IEE IEE2620: System Aspects in Communications

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Tunniplaan | Tunniplaani kalendrivaade

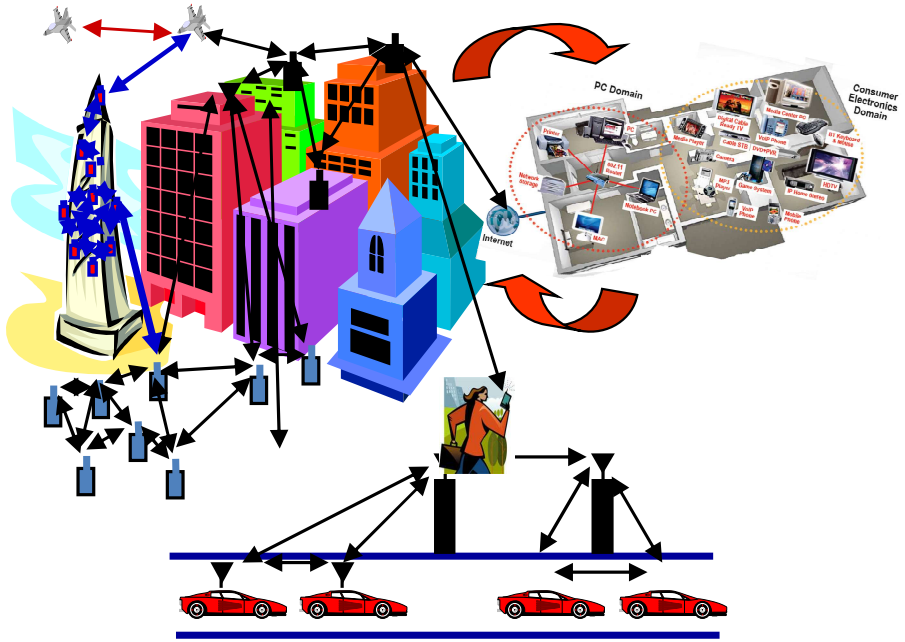
2023/2024 kevad

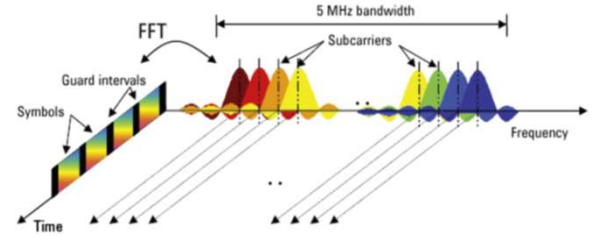
Muhammad Mahtab Alam (1-16. õppenädal)

Muu | Paaris | Paaritu | 1 - 16

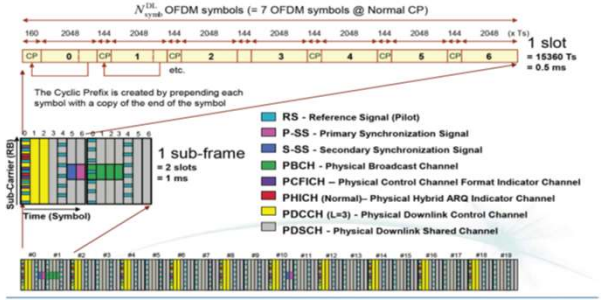
Kopeeri URL | Ekspordi iCalendar fail | Nädal | Semester

Aeg	Õppeaine	Keel	Kohustuslik / Valik / Vaba	Tüüp	Õppejõud	Ruum	Õppenädalad	Rühmad	Ainekava	Kommentaar
Esmaspäev										
12:00 - 13:30	IEE2620 - Süsteemiaspektid sides	Eesti keel	valik	loeng	Muhammad Mahtab Alam (täisprofessor tenuuris)	Distantsõpe SOC-218	1-16	IAVM21	Vaata	





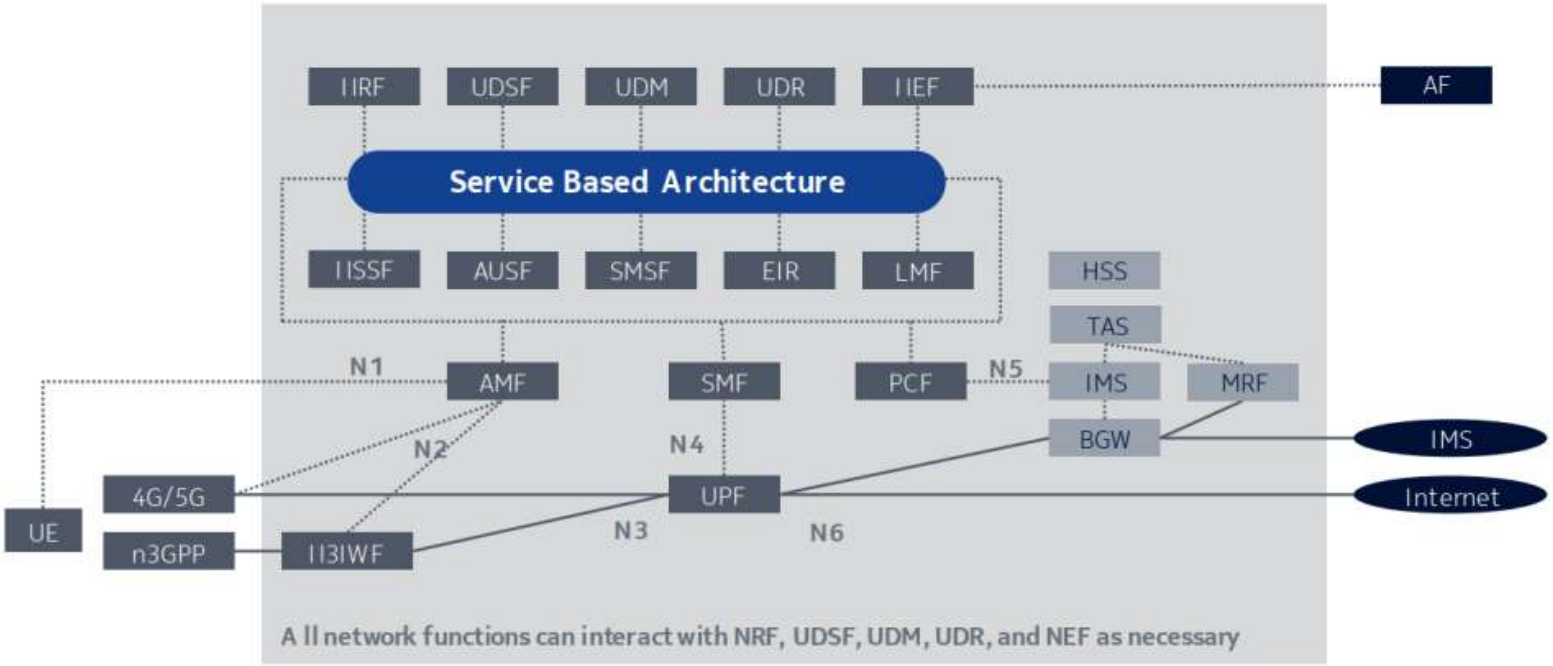
Downlink Frame Structure Type 1



5G Core Network (Quick Recap..)

5G Service based Architecture

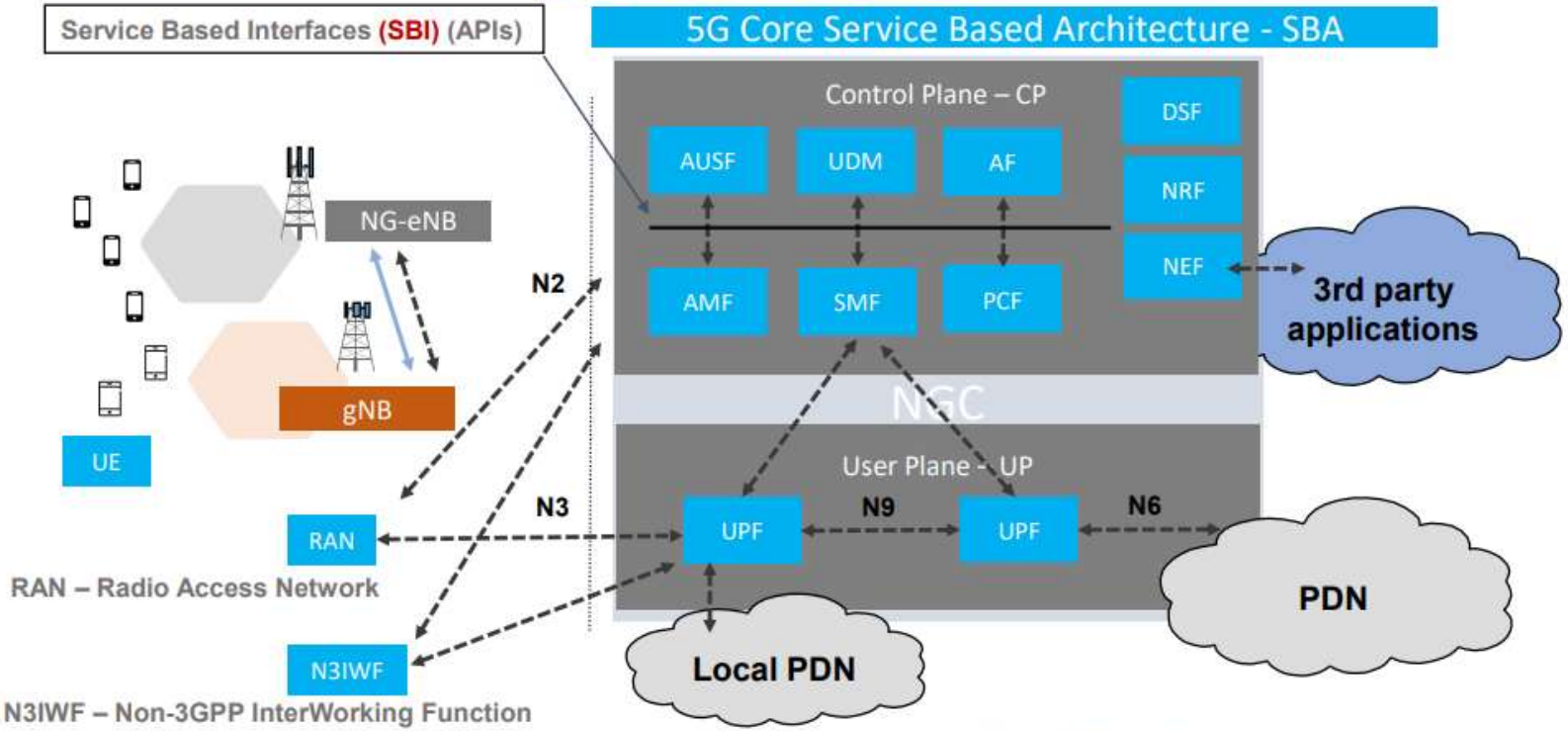
In 5G, Service-Based Architecture (SBA) is a core network approach where network **functions (NFs) offer services to other NFs via well-defined interfaces**, enabling modularity, reusability, and agility in network deployment and service delivery.



This offers Communications Service Providers greater flexibility and more efficiency by decoupling the service consumer from the service producer

NF services are self-contained, reusable and independent management schemes

5G SA Core



UPF – User Plane Function

PDN – Packet Data Network

AMF – Access and Mobility Managaement Function

SMF – Session Management Function

PCF – Policy Control Function

AUSF – Audentication Server Function

UDM – Unified (User) Data Management

AF – Application Function

DSF – Data Storage Function

NRF – Network Repository Function

NEF – Network Exposure Function

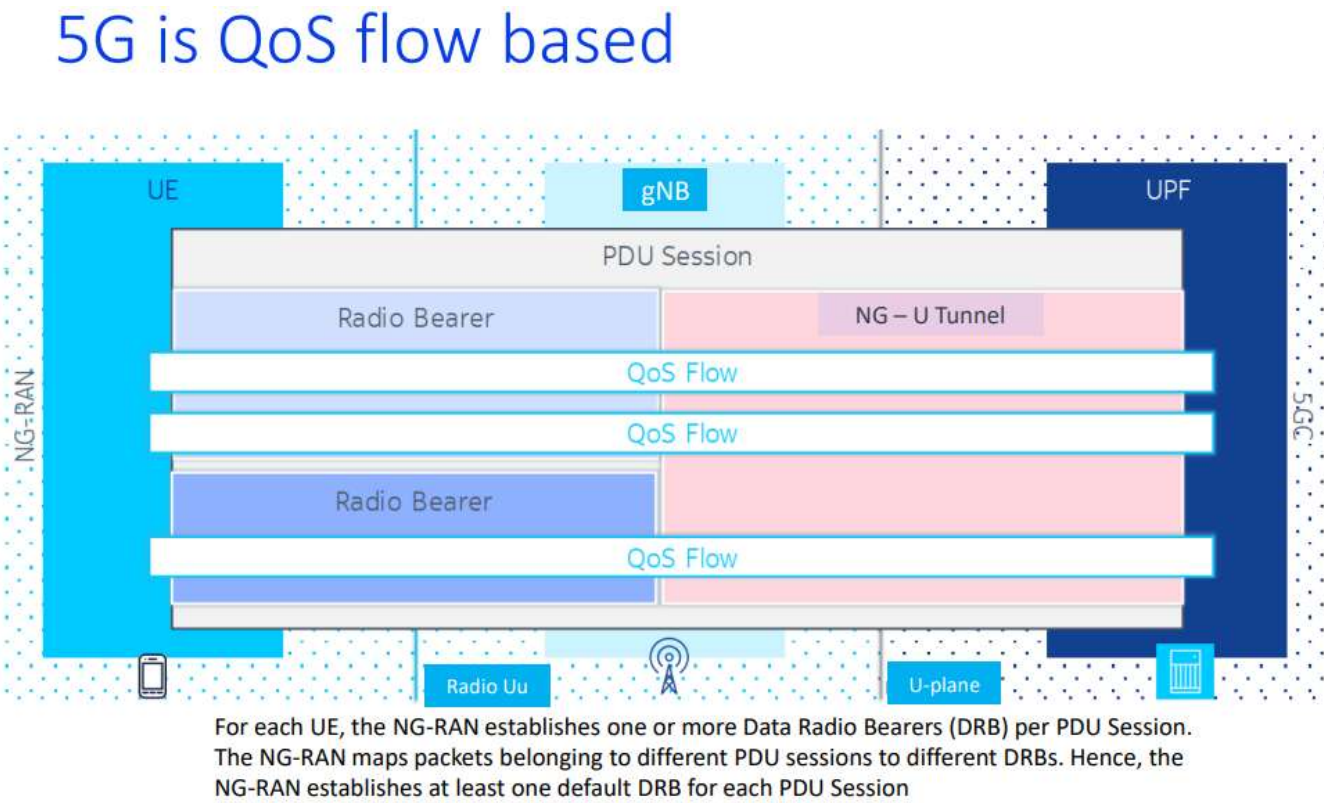
5G Core Network (Cont…)

QoS Flows in 5G

- PDU stands for Packet Data Unit. PDU Session Establishment is the process of establishing a data path between the UE and the 5G core network. A PDU session is a logical connection between the UE and a data network, such as the internet or a private network.

- GPRS Tunnelling Protocol (GTP) is a group of IP-based communications protocols used to carry general packet radio service (GPRS) within GSM, UMTS, LTE and 5G NR radio networks

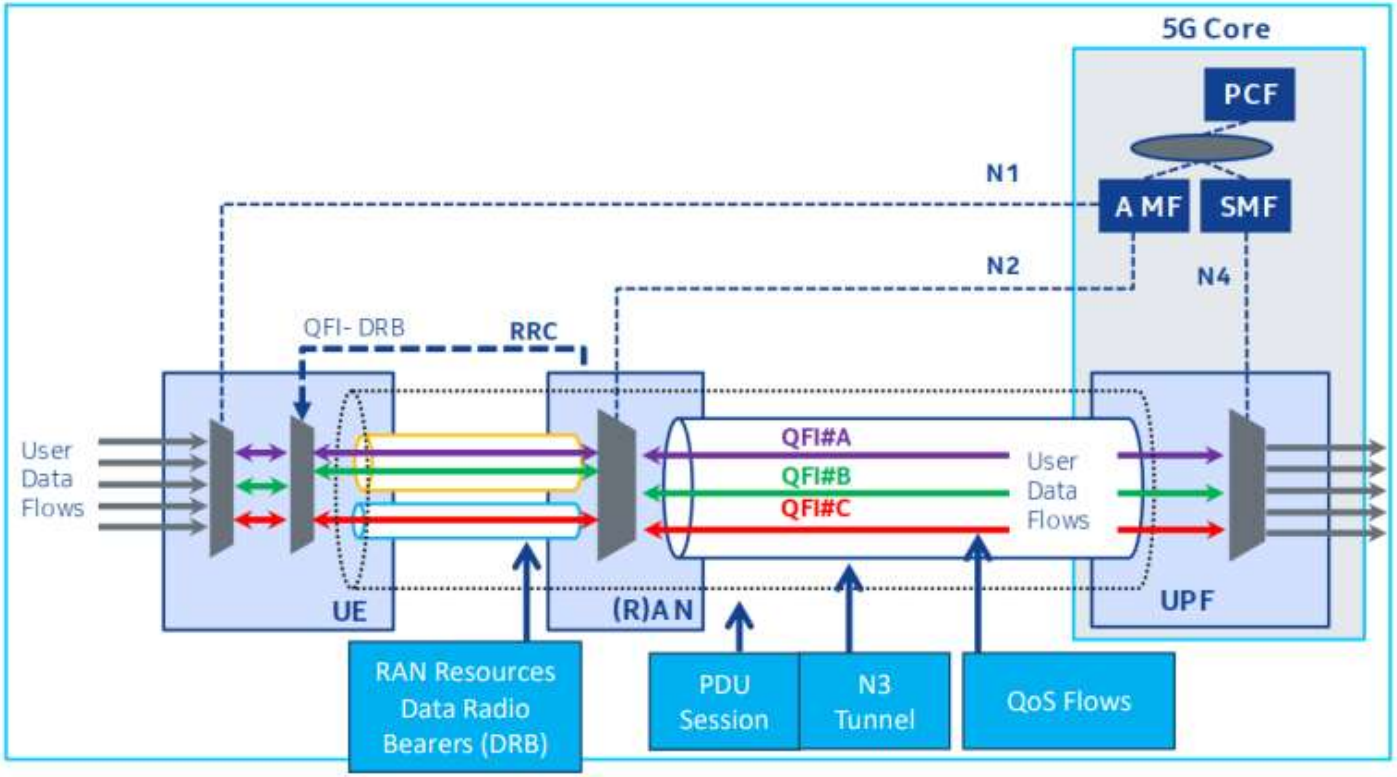
- GTP-U is an integral part of the 5G architecture, specifically designed for the User Plane communication, and it plays a crucial role in encapsulating and transporting user data packets between different network elements.



For each UE, the NG-RAN establishes one or more Data Radio Bearers (DRB) per PDU Session. The NG-RAN maps packets belonging to different PDU sessions to different DRBs. Hence, the NG-RAN establishes at least one default DRB for each PDU Session

5G QoS model

QoS flow
based framework



QFI – QoS flow index
DRB – Data Radio Bearer
RRC – Radio Resource Control
UPF – User Plane Function

Source: Nokia & 3GPP

Network Slice:
Definition and Concepts

SLICE DEFINITION BY NGMN

- **Service Instance:** a run-time construct of an end-user service or a business service that is realized within/by a Network Slice
- **Network Slice Instance (NSI):** a set of run-time Network Functions (NFs), and resources to run these NFs (an NSI can include zero, one or more sub-network instances), forming a complete instantiated logical network to meet certain network characteristics (e.g., ultra-low-latency, ultra-reliability) required by the Service Instance(s)
  - **Network slice** instance examples: enhanced Mobile Broadband (eMBB), massive Internet of Things (mIoT), and Ultra-Reliable Low-Latency Communication (URLLC), Enterprise and Industry etc.
- **Network Slice Sub-network Instance (NSSI**): a run-time construct and comprises a set of NFs and the required resources
- **Resource:** asset for computation, storage or transport including radio access, physical or logical

SLICE DEFINITION BY 3GPP

- From a mobile operator's point of view, a network slice is an independent **end-to-end logical network** that runs on a shared physical infrastructure, capable of providing a negotiated service quality. The technology enabling network slicing is transparent to business customers. A network slice could span across **multiple parts of the network** (e.g. terminal, access network, core network and transport network) and could also be deployed across multiple operators. A network slice comprises dedicated and/or shared resources, e.g. in terms of processing power, storage, and bandwidth and has isolation from the other network slices.
- 5G networks, in combination with network slicing, permit **V2X customers to enjoy connectivity and data processing** tailored to the specific business requirements that adhere to a Service Level Agreement (SLA) agreed with the mobile operator. The customizable network capabilities include data speed, quality, latency, reliability, security, and services.

NETWORK SLICE CONCEPTS

- Network slicing is transforming the network from a **static** one ‘’**where one network configuration fits all**” to a new paradigm where logical network partitions are created with appropriate resources and topology to serve a particular service.
  - This way we have multiple logical networks on a common physical infrastructure.
- For V2x CAM services, network slicing offers an effective way to meet the requirements for the different CAM services: platooning, autonomic mobility, lane maneuvering, etc. Slicing supports very diverse requirements for latency, throughput, capacity and availability.

NETWORK SLICING – SLICE IDENTIFICATION

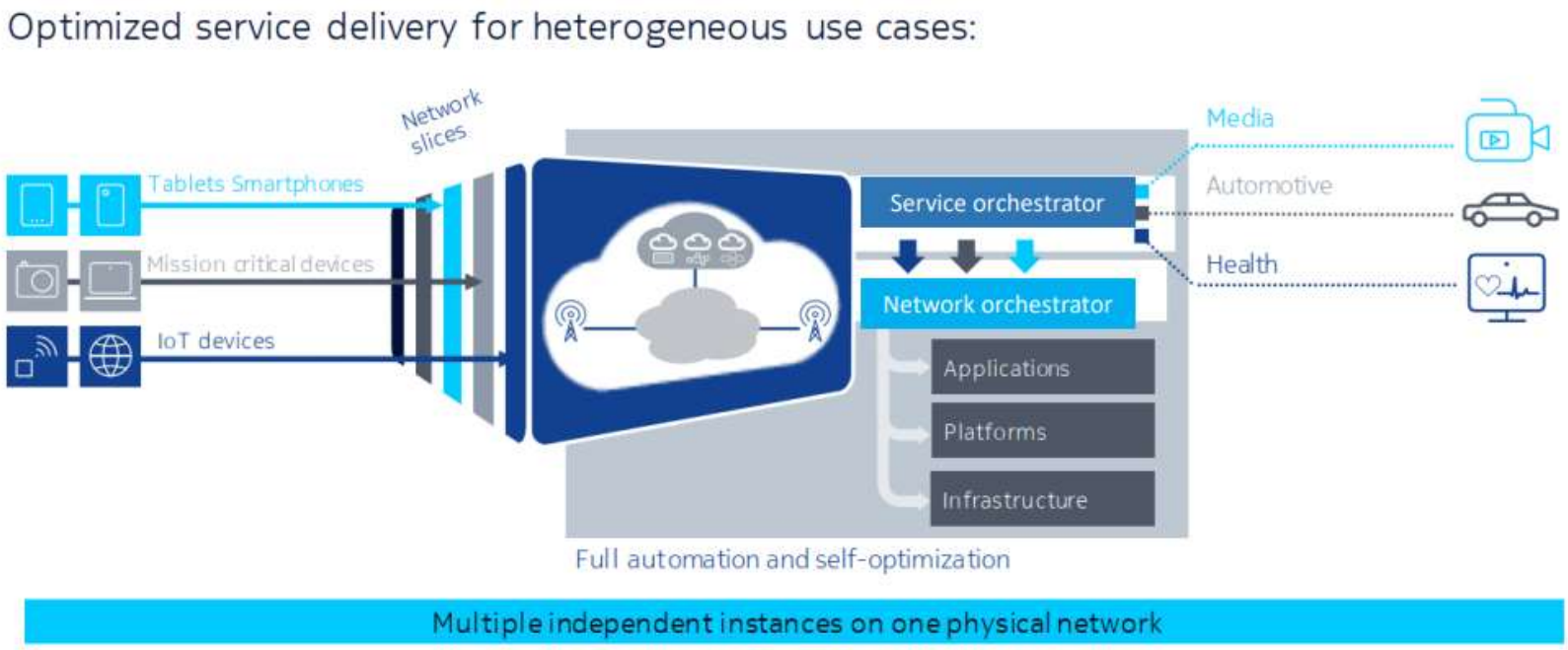
- NSSAI –network slice selection assistance information
  - SST – slice type, describes expected network behavior
  - SD – slice differentiator, optional, further differentiation
- NSSAI can have standard or network-specific values
  - Standard SST values: *eMBB, URLCC, MIoT* (see next slides)
- UE (vehicle) for a specific CAM service will have a profile mapped to a slice or two slices. UE sends NSSAI – based on which related slice(s) are selected

SLICE DEFINITION DESCRIPTOR

- A network slice is an **independent, resource-isolated, end-to-end logical network** running on a shared physical infrastructure, which spans across all the end-to-end network segments and thus may include a vertical's enterprise network, Radio Access Network (or Fixed Access Network), Edge/Mobile Edge Computing (MEC) network, Core Network and multiple administrative domains.
- A network slice comprises a **minimum set of network functions/apps** (virtual and/or physical) over the end-to-end logical network to achieve the expected SLA(s) and all the resources (virtual and/or physical, dedicated and/or shared) required to run these functions/apps that are purposely selected/chained to deliver the end-to-end service and SLA(s). These network functions can provide functionality over data or control planes. A network slice should be **programmable at the data plane** to help meet the QoS requirements.
- The network slice's **lifecycle management and orchestration** is not part of the network slice instance and belongs to the network slice management plane.
- A network **sub-slice** is defined as a slice (instance) running in a specific network segment.

5G End-to-End Network Slicing

Network slicing will provide scalability with horizontal slicing by using resources efficiently and will provide flexibility by vertically slicing the resources per application type.



Network resources can be dedicated per slice, thus enabling end-to-end service differentiation. Both vertical and horizontal slicing can be specified within the same service slice enabling different slices per tenant and fulfilling different SLAs.

Network Slice Management and Configuration

5G Network Slice Instance

Network Function:

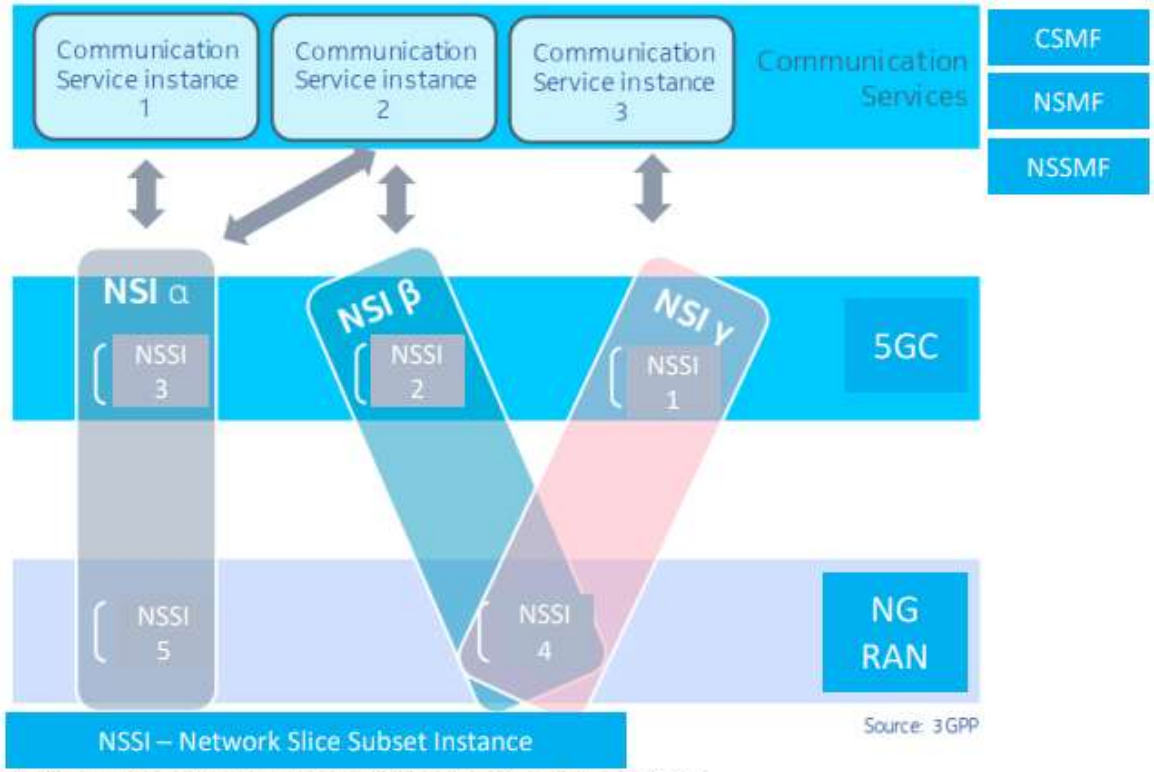
A 3GPP adopted or 3GPP defined processing function in a network, which has defined functional behavior and 3GPP defined interfaces.

Network Slice:

A logical network that provides specific network capabilities and network characteristics to serve a defined business purpose of a customer.

Network Slice Instance (NSI):

A set of Network Function instances and the required resources (e.g. compute, storage and networking resources) which form a deployed Network Slice.



Network Slice Instance: A set of Network Function instances and the required resources (e.g. compute, storage and networking resources) which form a deployed Network Slice.

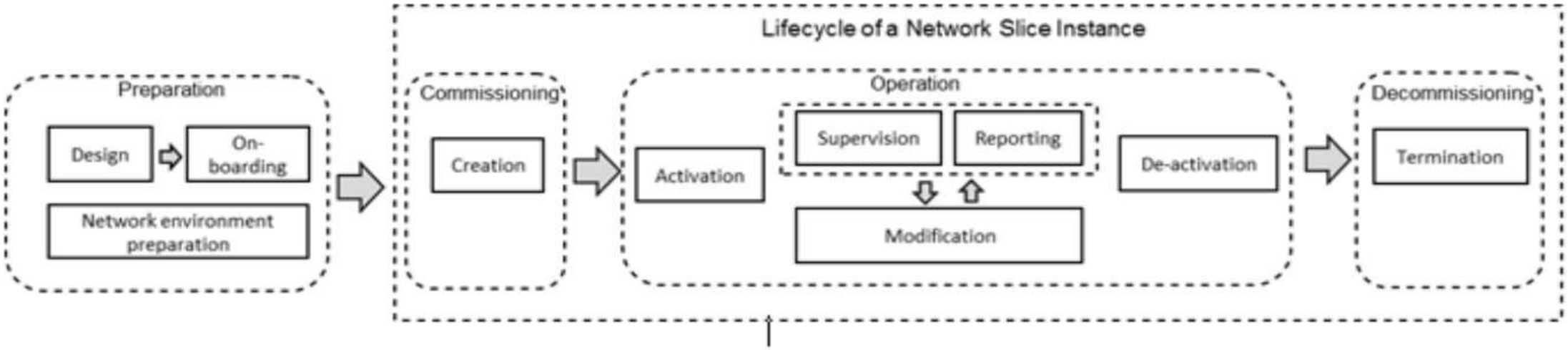
CSMF – Communication Service Management Function

NSMF – Network Slice Management Function

NSSMF – Network Slice Subnet Management Function

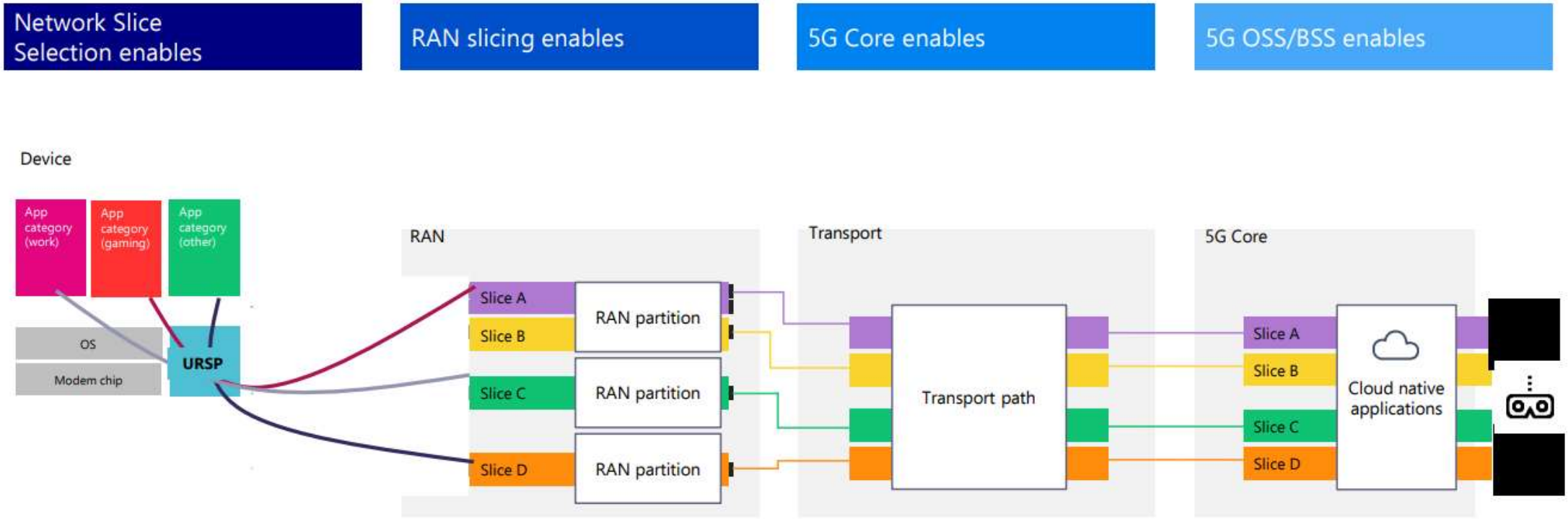
Source: Nokia & 3GPP

LIFECYCLE OF A SLICE



- Preparation: preparation of network slice design, capacity and on-boarding of NFs
- Commissioning: Creation of NSI and allocation of resources
- Operation: Activation, supervision, performance reporting, modification and deactivation
- Decommissioning: Termination of NSI

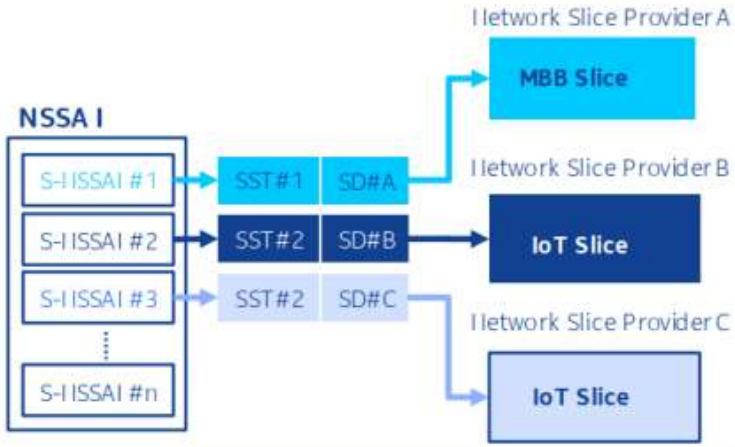
END-TO-END NETWORK SLICE SELECTION OVERVIEW



5G Network Slice selection

NSSAI:	• Network Slice Selection Assistance Information • The NSSAI is a collection of up to 8 S-NSSAIs
S-NSSAI: Single NSSAI	• S-NSSAI : Single Network Slice Selection Assistance information • It identifies a Network Slice.
S-NSSAI is comprised of:	• A **Slice/Service type (SST),** which refers to the expected Network Slice behavior in terms of features and services • A **Slice Differentiator (SD).** which is optional information that complements the Slice/Service type(s) to allow further differentiation for selecting a Network Slice from the potentially multiple Network Slices that all comply with the indicated Slice/Service type

S-NSSAI = Slice/Service type (SST) + Slice Differentiator (SD)



SST	SST value	Characteristics.
eMBB	1	Slice suitable for the handling of 5G enhanced Mobile Broadband.
URLLC	2	Slice suitable for the handling of ultra-reliable low latency communications.
MIoT	3	Slice suitable for the handling of massive IoT.

TS 23.501 Standardised SST table

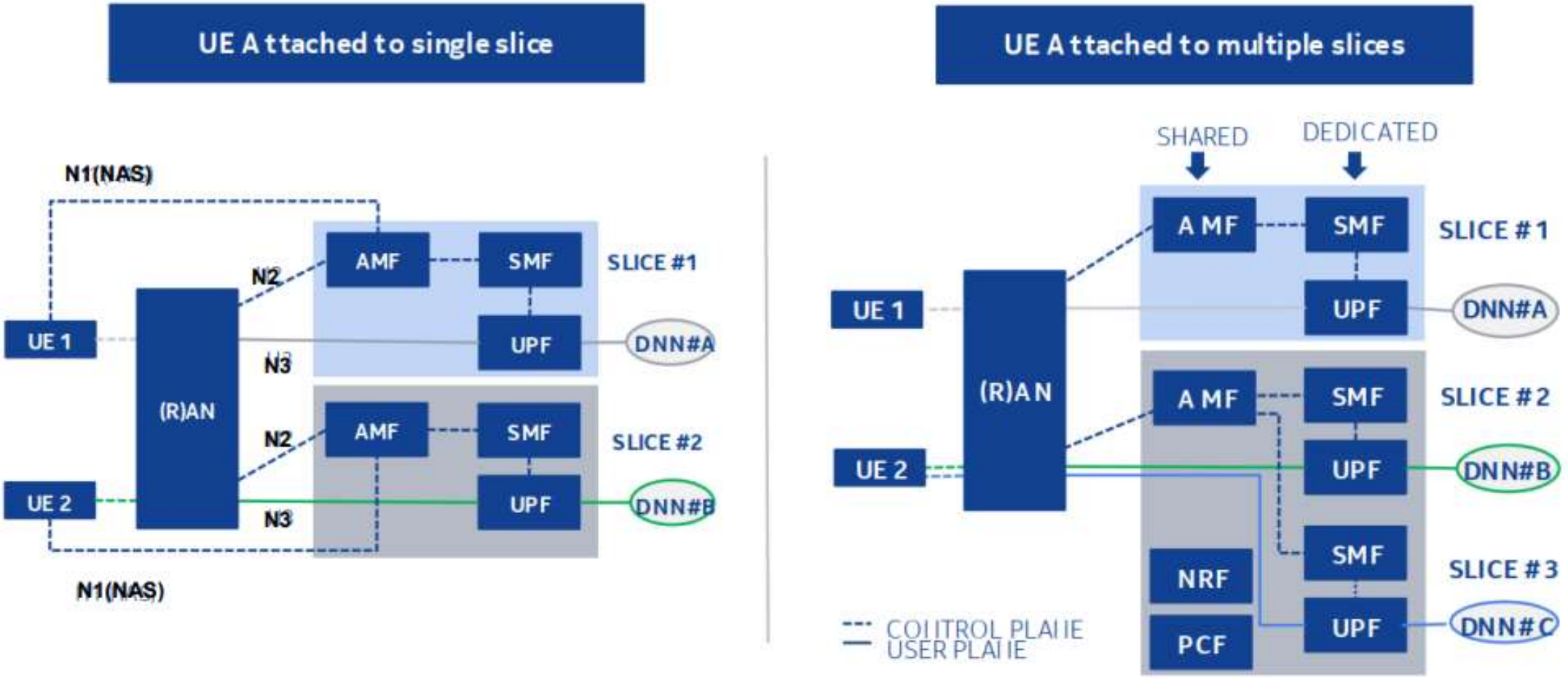
Major identifier for enabling end to end network slice is Single Network Slice Selection Assistance Information (S-NSSAI). UE may be entitled to use a set of slices, which means a set of S-NSSAIs that is referred to as NSSAI. Currently 3GPP allows up to eight S-NSSAIs in the NSSAI sent in signaling messages between the UE and the Network.

SST – Slice/Service Type

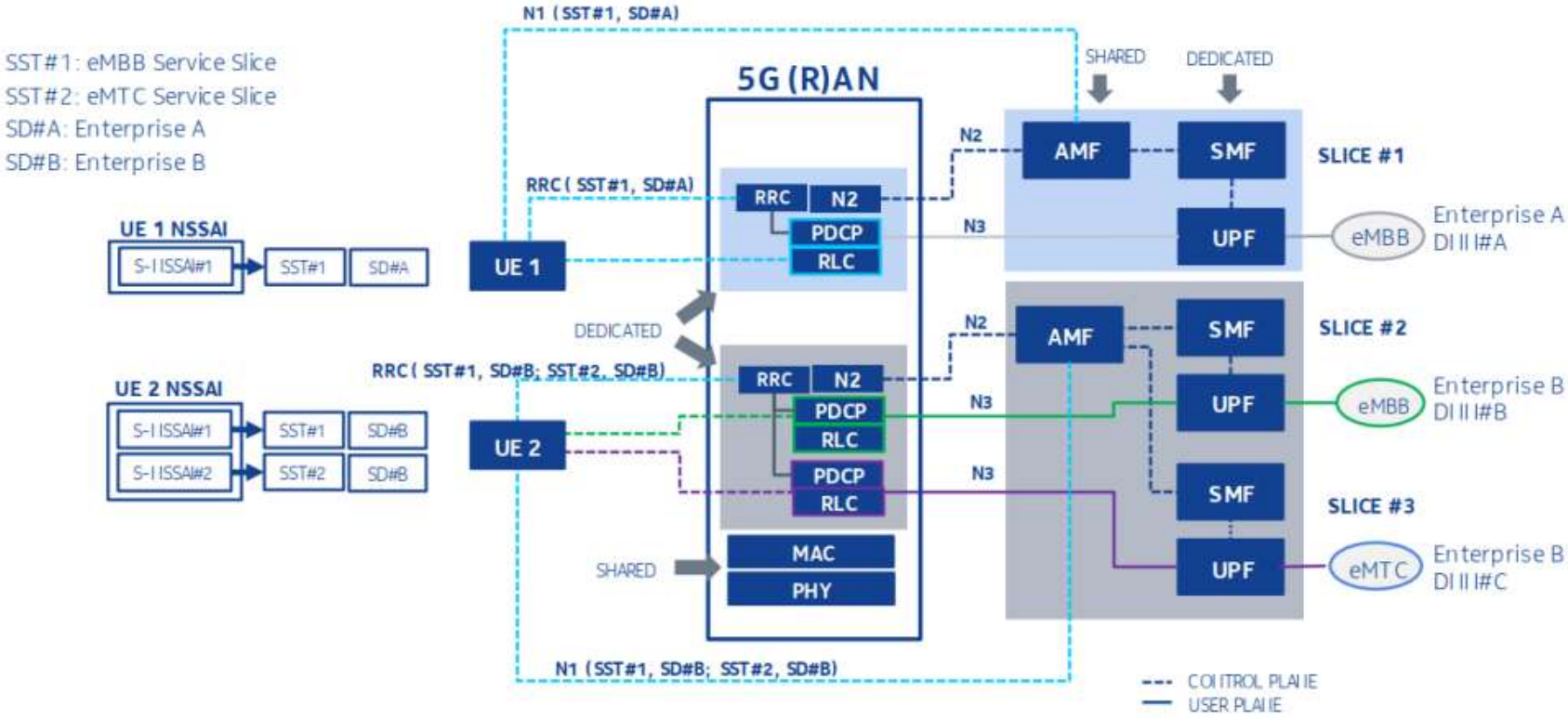
SD – Slice Differentiation (is optional)

Source: Nokia & 3GPP

5G Core Slices



5G RAN and Core Slices



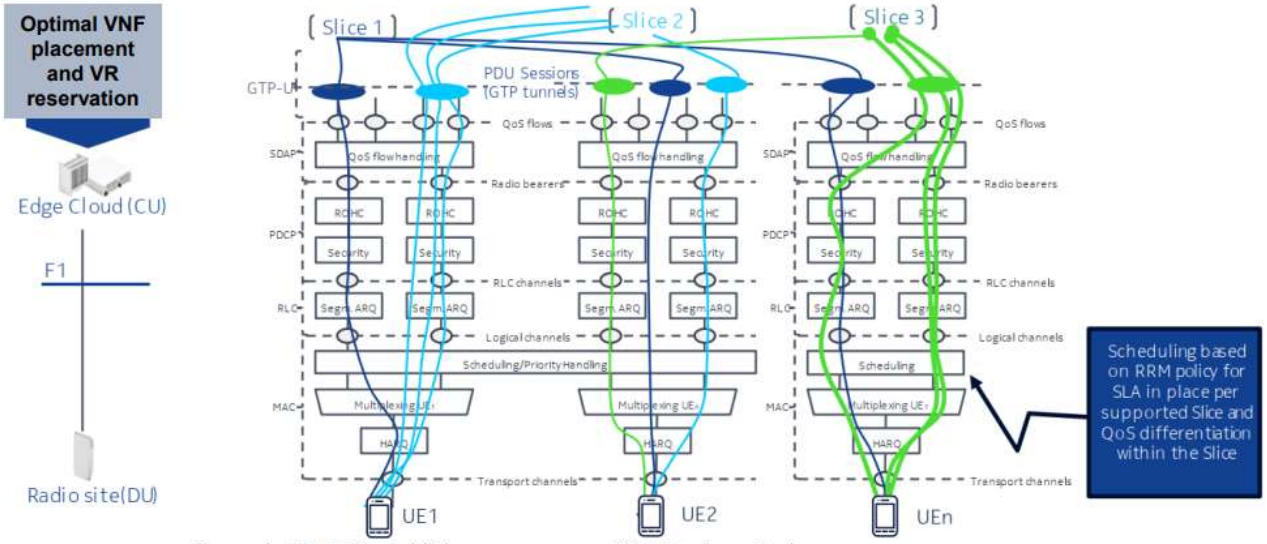
NG-RAN is pre-configured with a set of different configurations for different network slices. Each slice is assigned with either shared or dedicated radio resource.

How NG-RAN supports the slice enabling in terms of NG-RAN functions (i.e. the set of network functions that comprise each slice) is implementation dependent.

Source: Nokia & 3GPP

RAN Slice Configuration

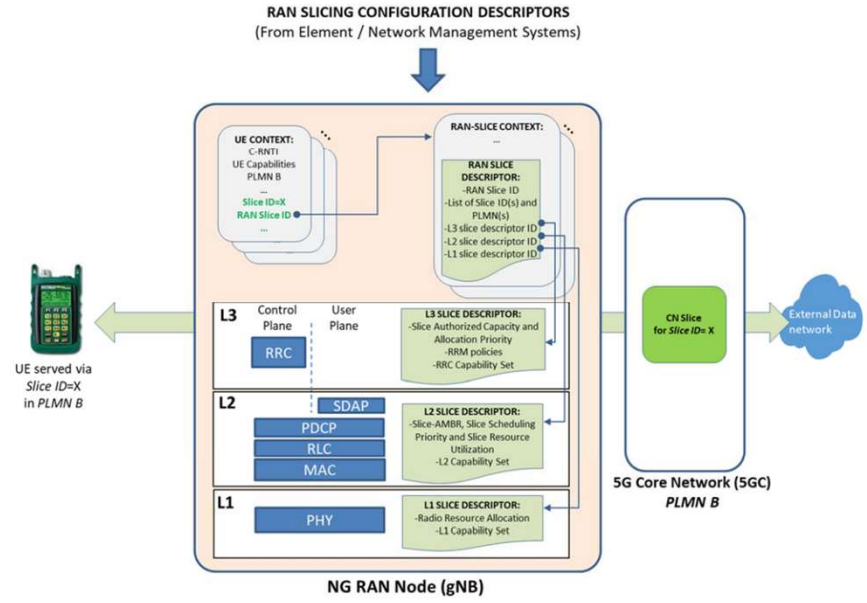
5G RAN Slicing



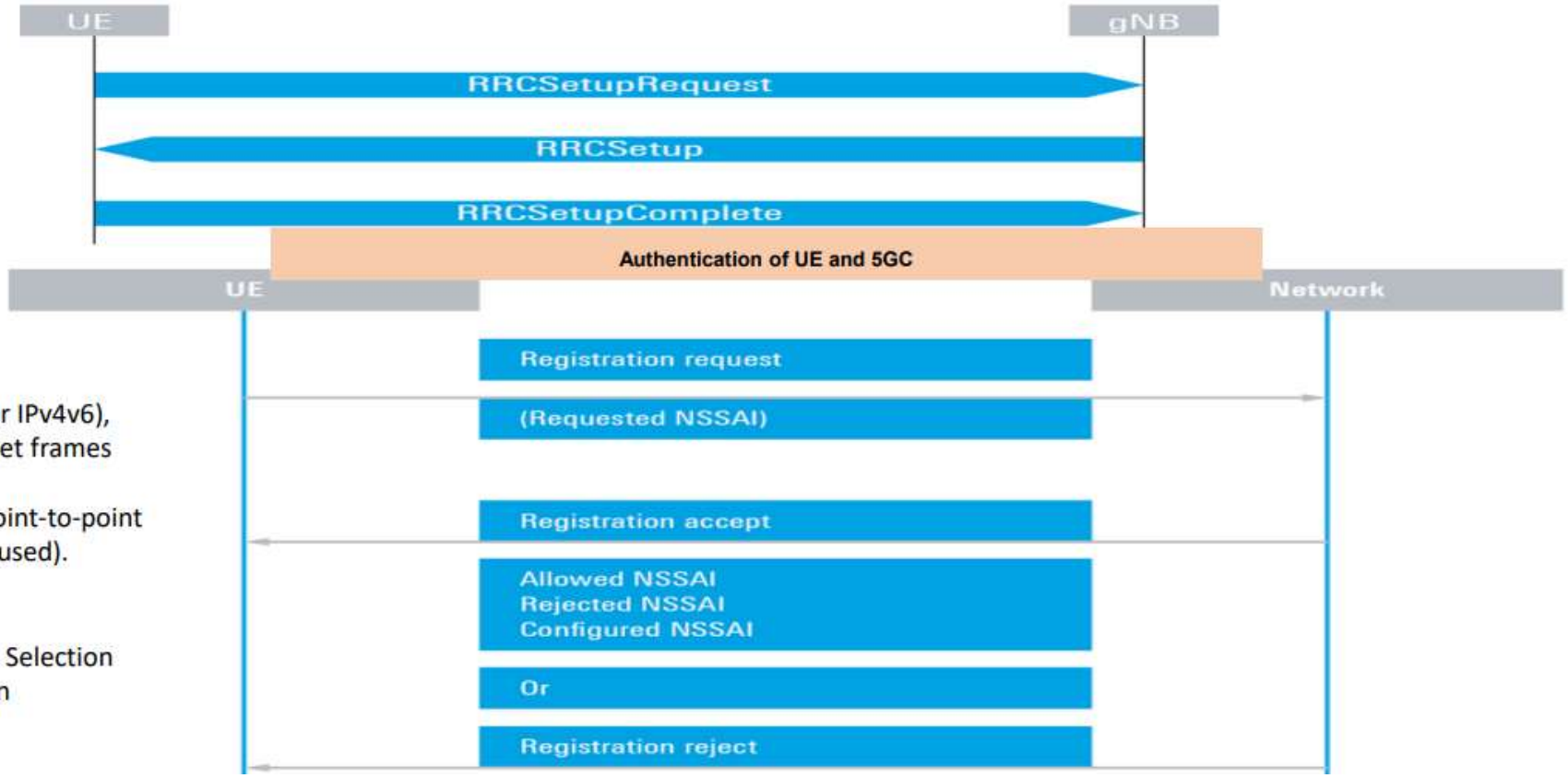
For each UE, 5GC establishes one or more PDU Sessions. Each PDU Session is associated to one slice. And the UE can use multiple network slices simultaneously.

The Service data adaptation protocol (SDAP) sublayer provides mapping of IP flows with different QoS requirements

Source: Nokia & 3GPP



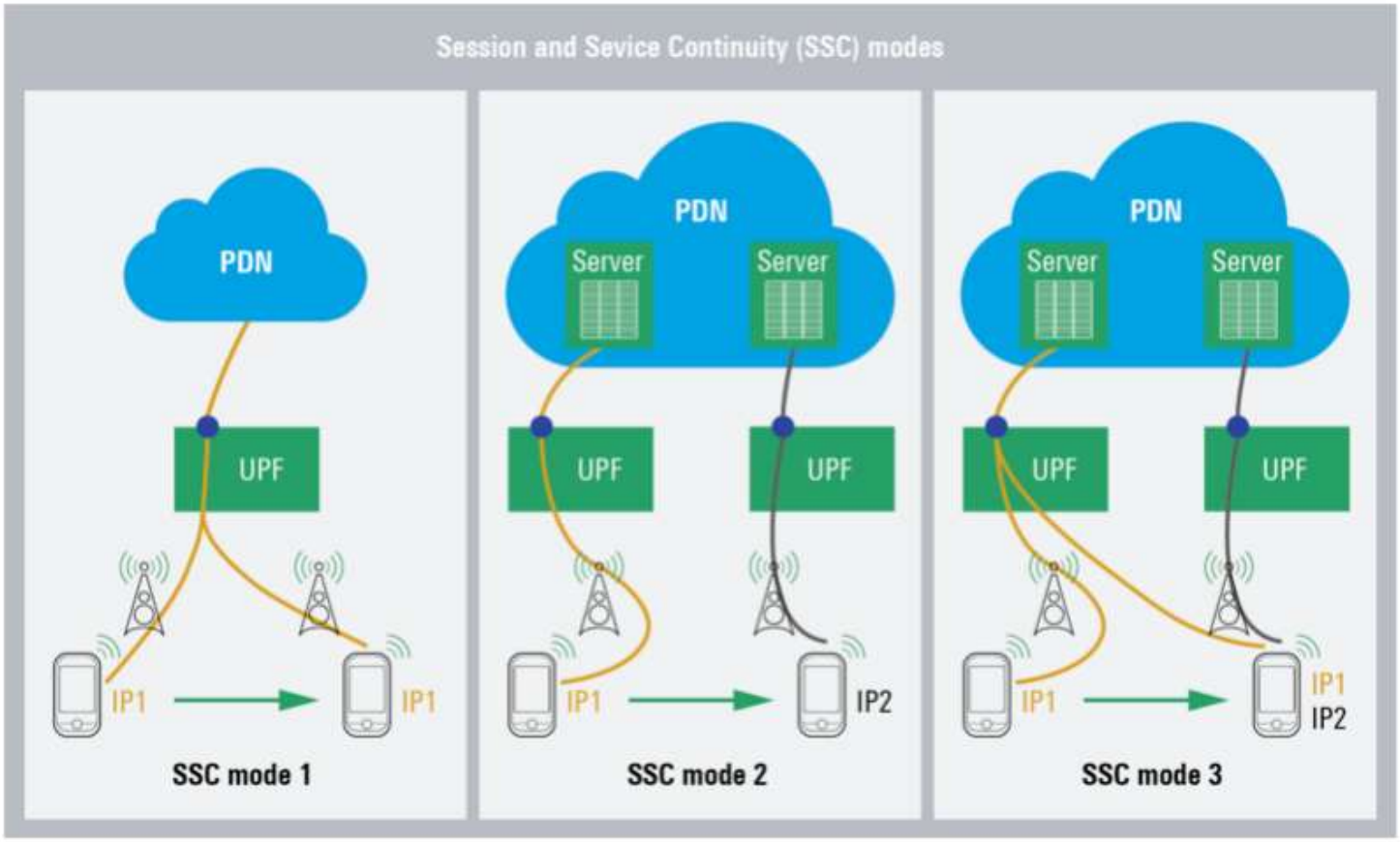
5G PDU session establishment



PDU session types:
IP type (IPv4 or IPv6 or IPv4v6),
Ethernet type (Ethernet frames related behavior),
Unstructured type (point-to-point tunneling techniques used).

NSSAI – Network Slice Selection Assistance Information

5G Session and Service Continuity



In SSC mode 2 network may release the IP address (PDU session type IP) as there is a new PDU session anchor point.
In SSC mode 3 a new PDU sessioon will be established before the previous connection is terminated.
SSC mode is defined by the application requirements.

Source: Rohde&Schwarz & 3GPP