

Network Slicing in 5G RAN

3GPP Standards Perspective

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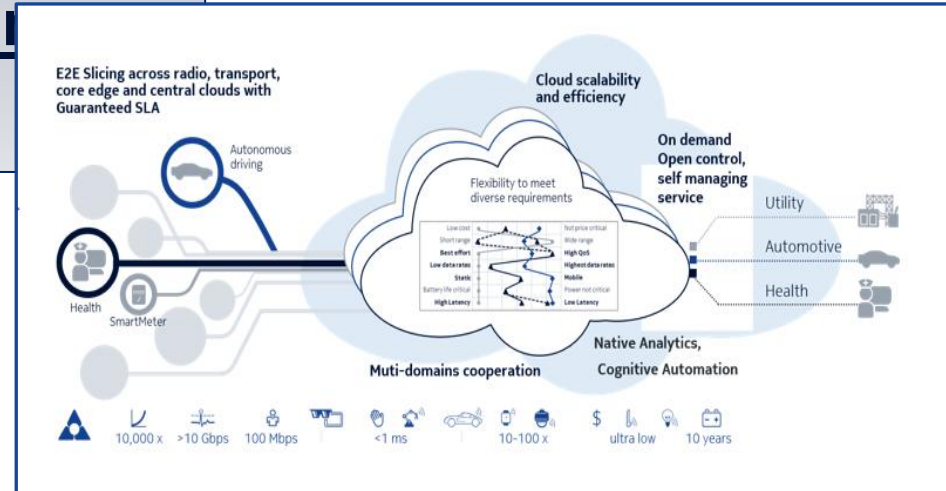


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**Slicing in 5G
RAN -
Overview**

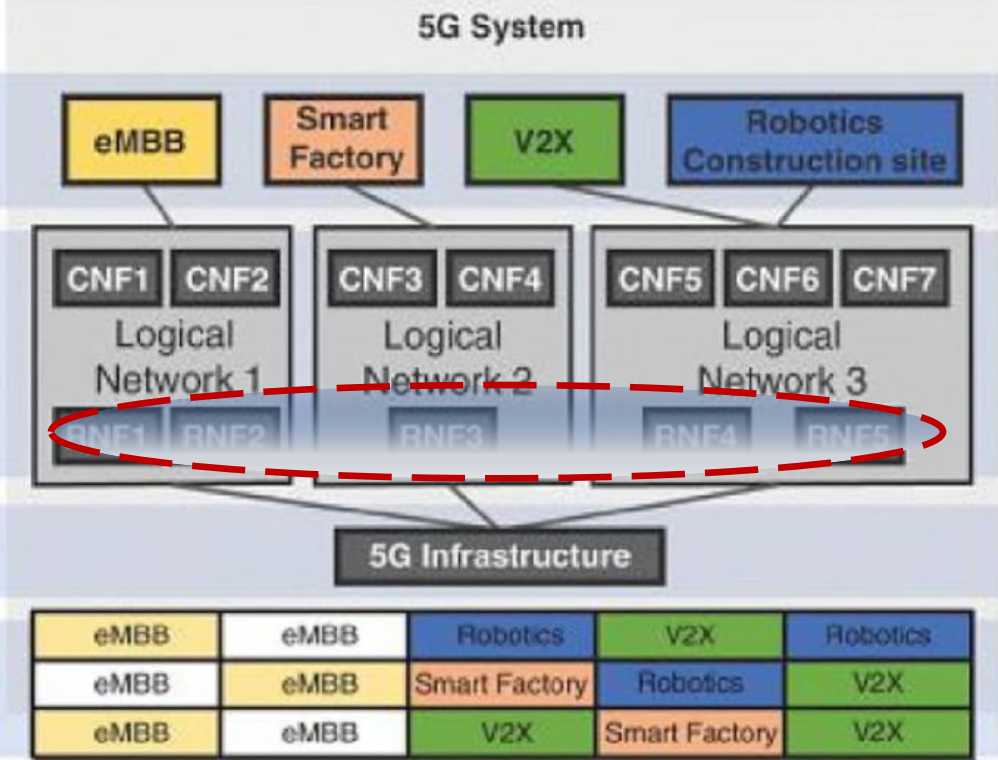
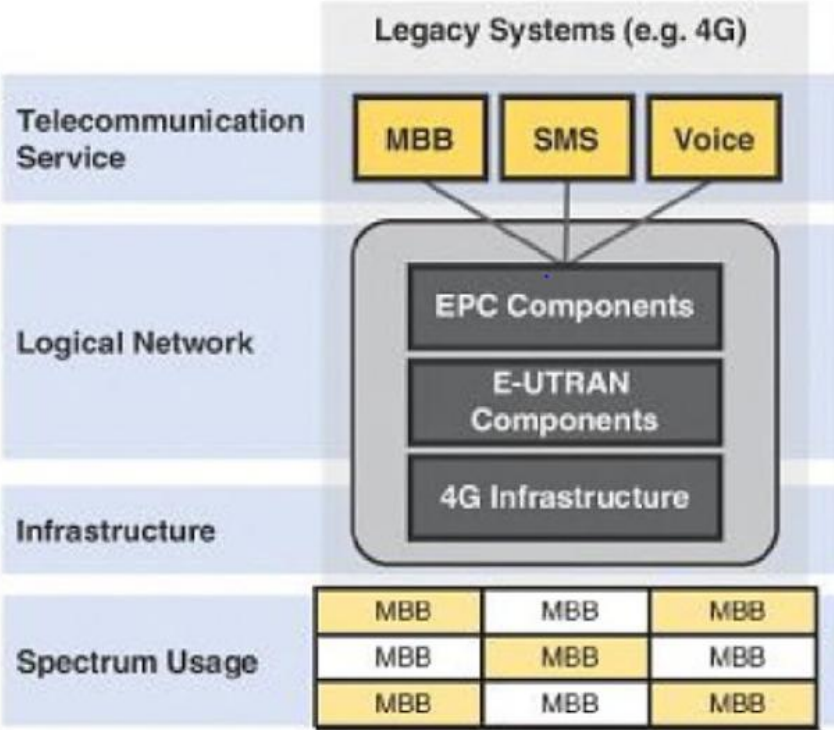
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**Key
Concepts**

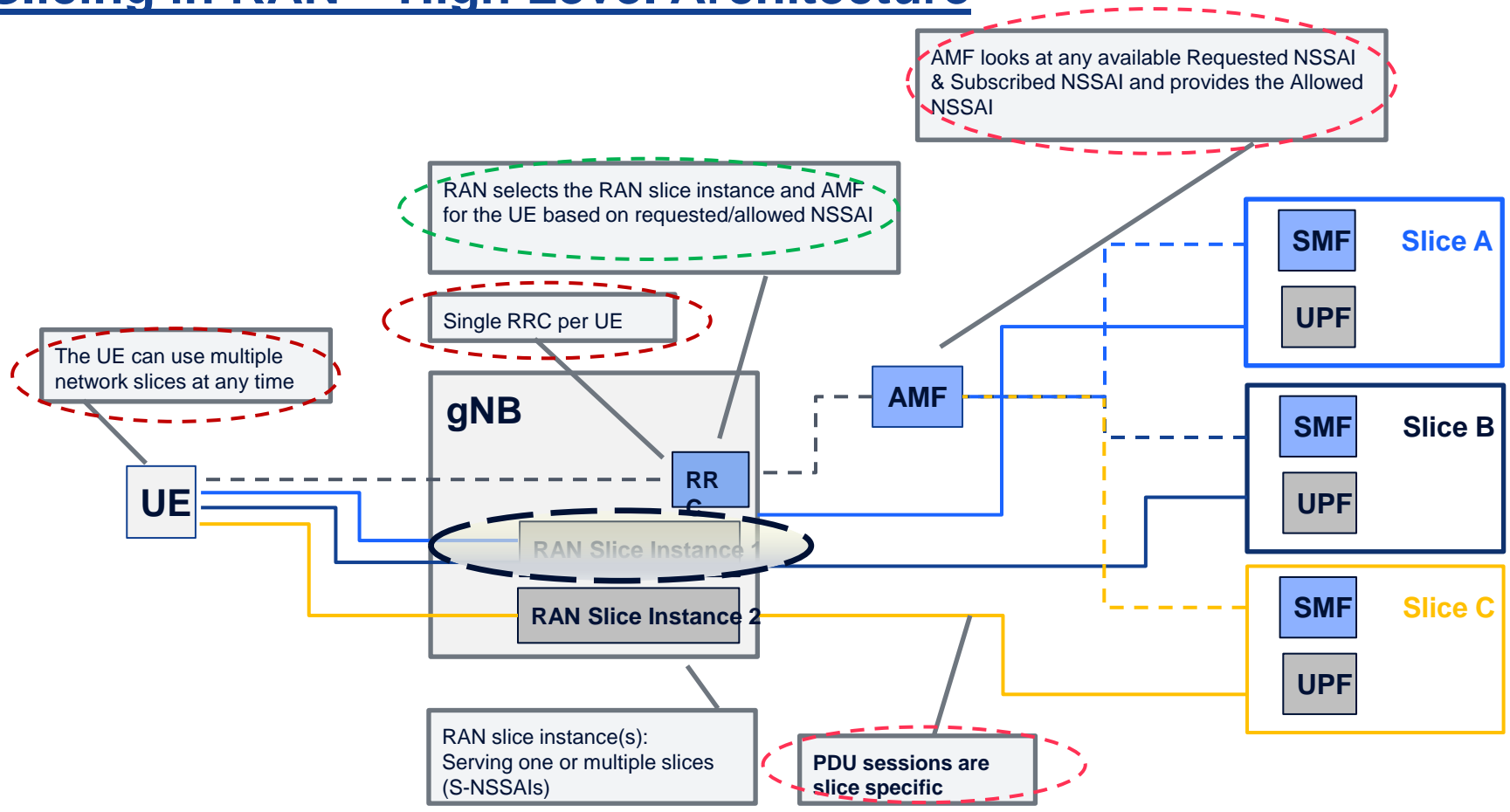
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**Slicing in 5G
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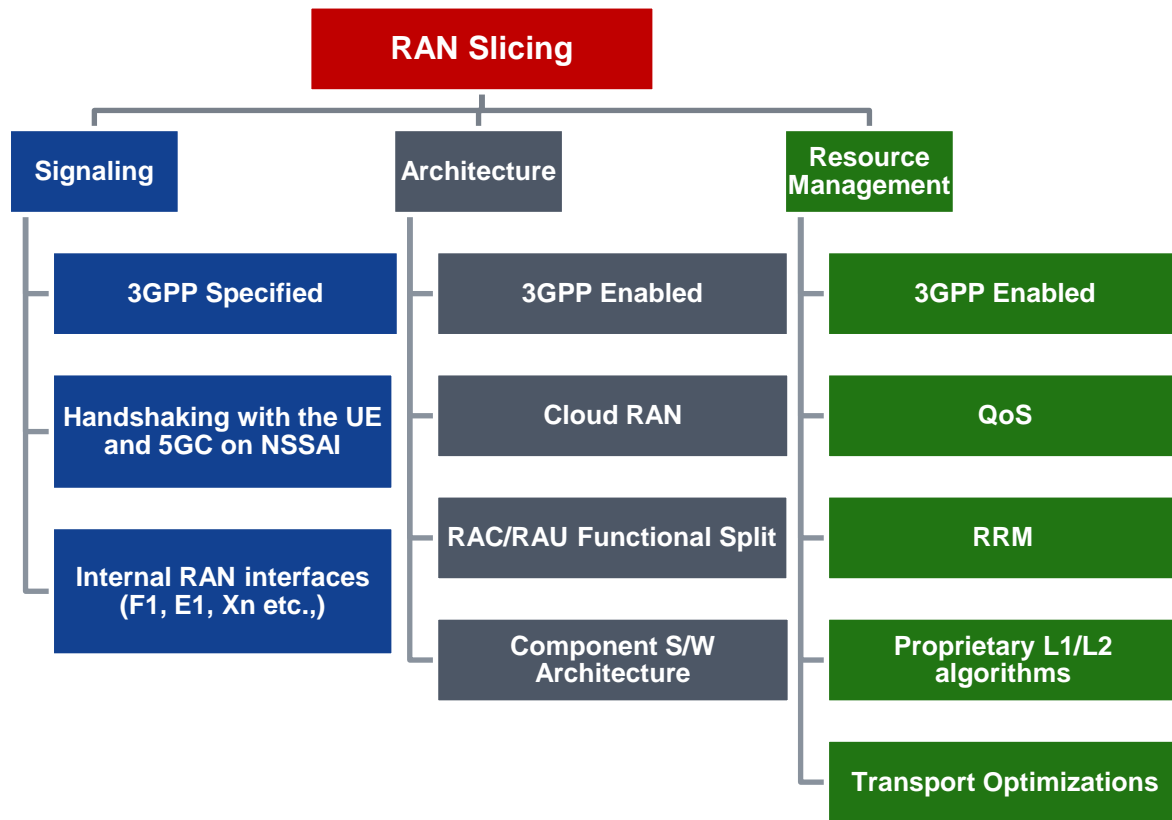
E2E Network Slicing – Legacy vs 5GS



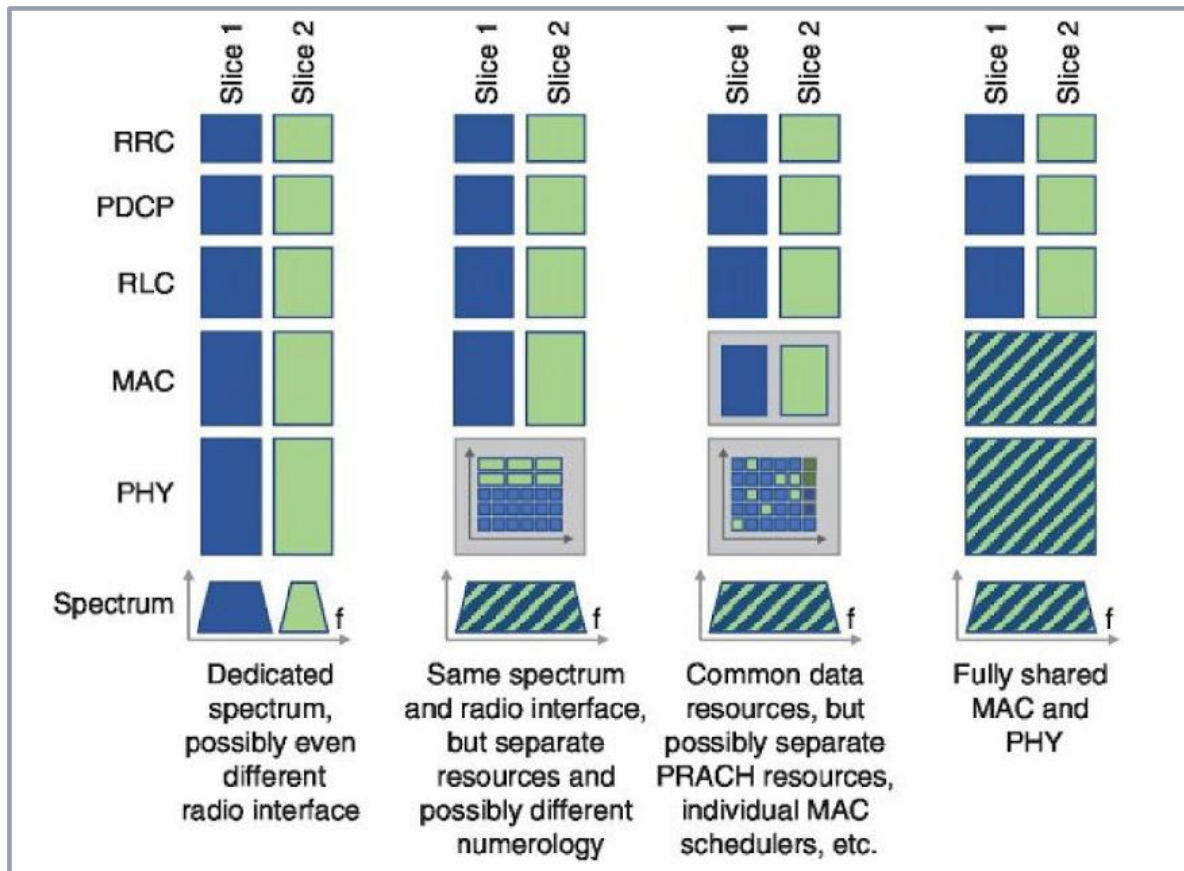
Slicing in RAN – High Level Architecture



Slicing in RAN – What Could It Mean?



RAN Slice – Resource Management



- Multiple implementations possible
- The option itself is not mandated in the standards
- The standards define a framework where any of these could be realized
- Typical considerations
 - Service characteristics
 - Network deployment
 - Commercial aspects

RAN Slice – Example

	Static Temperature Sensor (mMTC)	Video Streaming (eMBB)	Smart Grid (URLLC)
RRC	Handover measurements omitted	State handling optimized for reduced RAN/CN signaling	State handling optim. for reduced state change latency
PDCP	Potential omitting of ciphering and header compression	default	Potential omitting of ciphering and header compression
RLC	Unacknowledged mode only	default	Acknowledged mode only
MAC	HARQ optimized for coverage	default	HARQ omitted for low-latency, RACH prioritization
PHY	Coding optimized for coverage, energy efficiency	Coding optimized for very large payloads	Coding optimized for short payloads, low latency

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Slicing in 5G RAN – Key Concepts



Slice Identity Management

NSSAI – Network Slice Selection Assistance Information – used to identify the slice in the 5GS

- List of up to 8 S-NSSAIs (Single NSSAIs)
- Each S-NSSAI
 - Mandatory SST (Slice/Service Type) - identifies the slice type - 8 bits
 - Optional SD (Slice Differentiator) - differentiates among Slices with same SST - 24 bits
- Standardized S-NSSAI has only SST and no SD
- Non-Standard S-NSSAI can be defined as either SST alone or SST + SD

Slice/Service Type	SST Value
eMBB	1
URLLC	2
MIIOT	3


- Types of NSSAI used in signalling
 - Subscribed S-NSSAIs
 - Stored in the UDM -> 5GC uses this as a default when the UE doesn't send a Requested NSSAI
 - Configured NSSAI
 - The PLMN may configure a UE with 1 or more configured NSSAIs – UE uses this as its default NSSAI
 - Typically, matches the Subscribed S-NSSAIs
 - Allowed NSSAI
 - This is the value assigned by the 5GC & valid in a Registration Area or the PLMN
 - Requested NSSAI
 - Can be either Configured or Allowed NSSAI or a combination
 - The UE sends this in both RRC and NAS signalling as part of registration
 - RAN uses this for AMF selection and provisional handling before getting Allowed NSSAI
 - 5GC use this for slice selection, validation etc., and returns the Allowed NSSAI
 - Rejected NSSAI
 - Can be rejected in the Registration Area (or) for the entire PLMN
 - UE shouldn't attempt this NSSAI again in that RA or in the PLMN
 - NSSAIs could be mapped – across PLMNs for example

*Complex interworking
between the NSSAI types –
required to offer the
flexibility that slicing calls
for*

Key Concepts - Description

RAN Slice Awareness

- Differentiated Traffic Handling within the RAN
- QoS Differentiation within a slice
 - Different QoS profiles can be applied for non-GBR bearers within a slice
 - DRB profile can be different for the same 5QI flow type in different slices
- Granularity of Slice Awareness is at the level of a PDU session




**DRB = f(5QI,
NSSAI &
PLMN)**

Selection Functions

- RAN Slice Selection based on Requested/Allowed NSSAI
- AMF Selection based on Requested NSSAI

Resource Management

- RRM policy enforcement across slices
 - Slice specific Radio Admission Control policies
- Resource Isolation across slices
 - Failure in one slice not affecting the others



**Cloud
Architecture &
Slice specific
dimensioning**

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Key Concepts – Description - Continued

Slice Availability in the 5G System

- Some slices may be available only in a part of the network
- A given Registration Area (ie the list of Tracking Areas within an RA) shall support a common set of slices

Multiple Slices Support

- A single UE could have PDU sessions corresponding to 8 slices at the maximum at any point
- However, a single signalling connection (example : RRC state) is maintained for a given UE

UE Slice Validation

- Comparison of the UE's Requested NSSAI vs Subscribed NSSAI done by the 5GC
- 5G-RAN plays the slave here, getting the validated slice information in the ICS/PDU Session Request

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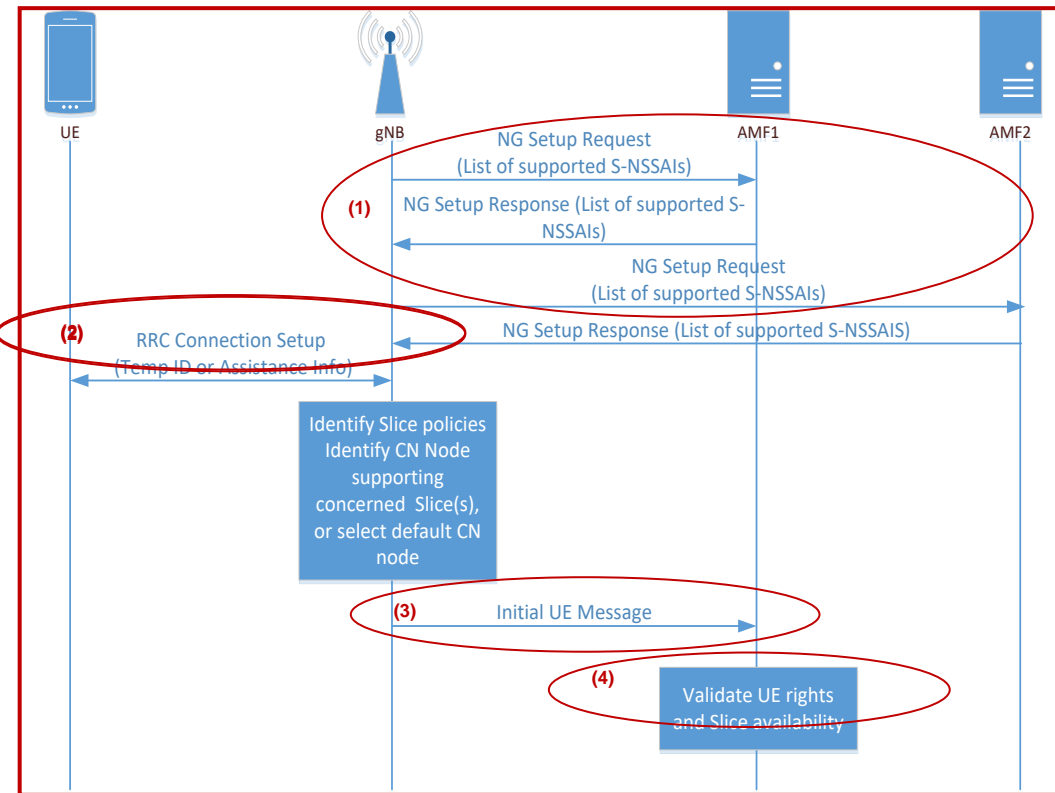
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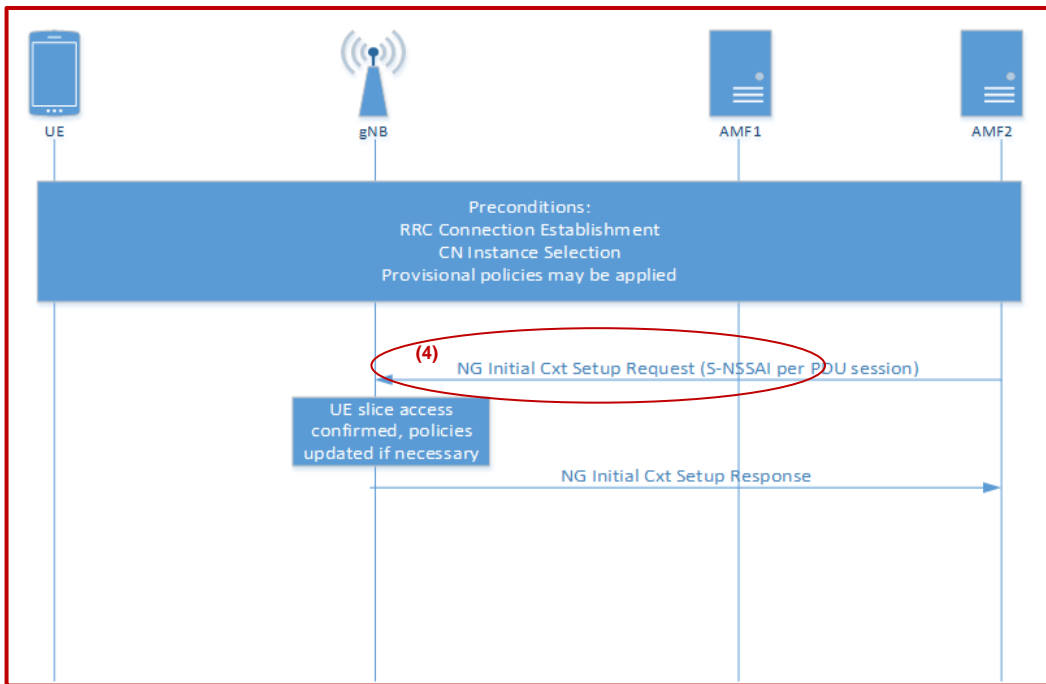
**Slicing in 5G
RAN
Procedures**

RAN Slice & AMF Selection



- 1) During NG Setup with AMF-1 & AMF-2
 - gNB and AMFs exchange their supported NSSAI lists
 - gNB -> NSSAIs per TAC
 - AMF -> NSSAIs in the PLMN
- 2) In the RRC Setup Complete message
 - UE optionally provides the Requested NSSAI along with the PDU session to be established
 - Provisional RAN slice selection & AMF selection done based on this
- 3) gNB forwards the NAS Registration Request to the selected AMF instance
- 4) AMF validates the Requested NSSAI using Subscribed NSSAI

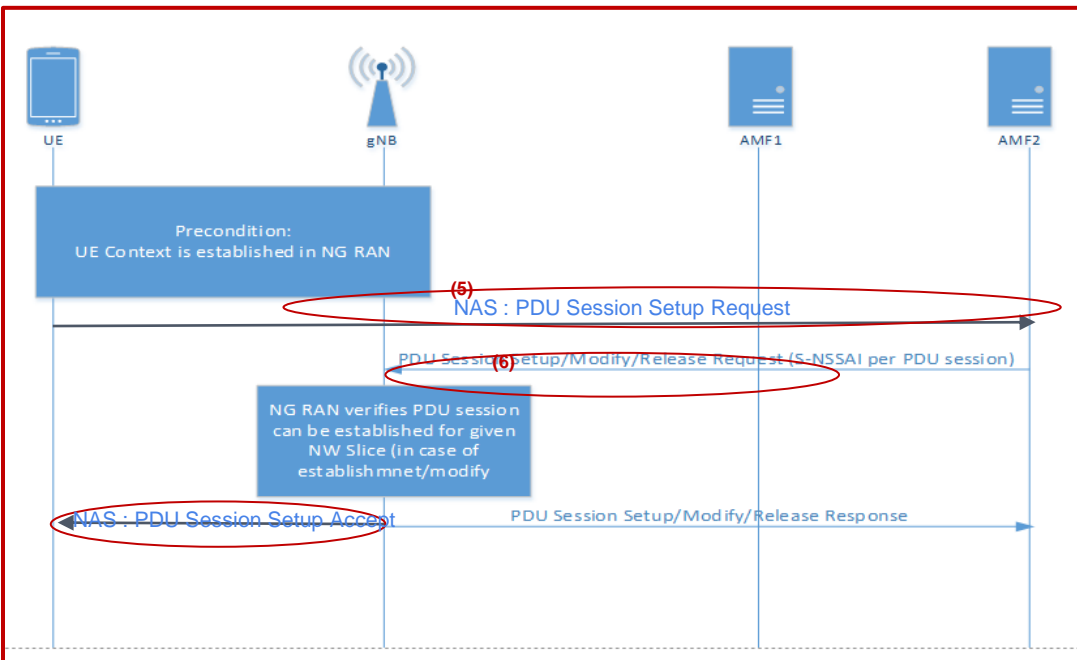
Slice Aware Initial Context Setup



4) AMF responds with NAS Registration Accept in the ICS Request

- Includes the Allowed NSSAI
- gNB may have to update the policies based on the Allowed NSSAI

Slice Aware PDU Session Handling



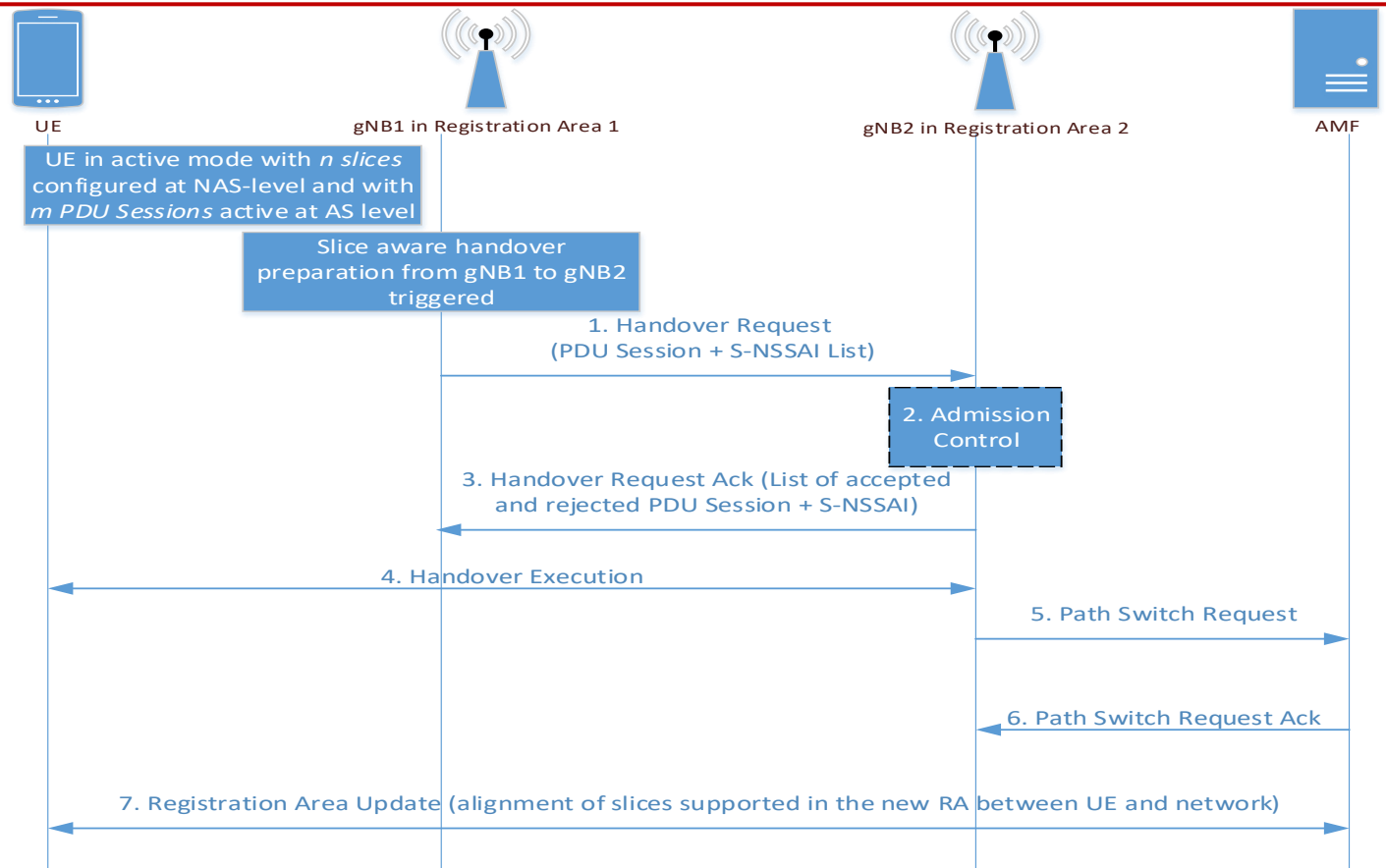
5) UE initiates PDU Session Establishment

- Includes the Allowed NSSAI assigned during the registration

6) AMF sets up the PDU Session with the gNB

- Includes the Allowed NSSAI that has been validated for the PDU Session
- Used by the gNB to map the PDU session to the appropriate slice instance

Slice Aware Xn Based Mobility Handling



Looking Forward – Rel 16

Improvements Being Studied

- Security Enhancements – Slice level Authentication & Authorization post the general procedure
- Network Slicing Enhancement to interwork with EPC in Idle/Connected modes
- Handling cases where 5GS is not able to support all possible combination of S-NSSAIs for the UE
- Isolation impacts among slices
- Business role models for network slicing
- Trust relationships between MNOs and slice tenants under various business role models

Spec References

- 3GPP TS 38.300 – 5G RAN Architecture
- 3GPP TS 23.501 – 5GS Architecture
- 3GPP TS 23.502 – 5GS Procedures



Thanks!