specific AS – Mavenir.
  - Specific Platform – Nokia.
  - No changes – Ericsson & Mavenir
    - ViLTE/ViNR. With QCI=1 for audio, QCI=7 for video and QCI=8 or 9 for sharing.

IMS LONG TERM

Slicing

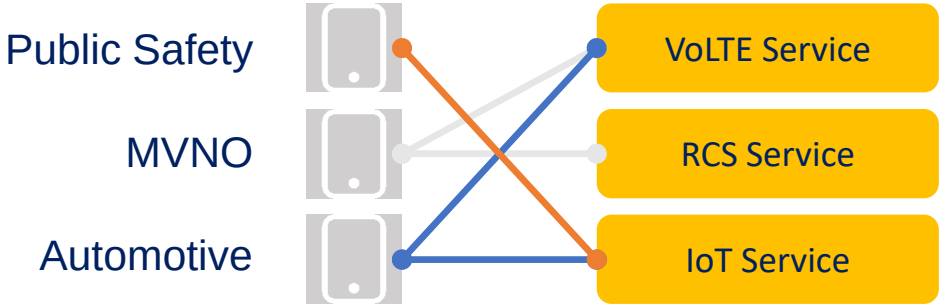
Common IMS across Network Slices



- Independently of the network slice, IMS is always the same.
- CSCF will know which services to “apply”.
- Customer Category based:

IMS Slices

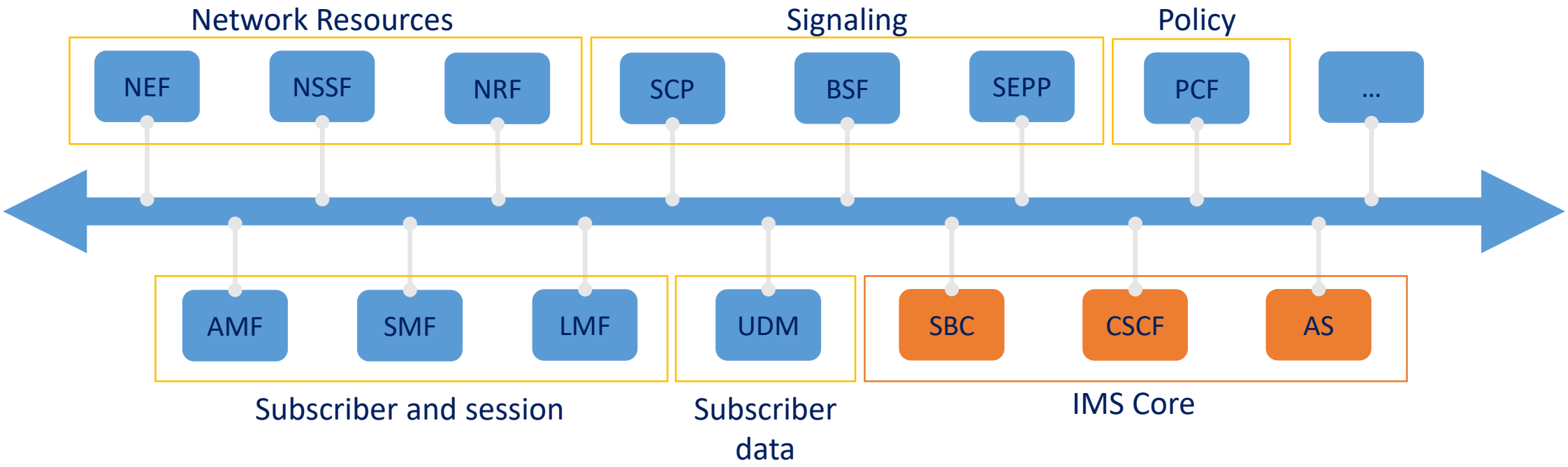
- One network slice could access different IMS slices.
- Different network slices could access one IMS slice.
- Service based:



In case of standardization, IMS Slicing will be available at the same time of SBA Architecture for IMS: 2021.

IMS LONG TERM

- Including IMS in SBA architecture is a candidate for 3GPP release 17.



- Diameter will change to HTTPv2 and SIP will remain.
- It is not clear if it is going to be applied and when (standardization has not started yet).
- CUPS: there will be an split in SBC and AS in control and user plane, a standard interface between them must be defined.

IMS SUMMARY Key take away from suppliers

1
- Early deployments with option 3x will use standard 4G VoLTE.
- For SA option 2 first deployments, EPS Fallback is expected before VoNR because of NG RAN limitations/availability.

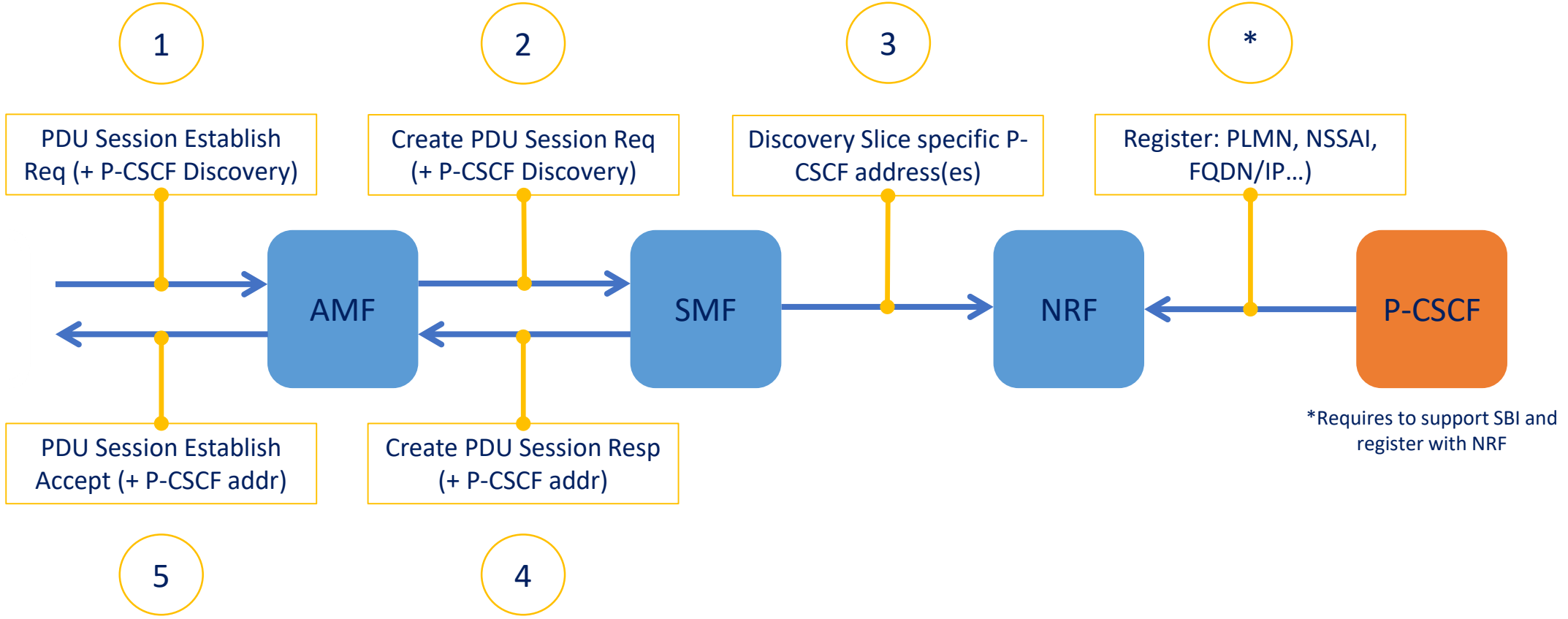
2
- To have a perfect service for VoNR, and also EPS Fallback, is mandatory to have VoLTE working properly in at least the same area of coverage than 5G .
- Also, interfaces N26 and S5 and having a Common Core (UPF+S/PGW-U and SMF+S/PGW-C) are mandated to have service continuity.
- CSFB in 5G is not defined, USSD service will not be possible for UEs attached to 5G.

3
- IMS slicing is proposal for being defined in 3GPP Rel17. There are two possibilities: integrating the whole IMS or make it by specific service.

4
- New multimedia services such as AR/VR are recently included in standards, so there is no clear support for them.
- New kind of codecs and protocols (mandatory EVS and H.265): need to scale our platforms to support them and minimize transcoding.

5
- Different approaches, but is a clear trend to distribute further media processing close to the edge.
- Integration of IMS in SBA is a WI for 3GPP Rel17 so there is no a clear approach at this stage.

P-CSCF Discovery



RESUMEN 5G N2

TEMARIO 5G N2

MODULO 1
Arquitectura de la red de Red de Acceso.
Protocolos: Capa física, MAC, RLC, PDCP, Capas altas.
Ancho de banda asociado a cada capa.
Modelo de Centralización y de Distribución.
CPRI.

MODULO 2
Arquitectura del Núcleo en redes SA
Concepto de Slicing
Entidades, Interfaces protocolos.
Overlay 5GC con EPC

MODULO 3
La red de transporte en 5G.
Requerimientos de ancho de banda.
Requerimientos de latencia. TSN.
Desagregación de la Red de Acceso.

MODULO 4
Open RAN
Arquitectura.
Modelo
Casos y desafíos

REQUERIMIENTOS Y ESTRATEGIAS

Transporte y backahul

Midhaul

- Cambio de arquitectura
- Desagregación
- Anillos de agregacion entre DU y CU

Fronthaul

- Crecimiento de datos
- Latencia
- Escalabilidad
- Densificación de RAN
- Micro celdas
- Cloud RAN.

eCPRI

- Conexión entre RRU y CU/DU para 5G.
- Granularidad de 25 Gbit/s.
- Tambien para 4G
- Jitter/latencia.

Dispositivos

Borde

IPSec en el transporte
Edge Computing

- VNF /CNF en el borde

Terminación de túneles IPSec en los POP de borde

Sincronismo

- 5G, mayormente TDD
- Sincronización de fase mandatoria
- GPS como primer paso, costoso, inseguro
- PTP ITU profiles

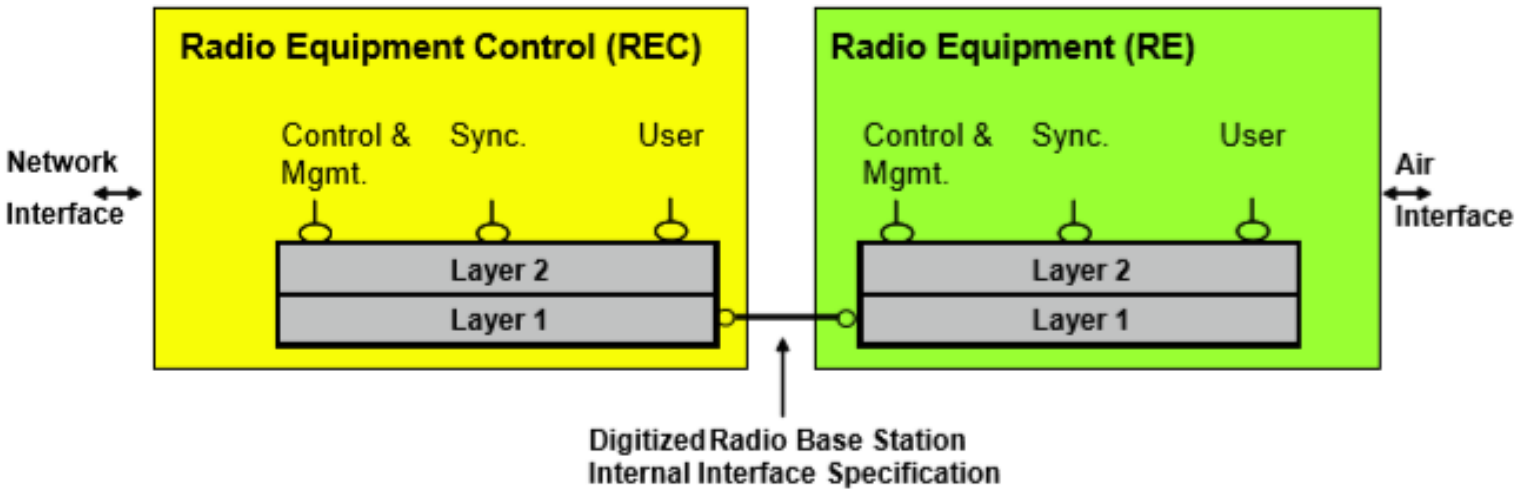
CPRI

CPRI (Common Public Radio Interface) es un protocolo desarrollado EN 2003 por la industria de BTS (Ericsson, Nokia Siemens Networks, Alcatel Lucent, NEC, and Huawei Technologies) a fin de enlazar la unidad de radio (RU/RRU), con la unidad banda base (BU/BBU). La aspiración original fue especificar un protocolo standard, sin embargo todos los casos de uso son monovendor.

CPRI Specification V7.0 (2015-10-09)

Interface Specification

Common Public Radio Interface (CPRI);
Interface Specification



PUNTOS DE REFERENCIA

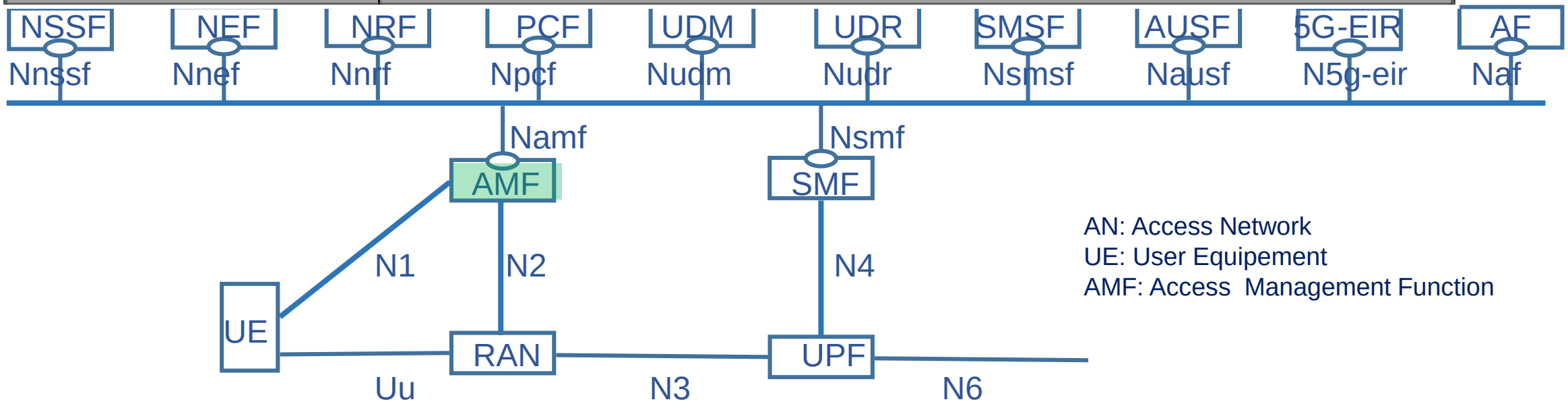
N1	UE – AMF
N2	(R)AN – AMF
N3	(R)AN – UPF
N4	SMF – UPF
N5	PCF – AF
N6	UPF – DN
N7	SMF – PCF
N8	UDM – AMF
N9	UPF – UPF
N10	UDM – SMF
N11	AMF – SMF
N12	AMF – AUSF
N13	UDM – AUSF
N14	AMF – AMF
N15	AMF – PCF
N16	SMF – SMF
N16a	*SMF – I-SMF*

N17	AMF – 5G-EIR
N18	Any NF – UDSF
N19	*Two PSA UPFs (5G-LAN)*
N20	AMF – SMSF
N21	UDM – SMSF
N22	AMF – NSSF
N23	PCF – NWDAF
N24	H-PCF – V-PCF
N25	PCF – UDR
N26	AMF – MME
N27	H-NRF – V-NRF
N28	PCF – CHF
N29	SMF – NEF
N29i	*I-NEF – SMF (in VPLMN)*
N30	PCF – NEF
N31	V-NSSF – H-NSSF
N32	V-SEPP – H-SEPP

N33	NEF – AF
N34	NSSF – NWDAF
N35	UDM – UDR
N36	PCF – UDR
N37	NEF – UDR
N38	*I-SMF – I-SMF*
N40	SMF – CHF
N50	AMF – CBCF
N51	*NEF – AMF*
N51i	*I-NEF – AMF (in VPLMN)*
N52	*NEF – UDM*
N52	*I-NEF – NEF*
N55	*AMF – UCMF*
N56	*NEF – UCMF*
N57	*AF -- UCMF*
N58	*AF – NEF*

SERVICE PROPORCIONADOS POR EL **AMF**

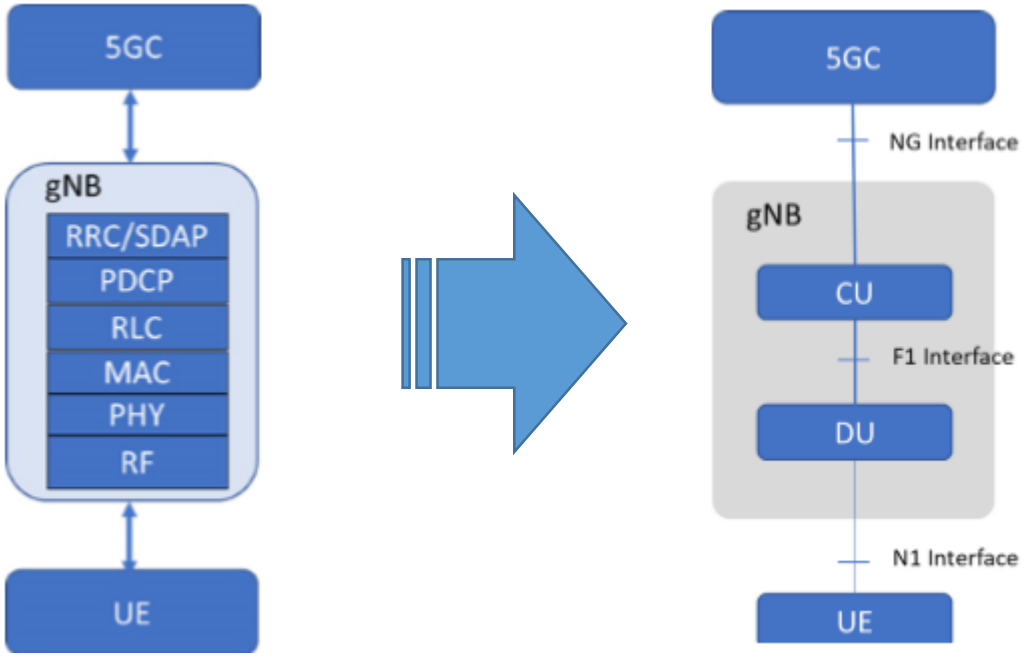
Service Name	Description
Namf_Communication	This service enables an NF to communicate with the UE and/or the AN through the AMF.
Namf_EventExposure	This service enables other NFs to subscribe or get notified of UE mobility related events and statistics.
Namf_MT	This service enables an NF to make sure UE is reachable.
Namf_Location	This service enables an NF to request location information for a target UE.



AN: Access Network
UE: User Equipement
AMF: Access Management Function

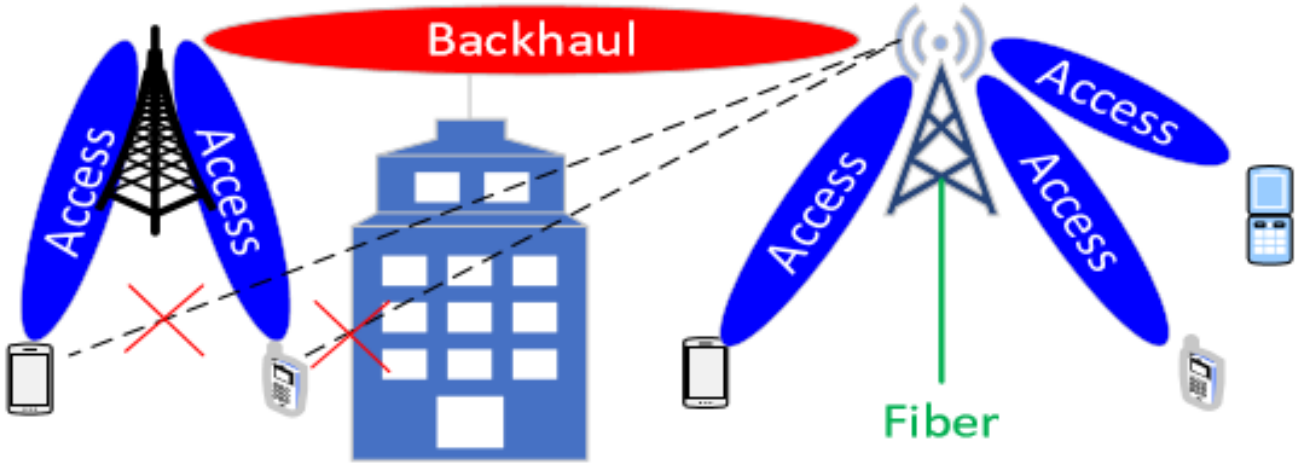
INCIATIVA DE 3GPP. CONCEPTO DE SPLIT DE RAN

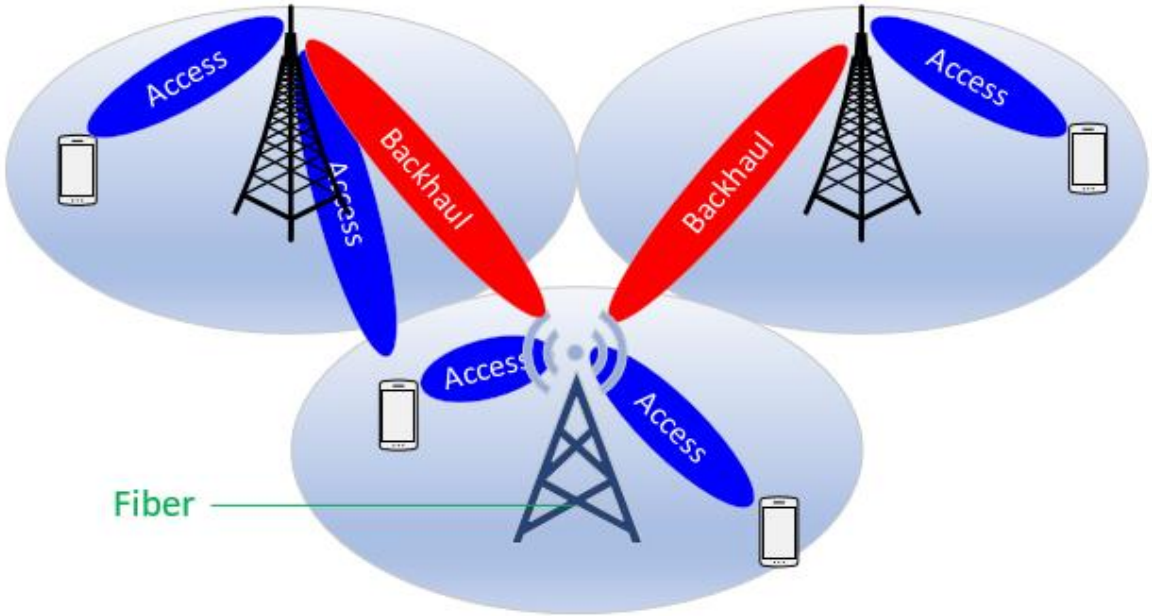
3GPP definió una arquitectura RAN de próxima generación (NG-RAN) donde la funcionalidad de la estación base 5G NR (gNB) se divide en dos unidades lógicas: una unidad central (CU) y una unidad distribuida. (DU). En el modelo 3GPP, la CU está conectada al núcleo 5G (5GC) a través de la interfaz NG y la CU está conectada a la DU a través de la interfaz F1, como se muestra a continuación en la Figura 3.



Algunas funciones son Real-Time
Otras no.

IAB


Backhaul
Access
Access
Access
Access
Access
Fiber


Access
Backhaul
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Backhaul
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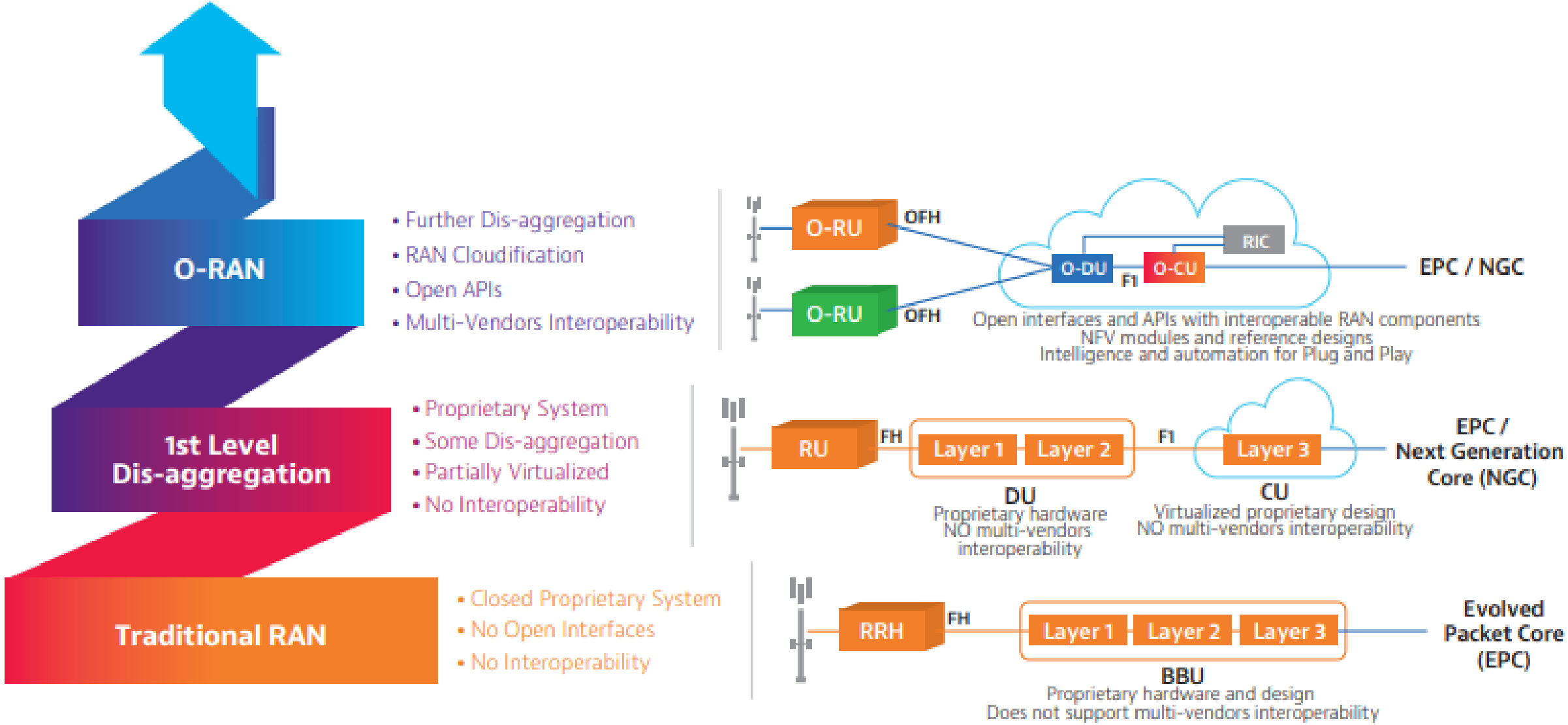
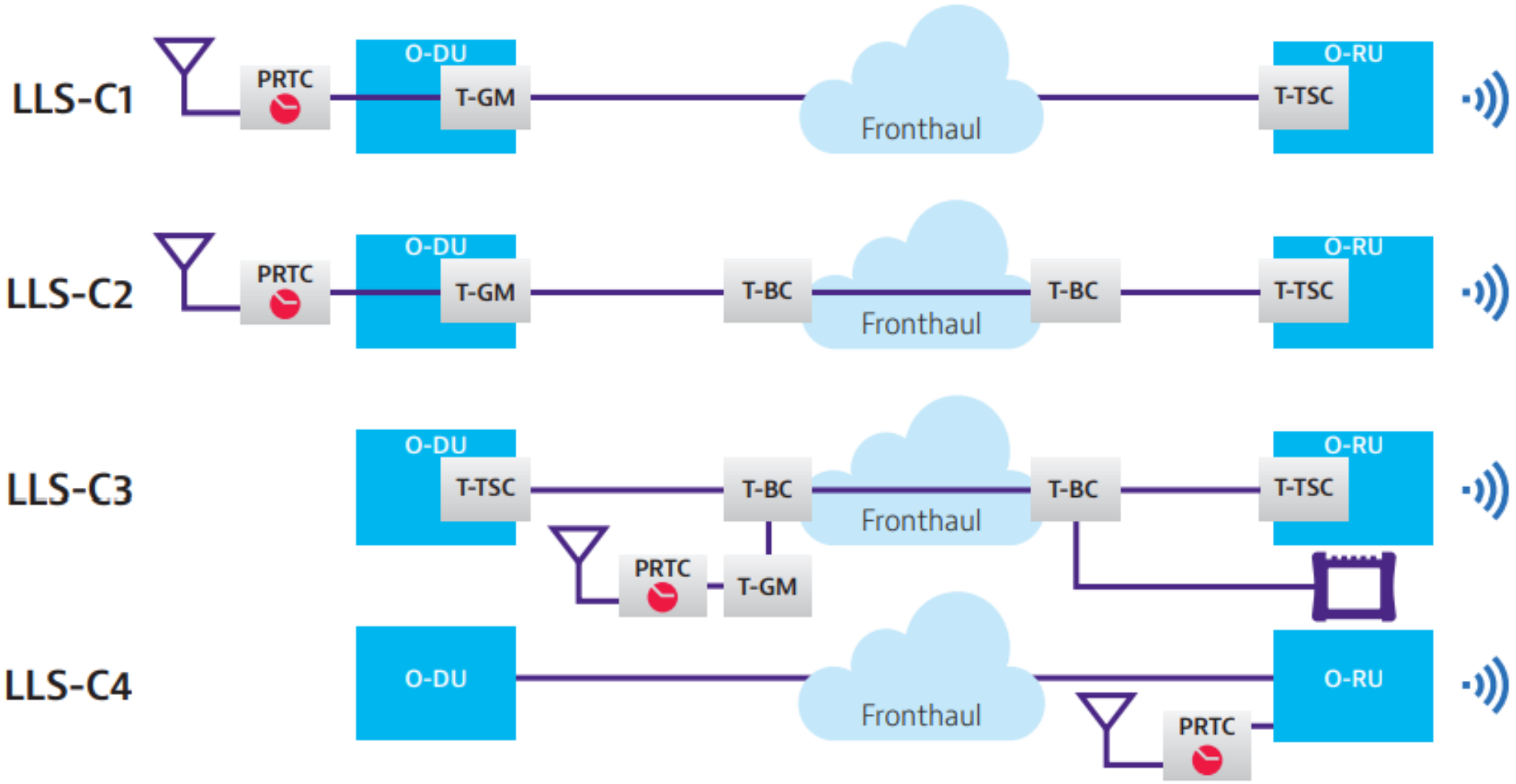
Fiber

INTRODUCCIÓN A O-RAN. EVOLUCIÓN DE LA RAN



Open RAN- Sincronismo en el Fronthaul. Variantes