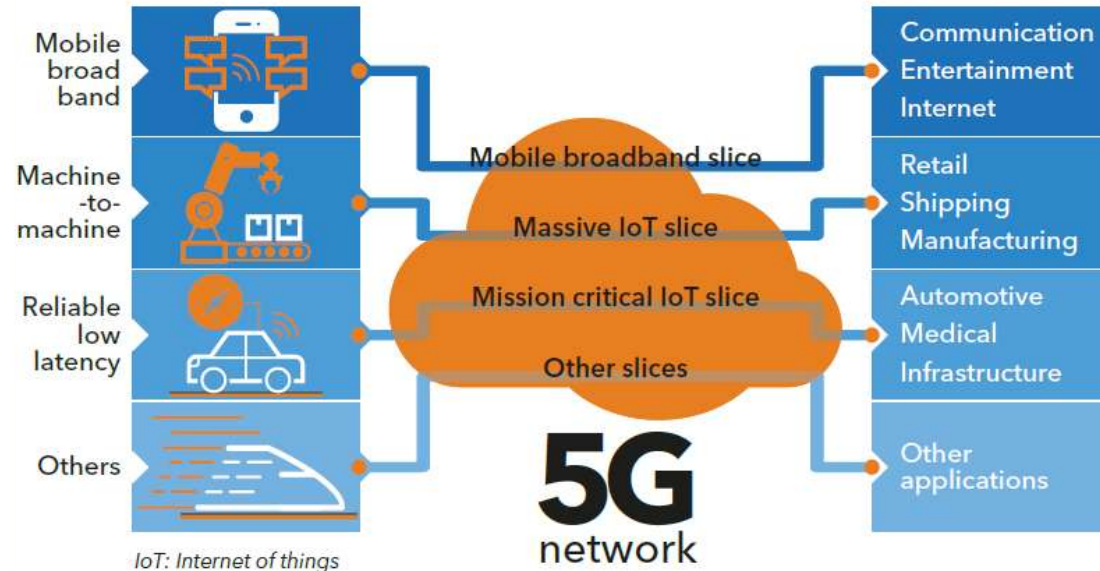


5G Network Slicing

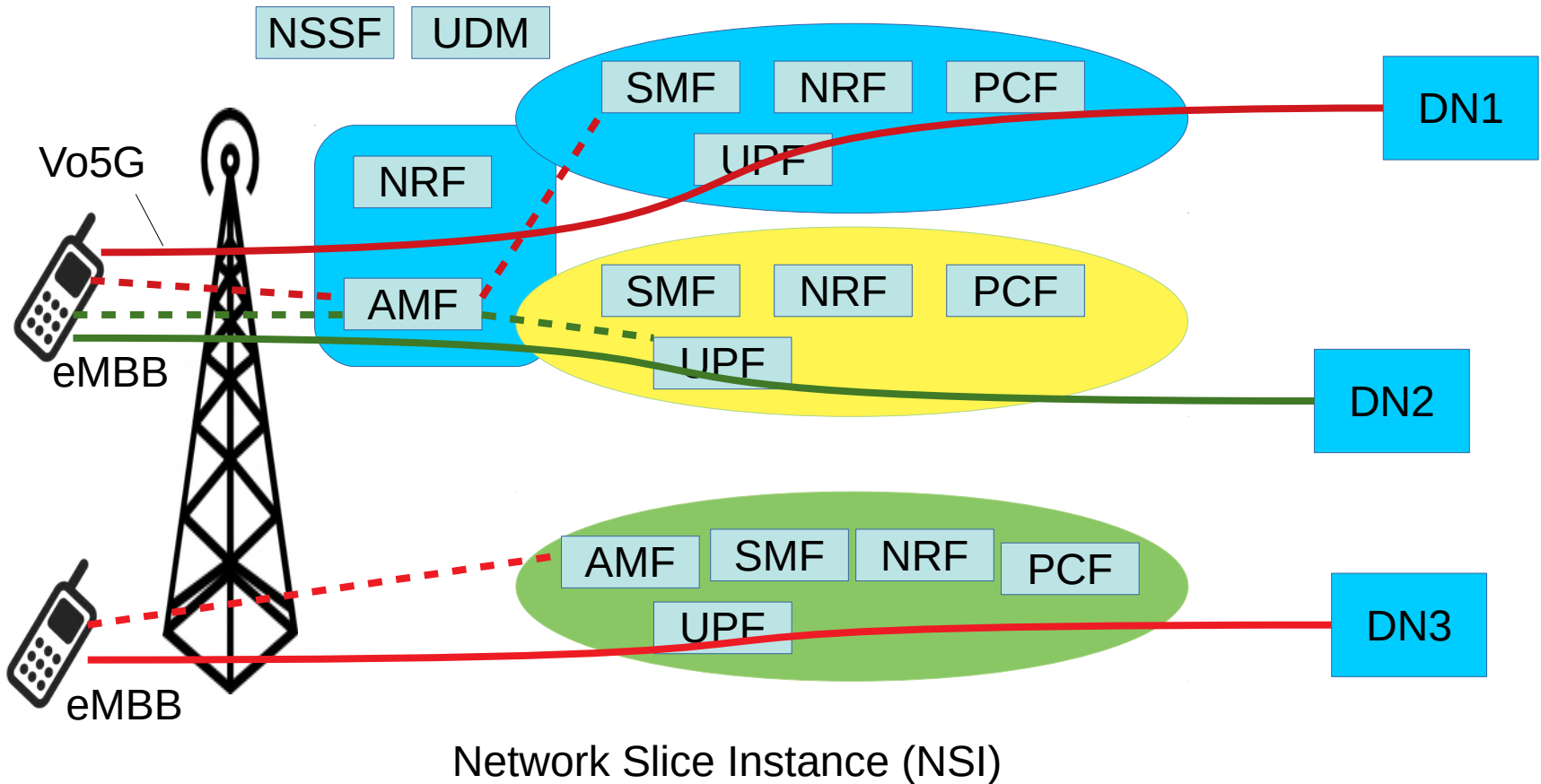
What is network slice?

Network Slice is a logical network serving a defined customer, consisting of all required network resources configured together.

- Complete network within a provider
- Resources optimized for one use case
- Isolated but may share resources
- User experience it is as a separate network
- On demand allocation of resources



Example of Network Slicing In 5G



Single Network Slice Selection Assistance Information (S-NSSAI)

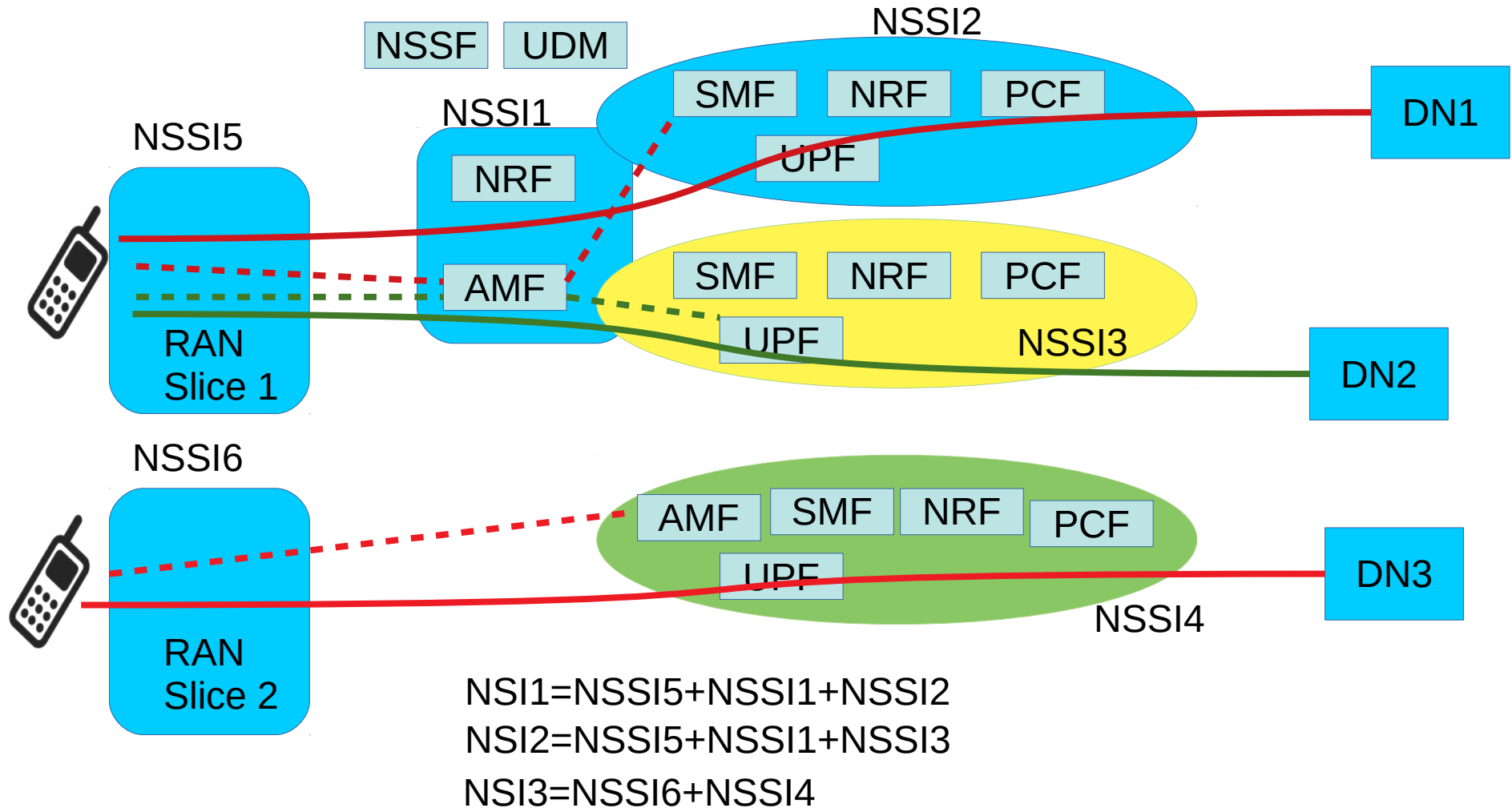
- A Network Slice Instance (NSI) is identified by S-NSSAI

Slice/Service Type (SST) 8-bit	Slice Differentiator (SD) 24 bits
--------------------------------------	---

1	eMBB
2	URLLC
3	MIOT
4	V2X
5-127	Reserved
128-255	Operator Specific

- SD part is optional
- used to differentiate between different Network Slices used for different customers

Network Slice Subnet Instance (NSSI) In 5G



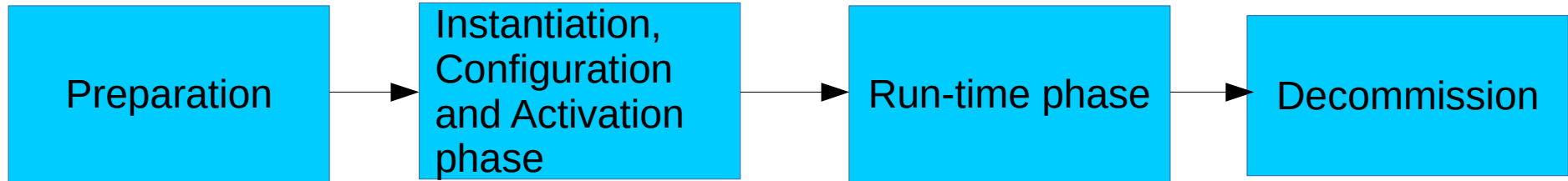
Network Slice Subnet Instance (NSSI)

- A NSI is composed of one or multiple Network Slice Subnet Instances (NSSIs)
- A NSSI may contain one or multiple virtualized network functions.
- A NSSI may
 - consist NF(s) and other NSSI(s).
 - be shared by two or more NSIs.
 - May contain Core Network functions or Access Network functions, or both

Multiple Slices Support

- At one time, maximum 8 slices can be assigned to a single UE
 - This UE must support PDU sessions associated with these slices
- A common AMF instance supports all slices assigned to a UE
 - But these slices can have separate SMF/UPF instances
- **a PDU Session is associated with only one S-NSSAI and one DN (Data Network)**

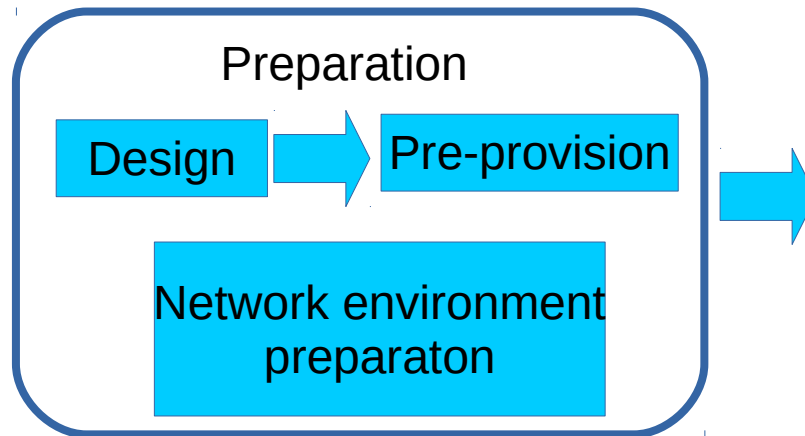
Network Slice Instance (NSI) life cycle



A so called **Network Slice Management Function (NSMF)** oversees the respective tasks of each phase,

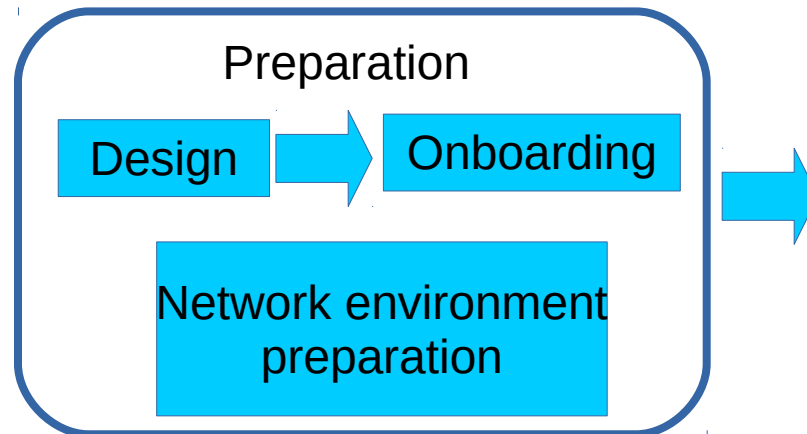
1. Preparation phase

- Network Slice “blueprints” or “templates” lists necessary attributes of Network slice
- If an existing Network Slice template meets the customer requirements,
 - This template can be used as it is...
 - Or it can be scaled to meet customer requirements,
- In this case the preparation phase can be excluded,



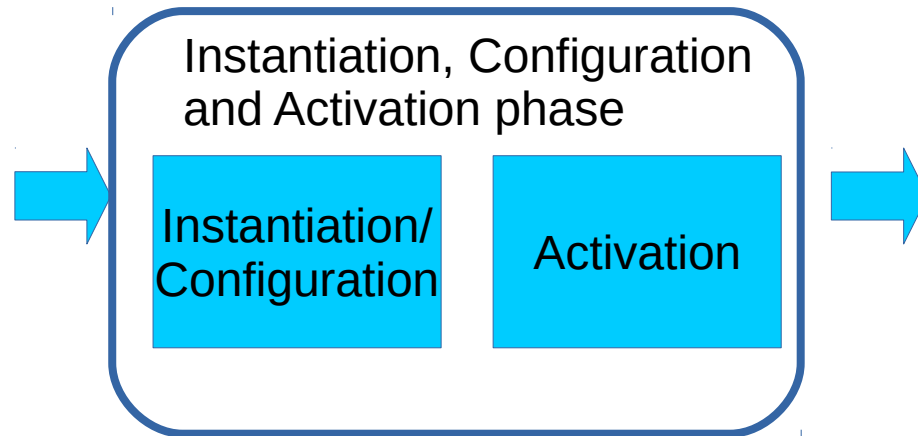
1. Preparation phase

- If no suitable Network Slice template
 - new one is designed using the customer requirements.
- Newly designed template can be added to a catalogue of Network Slice templates
- So preparation phase is skipped/shortened for the next customer with similar requirements.



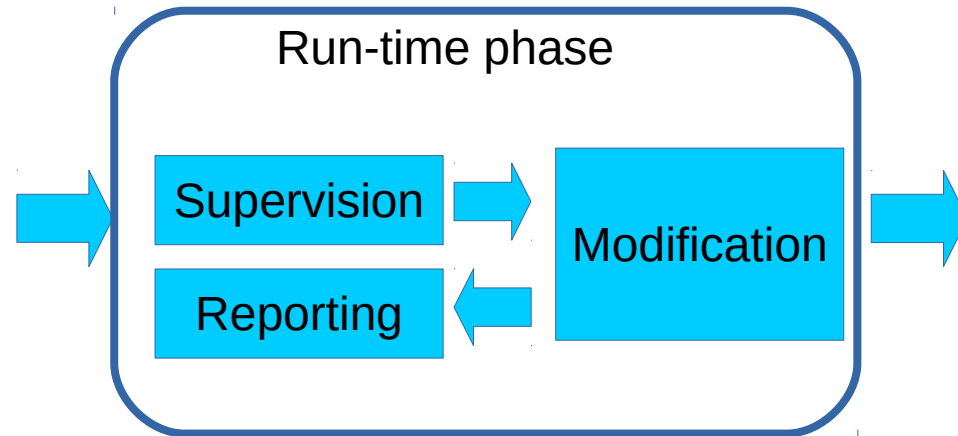
2. Instantiation, Configuration and Activation phase

- All resources shared/dedicated required by a NSI are created (Instantiated) and configured,
- actions to makes NSI active, e.g. diverting traffic to it, provisioning databases



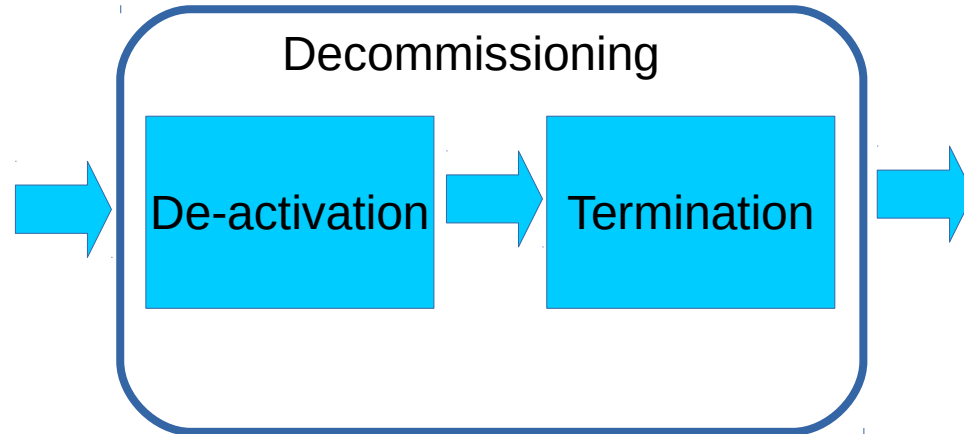
3. Run-time phase

- NSI is capable of traffic handling
- Performance monitoring using Key Performance Indicators (KPI) **reporting**
- **Supervision:** NSI may need to be modified.
 - NSI reconfiguration, NSI Capacity change, NSI topology change, addition/deletion of NFs



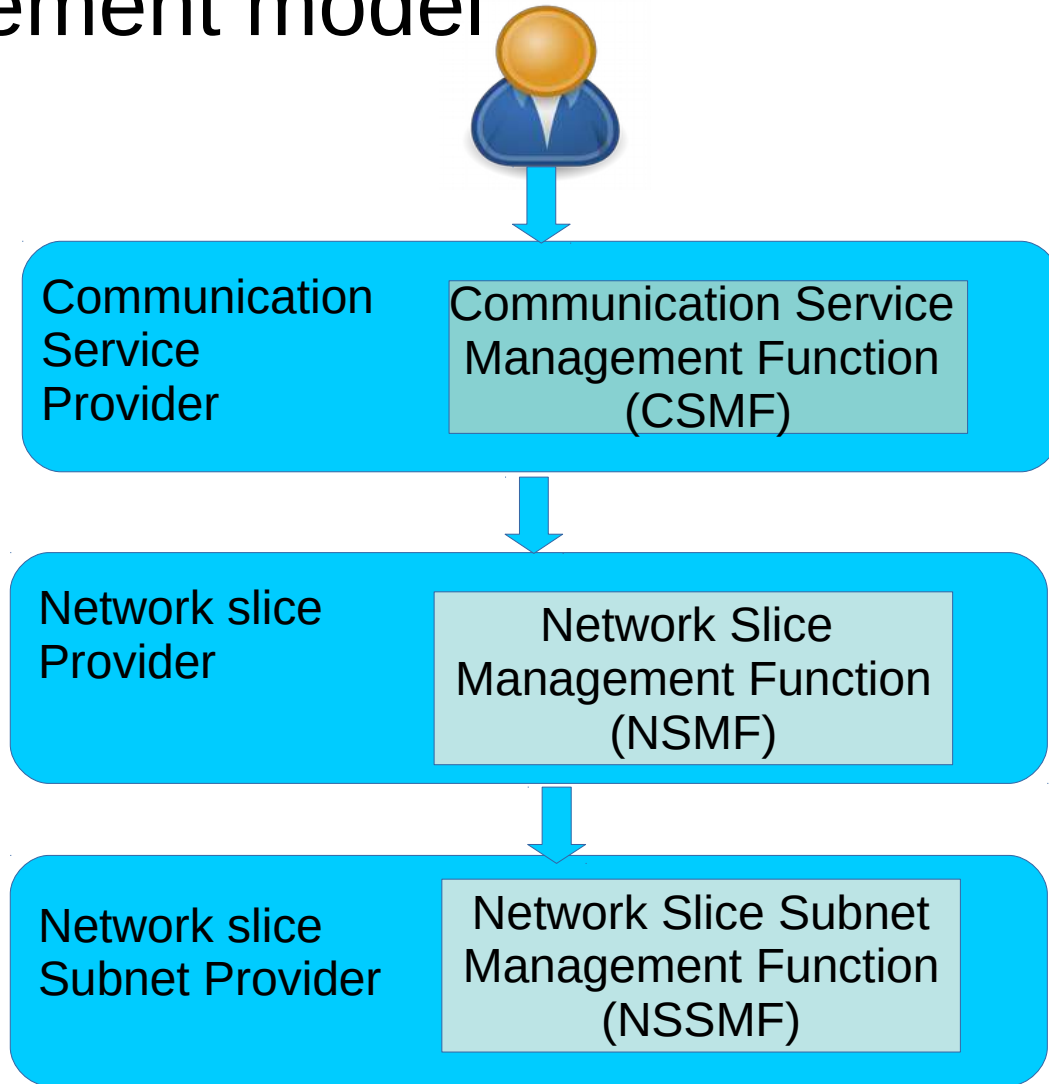
4. Decommissioning phase

- The decommissioning phase includes deactivation
- the dedicated resources (e.g. NFs) assigned to this NSI are free
- shared/dependent resources are reconfigured.
- After decommissioning the NSI does not exist anymore.



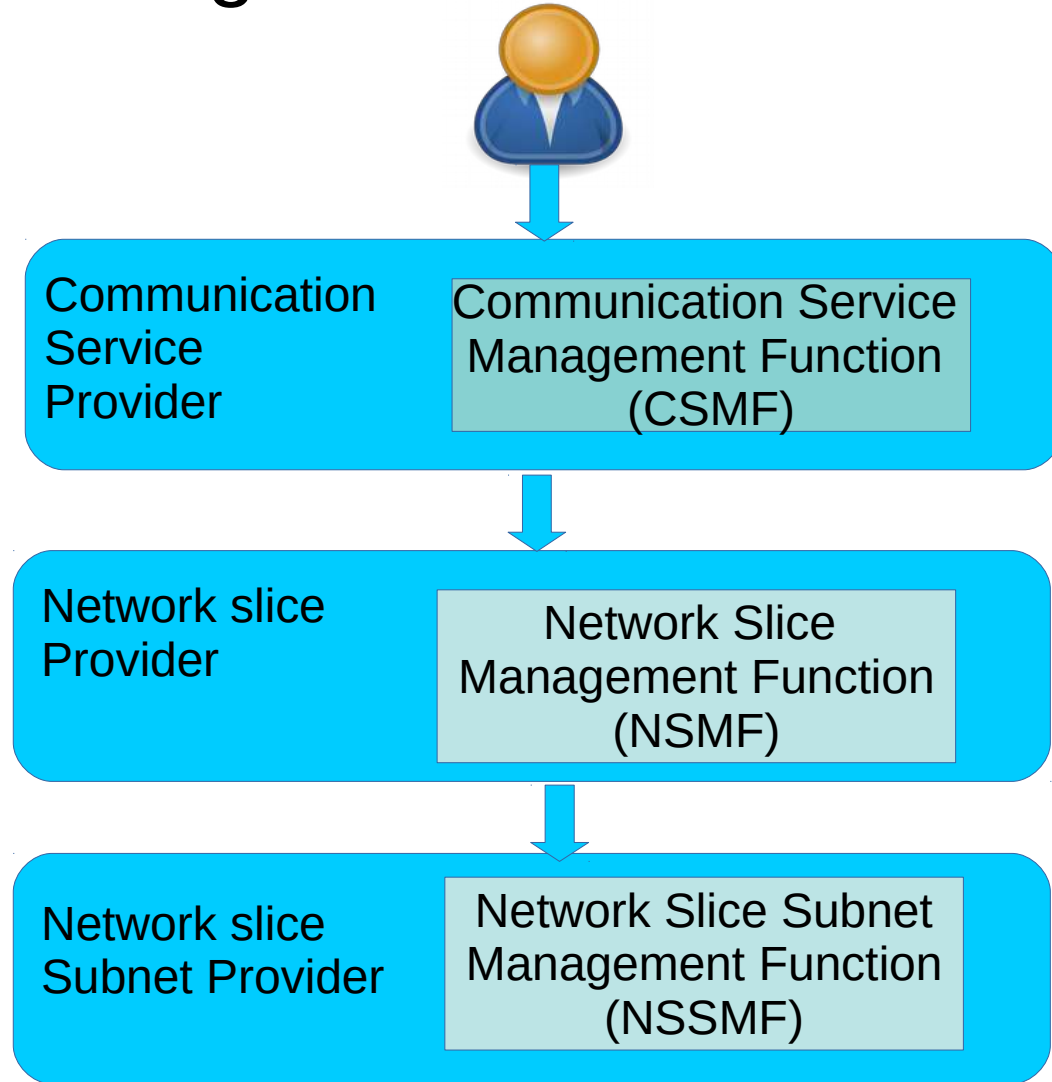
Network slicing management model

- CSMF converts the customer requirements to the network slice related requirements
 - network type,
 - network capacity,
 - QoS requirements, etc.



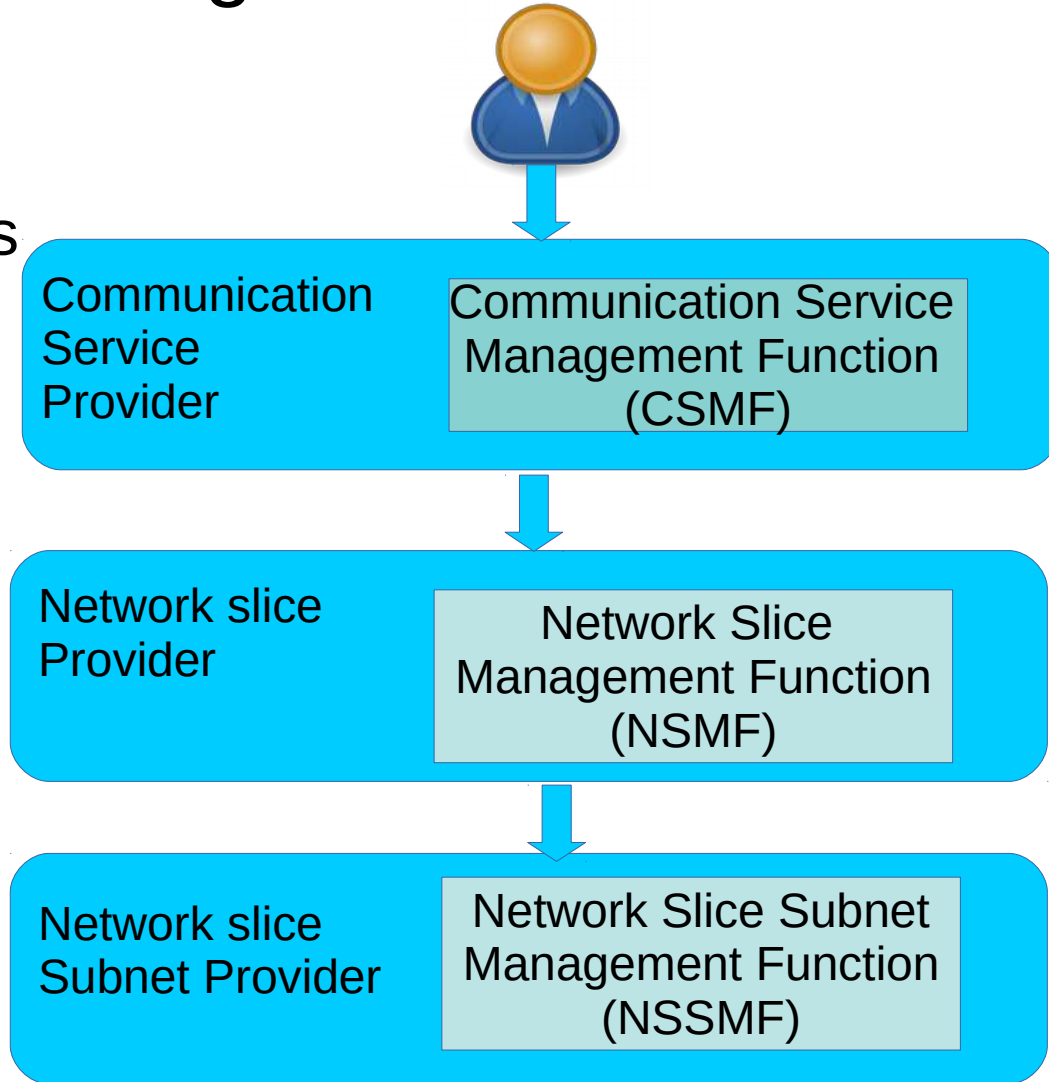
Network slicing management functions

- CSMF provides network slice requirements to NSMF
- NSMF manages the Network Slice Instance
- NSMF converts the network slice related requirements to network slice subnet related requirements.

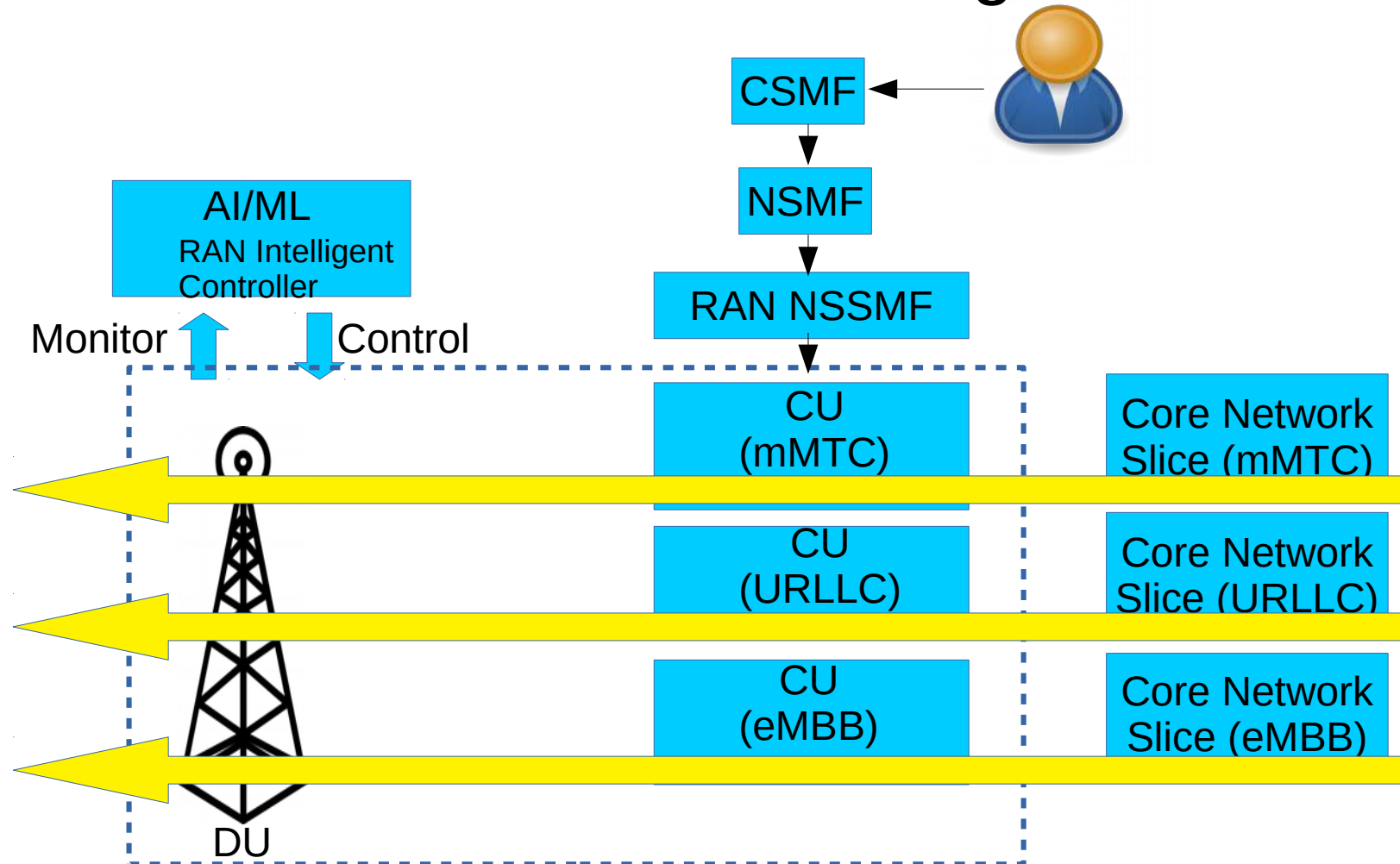


Network slicing management functions

- The NSSMF manages the NSSIs based on the network slice subnet related requirements received from the NSMF.



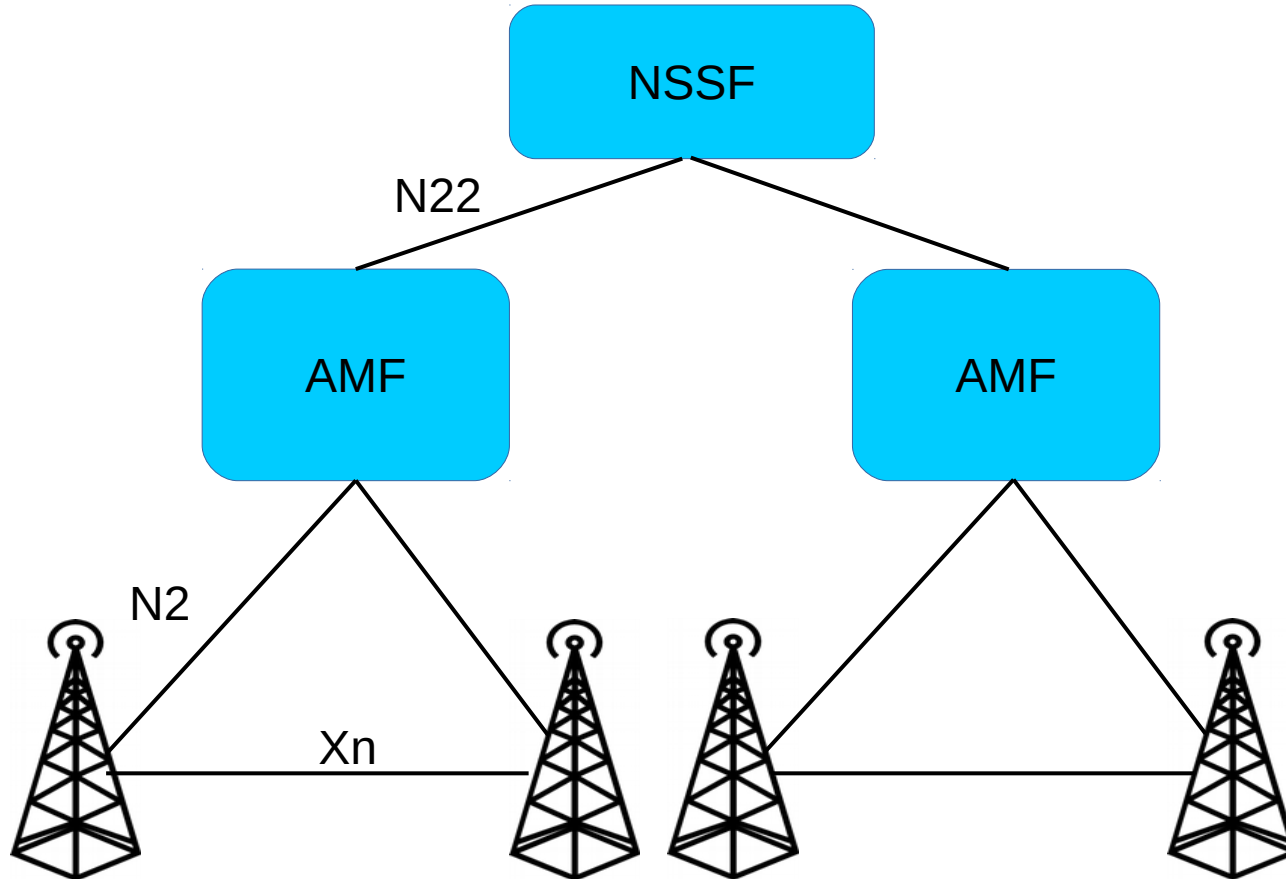
Radio Access Network Slicing



Slice Availability in the 5G Network

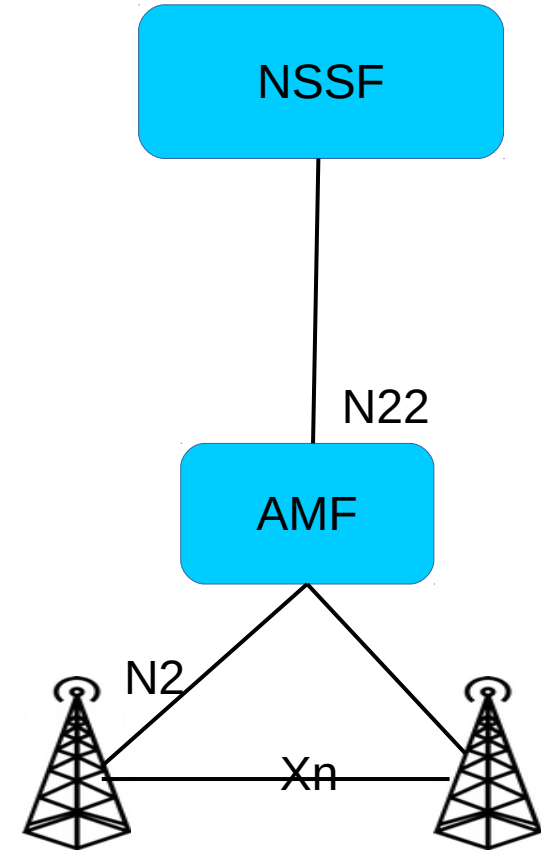
- Network Slice Selection Assistance Information (NSSAI) is a set of S-NSSAIs.
- NSSAIs are managed at the
 - Tracking area level in the 5G RAN
 - Registration area level in 5GC
- A given Registration Area (ie the list of Tracking Areas) shall support a common set of slices

Signaling related to Slice Availability



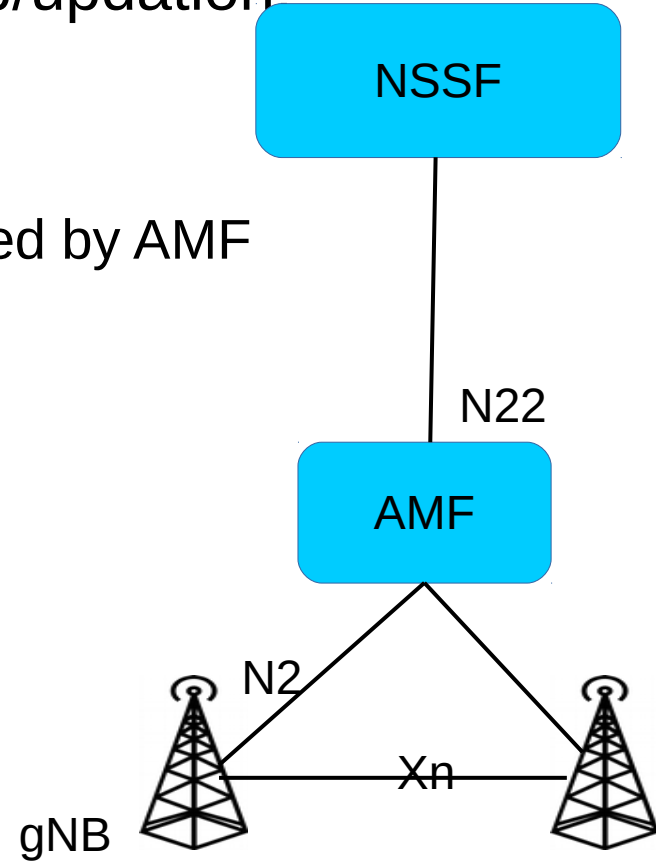
Signaling related to Slice Availability

- Using OMC, the operator configures
 - the NSSF about where Network Slices are available in a 5G PLMN,
 - the 5G gNBs about Network Slice availability per TA level.



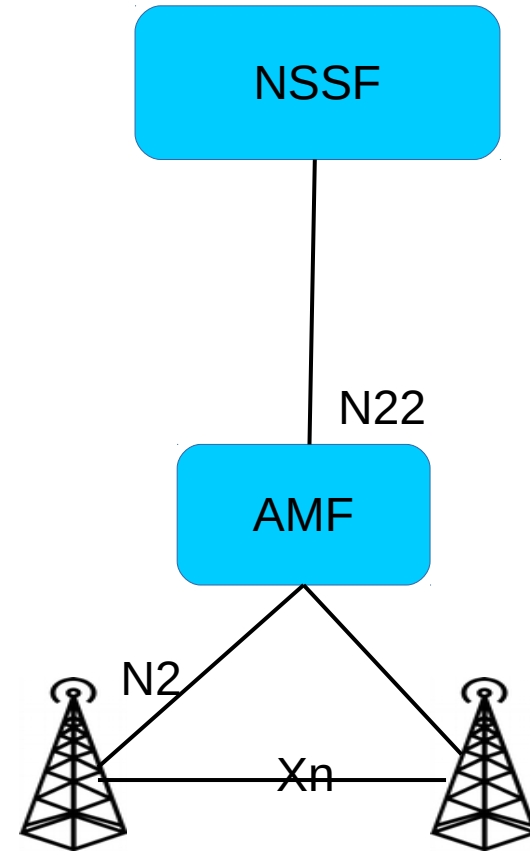
Signaling related to Slice Availability

- **Over N2 interface:** during N2 connection Setup/updation during RAN/AMF Configuration Update:
 - gNB-->AMF about S-NSSAIs supported per TA
 - AMF-->gNB about S-NSSAIs per PLMN ID supported by AMF
- **Over Xn interface:** At Xn Setup and 5G RAN node Configuration Update
 - gNBs exchange S-NSSAIs per TA.

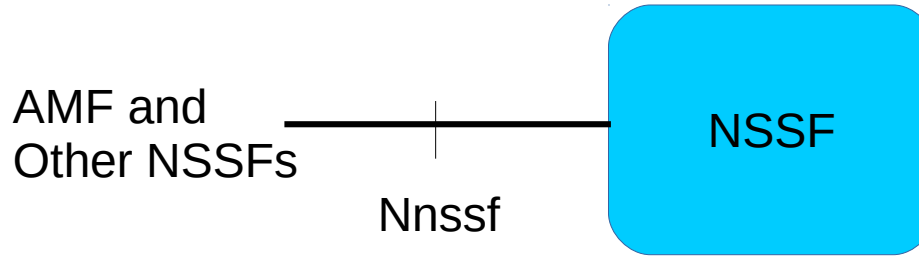


Signaling related to Slice Availability

- **Over N22 interface:** At setup or change
 - AMF-->NSSF about S-NSSAIs per TA.
 - NSSF-->AMF about restricted restricted S-NSSAIs per TA



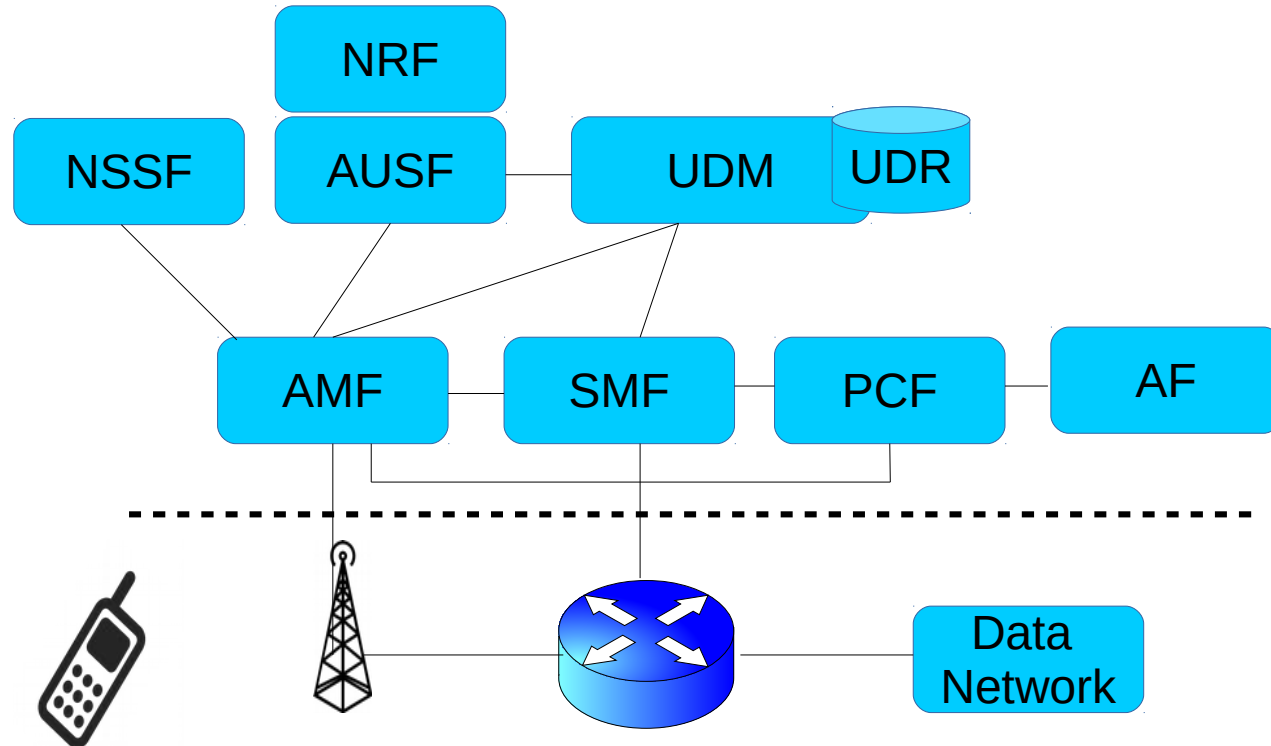
Network Slice Selection Function (NSSF)



Service Name	Service Operations	Descriptions
Nnssf_NSSelection	Get	Return slices that should serve UE Return a target AMF set Return an NRF for a particular slice
Nnssf_NSSAIAvailability	Update Notify	Update slice availability and AMF slice support in each TA

Types of NSSAIs

- **Subscribed S-NSSAIs:** Stored in the UDM
 - 5GC uses this as a default when the UE doesn't send a Requested NSSAI



Types of NSSAIs

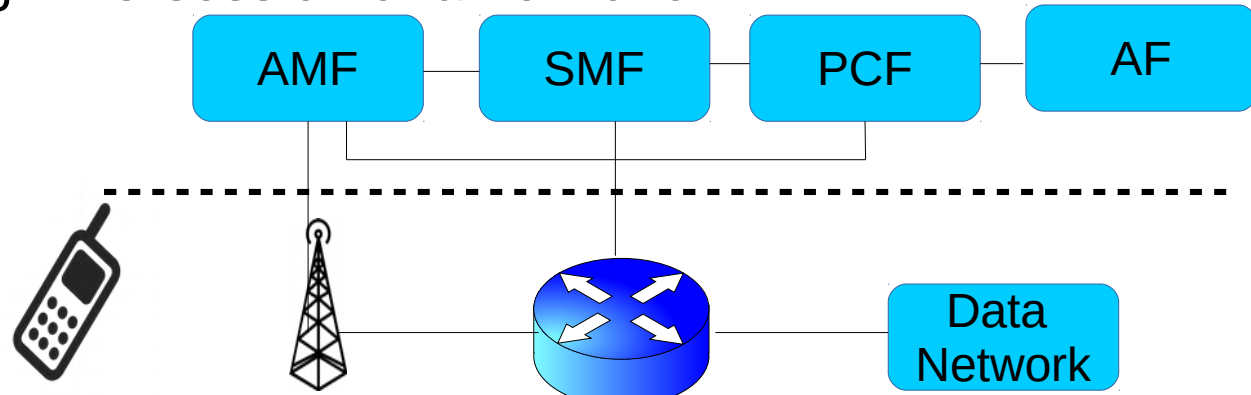
- **Configured S-NSSAIs:** The serving PLMN may configure a UE with 1 or more configured S-NSSAIs
 - UE uses this as its default NSSAI
 - Could be the same as the Subscribed S-NSSAI
 - Stored by the UE per PLMN until a new Configured NSSAI is received for the same PLMN.

Types of NSSAIs

- **Requested S-NSSAIs:** Contains up to eight S-NSSAIs that the UE wants to register in serving PLMN during Registration procedures
- **Allowed S-NSSAIs:** The value assigned by the 5GC & valid in a Registration Area
- **Default configured S-NSSAIs:** May be provided to the UE by the UDM in the HPLMN, via the AMF
- **Rejected S-NSSAIs:** 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

UE Route Selection Policy (URSP) information

- 5G allows the PCF to provide UE Route Selection Policy (URSP) to UE via the AMF.
- URSP consists of URSP rules
- These rules indicate to UE how data shall be sent over the 5G network,
 - e.g., which PDU session, which DN, slice for a certain application.
 - For a new app existing PDU session or a new one



UE Route Selection Policy (URSP) information

Rule Precedence	Traffic descriptor	Route Selection Descriptor Precedence	Route Selection compnents
1	Application Identifiers =App1	1	Network slice: S-NSSAI-a DNN: Internet Access type preference: 3GPP
		2	Network slice: S-NSSAI-b Access type preference: non- 3GPP
.....
Lowest	Match all	1	Network slice: S-NSSAI-c DNN: Internet

Requested S-NSSAI selection by UE

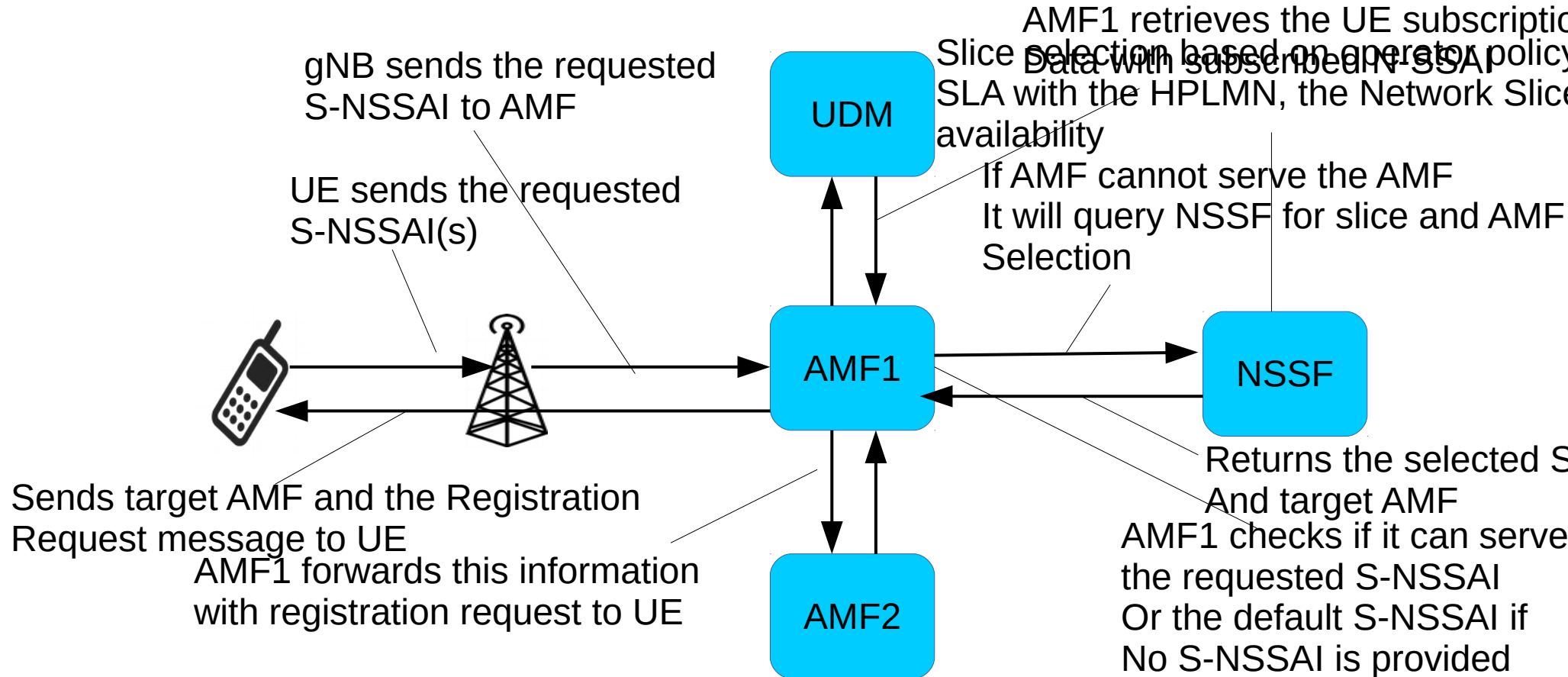
- The UE decides which application it wants to enable.
- UE uses URSP rules in order of priority to determine matched S-NSSAI

Rule Precedence	Traffic descriptor	Route Selection Descriptor Precedence	Route Selection compnents
1	Application Identifiers =App1	1	Network slice: S-NSSAI-a DNN: Internet Access type preference: 3GPP
		2	Network slice: S-NSSAI-b Access type preference: non-3GPP
.....
Lowest	Match all	1	Network slice: S-NSSAI-c DNN: Internet

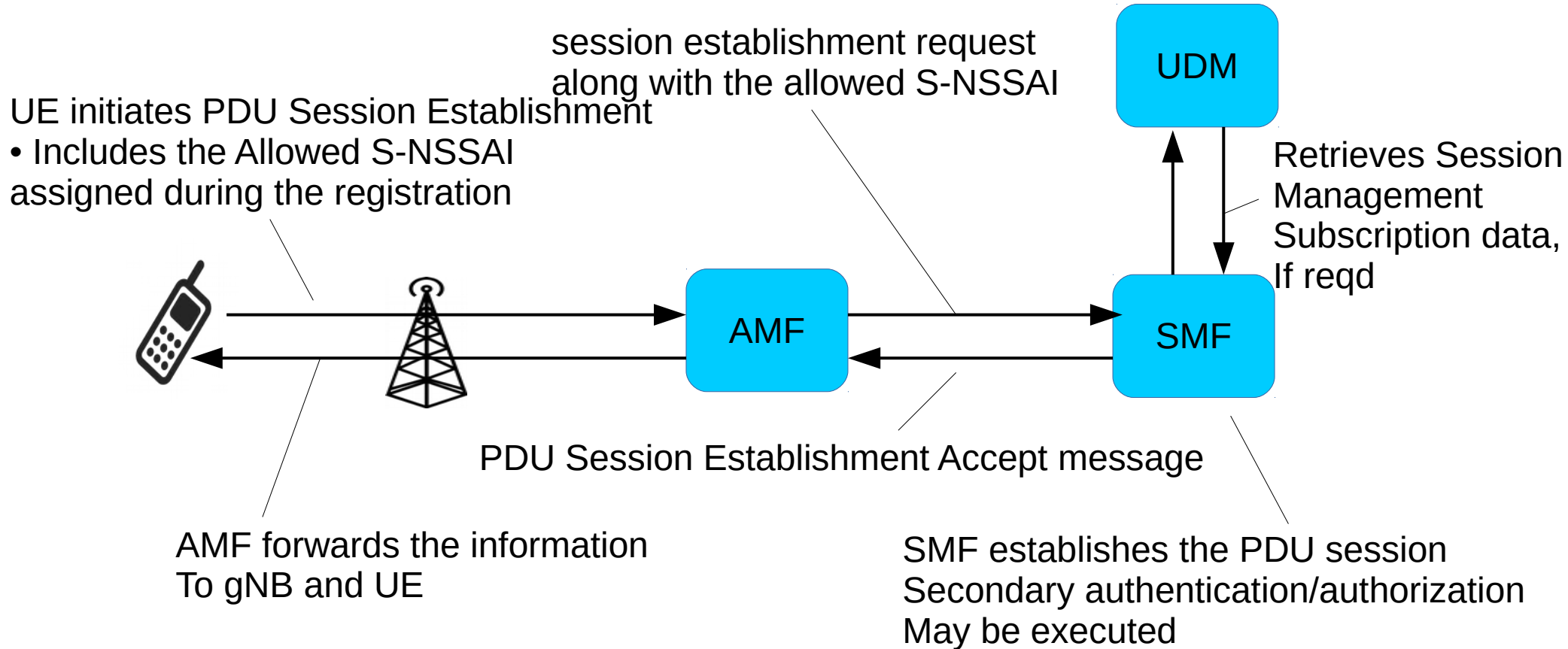
Requested S-NSSAI selection by UE

- UE compared the matched S-NSSAI with following in current PLMN in order of priority
 - Rejected S-NSSAIs
 - Allowed S-NSSAIs
 - Configured S-NSSAIs
- If matched S-NSSAI not in above list, UE will select default configured S-NSSAI
- If no default S-NSSAI, UE does not include S-NSSAI in the connection setup request

Slice Aware Registration



Slice Aware PDU Session Handling



Network slicing management functions

Communication Service Consumer (CSC)

Communication Service Provider (CSP)

Network Provider (NOP)

Network Slice Service Provider (NOP)

Virtual Infrastructure Service Provider

Physical Infrastructure Provider