

# 5G Architecture model and concepts

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# 5G Architecture model & concepts

# Key principles :

- Seperate UP functions from CP functions.
- Enable flexible & efficient network slicing.
- Define procedures as services, so that their reuse is possible.
- Enable each NF to interact with other NF directly .
- Minimize dependencies between Access network and core network.

# Key principles :

- Minimize dependencies between Access network and core network.
- Support a unified authentication framework.
- Support “stateless” NFs, where the “compute” resource is decoupled from the “storage” resource.
- Support capability exposure.
- Support roaming

# Architecture reference model

# General :

The 5G architecture is defined as service based and the interaction between NFs is represented in two ways as :

- A service based representation
- A reference point representation

# Network functions and entities :

- AUSF
- AMF
- DN
- UDSF
- NEF
- NRF
- NSSF
- PCF
- SMF
- UDM

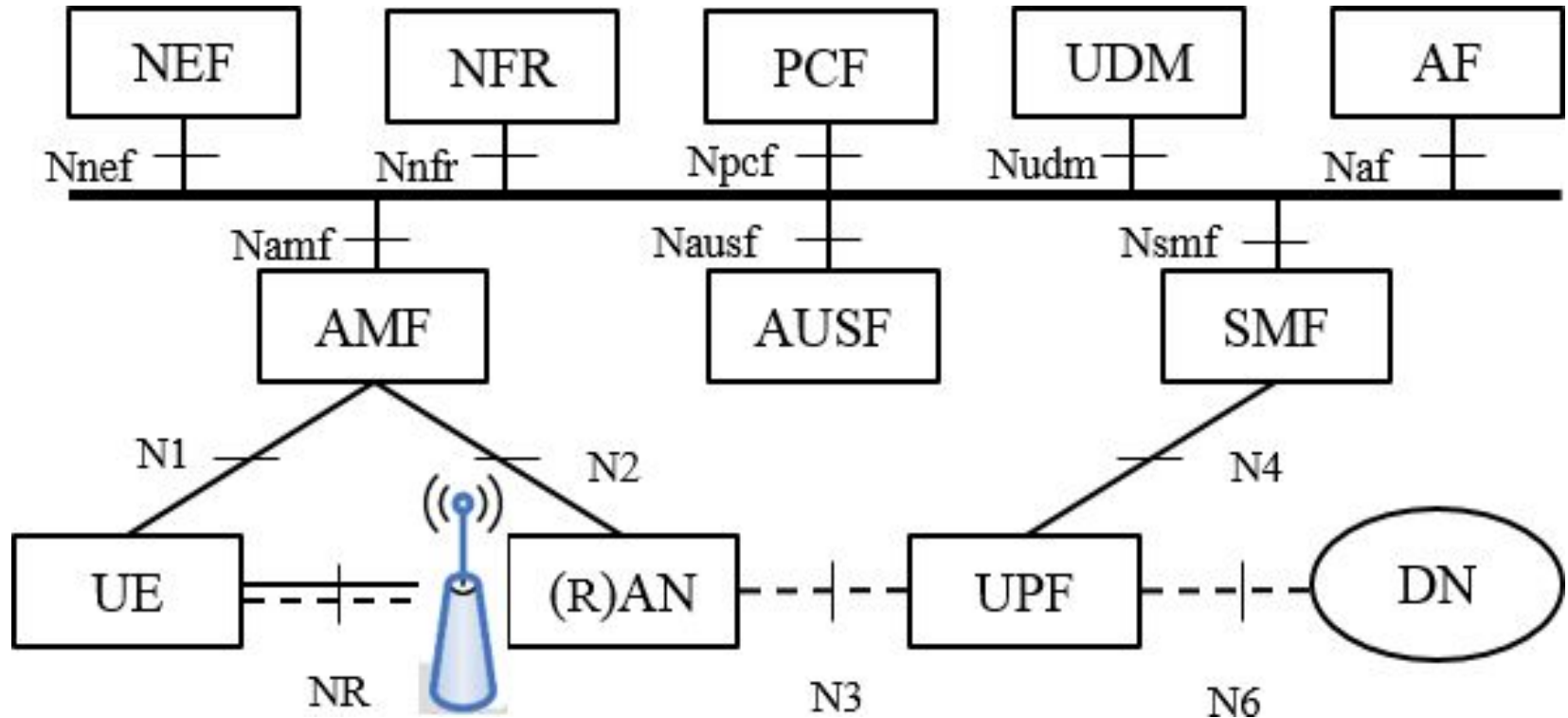
# Network functions and entities :

- UDR
- UPF
- AP
- UE
- RAN
- 5G-EIR
- SEPP
- NWDAF

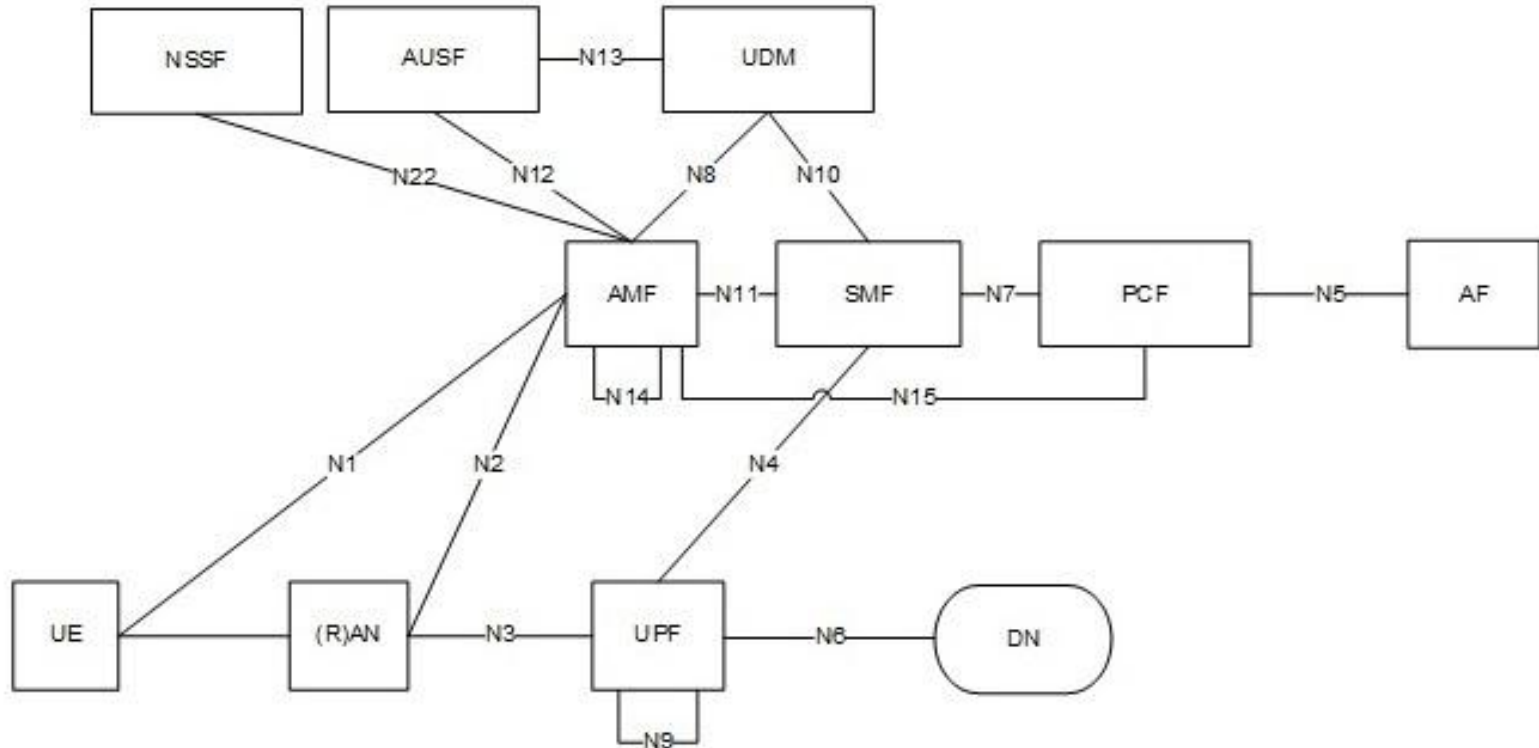


# Non-roaming reference architecture

# 5G system architecture :



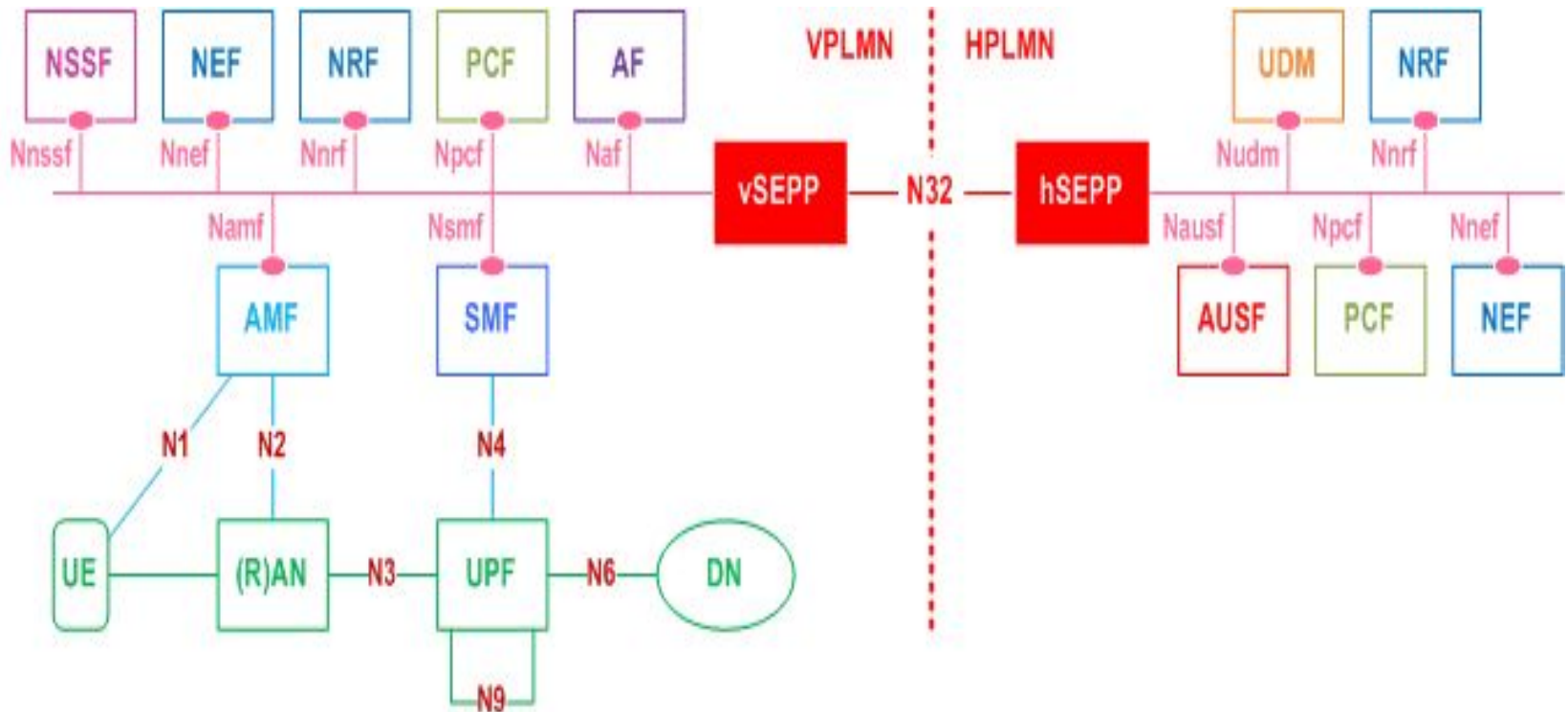
# 5G system architecture :



# 5G system architecture :

- Non roaming architecture for UE's concurrently accessing two (local and central ) data networks using multiple PDU sessions , using reference point representation.
- This architecture is for multiple PDU sessions where two SMFs are selected for two different PDU sessions .
- Each SMF may have the capability to control both a local and a central UPF within a PDU session.

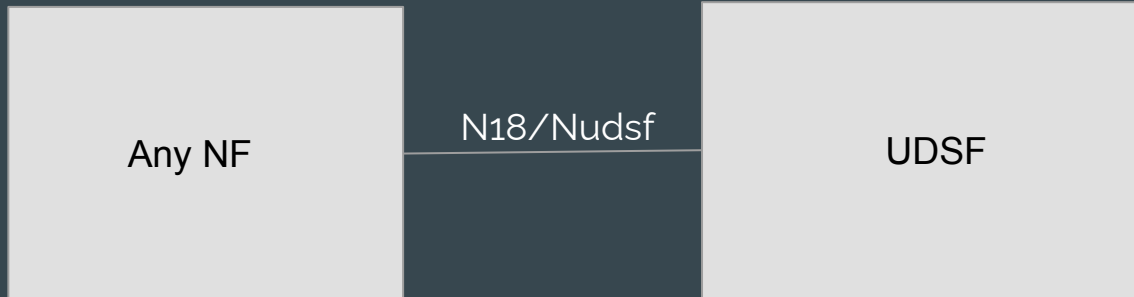
# Roaming reference architecture :



# Data storage architectures

# Data storage architectures :

- The 5G system architecture allows any NF to store and retrieve its unstructured data into/from a UDSF.
- The UDSF belongs to the same PLMN where the network function is located.



# Data storage architectures :

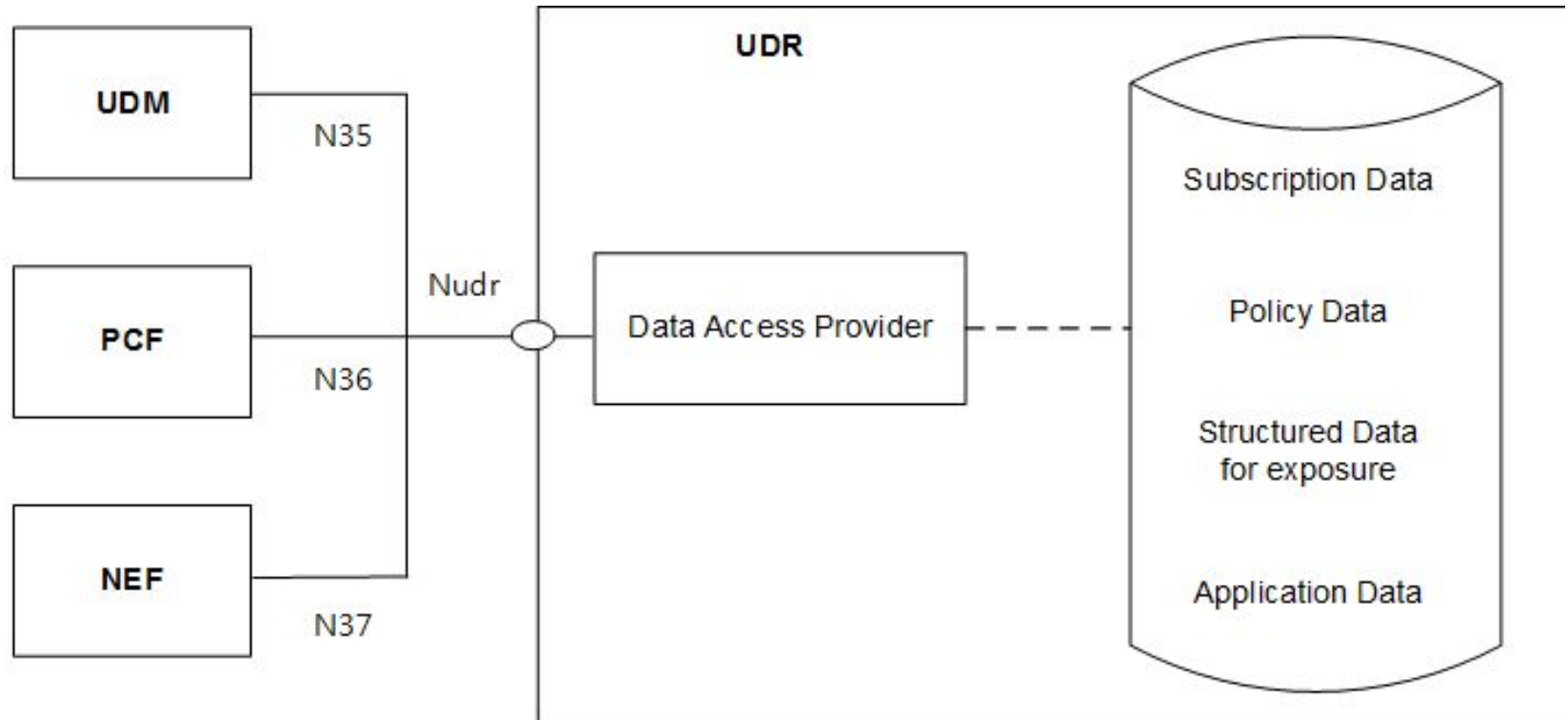
- The 5G system architecture allows the UDM, PCF and NEF to store data in the UDR, including subscription data and policy data by UDM and PCF, structured data for exposure and application data for application detection, AF request information for multiple UE's by the NEF.



# UDR deployment :

- UDR accessed by the NEF belongs to the same PLMN where the NEF is located.
- UDR accessed by the UDM belongs to the same PLMN where the UDM is located if UDM supports a split architecture.
- UDR accessed by the PCF belongs to the same PLMN where the PCF is located.

# Data storage architecture :



# Data storage architectures :

- The Nudr interface is defined for the network functions such as UDM,PCF and NEF to access a particular set of data stored and to read , update , delete and subscribe to notification of relevant data changes in the UDR.

# Data storage architectures :

- Data in the UDR sets exposed via Nudr to the respective NF service consumer and stored shall be standardized :  
subscription data, policy data , structured data for exposure, application data : packet flow descriptions for application detection and AF request information for multiple UE's.

# Data storage architectures :

- The service based Nudr interface defines the content and format / encoding of 3GPP defined information elements exposed by data sets.

# Service based interfaces

# Service based interfaces :

- Namf
- Nsmf
- Nnef
- Npcf
- Nudm
- Naf
- Nnrf
- Nnssf
- Nausf
- Nudr

# Service based interfaces :

- Nudsf
- N5g-eir
- Nnwdaf



# Reference points

# Reference points :

- N1
- N2
- N3
- N4
- N6
- N9
- N5
- N7
- N8

# Reference points :

- N 10
- N11
- N12
- N13
- N14
- N15
- N16
- N17
- N18
- N22

# Reference points :

- N23
- N24
- N27
- N31
- N32
- N33
- N34
- N35
- N36
- N37
- N40
- N50

# Support of non-3GPP access

# General concepts :

- Non - 3GPP access networks shall be connected to the 5G core network via non-3GPP interworking function ( N31WF).
- The N31WF interfaces the 5G core network CP and UP functions via N2 and N3 interfaces respectively.
- The N2 and N3 reference points are used to connect standalone non-3GPP accesses to 5G core network control plane and user plane functions respectively.

# General concepts :

- A UE that accesses the 5G core network over a standalone non-3GPP access shall, after UE attachment , support NAS signalling with 5G core network control plane functions using the N1 reference point.
- The PLMN selection for the 3GPP access does not depend on the N31WF selection. If a UE is registered over a non-3GPP, the UE performs PLMN selection for the 3GPP access independently of the PLMN to which the N31WF belongs.

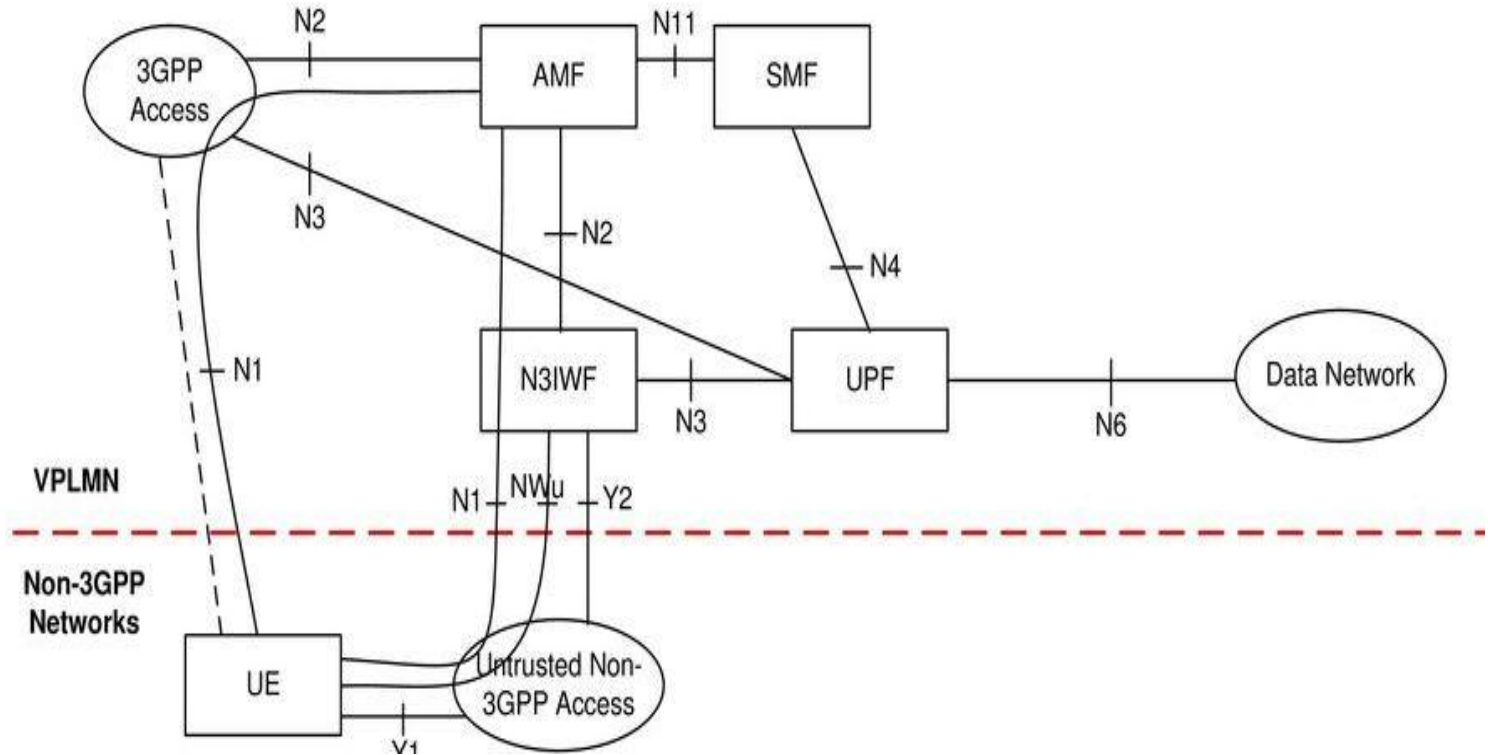
# General concepts :

- A UE shall establish an IPsec tunnel with the N31WF to attach to the 5G core network over untrusted non-3GPP access.
- N1 NAS signalling over standalone non-3GPP accesses shall be protected with the same security mechanism applied for N1 over a 3GPP access.



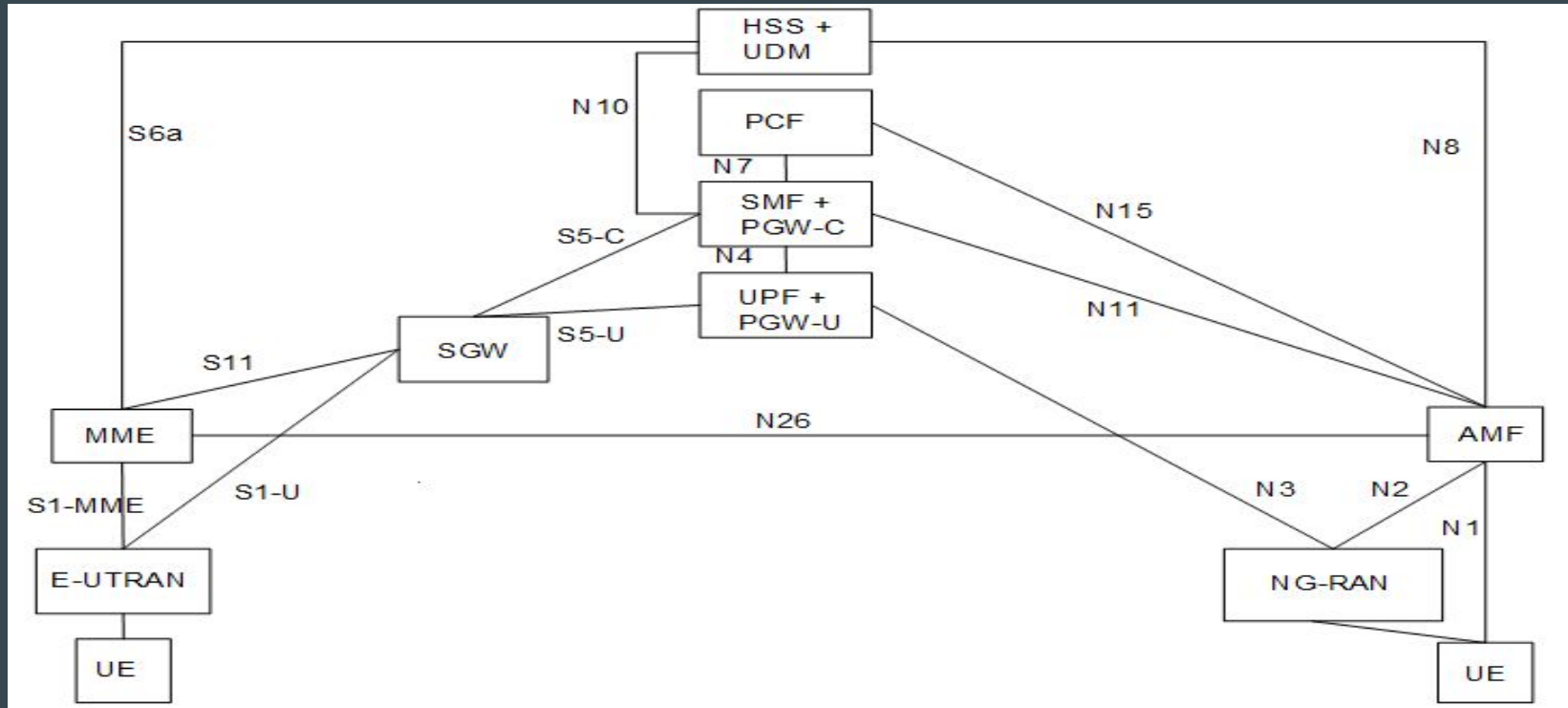
# Architecture reference model for non-3GPP accesses

# Non roaming architecture for non-3GPP accesses



# Interworking with EPC

# Non-roaming architecture :



# Registration & connection management

# General :

- The registration management is used to register or deregister a UE/user with the network, and establish the user context in the network.
- The connection management is used to establish and release the signalling connection between UE and the AMF.

# Registration management :

- A UE/user needs to register with the network to receive services that requires registration.
- Periodic registration update
- Mobility registration update

# Registration management :

- The initial registration procedure involves execution of network access control functions i.e user authentication and access authorization based on subscription profiles in UDM.



# **5GS Registration management states**

# 5GS registration management states :

Two RM states are used in the UE and the AMF that reflect the registration status of the UE in the selected PLMN :

- RM-DEREGISTERED
- RM-REGISTERED

# RM-DEREGISTERED state :

In this state, the UE shall :

- Attempt to register with the selected PLMN using the initial registration procedure if it needs to receive service that requires registration.
- Remain in RM-DEREGISTERED state if receiving a registration reject upon initial registration.
- Enter RM-registered state upon receiving a registration accept.

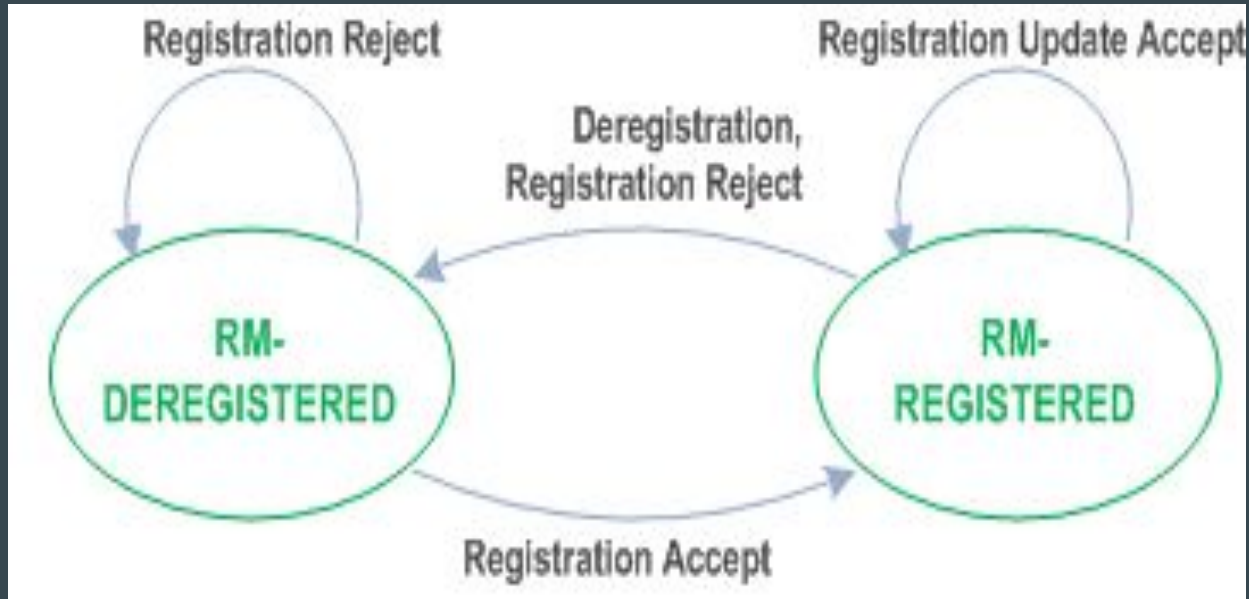
# RM-REGISTERED STATE :

In this state the UE shall :

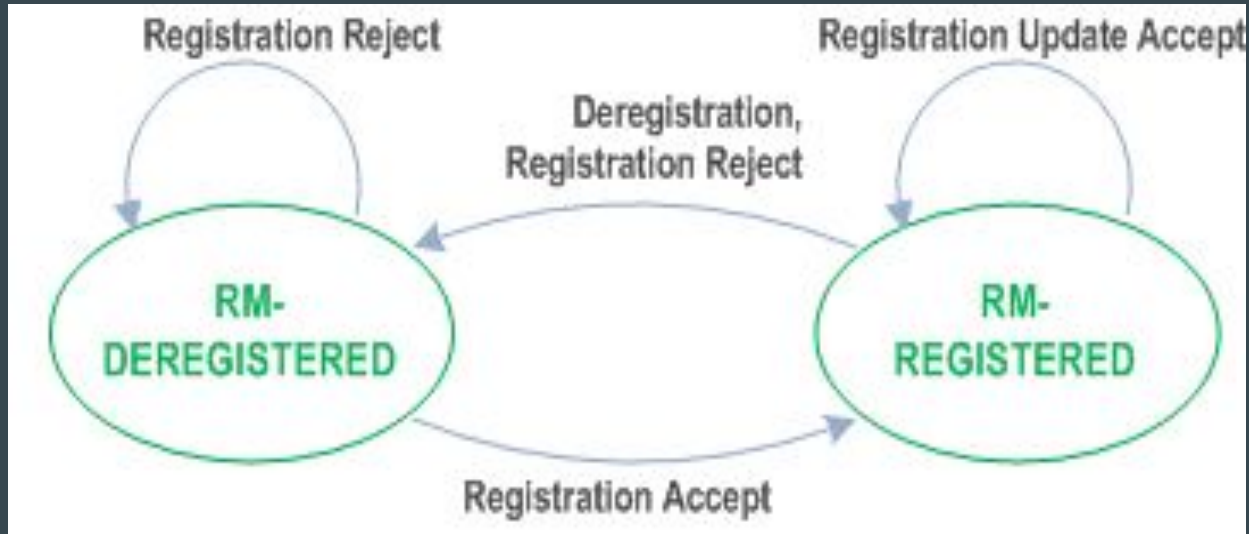
- Perform mobility registration update procedure if the current TAI of the serving cell is not in the list of TAI's that the UE has received from the network in order to maintain the registration and enable the AMF to page the UE.
- Perform periodic registration update procedure triggered by expiration of the periodic update timer to notify the network that the UE is still alive.

# 5GS registration management state models

# RM State model in UE :



# RM state model in AMF :



# Registration area management :

- It comprises the functions to allocate and reallocate a registration area to a UE.
- Registration area is managed per access type i.e 3GPP access or non-3GPP access.



# Registration area management :

- When a UE registers with the network over the 3GPP access, the AMF allocates a set of tracking areas in TAI list to the UE.
- An AMF which has the whole PLMN as serving area may alternatively allocate the whole PLMN as registration area to a UE in MICO mode.

# Registration area management :

- The 5G system shall support allocating a Registration area using a single TAI list which includes tracking areas of any NG-RAN nodes in the registration area for a UE.
- A single TAI dedicated to a non-3GPP access, the N3GPP TAI, is defined in a PLMN and applies within the PLMN.
- When a UE registers with the network over the non-3GPP access, the AMF allocates a registration area that only includes the N3GPP TAI to the UE.

# Connection Management

# General :

- It comprises the functions of establishing and releasing a NAS signalling connection between a UE and the AMF over N1.
- It comprises both the AN Signalling connection between the UE and the AN.
- N2 connection for this UE between the AN and the AMF.

# 5G connection management states :

- Two CM states are used to reflect the NAS signalling connection of the UE with the AMF: CM-IDLE , CM-CONNECTED
- The CM state for 3GPP access and non-3GPP are independent of each other, i.e one can be in CM-IDLE state at the same time when the other in CM-CONNECTED state.

# CM-IDLE state

# CM-IDLE state :

- A UE in CM-IDLE state has no NAS signalling connection established with the AMF over N1.
- There are no AN signalling connection , N2 connection and N3 connections for the UE in the CM-IDLE state.
- The AMF shall be able to retrieve stored information required for initiating communication with the UE using 5G-GUTI.

# CM-IDLE state :

- The AMF shall enter CM-CONNECTED state for the UE whenever an N2 connection is established for this UE between the AN and AMF.
- The reception of initial N2 message initiates the transition of AMF from CM-IDLE to CM-CONNECTED state.
- The UE and AMF may optimize the power efficiency and signalling efficiency of the UE by activating MICO mode.



# CM-CONNECTED state

# CM-CONNECTED state :

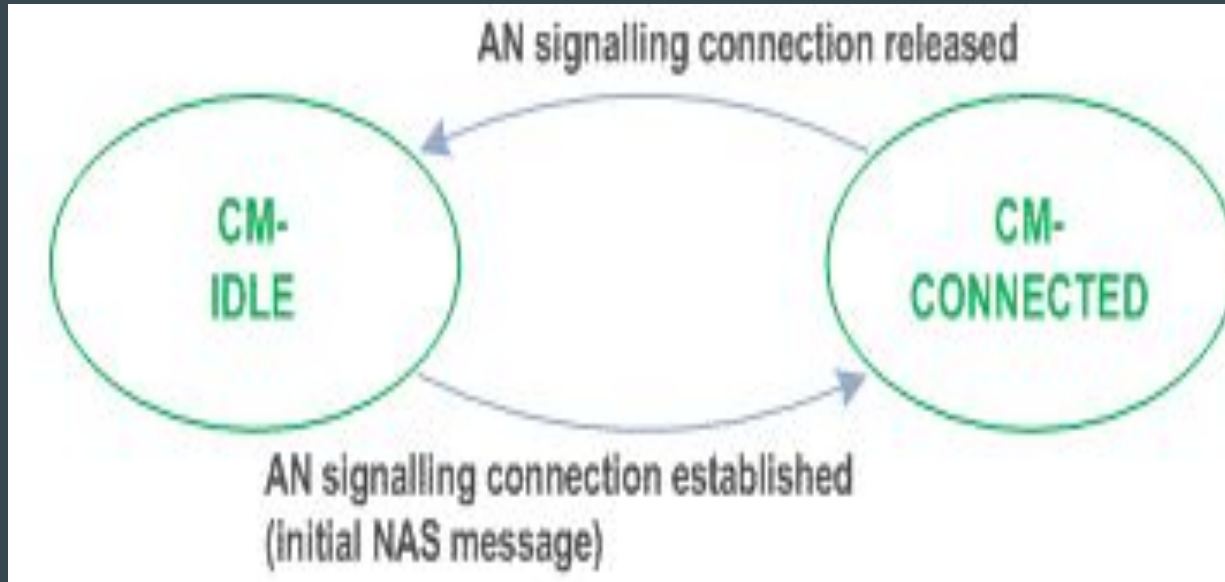
- A UE in CM-CONNECTED state has a NAS signalling connection with the AMF over N1.
- A NAS signalling connection uses an RRC connection between UE and NG-RAN and an NGAP UE association between the AN and AMF for 3GPP access.

# CM-CONNECTED state :

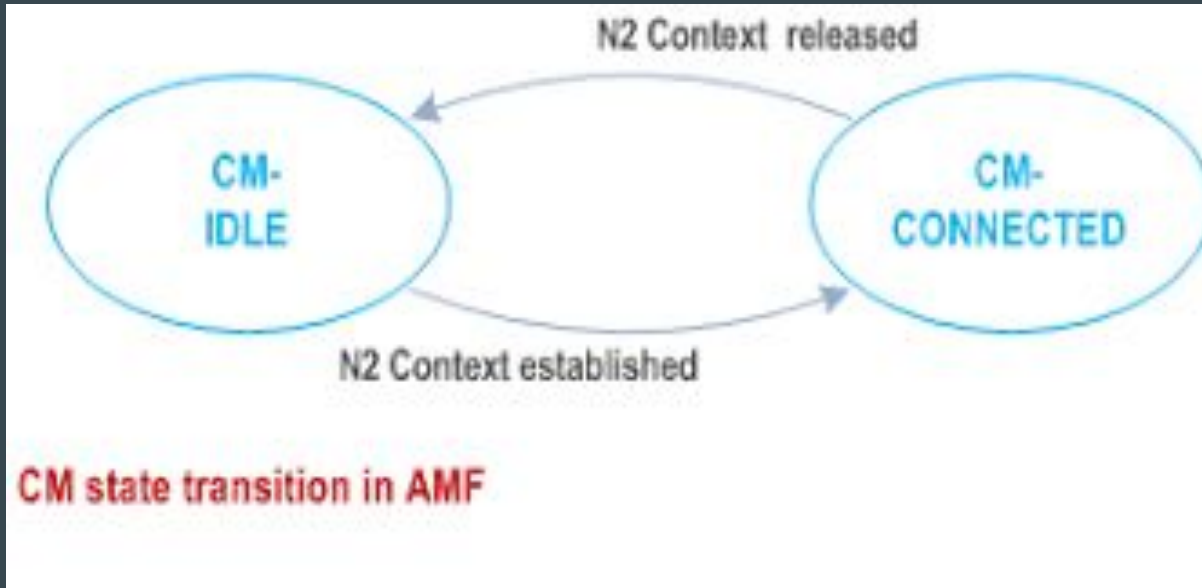
- In this state, the UE shall enter CM-IDLE state whenever the AN signalling connection is released.
- When the UE CM state in the AMF is CM-CONNECTED , the AMF shall : enter CM-IDLE state for the UE whenever the logical NGAP signalling connection and the N3 user plane connection for this UE are released upon completion of the AN release procedure.

# 5GS Connection management state models

# Connection management models :



# Connection management models :



# **NAS signalling connection management**

# NAS signalling connection establishment :

- NAS signalling connection establishment function is provided by the UE and AMF to establish a NAS signalling connection for a UE in CM-IDLE state.
- The AMF shall provide the list of recommended cells/ TA's/ NG-RAN node identifiers.



# NAS signalling connection release :

- The procedure of releasing a NAS signalling connection is initiated by the AN node .
- The NG-RAN node may include the list of recommended cells / TAs / NG-RAN node identifiers for paging, during the AN release procedure in the AN.
- The AMF stores this information , if provided by NG-RAN.

# UE Mobility

# Mobility restrictions :

- It restrict mobility handling or service access of a UE.
- Service area restrictions and handling of forbidden areas for CM-IDLE state and for CM-CONNECTED state when in RRC inactive state are executed by the UE based on information received from the core network.

# Mobility restrictions :

- Mobility restrictions consists of RAT restriction, forbidden area, service area restrictions and core network type restriction .

# **Core network assistance information for RAN optimization**

# General :

- Core network assistance information for RAN aids the RAN to optimize the uE state transition steering and the RAN paging strategy formulation in RRC inactive state.

# CN assisted RAN parameters tuning :

- If the expected UE behaviour parameters of the uE is available, the AMF may use this information for selecting the CN assisted RAN parameter values.
- The expected UE behaviour parameters can be provisioned by external party via NEF.

# CN assisted RAN parameters tuning :

- Expected UE activity behavior
- Expected HO behavior
- Expected UE mobility
- Expected UE moving trajectory



# Session management

# Overview :

- The 5GC supports a PDU connectivity service i.e a service that provides exchange of PDUs between a UE and a data network identified by a DNN.
- The PDU connectivity service is supported via PDU sessions that are established upon request from the UE.

# Overview :

- The subscription information for each S-NSSAI may contain a subscribed DNN list and one default DNN.
- If the DNN provided by the UE is not supported by the network and ANF cannot select an SMF by querying NRF, the AMF shall reject the NAS message containing PDU session establishment request from the UE with a cause that the DNN is not supported.

# Overview :

- PDU session types are defined : IPv4, IPV6, IPv4v6, ethernet, unstructured.
- PDU sessions are established ( upon UE request) , modified ( upon UE and 5GC request) and released ( upon UE and 5GC request) using NAS SM signalling exchanged over N1 between UE and SMF.

# 5G QoS parameters

# 5QI :

- Access node specific parameters that control QoS forwarding treatment for the QoS flow.
- Scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration etc.

# ARP :

- The QoS parameter ARP contains information about the priority level.
- The priority level defines the relative importance of a resource request.
- The range of ARP priority level is 1 to 15 with 1 is the highest level of priority.

# RQA :

- It is an optional parameter which indicates that certain traffic carried on this QoS flow is subject to reflective QoS.
- The RQA may be signalled to NG-RAN via N2 reference point at UE context establishment in NG-RAN and at QoS flow establishment or modification.



# 5G QoS characteristics

# Characteristics :

- Resource type ( GBR, delay critical GBR and non-GBR)
- Priority level
- Packet delay budget
- Packet error rate
- Averaging window
- Maximum data burst volume

# User plane management

# General :

- User plane functions handle the user plane path of PDU sessions.
- Support deployments with a single UPF or multiple UPF's for a given PDU session.

# UPF traffic detection :

- Traffic detection
- Traffic reporting
- QoS enforcement
- Traffic routing

# UE IP address management :

- The UE sets the requested PDU session type during the PDU session establishment procedure based on its IP stack capabilities.
- A UE shall support IPV4,IPV6 or IPv4v6.
- When the IP version capability of the UE is unknown in the UE, the UE shall request for PDU session type IPv4v6.

# The 5GC and UE support mechanisms :

- During PDU session establishment procedure, the SMF sends the IP address to the UE via SM NAS signalling.
- The IPv4 address allocation and/or IPv4 parameter configuration via DHCPv4 can also be used once PDU session is established.
- IPv6 prefix allocation shall be supported via IPv6 stateless auto-configuration if IPv6 is supported.

# The 5GC and UE support mechanisms :

- When the 5GC network supports DHCPv4 and allows that, it does not provide the IPv4 address for the UE as part of PDU session establishment procedure.
- The IP address/prefix is released by the SMF upon release of the PDU session.



# Identifiers

# General :

- Each subscriber in the 5G system shall be allocated one 5G subscription permanent identifier (SUPI) for use within 3GPP system .
- Each UE accessing the 5G system shall be assigned a permanent equipment identifier ( PEI).

# Subscription permanent identifier :

- A globally unique 5G subscription permanent identifier ( SUPI) shall be allocated to each subscriber in the 5G system and provisioned in the UDM/UDR.
- The SUPI may contain : an IMSI , a network specific identifier used for private networks.

# Permanent equipment equipment :

- A PEI is defined for the 3GPP UE accessing the 5G system.
- If the UE supports at least one 3GPP access technology, the UE must be allocated a PEI in the IMEI format.

# 5G-GUTI :

- The AMF shall allocate a 5G-GUTI to the UE that is common to both 3GPP and non-3GPP access.
- An AMF may re-assign a new 5G-GUTI to the UE at any time.

# AMF name :

- An AMF is identified by an AMF name.

# Data network name :

- A DNN is equivalent to an APN.
- DNN may be used to : select a SMF & UPF for a PDU session , select N6 interface(s) for a PDU session , determine policies to apply to this PDU session.

# Internal - group identifier :

- The subscription data for an UE in UDR may associate the subscriber with groups.
- A group is identified by an internal group identifier.



# Generic public subscription identifier :

- It is needed for addressing a 3GPP subscription in different data network outside the 3GPP system.
- GPSI's are public identifiers used both inside and outside of 3GPP system.

# AMF UE NGAP ID :

- An AMF UE NGAP ID is an identifier used to identify the UE in AMF on N2 reference point.
- AMF allocates the AMF UE NGAP ID and send it to the 5G-AN.

# 5G security aspects

# 5G Security aspects :

- Mutual authentication between UE and network.
- Security context generation & distribution.
- User plane data confidentiality and integrity protection.
- Control plane signalling confidentiality and integrity protection.
- User identity confidentiality.
- Support of L1 requirements.

# Security model for non-3GPP access :

## Signalling security

- When a UE is connected via NG-RAN and via stand-alone non-3GPP accesses, the multiple N1 instances are secured using independent NAS security contexts

# PDU session user plane security :

It indicates : whether UP integrity & confidentiality protection is ..

- Required for all the traffic on the PDU session UP integrity protection shall apply.
- Preferred for all the traffic on the PDU session UP integrity protection shall apply.
- Not required

# Security aspects :

- The SMF determines at PDU session establishment of a user plane security enforcement information.
- User plane security policy from UDM takes precedence over locally configured user plane security policy.

# Security aspects :

- The user plane security enforcement information is communicated from SMF to NG-RAN for enforcement as part of PDU session related information.



# Support for dual Connectivity, multi-connectivity

# Support for dual Connectivity

# Dual-connectivity :

- It involves two radio network nodes in providing radio resources to a given UE.
- Master RAN node which may use resources of another RAN node, the secondary RAN node, to exchange user plane traffic of an UE.

# Dual-connectivity :

Dual- connectivity provides the possibility for the master node RAN to request SMF :

- For some or all PDU sessions of an UE
- For some other PDU sessions of an UE

# Additional characteristics :

- User location in

# Charging

# Charging :

- The 5GC charging supports collection & reporting of charging information for network resource usage.
- The SMF supports the interactions towards the charging system.

# Usage data reporting for secondary RAT :

- The PLMN locally activates the secondary RAT usage data reporting by NG-RAN OAM. the activation can happen separately for data volume reporting of NR and E-UTRA.
- The NG-RAN reports UL and DL data volumes to the 5GC for the secondary RAN on a per QoS flow and per time arrival .



# Secondary RAT periodic usage data reporting procedure :

- When NG-RAN is configured with a “ time interval for secondary RAT usage data reporting “ , the NG-RAN shall send a RAN usage data report message for periodic purposes to the SMF only when the timer expires for a UE for which secondary RAT usage data reporting is on-going.

# Support for Edge computing

# Support for Edge Computing :

- It enables operator and 3rd party services to be hosted close to UE's access point of attachment , so as to achieve an efficient service delivery through the reduced end-to-end latency and load on the transport network.

# Edge Computing supported by enablers :

- User plane (re) selection
- Local routing & traffic steering
- Session & service continuity
- Network capability exposure
- QoS and charging
- Support of local area data network

# Network slicing

# Network slicing :

- A network slice is defined within PLMN and shall include : the CN control plane and user plane network functions.
- In Serving PLMN, at least one of the following : NG RAN and N3IWF function to non-3GPP access.

# Network slicing :

- Network slices may differ for supported features and network functions optimisations , in which case such network slice may have e.g different S-NSSAI's with different slice/service types.

# Identification & selection of a network slice :

- An S-NSSAI identifies a network slice and it is composed of : SST and SD.
- Based on operator's operational or deployment needs, a network slice instance can be associated with one or more S-NSSAI's and an S-NSSAI can be associated with one or more network slice instances.



# Standardized SST values

# SST values :

- Standardized SST values provide a way for establishing global interoperability for slicing so that PLMN's can support the roaming use case more efficiently for the most commonly used service/slice types.

# SST values :

- 1 - eMBB
- 2 - URLLC
- 3 - MIOT

# Network slicing & interworking with EPS

# Network slicing & interworking with EPS :

- A 5GS supports network slicing and might need to interwork with the EPS in its PLMN or in other PLMNs.
- In some deployments, the MME selection may be assisted by DCN-ID provided by the UE to the RAN.

# Network slicing & interworking with EPS :

- During PDN connection establishment in the EPC, the UE allocates the PDU session ID and sends it to the PGW-C + SMF via PCO.

# Idle mode aspects :

- When UE moves from 5GS to EPS, the UE context information sent by AMF to MME includes the UE usage type, which is retrieved from UDM by AMF as part of subscribed as part of subscription data.
- When UE moves from EPS to 5GS , the the UE includes the S-NSSAI,s associated PDN connection in the requested NSSAI in RRC connection establishment NAS.

# Connected mode aspects :

- When a UE is CM-CONNECTED in 5GC and a handover to EPS occur, the AMF selects the target MME based on the source AMF Region ID , AMF set ID and target location information.
- When a UE is ECM-CONNECTED in EPC and performs a handover to 5GS, the MME selects the target AMF based on target AMF based on target location information.



# Configuration of network slice availability in a PLMN

# Configuration :

- A network slice may be available in the whole PLMN or in one or more tracking areas of the PLMN.
- The availability of a network slice refers to the support of the NSSAI in the involved NFs.

# Configuration :

- The NSSF may be configured with operator policies specifying under what conditions the S-NSSAIs can be restricted per TA and per HPLMN of the UE.
- The per TA restricted S-NSSAIs may be provided to the AMFs of the AMF sets at setup of the network and whenever changed.

# IMS support

# IMS support :

5G Supports IMS with functionality :

- Indication toward the UE if IMS voice over PS session is supported.
- Capability to transport the P-CSCF address(es) to UE.
- Paging policy differentiation for IMS
- IMS emergency service
- Domain selection for UE originating sessions.
- Terminating domain selection for IMS voice.
- Support of P-CSCF restoration proce

# IMS voice over PS session :

- The serving PLMN AMF shall send an indication towards the UE during registration procedure over 3GPP access to indicate if an IMS voice over PS session is supported or not supported in 3GPP or non-3GPP access.

# Cases :

- If the network is able to provide a successful IMS voice over PS session in the current registration area with a 5G QoS flow that supports voice.
- If the network is not able to provide a successful IMS voice over PS session over NR connected to 5GC , but is able for :

# P-CSCF address delivery :

- At PDU session establishment procedure related to IMS, SMF shall support the capability to send the P-CSCF addresses to the UE.
- For home routed, this information is sent by the SMF in HPLMN.



# Interworking & Migration

# Support for migration from EPC to 5GC :

- Deployments based on different 3GPP architecture options and UE's with different capabilities may co-exist at the same time within one PLMN.
- The UE will use EPC NAS or 5GC NAS procedures depending on the core network by which it is served.

# Support for migration from EPC to 5GC :

A UE that supports only EPC based dual connectivity with secondary RAT NR :

- Always performs initial access through E-UTRA .
- Performs EPC NAS procedures over E-UTRA.

# Support for migration from EPC to 5GC :

A UE that supports camping on 5G systems with 5GC NAS :

- Performs initial access either through E-UTRAN that connects to 5GC or NR towards 5GC.
- Performs initial access through E-UTRAN towards EPC , if supported and needed.
- Performs EPC NAS or 5GC NAS procedures over E-UTRAN or NR respectively.

# User plane management to support interworking :

- In order to support the interworking with EPC, the SMF+PGW-C provides information over N4 to the UPF+PGW-U related to handling of traffic over S5-U.
- When the UE is connected to EPC and establishes/ releases PDN connections , the following differences apply to N4 compared to when the UE is connected to 5GC.

# Interworking with EPC

# Interworking with EPC :

In order to interwork with EPC, the UE that supports both 5GC and EPC NAS can operate in single - registration mode or dual registration mode.

- In single registration mode, UE has only one active MM state and it is either in 5GC NAS mode or in EPC NAS mode.
- In dual registration mode, UE handles independent registrations for 5GC and EPC using separate RRC connections.

# Interworking with EPC :

- PDU session types “ethernet” and “ unstructured” are transferred to EPC as “non-IP” PDN type.
- Interworking procedures with N26 support provides IP address continuity on inter-system mobility to UE's that support 5GC NAS and EPC NAS and that operate in single registration mode.



# Interworking without & with N26 interface

# Interworking without N26 interface :

- If the PDU session supports interworking, the PGW-C + SMF FQDN to SMF context in HSS + UDM when the SMF is registered to HSS + UDM.
- For an APN, the HSS + UDM selects one of the stored PGW-C + SMF FQDN based on operator's policy.

# Interworking with N26 interface :

- For a DNN, AMF determines PDU session(s) associated with 3GPP access in only one PGW-C + SMF supporting EPS interworking via EBI allocation procedure.
- If the network supports EPS interworking of non-3GPP connected to 5GC, the AMF serving 3GPP access notifies the UDM to store the association between DNN and PGW-C + SMF FQDN which supports EPS interworking as intersystem continuity context, to avoid MME receiving inconsistent PGW-C + SMF FQDN from AMF and HSS + UDM.

# Mobility between 5GS & GERAN/UTRAN

# Mobility :

- IP address preservation upon mobility between 5GS and GERAN/ UTRAN is not supported.
- Upon mobility from GERAN/UTRAN to 5GS , the UE shall perform the registration procedure of “ initial registration ” type.

# Mobility :

- If a UE in MICO mode moves to GERAN and any of the trigger occur, then the UE shall locally disable MICO mode and perform A/Gb mode GPRS attach procedure or Iu mode GPRS attach procedure.

# Network sharing

# Network sharing :

- A network sharing architecture shall allow multiple participating operators to share resources of a single shared network according to agreed allocation schemes.
- The shared network includes a radio access network .
- The shared resources includes radio resources.



# Network sharing :

- 5G MOCN for 5G system , including UE, RAN and AMF shall support operators ability to use more than one PLMN ID and different network codes (MNC).

# Broadcast system info for network sharing :

- All 5G system capable UE's that connect to NG-RAN support reception of multiple PLMN IDs and per PLMN specific parameters.
- UE decodes the broadcast system information and takes the information concerning available PLMN IDs into account in PLMN and cell (re) selection procedures.

# PLMN list handling for network sharing :

- The AMF prepares list of PLMN ID's suitable as target PLMN's for use at idle mode cell re (selection) and for use at handover and RRC connection release with redirection.

# **Network selection by the UE and by the network**

# Network selection by the UE :

- A UE that has a subscription to one of the sharing core network operators shall be able to select this core network operator while within the coverage area of the shared network and to receive subscribed services from that CN operator.

# Network selection by the network :

- The NG-RAN uses the selected PLMN to select target cells for future handovers appropriately.
- The network should not move the UE to another available PLMN e.g by handover as long as the selected PLMN is available to serve the UE's location.

# HO or network controlled release to a shared network :

- When multiple PLMN IDs are broadcasted in a cell selected by NG-RAN, NG-RAN shall select a target PLMN, taking into account the prioritized list of PLMN IDs provided by mobility restriction list from AMF.
- For RRC connection release with redirection to E-UTRAN procedure, NG-RAN decides the target network by using PLMN information as defined.

# Network Functions



# AMF :

- Termination of RAN CP interface (N2)
- Termination of NAS (N1), NAS ciphering & integrity protection
- Registration management
- Connection management
- Reachability management
- Mobility management
- Access authentication
- Access authorization

# AMF to support non-3GPP access :

- Support of N2 interface with N3IWF .
- Support of NAS signalling with a UE over N3IWF.
- Support of authentication of UE's connected over N3IWF.

# SMF :

- Session management
- UE IP address allocation and management
- DHCPv4 & DHCPv6 functions
- ARP & IPv6 proxying
- Selection and control of UP functions

# UPF :

- External PDU session point of interconnect to data network
- Packet routing & forwarding
- Packet inspection
- User plane part of policy rule enforcement
- Lawful intercept
- Traffic usage reporting
- QoS handling for UP
- UL traffic verification

# PCF :

- Supports unified policy framework to govern network behaviour.
- Provides policy rules to CP functions to enforce them
- Access subscription information relevant for policy decisions in UDR.

# NEF :

- Exposure of capabilities and events
- Secure provision of information from external application to 3GPP network.

# NRF :

- It supports service discovery functions.
- NF profile of NF instance maintained in NRF includes information as :
  - NF instance ID
  - NF type
  - PLMN ID
  - FQDN or IP address of NF
  - NF capacity information
  - NF priority information

# UDM :

- Generation of 3GPP AKA authentication credentials.
- User identification handling
- Support of de-concealment of privacy protected subscription identifier ( SUCI).
- Access authorization based on subscription data
- Support of service/session continuity.
- Subscription management
- SMS management



# Network Functions

# AUSF :

- It supports authentication for 3GPP access and untrusted non - 3GPP access.

# N3IWF :

- Support of IPsec tunnel establishment with the UE.
- Termination of N2 and N3 interfaces to 5G core network for CP and UP respectively.
- Relaying UL and DL CP NAS (N1) signalling between UE and AMF.
- Handling of N2 signalling from SMF related to PDU sessions and QoS.

# AF :

- Application influence on traffic routing
- Accessing network exposure function
- Interacting with the policy framework for policy framework.

# UDR :

- Storage and retrieval of subscription data by the UDM.
- Storage and retrieval of policy data by PCF.
- Storage and retrieval of structured data for exposure.
- Application data by the NEF.

# UDSF :

- Storage and retrieval of information as unstructured data by any NF.

# SMSF :

- SMS management subscription data checking and conducting SMS delivery accordingly.
- SM-RP/SM-CP with the UE.
- Relay the SM from UE toward SMS-GMSC/IWMSC/SMS-Router.
- Relay the SM from SMS-GMSC/IWMSC/IWMSC/SMS-Router toward the UE.

# NSSF :

- Selecting the set of network slice instances serving the UE.
- Determining the allowed NSSAI and if needed, the mapping to the subscribed S-NSSAIs.
- Determining the configured NSSAI and if needed, the mapping to the subscribed S-NSSAIs.



# 5G EIR :

- It is an optional network function which checks the status of PEI.

# LMF :

- It supports location determination for a UE.
- Obtains UL location measurements from the NG-RAN.
- Obtains non-UE associated assistance data from the NG-RAN.

# SEPP :

- It is a non transparent proxy and supports message filtering and policing on inter-PLMN control plane interfaces.

# NWDAF :

- It represents operator managed network analytics logical function.
- NWDAF notifies slice specific network status analytics information to the NFs that are subjected to it.