5G NETWORK SLICING – ALL YOU NEED TO KNOW

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ROHDE&SCHWARZ
Make ideas real

5G NETWORK SLICING – ALL YOU NEED TO KNOW

Introduction

Network slicing

RAN slicing

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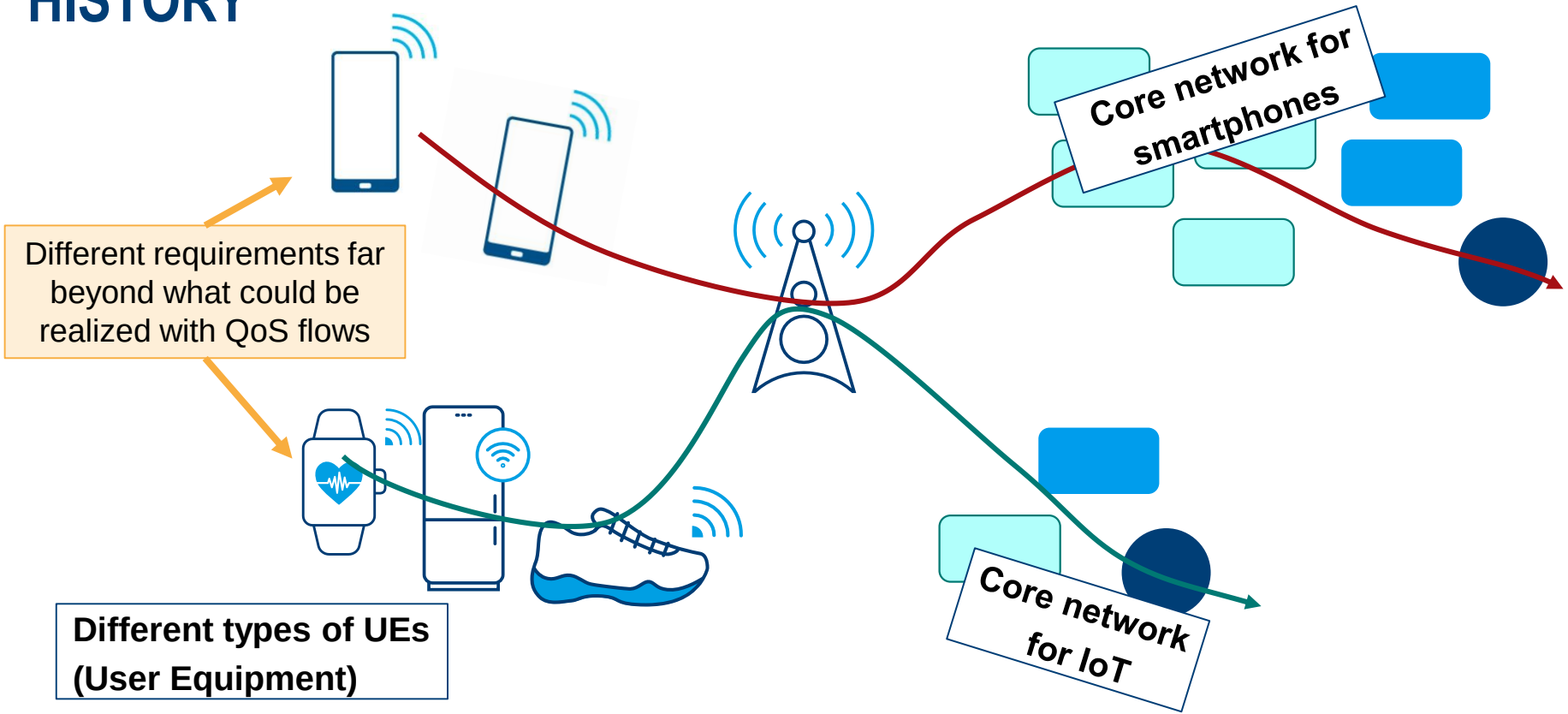
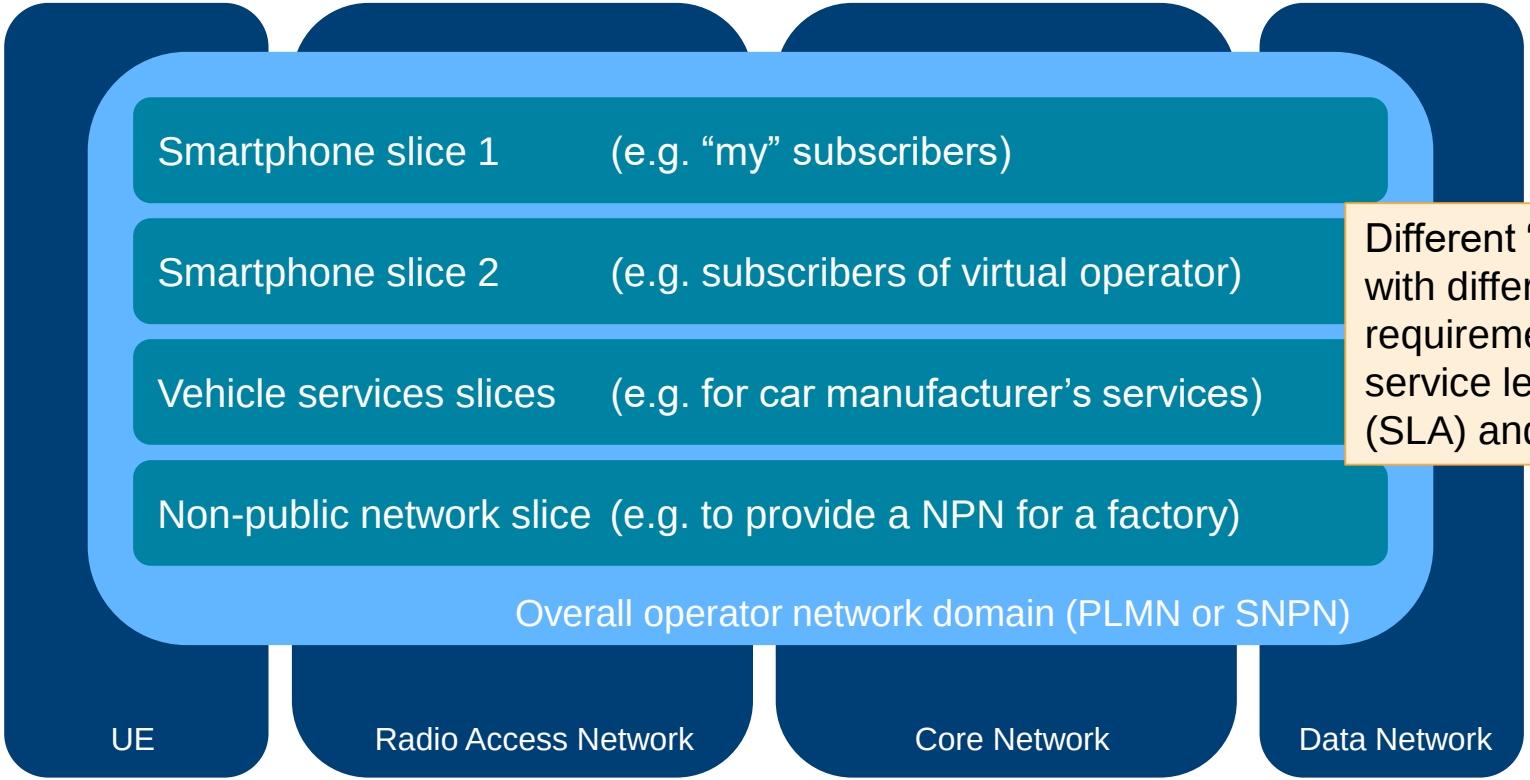
RAN slicing

NETWORK OPERATORS PROVIDING DIVERS SERVICES – HISTORY

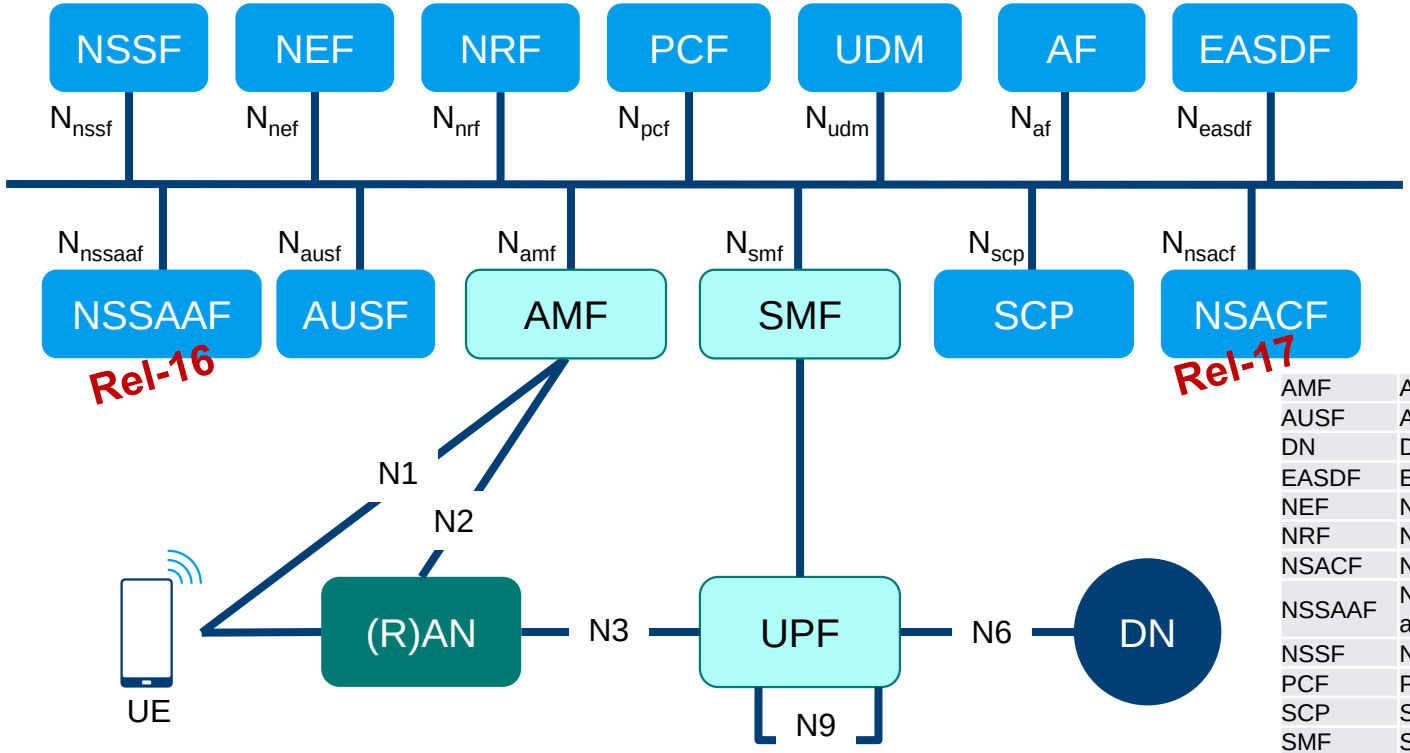


ABSTRACT REPRESENTATION OF A NETWORK DEPLOYING NETWORK SLICES



Different “tenant types” with different service requirements based on service level agreement (SLA) and subscriptions

NON-ROAMING 5G SYSTEM ARCHITECTURE
SERVICE BASED



AMF	Access and mobility management function
AUSF	Authentication server function
DN	Data network
EASDF	Edge application server discovery function
NEF	Network exposure function
NRF	Network repository function
NSACF	Network slice admission control function
NSSAAF	Network slice-specific and SNPN authentication and authorization function
NSSF	Network slice selection function
PCF	Policy control function
SCP	Service communication proxy
SMF	Session management function
UDM	Unified data management
UPF	User plane function

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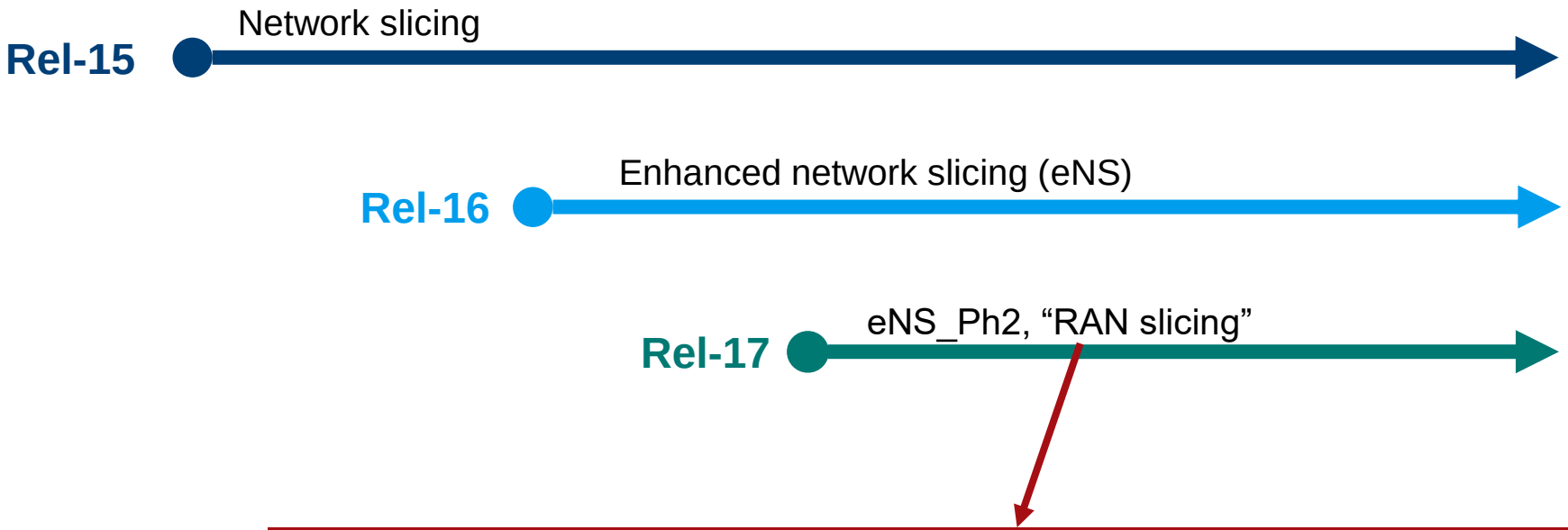
3GPP RAN STANDARDIZATION TIMELINE



Work item title: “Enhancement of RAN slicing for NR” or for short: “RAN Slicing”

both misleading

Work item objective states: **enhancement on RAN support of network slicing**

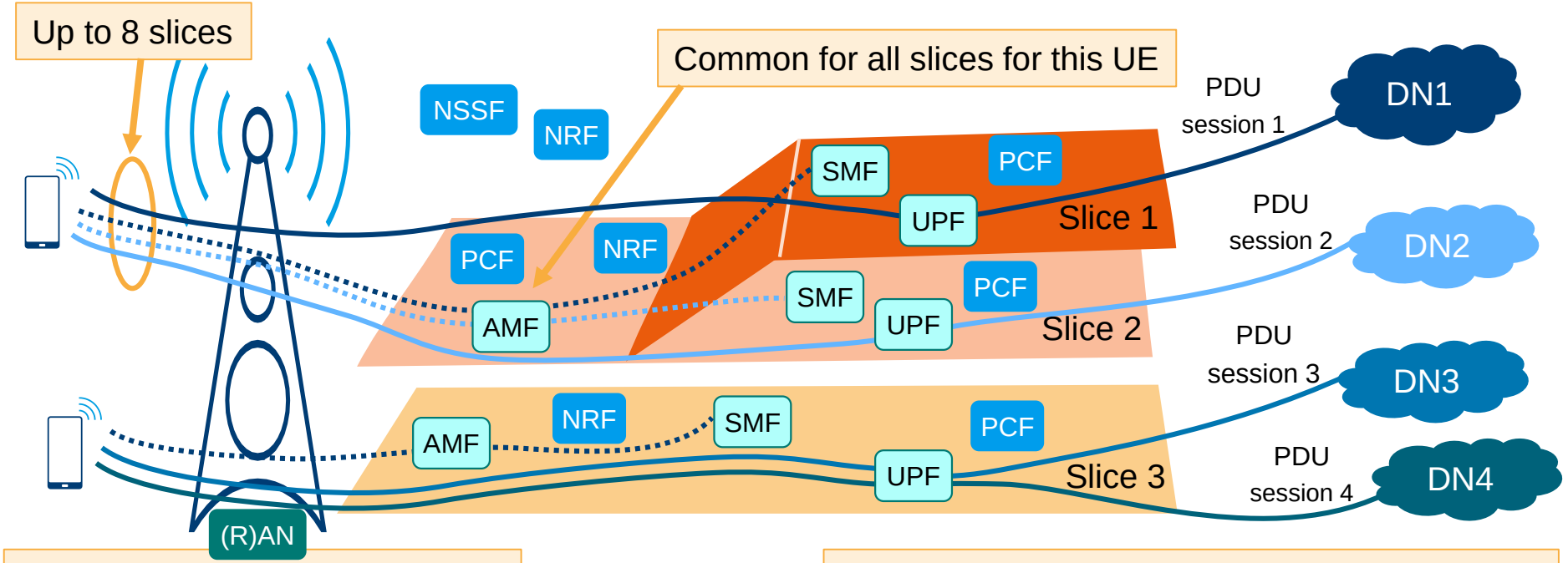
5G NETWORK SLICING – ALL YOU NEED TO KNOW

Introduction

Network slicing

RAN slicing

NETWORK FUNCTIONS COMPOSING NETWORK SLICES



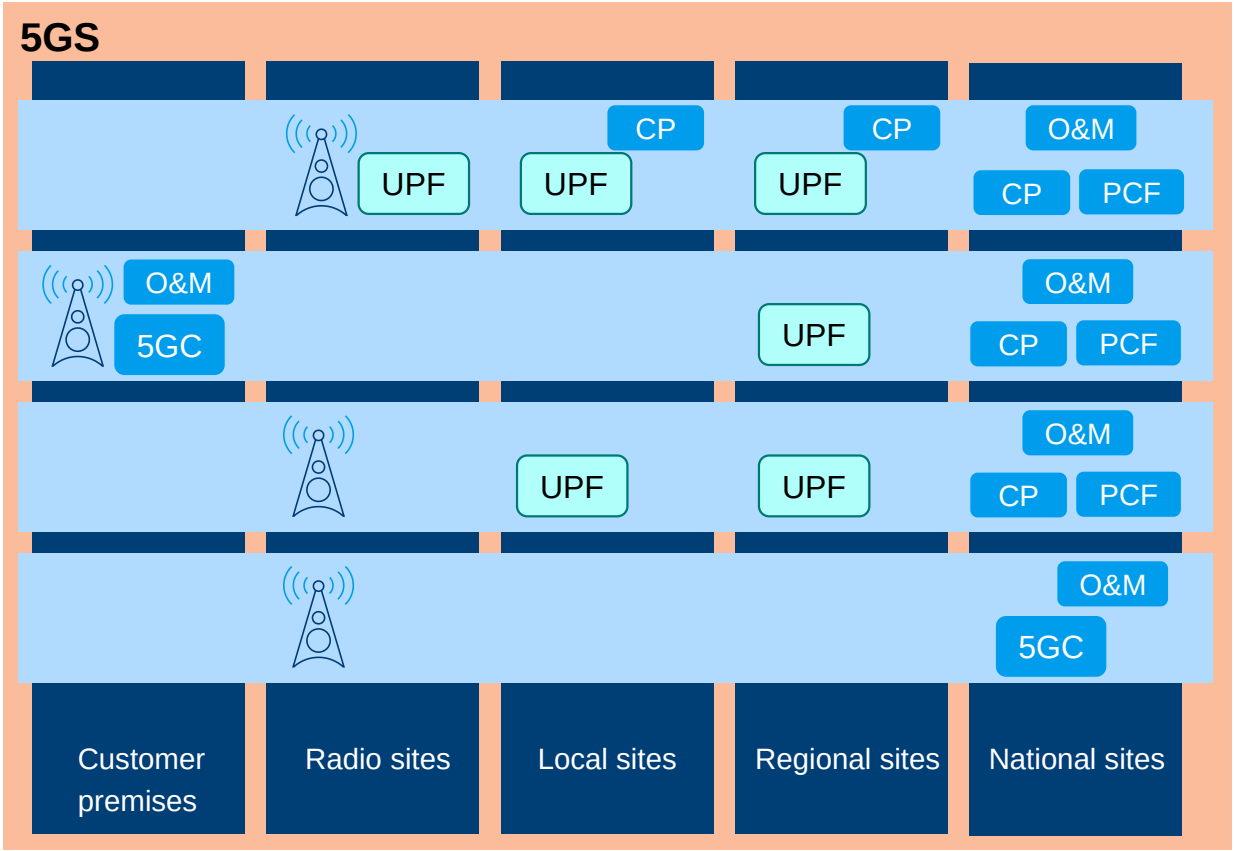
Slices may be realized by scheduling, different L1/L2 configurations, BWPs, etc
→ **details not specified**

Data
Control

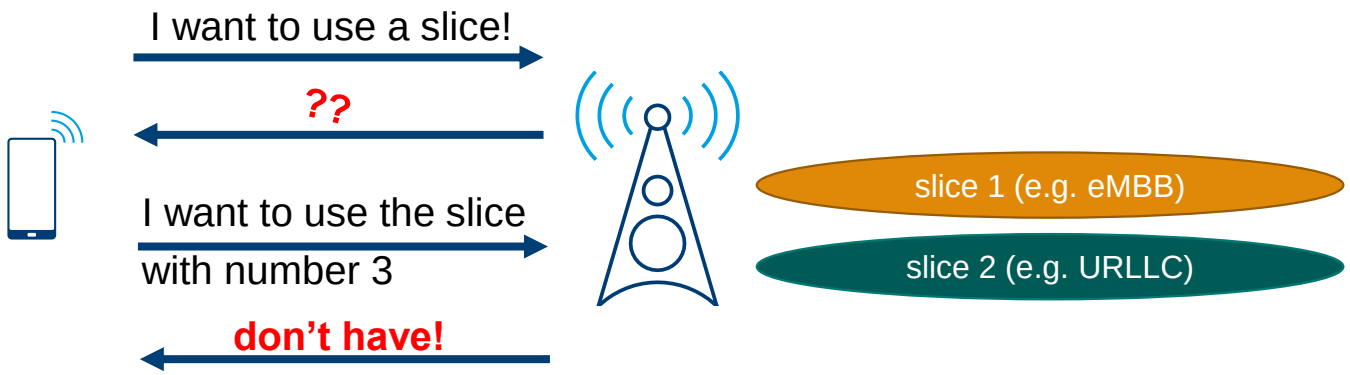
There can be several PDU sessions per slice.
But one PDU session can only belong to one slice.
QoS flows per PDU session.

NETWORK SLICE EXAMPLES

Critical IoT URLLC	Very high availability Very low latency
Enterprise Industrial IoT	High availability Low latency
Enhanced MBB	Wide area coverage Internet access Operator services
Massive IoT	Low cost Low energy Massive number

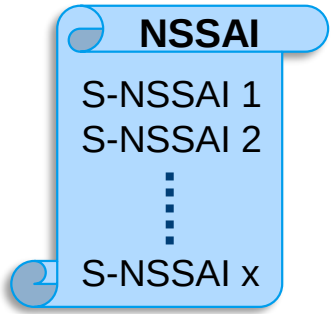


NETWORK SLICING IDENTIFICATION



- How do I know which slices exist?
- How do I know which slice number offers which service?

(S)-NSSAI: (SINGLE)-NETWORK SLICE SELECTION ASSISTANCE INFORMATION



NSSAI can be of type:
- Configured
- Default configured
- Requested
- Allowed
- Default
- Subscribed
- Pending
- Rejected
- Mapped

- S-NSSAI uniquely identifies a slice within a PLMN
- NSSAI is a list of S-NSSAIs (max number x depends on type)

S-NSSAI
Single-network slice selection assistance information

SST	SD
Slice/service type	Slice differentiator
► **Mandatory** ► Separates slices with different features / functions	► **Optional** ► Separates different UE groups using slices with same features / functions

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NETWORK SLICING – SST VALUES

Standardized values
→ only SST, no SD

Non-standardized values
→ SST with or without SD
→ only to be used within the network that issued the S-NSSAI

Slice/service type	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
V2X	4	Slice suitable for the handling of V2X services
HMTC	5	Slice suitable for the handling of high-performance machine-type communications
	6-127	Reserved
	128-255	Operator specific

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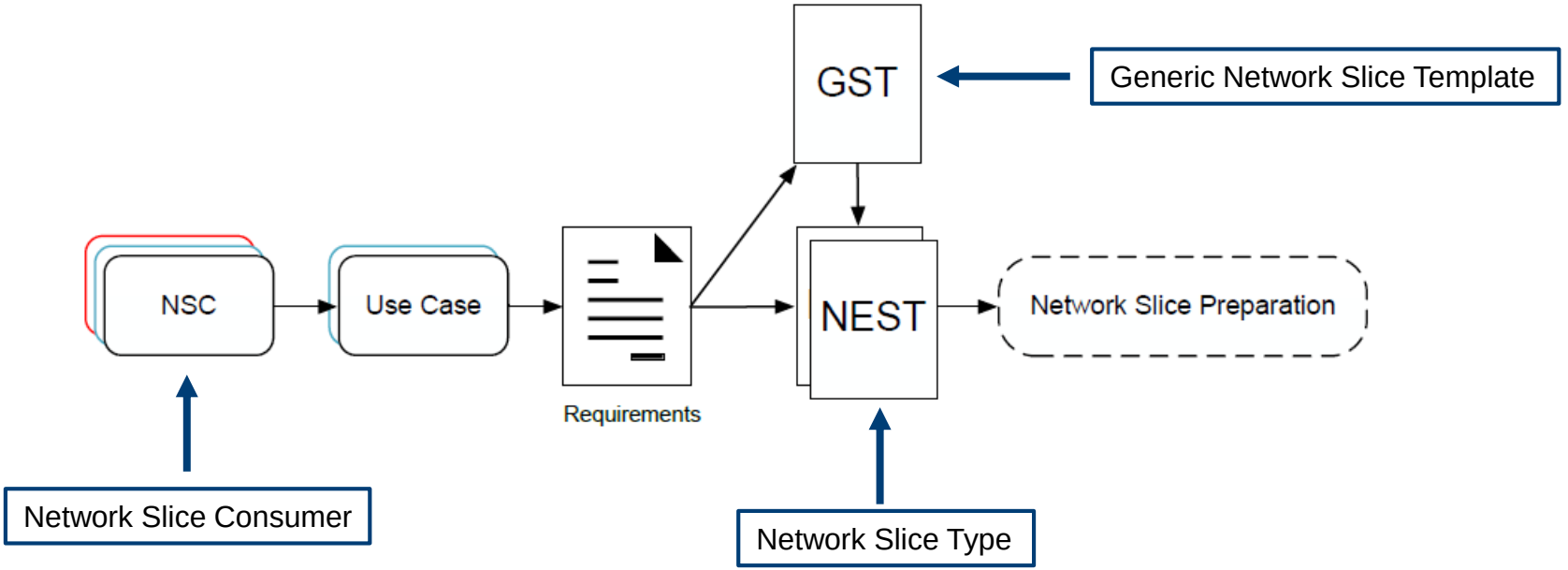
GSMA GENERIC NETWORK SLICE TEMPLATE



GST provides only a list of parameters, NEST is a GST filled with values per slice

GSMA NG.116-v7.0

GSMA EXAMPLE NEST

NEST for eMBB with IMS:

Attribute		Value
Availability		99,999
MMTel support		Supported
Session and Service Continuity support		SSC mode 1
Data Network access	Data access per data network	{Internet DNN, Direct access to the internet}, {IMS, Local traffic (no internet access)}
Supported data network	Supported data network list	Internet DNN, IMS
Slice quality of service	3GPP 5QI	1,2,5,6,7,8,9

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GSMA EXAMPLE NEST

NEST for URLLC:

Attribute		Value
Availability		99.999
Session and Service Continuity Support		1
Slice quality of service	3GPP 5QI	82
Supported device velocity		2

km/h

NEST for massive IoT:

Attribute		Value
Availability		99,9
Slice quality of service	3GPP 5QI	9
Supported device velocity		2
UE density		100000

per km^2

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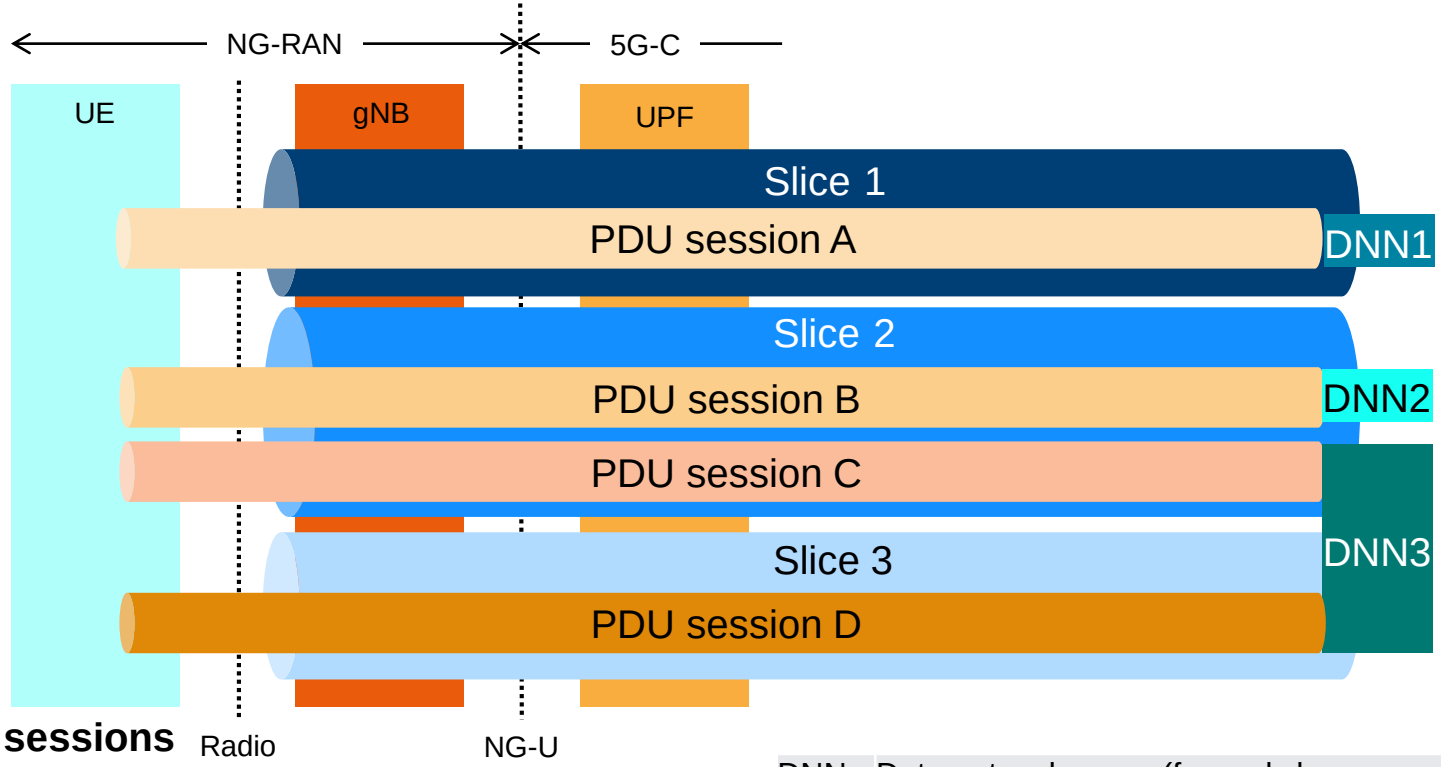
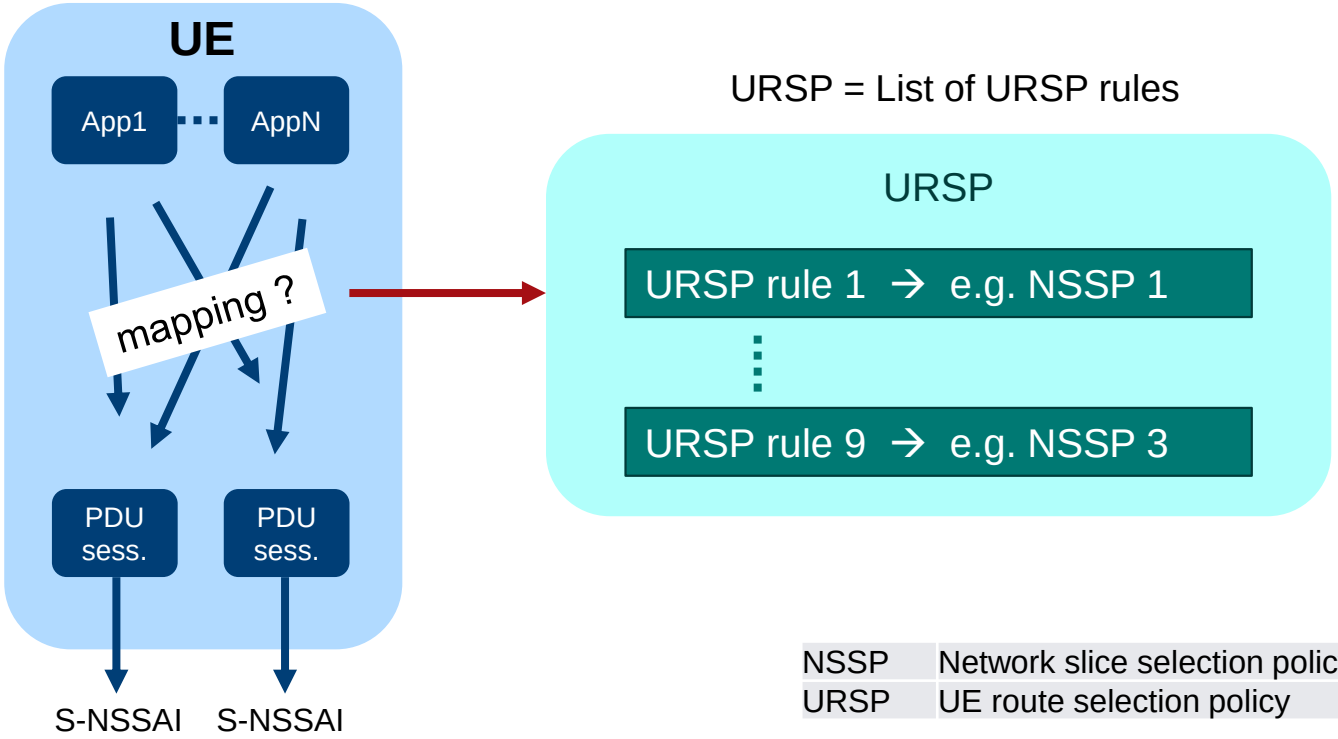
NETWORK SLICE ←→ PDU SESSION ←→ DNN



1 UE:
up to 8 slices
up to 15 PDU sessions

DNN	Data network name (formerly known as APN)

UE ROUTE SELECTION POLICY – URSP



NSSP	Network slice selection policy
URSP	UE route selection policy

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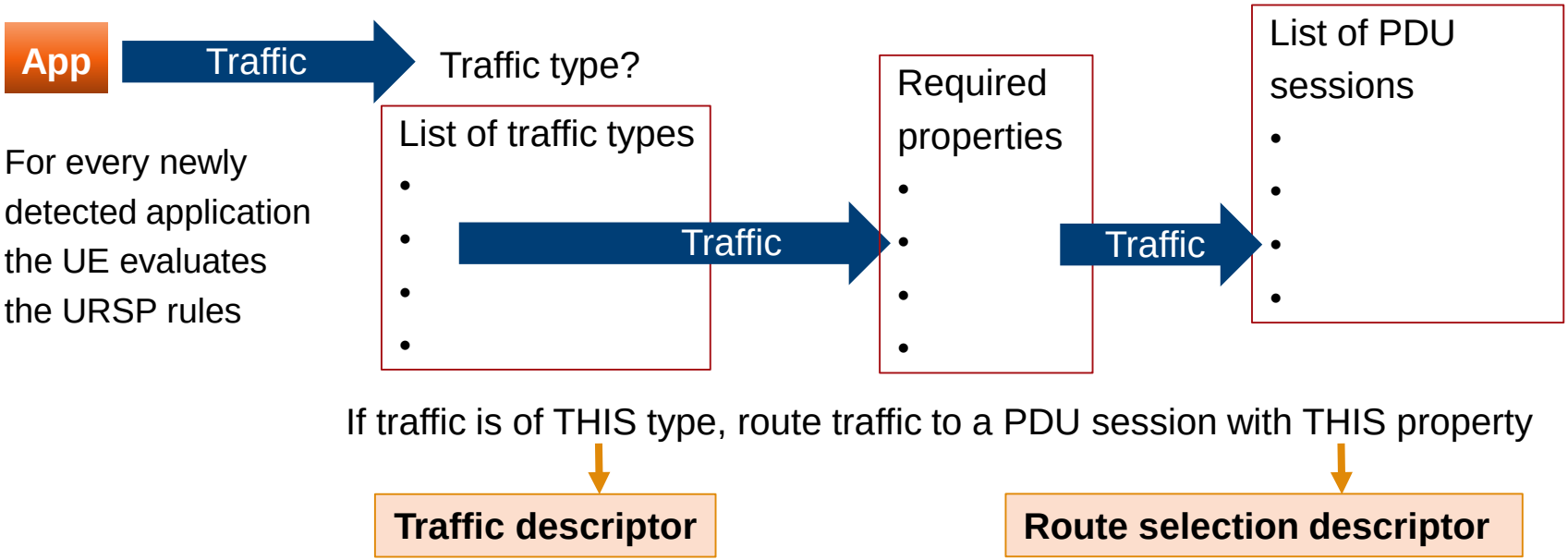
URSP RULES – CONCEPT

URSP rule #1:



URSP RULES – CONCEPT/EXAMPLE

UE Route Selection Policy (URSP)

Rule precedence	Traffic descriptor	Route selection descriptor precedence	Route selection descriptor
1	Application identifier=App1	1	Network slice selection: S-NSSAI={1,2,5} DNN selection: Internet Access type preference: 3GPP access
		2	Network slice selection: S-NSSAI=3 Access type preference: non-3GPP access
…	…	…	…
Lowest	Match all	1	Network slice selection: S-NSSAI=1 SCC mode selection: SCC mode 3 DNN selection: Internet

Match any of the list

more examples: 23.503 Table A-1

UE PROCEDURE FOR ASSOCIATING APPLICATIONS TO PDU SESSIONS BASED ON URSP

UE Route Selection Policy (URSP)				Matching PDU Session ID
Rule precedence	**Traffic descriptor**	**Route selection descriptor precedence**	**Route selection descriptor**	
1	Application Identifier= App1	1	Network slice selection: S-NSSAI={1,2,5} DNN selection: Internet Access type preference: 3GPP access	2
		2	Network slice selection: S-NSSAI=3 Access type preference: non-3GPP access	3, 4, 5
		3	Network slice selection: S-NSSAI=5	---

UE associates App1 to PDU session 2 because it matches the route selection criteria

In case several PDU sessions match the route selection criteria:
up to UE which one to use

In case no PDU session matches the route selection criteria:
UE tries to establish new one
→ if it does not work, continue with next URSP rule

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TRAFFIC DESCRIPTOR

Traffic descriptor component type identifier

8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 1	Match-all type
0 0 0 0 1 0 0 0	OS Id + OS App Id type
0 0 0 1 0 0 0 0	IPv4 remote address type
0 0 1 0 0 0 0 1	IPv6 remote address/prefix length type
0 0 1 1 0 0 0 0	Protocol identifier/next header type
0 1 0 1 0 0 0 0	Single remote port type
0 1 0 1 0 0 0 1	Remote port range type
0 1 0 1 0 0 1 0	IP 3 tuple type
0 1 1 0 0 0 0 0	Security parameter index type
0 1 1 1 0 0 0 0	Type of service/traffic class type
1 0 0 0 0 0 0 0	Flow label type
1 0 0 0 0 0 0 1	Destination MAC address type
1 0 0 0 0 0 1 1	802.1Q C-TAG VID type
1 0 0 0 0 1 0 0	802.1Q S-TAG VID type
1 0 0 0 0 1 0 1	802.1Q C-TAG PCP/DEI type
1 0 0 0 0 1 1 0	802.1Q S-TAG PCP/DEI type
1 0 0 0 0 1 1 1	Ethertype type
1 0 0 0 1 0 0 0	DNN type
1 0 0 1 0 0 0 0	Connection capabilities type
1 0 0 1 0 0 0 1	Destination FQDN
1 0 0 1 0 0 1 0	Regular expression
1 0 1 0 0 0 0 0	OS App Id type
1 0 1 0 0 0 0 1	Destination MAC address range type

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ROUTE SELECTION DESCRIPTOR

Route selection descriptor component type identifier

Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 1	SSC mode type
0 0 0 0 0 0 1 0	S-NSSAI type
0 0 0 0 0 1 0 0	DNN type
0 0 0 0 1 0 0 0	PDU session type type
0 0 0 1 0 0 0 0	Preferred access type type
0 0 0 1 0 0 0 1	Multi-access preference type
0 0 1 0 0 0 0 0	Non-seamless non-3GPP offload indication type
0 1 0 0 0 0 0 0	Location criteria type
1 0 0 0 0 0 0 0	Time window type
1 0 0 0 0 0 0 1	5G ProSe layer-3 UE-to-network relay offload indication type
1 0 0 0 0 0 1 0	PDU session pair ID type
1 0 0 0 0 0 1 1	RSN type

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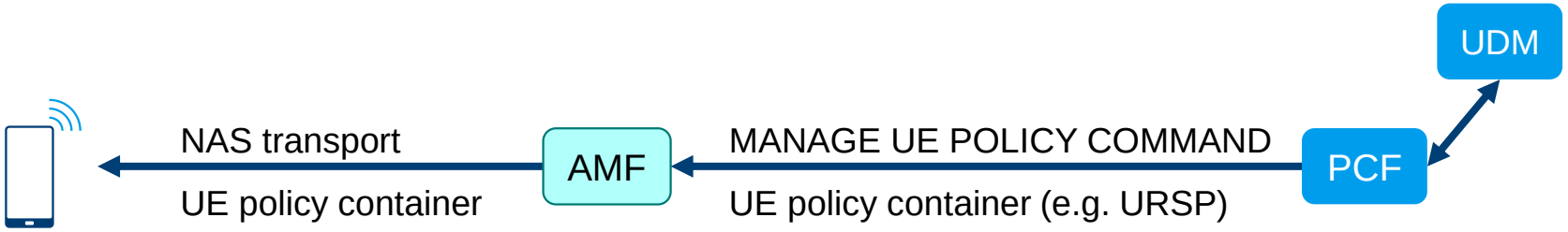
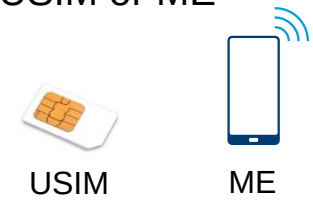
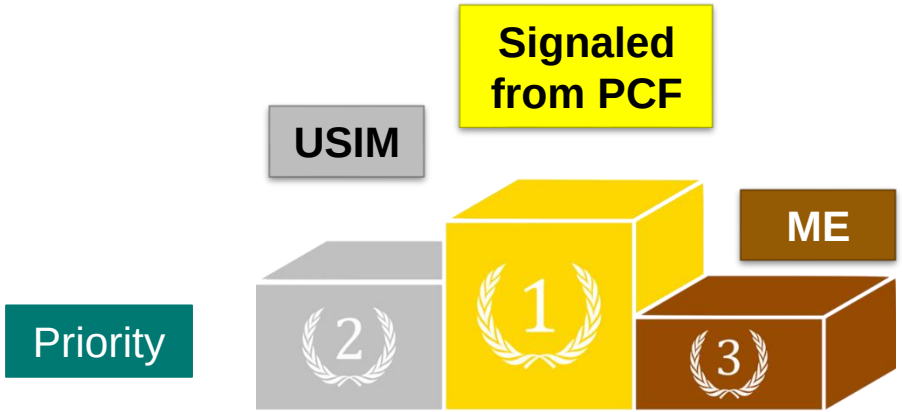
URSP PROVISIONING



URSP may also be pre-provisioned on USIM or ME





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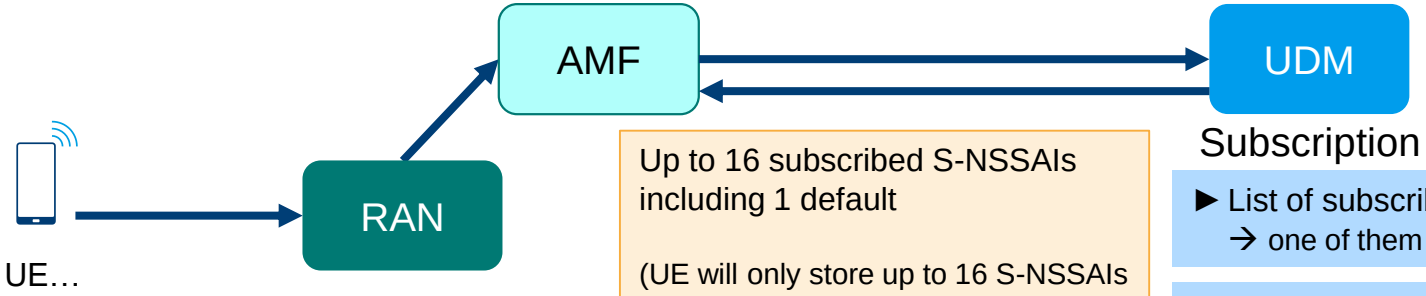
ACCESSING NETWORK SLICES



….wants to be connected to S-NSSAI (requested S-NSSAI)

…but, which AMF supports this slice??

If UE does not provide NSSAI, RAN selects a default AMF

Up to 16 subscribed S-NSSAIs including 1 default

(UE will only store up to 16 S-NSSAIs of a configured NSSAI in a non-volatile memory together with NSSRG information)

Subscription

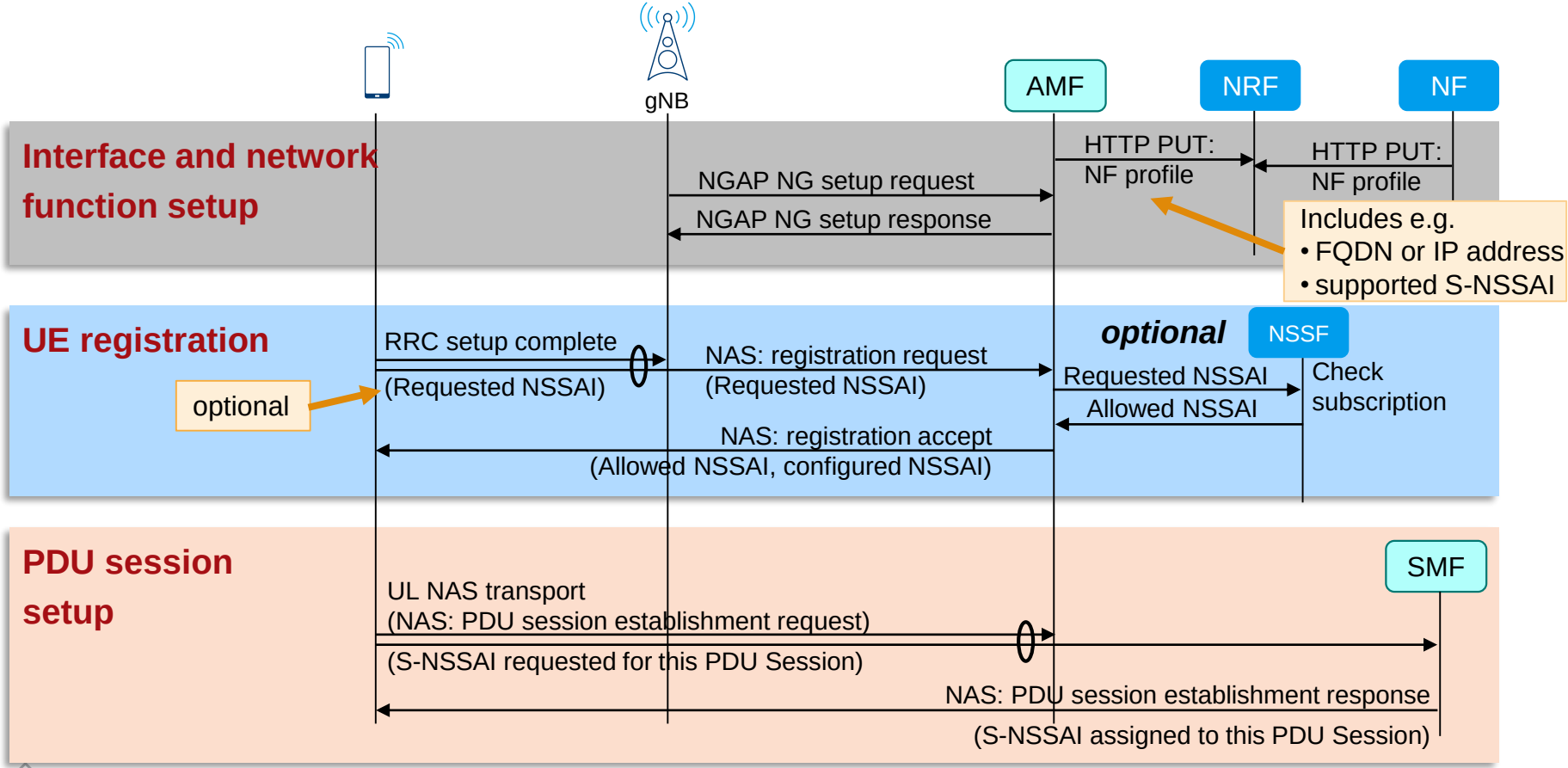
- List of subscribed S-NSSAIs
  → one of them marked as default S-NSSAI

Per S-NSSAI:

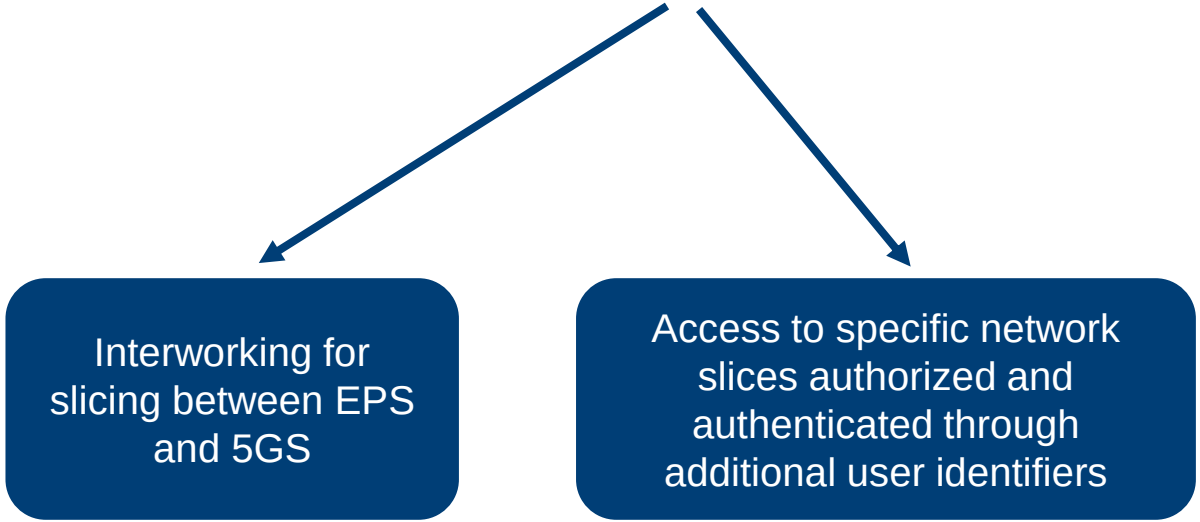
- Subscribed DNN list / one default DNN
- Is S-NSSAI default subscribed S-NSSAI?
- Is S-NSSAI subject to slice-specific authentication and authorization (NSSAA)?
- Network slice simultaneous usage group (NSSRG) information

S-NSSAI	Single network slice selection assistance information

SIGNALLING PROCEDURES INVOLVING SLICES



ENHANCED NETWORK SLICING – eNS (REL-16)



Network slice-specific authentication and authorization (NSSAA)

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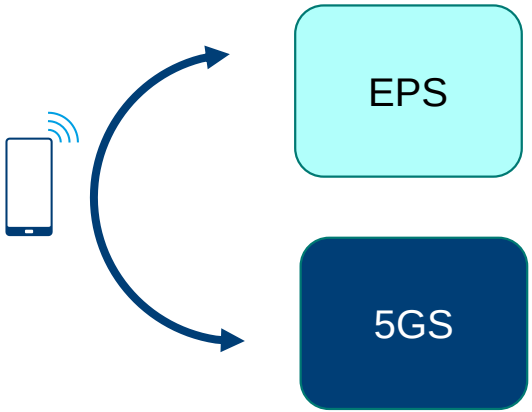
SP-181232

eNS - NETWORK SLICING AND INTERWORKING WITH EPS



EPS may support dedicated core network IDs

5GS supports NSSAIs

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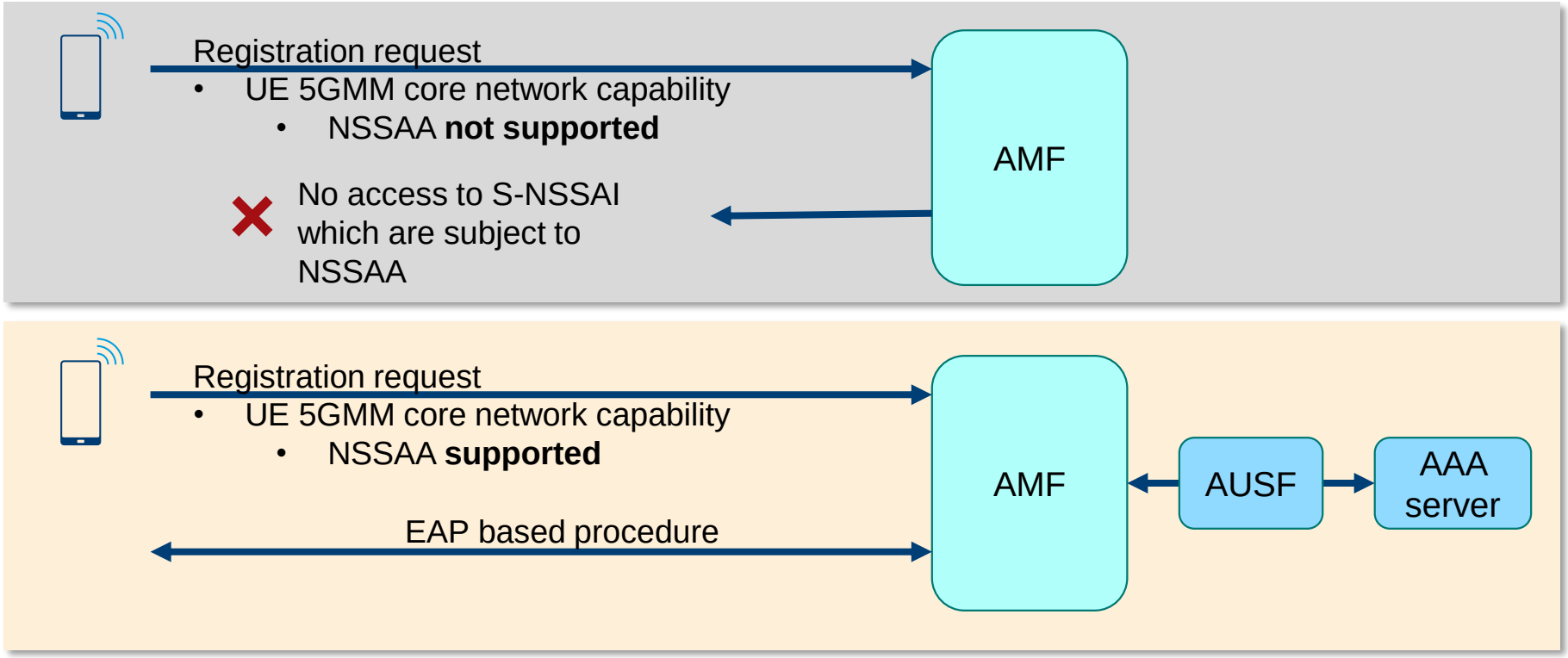
ENHANCED NETWORK SLICING – eNS / NSSAA (REL-16)



NSSAA Network slice-specific authentication and authorization

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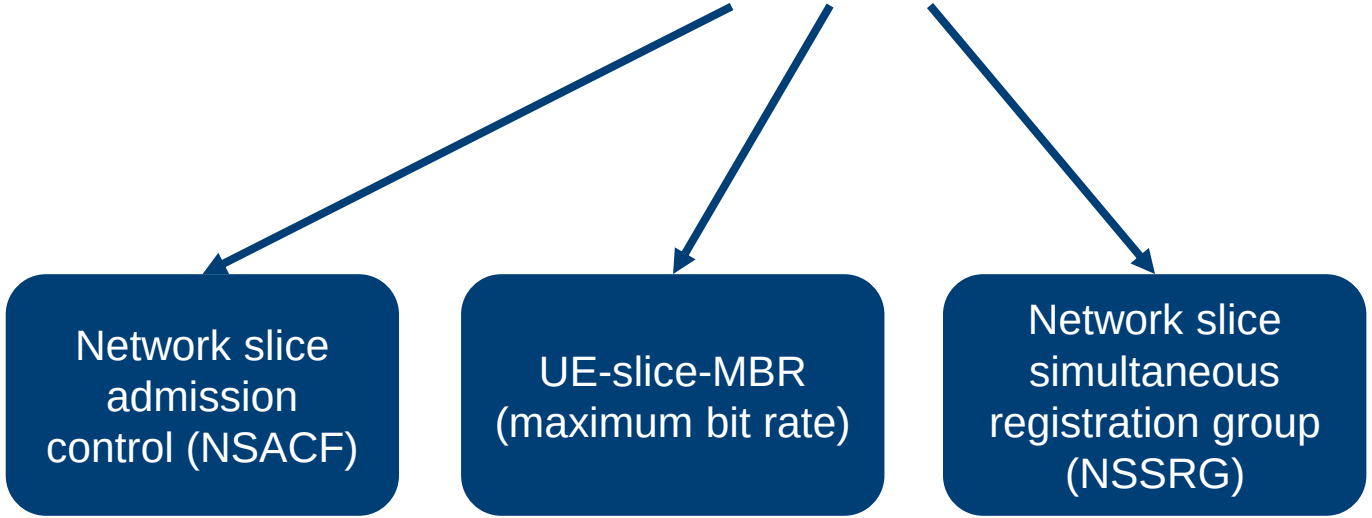
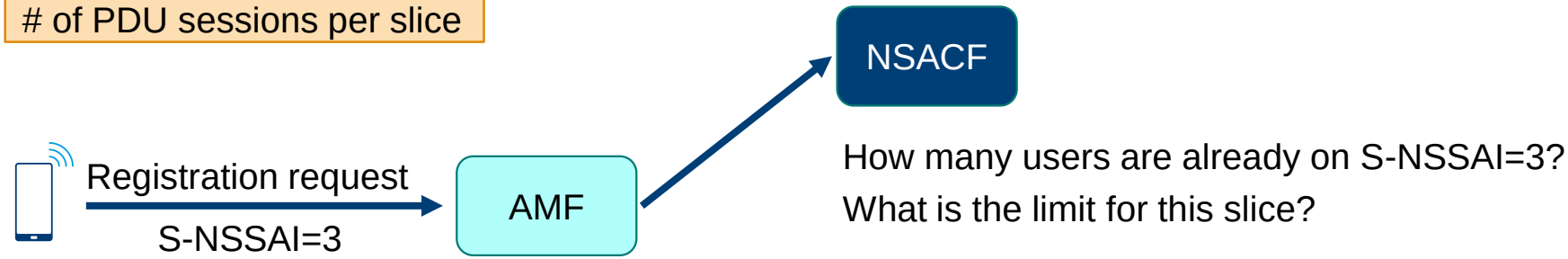
ENHANCED NETWORK SLICING PHASE 2 – eNS_PH2 (REL-17)



ENHANCED NETWORK SLICING – eNS_PH2
NETWORK SLICE ADMISSION CONTROL (NSACF)

NSACF controls the limits of
# of registered UE per slice
# of PDU sessions per slice



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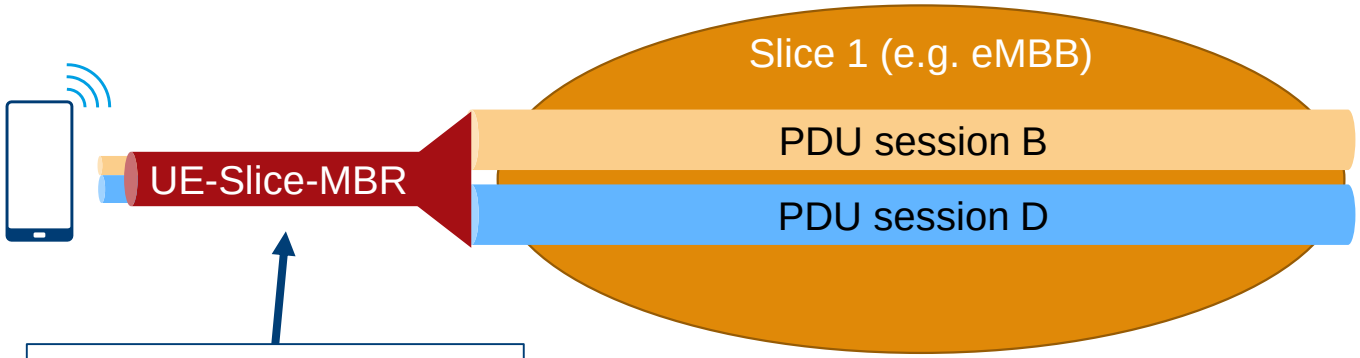
UE-SLICE-MBR (MAXIMUM BIT RATE)



Applied to the sum of all PDU sessions of this slice

Value from:

- Operator policy
- User subscription

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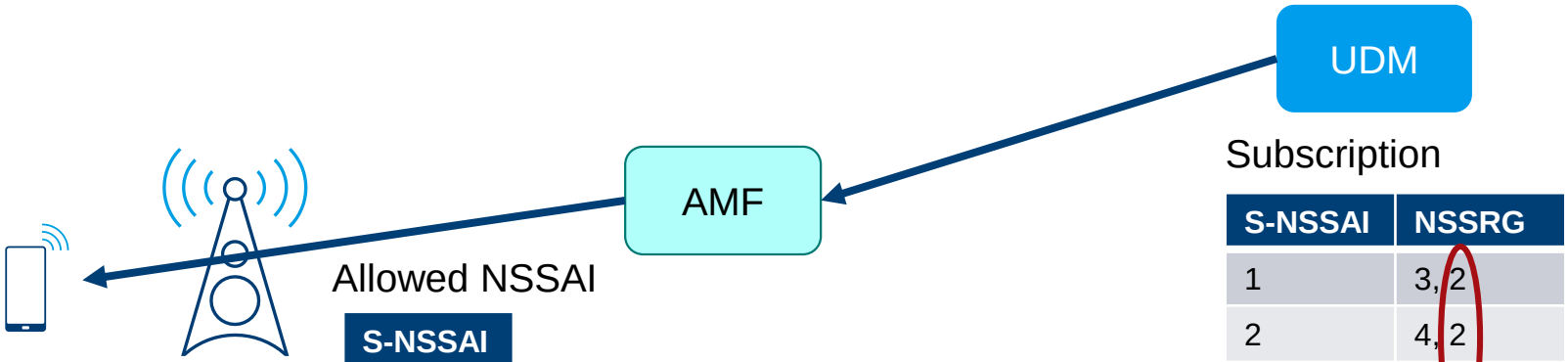
NETWORK SLICE SIMULTANEOUS REGISTRATION GROUP (NSSRG)



S-NSSAI
1
2
3
4
5

Subscription

S-NSSAI	NSSRG
1	3, 2
2	4, 2
3	4, 2
4	5
5	5, 3

UE can register to more than one S-NSSAI at the same time only if the slices have the same NSSRG number.
E.g. S-NSSAI 1,2,3

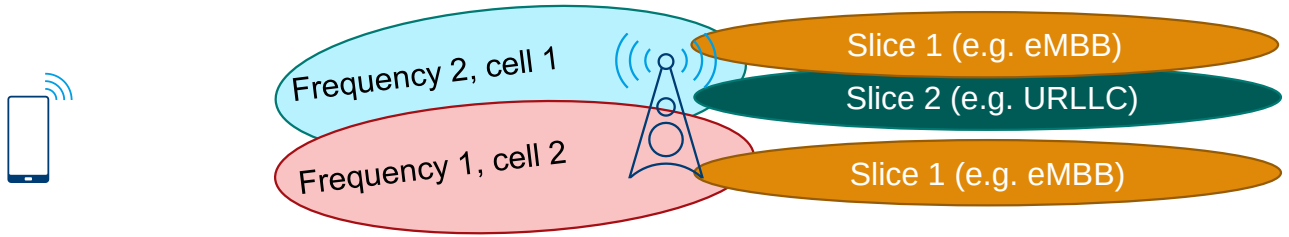
5G NETWORK SLICING – ALL YOU NEED TO KNOW

Introduction

Network slicing

RAN slicing

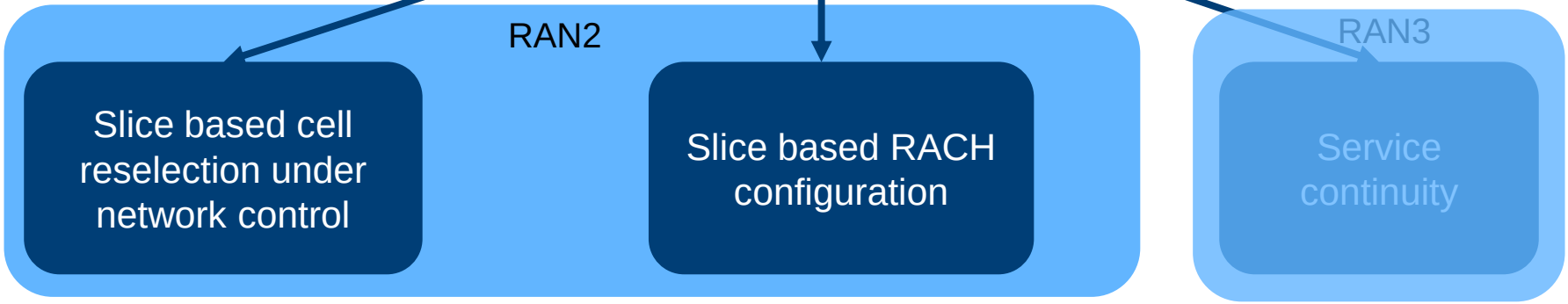
ENHANCEMENT ON RAN SUPPORT OF NETWORK SLICING “RAN SLICING” (REL-17)



1) How do I know which cell / frequency supports the slice I like?
→ Slice-based cell reselection under network control

2) How can I access the respective cell fast?
→ Slice-based RACH configuration

ENHANCEMENT ON RAN SUPPORT OF NETWORK SLICING "RAN SLICING" (REL-17)



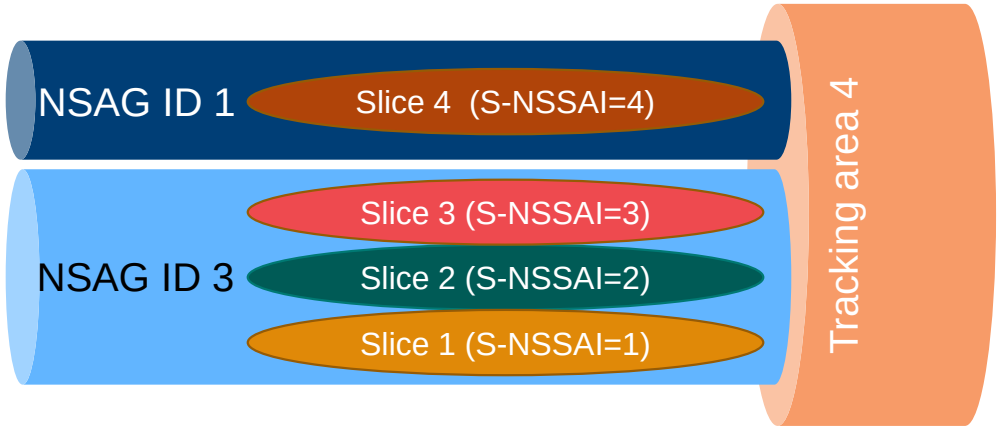
- Slice group based **inter-frequency** cell re-selection priorities
  - use SIB and/or RRCRelease
- **Intra-frequency:** always use best cell

- RACH partitioning per slice group
- RACH prioritization per slice group

- Mobility scenarios

Slice group = Network slice AS group (NSAG)

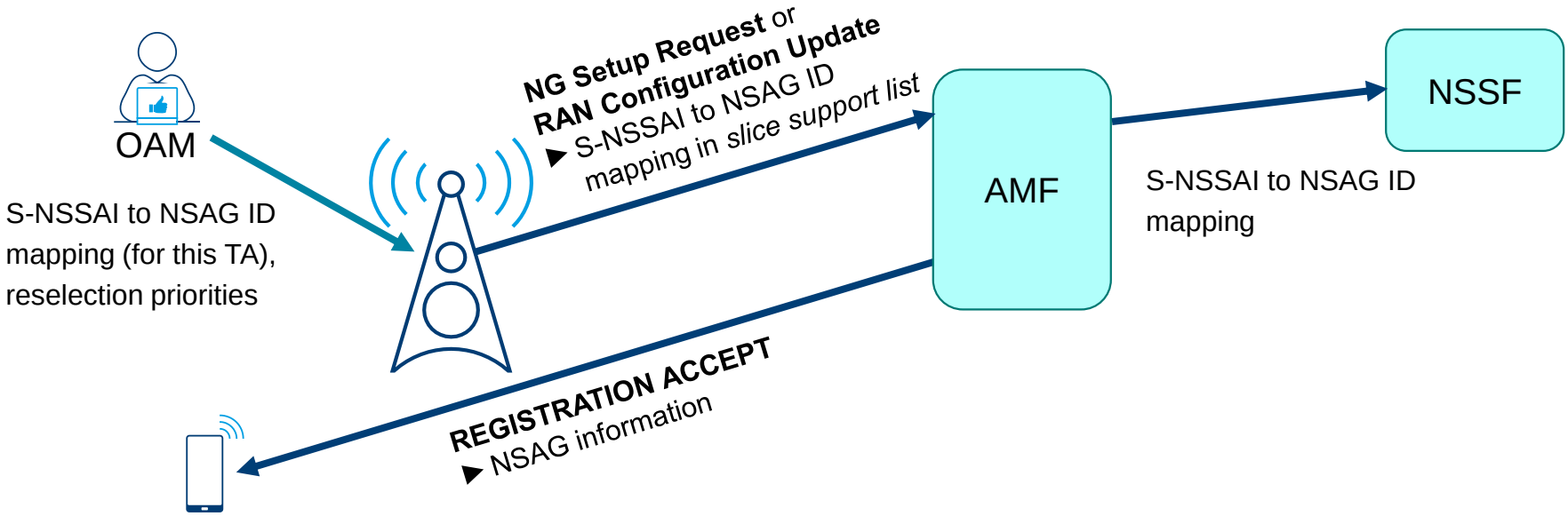
SLICE GROUPING – NETWORK SLICE AS GROUP (NSAG)



Network Slice AS Group (NSAG):

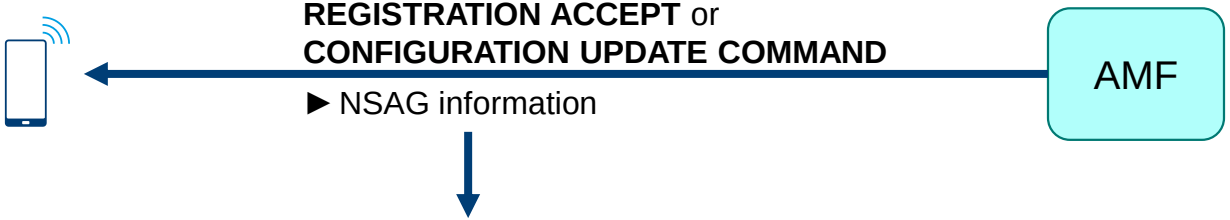
- Identifies a slice or a set of slices
- An NSAG is defined within a TA, used for slice-based cell reselection and/or slice-based RACH configuration

RAN SLICING – NSAG NETWORK SLICE AS GROUP



NSSF	Network slice selection function
OAM	Operation and maintenance

RAN SLICING – NSAG INFORMATION



NSAG ID	List of S-NSSAIs	NSAG area (list of TAIs)	NSAG priority
NSAG 7	S-NSSAI 4, S-NSSAI 8, S-NSSAI 3	1, 4, 8	1
NSAG 8	S-NSSAI 5, S-NSSAI 9, S-NSSAI 7	1, 3, 8	2

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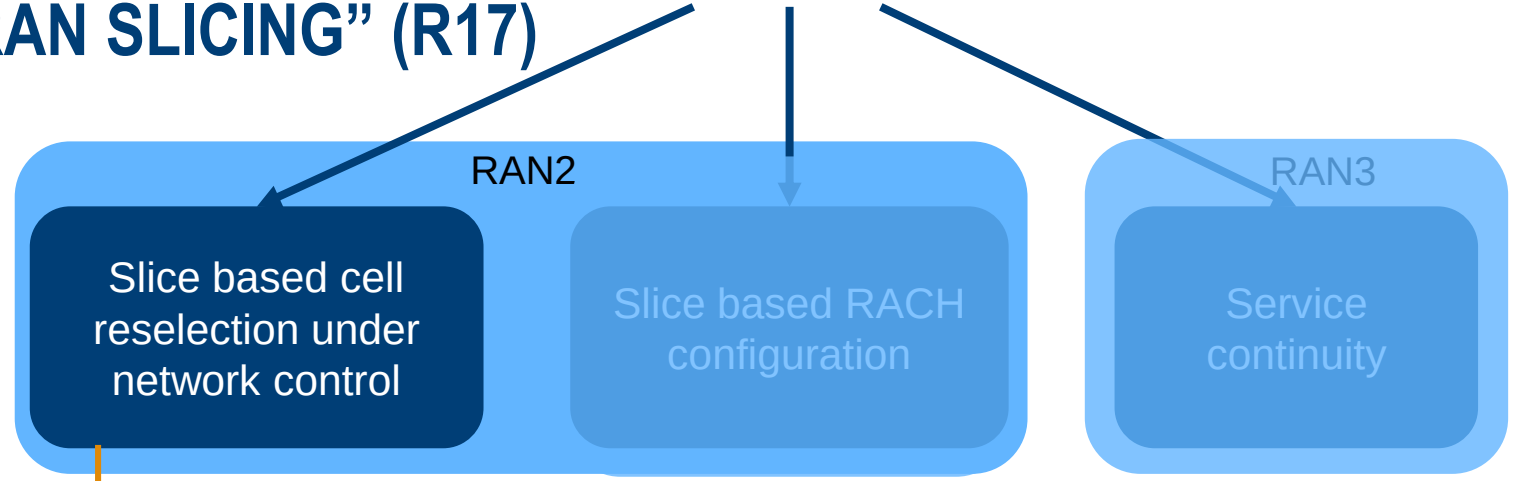
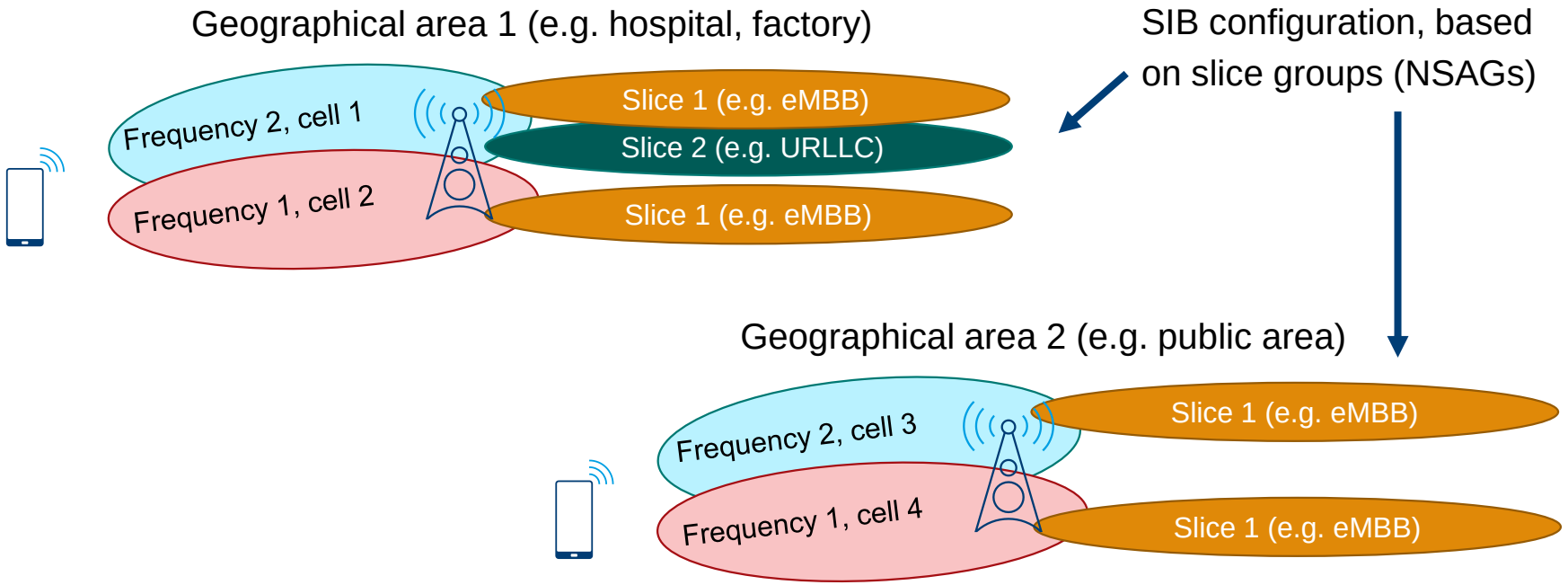
ENHANCEMENT ON RAN SUPPORT OF NETWORK SLICING "RAN SLICING" (R17)



Slice group based (NSAG) **inter-frequency** cell re-selection priorities

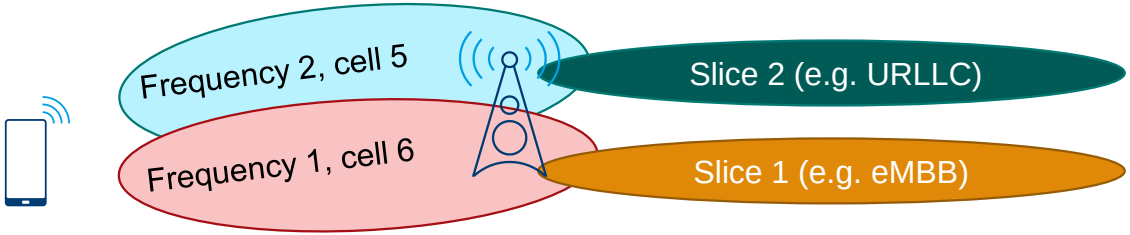
- ►Use SIB16 (*sliceInfoList)* and/or
- ►RRCRelease (*sliceInfoListDedicated*)
- ►RRC config overrides SIB config
- ►S-NSSAI mapping to NSAG, NSAG priorities from NAS

RAN SLICING – EXAMPLE SCENARIOS



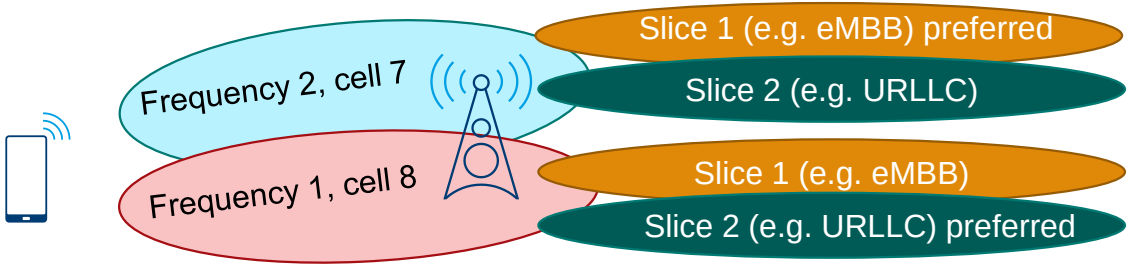
RAN SLICING – EXAMPLE SCENARIOS

Geographical area 3 (slices separated by frequency)

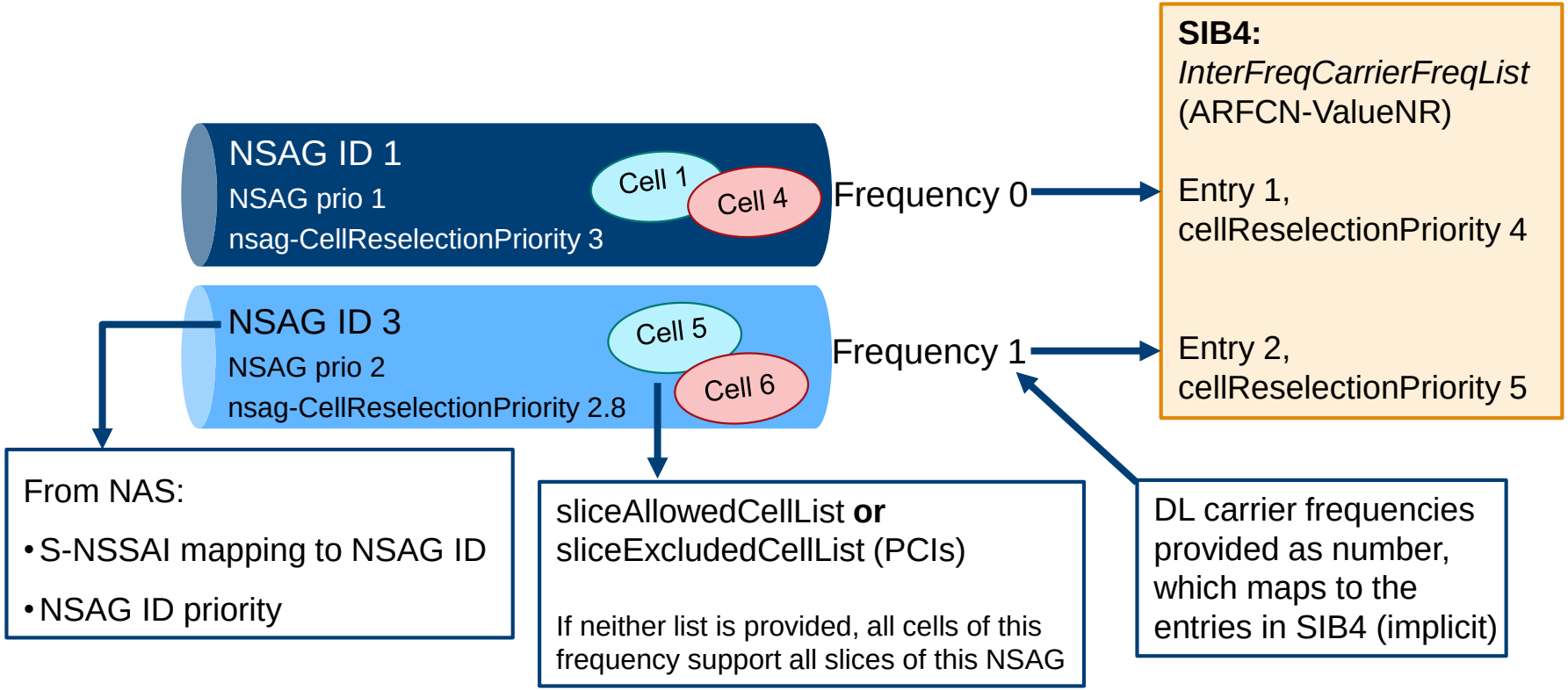


SIB configuration, based on slice groups (NSAGs)

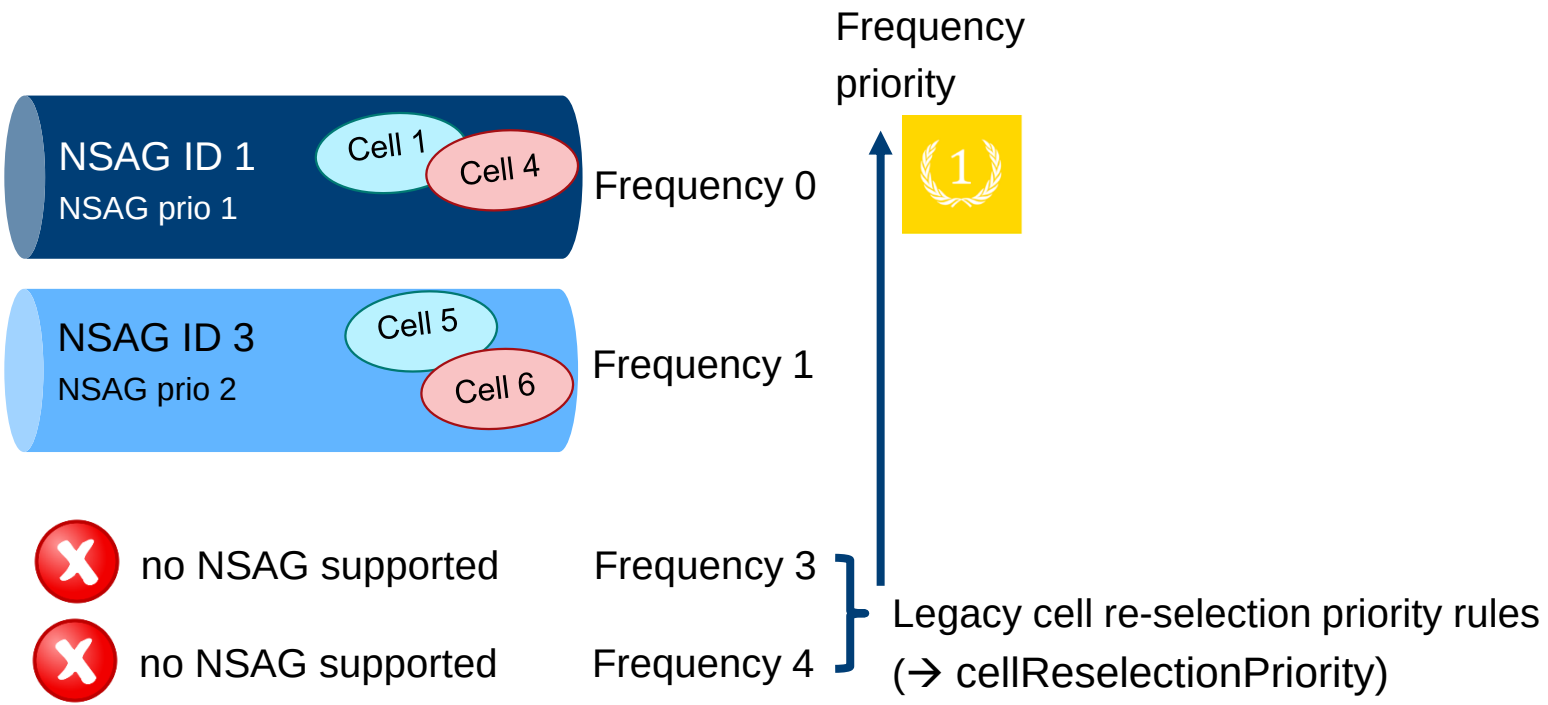
Geographical area 4 (all slices supported on every frequency, but with different priority)



RAN SLICING – RESELECTION PRIORITIES - SIB16

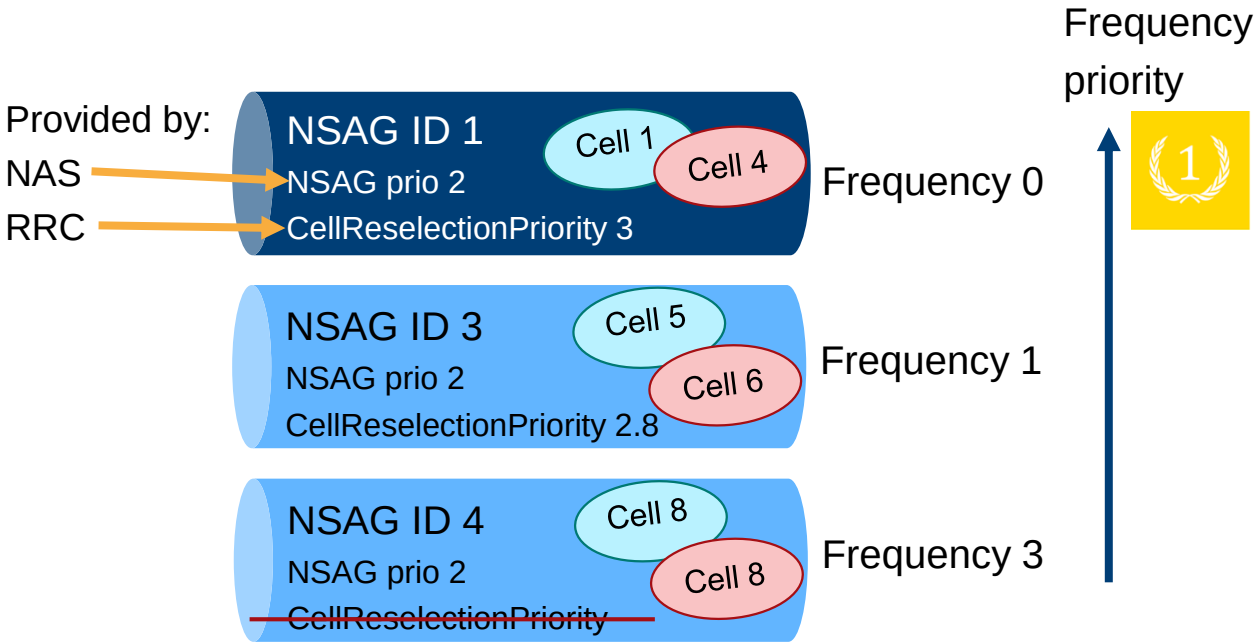


FREQUENCY PRIORITY ORDER



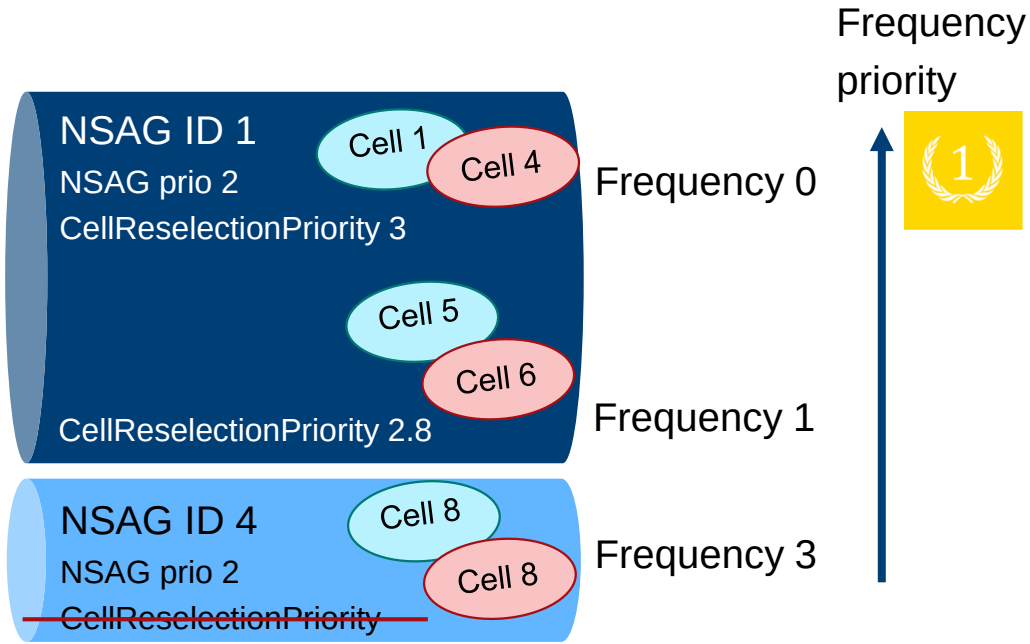
TS 38.304 5.2.4.11

FREQUENCY PRIORITY ORDER



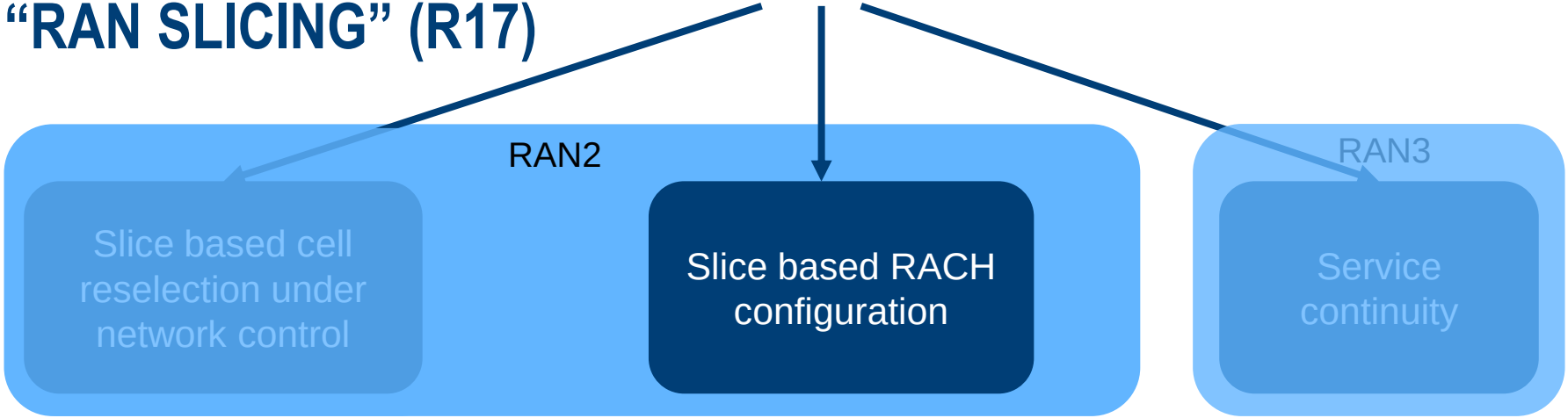
TS 38.304 5.2.4.11

FREQUENCY PRIORITY ORDER



TS 38.304 5.2.4.11

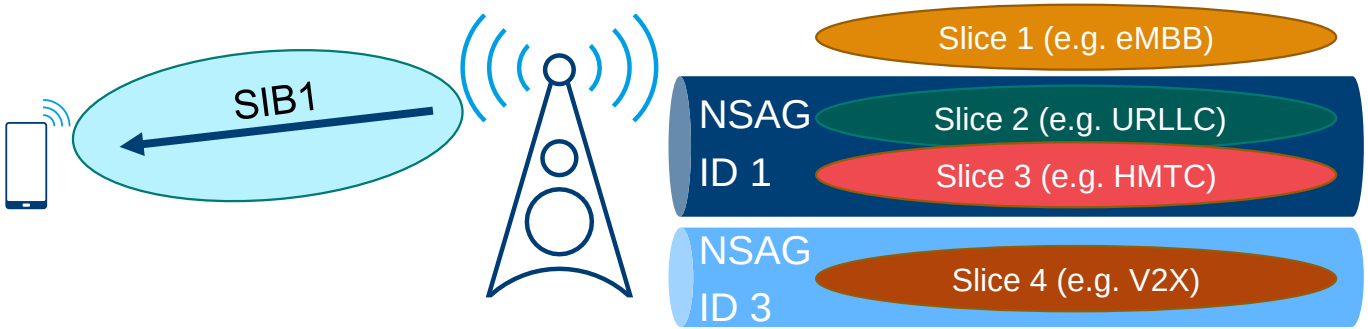
ENHANCEMENT ON RAN SUPPORT OF NETWORK SLICING "RAN SLICING" (R17)



- RACH partitioning per slice group
- RACH prioritization per slice group

Slice group = NSAG Network Slice AS Group

RAN SLICING:
SLICE (GROUP) BASED RACH CONFIGURATION



Slices with no group use RA common configuration

Slices within a group share same RACH configuration

Same RACH configuration could be assigned to several groups

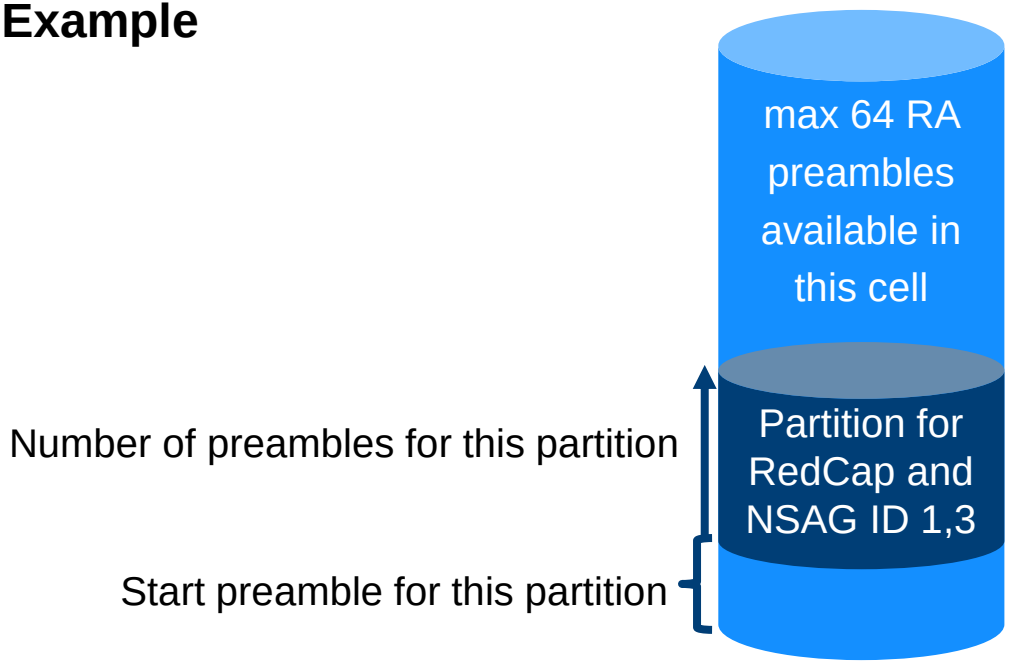
In order to perform CBRA to access	
Slice	**Use RACH config**
1	common
2	4
3	
4	5

4-step, 2-step, or both.
CFRA not supported in Rel-17

Isolated RA resources (RO, preamble partitioning) with higher priority (*scalingFactorBI* and *powerRampingStepHighPriority)*

SLICE (GROUP) BASED RACH PARTITIONING

Example



Partitioning per:

- Feature combination
  → can contain only one feature
- List of NSAG IDs
  →can contain only one ID

SLICE (GROUP) BASED RACH PRIORITIZATION

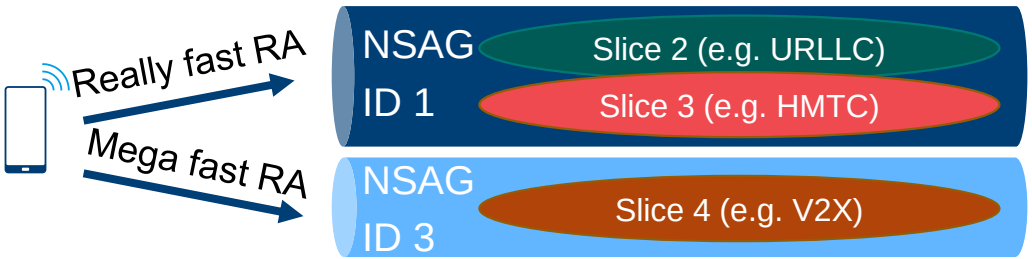
RACH-ConfigCommon

RACH-ConfigCommonTwoStepRA

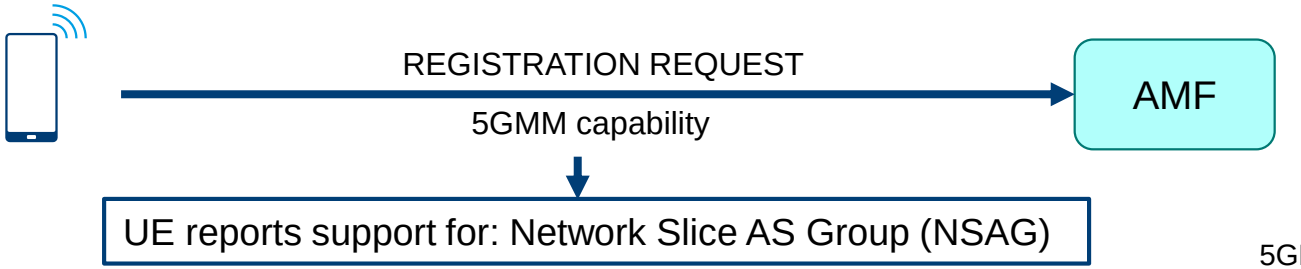
RA-PrioritizationForSlicing-r17

Connect NSAG-ID with
RA prioritization configuration

scalingFactorBI
powerRampingStepHighPriority



RAN SLICING – UE CAPABILITIES



5GMM 5G Mobility Management

Definitions for parameters	Per	M	FDD-TDD DIFF	FR1-FR2 DIFF
sliceInfoforCellReselection-r17 Indicates whether the UE supports slice reselection information in SIB and on RRC release for slice based cell reselection in RRC _IDLE and RRC INACTIVE as defined in TS 38.304	UE	No	No	No

TS 38.306

Definitions for feature
Random access prioritisation for slicing It is optional for UE to support slice based prioritisation for random access as specified in TS 38.321
Random access partitioning for slicing It is optional for UE to support slice based RACH partitioning as specified in TS 38.321

TS 38.306

THANK YOU

Find out more

www.rohde-schwarz.com/5g

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