5G Advanced towards B5G & 6G Networks

5G Network (Data) Resource Model (NRM)

and

5G SBI APIs Common Data Types and Common Protocol and Data Model

(3GPP Rel-18 "Stage 3" - "concrete Protocols & Interfaces Implementation)

for

5G Core Network (CN) and 5G NR NG-RAN Network

with

Deterministic Networking (DetNet) Data Flows Model

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2024 - 03 - 04 Rev PA06

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1. Introduction - 3GPP 5G Advanced First (1st) Release (Rel-18) key aspects

Up until Rel-17, the AI/ML functionalities at the network side and at the device side have been developed separately with the interaction between the two sides having been largely limited to data collection. One of the visions of the 5G-Advanced, beginning from the Rel-18 AI/ML study, is to bring synergy between AI/ML functionalities at the two sides by introducing various levels of collaborations through the air-interface. Specifically, Rel-18 study aims to explore the benefits of augmenting the air-interface with features enabling improved support of AI/ML through studying few carefully selected use cases and assessing their performance in comparison with traditional methods. It would lay the foundation for future air interface use cases leveraging AI/ML techniques.

The initial three use cases listed below are aimed to focus on the formulation of a framework to apply AI/ML to the air-interface.

- CSI feedback enhancement. e.g., overhead reduction, improved accuracy, prediction
- Beam management. e.g., Beam prediction in time and/ or spatial domain for overhead reduction and accuracy improvement
- Positioning accuracy enhancements for different scenarios including NLOS operation

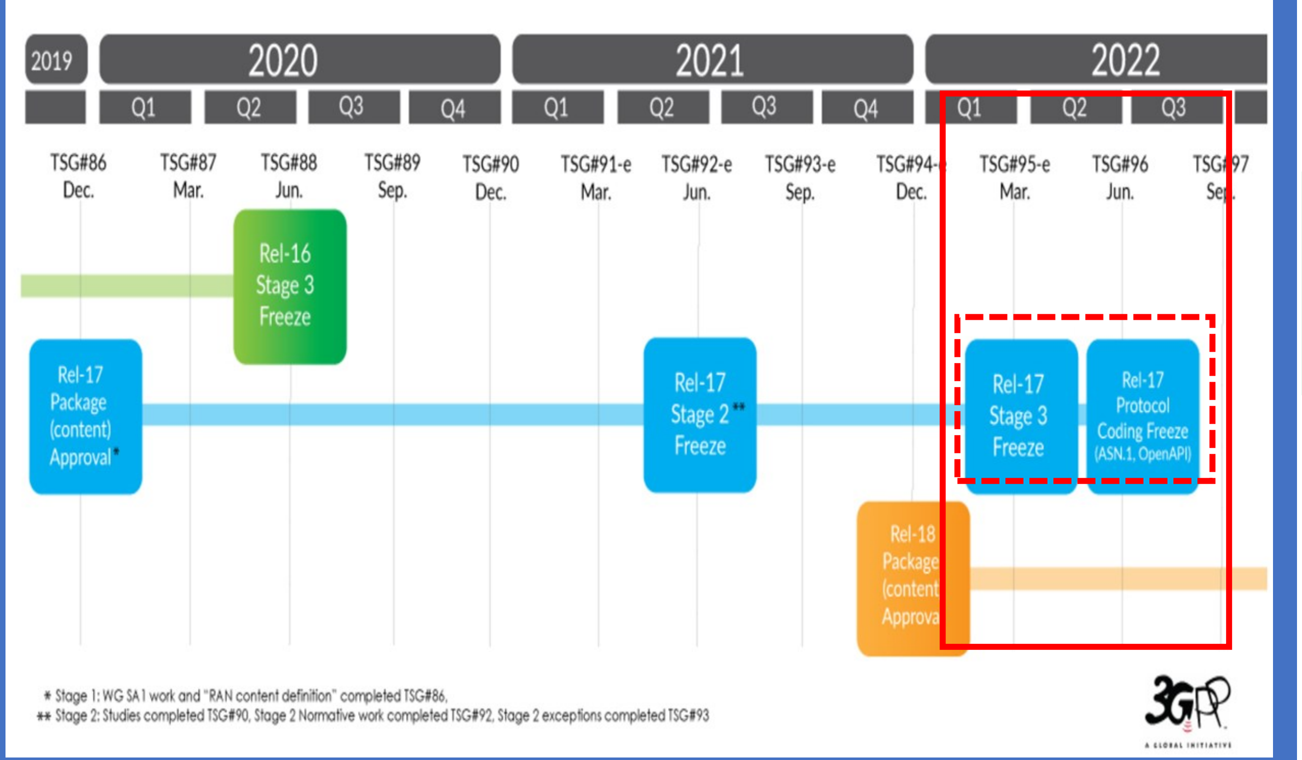
Release-18 still brings certain downlink-related enhancements, yet its main focus are the uplink ones. In this way, the first release of 5G-Advanced will not only achieve a symmetry of downlink and uplink capabilities, but it will also prepare for the new emerging applications like AR/VR/XR, which are uplink-heavy. Another aspect of Release-18 worth noting is the increased interest for a diverse set of devices: now that every commercial 5G hand-held device is successfully using massive MIMO solutions to boost the user experience, it is time to extend massive MIMO to CPE, FWA, industrial and vehicular devices.

O-RAN use-case realization using AI/ML

For mobile networks to evolve from a design that offers best-effort services to a design that offers performance and user experience guarantees, intelligence needs to be an integral component of the network. O-RAN WG1 Use Case Task Group [3] has defined a set of use cases, such as traffic steering, QoS-based resource optimization, QoE optimization, RAN Slicing Service Level Assurance, massive MIMO beamforming optimization, Dynamic Spectrum Sharing etc., along with the corresponding use-case requirements. Realization of these use cases require meeting certain performance guarantees and service assurances that mandate the usage of AI/ML tools.

1. Introduction - 3GPP Rel-17 Timeline Stage 3 from March 2022 towards 3GPP 5G Advanced First (1st) Release (Rel-18)

More 5G system enhancements are reaching maturity with the completion of Release 17.



3GPP uses a system of parallel "Releases"

Stage 1 refers to the Service Description from a Service-User's point of view.

Stage 2 is a logical analysis, devising an abstract Architecture of Functional Elements and the Information Flows amongst them across Reference Points between Functional Entities.

"Stage 3" is the ***concrete Implementation of the Functionality and of the Protocols*** *appearing at Physical Interfaces between Physical Elements onto which the Functional Elements have been mapped.*

Furthermore, some Stage 3 Specifications *require Test Specifications* to be prepared: effectively a "***Stage 4***".

Some Release 17 highlights

TSG#95-e (March 2022) saw the completion of the Rel-17 functional freeze.

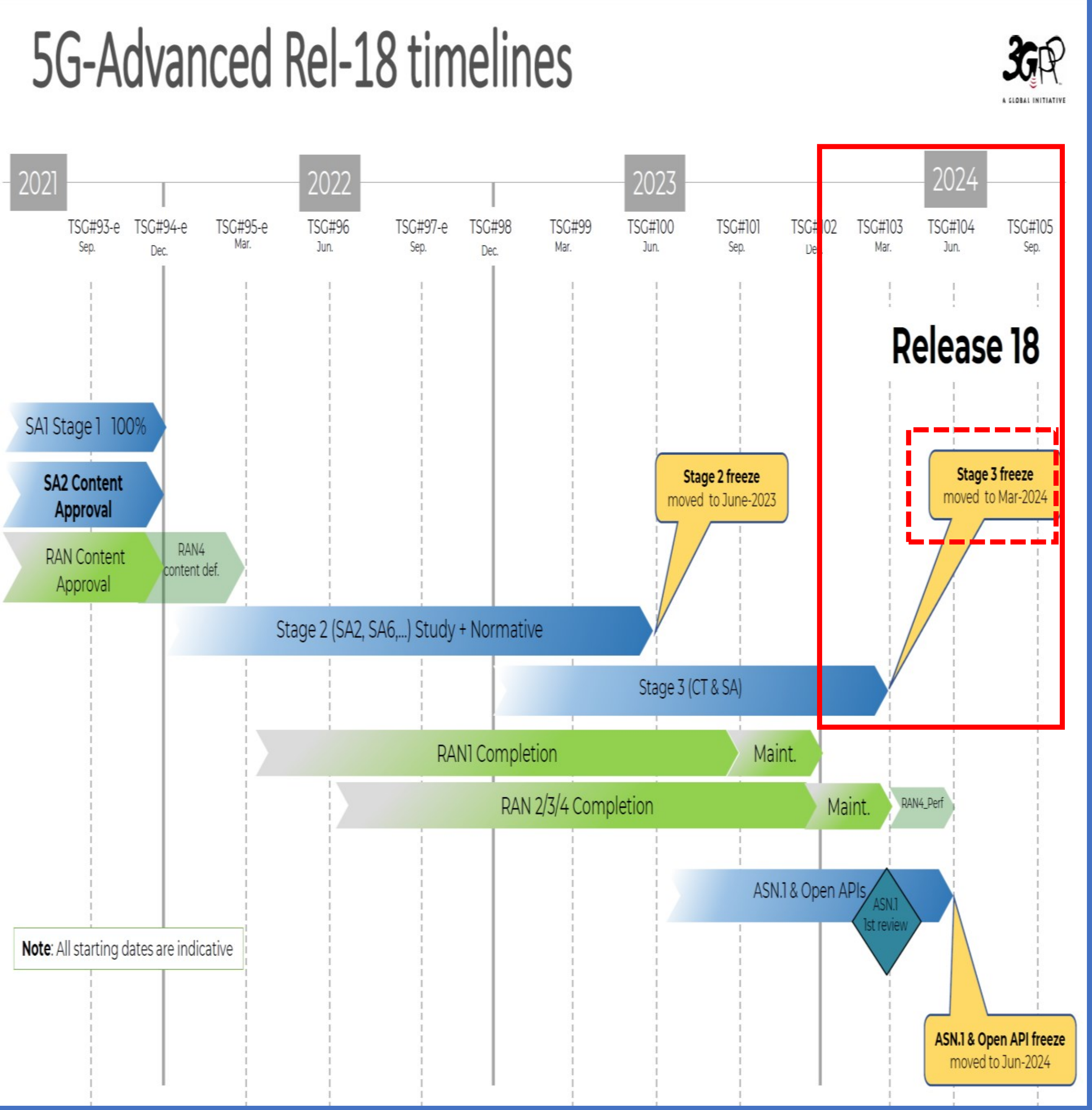
Some important Rel-17 projects were:

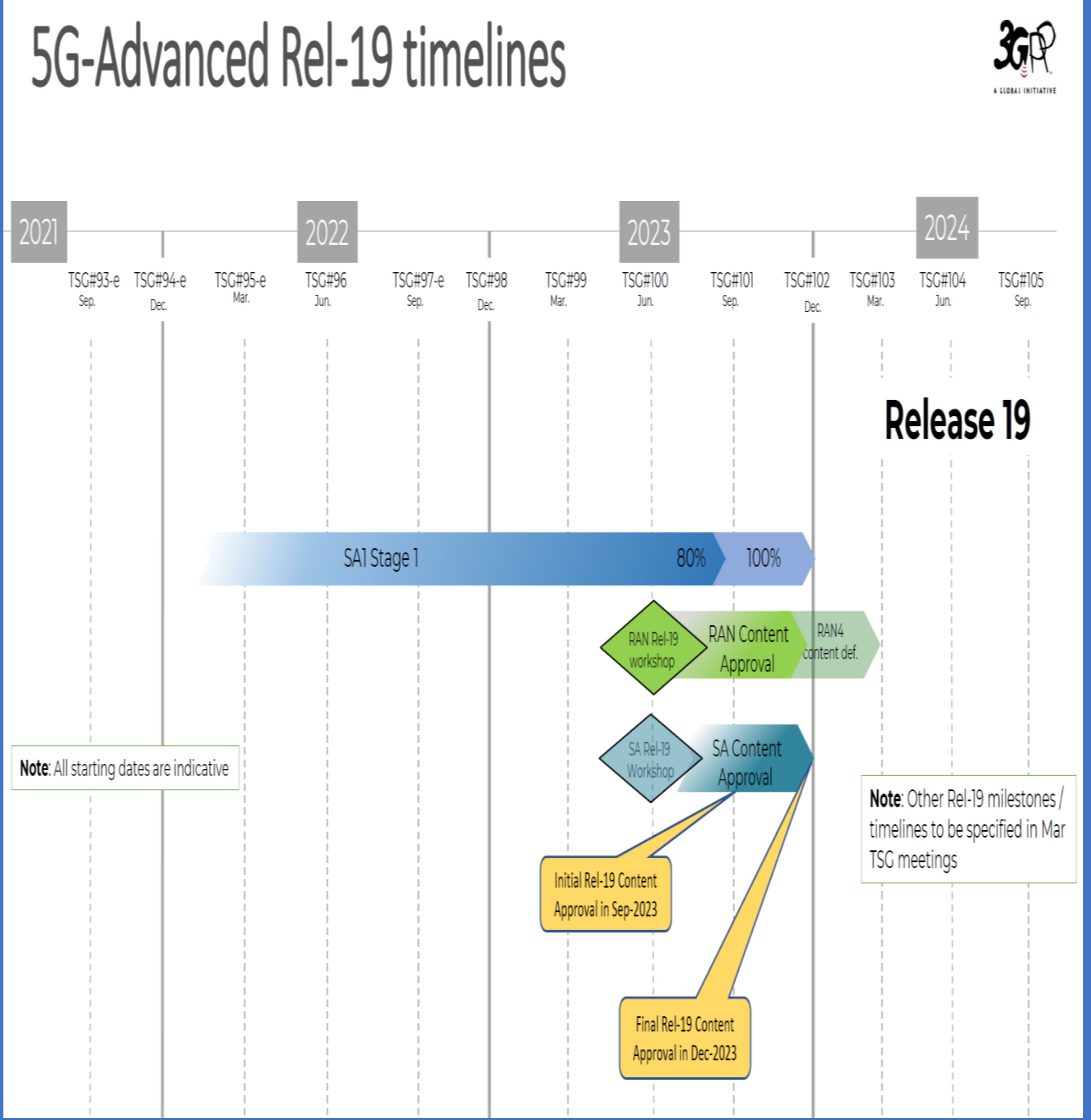
- Sidelink enhancements,
- Reduced capability (Redap) NR devices,
- NR operation extended to 71GHz,
- Further enhancements on MIMO for NR,
- NR over Non terrestrial Networks (NTN),
- IoT over NTN,
- UE power saving enhancements for NR,
- Enhancements to Integrated Access and Backhaul for NR,
- Enhancement of RAN slicing for NR,
- RF requirements enhancement for NR FR1,
- RF requirements for NR FR2,
- Coverage and positioning enhancements,
- NR and slicing QoE,
- Enhanced support of non-public networks,
- Support for uncrewed aerial systems,
- Support for edge computing in 5GC,
- Proximity-based services in 5GS,
- Access traffic steering, switch and splitting (ATSSS),
- Network automation for 5G (Phase 2).

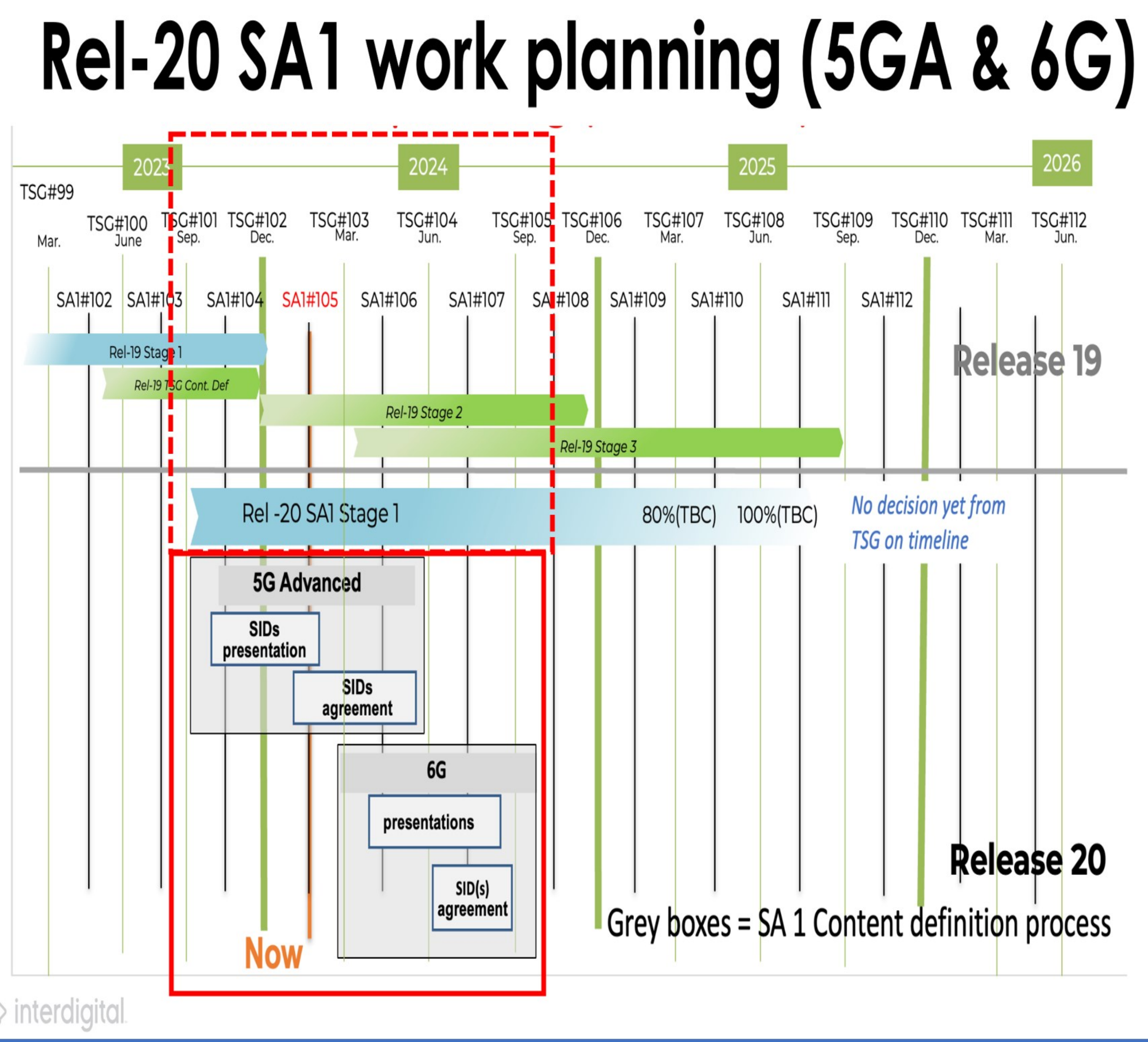
During 2022, Release 18 started its progress - becoming the main focus from June onwards.

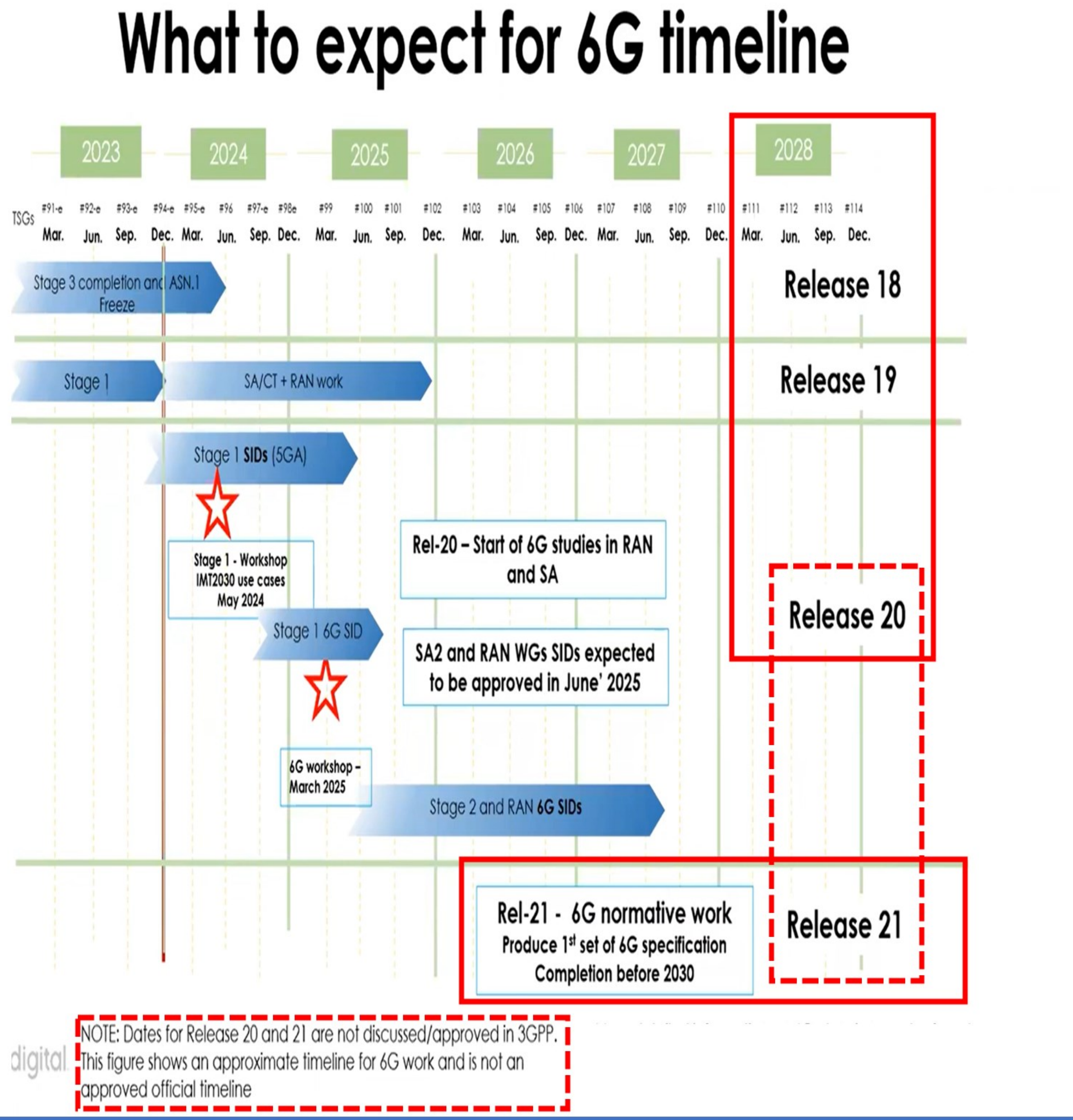
https://www.3gpp.org/specifications-technologies/releases

Introduction - Rel-18 and Rel-19 Timelines towards 6G - from March, 2024): Rel-18 "Stage 3" freeze" scheduled for March 2024






Rel-20 SA1 work planning (5GA & 6G)
2023
2024
2025
2026
TSG#99 Mar.
TSG#100 June
TSG#101 Sep.
TSG#102 Dec.
TSG#103 Mar.
TSG#104 Jun.
TSG#105 Sep.
TSG#106 Dec.
TSG#107 Mar.
TSG#108 Jun.
TSG#109 Sep.
TSG#110 Dec.
TSG#111 Mar.
TSG#112 Jun.
SA1#102
SA1#103
SA1#104
SA1#105
SA1#106
SA1#107
SA1#108
SA1#109
SA1#110
SA1#111
SA1#112
Rel-19 Stage 1
Rel-19 TSG Cont. Def
Rel-19 Stage 2
Rel-19 Stage 3
Release 19
Rel -20 SA1 Stage 1
80%(TBC)
100%(TBC)
No decision yet from TSG on timeline
5G Advanced
SIDs presentation
SIDs agreement
6G
presentations
SID(s) agreement
Now
Release 20
Grey boxes = SA 1 Content definition process
interdigital


What to expect for 6G timeline
2023
2024
2025
2026
2027
2028
TSGs
Mar.
Jun.
Sep.
Dec.
Stage 3 completion and ASN.1 Freeze
Release 18
Stage 1
SA/CT + RAN work
Release 19
Stage 1 SIDs (5GA)
Stage 1 - Workshop IMT2030 use cases May 2024
Rel-20 – Start of 6G studies in RAN and SA
Stage 1 6G SID
SA2 and RAN WGs SIDs expected to be approved in June' 2025
Release 20
6G workshop – March 2025
Stage 2 and RAN 6G SIDs
Rel-21 - 6G normative work
Produce 1st set of 6G specification
Completion before 2030
Release 21
NOTE: Dates for Release 20 and 21 are not discussed/approved in 3GPP. This figure shows an approximate timeline for 6G work and is not an approved official timeline

1. Introduction - 5G System AI ML Model Split use on 5G Network Endpoints as specified in 5G Advanced Rel-18/Rel-19 Service Requirements

5G System AI/ML Model Transfer

The ***5G System*** can at least support *three (3) types of AI/ML Operations:*

1.AI/ML Operation splitting between AI/ML (Network) End-points: The AI/ML Operation/Model is split into Multiple Parts according to the current Task and Environment. The intention is to *off-load the Computation-Intensive, Energy-Intensive Parts to Network End-points*, whereas *leave the Privacy-sensitive and Delay-sensitive Parts at the End Device.* The Device executes the Operation/Model up to a specific Part/Layer and ***then sends the intermediate Data to the Network Endpoint***. The Network End-point executes the remaining Parts/Layers and feeds the Inference Results back to the Device.

2. AI/ML Model/Data Distribution and Sharing over 5G System: Multi-functional Mobile Terminals might need to switch the AI/ML Model in response to task and environment variations. The condition of adaptive model selection is that the models to be selected are available for the Mobile Device. However, given the fact that the AI/ML Models are becoming increasingly diverse, and with the *limited storage resource in a UE*, it can be determined to *not pre-load all candidate AI/ML Models on-board*. *Online model distribution (i.e. New Model Downloading) is needed*, in which an AI/ML Model can be distributed from a NW end-point to *the Devices when they need it to adapt to the changed AI/ML Tasks and Environments. For this purpose, the Model Performance at the UE needs to be monitored constantly.*

3. Distributed/Federated Learning (FL) over 5G System: The Cloud Server trains a Global Model by aggregating Local Models partially-trained by each End devices. Within each training iteration, a UE performs the training based on the Model downloaded from the AI Server using the Local Training Data. Then the UE reports the interim training results to the Cloud server via 5G UL channels. The Server aggregates the Interim Training Results from the UEs and updates the Global Model. The updated Global Model is then distributed back to the UEs and the UEs can perform the training for the next iteration.

In Mobile Communications Systems, Mobile Devices (e.g. Smartphones, Automotive, Robots) are increasingly replacing conventional Algorithms (e.g. Speech Recognition, Image Recognition, Video Processing) with AI/ML Models to enable Applications.

Table: 5G System AI/ML Model Transfer KPI of split AI/ML Inference between UE and Network Server/ Application Function (AF)

Uplink KPI					Downlink KPI				
Max allowed UL end-to-end latency	Experienced data rate	Payload size	Communication service availability	Reliability	Max allowed DL end-to-end latency	Experienced data rate	Payload size	Reliability	Remarks
2 ms	1.08 Gbit/s	0.27 MByte	99.999 %	99.9 %				99.999 %	Split AI/ML image recognition
100 ms	1.5 Mbit/s				100 ms	150 Mbit/s	1.5 MByte/ frame		Enhanced media recognition
	4.7 Mbit/s				12 ms	320 Mbit/s	40 kByte		Split control for robotics
NOTE 1: Communication service availability relates to the service interfaces, and reliability relates to a given system entity. One or more retransmissions of network layer packets can take place in order to satisfy the reliability requirement.									

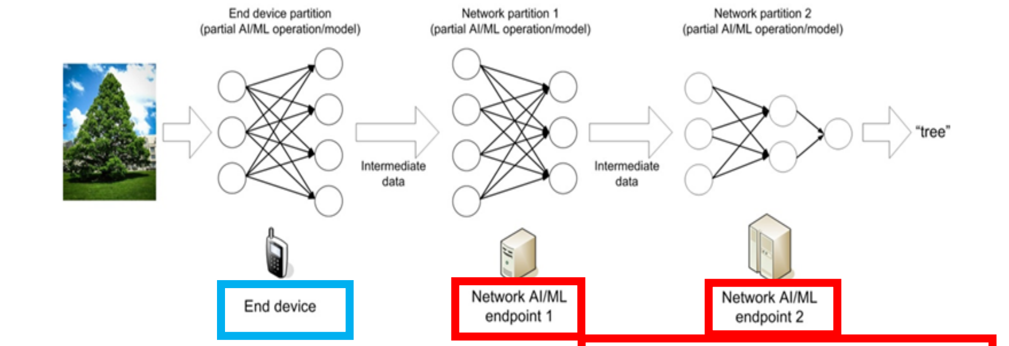


Figure: 5G System example of split AI/ML interference between End Device and Network AI/ML Endpoint(s)

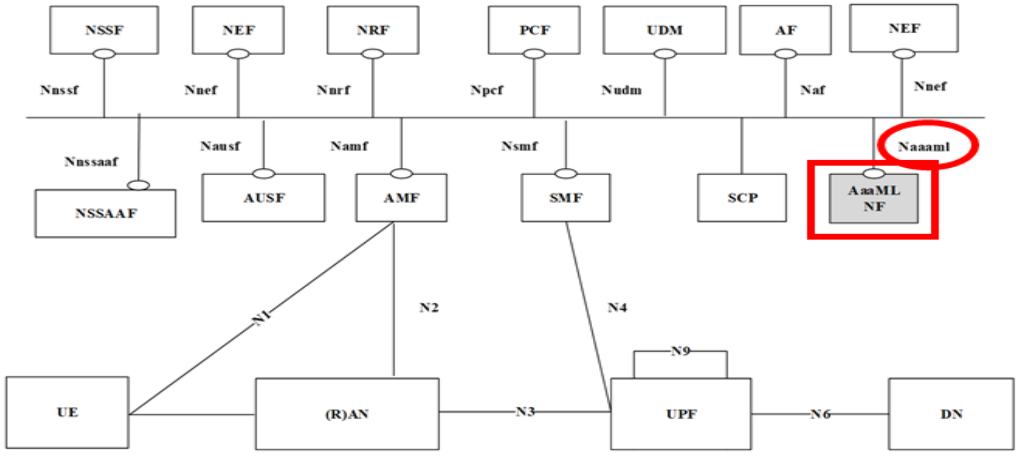


Figure: 5G System Service Architecture with AaaML NF

1. Introduction - 5G System Performance Measurement Functionality (PMF) E2E from UE through the TN & RAN to CN for 3GPP & Non-3GPP Access

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Figure shows the 5G System Architecture for ATSSS support in a roaming case with home-routed traffic and when the UE is registered to a VPLMN over 3GPP access and to HPLMN over non-3GPP access (i.e. the UE is registered to different PLMNs). In this case, the MPTCP Proxy functionality, the MPQUIC functionality, the ATSSS-LL functionality and the PMF are located in the H-UPF.

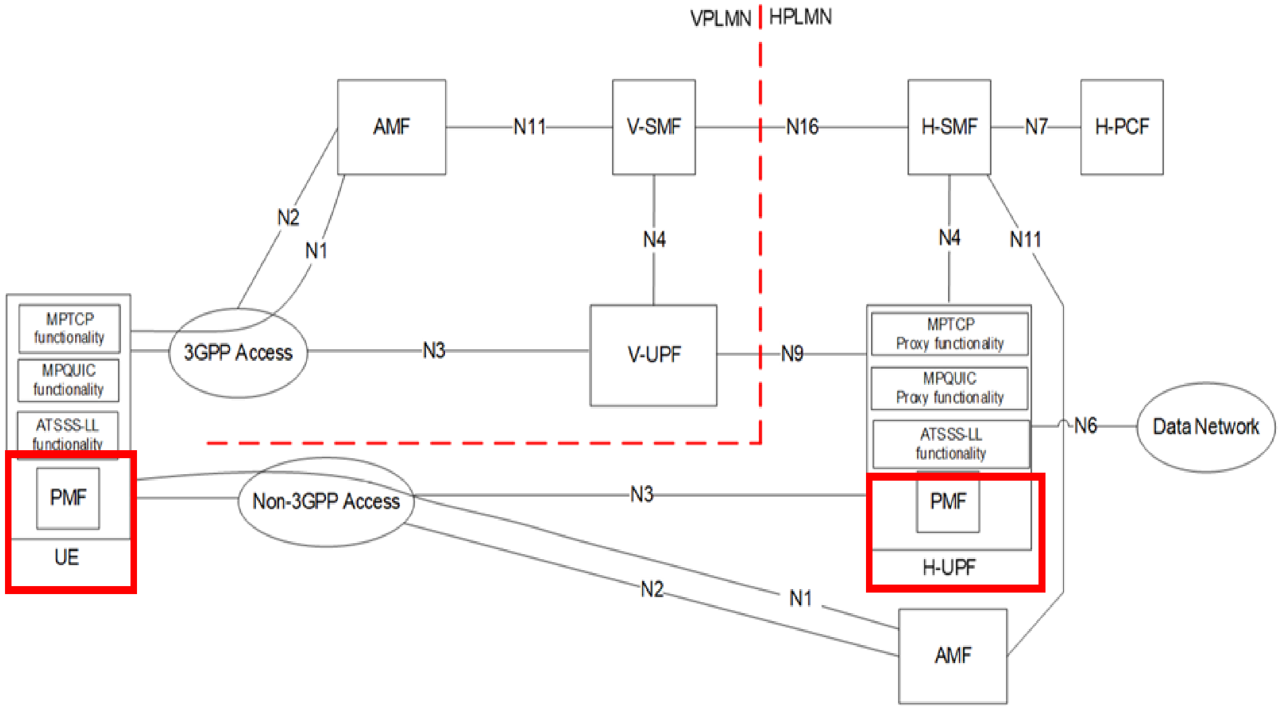

Figure: 5G System (5GS) Roaming with Home-Routed(HR) Architecture for ATSSS support (UE registered to different PLMNs) with Performance Measurement Functionality (PMF) located in the H-UPF

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Protocol stack for user plane measurements and measurement reports

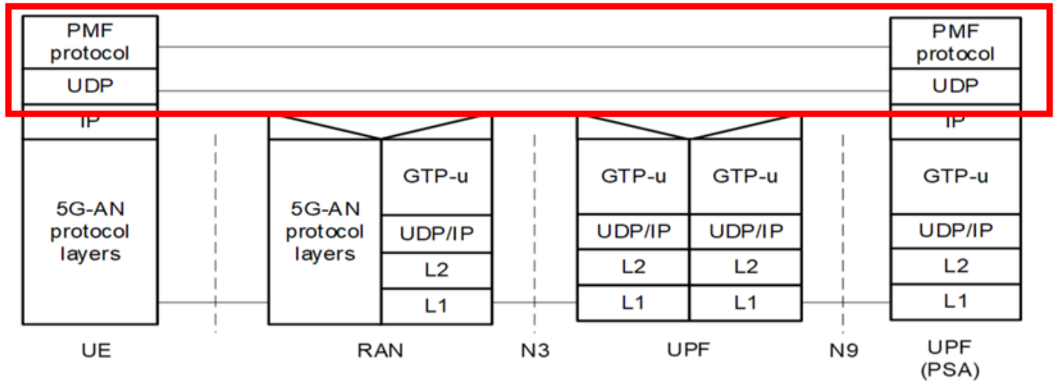

Figure: 5G System (5GS) UE/UPF Measurements related Protocol Stack for 3GPP Access and for an MA PDU Session with type IP

Release 18 3GPP V18.4.0 (2023-12)

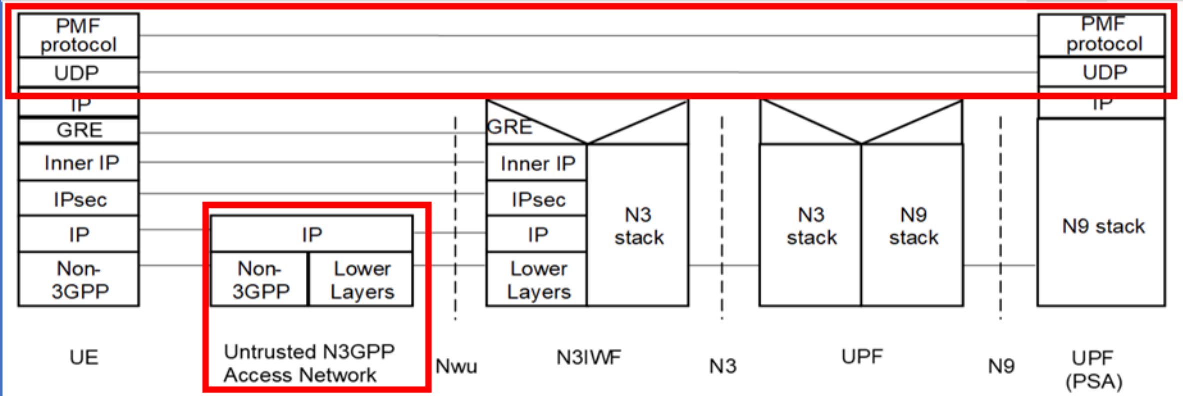

Figure: 5G System (5GS) UE/UPF Measurements related Protocol Stack for Untrusted Non-3GPP Access and for an MA PDU Session with type IP

1 Introduction: Mobile Networks to evolve from:

a 2G, 3G, 4G Design that offers "Best-effort" Services

to

a Design that offers Performance and User Experience Guarantees

=>

=>

Capabilities related to e.g.:

When a *Multi-access* (**MA**) **PDU Session** is established, the Network may provide the UE with *Measurement Assistance Information* to enable the UE in determining which measurements shall be performed over both Accesses, as well as whether measurement reports need to be sent to the Network.

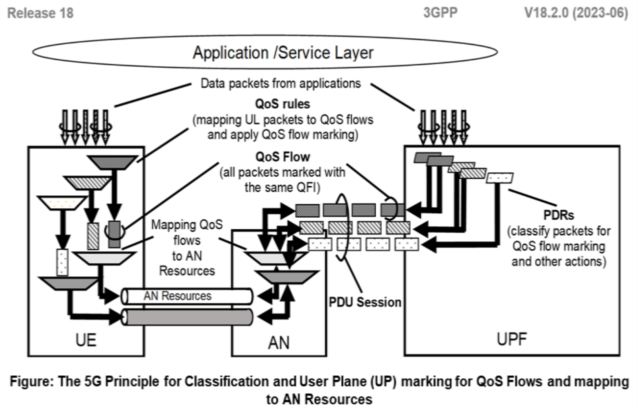

Figure: The 5G Principle for Classification and User Plane (UP) marking for QoS Flows and mapping to AN Resources

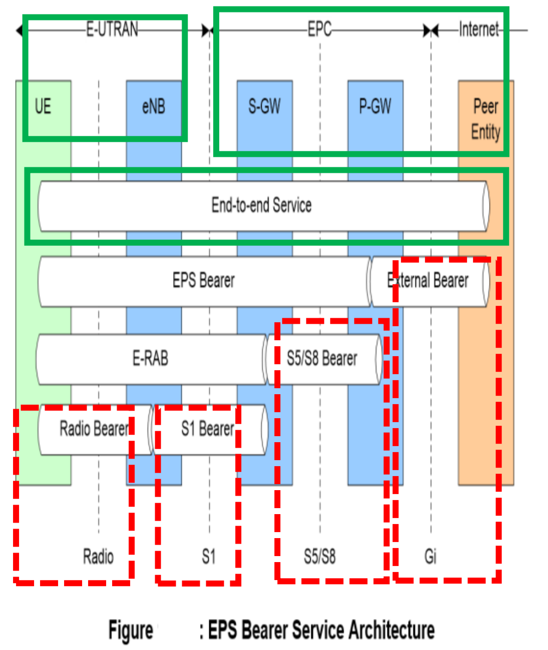

Figure : EPS Bearer Service Architecture

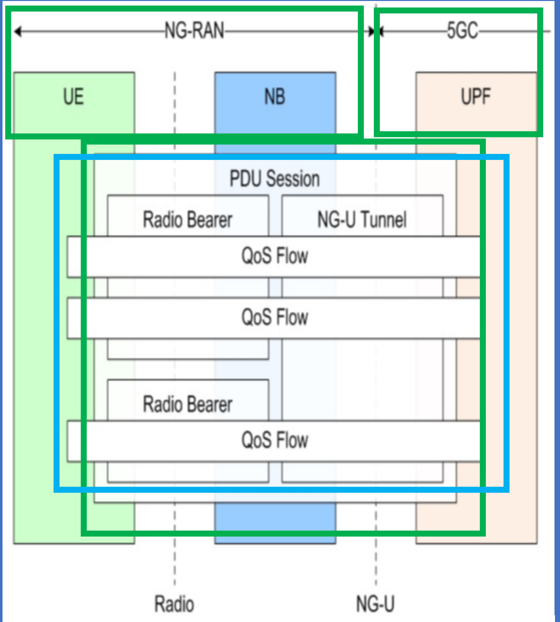

Figure: 5G CN NG-RAN Bearer Services QoS Architecture

Measurement Assistance Information shall include the addressing information of *a Performance Measurement Functionality* (**PMF**) in the UPF, the UE can send PMF protocol messages incl.:

- Messages to allow for *Round Trip Time* (**RTT**) Measurements: the "*Smallest Delay*" steering mode is used or when either "*Priority-based*", "*Load-Balancing*" or "**Redundant**" steering mode is used with RTT threshold value being applied;
- Messages to allow for *Packet Loss Rate* (**PLR**) measurements, i.e. when steering mode is used either "*Priority-based*", "*Load-Balancing*" or "*Redundant*" steering mode is used with **PLR** threshold value being applied;

- Messages for reporting Access Availability/Un-availability by the UE to the UPF.
- Messages for sending **UE-assistance Data** to **UPF.**
- Messages for sending "*Suspend Traffic Duplication*" and "*Resume Traffic Duplication*" from **UPF** to **UE** to "suspend" or "resume" traffic duplication as defined in **5GS Architecture**.

2. 5G System Common (CN and RAN) Network Resource Model (NRM) for 5G System Management

The 5GS specifies the Generic Network Resource Information that can be communicated between an MnS "Producer" and MnS "Consumer "for Telecommunication Network Management purposes, including Management of Converged Networks and Networks that include Virtualized Network Functions (VNFs).

The 5GS specifies the Semantics of information Object Class (IOC) attributes and relations visible across the Reference Point in a Protocol and Technology neutral way. It does not define their Syntax and Encoding.

The 5GS supports the Federated Network Information Model (FNIM) concept in that the relevant Information Object Class (IOC) is defined in this specification are directly or indirectly inherited from those specified in the Umbrella Information Model (UIM) of Fixed Mobile Convergence.

Note. The presented NRM is applicable to Deployment scenarios using the Service Based Management Architecture (SBMA) as defined in 5G System Management and Orchestration Architecture Framework.

The Figures show the containment/naming hierarchy and the associations of the Classes defined that are combined with the Figure showing the Umbrella Information Model (UIM) Class Diagram.

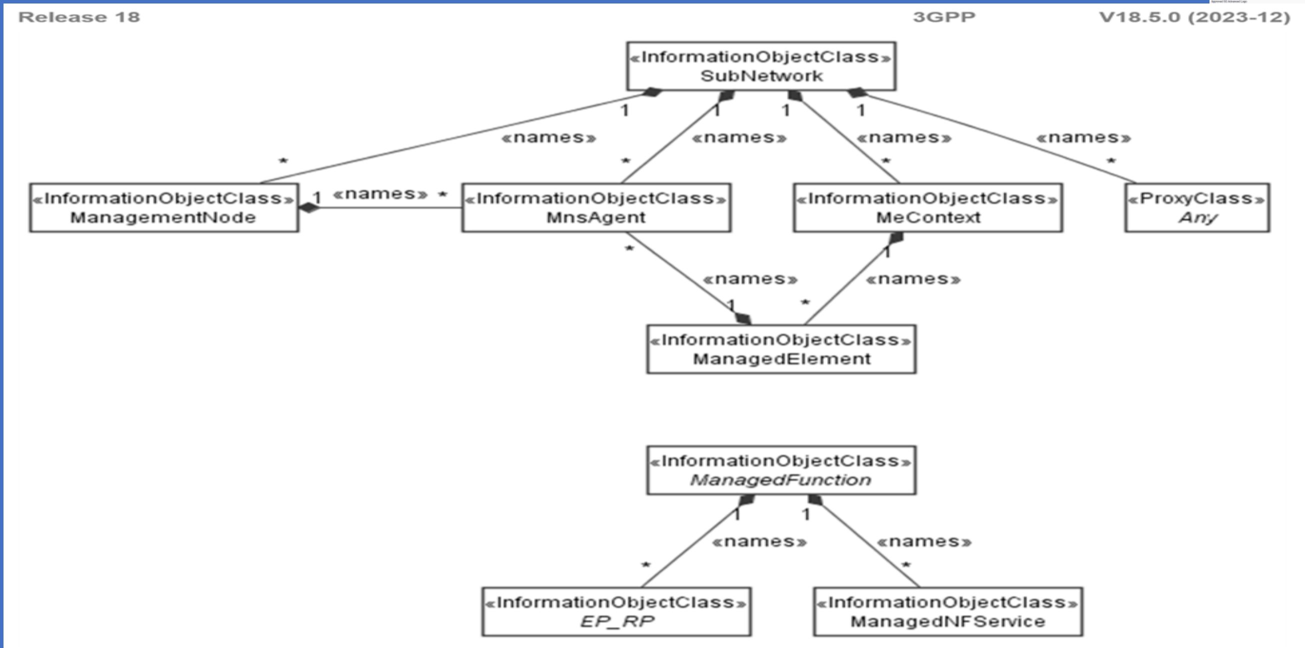

Figure: 5G Network Resource Model (NRM) Fragment

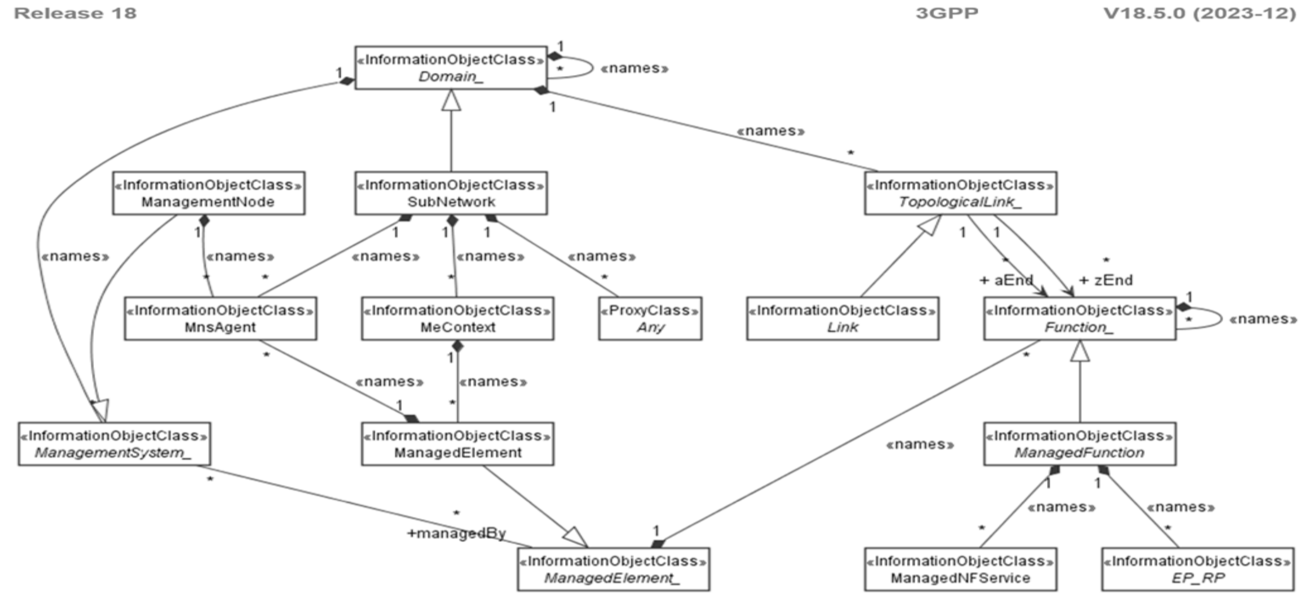

Figure: 5G Network Resource Model (NRM) Umbrella Information Model (UIM) Class Diagram

2. 5G System Common (CN and RAN) Network Resource Model (NRM) for 5G System Management

The 5G System specifies the Information Model and Solution Set for the Network Resource Model (NRM) definitions of 5G NR, NG-RAN, 5G Core Network (5G CN) and Network Slice (SST), to support the 5G System Management for:

- ***Variety of 5G Radio Access Network (RAN) Functions and Features, covering 5G Management for 5G NR Connectivity Options*** defined in 5G System for 3G, 4G LTE E-UTRA and 5G NR Multi-RAT Connectivity and NG-RAN Architectural Options as specified by 3GPP.

- ***Variety of 5G Core Network (CN) Functions and Features*** defined by 3GPP in 5G System Architecture specification.

- ***5G Network Slice (SST) and Network Slice Subnet.***

The 5GS NRM Information Model defines the Semantics and Behaviour of Information Object Class (IOC) Attributes and Relations visible on the Management Interfaces in a Protocol and Technology Neutral way.

The 5GS NRM Solution Set defines one (1) or more Solution Set(s) with specific Protocol(s) according to the Information Model definitions.

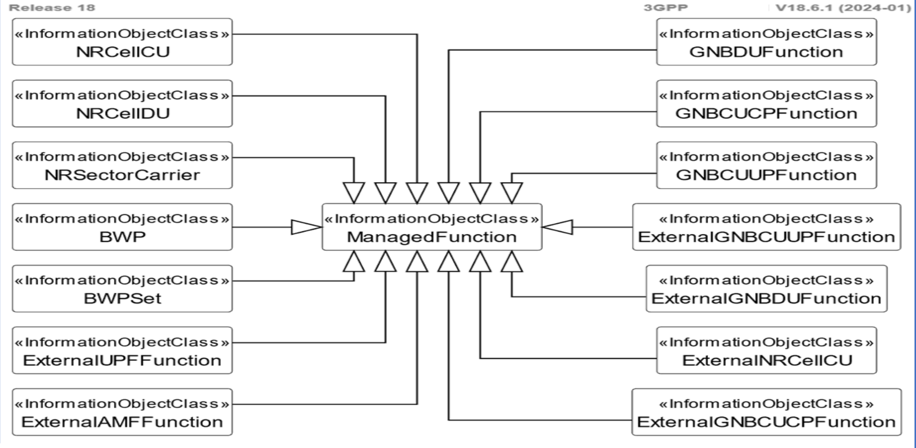

Figure: 5G New Radio (NR) Network Resource Model (NRM) fragment in All Deployment Scenarios

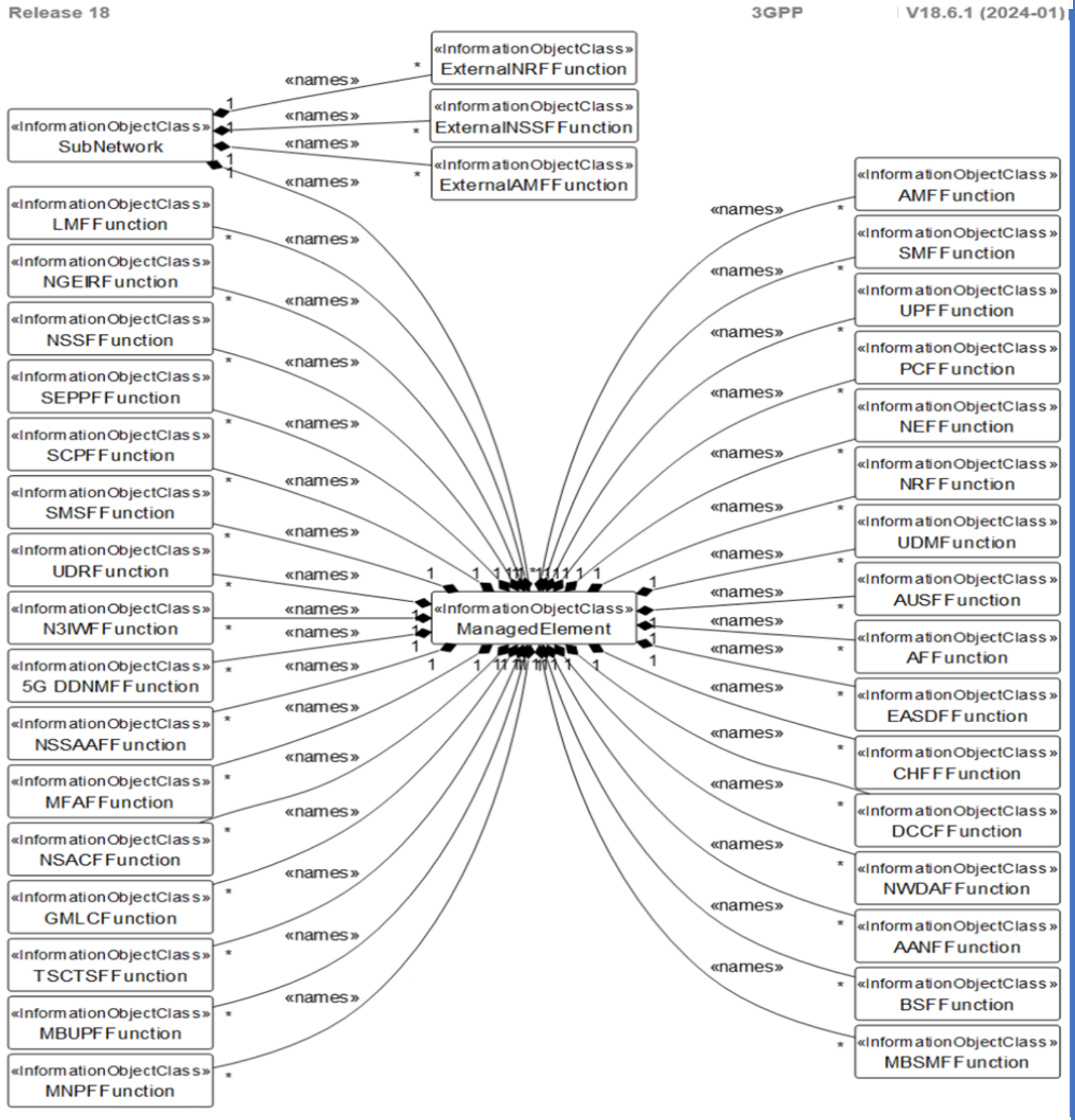

Figure: 5G Core Network (CN) Network Resource Model (NRM) Containment/Naming Relationship

2. 5G System Common (CN and RAN) Network Resource Model (NRM) for 5G System Management

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Information Model definitions for 5GC NRM

Table: 5G Core Network (CN) Network Resource Model (NRM) Information Entities and Local Labels

Label reference	Local label
IOC, SubNetwork	SubNetwork
IOC, ManagedElement	ManagedElement
IOC, ManagedFunction	ManagedFunction
IOC, EP_RP	EP_RP
IOC, ServingGWFunction	ServingGWFunction
IOC, SmsIwmscFunction	SmsIwmscFunction
IOC, SmsGmscFunction	SmsGmscFunction
IOC, GmlcFunction	GmlcFunction
dataType, PLMNId	PLMNId
IOC, EASFunction	EASFunction
IOC, EESFunction	EESFunction
IOC, ECSFunction	ECSFunction
datatype, ServingLocation	ServingLocation
datatype, TimeWindow	TimeWindow

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Information model definitions for NR NRM

Table: 5G New Radio (NR) Network Resource Model (NRM) Information Entities and Local Labels

Label reference	Local label
IOC, ManagedFunction	ManagedFunction
IOC, EP_RP	EP_RP
IOC, SectorEquipmentFunction	SectorEquipmentFunction
IOC, ExternalENBFunction	ExternalENBFunction
IOC, ServingGWFunction	ServingGWFunction
IOC, EUtranCellFDD	EUtranCellFDD
IOC, EUtranCellTDD	EUtranCellTDD
dataType, PLMNId	PLMNId
IOC, ENBFunction	ENBFunction
IOC, vingGWFunction	ExternalServingGWFunction
IOC, ExternalEUtranCellFDD	ExternalEUtranCellFDD
IOC, ExternalEUtranCellTDD	ExternalEUtranCellTDD
IOC, AdjacentCell	AdjacentEUtranCell
IOC, EUtranFrequency	EUtranFrequency
IOC, EUtranFreqRelation	EUtranFreqRelation
IOC, EUtranRelation	EUtranCellRelation
dataType, Tai	Tai

2. 5G System Common (CN and RAN) Network Resource Model (NRM) for 5G System Management
5G Core Network (CN) YANG Definitions APIs specified and available at 3GPP Forge

Directory: yang-models
Files:
_3gpp-5gc-nrm-affunction.yang
_3gpp-5gc-nrm-amffunction.yang
_3gpp-5gc-nrm-amfregion.yang
_3gpp-5gc-nrm-amfset.yang
_3gpp-5gc-nrm-ausffunction.yang
_3gpp-5gc-nrm-configurable5qiset.yang
_3gpp-5gc-nrm-dnfunction.yang
_3gpp-5gc-nrm-dynamic5qiset.yang
_3gpp-5gc-nrm-ep.yang
_3gpp-5gc-nrm-externalnrffunction.yang
_3gpp-5gc-nrm-externalnssffunction.yang
_3gpp-5gc-nrm-externalseppfunction.yang
_3gpp-5gc-nrm-FiveQiDscpMappingSet.yang
_3gpp-5gc-nrm-GtpUPathQoSMonitoringControl.yang
_3gpp-5gc-nrm-lmffunction.yang
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_3gpp-5gc-nrm-ngeirfunction.yang
_3gpp-5gc-nrm-nrffunction.yang
_3gpp-5gc-nrm-nssffunction.yang
_3gpp-5gc-nrm-nwdaffunction.yang
_3gpp-5gc-nrm-pcffunction.yang
_3gpp-5gc-nrm-predefinedpccruleset.yang
_3gpp-5gc-nrm-QFQoSMonitoringControl.yang
_3gpp-5gc-nrm-scpfunction.yang
_3gpp-5gc-nrm-seppfunction.yang
_3gpp-5gc-nrm-smffunction.yang
_3gpp-5gc-nrm-smsffunction.yang
_3gpp-5gc-nrm-udmfunction.yang
_3gpp-5gc-nrm-udrfunction.yang
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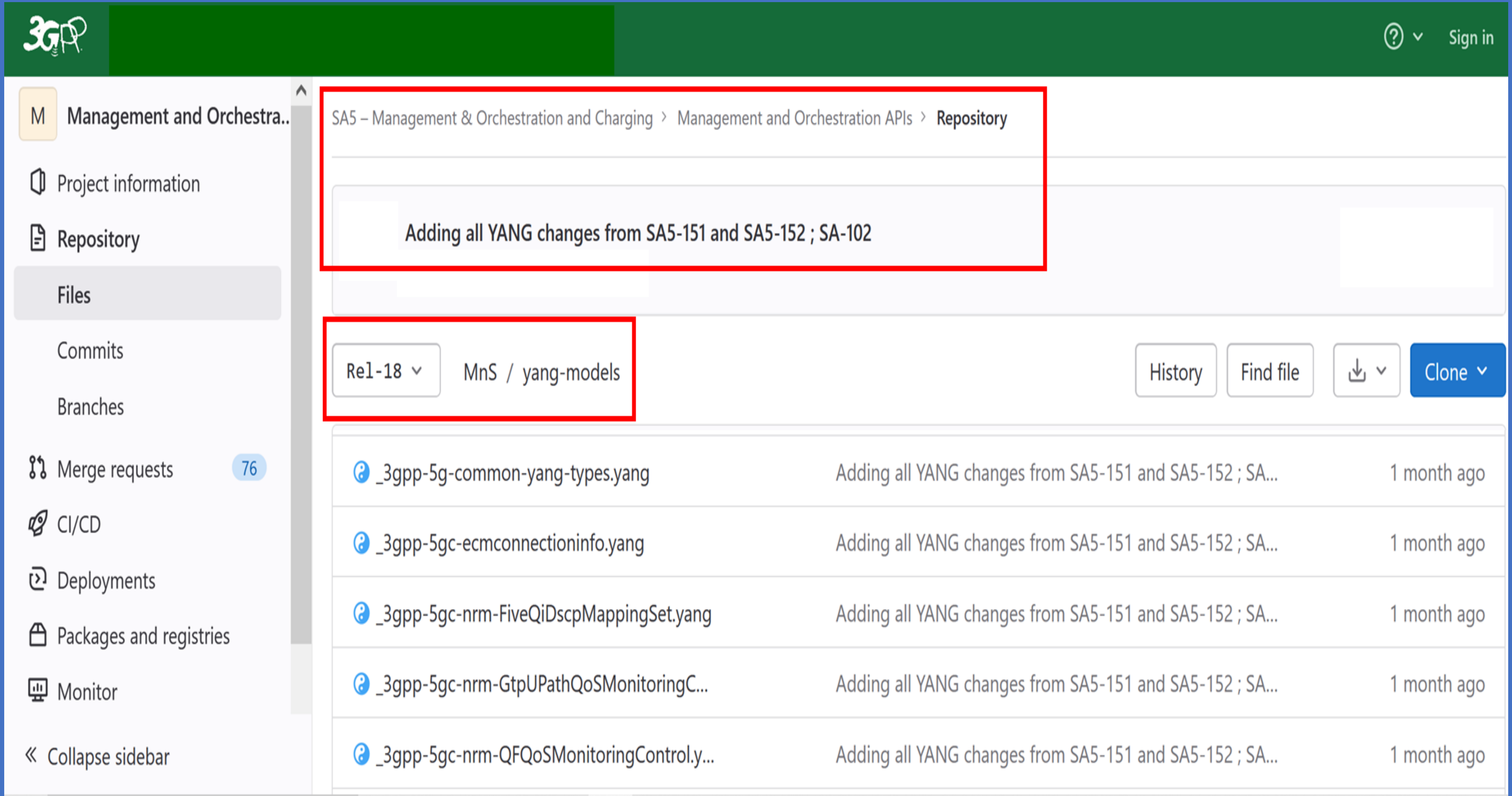
_3gpp-5gc-nrm-upffunction.yang
_3gpp-5g-common-yang-types.yang



If the Class Managed Element and the underlying hierarchy is contained under a Sub Network all YANG Modules containing IOCs that can be contained under the Managed Element directly or under other IOCs contained by the Managed Element and the YANG Module for Managed Element itself shall be mounted at the mountpoint "children-of-Sub Network" in the YANG Module _3gpp-common-subnetwork.
IETF YANG Model describes the Mechanism that adds the schema trees defined by a set of YANG Modules onto a mount point defined in the schema tree in another YANG module.

2. 5G System Common (CN and RAN) Network Resource Model (NRM) for 5G System Management

5G CN NRM - Inheritance

The 5GS CN inheritance relationships that exist between IOCs, as depicted in the Figure below shows the Inheritance Hierarchy from IOC (Information Object Class) Managed Function related to the 5G CN NF NRM. The Figure - 2 shows the Inheritance Hierarchy from IOC EP_RP related to 5G CN NF NRM.

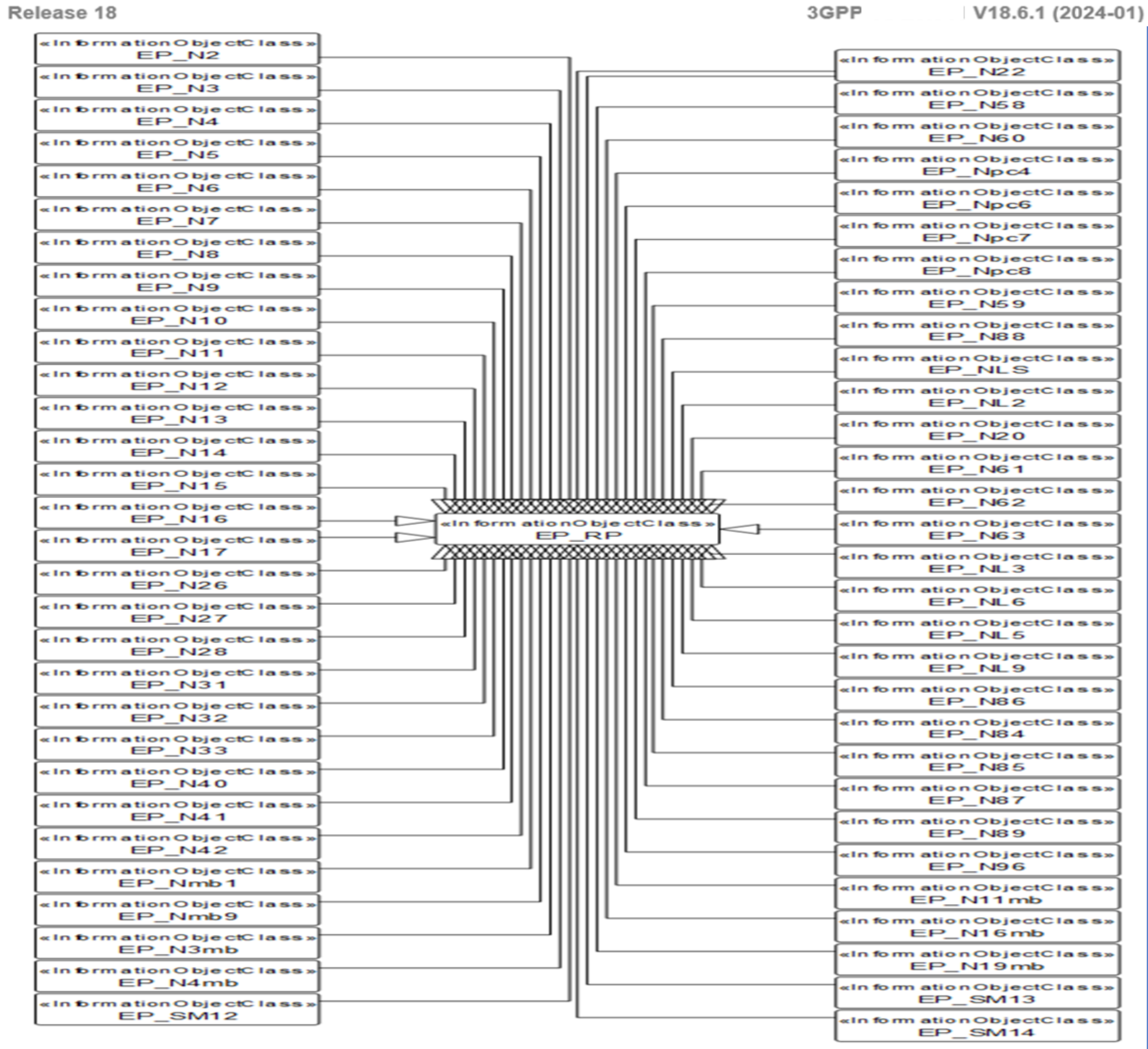


Figure: 5G Core Network NF Network Resource Model (NRM) Inheritance Hierarchy from IOC EP_RP

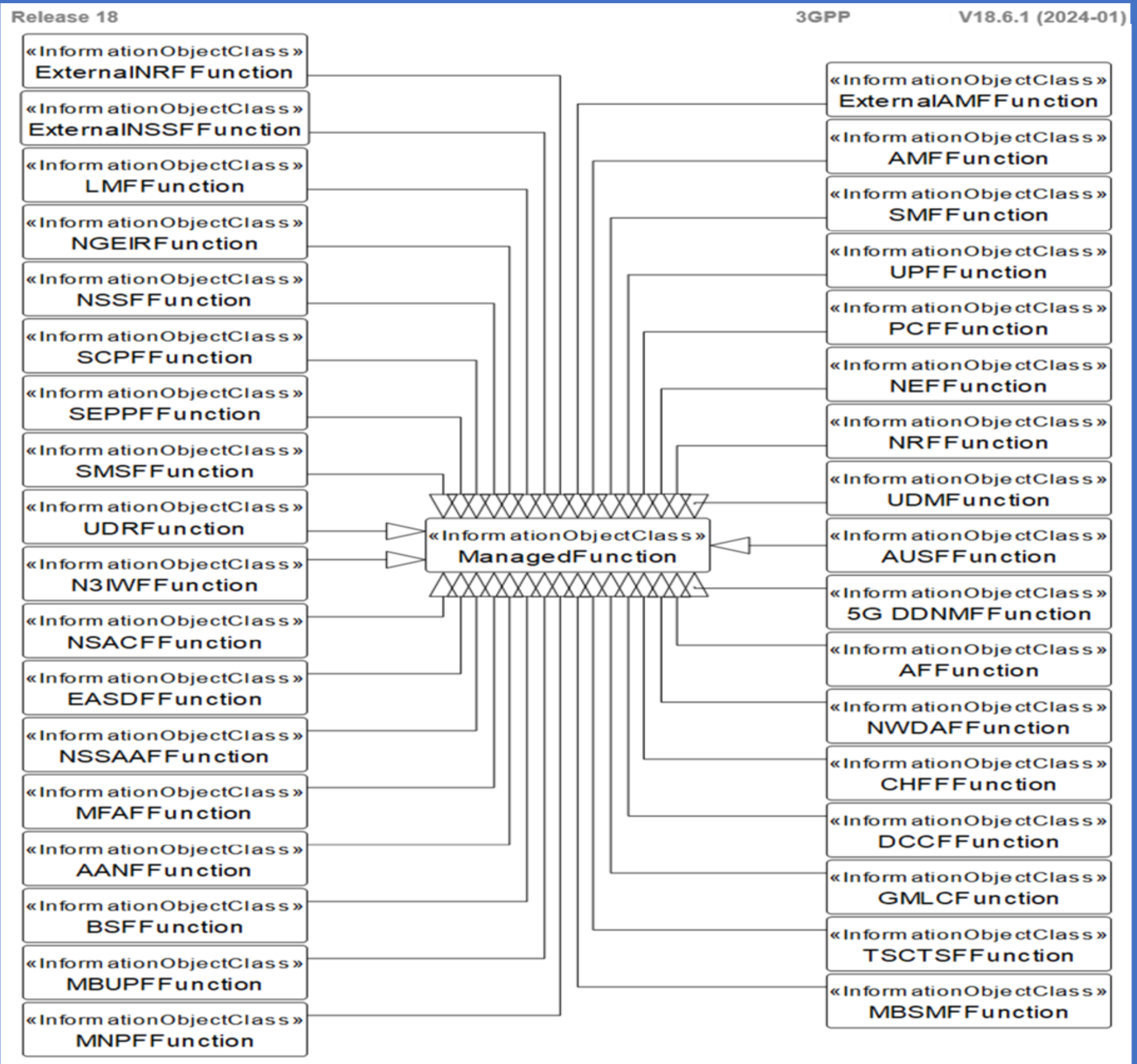


Figure: 5G Core Network NF Network Resource Model (NRM) Inheritance Hierarchy from IOC Managed Function

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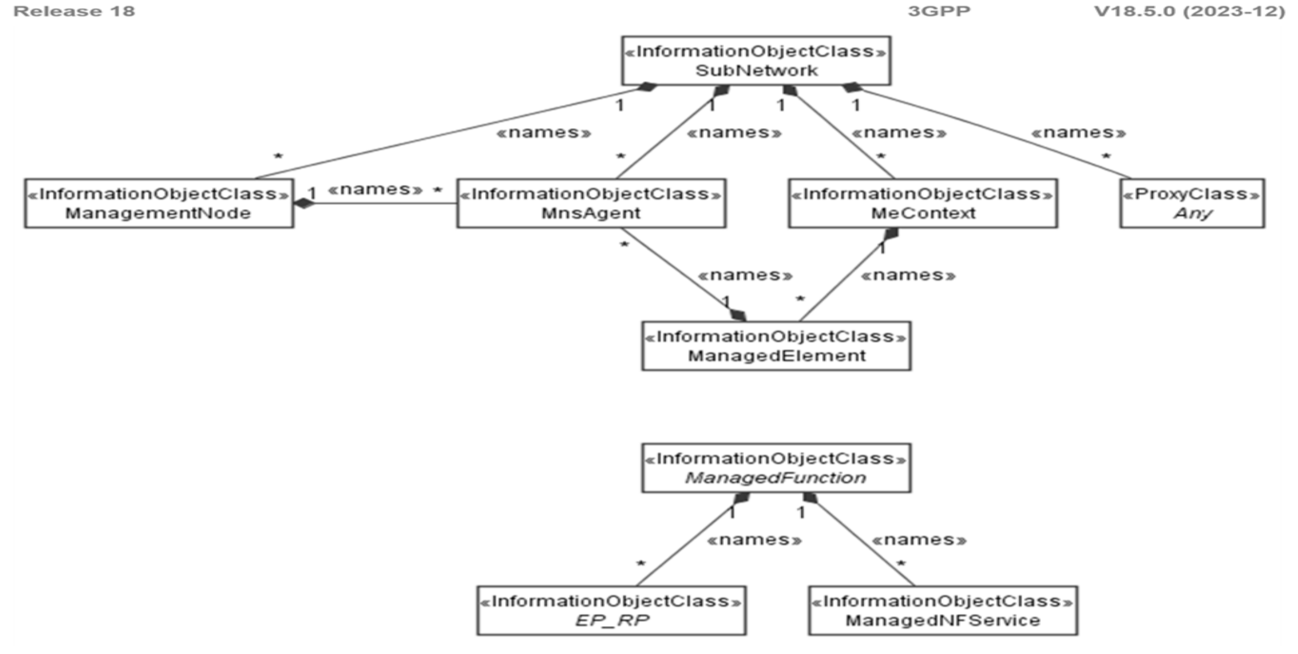

Figure: 5G Network Resource Model (NRM) Fragment

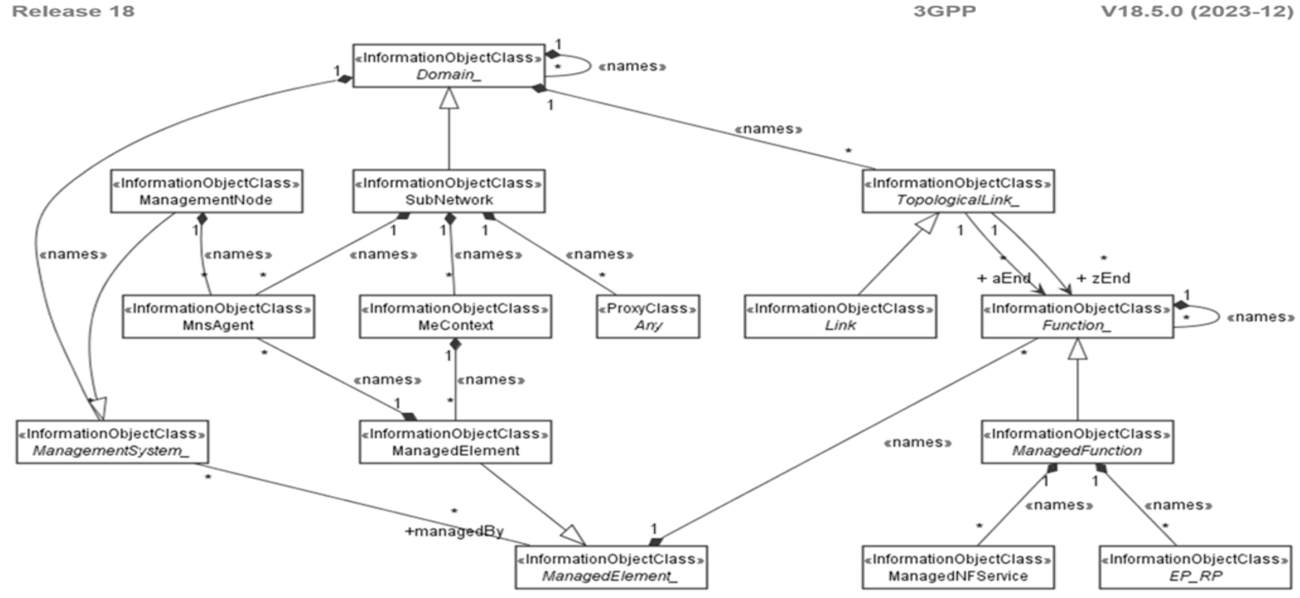

Figure: 5G Network Resource Model (NRM) Umbrella Information Model (UIM) Class Diagram

2. 5G CN Network Resource Model (NRM) for 5G System Management

The 5G System defined Class diagram of 5G Core Network (CN) Network Functions (NFs) and defined the set of Classes (e.g. IOCs-Information Object Class) that encapsulates the Information relevant for 5G CN NFs NRM definitions.

The Relationships of relevant Classes is defined in UML. Subsequent clauses provide more detailed specification of various aspects of these Classes.

The Figure shows the 5G CN NF NRM Containment/Naming Relationship.

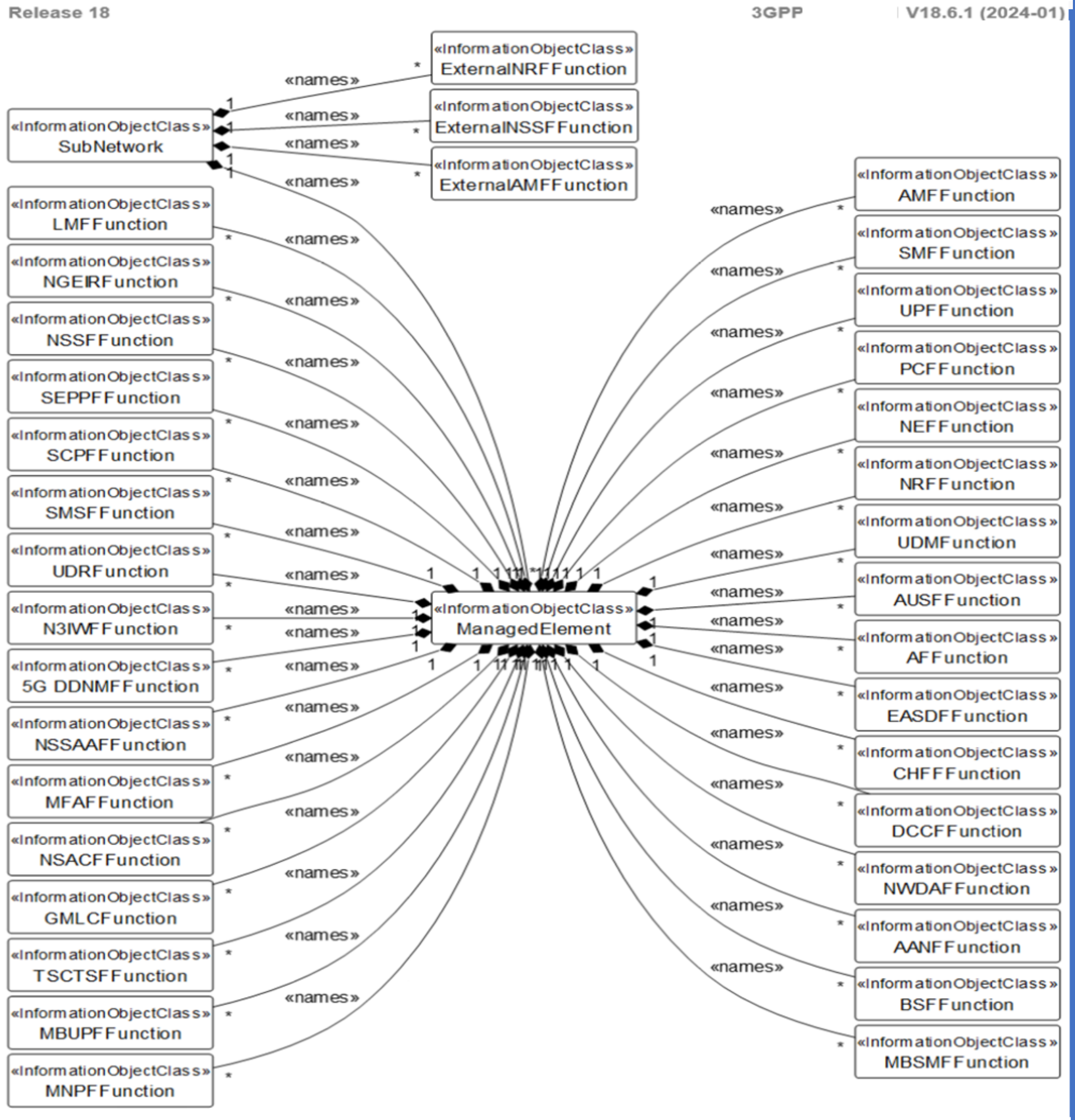

Figure: 5G Core Network (CN) Network Resource Model (NRM) Containment/Naming Relationship

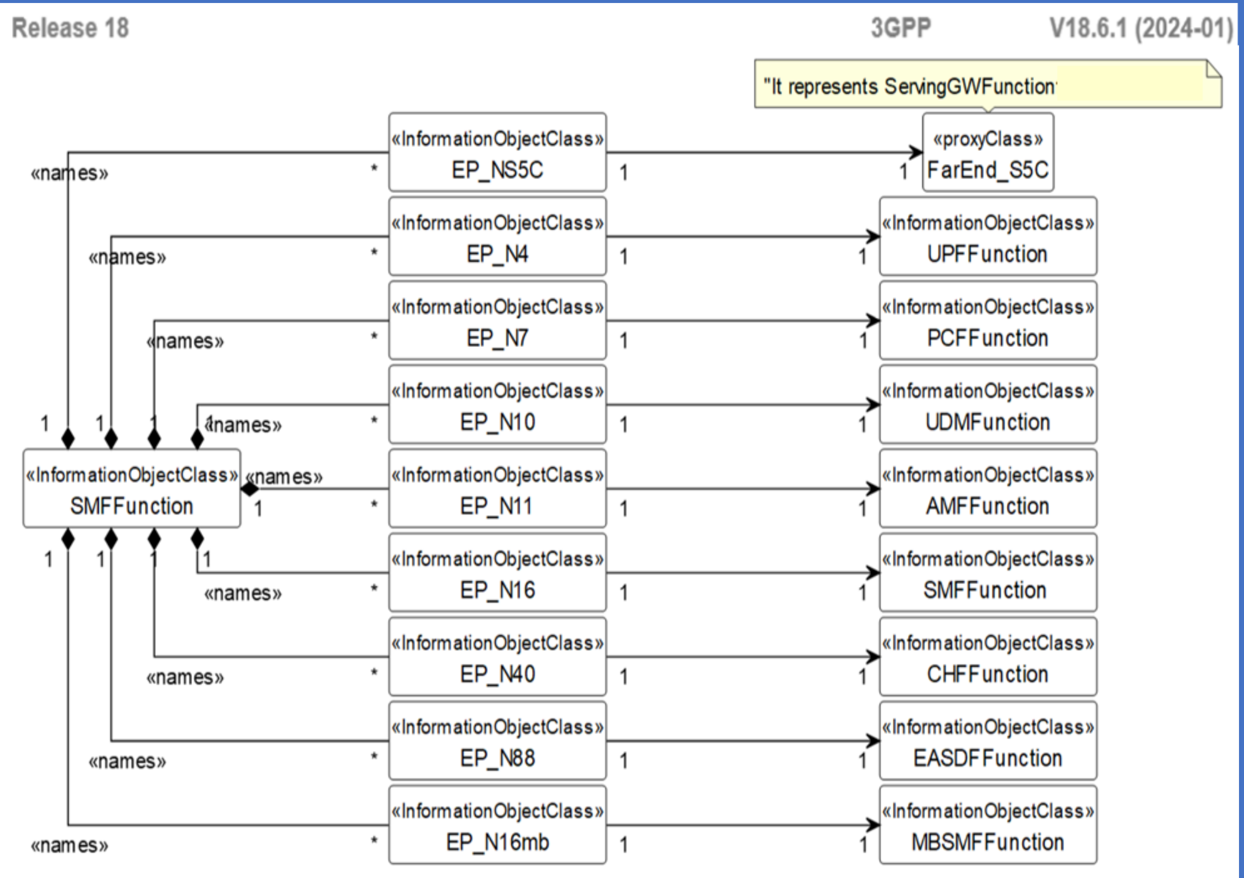

Figure: 5G Network Resource Model (NRM) Transport view of all 5G CN SMF NRM

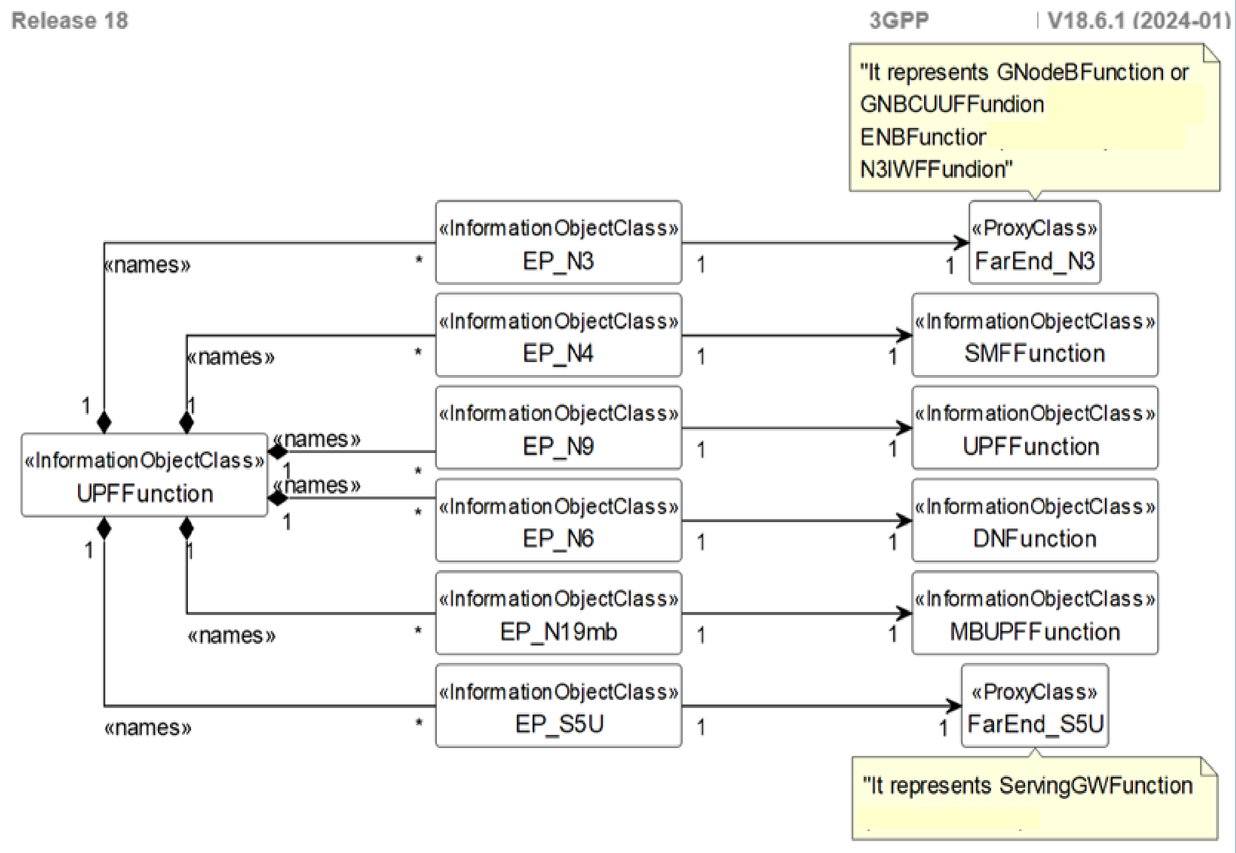

Figure: 5G Network Resource Model (NRM) Transport view of all 5G CN UPF NRM

2. 5G System Core Network (CN) UDM and AUSF Network Resource Model (NRM) for 5G System Management - selected examples

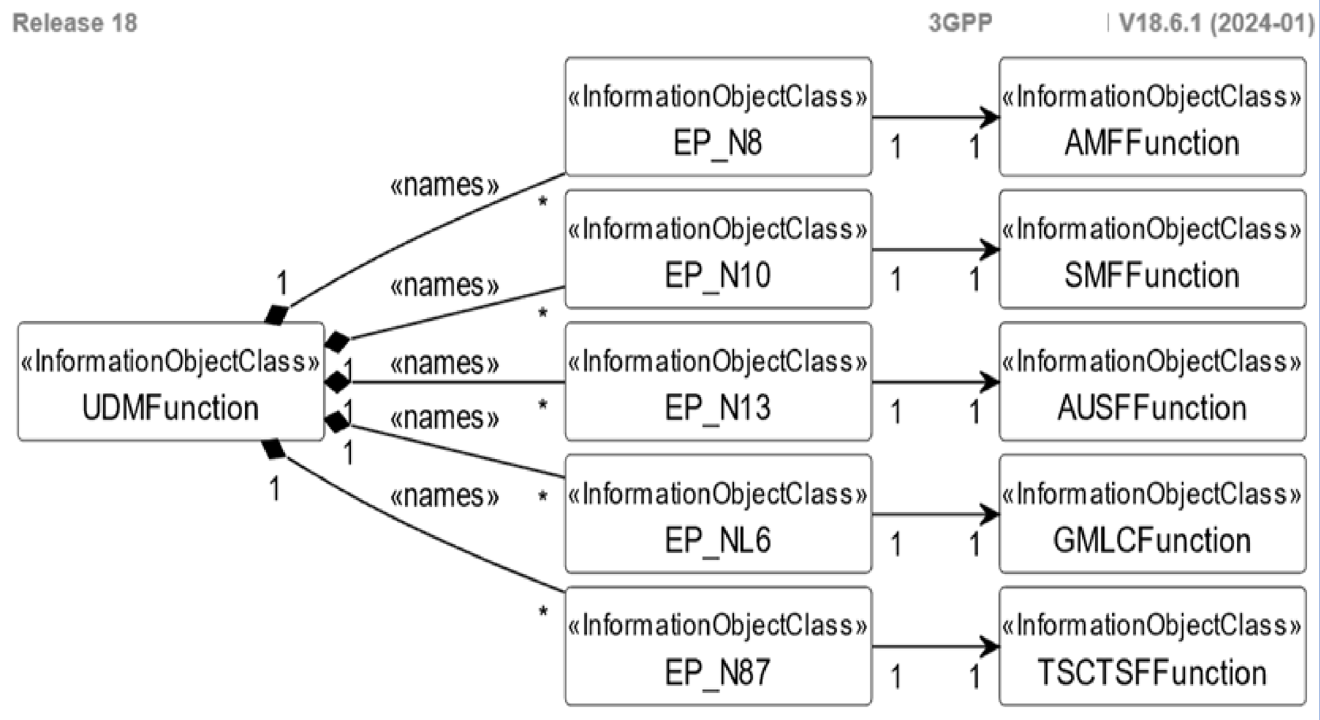

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN UDM NRM

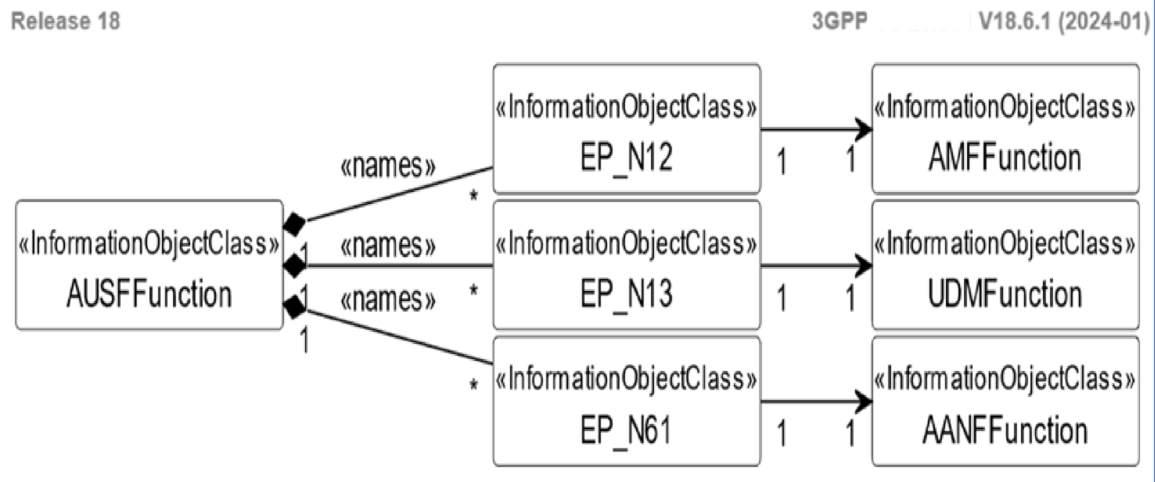

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN AUSF NRM

2. 5G System Core Network (CN) PCF and N3IWF Network Resource Model (NRM) for 5G System Management - selected examples

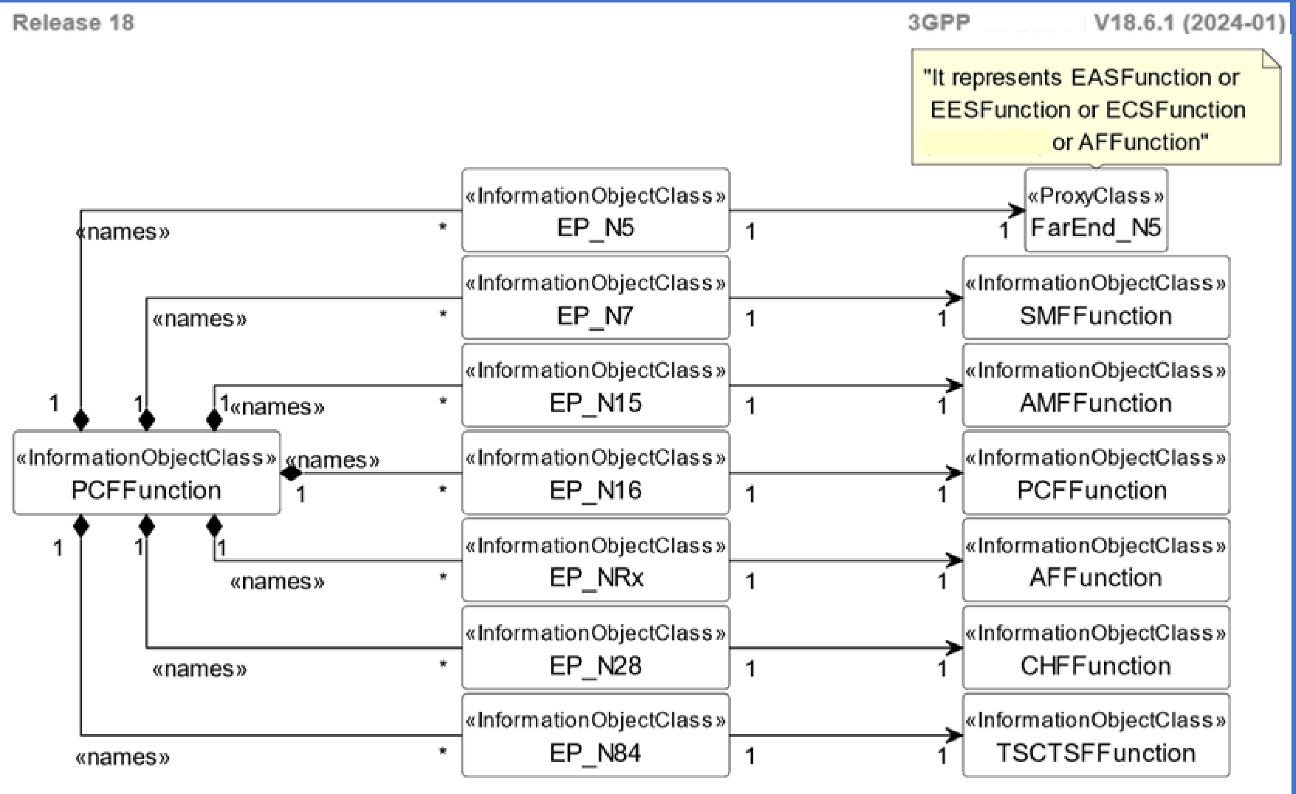

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN PCF NRM

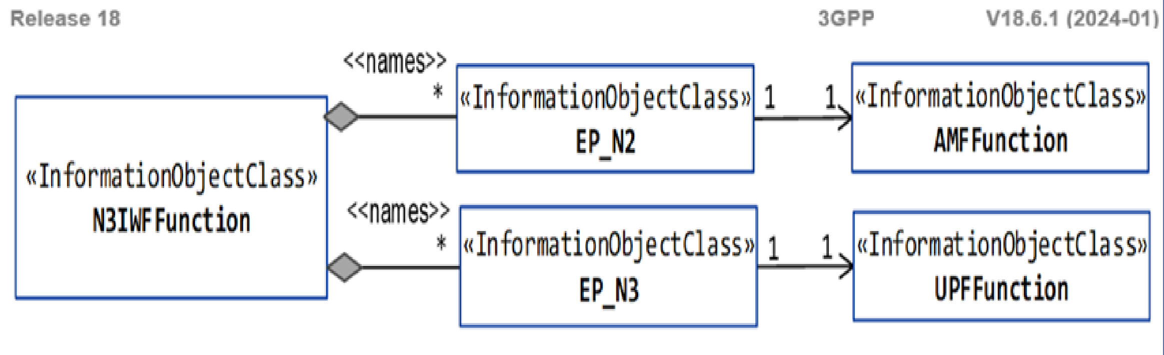

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN N3IWF NRM

2. 5G System Core Network (CN) NEF, EASDF Network Resource Model (NRM) for 5G System Management - selected examples

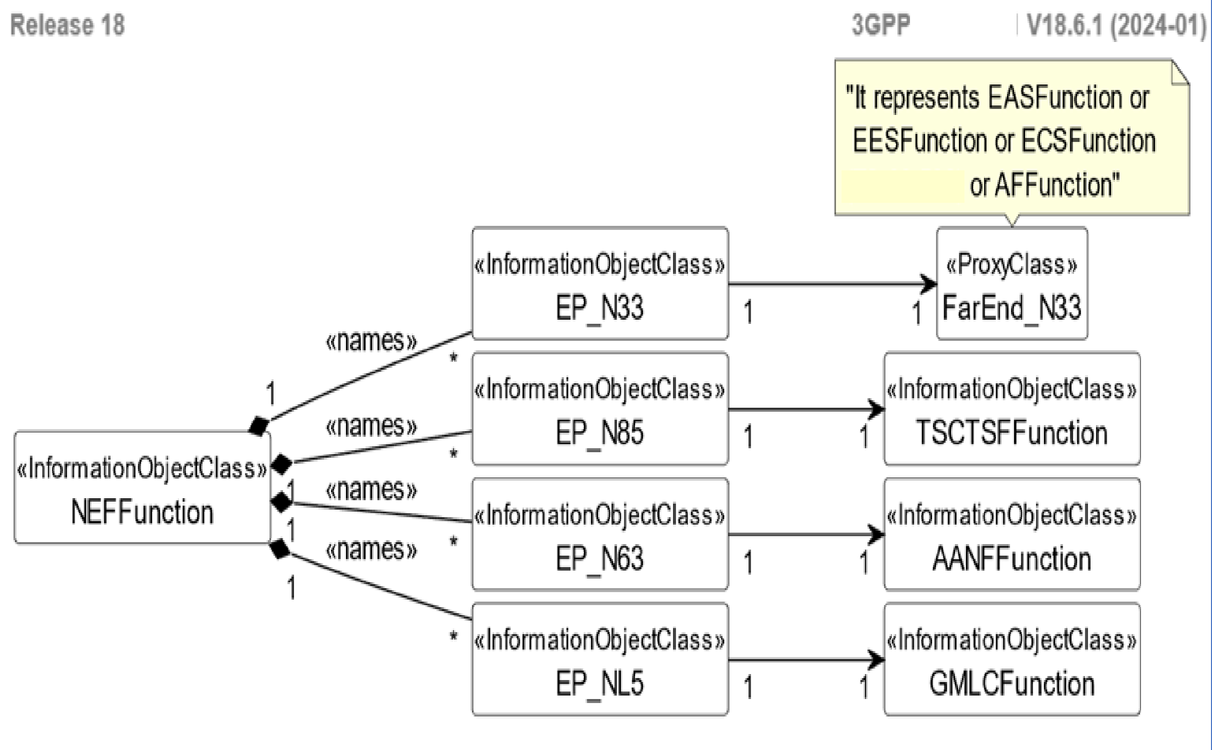

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN NEF NRM

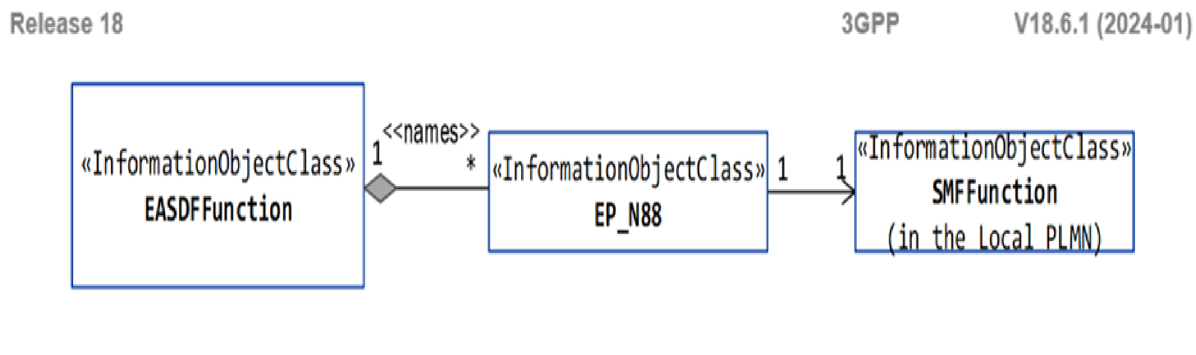

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN EASDF NRM

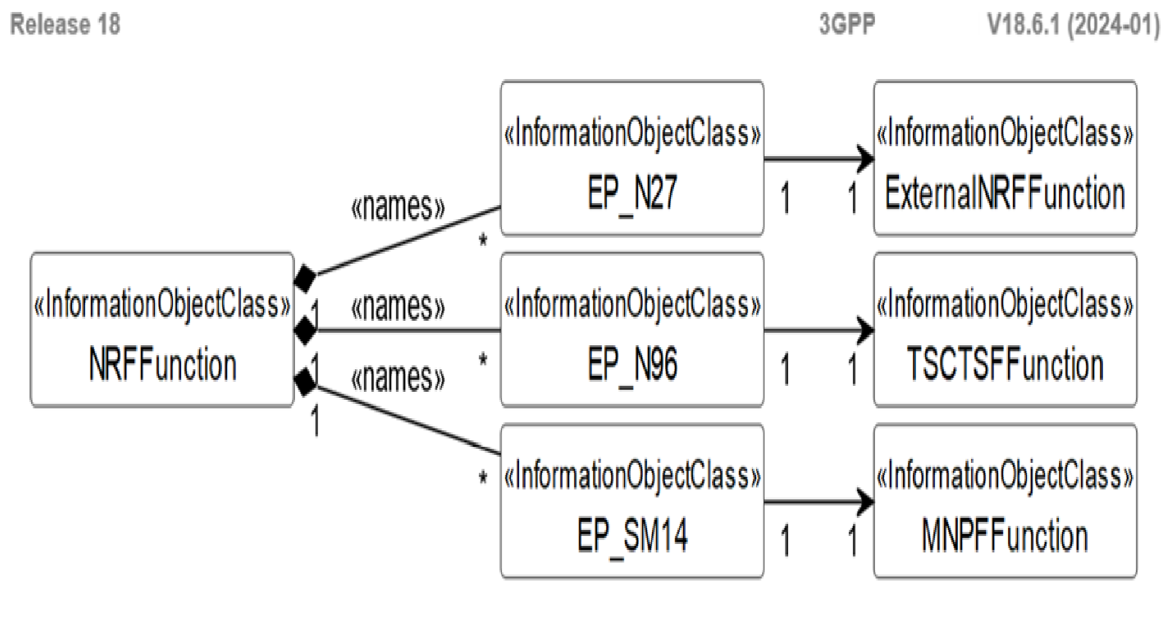

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN NRF NRM

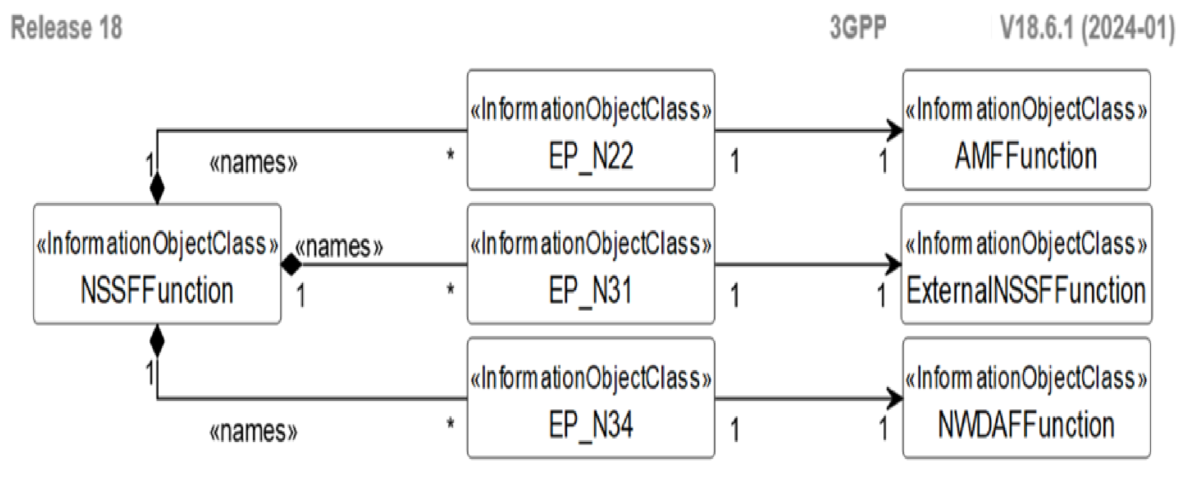

Figure: 5G Network Resource Model (NRM) Transport view of 5G CN NSSF NRM

2. 5G System Core Network (CN) Pre-configured and Dynamically assigned 5G QoS Identifiers (5QIs) Network Resource Model (NRM) for 5G System Management - selected examples

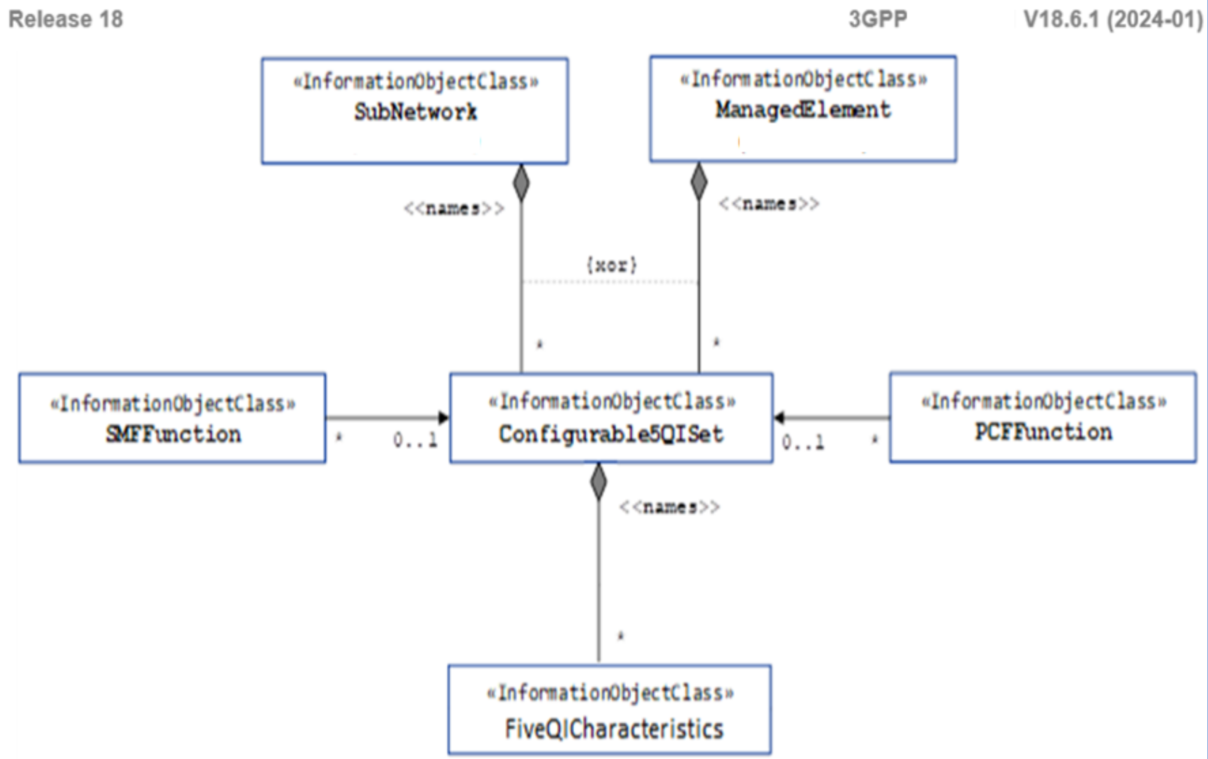

Figure: 5G Network Resource Model (NRM) fragment for Pre-Configured 5G QoS Identifiers (5QIs) in 5G Core Network (CN)

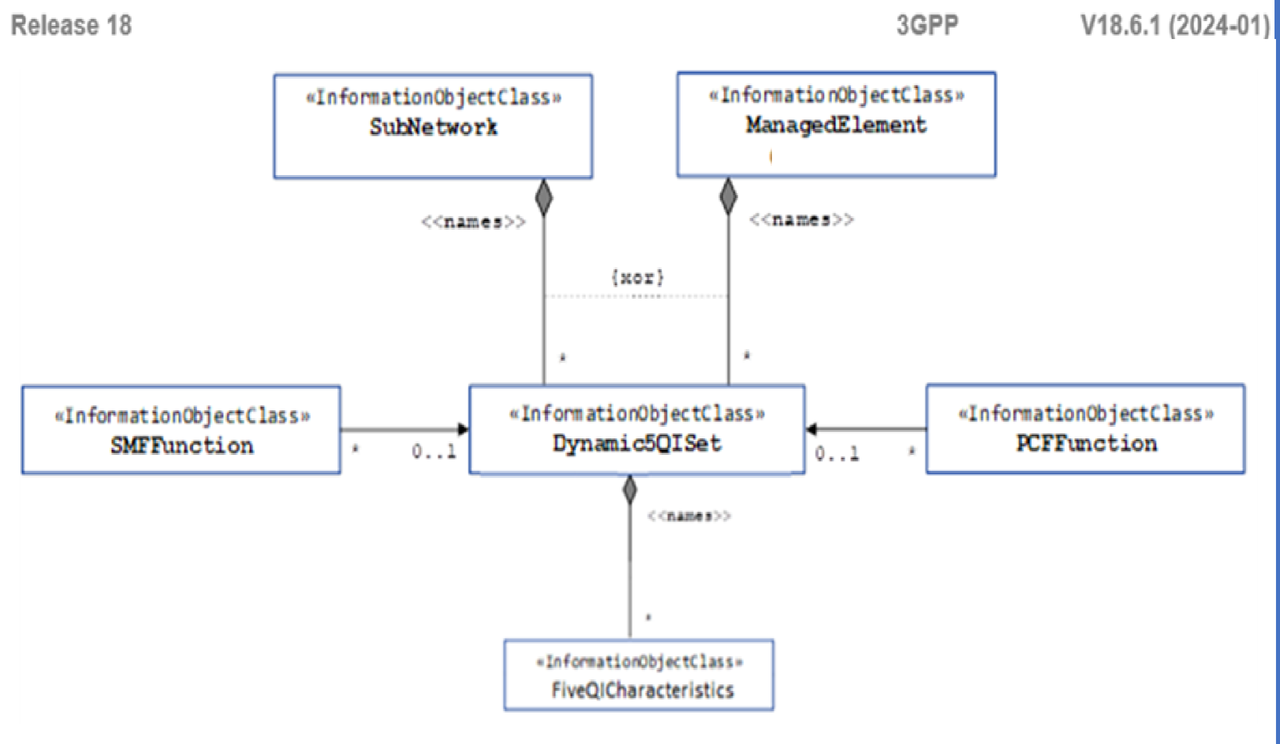

Figure: 5G Network Resource Model (NRM) fragment for Dynamically assigned 5G QoS Identifiers (5QIs) in 5G Core Network (CN)

2. 5G System Core Network (CN) Control 5G QoS Identifiers (5QIs) Monitoring per UE QoS Flow and GTP-U path Network Resource Model (NRM) for 5G System Management - selected examples

Release 18 3GPP V18.6.1 (2024-01)

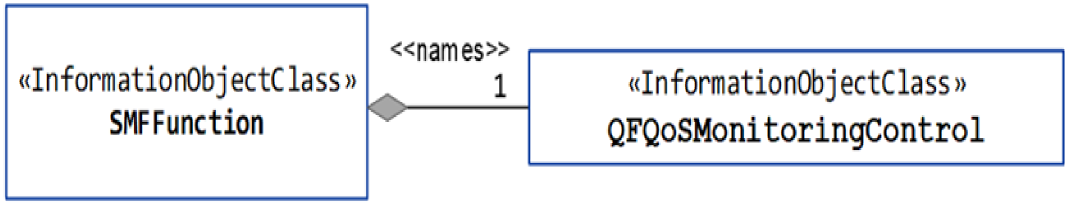

Figure: 5G Network Resource Model (NRM) fragment for Control of 5G QoS Monitoring per QoS Flow per UE

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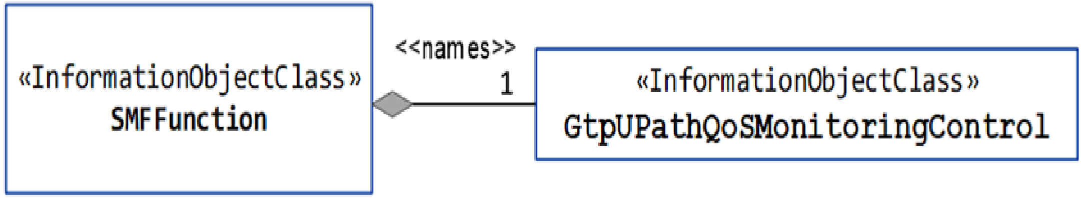

Figure: 5G Network Resource Model (NRM) fragment for Control of GTP-U path QoS Monitoring

2. 5G System Core Network (CN) AF Function and NWDAF Function Network Resource Model (NRM) for 5G System Management - selected examples

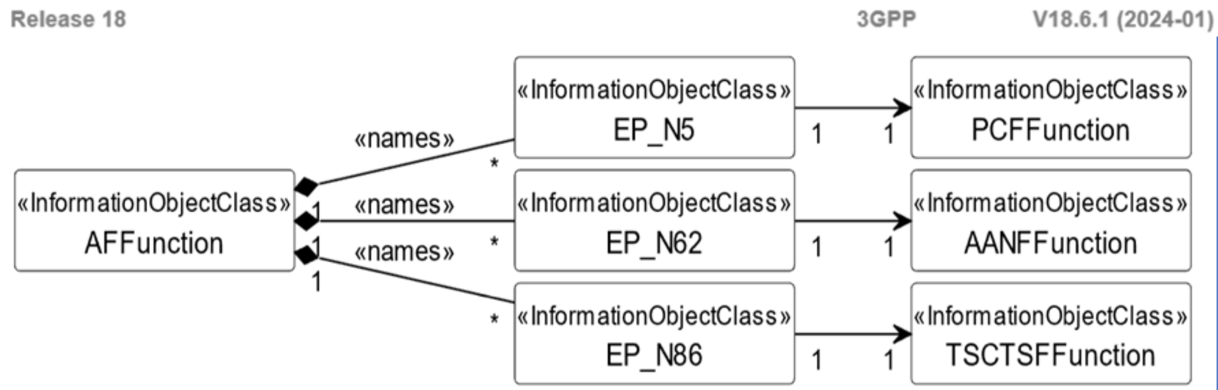

Figure: 5G Network Resource Model (NRM) AF Function

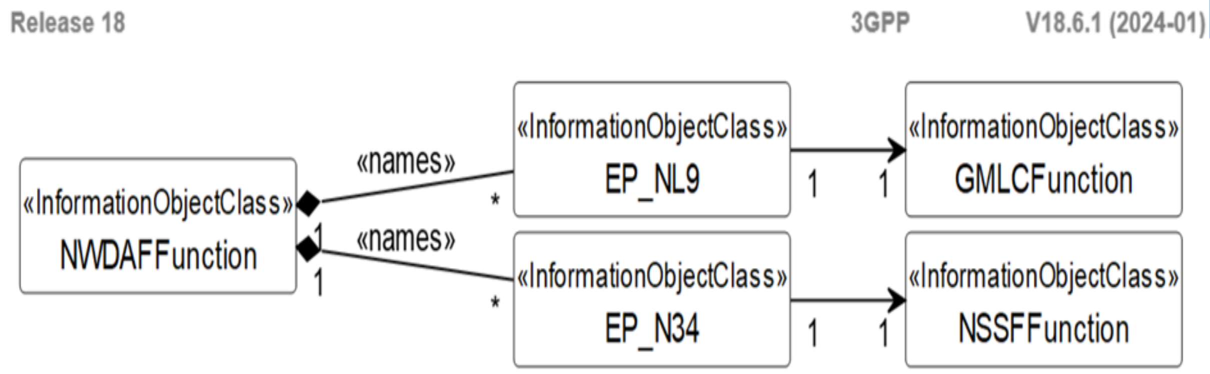

Figure: 5G Network Resource Model (NRM)for 5G NWDAF Function NRM Fragment

5GS CN NRF Info DataType NRM

This Data Type represents information of an NRF NF Instance, used in Hierarchical NRF Deployments.

Figure: 5G Core Network NRF Data Type NRM NF Instance Function in Hierarchical NRF Deployments

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
servedUdrInfo	O	T	T	F	T
servedUdrInfoList	O	T	T	F	T
servedUdmInfo	O	T	T	F	T
servedUdmInfoList	O	T	T	F	T
servedAusfInfo	O	T	T	F	T
servedAusfInfoList	O	T	T	F	T
servedAmfInfo	O	T	T	F	T
servedAmfInfoList	O	T	T	F	T
servedSmfInfo	O	T	T	F	T
servedSmfInfoList	O	T	T	F	T
servedUpfInfo	O	T	T	F	T
servedUpfInfoList	O	T	T	F	T
servedPcfInfo	O	T	T	F	T
servedPcfInfoList	O	T	T	F	T
servedBsfInfo	O	T	T	F	T
servedBsfInfoList	O	T	T	F	T
servedChfInfo	O	T	T	F	T
servedChfInfoList	O	T	T	F	T
servedNefInfo	O	T	T	F	T
servedNwdafInfo	O	T	T	F	T
servedNwdafInfoList	O	T	T	F	T
servedGmlcInfo	O	T	T	F	T
servedLmfInfo	O	T	T	F	T
servedHssInfoList	O	T	T	F	T
servedUdsfInfo	O	T	T	F	T
servedUdsfInfoList	O	T	T	F	T
servedScpInfoList	O	T	T	F	T
servedSeppInfoList	O	T	T	F	T
served5gDdnmfInfo	O	T	T	F	T
servedMfafInfoList	O	T	T	F	T
servedEasdfInfoList	O	T	T	F	T
servedDccfInfoList	O	T	T	F	T
servedMbSmfInfoList	O	T	T	F	T
servedTsctsfInfoList	O	T	T	F	T
servedMbUpfInfoList	O	T	T	F	T
servedTrustAfInfo	O	T	T	F	T
servedNssaafInfo	O	T	T	F	T

5GS CN Network Slice (SST) Info DataType NRM

This Data type represents the properties of the Network Slice (SST) related Requirements that should be supported by a Network Slice instance (NSI) in a 5G Network.

The Network Slice (SST) related Requirements apply to a one-to-one relationship between a *Network Slice Customer (**NSC**) and a Network Slice Provider (**NSP**).*

A Network Slice can be tailored based on the Specific Requirements adhered to an SLA agreed between NSC and NSP. An NSP may add additional requirements not directly derived from SLA's, associated to the NSP internal [Business] goals.

The GSMA defined GST and the Service Performance Requirements defined in 5G System Service Requirements and 5G System Service Requirements for Cyber-Physical Control Applications in Vertical Domains are all considered as input for the Network Slice related Requirements.

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Information model definitions for network slice NRM

Table: 5G Network Slice Network Resource Model (NRM) Information Entities and Local Labels

Label reference	Local label
IOC, Top	Top
IOC, SubNetwork	SubNetwork
IOC, ManagedFunction	ManagedFunction
dataType, PLMNId	PLMNId
dataType, ProcessMonitor	ProcessMonitor
dataType, GeoArea	GeoArea
dataType, Tai	Tai

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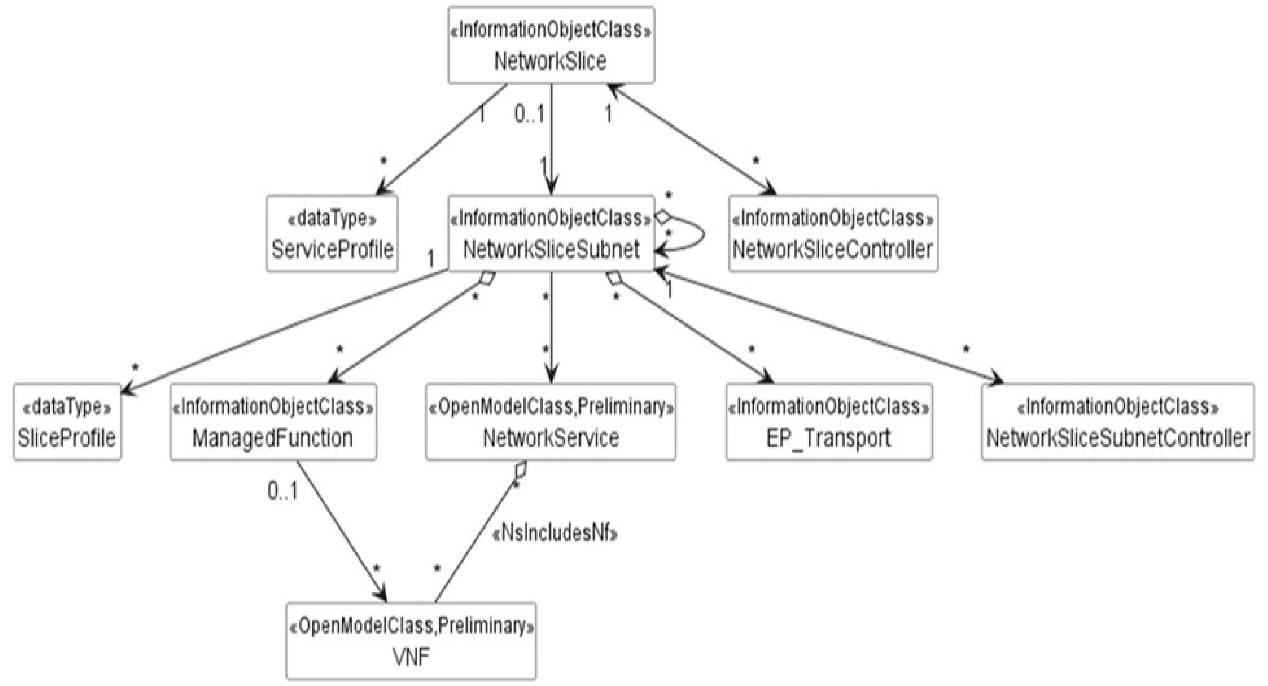

Figure: 5G Network Slice Network Resource Model (NRM) Relationship fragment

5GS CN Network Slice (SST) Info DataType NRM

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Table: 5G System (5GS) Slice/Service Type (SST) Standardised Values

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.
HDLLC	6	Slice suitable for the handling of High Data rate and Low Latency Communications.

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Table: 5G Network Slice Service Profile Data Type Attributes Network Resource Model (NRM)

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
serviceProfileId	M	T	F	T	T
pLMNInfoList	M	T	F	F	T
maxNumberofUEs	O	T	T	F	T
coverageArea	O	T	T	F	T
dLLatency	O	T	T	F	T
uLLatency	O	T	T	F	T
uEMobilityLevel	O	T	T	F	T
networkSliceSharingIndicator	O	T	T	F	T
sST	M	T	T	F	T
availability	O	T	T	F	T
delayTolerance	O	T	T	F	T
dLDeterministicComm	O	T	T	F	T
uLDeterministicComm	O	T	T	F	T
dLThptPerSlice	O	T	T	F	T
dLThptPerUE	O	T	T	F	T
uLThptPerSlice	O	T	T	F	T
uLThptPerUE	O	T	T	F	T
dLMaxPktSize	O	T	T	F	T
uLMaxPktSize	O	T	T	F	T
maxNumberofPDUSessions	O	T	T	F	T
kPIMonitoring	O	T	T	F	T
userMgmtOpen	O	T	T	F	T
v2XCommModels	O	T	T	F	T
termDensity	O	T	T	F	T
activityFactor	O	T	T	F	T
uESpeed	O	T	T	F	T
jitter	O	T	T	F	T
survivalTime	O	T	T	F	T
radioSpectrum	O	T	T	F	T
dLReliability	O	T	T	F	T
uLReliability	O	T	T	F	T
maxDLDataVolume	O	T	T	F	T
maxULDataVolume	O	T	T	F	T
nBIoT	O	T	T	F	T
synchronicity	O	T	T	F	T
positioning	O	T	T	F	T
sliceSimultaneousUse	O	T	T	F	T
energyEfficiency	O	T	T	F	T
nssaaSupport	O	T	T	F	T
n6Protection	O	T	T	F	T
nonIPSupport	O	T	T	F	T
supportedDataNetworks	O	T	T	F	T
dataNetworkAccess	O	T	T	F	T

NOTE: The attributes in ServiceProfile represent mapped requirements from an NSC (e.g. an enterprise) to an NSP

5G System YANG Definitions for Slice (SST) and Network Slice Subnet

YANG definitions are specified in 3GPP Forge.

Directory: Yang-Models

Files:

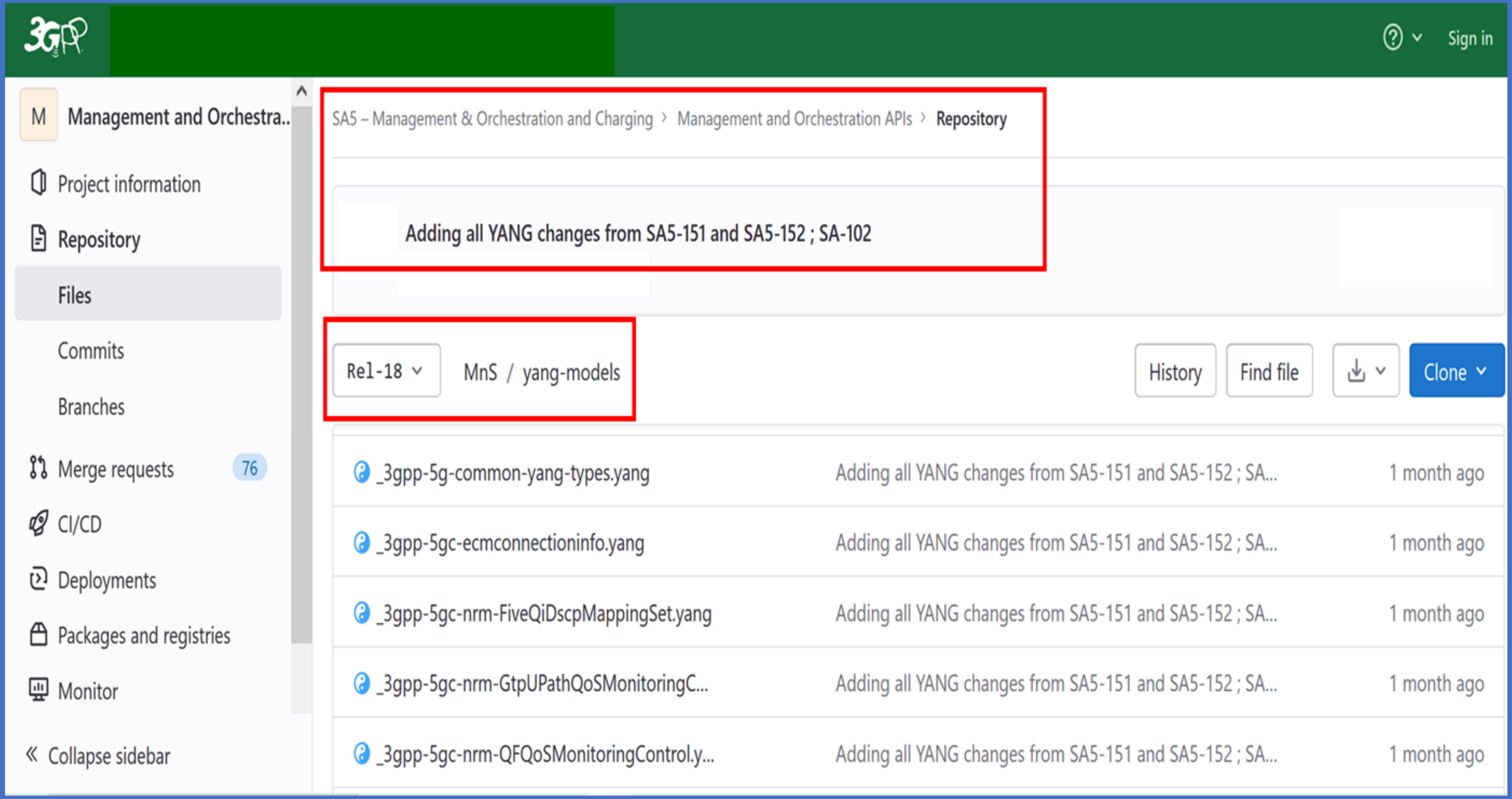
_3gpp-ns-nrm-common.yang

_3gpp-ns-nrm-networkslice.yang

_3gpp-ns-nrm-networkslicesubnet.yang

_3gpp-ns-nrm-serviceprofile.yang

_3gpp-ns-nrm-sliceprofile.yang



2. 5G System RAN (NR, NG-RAN) Network Resource Model (NRM) - selected examples

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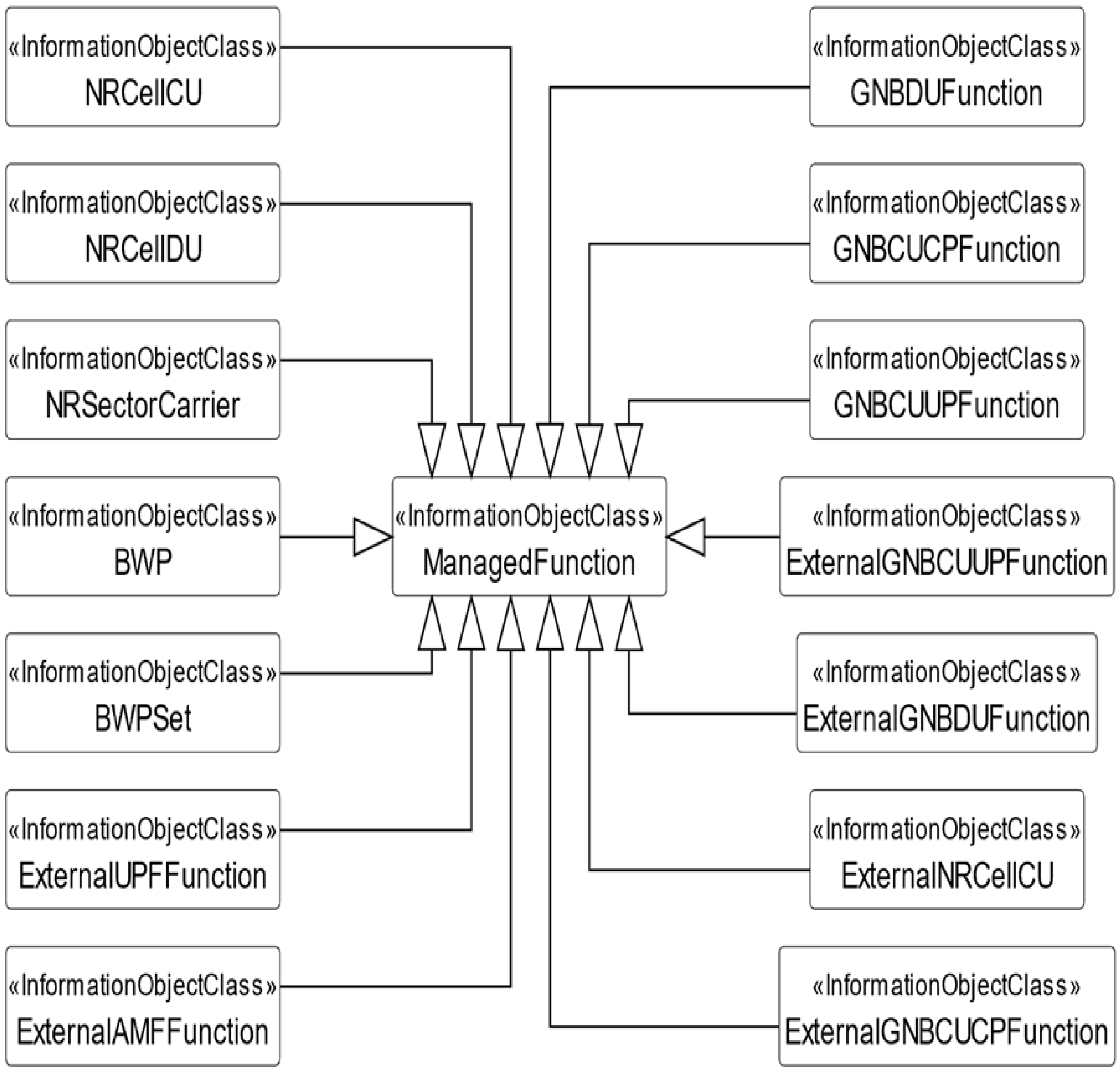


Figure: 5G New Radio (NR) Network Resource Model (NRM) fragment in All Deployment Scenarios

Release 18 3GPP V18.6.1 (2024-01)

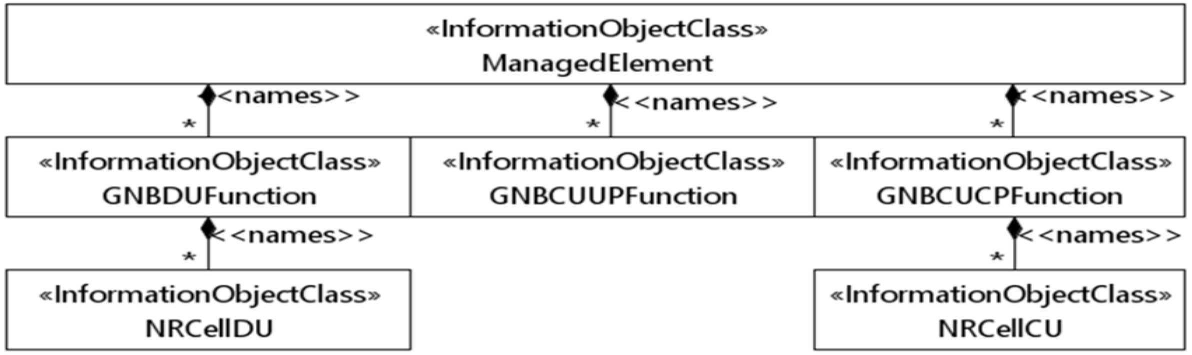


Figure: 5G Network Resource Model (NRM) gNB and en-gNB EPs for All Deployment Scenarios

Release 18 3GPP V18.6.1 (2024-01)

Information model definitions for NR NRM

Table: 5G New Radio (NR) Network Resource Model (NRM) Information Entities and Local Labels

Label reference	Local label
IOC, `ManagedFunction`	`ManagedFunction`
IOC, `EP_RP`	`EP_RP`
IOC, `SectorEquipmentFunction`	`SectorEquipmentFunction`
IOC, `ExternalENBFunction`	`ExternalENBFunction`
IOC, `ServingGWFunction`	`ServingGWFunction`
IOC, `EUtranCellFDD`	`EUtranCellFDD`
IOC, `EUtranCellTDD`	`EUtranCellTDD`
dataType, `PLMNId`	`PLMNId`
IOC, `ENBFunction`	`ENBFunction`
IOC, `vingGWFunction`	`ExternalServingGWFunction`
IOC, `ExternalEUtranCellFDD`	`ExternalEUtranCellFDD`
IOC, `ExternalEUtranCellTDD`	`ExternalEUtranCellTDD`
IOC, `AdjacentCell`	`AdjacentEUtranCell`
IOC, `EUtranFrequency`	`EUtranFrequency`
IOC, `EUtranFreqRelation`	`EUtranFreqRelation`
IOC, `EUtranRelation`	`EUtranCellRelation`
dataType, Tai	`Tai`

2. 5G System RAN (NR, NG-RAN) Network Resource Model (NRM) - selected examples

5GS NRM Class diagram for gNB and en-gNB

The 5G NRM Model fragments are for Management representation of gNB and en-gNB for all NG-RAN Deployment Scenario as listed below.

- Non-split NG-RAN Deployment scenario, represents the gNB defined in 5G NG-RAN Architecture. In this scenario, a gNB is represented by a combination of a gNB CU CP Function, one (1) or more gNB CU UP Functions and one (1) or more gNB DU Functions.

- 2-Split NG-RAN Deployment scenario, represents the gNB consist of gNB-CU and gNB-DU defined in 5G NG-RAN Architecture. In this scenario, a gNB-CU is represented by a combination of a gNB CU CP Function and one (1) or more gNB CU UP Functions, whereas a gNB-DU is represented by a gNB DU Function.

- 3-Split NG-RAN Deployment scenario, represents the gNB consist of gNB-CU-CP, gNB-CU-UP and gNB-DU defined in NG-RAN Architecture, a gNB-CU-CP is represented by a gNB CU CP Function, a gNB-CU-UP is represented by a gNB CU UP Function, and a gNB-DU is represented by a gNB DU Function.

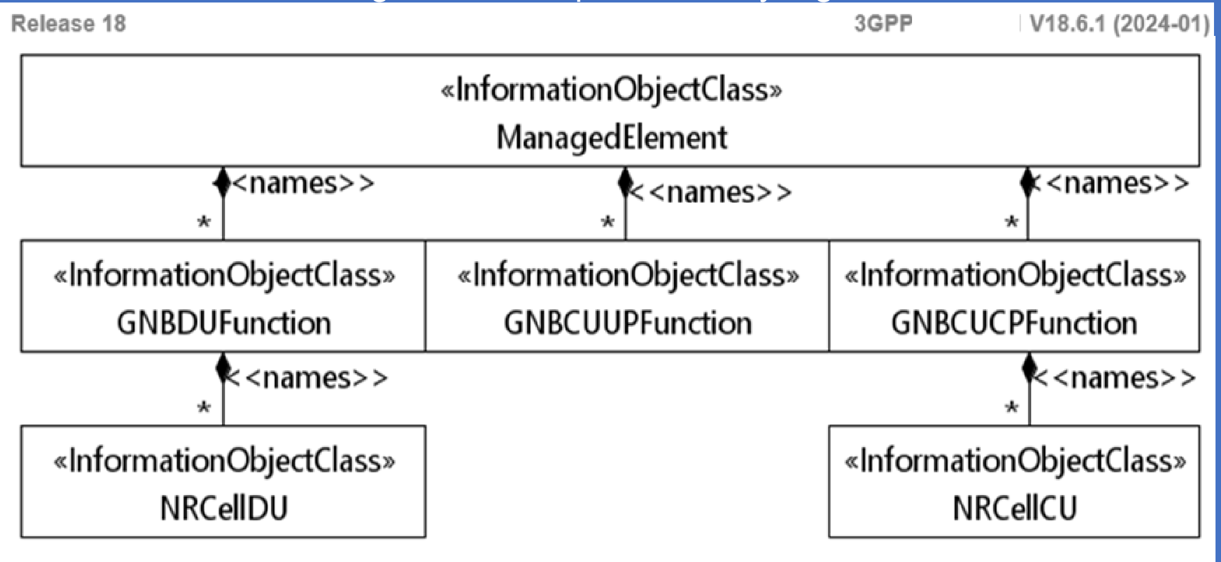


Figure: 5G Network Resource Model (NRM) gNB and en-gNB EPs for All Deployment Scenarios

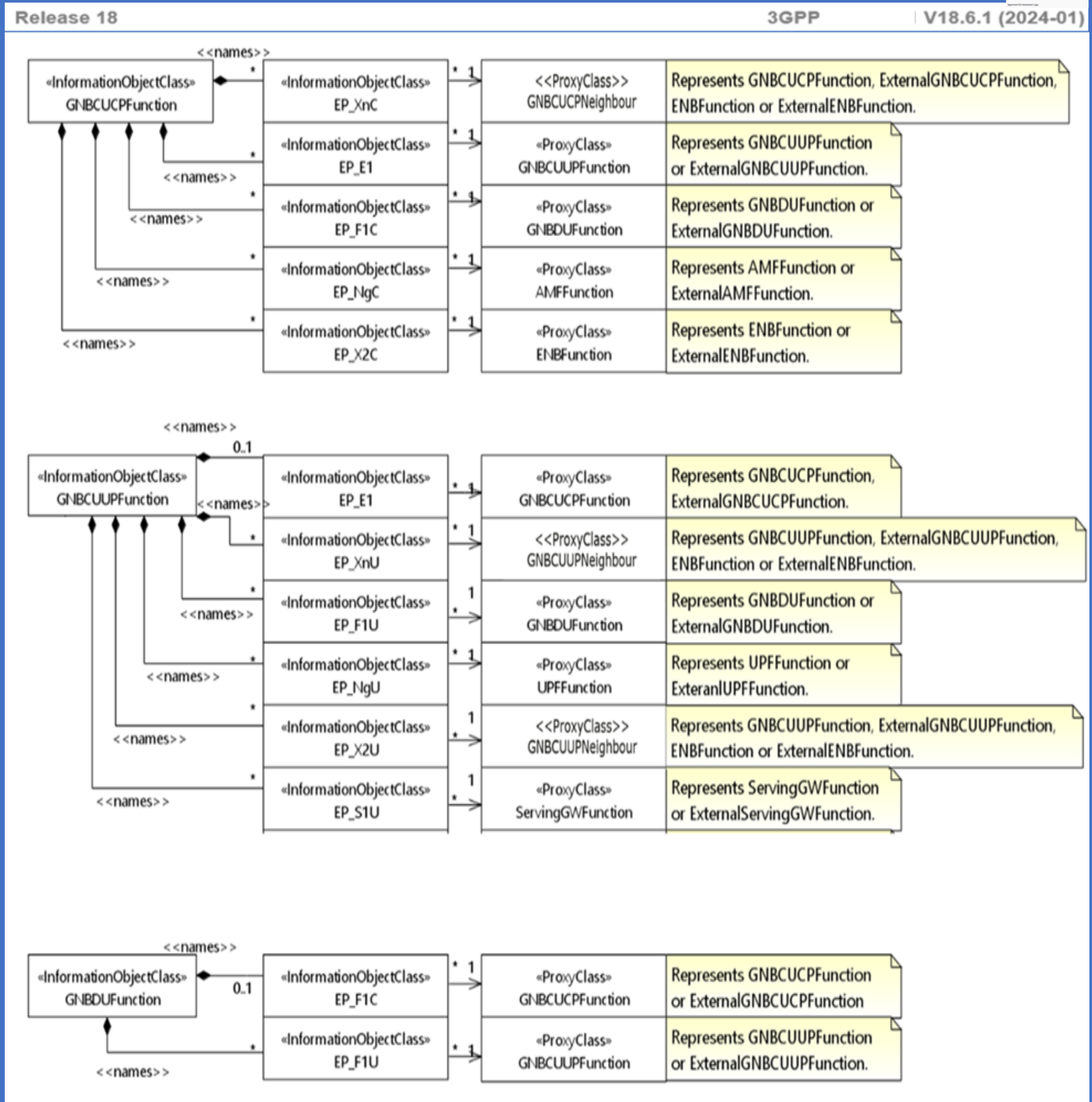
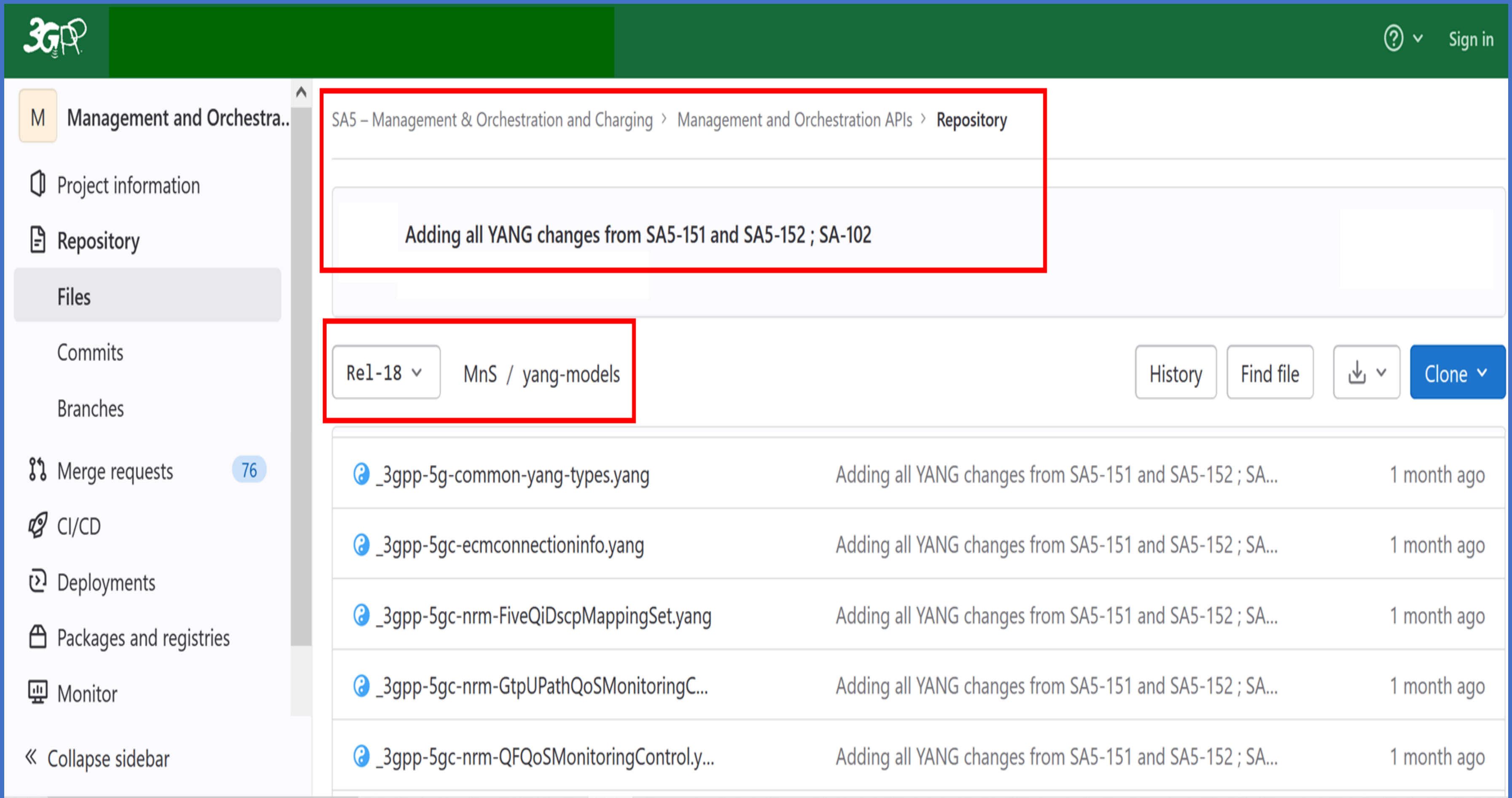


Figure: 5G Network Resource Model (NRM) gNB and en-gNB EPs for All Deployment Scenarios

5G NR and NG-RAN YANG Definitions specified and available a*t 3GPP Forge*

YANG definitions are specified in 3GPP Forge
Directory: yang-mod
Files:
_3gpp-nr-nrm-beam.yang
_3gpp-nr-nrm-bwp.yang
_3gpp-nr-nrm-bwpset.yang
_3gpp-nr-nrm-cesmanagementfunction.yang
_3gpp-nr-nrm-commonbeamformingfunction.yang
_3gpp-nr-nrm-cpciconfigurationfunction.yang
_3gpp-nr-nrm-danrmanagementfunction.yang
_3gpp-nr-nrm-desmanagementfunction.yang
_3gpp-nr-nrm-dlbofunction.yang
_3gpp-nr-nrm-dmrofunction.yang
_3gpp-nr-nrm-dpciconfigurationfunction.yang
_3gpp-nr-nrm-drachoptimizationfunction.yang
_3gpp-nr-nrm-ep.yang
_3gpp-nr-nrm-eutrancellrelation.yang
_3gpp-nr-nrm-eutranetwork.yang
_3gpp-nr-nrm-eutranfreqrelation.yang
_3gpp-nr-nrm-eutranfrequency.yang
_3gpp-nr-nrm-externalamffunction.yang
_3gpp-nr-nrm-externalenbfunction.yang
_3gpp-nr-nrm-externaleutrancell.yang
_3gpp-nr-nrm-externalgnbcucpfunction.yang
_3gpp-nr-nrm-externalgnbcuupfunction.yang
_3gpp-nr-nrm-externalgnbdufunction.yang
_3gpp-nr-nrm-externalnrcellcu.yang
_3gpp-nr-nrm-externalservinggwfunction.yang
_3gpp-nr-nrm-externalupffunction.yang
_3gpp-nr-nrm-gnbcucpfunction.yang
_3gpp-nr-nrm-gnbcuupfunction.yang
_3gpp-nr-nrm-gnbdufunction.yang
_3gpp-nr-nrm-nrcellcu.yang
_3gpp-nr-nrm-nrcelldu.yang
_3gpp-nr-nrm-nrcellrelation.yang
_3gpp-nr-nrm-nrfreqrelation.yang
_3gpp-nr-nrm-nrfrequency.yang
_3gpp-nr-nrm-nrnetwork.yang
_3gpp-nr-nrm-nroperatorcelldu.yang
_3gpp-nr-nrm-nrsectorcarrier.yang
_3gpp-nr-nrm-operatordu.yang
_3gpp-nr-nrm-rimrsset.yang
_3gpp-nr-nrm-rrmpolicy.yang



If the Class Managed Element and the underlying hierarchy is contained under a Sub Network all YANG Modules containing IOCs that can be contained under the Managed Element directly or under other IOCs contained by the Managed Element and the YANG module for Managed Element itself shall be mounted at the mountpoint "children-of-Sub Network" in the YANG module _3gpp-common-subnetwork.
IETF describes the Mechanism that adds the Schema trees defined by a set of YANG Modules onto a mount point defined in the schema tree in another YANG module.

2. 5G System RAN(NR, NG-RAN) Network Resource Model (NRM) - selected examples

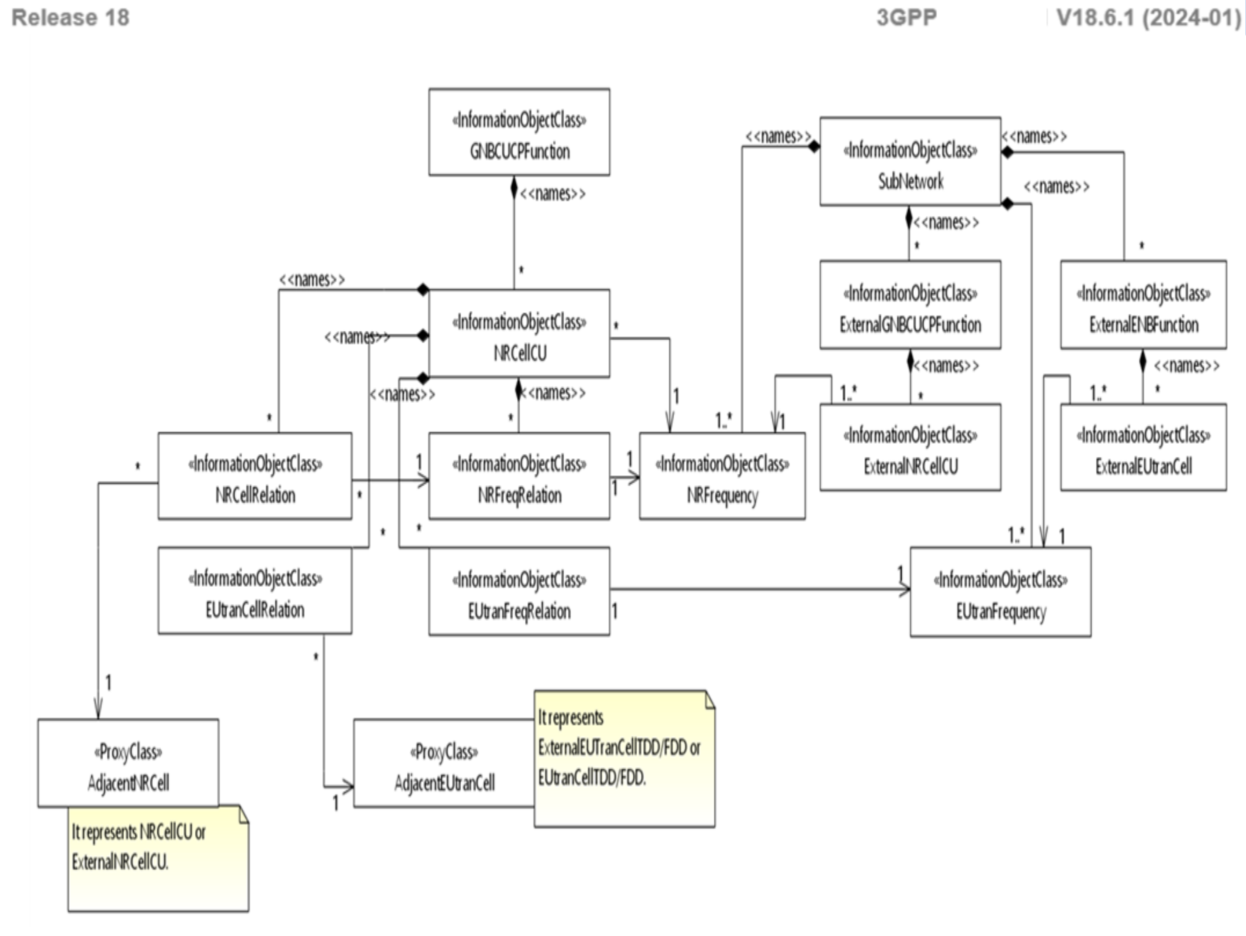


Figure: 5G New Radio (NR) Network Resource Model (NRM) Cell Relation for all Deployment Scenarios

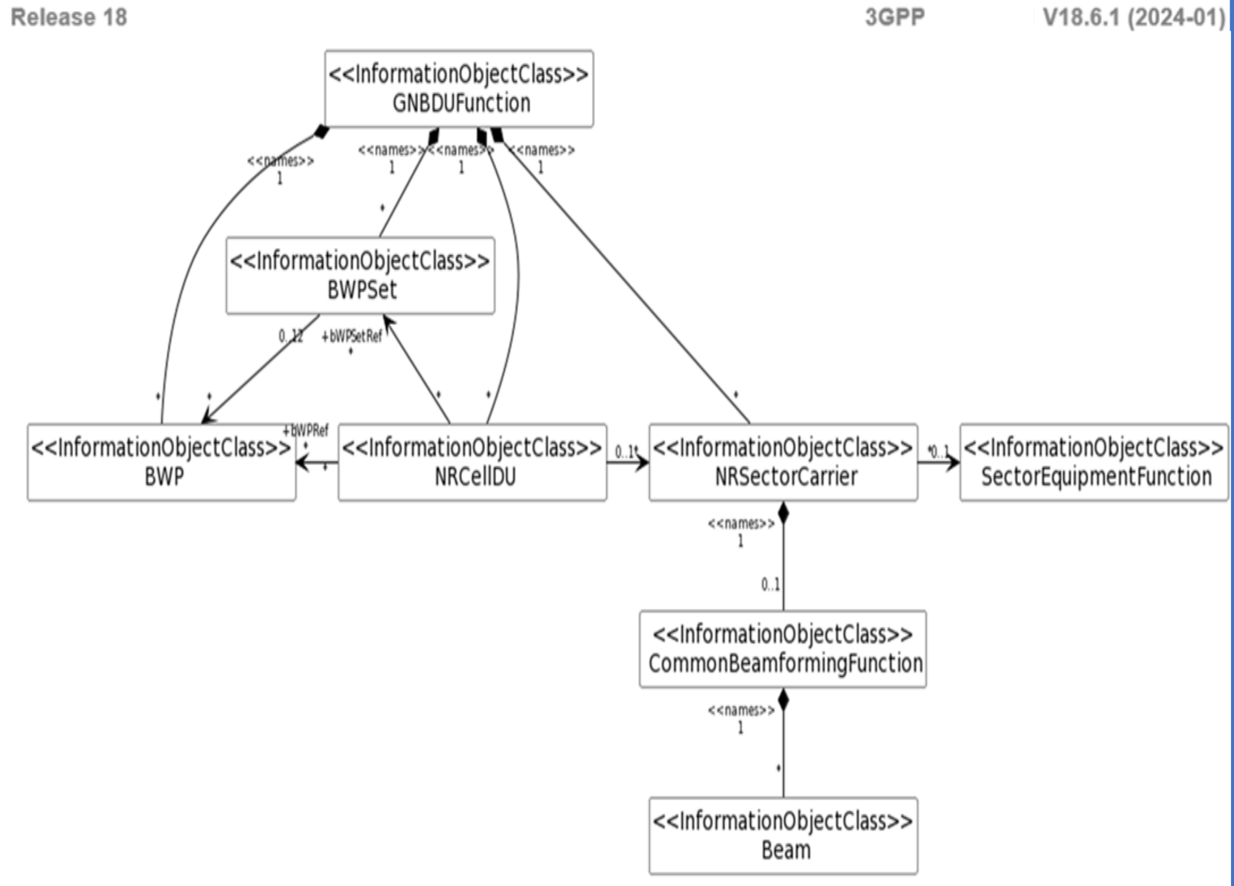


Figure: 5G New Radio (NR) Network Resource Model (NRM) for <<IOC>>NRSectorCarrier, <<IOC>>BWP and <<IOC>> BWSet for all Deployment Scenarios

NOTE: *The above NRM Fragment uses SubNetwork to hold both NR and LTE external Entities and Frequencies.*

2. 5G System RAN (NR, NG-RAN) Network Resource Model (NRM) - selected examples

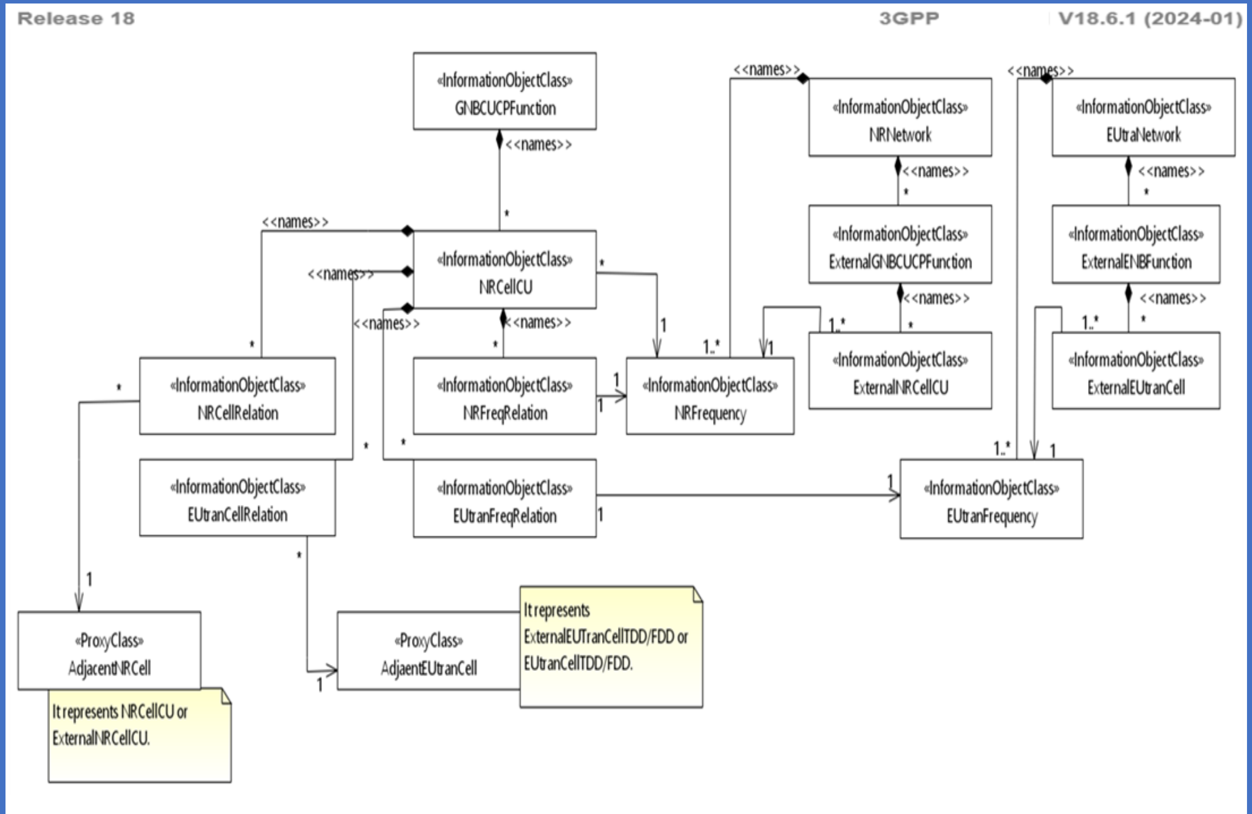


Figure: 5G New Radio (NR) Network Resource Model (NRM) Cell Relation for all Deployment Scenarios

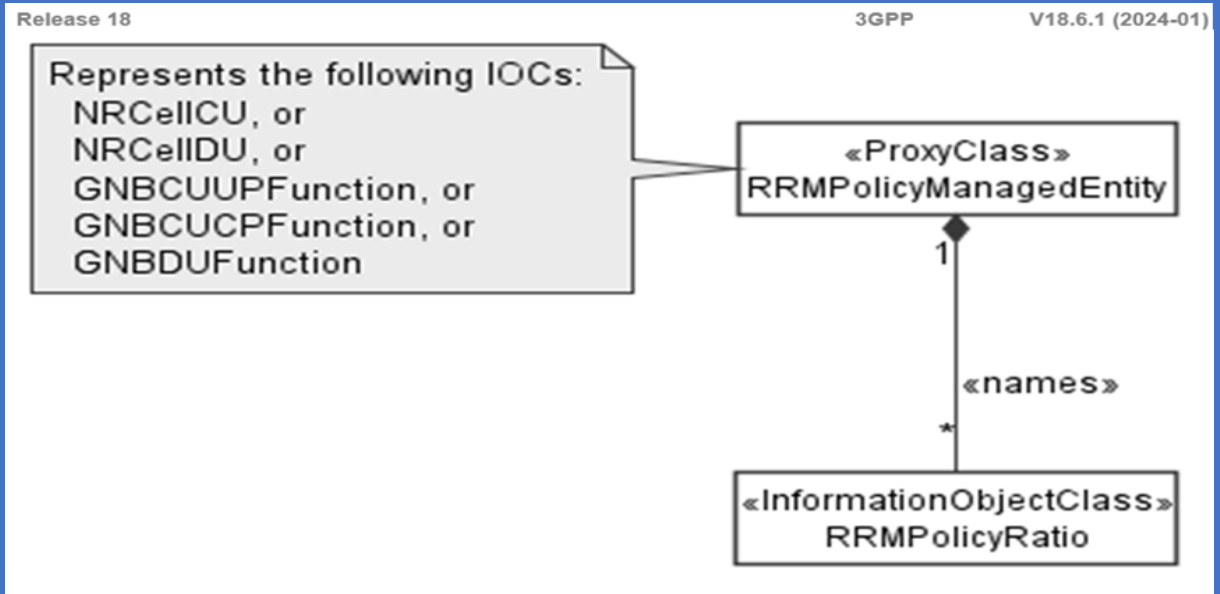


Figure: 5G New Radio (NR) Network Resource Model (NRM) for RRM Policy Ratio

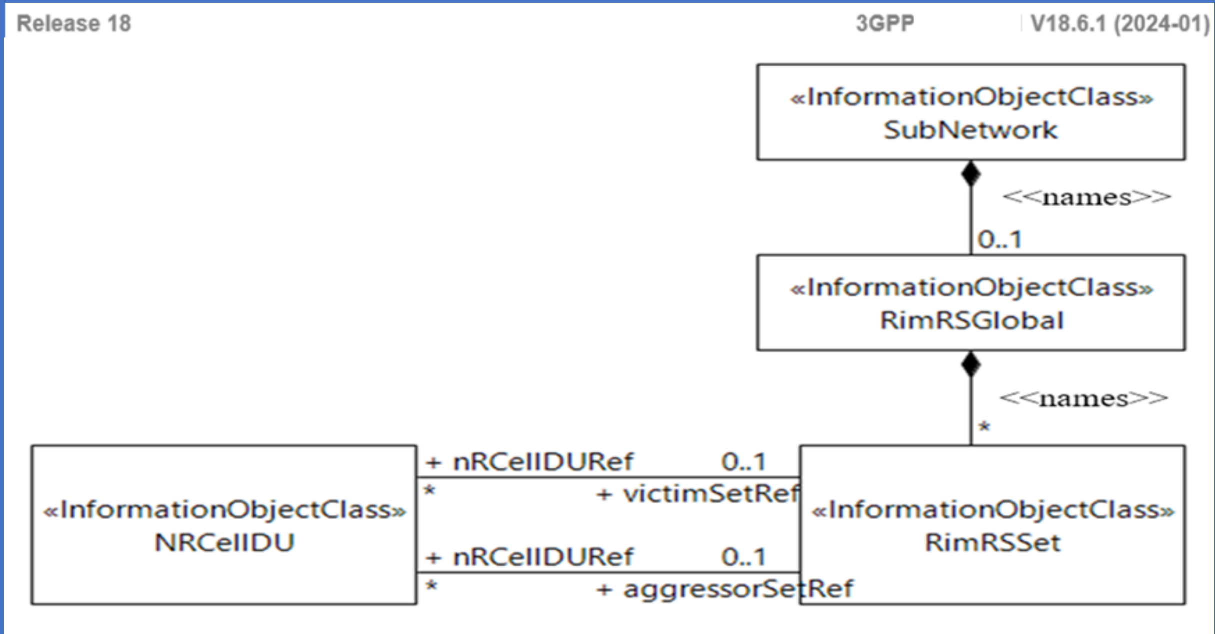


Figure: 5G New Radio (NR) Network Resource Model (NRM) fragment to support RIM

NOTE: *The above 5G NR NRM fragment uses NR Network to hold NR External Entities and Frequency and using E-UTRAN to hold LTE External Entities and Frequency. The NR Network and E-UTRAN are subclasses of Sub Network defined by 3GPP NRM IRPs with no additional attributes. The reason using NR Network and E-UTRAN is for a clean separation of NR External Entities and Frequency and LTE External Entities and Frequency.*

2. 5G System RAN (NR, NG-RAN) Network Resource Model (NRM) - Dynamically assigned & Pre-configured 5QIs in NG-RAN

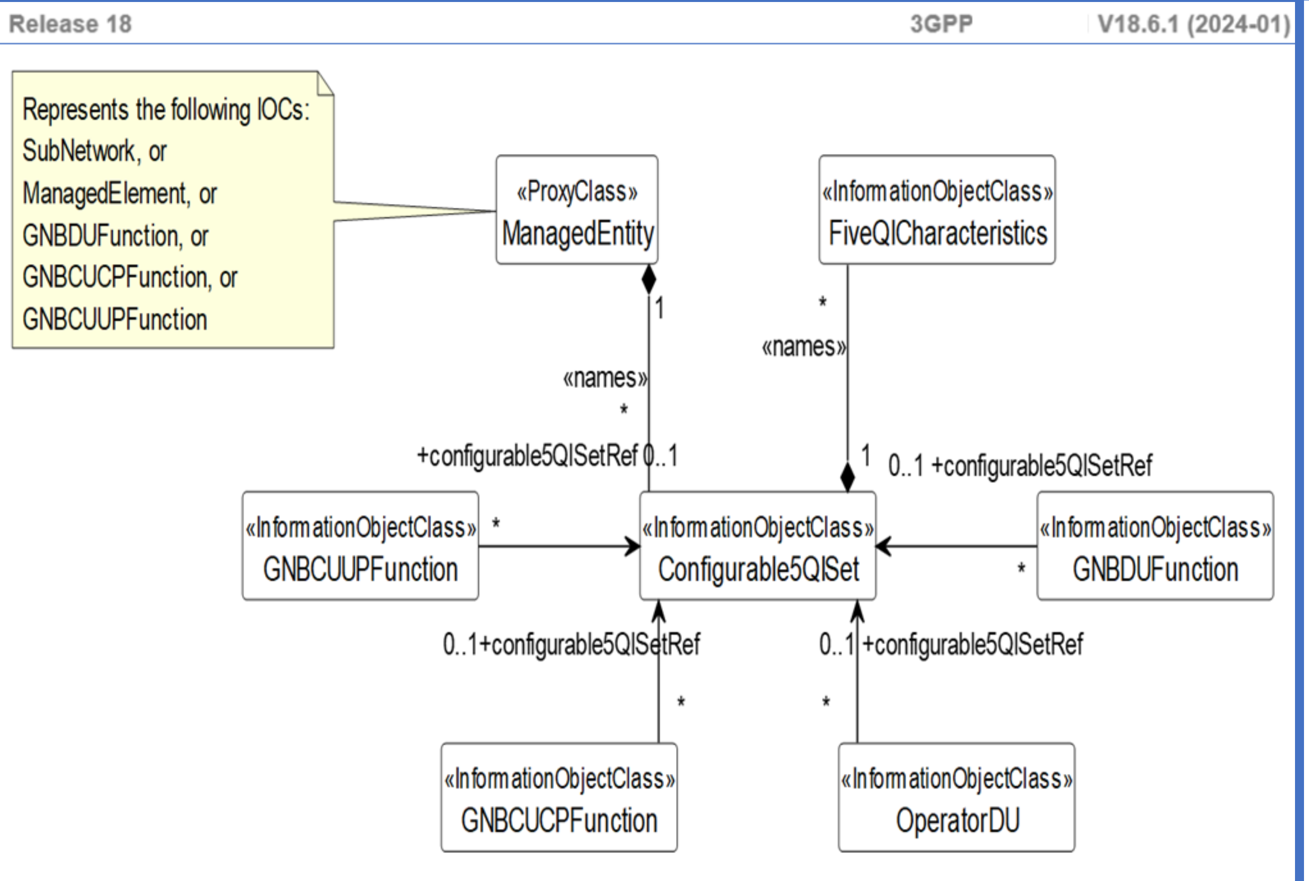


Figure: 5G Network Resource Model (NRM) fragment for Pre-Configured 5QIs in NG-RAN

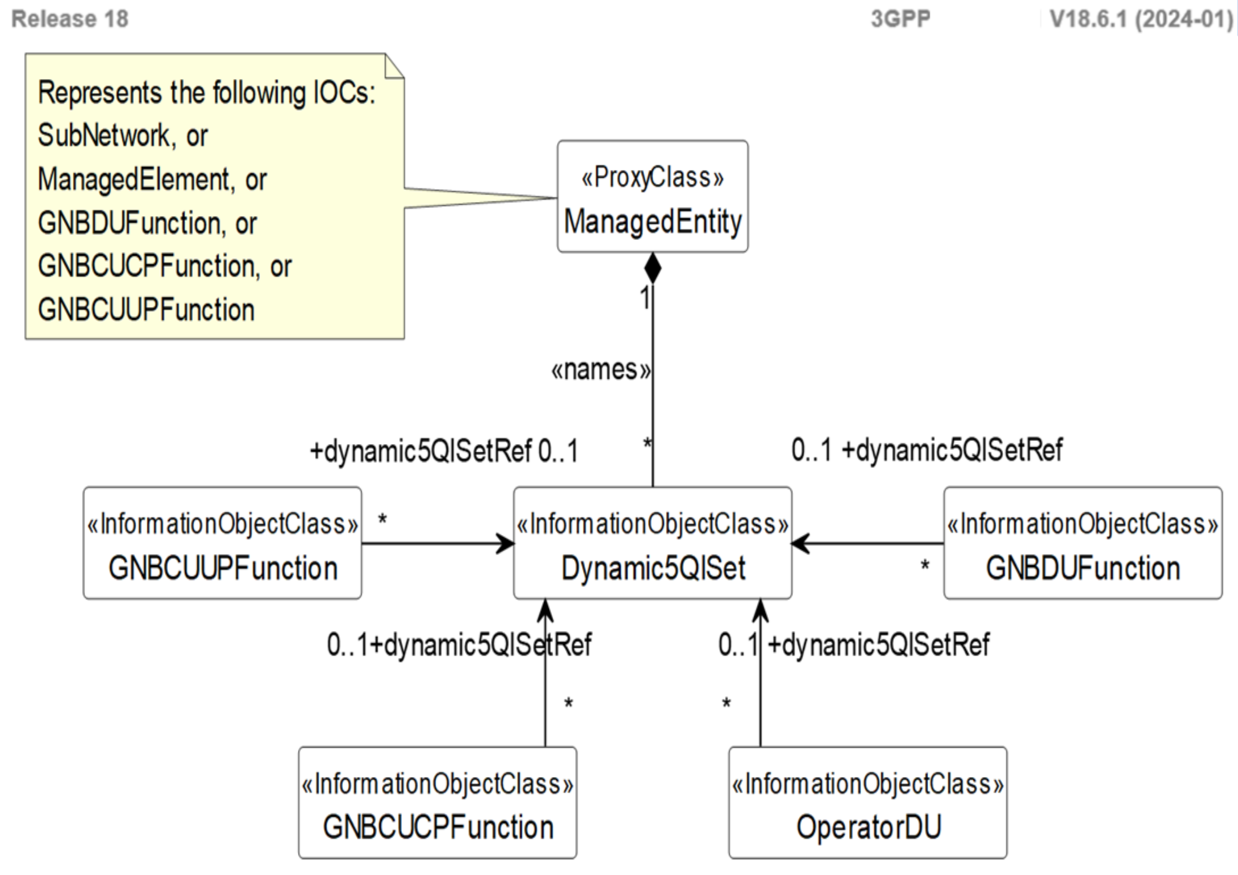


Figure: 5G Network Resource Model (NRM) fragment for Dynamically assigned 5QIs in NG-RAN

2. 5G System RAN ((NR, NG-RAN) Network Resource Model (NRM) - NG-RAN Multi-Operator Core Network (MOCN)

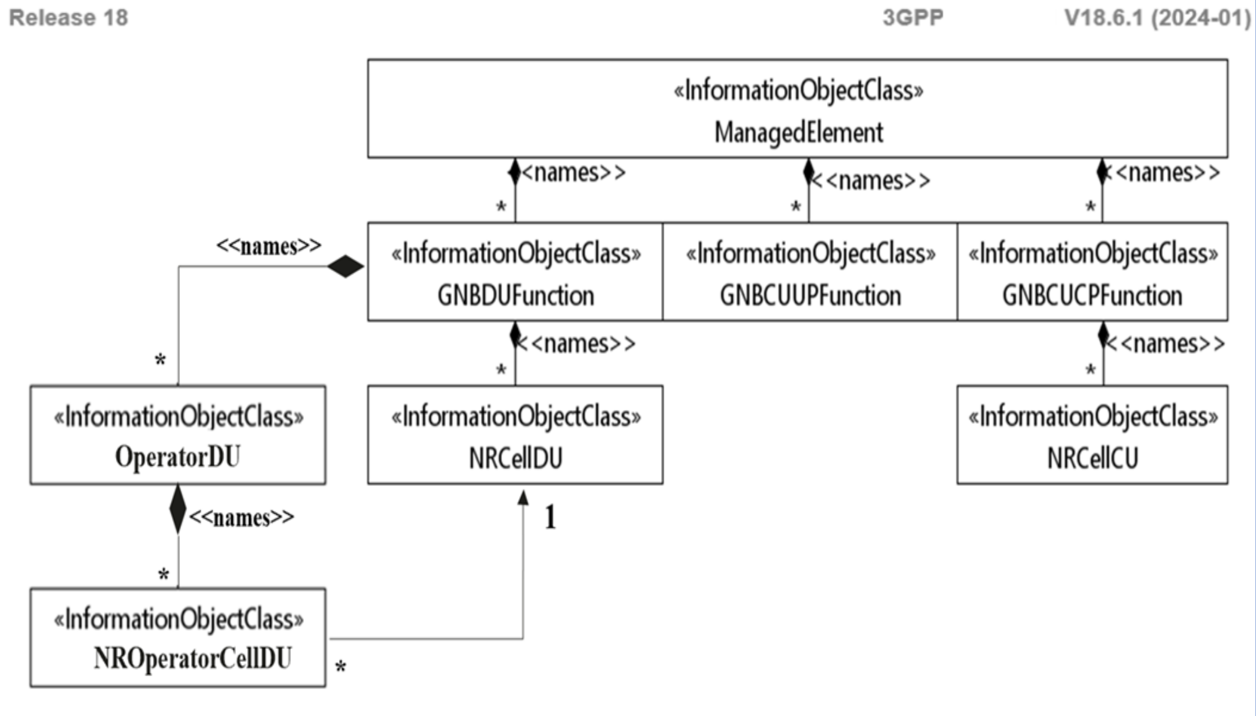


Figure: 5G Network Resource Model (NRM) fragment for NG-RAN Multi-Operator Core Network (MOCN) Network Sharing with Multiple Cell Identity Broadcast Feature

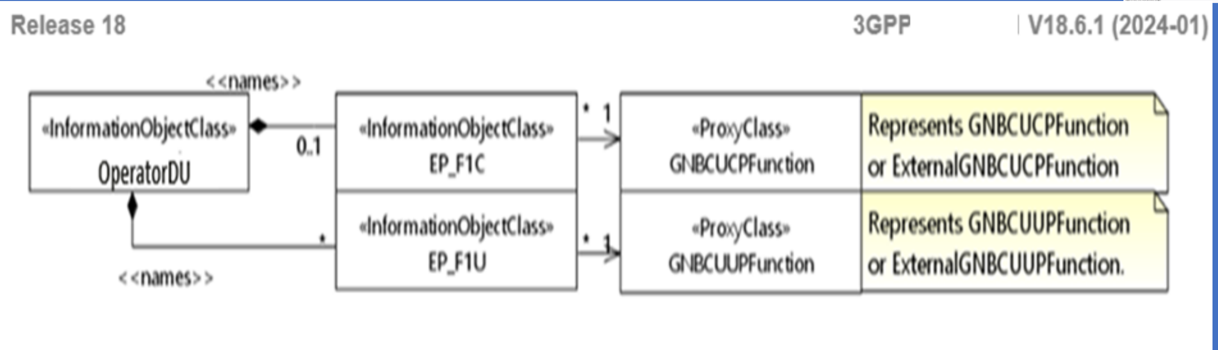


Figure: 5G Network Resource Model (NRM) fragment for F1 related EPs to support Individual F1 Interface for NG-RAN Multi-Operator Core Network (MOCN) Network Sharing with Multiple Cell Identity Broadcast Feature

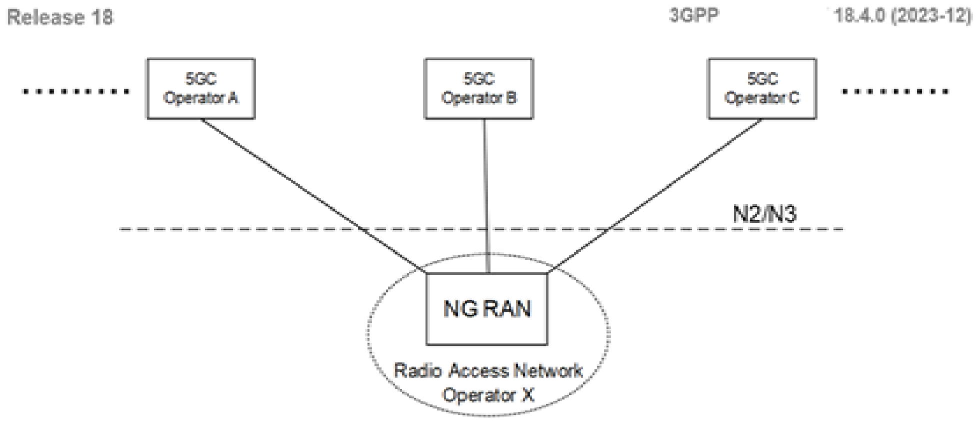


Figure: A 5G Multi-Operator Core Network (5G MOCN) in which multiple CNs are connected to the same NG-RAN

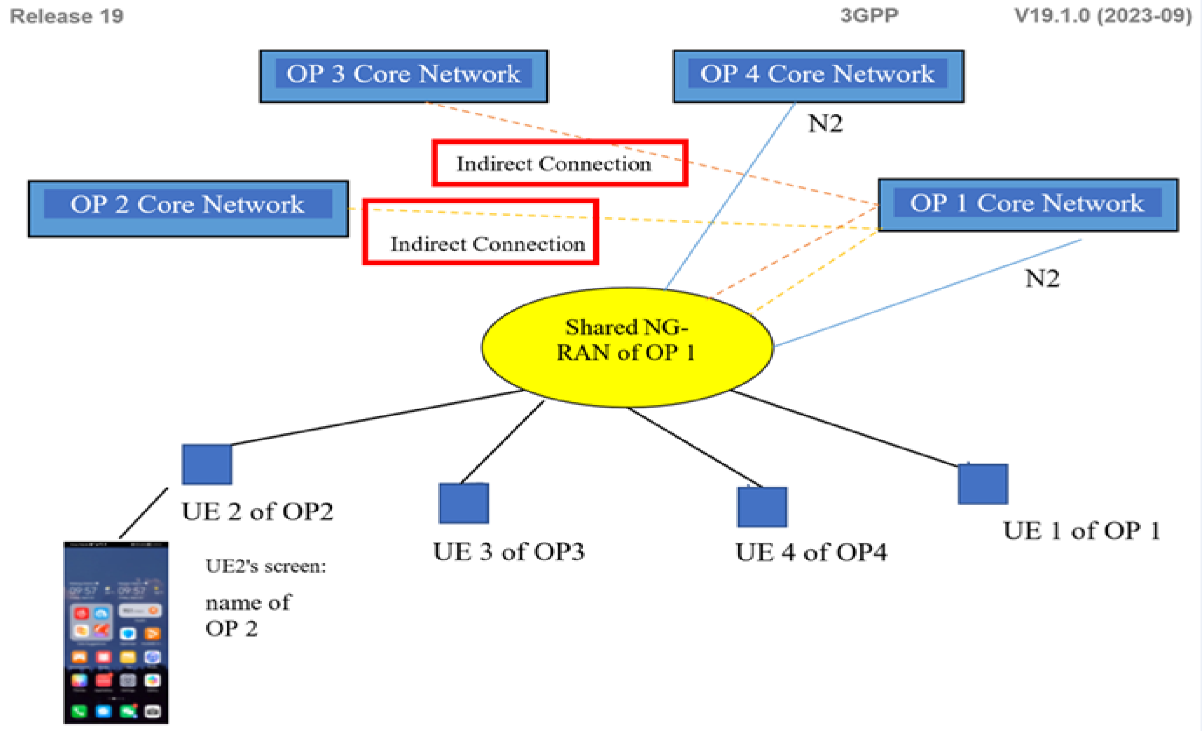


Figure: A 5G Multi-Operator Core Network (5G MOCN) with Different Options both Direct and Indirect Connections between the Shared Access and the Core Networks (CNs) of the Participating Operators

The 5GS Architecture specifies the **Stage 3 (Implementation of) Protocol and Data Model for Common Data types** that are used and/or expected to be used by multiple ***Service Based Interface (SBI) APIs*** supported by the same or different **5GS Network Function(s) (NFs).**

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Table: 5GS Re-used OpenAPI Data Types

Type Name	Description
boolean	As defined in OpenAPI Specification [3]
integer	As defined in OpenAPI Specification [3]
number	As defined in OpenAPI Specification [3]
string	As defined in OpenAPI Specification [3]
object	As defined in OpenAPI Specification [3]
array	As defined in OpenAPI Specification [3]
NOTE	Data types defined in OpenAPI Specification [3] do not follow the UpperCamel convention for data types

5GS Common Data Types

The 5GS Common Data types for the following areas are defined:

- Data types for **Generic Usage**;
- Data types for ***Subscription, Identification and Numbering***;
- Data types related to ***5G Network***;
- Data types related to ***5G QoS***;
- Data types related to ***5G Trace***;
- Data types related to 5G ODBs (Observational Data Base).

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Table: 5GS Re-used Data Types

Data Type
NFType
ServiceName
DataSetId
PlmnSnssai
GeographicArea
CivicAddress

Table: 5G System Simple Data Types

<table>
<tr><th>Type Name</th><th>Type Definition</th><th>Description</th></tr>
<tr><td>Binary</td><td>string</td><td>String with format "binary" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>BinaryRm</td><td>string</td><td>This data type is defined in the same way as the "Binary" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Bytes</td><td>string</td><td>String with format "byte" as defined in OpenAPI Specification [3], i.e, base64-encoded characters,</td></tr>
<tr><td>BytesRm</td><td>string</td><td>This data type is defined in the same way as the "Bytes" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Date</td><td>string</td><td>String with format "date" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>DateRm</td><td>string</td><td>This data type is defined in the same way as the "Date" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>DateTime</td><td>string</td><td>String with format "date-time" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>DateTimeRm</td><td>string</td><td>This data type is defined in the same way as the "DateTime" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>DiameterIdentity</td><td>Fqdn</td><td>String containing a Diameter Identity (FQDN), according to clause 4.3 of IETF RFC 6733 [18].
DiameterIdentity is defined as a simple data type because Fqdn is also a simple data type (string).</td></tr>
<tr><td>DiameterIdentityRm</td><td>FqdnRm</td><td>This data type is defined in the same way as the "DiameterIdentity" data type, but with the OpenAPI "nullable: true" property.
DiameterIdentityRm is defined as a simple data type because FqdnRm is also a simple data type (either a string or null).</td></tr>
<tr><td>Double</td><td>number</td><td>Number with format "double" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>DoubleRm</td><td>number</td><td>This data type is defined in the same way as the "Double" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>DurationSec</td><td>integer</td><td>Unsigned integer identifying a period of time in units of seconds.</td></tr>
<tr><td>DurationSecRm</td><td>integer</td><td>This data type is defined in the same way as the "DurationSec" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Float</td><td>number</td><td>Number with format "float" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>FloatRm</td><td>number</td><td>This data type is defined in the same way as the "Float" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Uint16</td><td>integer</td><td>Integer where the allowed values correspond to the value range of an unsigned 16-bit integer, i.e. 0 to 65535.
Minimum = 0. Maximum = 65535.</td></tr>
<tr><td>Uint16Rm</td><td>integer</td><td>This data type is defined in the same way as the "Uint16" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Int32</td><td>integer</td><td>Integer with format "int32" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>Int32Rm</td><td>integer</td><td>This data type is defined in the same way as the "Int32" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Int64</td><td>integer</td><td>Integer with format "int64" as defined in OpenAPI Specification [3]</td></tr>
<tr><td>Int64Rm</td><td>integer</td><td>This data type is defined in the same way as the "Int64" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Ipv4Addr</td><td>string</td><td>String identifying a IPv4 address formatted in the "dotted decimal" notation as defined in IETF RFC 1166 [4].
Pattern: '^(([0-9]|[1-9][0-9]|1[0-9][0-9]|2[0-4][0-9]|25[0-5])\.){3}([0-9]|[1-9][0-9]|1[0-9][0-9]|2[0-4][0-9]|25[0-5])$'</td></tr>
<tr><td>Ipv4AddrRm</td><td>string</td><td>This data type is defined in the same way as the "Ipv4Addr" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Ipv4AddrMask</td><td>string</td><td>String identifying a IPv4 address mask formatted in the "dotted decimal" notation as defined in IETF RFC 1166 [4].
Pattern: '^(([0-9]|[1-9][0-9]|1[0-9][0-9]|2[0-4][0-9]|25[0-5])\.){3}([0-9]|[1-9][0-9]|1[0-9][0-9]|2[0-4][0-9]|25[0-5])(\/([0-9]|[1-2][0-9]|3[0-2]))$'</td></tr>
<tr><td>Ipv4AddrMaskRm</td><td>string</td><td>This data type is defined in the same way as the "Ipv4AddrMask" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Ipv6Addr</td><td>string</td><td>String identifying an IPv6 address formatted according to clause 4 of IETF RFC 5952 [5]. The mixed IPv4 IPv6 notation according to clause 5 of IETF RFC 5952 [5] shall not be used.
Pattern: '^((:|(0?|([1-9a-f][0-9a-f]{0,3}))):)((0?|([1-9a-f][0-9a-f]{0,3})):){0,6}(:|(0?|([1-9a-f][0-9a-f]{0,3})))$'
and
Pattern: '^((([^:]+:){7}([^:]+))|((([^:]+:)*[^:]+)?::(([^:]+:)*[^:]+)?))$'</td></tr>
<tr><td>Ipv6AddrRm</td><td>string</td><td>This data type is defined in the same way as the "Ipv6Addr" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Ipv6Prefix</td><td>string</td><td>String identifying an IPv6 address prefix formatted according to clause 4 of IETF RFC 5952 [5]. IPv6Prefix data type may contain an individual /128 IPv6 address.
Pattern: '^((:|(0?|([1-9a-f][0-9a-f]{0,3}))):)((0?|([1-9a-f][0-9a-f]{0,3})):){0,6}(:|(0?|([1-9a-f][0-9a-f]{0,3})))(\/(([0-9])|([0-9]{2})|(1[0-1][0-9])|(12[0-8])))$'
and
Pattern:
'^((([^:]+:){7}([^:]+))|((([^:]+:)*[^:]+)?::(([^:]+:)*[^:]+)?))(\/.+)$'</td></tr>
<tr><td>Ipv6PrefixRm</td><td>string</td><td>This data type is defined in the same way as the "Ipv6Prefix" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>MacAddr48</td><td>string</td><td>String identifying a MAC address formatted in the hexadecimal notation according to clause 1.1 and clause 2.1 of IETF RFC 7042 [17].
Pattern: '^([0-9a-fA-F]{2})((-[0-9a-fA-F]{2}){5})$'</td></tr>
<tr><td>MacAddr48Rm</td><td>string</td><td>This data type is defined in the same way as the "MacAddr48" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>SupportedFeatures</td><td>string</td><td>A string used to indicate the features supported by an API that is used as defined in clause 6.6 in 3GPP TS 29.500 [25].
The string shall contain a bitmask indicating supported features in hexadecimal representation:
Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent the support of 4 features as described in table 5.2.2-3. The most significant character representing the highest-numbered features shall appear first in the string, and the character representing features 1 to 4 shall appear last in the string. The list of features and their numbering (starting with 1) are defined separately for each API. If the string contains a lower number of characters than there are defined features for an API, all features that would be represented by characters that are not present in the string are not supported.</td></tr>
<tr><td>Uinteger</td><td>integer</td><td>Unsigned Integer, i.e. only value 0 and integers above 0 are permissible.
Minimum = 0.</td></tr>
<tr><td>UintegerRm</td><td>integer</td><td>This data type is defined in the same way as the "Uinteger" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Uint32</td><td>integer</td><td>Integer where the allowed values correspond to the value range of an unsigned 32-bit integer, i.e. 0 to (2^32)-1.
Minimum = 0. Maximum = 4294967295.</td></tr>
<tr><td>Uint32Rm</td><td>integer</td><td>This data type is defined in the same way as the "Uint32" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Uint64</td><td>integer</td><td>Integer where the allowed values correspond to the value range of an unsigned 64-bit integer, i.e. 0 to (2^64)-1.
Minimum = 0. Maximum = 18446744073709551615.</td></tr>
<tr><td>Uint64Rm</td><td>integer</td><td>This data type is defined in the same way as the "Uint64" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>Uri</td><td>string</td><td>String providing an URI formatted according to IETF RFC 3986 [6].
If the URI fields intended to convey generic data (e.g., in the value part of a query parameter, or in the URI path segments) contain reserved characters, these reserved characters shall be percent-encoded as defined in clause 5.2.10.2 of 3GPP TS 29.500 [25].</td></tr>
<tr><td>UriRm</td><td>string</td><td>This data type is defined in the same way as the "Uri" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>VarUeId</td><td>string</td><td>String represents the SUPI or GPSI.
Pattern: "^(imsi-[0-9]{5,15}|nai-.+|msisdn-[0-9]{5,15}|extid-[^@]+@[^@]+|gci-.+|gli-.+|.+)$".</td></tr>
<tr><td>VarUeIdRm</td><td>string</td><td>This data type is defined in the same way as the "VarUeId" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>TimeZone</td><td>string</td><td>String with format "<time-numoffset>" optionally appended by "<daylightSavingTime>", where:

- <time-numoffset> shall represent the time zone adjusted for daylight saving time and be encoded as time-numoffset as defined in clause 5.6 of IETF RFC 3339 [10];

- <daylightSavingTime> shall represent the adjustment that has been made and shall be encoded as "+1" or "+2" for a +1 or +2 hours adjustment.

Example: "-08:00+1" (for 8 hours behind UTC, +1 hour adjustment for Daylight Saving Time).</td></tr>
<tr><td>TimeZoneRm</td><td>string</td><td>This data type is defined in the same way as the "TimeZone" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>StnSr</td><td>string</td><td>String representing the STN-SR as defined in clause 18.6 of 3GPP TS 23.003 [7].</td></tr>
<tr><td>StnSrRm</td><td>string</td><td>This data type is defined in the same way as the "StnSr" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>CMsisdn</td><td>string</td><td>String representing the C-MSISDN as defined in clause 18.7 of 3GPP TS 23.003 [7]).
Pattern: "^[0-9]{5,15}$".</td></tr>
<tr><td>CMsisdnRm</td><td>string</td><td>This data type is defined in the same way as the "CMsisdn" data type, but with the OpenAPI "nullable: true" property.</td></tr>
<tr><td>DayOfWeek</td><td>integer</td><td>Integer between and including 1 and 7 denoting a weekday. "1" shall indicate "Monday", and the subsequent weekdays shall be indicated with the next higher numbers. "7" shall indicate "Sunday".</td></tr>
<tr><td>TimeOfDay</td><td>string</td><td>String with format "partial-time" or "full-time" as defined in clause 5.6 of IETF RFC 3339 [10].
Examples: "20:15:00", "20:15:00-08:00" (for 8 hours behind UTC).</td></tr>
<tr><td>EmptyObject</td><td>object</td><td>Empty JSON object: { }
It is defined with the keyword: "additionalProperties: false".</td></tr>
<tr><td>Fqdn</td><td>string</td><td>Fully Qualified Domain Name

Pattern: '^([0-9A-Za-z]([-0-9A-Za-z]{0,61}[0-9A-Za-z])?\.)+[A-Za-z]{2,63}\.?$'

minLength: 4
maxLength: 253</td></tr>
<tr><td>FqdnRm</td><td>string</td><td>This data type is defined in the same way as the "Fqdn" data type, but it also allows the null value.</td></tr>
</table>

3. 5G System (5GS) Common Data Types for 5GS SBA/SBIs

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Table: 5G System Structured Data Types Definition of type ChangeItem

Attribute name	Data type	P	Cardinality	Description	Applicability
op	ChangeType	M	1	This IE indicates the operation to be performed on the resource.	
path	string	M	1	This IE contains a JSON pointer value (as defined in IETF RFC 6901 [12]) that references a target location within the resource on which the change has been applied. (See Note)	
from	string	C	0..1	This IE indicates the path of the source JSON element (according to JSON Pointer syntax) being moved or copied to the location indicated by the "path" attribute. It shall be present if the "op" attribute is of value "MOVE".	
origValue	Any type	O	0..1	This IE indicates the original value at the target location within the resource specified in the path attribute. This attribute only applies when the "op" attribute is of value "REMOVE", "REPLACE" or "MOVE" Based on the use case, this attribute may be included.	
newValue	Any type	C	0..1	This IE indicates a new value at the target location within the resource specified in the path attribute. It shall be present if the "op" attribute is of value "ADD", "REPLACE". The data type of this attribute shall be the same as the type of the resource on which the change has happened. The null value shall be allowed.	
NOTE: As described in IETF RFC 6901 [12], the value "" (empty JSON string) is the JSON Pointer expression to represent "the whole JSON document"; therefore, when the attribute "path" takes value "" and attribute "op" takes values "ADD" or "REMOVE", this shall be interpreted as the creation or deletion respectively of the resource to which this "ChangeItem" refers to.					

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Table: 5G System Structured Data Types Definition of type ProblemDetails

Attribute name	Data type	P	Cardinality	Description
type	Uri	O	0..1	A URI reference according to IETF RFC 3986 [6] that identifies the problem type.
title	string	O	0..1	A short, human-readable summary of the problem type. It should not change from occurrence to occurrence of the problem.
status	integer	O	0..1	The HTTP status code for this occurrence of the problem.
detail	string	O	0..1	A human-readable explanation specific to this occurrence of the problem.
instance	Uri	O	0..1	A URI reference that identifies the specific occurrence of the problem.
cause	string	C	0..1	A machine-readable application error cause specific to this occurrence of the problem This IE should be present and provide application-related error information, if available.
invalidParams	array(InvalidParam)	O	1..N	Description of invalid parameters, for a request rejected due to invalid parameters.
supportedFeatures	SupportedFeatures	C	0..1	Features supported by the NF Service Producer. This IE shall be present when rejecting a request due to an unsupported query parameter, if at least one feature is defined for the corresponding service in the version of the specification that the NF Service Producer implements (see clause 5.2.9 of 3GPP TS 29.500 [25]). When present, this IE shall indicate the features supported by the NF Service Producer; if the NF Service Producer supports no features, this IE shall be set to the character "0".
accessTokenError	AccessTokenErr	C	0..1	This IE should be present if an SCP request to get an access token was rejected by the NRF. When present, it should contain the Access Token Error content received from the NRF.
accessTokenRequest	AccessTokenReq	O	0..1	This IE may be present if an SCP request to get an access token was rejected by the NRF. When present, it shall contain the Access Token Request that was sent by the SCP.
nrfId	Fqdn	O	0..1	This IE may be present if an SCP request to get an access token was rejected by the NRF. When present, it shall contain the Identity (i.e. FQDN) of the NRF that rejected the access token request.
supportedApiVersions	array(string)	O	1..N	This IE may be present if the SCP did not find NF service producers matching the MAJOR API version of the incoming service request and MAJOR API version(s) are known to be supported by NF service producers for the corresponding service. When present, it shall contain MAJOR API version(s) known to be supported by NF service producers for the corresponding service. The API version shall be encoded as the apiVersionInUri defined in NFServiceVersion
NOTE 1: See IETF RFC 9457 [9] for detailed information and guidance for each attribute, for guidelines on error handling support by 5GC SBI APIs. NOTE 2: Additional attributes may be defined per API.				

Table: 5GS Data Types related to Subscription, Identification and Numbering

Type Name	Type Definition	Description
Dnn	string	String representing a Data Network as defined in clause 9A of 3GPP TS 23.003 [7]; it shall contain either a DNN Network Identifier, or a full DNN with both the Network Identifier and Operator Identifier, as specified in 3GPP TS 23.003 [7] clause 9.1.1 and 9.1.2. It shall be coded as string in which the labels are separated by dots (e.g. "Label1.Label2.Label3"). See NOTE 2. As specified for APNs in 3GPP TS 23.003 [7], clause 9.1, DNNs shall be handled as case-insensitive strings.
DnnRm	string	This data type is defined in the same way as the "Dnn" data type, but with the OpenAPI "nullable: true" property.
WildcardDnn	string	String representing the Wildcard DNN. It shall contain the string "*". Pattern: '^[*]$'
WildcardDnnRm	string	This data type is defined in the same way as the "WildcardDnn" data type, but with the OpenAPI "nullable: true" property.
Gpsi	string	String identifying a Gpsi shall contain either an External Id or an MSISDN. It shall be formatted as follows: -External Identifier: "extid-<extid>, where <extid> shall be formatted according to clause 19.7.2 of 3GPP TS 23.003 [7] that describes an External Identifier. -MSISDN: "msisdn-<msisdn>, where <msisdn> shall be formatted according to clause 3.3 of 3GPP TS 23.003 [7] that describes an MSISDN. Pattern: '^(msisdn-[0-9]{5,15}|extid-.+@.+|.+)$'
GpsiRm	string	This data type is defined in the same way as the "Gpsi" data type, but with the OpenAPI "nullable: true" property.
GroupId	string	String identifying a group of devices network internal globally unique ID which identifies a set of IMSIs, as specified in clause 19.9 of 3GPP TS 23.003 [7]. For 5G related service, the GroupServiceId shall identify the specific service for which the IMSI-Group-Id is used, as specified in clause 5.3.3.1. Pattern: '^[A-Fa-f0-9]{8}-[0-9]{3}-[0-9]{2,3}-([A-Fa-f0-9][A-Fa-f0-9]){1,10}$'.
GroupIdRm	string	This data type is defined in the same way as the "GroupId" data type, but with the OpenAPI "nullable: true" property.
ExternalGroupId	string	String identifying External Group Identifier that identifies a group made up of one or more subscriptions associated to a group of IMSIs, as specified in clause 19.7.3 of 3GPP TS 23.003 [7]. Pattern: "^extgroupid-[^@]+@[^@]+$"
ExternalGroupIdRm	string	This data type is defined in the same way as the "ExternalGroupId" data type, but with the OpenAPI "nullable: true" property.
Pei	string	String representing a Permanent Equipment Identifier that may contain: - an IMEI or IMEISV, as specified in clause 6.2 of 3GPP TS 23.003 [7]; - a MAC address for a 5G-RG or FN-RG via wireline access, with an indication that this address cannot be trusted for regulatory purpose if this address cannot be used as an Equipment Identifier of the FN-RG, as specified in clause 4.7.7 of 3GPP TS 23.316 [30]. - an IEEE Extended Unique Identifier (EUI-64), for UEs not supporting any 3GPP access technologies, as defined in IEEE "Guidelines for Use of Extended Unique Identifier (EUI), Organizationally Unique Identifier (OUI), and Company ID (CID)" [38]. Pattern: '^(imei-[0-9]{15}|imeisv-[0-9]{16}|mac((-[0-9a-fA-F]{2}){6})(-untrusted)?|eui((-[0-9a-fA-F]{2}){8})|.+)$'. See NOTE 1. Examples: imei-012345678901234 imeisv-0123456789012345 mac-00-00-5E-00-53-00 mac-00-00-5E-00-53-00-untrusted eui-AC-DE-48-23-45-67-01-9F
PeiRm	string	This data type is defined in the same way as the "Pei" data type, but with the OpenAPI "nullable: true" property.
Supi	string	String identifying a Supi that shall contain either an IMSI, a network specific identifier, a Global Cable Identifier (GCI) or a Global Line Identifier (GLI) as specified in clause 2.2A of 3GPP TS 23.003 [7]. It shall be formatted as follows: - for an IMSI "imsi-<imsi>", where <imsi> shall be formatted according to clause 2.2 of 3GPP TS 23.003 [7] that describes an IMSI. - for a network specific identifier "nai-<nai>, where <nai> shall be formatted according to clause 28.7.2 of 3GPP TS 23.003 [7] that describes an NAI. - for a GCI: "gci-<gci>", where <gci> shall be formatted according to clause 28.15.2 of 3GPP TS 23.003 [7]. - for a GLI: "gli-<gli>", where <gli> shall be formatted according to clause 28.16.2 of 3GPP TS 23.003 [7]. To enable that the value is used as part of an URI, the string shall only contain characters allowed according to the "lower-with-hyphen" naming convention defined in 3GPP TS 29.501 [2]. Pattern: '^(imsi-[0-9]{5,15}|nai-.+| gci-.+|gli-.+|.+)$' (NOTE 1).
SupiRm	string	This data type is defined in the same way as the "Supi" data type, but with the OpenAPI "nullable: true" property.
NfInstanceId	string	String uniquely identifying a NF instance. The format of the NF Instance ID shall be a Universally Unique Identifier (UUID) version 4, as described in IETF RFC 4122 [15]. The hexadecimal letters should be formatted as lower-case characters by the sender, and they shall be handled as case-insensitive by the receiver. Example: "4ace9d34-2c69-4f99-92d5-a73a3fe8e23b" (NOTE 3)
AmfId	string	String identifying the AMF ID composed of AMF Region ID (8 bits), AMF Set ID (10 bits) and AMF Pointer (6 bits) as specified in clause 2.10.1 of 3GPP TS 23.003 [7]. It is encoded as a string of 6 hexadecimal characters (i.e., 24 bits). Pattern: '^[A-Fa-f0-9]{6}$'
AmfRegionId	string	String identifying the AMF Region ID (8 bits), as specified in clause 2.10.1 of 3GPP TS 23.003 [7]. It is encoded as a string of 2 hexadecimal characters (i.e. 8 bits). Pattern: '^[A-Fa-f0-9]{2}$'
AmfSetId	string	String identifying the AMF Set ID (10 bits) as specified in clause 2.10.1 of 3GPP TS 23.003 [7]. It is encoded as a string of 3 hexadecimal characters where the first character is limited to values 0 to 3 (i.e. 10 bits). Pattern: '^[0-3][A-Fa-f0-9]{2}$'
RfspIndex	integer	Unsigned integer representing the "Subscriber Profile ID for RAT/Frequency Priority" as specified in 3GPP Minimum = 1. Maximum = 256.
RfspIndexRm	integer	This data type is defined in the same way as the "RfspIndex" data type, but with the OpenAPI "nullable: true" property.
NfGroupId	string	Identifier of a group of NFs
MtcProviderInformation	string	String uniquely identifying MTC provider information.
CagId	string	String containing a Closed Access Group Identifier. Pattern: "^[A-Fa-f0-9]{8}$"
SupiOrSuci	string	String identifying a SUPI or a SUCI. Pattern: "^(imsi-[0-9]{5,15}|nai-.+|gli-.+|gci-.+|suci-(0-[0-9]{3}-[0-9]{2,3}|[1-7]-.+)-[0-9]{1,4}-(0-0-.*|[a-fA-F1-9]-([1-9]|[1-9][0-9]|1[0-9]{2}|2[0-4][0-9]|25[0-5])-[a-fA-F0-9]+)|.+)$"
Imsi	string	String identifyting an IMSI Pattern: ^[0-9]{5,15}$
ApplicationlayerId	string	String identifying an application layer ID. The format of the application layer ID parameter is same as the Application layer ID defined in clause 11.3.4 of 3GPP
NsacSai	string	String that uniquely identifies the NSAC Service Area Identifier. Reserved value(s): "ENTIRE_PLMN", it indicates the NSACF serves the entire PLMN.
NOTE 1: The encoding of 3GPP defined identifiers (e.g. IMSI, NAI, IMEI, GCI, GLI) shall be prefixed with its corresponding prefix (e.g. 'imsi-','nai-', 'imei-', 'gci-', 'gli-'). NOTE 2: Whether the Dnn data type contains just the DNN Network Identifier, or the Network Identifier plus the Operator Identifier, shall be documented in each API where this data type is used. NOTE 3: NFs shall be able to receive a NF Instance Id in any UUID format.		

Table: 5GS Data types related to 5G Network

Type Name	Type Definition	Description
ApplicationId	string	String providing an application identifier.
ApplicationIdRm	string	This data type is defined in the same way as the "ApplicationId" data type, but with the OpenAPI "nullable: true" property.
PduSessionId	integer	Unsigned integer identifying a PDU session, within the range 0 to 255, as specified in clause 11.2.3.1b, bits 1 to 8, of 3GPP TS 24.007 [13]. If the PDU Session ID is allocated by the Core Network for UEs not supporting N1 mode, reserved range 64 to 95 is used. PDU Session ID within the reserved range is only visible in the Core Network (NOTE).
Mcc	string	Mobile Country Code part of the PLMN, comprising 3 digits, as defined in clause 9.3.3.5 of 3GPP TS 38.413 [11]. Pattern: '^[0-9]{3}$'
MccRm	string	This data type is defined in the same way as the "Mcc" data type, but with the OpenAPI "nullable: true" property.
Mnc	string	Mobile Network Code part of the PLMN, comprising 2 or 3 digits, as defined in clause 9.3.3.5 of 3GPP TS 38.413 [11]. Pattern: '^[0-9]{2,3}$'
MncRm	string	This data type is defined in the same way as the "Mnc" data type, but with the OpenAPI "nullable: true" property.
Tac	string	2 or 3-octet string identifying a tracking area code as specified in clause 9.3.3.10 of 3GPP TS 38.413 [11], in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the TAC shall appear first in the string, and the character representing the 4 least significant bit of the TAC shall appear last in the string. Examples: A legacy TAC 0x4305 shall be encoded as "4305". An extended TAC 0x63F84B shall be encoded as "63F84B"
TacRm	string	This data type is defined in the same way as the "Tac" data type, but with the OpenAPI "nullable: true" property.
EutraCellId	string	28-bit string identifying an E-UTRA Cell Id as specified in clause 9.3.1.9 of 3GPP TS 38.413 [11], in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the Cell Id shall appear first in the string, and the character representing the 4 least significant bit of the Cell Id shall appear last in the string. Pattern: '^[A-Fa-f0-9]{7}$' Example: An E-UTRA Cell Id 0x5BD6007 shall be encoded as "5BD6007".
EutraCellIdRm	string	This data type is defined in the same way as the "EutraCellId" data type, but with the OpenAPI "nullable: true" property.
NrCellId	string	36-bit string identifying an NR Cell Id as specified in clause 9.3.1.7 of 3GPP TS 38.413 [11], in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the Cell Id shall appear first in the string, and the character representing the 4 least significant bit of the Cell Id shall appear last in the string. Pattern: '^[A-Fa-f0-9]{9}$' Example: An NR Cell Id 0x225BD6007 shall be encoded as "225BD6007".
NrCellIdRm	string	This data type is defined in the same way as the "NrCellId" data type, but with the OpenAPI "nullable: true" property.
Dnai	string	DNAI (Data network access identifier), see clause 5.6.7 of 3GPP TS 23.501 [8].
DnaiRm	string	This data type is defined in the same way as the "Dnai" data type, but with the OpenAPI "nullable: true" property.
5GMmCause	Uinteger	This represents the 5GMM cause code values as specified in 3GPP TS 24.501 [20].
AreaCodeRm	string	This data type is defined in the same way as the "AreaCode" data type, but with the OpenAPI "nullable: true" property.
AmfName	Fqdn	FQDN (Fully Qualified Domain Name) of the AMF as defined in clause 28.3.2.5 of 3GPP TS 23.003 [7].
AreaCode	string	Values are operator specific.
N3IwfId	string	This represents the identifier of the N3IWF ID as specified in clause 9.3.1.57 of 3GPP TS 38.413 [11] in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the N3IWF ID shall appear first in the string, and the character representing the 4 least significant bit of the N3IWF ID shall appear last in the string. Pattern: '^[A-Fa-f0-9]+$' Example: The N3IWF Id 0x5BD6 shall be encoded as "5BD6".
WAgfId	string	This represents the identifier of the W-AGF ID as specified in clause 9.3.1.162 of 3GPP TS 38.413 [11] in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the W-AGF ID shall appear first in the string, and the character representing the 4 least significant bit of the W-AGF ID shall appear last in the string. Pattern: '^[A-Fa-f0-9]+$' Example: The W-AGF Id 0x5BD6 shall be encoded as "5BD6".
TngfId	string	This represents the identifier of the TNGF ID as specified in clause 9.3.1.161 of 3GPP TS 38.413 [11] in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The most significant character representing the 4 most significant bits of the TNGF ID shall appear first in the string, and the character representing the 4 least significant bit of the TNGF ID shall appear last in the string. Pattern: '^[A-Fa-f0-9]+$' Example: The TNGF Id 0x5BD6 shall be encoded as "5BD6".
NgeNbId	string	This represents the identifier of the ng-eNB ID as specified in clause 9.3.1.8 of 3GPP TS 38.413 [11]. The string shall be formatted with following pattern: Pattern: '^(MacroNGeNB-[A-Fa-f0-9]{5}|LMacroNGeNB-[A-Fa-f0-9]{6}|SMacroNGeNB-[A-Fa-f0-9]{5})$' The value of the ng-eNB ID shall be encoded in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The padding 0 shall be added to make multiple nibbles, so the most significant character representing the padding 0 if required together with the 4 most significant bits of the ng-eNB ID shall appear first in the string, and the character representing the 4 least significant bit of the ng-eNB ID (to form a nibble) shall appear last in the string. Examples: " SMacroNGeNB-34B89" indicates a Short Macro NG-eNB ID with value 0x34B89.
Nid	string	This represents the Network Identifier, which together with a PLMN ID is used to identify an SNPN (see 3GPP TS 23.003 [7] and 3GPP TS 23.501 [8] clause 5.30.2.1). Pattern: '^[A-Fa-f0-9]{11}$'
NidRm	string	This data type is defined in the same way as the "Nid" data type, but with the OpenAPI "nullable: true" property.
NfSetId	string	NF Set Identifier (see clause 28.12 of 3GPP TS 23.003 [7]), formatted as the following string: " set<Set ID>.<nftype>set.5gc.mnc<MNC>.mcc<MCC>", or "set<SetID>.<NFType>set.5gc.nid<NID>.mnc<MNC>.mcc<MCC>" with <MCC> encoded as defined in clause 5.4.2 ("Mcc" data type definition) <MNC> encoding the Mobile Network Code part of the PLMN, comprising 3 digits. If there are only 2 significant digits in the MNC, one "0" digit shall be inserted at the left side to fill the 3 digits coding of MNC. Pattern: '^[0-9]{3}$ <NFType> encoded as a value defined in Table 6.1.6.3.3-1 of 3GPP TS 29.510 [29] but with lower case characters <Set ID> encoded as a string of characters consisting of alphabetic characters (A-Z and a-z), digits (0-9) and/or the hyphen (-) and that shall end with either an alphabetic character or a digit. Pattern: '^([A-Za-z0-9\-]*[A-Za-z0-9])$' Examples: "setxyz.smfset.5gc.mnc012.mcc345" "set12.pcfset.5gc.mnc012.mcc345"
NfServiceSetId	string	NF Service Set Identifier (see clause 28.12 of 3GPP TS 23.003 [7]) formatted as the following string: " set<Set ID>.sn<Service Name>.nfi<NF Instance ID>.5gc.mnc<MNC>.mcc<MCC>">", or "set<SetID>.sn<ServiceName>.nfi<NFInstanceID>.5gc.nid<NID>.mnc<MNC>.mcc<MCC>" with <MCC> encoded as defined in clause 5.4.2 ("Mcc" data type definition) <MNC> encoding the Mobile Network Code part of the PLMN, comprising 3 digits. If there are only 2 significant digits in the MNC, one "0" digit shall be inserted at the left side to fill the 3 digits coding of MNC. Pattern: '^[0-9]{3}$' <NID> encoded as defined in clause 5.4.2 ("Nid" data type definition) <NFInstanceId> encoded as defined in clause 5.3.2 <ServiceName> encoded as defined in 3GPP TS 29.510 [29] <Set ID> encoded as a string of characters consisting of alphabetic characters (A-Z and a-z), digits (0-9) and/or the hyphen (-) and that shall end with either an alphabetic character or a digit. Pattern: '^([A-Za-z0-9\-]*[A-Za-z0-9])$ Examples: "setxyz.snnsmf-pdusession.nfi54804518-4191-46b3-955c-ac631f953ed8.5gc.mnc012.mcc345" "set2.snnpcf-smpolicycontrol.nfi54804518-4191-46b3-955c-ac631f953ed8.5gc.mnc012.mcc345"
PlmnAssiUeRadioCapId	Bytes	String with format "byte" as defined in OpenAPI Specification [3], i.e. base64-encoded characters, encoding the "UE radio capability ID" IE as specified in clause 9.11.3.68 of 3GPP TS 24.501 [20] (starting from octet 1).
ManAssiUeRadioCapId	Bytes	String with format "byte" as defined in OpenAPI Specification [3], i.e. base64-encoded characters, encoding the "UE radio capability ID" IE as specified in clause 9.11.3.68 of 3GPP TS 24.501 [20] (starting from octet 1).
TypeAllocationCode	string	Type Allocation Code (TAC) of the UE, comprising the initial eight-digit portion of the 15-digit IMEI and 16-digit IMEISV codes. See clause 6.2 of 3GPP TS 23.003 [7]. Pattern: '^[0-9]{8}$'
HfcNId	string	This IE represents the identifier of the HFC node Id as specified in CableLabs WR-TR-5WWC-ARCH [32]. It is provisioned by the wireline operator as part of wireline operations and may contain up to six characters.
HfcNIdRm	string	This data type is defined in the same way as the "HfcNId" data type, but with the OpenAPI "nullable: true" property.
ENbId	string	This represents the identifier of the eNB ID as specified in clause 9.2.1.37 of 3GPP TS 36.413 [16]. The string shall be formatted with following pattern: Pattern: '^('MacroeNB-[A-Fa-f0-9]{5}|LMacroeNB-[A-Fa-f0-9]{6}|SMacroeNB-[A-Fa-f0-9]{5}|HomeeNB-[A-Fa-f0-9]{7})$' The value of the eNB ID shall be encoded in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The padding 0 shall be added to make multiple nibbles, so the most significant character representing the padding 0 if required together with the 4 most significant bits of the eNB ID shall appear first in the string, and the character representing the 4 least significant bit of the eNB ID (to form a nibble) shall appear last in the string. Examples: "SMacroeNB-34B89" indicates a Short Macro eNB ID with value 0x34B89.
Gli	Bytes	Global Line Identifier uniquely identifying the line connecting the 5G-BRG or FN-BRG to the 5GS. See clause 28.16.3 of 3GPP TS 23.003 [7]. This shall be encoded as a string with format "byte" as defined in OpenAPI Specification [3], i.e. base64-encoded characters, representing the GLI value (up to 150 bytes) encoded as specified in BBF WT-470 [37].
Gci	string	Global Cable Identifier uniquely identifying the connection between the 5G-CRG or FN-CRG to the 5GS. See clause 28.15.4 of 3GPP TS 23.003 [7]. This shall be encoded as a string per clause 28.15.4 of 3GPP TS 23.003 [7], and compliant with the syntax specified in clause 2.2 of IETF RFC 7542 [47] for the username part of a NAI. The GCI value is specified in CableLabs WR-TR-5WWC-ARCH [32].
NsSrg	string	String representing Network Slice Simultaneous Registration Group (see clause 5.15.12 of 3GPP TS 23.501 [8])
NsSrgRm	string	This data type is defined in the same way as the " NsSrg" data type, but with the OpenAPI "nullable: true" property.
RelayServiceCode	integer	Relay Service Code to identify a connectivity service provided by the UE-to-Network relay or the UE-to-UE relay. Integer type as defined in OpenAPI Specification [3], with value range from 0 to 16777215 (decimal). Minimum = 0. Maximum = 16777215.
5GPrukId	string	Prose Remote User Key ID over Control Plane A string carrying the CP-PRUK ID of the the 5G ProSe Remote UE or the 5G ProSe End UE as specified in 3GPP TS 33.503 [50]. The CP-PRUK ID is a string in NAI format as specified in clause 28.7.11 of 3GPP TS 23.003 [7]. pattern: "^rid[0-9]{1,4}\.pid[0-9a-fA-F]+\@prose-cp\.5gc\.mnc[0-9]{2,3}\.mcc[0-9]{3}\.3gppnetwork\.org$"
NsagId	integer	Containing a Network Slice AS Group ID, see 3GPP TS 38.413 [11]. Values between 0 and 255 are allowed for this data type in this release.
NsagIdRm	integer	This data type is defined in the same way as the "NsagId" data type, but with the OpenAPI "nullable: true" property.
GeoSatelliteId	string	Unique identifier of a GEO satellite. See e.g. clause 5.43.2 in 3GPP TS 23.501 [2].
OffloadIdentifier	string	Offload identifier uniquely identifying a VPLMN offloading policy information instance of the HPLMN. It shall comprise the PLMN ID of the HPLMN providing the VPLMN offloading policy and a unique identifier of the VPLMN offloading policy instance in the HPLMN. The PLMN ID shall be composed of three digits "mcc" followed by "-" and two or three digits "mnc" and shall match the following pattern: '[0-9]{3}-[0-9]{2,3}' The unique identifier shall match the following pattern: '[A-Fa-f0-9]{8}' It may further contain the version number (between 0 and 99) of the VPLMN offloading policy instance in the HPLMN. A VPLMN Specific Offloading Information provided by the H-SMF with a higher version number will overwrite the one with lower version number. When present, the version number shall match the following pattern: '-v[0-9]{1,2}' Pattern: "^[0-9]{3}-[0-9]{2,3}-[A-Fa-f0-9]{8}(-v[0-9]{1,2}){0,1}$" Examples (with and without a version number): "262-01-00A17C01-v3" "302-720-00A17C01"

NOTE: For a PDN connection established via MME, the PDU Session ID value is set to 64 plus the EPS bearer ID of the default EPS bearer of the PDN connection; for a PDN connection established via ePDG, the PDU Session ID value is set to 80 plus the EPS bearer ID of the default EPS bearer of the PDN connection.

3. 5G System (5GS) Common Data Types for 5GS SBA/SBIs related to 5G Network

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Table: 5G System Structured Data Types Definition of type GlobalRanNodeId

Attribute name	Data type	P	Cardinality	Description
plmnId	PlmnId	M	1	Indicates the identity of the PLMN that the RAN node belongs to.
n3IwfId	N3IwfId	C	0..1	This IE shall be included if the AN node represents a N3IWF. When present, this IE shall contain the identifier of the N3IWF. (NOTE 1).
gNbId	GNbId	C	0..1	This IE shall be included if the RAN Node Id represents a gNB. When present, this IE shall contain the identifier of the gNB. (NOTE 1).
ngeNbId	NgeNbId	C	0..1	This IE shall be included if the RAN Node Id represents a NG-eNB. When present, this IE shall contain the identifier of an NG-eNB. (NOTE 1).
wagfId	WAgfId	C	0..1	This IE shall be included if the AN node represents a W-AGF. When present, this IE shall contain the identifier of the W-AGF. (NOTE 1).
tngfId	TngfId	C	0..1	This IE shall be included if the AN node represents a TNGF. When present, this IE shall contain the identifier of the TNGF. (NOTE 1).
nid	Nid	O	0..1	Network Identifier shall be present in case of SNPN, PlmnId together with Nid indicates the identity of the SNPN to which the RanNode belongs to.
eNbId	ENbId	C	0..1	This IE shall be included if the RAN Node Id represents an eNB. When present, this IE shall contain the identifier of an eNB. (NOTE 1, NOTE 2).
NOTE 1: One of the six attributes n3IwfId, gNbIdm, ngeNbId, wagfId, tngfId, eNbId shall be present. NOTE 2: For UEs with 5GS subscription but without 5G NAS support, eNbId is used on N7 instead of n3IwfId, gNbIdm, ngeNbId.				

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Table: 5G System Structured Data Types Definition of type gNBid

Attribute name	Data type	P	Cardinality	Description
bitLength	integer	M	1	Unsigned integer representing the bit length of the gNB ID as defined of within the range 22 to 32
gNBValue	string	M	1	This represents the identifier of the gNB. The string shall be formatted with following pattern: '^[A-Fa-f0-9]{6,8}$' The value of the gNB ID shall be encoded in hexadecimal representation. Each character in the string shall take a value of "0" to "9", "a" to "f" or "A" to "F" and shall represent 4 bits. The padding 0 shall be added to make multiple nibbles, the most significant character representing the padding 0 if required together with the 4 most significant bits of the gNB ID shall appear first in the string, and the character representing the 4 least significant bit of the gNB ID shall appear last in the string. Examples: A 30 bit value "382A3F47" indicates a gNB ID with value 0x382A3F47 A 22 bit value "2A3F47" indicates a gNB ID with value 0x2A3F47

3. 5G System (5GS) ***Common Data Types*** for 5GS SBA/SBIs related to ***5G Network - ProSe, ECSServer and (Network) Endpoint***

Table: 5G System Structured Data Types Definition of type ProseServiceAuth

Attribute name	Data type	P	Cardinality	Description
proseDirectDiscoveryAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to use ProSe Direct Discovery.
proseDirectCommunicationAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to use ProSe Direct Communication.
proseL2RelayAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-2 UE-to-Network Relay.
proseL3RelayAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-3 UE-to-Network Relay.
proseL2RemoteAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-2 Remote UE.
proseL3RemoteAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-3 Remote UE.
proseMultipathComL2RemoteAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to use multi-path communication via direct Uu path and via 5G ProSe Layer-2 UE-to-Network Relay as a 5G ProSe Layer-2 Remote UE.
proseL2UeRelayAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-2 UE-to-UE Relay.
proseL3UeRelayAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-3 UE-to-UE Relay.
proseL2EndAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-2 End UE.
proseL3EndAuth	UeAuth	C	0..1	This IE shall be present if available. When present, it shall indicate whether the UE is authorized to act as 5G ProSe Layer-3 End UE.

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Table: 5G System Structured Data Types Definition of type ECSServerAddr

Attribute name	Data type	P	Cardinality	Description
ecsFqdnList	array(Fqdn)	C	1..N	This IE shall be included if available. When present, it shall contain the list of FQDN(s) of Edge Configuration Server(s).
ecsIpAddressList	array(IpAddr)	C	1..N	This IE shall be included if available. When present, it shall contain the list of IP Address (es) of Edge Configuration Server(s).
ecsUriList	array(Uri)	C	1..N	This IE shall be included if available. When present, it shall contain the list of URI(s) of the Edge Configuration Server(s).
ecsProviderId	string	C	0..1	This IE shall be included if available. When present, it shall contain the identifier of the Edge Configuration Server Provider.

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Table: 5G System Structured Data Types Definition of type Endpoint

Attribute name	Data type	P	Cardinality	Description	Applicability
ip	IpAddr	M	1	Represents the IP address of the endpoint.	
transport	TransportProtocol	M	1	Represents the transport protocol.	
portNumber	Uinteger	M	1	Represents the TCP or UDP port number of the endpoint.	

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Table: 5G System Structured Data Types Definition related to 5G QoS Simple data Types

Type Name	Type Definition	Description
Qfi	integer	Unsigned integer identifying a QoS flow, within the range 0 to 63.
QfiRm	integer	This data type is defined in the same way as the "Qfi" data type, but with the OpenAPI "nullable: true" property.
5Qi	integer	Unsigned integer representing a 5G QoS Identifier (see]), within the range 0 to 255.
5QiRm	integer	This data type is defined in the same way as the "5Qi" data type, but with the OpenAPI "nullable: true" property.
BitRate	string	String representing a bit rate that shall be formatted as follows: Pattern: '^\d+(\.\d+)? (bps|Kbps|Mbps|Gbps|Tbps)$' (NOTE) Examples: "125 Mbps", "0.125 Gbps", "125000 Kbps"
BitRateRm	string	This data type is defined in the same way as the "BitRate" data type, but with the OpenAPI "nullable: true" property.
PacketRate	string	String representing a packet rate, i.e. packets per second, that shall be formatted as follows: Pattern: '^\d+(\.\d+)? (pps|kpps|Mpps|Gpps|Tpps)$' (NOTE) Examples: "125 Mpps", "0.125 Gpps", "125000 kpps"
PacketRateRm	string	This data type is defined in the same way as the "PacketRate" data type, but with the OpenAPI "nullable: true" property.
TrafficVolume	string	String representing a traffic volume measured in bytes that shall be formatted as follows: Pattern: '^\d+(\.\d+)? (B|kB|MB|GB|TB)$' (NOTE) Examples: "125 MB", "0.125 GB", "125000 kB"
TrafficVolumeRm	string	This data type is defined in the same way as the "TrafficVolume" data type, but with the OpenAPI "nullable: true" property.
ArpPriorityLevel	integer	Unsigned integer indicating the ARP Priority Level (see), within the range 1 to 15. Values are ordered in decreasing order of priority, i.e. with 1 as the highest priority and 15 as the lowest priority.
ArpPriorityLevelRm	integer	This data type is defined in the same way as the "ArpPriorityLevel" data type, but with the OpenAPI "nullable: true" property.
5QiPriorityLevel	integer	Unsigned integer indicating the 5QI Priority Level (see within the range 1 to 127. Values are ordered in decreasing order of priority, i.e. with 1 as the highest priority and 127 as the lowest priority.
5QiPriorityLevelRm	integer	This data type is defined in the same way as the "5QiPriorityLevel" data type, but with the OpenAPI "nullable: true" property.
PacketDelBudget	integer	Unsigned integer indicating Packet Delay Budget (see)), expressed in milliseconds. Minimum = 1.
PacketDelBudgetRm	integer	This data type is defined in the same way as the "PacketDelBudget" data type, but with the OpenAPI "nullable: true" property.
PacketErrRate	string	String representing Packet Error Rate (see clause 5.7.3.5 and ssed as a "*scalar* x 10-k" where the scalar and the *exponent k are each encoded as one decimal digit*. Pattern: '^([0-9]E-[0-9])$' Examples: Packer Error Rate 4x10-6 shall be encoded as "4E-6". Packer Error Rate 10-2 shall be encoded as "1E-2".
PacketErrRateRm	string	This data type is defined in the same way as the "PacketErrRate" data type, but with the OpenAPI "nullable: true" property.
PacketLossRate	integer	Unsigned integer indicating Packet Loss Rate (see c , expressed in tenth of percent. Minimum = 0. Maximum = 1000.
PacketLossRateRm	integer	This data type is defined in the same way as the "PacketLossRate" data type, but with the OpenAPI "nullable: true" property.
AverWindow	integer	Unsigned integer indicating Averaging Window (see , expressed in milliseconds. Minimum = 1. Maximum = 4095. Default = 2000.
AverWindowRm	integer	This data type is defined in the same way as the "AverWindow" data type, but with the OpenAPI "nullable: true" property.
MaxDataBurstVol	integer	Unsigned integer indicating Maximum Data Burst Volume (see]), expressed in Bytes. Minimum = 1. Maximum = 4095.
MaxDataBurstVolRm	integer	This data type is defined in the same way as the "MaxDataBurstVol" data type, but with the OpenAPI "nullable: true" property.
SamplingRatio	integer	Unsigned integer indicating Sampling Ratio (see clauses 4.15.1 of 3GPP TS 23.502 [28], expressed in percent. Minimum = 1. Maximum = 100
SamplingRatioRM	integer	This data type is defined in the same way as the "SamplingRatio" data type, but with the OpenAPI "nullable: true" property.
RgWirelineCharacteristics	Bytes	RG Level Wireline Access Characteristics (see BBF TR-456 [41] and BBF TR-470 [37]). It shall be encoded as a string with format "byte" as defined in OpenAPI Specification [3], i.e. base64 encoded characters, representing the RG-Level Wireline Access Characteristics encoded as specified in clause 7.5 of BBF TR-470 [37].
RgWirelineCharacteristicsRm	Bytes	This data type is defined in the same way as the "RgWirelineCharacteristics" data type, but with the OpenAPI "nullable: true" property.
ExtMaxDataBurstVol	integer	Unsigned integer indicating Maximum Data Burst Volume (see]), expressed in Bytes. Minimum = 4096. Maximum = 2000000.
ExtMaxDataBurstVolRm	integer	This data type is defined in the same way as the "ExtMaxDataBurstVol" data type, but with the OpenAPI "nullable: true" property.
ExtPacketDelBudget	integer	Unsigned integer indicating Packet Delay Budget (see c), expressed in 0.01 milliseconds. Minimum = 1.
ExtPacketDelBudgetRm	integer	This data type is defined in the same way as the "ExtPacketDelBudget" data type, but with the OpenAPI "nullable: true" property.
Metadata	string	This datatype contains information that is transparently passed to UPF and the UPF provides it to the service functions in N6-LAN. When present, this IE shall be encoded as a string with format "byte" as defined in OpenAPI Specification [3], i.e. base64-encoded characters, representing the Metadata.
PduSetDelayBudget	integer	Unsigned integer indicating PDU Set Delay Budget (PSDB) (see clause 5.7.7.2 of , expressed in 0.01 milliseconds. Minimum = 1.
PduSetDelayBudgetRm	integer	This data type is defined in the same way as the "PduSetDelayBudget" data type, but with the OpenAPI "nullable: true" property.
PduSetErrRate	string	String representing PDU Set Error Rate (PSER) (see), expressed as a "*scalar* x 10-k" where the scalar and the *exponent k are each encoded as one decimal digit*. Pattern: '^([0-9]E-[0-9])$' Examples: PDU Set Error Rate 4x10-6 shall be encoded as "4E-6". PDU Set Error Rate 10-2 shall be encoded as "1E-2".
PduSetErrRateRm	string	This data type is defined in the same way as the "PduSetErrRate" data type, but with the OpenAPI "nullable: true" property.

NOTE: The prefixes used for bit rate unit "bps", packet rate unit "pps" and traffic volume in byte unit "B" shall be taken as x1000 multipliers and were meant to follow the standard symbols from "The International System of Units" (https://www.bipm.org/en/measurement-units/si-prefixes). However, even when the standard symbol for 10^3 multiplier is "k", in the present specification it has been defined as "K", and has been kept as such due to backwards-compatibility with earlier versions of this specification.

3. 5G System (5GS) Common Data Types for 5GS SBA/SBIs related to 5G Network - Data Types related to Dynamic & Non-Dynamic 5QI

Table: 5G System Structured Data Types Definition of type Dynamic 5QI

Attribute name	Data type	P	Cardinality	Description	Applicability
resourceType	QosResourceType	M	1	Defines the 5QI resource type. See clause 5.5.3.6.	
priorityLevel	5QiPriorityLevel	M	1	Defines the 5QI Priority Level. See clause 5.5.2.	
packetDelayBudget	PacketDelBudget	M	1	Defines the packet delay budget. See clause 5.5.2. See NOTE 3.	
packetErrRate	PacketErrRate	M	1	Defines the packet error rate. See clause 5.5.2.	
averWindow	AverWindow	C	0..1	Defines the averaging window. See clause 5.5.2. This IE shall be present only for a GBR QoS flow or a Delay Critical GBR QoS flow.	
maxDataBurstVol	MaxDataBurstVol	C	0..1	Defines the maximum data burst volume. See clause 5.5.2. See NOTE 1, NOTE 2. This IE shall be present for a Delay Critical GBR QoS flow.	
extMaxDataBurstVol	ExtMaxDataBurstVol	C	0..1	Defines the maximum data burst volume. See clause 5.5.2. See NOTE 1, NOTE 2.	
extPacketDelBudget	ExtPacketDelBudget	O	0..1	Defines the packet delay budget. See clause 5.5.2. See NOTE 3.	
cnPacketDelayBudgetDl	ExtPacketDelBudget	O	0..1	Defines the Core Network Packet Delay Budget for downlink. See clause 5.5.2.	
cnPacketDelayBudgetUl	ExtPacketDelBudget	O	0..1	Defines the Core Network Packet Delay Budget for uplink. See clause 5.5.2.	

NOTE 1: Unless specified otherwise in an API: if the maximum data burst volume value to be transmitted is lower than or equal to 4095 Bytes, the maxDataBurst Vol IE shall be set to the maximum data burst volume value to be transmitted and the extMaxDataBurstVol IE shall be omitted. If the maximum data burst volume value to be transmitted is greater than 4095 Bytes, the maxDataBurst Vol IE shall be set to 4095 Bytes and, if ExtMaxDataBurstVol data type is supported by the sender, the extMaxDataBurstVol IE shall be set to the maximum data burst volume value to be transmitted.

NOTE 2: Unless specified otherwise in an API: if both the maxDataBurstVol IE and the extMaxDataBurstVol IE are received, the value in the extMaxDataBurstVol IE shall be used if the receiver supports ExtMaxDataBurstVol data type, otherwise the value in the maxDataBurstVol IE shall be used.

NOTE 3: Unless specified otherwise in an API: if both the packetDelayBudget IE and the extPacketDelBudget IE are received, the value in the extPacketDelBudget IE shall be used if the receiver supports ExtPacketDelBudget data type, otherwise the value in the packetDelayBudget IE shall be used.

Table: 5G System Structured Data Types Definition of type Non-Dynamic 5QI

Attribute name	Data type	P	Cardinality	Description	Applicability
priorityLevel	5QiPriorityLevel	O	0..1	Defines the 5QI Priority Level. See clause 5.5.2. When present, it contains the 5QI Priority Level value that overrides the standardized or pre-configured value.	
averWindow	AverWindow	O	0..1	Defines the averaging window. See clause 5.5.2. This IE may be present for a GBR QoS flow or a Delay Critical GBR QoS flow. When present, it contains the Averaging Window that overrides the standardized or pre-configured value.	
maxDataBurstVol	MaxDataBurstVol	O	0..1	Defines the maximum data burst volume. See clause 5.5.2. This IE may be present for a Delay Critical GBR QoS flow. When present, it contains the Maximum Data Burst Volume value that overrides the standardized or pre-configured value. See NOTE 1, NOTE 2.	
extMaxDataBurstVol	ExtMaxDataBurstVol	C	0..1	Defines the maximum data burst volume. See clause 5.5.2. This IE may be present for a Delay Critical GBR QoS flow. When present, it contains the Maximum Data Burst Volume value that overrides the standardized or pre-configured value See NOTE 1, NOTE 2.	
cnPacketDelayBudgetDl	ExtPacketDelBudget	O	0..1	Defines the Core Network Packet Delay Budget for downlink. See clause 5.5.2.	
cnPacketDelayBudgetUl	ExtPacketDelBudget	O	0..1	Defines the Core Network Packet Delay Budget for uplink. See clause 5.5.2.	

NOTE 1: Unless specified otherwise in an API: if the maximum data burst volume value to be transmitted is lower than or equal to 4095 Bytes, the maxDataBurst Vol IE shall be set to the maximum data burst volume value to be transmitted and the extMaxDataBurstVol IE shall be omitted. If the maximum data burst volume value to be transmitted is greater than 4095 Bytes, the maxDataBurst Vol IE shall be set to 4095 Bytes and, if ExtMaxDataBurstVol data type is supported by the sender, the extMaxDataBurstVol IE shall be set to the maximum data burst volume value to be transmitted.

NOTE 2: Unless specified otherwise in an API: if both the maxDataBurstVol IE and the extMaxDataBurstVol IE are received, the value in the extMaxDataBurstVol IE shall be used if the receiver supports ExtMaxDataBurstVol data type, otherwise the value in the maxDataBurstVol IE shall be used.

OpenAPI specification for 5GS SBA/SBIs Common Data Types

5GS specifies the Formal definition of Common Data Types Format Definition, that consists of an OpenAPI 3.0.0 Specification, in YAML format.

NOTE 1: *The Semantics and Procedures, as well as Conditions, e.g. for the applicability and allowed combinations of Attributes or Values, not expressed in the OpenAPI definitions, but defined in other parts of the Specification also apply.*

Informative copies of the OpenAPI Specification Files Informative copies contained in this 3GPP Technical Specification (TS) are available on a Git-based Repository, that uses the GitLab SW version Control System (see 3GPP 5GS Principles and Guidelines for Service Definition Rel. 18.4.0 Dec 2023).

Release 18 3GPP V18.4.0 (2023-12)

OpenAPI specification

Data related to Common Data Types


```yaml
openapi: 3.0.0

info:
  version: '1.5.0-alpha.5'


  title: 'Common Data Types'
  description: |
    Common Data Types for Service Based Interfaces.
    © 2023, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).
    All rights reserved.

externalDocs:
  description:              Common Data Types for Service Based Interfaces, version 18.4.0
  url: 'https://www.3gpp.org/ftp/Specs/archive/

paths: {}
components:
  schemas:
#
# COMMON SIMPLE DATA TYPES
#
    Binary:
      format: binary
      type: string
      description: string with format 'binary' as defined in OpenAPI.

    BinaryRm:
      format: binary
      type: string
      nullable: true
      description: "string with format 'binary' as defined in OpenAPI OpenAPI with 'nullable: true'
property."

    Bytes:
      format: byte
      type: string
      description: string with format 'bytes' as defined in OpenAPI

    BytesRm:
      format: byte
      type: string
      nullable: true
      description: >
        string with format 'bytes' as defined in OpenAPI OpenAPI with 'nullable: true' property.

    Date:
      format: date
      type: string
      description: string with format 'date' as defined in OpenAPI.

    DateRm:
      format: date
      type: string
      nullable: true
      description: >
        string with format 'date' as defined in OpenAPI OpenAPI with 'nullable: true' property.

    DateTime:
```

4. IETF Deterministic Networking (DetNet) YANG Model (preliminary) & integration with 5GS Architecture

Workgroup: Network Working Group

Internet-Draft: draft-ietf-detnet-yang-20

Published: 23 February 2024

Intended Status: Standards Track

Expires: 26 August 2024

Deterministic Networking (DetNet) YANG Model

Abstract

This document contains the specification for the Deterministic Networking YANG Model for configuration and operational data of DetNet Flows. The model allows for provisioning of end-to-end DetNet service on devices along the path without dependency on any signaling protocol. It also specifies operational status for flows. The YANG module defined in this document conforms to the Network Management Datastore Architecture (NMDA).

the general structure of the DetNet YANG Model:

```
                 +-----------+
                 |ietf-detnet|
                 +-----+-----+
                       |
      +----------------+----------------+------------------+
      |                |                |                  |
+-----+------+  +-----+------+  +-------+------+           |
| App Flows  |  |service s-l |  |forwarding s-l|           |
+-----+------+  +-----+------+  +-------+------+           |
      |                |                |                  |
+-----+------+  +-----+------+  +-------+------+           |
| Reference  |  | Reference  |  | Reference    |           |
| to Traffic |  | to Traffic |  | to Traffic   |  +-------+-------+
| Profile    |  | Profile    |  | Profile      |  |Traffic Profile|
+------------+  +------------+  +--------------+  +---------------+
```

Release 18 3GPP V18.4.0 (2023-12)

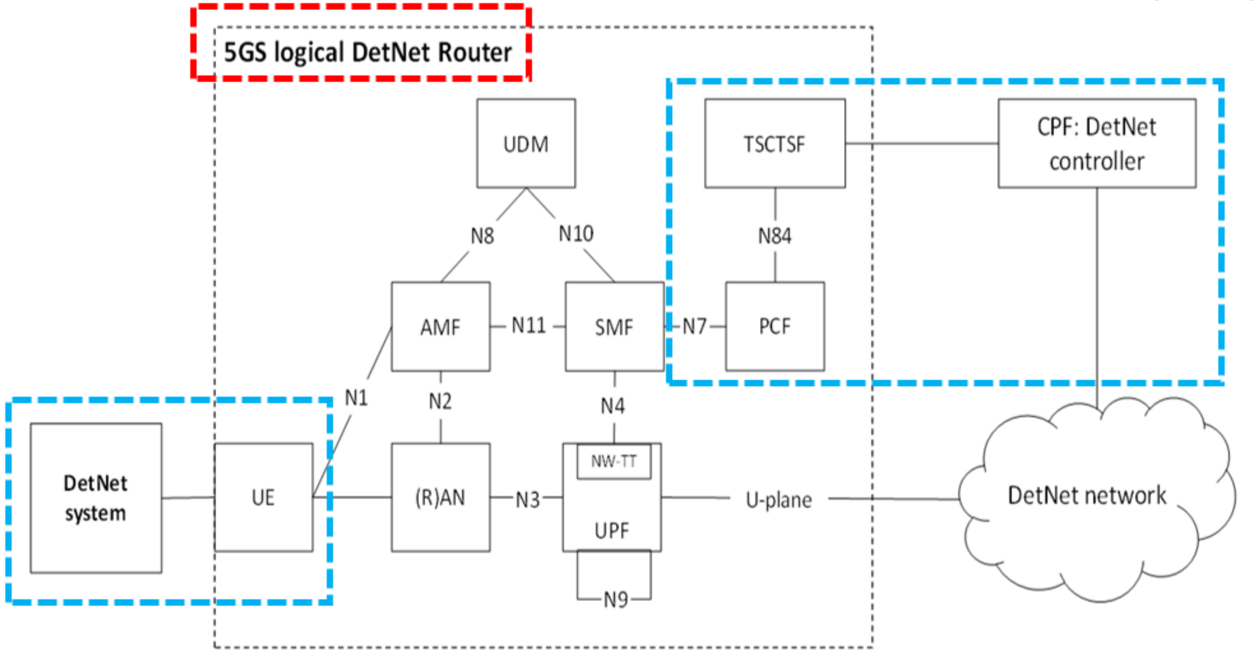


Figure: 5G System (5GS) Architecture support for IETF Deterministic Networking (DetNet)

4. IETF Deterministic Networking (DetNet) YANG Model (preliminary) & integration with 5GS Architecture

5G System (5GS) Architecture to support IETF Deterministic Networking

The 5GS is integrated with the Deterministic Network as defined in IETF as a logical DetNet Transit Router, see Figure.

The TSCTSF performs mapping in the Control Plane (CP) between the 5GS internal functions and the DetNet Controller. 5GS specific procedures in 5G CN and RAN remain hidden from the DetNet Controller.

On the Device side, the UE is connected with a DetNet System, which may be a DetNet End System or a DetNet Node.

The 5GS Architecture does not require the DS-TT Functionality to be supported in the Device, nor require the User Plane (UP) NW-TT Functionality to be supported in the UPF, however, it can co-exist with such Functions. For the reporting of information of the Network side Ports, NW-TT CP Function is used.

The 5GS Architecture can be combined with the Architecture to support Time Synchronization and TSC.

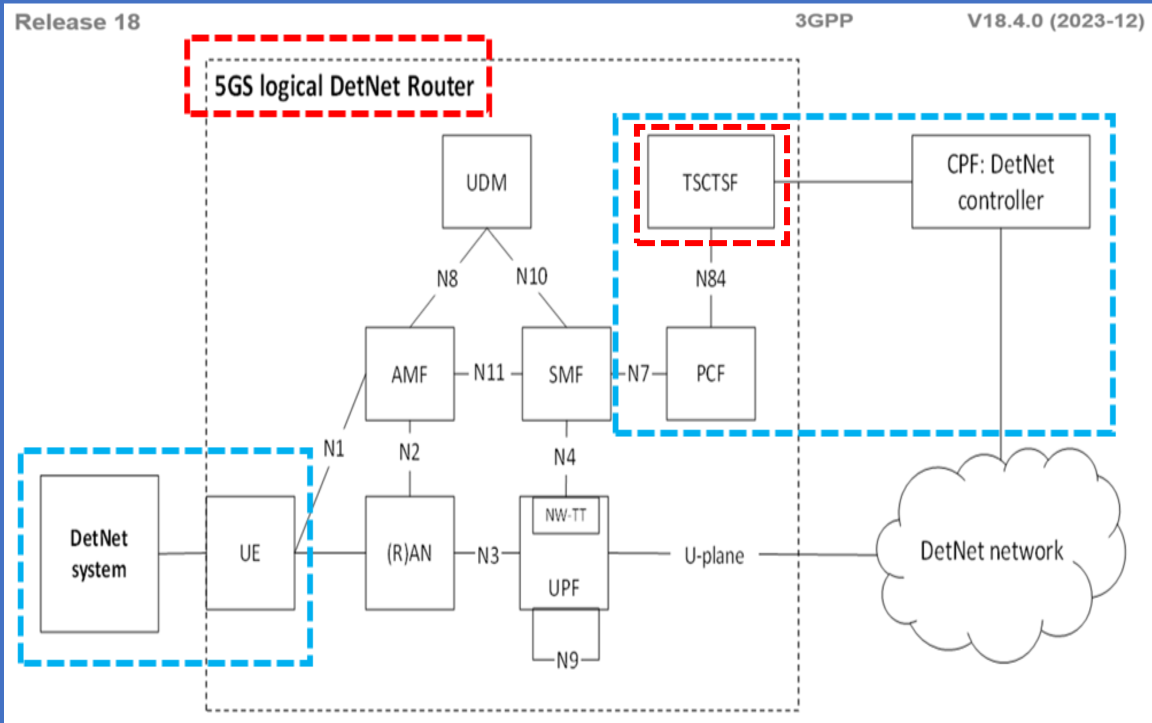


Figure: 5G System (5GS) Architecture support for IETF Deterministic Networking (DetNet)

DetNet could be used in combination with Time Synchronization Mechanisms, but it does not require usage of these mechanisms.

5GS acts as a DetNet Router in the DetNet Domain.

Use Cases where the 5GS acts as a Sub-Network (see IETF DetNet Architecture) are also possible but do not require any additional 3GPP Standardization. A special case where the 5GS can act as a Sub-Network is when the 5GS acts as a TSN Network, which is supported by the 3GPP specifications based on the 5GS Architecture TSN.

NOTE: *For DetNet interworking, it is assumed that there is a Business Agreement to support the use of the DetNet Controller so that it can be regarded trusted for the Operator. Depending on the needs of a given deployment, Functions such as the Authentication, Authorization and potential Signalling throttling from the DetNet Controller can be achieved by including such Functionalities in the 5GS TSCTSF. The routing of the Downlink (DL) packets is achieved using the existing 3GPP Functions.*

Deterministic Networking (DetNet) YANG Module

The DetNet YANG module includes:
- DetNet App-flow,
- DetNet Service Sublayer, and
- DetNet Forwarding Sub-layer Configuration and Operational Objects.

The corresponding attributes used in different Sub-Layers are defined. Layers of the objects typically occur in the different Data instances forming the Node types defined in IETF specification.

The Figure illustrates the Relationship between Data Instance Node Types and the included Layers.

Node types are Logical Roles per DetNet Service: a Device along one DetNet Service can be of one (1) Node type, while another Service may use the same Device with a different Node type.

This Model is a "Controller" based Mode, because a Controller or Operator configures all the Devices to form a Service.

All of the Layers have Ingress/Incoming and Egress/Outgoing Operations, but any Instance may be configured as only Unidirectional.

Ingress refers to any DetNet Layer, where a DetNet context is applied. "Ingress" allows Functions such as Switching, Aggregation and Encapsulation.

Likewise, "Egress" refers to any DetNet Layer where a DetNet context is removed. "Egress" allows Functions such as Switching, Disaggregation and Decapsulation.

This means that each Unidirectional flow identifier configuration is programmed starting at the ingress and flow status is reported at ingress on each end. In the MPLS cases once encapsulated, the IP 6-tuple, Parameters may not be required to be programmed again. In the IP case, without encapsulation, various IP flow id parameters must be configured along the flow path.

```
      +--------------------------------------------+
      |                  Instance                  |
+-----+---------------+---------------+------------+
|     |Edge Node      |  Relay Node   | Transit Node |
+-----+---------------+---------------+------------+
|  L  |Application    |               |            |
|  a  +---------------+---------------+------------+
|  y  |Service Sub-Layer|Service Sub-Layer|        |
|  e  +---------------+---------------+------------+
|  r  |Forwarding S-L |Forwarding S-L | Forwarding S-L|
+-----+---------------+---------------+------------+
```

Figure : DetNet Layers and Node Types

DetNet YANG Model Structure Considerations

The picture shows DetNet YANG Model General Structure.

There are three (3) Layer types in the DetNet YANG Model:
- App-Flow Data Layer,
- Service Sub-Layer and
- Forwarding Sub-Layer.

The Traffic parameters are captured in a Traffic Profile that can be referenced by any of the layers.

A *Traffic Profile* can be created for:
- Application,
- Service Sub-Layer or
- Forwarding Sub-layer.

A Single Profile could be shared by Multiple Applications/Sub-Layers. Each Profile indicates the members currently using that Profile.

Depending on which DetNet Layers and Functions are required, some or all of the Components could be configured.

```
                the general structure of the DetNet YANG Model:

                  +-----------+
                  |ietf-detnet|
                  +-----+-----+
                        |
     +------------+------------------+---------------+
     |            |                  |               |
+-----+------+ +-----+------+ +-------+------+       |
| App Flows  | |service s-l | |forwarding s-l|       |
+-----+------+ +-----+------+ +-------+------+       |
     |            |                  |               |
+-----+------+ +-----+------+ +-------+------+       |
| Reference  | | Reference  | | Reference    |       |
| to Traffic | | to Traffic | | to Traffic   |  +-------+-------+
| Profile    | | Profile    | | Profile      |  |Traffic Profile|
+------------+ +------------+ +--------------+  +---------------+
```

4. IETF Deterministic Networking (DetNet) YANG Model (preliminary) & integration with 5GS Architecture

DetNet YANG Model examples

The following DetNet YANG Model examples are *tested with Yanglint* and use Operational output to exercise both Config "true" and Config "false" objects.

IPv4 and IPv6 addresses are supported, but for clarity in the examples and diagrams, *IPv4 has been used in most examples.*

The IP types support both IPv4 and IPv6.

"Replication" and "Elimination" points are shown as an **R** in and **E** in **circles respectively.**

Packet Headers including DetNet Aggregation Label or A-label, Service label or S-label and Forwarding label or F-label are illustrated at each hop as defined by IETF

Aggregation/Disaggregation Nodes are indicated by dashed line boxes.

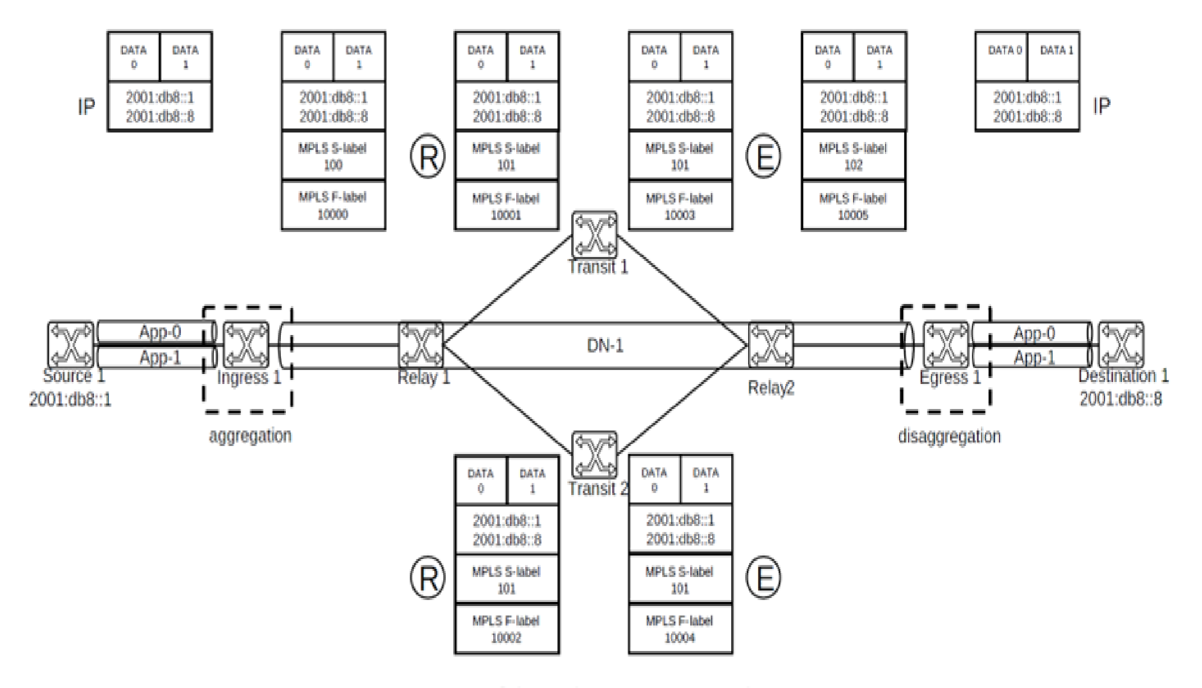
Since the Model augments IETF interfaces, Minimal Interface YANG Data is provided to validate the Interface Data.

Example A-1 JSON Configuration/Operational Data

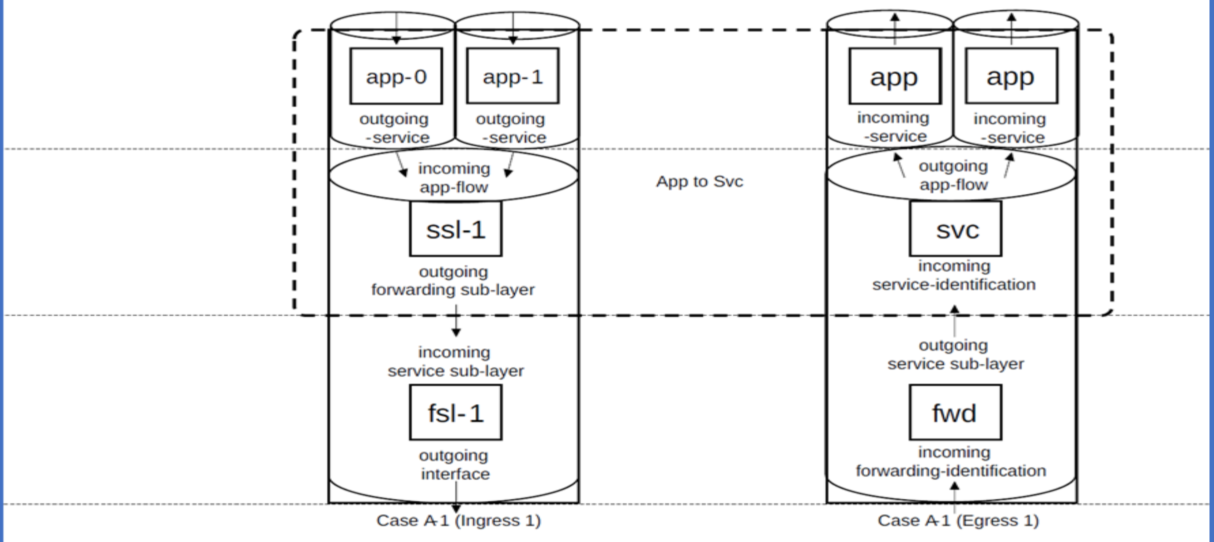
This example illustrates that Multiple App Flows with the same Source, the same Destination, and the same Traffic Specification are aggregated in a Single DetNet Flow Service Sub-Layer.

Ingress Node 1 aggregates App Flows 0 and 1 into a Service Sub-Layer of DetNet Flow 1.

Two ways of illustrating this follow, then the JSON Operational Data Model corresponding to the diagrams follows. This example uses IPv6 address format.



Case A-1 Application Aggregation



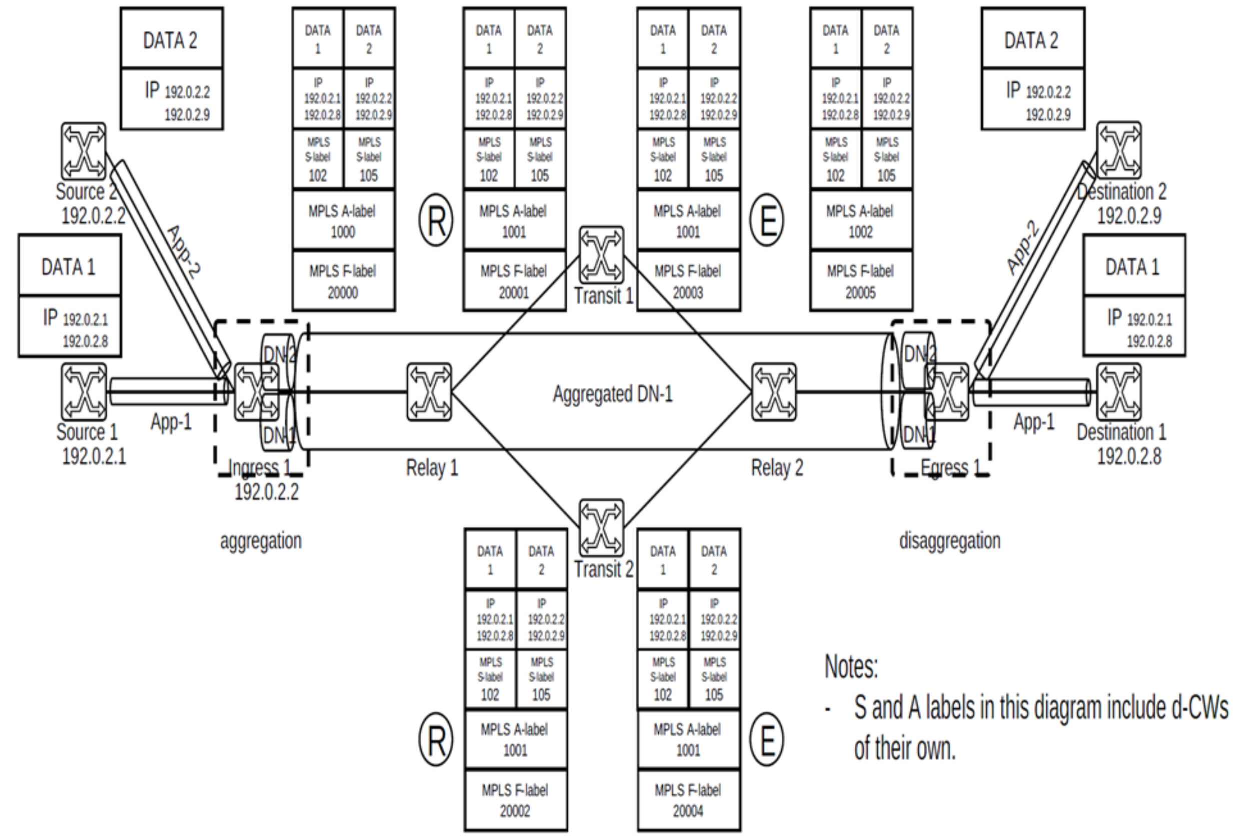
Case A-1 Application Aggregation Flow Stack Detail

DetNet YANG Model Example B-2 JSON Service Aggregation Configuration

The Figure illustrates DetNet Service Sub-Layer Flows 1 and 2 are aggregated into a Service Sub-Layer of an Aggregated Flow.

Multiple DetNet Flows with the same Requirements for the same Destination are aggregated into a Single Aggregated DetNet Flow, and Service Protection and Resource Allocation are performed by an Aggregated DetNet Flow Service Sub-Layer and Forwarding Sub-Layer.

A Diagram illustrating this case is shown and then the corresponding JSON Operational Data for Node Ingress 1 follows.



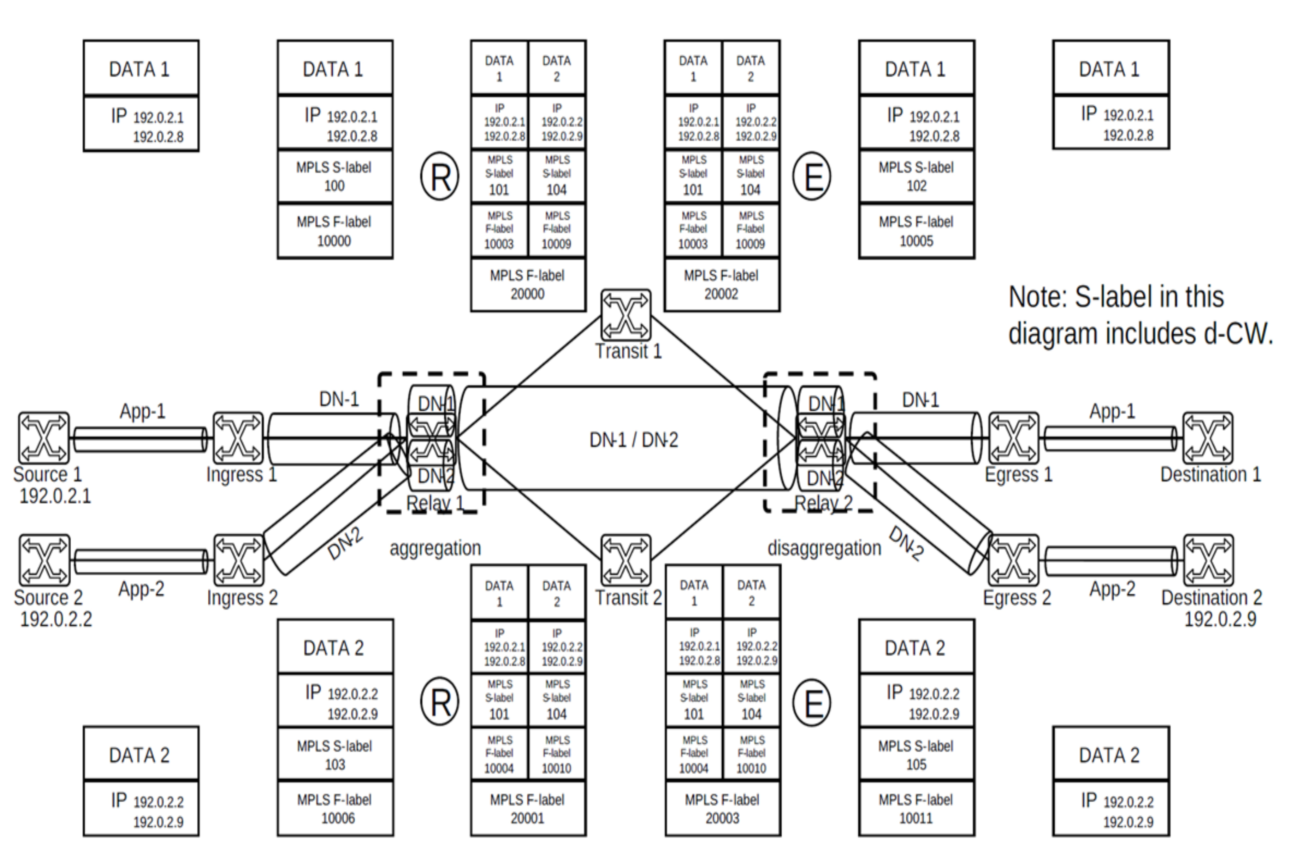
Case B-2 Example Service Aggregation

DetNet YANG Model Example C-1 JSON Relay Aggregation/Disaggregation Configuration

The Figure illustrates the Relay Node's Forwarding Sub-Layer Flows 1 and 2 Aggregated into a Single Forwarding Sub-Layer.

Service Protection and Resource Allocation are performed by the corresponding Service Sub-Layer and Forwarding Sub-Layer of each Flow.

A Diagram illustrating both Aggregation and Disaggregation is shown and then the corresponding JSON Operational Data.



Case C-1 Example Service Aggregation/Disaggregation

4. IETF Deterministic Networking (DetNet) YANG Model (preliminary) & integration with 5GS Architecture

Workgroup: Network Working Group
Internet-Draft: draft-ietf-detnet-yang-20
Published: 23 February 2024
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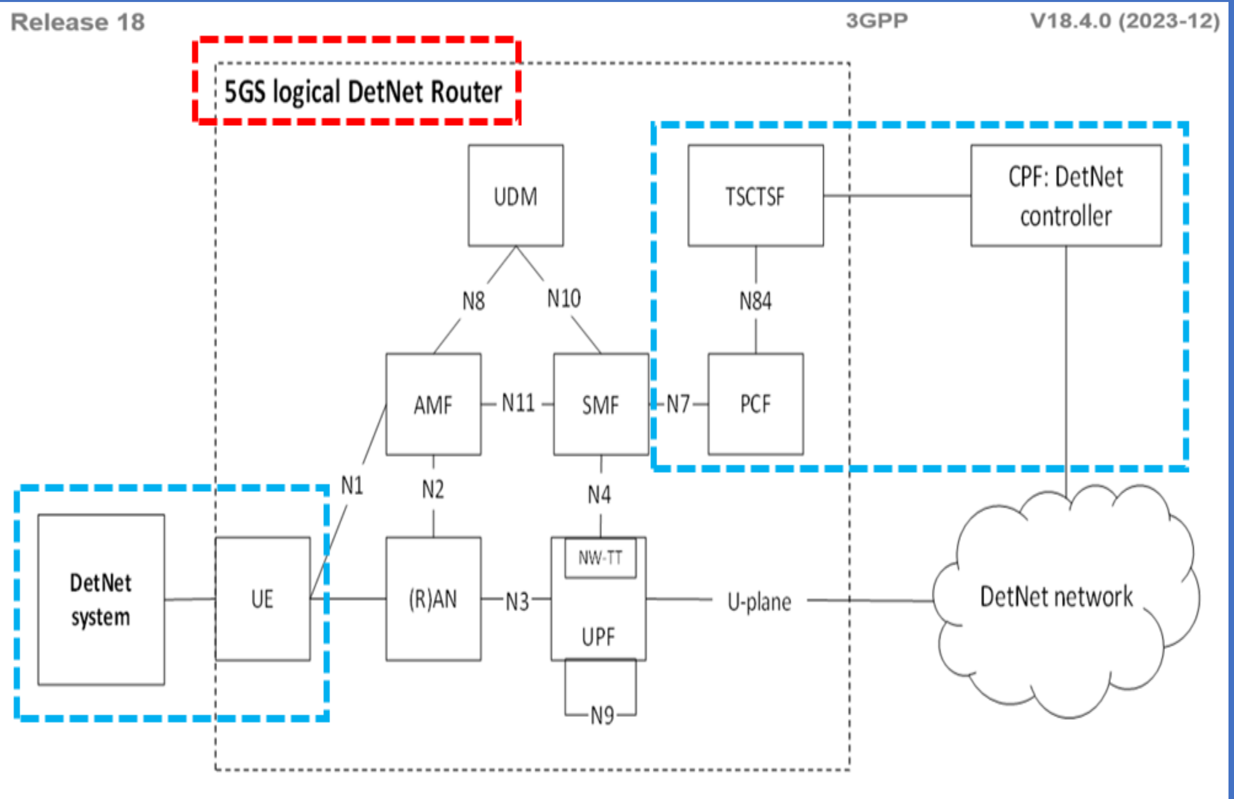
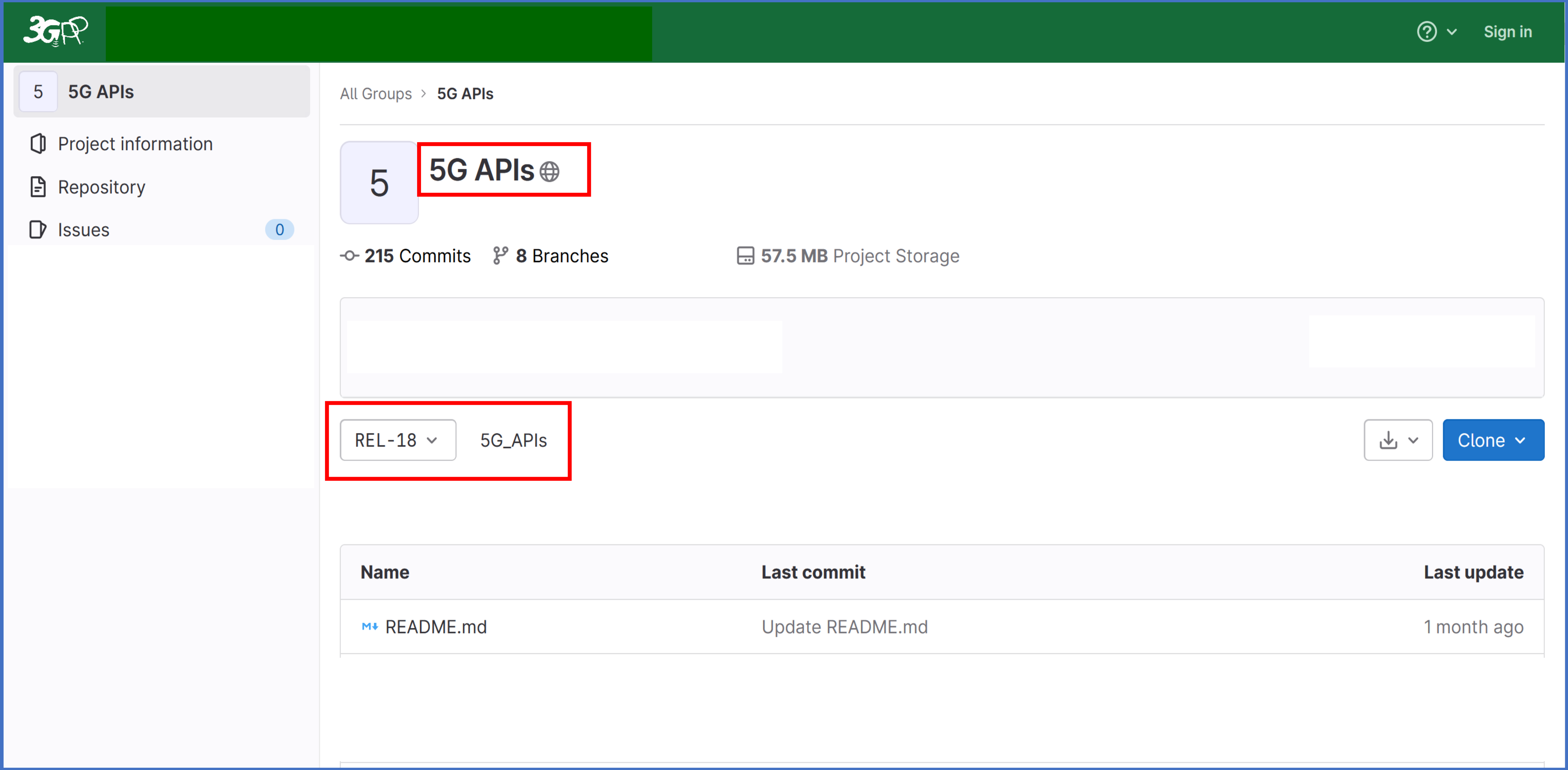
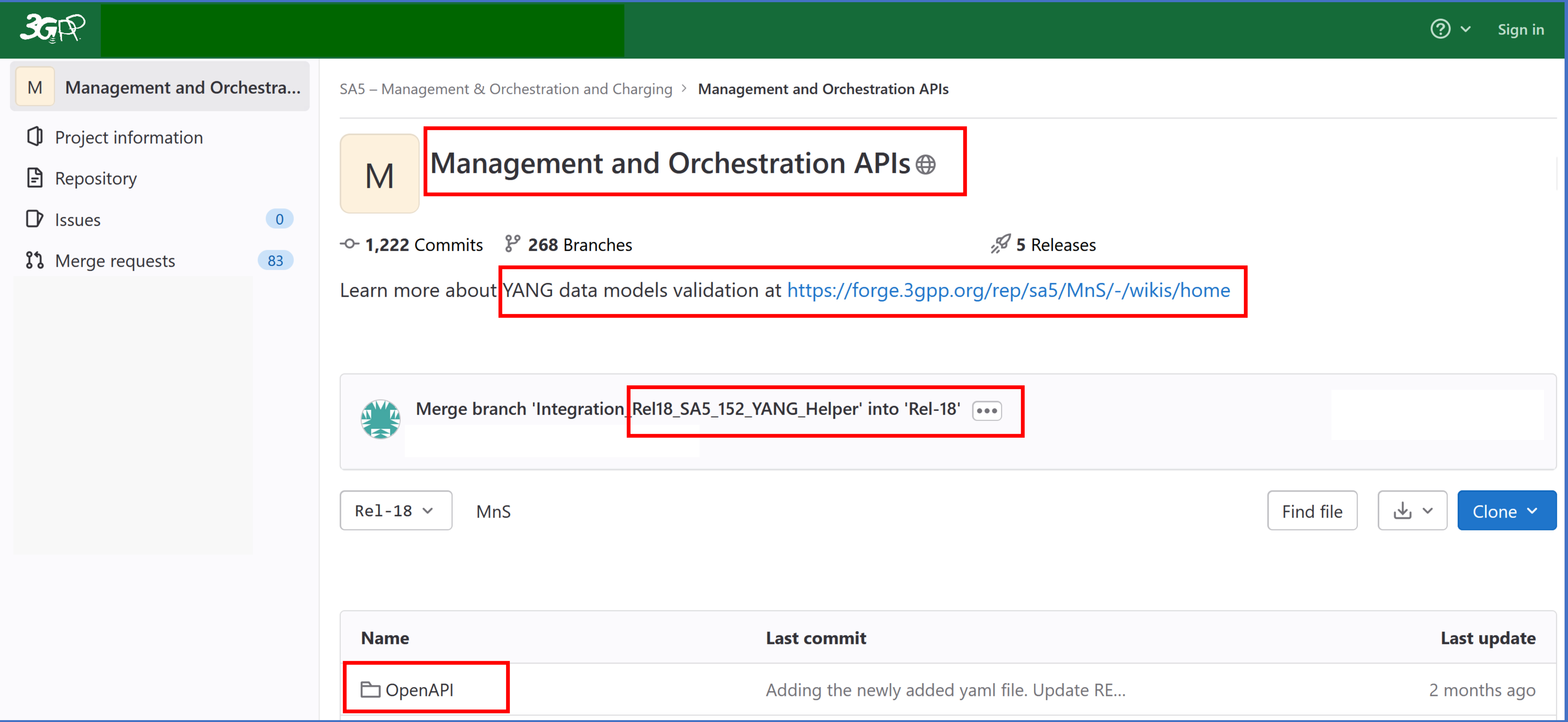


Figure: 5G System (5GS) Architecture support for IETF Deterministic Networking (DetNet)

Annex 1: 5G APIs for 3GPP Rel-16, rel-17 and Rel-18 at 3GPP Forge



Annex 2: 5G Management and Orchestration APIs at 3GPP Forge - available & accessible 7/24 to anyone/everyone



Annex 3: 5G NRM YANG Models Definitions specified and available at 3GPP Forge

YANG definitions are specified in 3GPP Forge
Directory: yang-mod
Files:
_3gpp-nr-nrm-beam.yang
_3gpp-nr-nrm-bwp.yang
_3gpp-nr-nrm-bwpset.yang
_3gpp-nr-nrm-cesmanagementfunction.yang
_3gpp-nr-nrm-commonbeamformingfunction.yang
_3gpp-nr-nrm-cpciconfigurationfunction.yang
_3gpp-nr-nrm-danrmanagementfunction.yang
_3gpp-nr-nrm-desmanagementfunction.yang
_3gpp-nr-nrm-dlbofunction.yang
_3gpp-nr-nrm-dmrofunction.yang
_3gpp-nr-nrm-dpciconfigurationfunction.yang
_3gpp-nr-nrm-drachoptimizationfunction.yang
_3gpp-nr-nrm-ep.yang
_3gpp-nr-nrm-eutrancellrelation.yang
_3gpp-nr-nrm-eutranetwork.yang
_3gpp-nr-nrm-eutranfreqrelation.yang
_3gpp-nr-nrm-eutranfrequency.yang
_3gpp-nr-nrm-externalamffunction.yang
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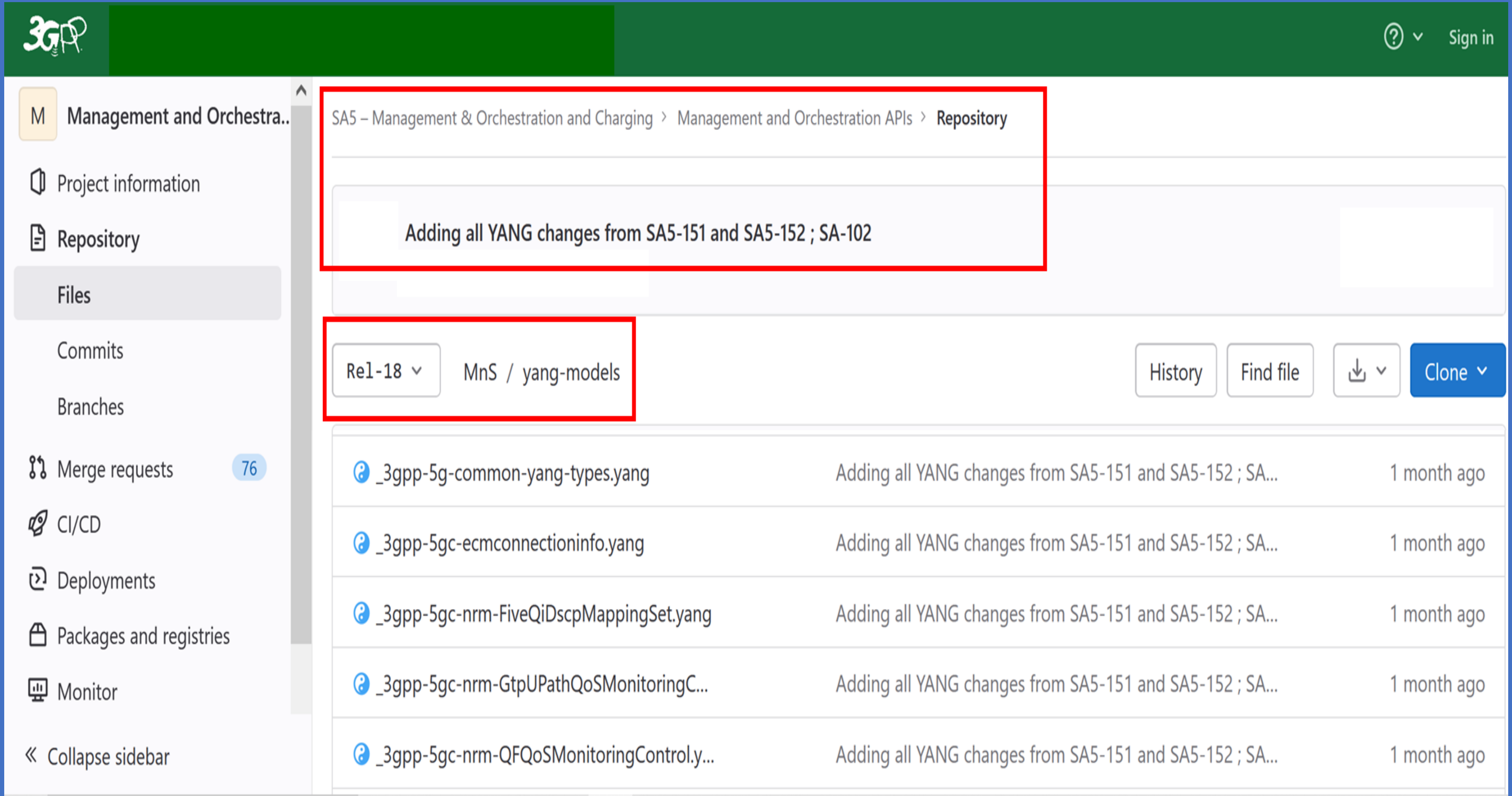

If the Class Managed Element and the underlying hierarchy is contained under a Sub Network all YANG Modules containing IOCs that can be contained under the Managed Element directly or under other IOCs contained by the Managed Element and the YANG module for Managed Element itself shall be mounted at the mountpoint "children-of-Sub Network" in the YANG module _3gpp-common-subnetwork.
IETF describes the Mechanism that adds the Schema trees defined by a set of YANG Modules onto a mount point defined in the schema tree in another YANG module.

3GPP 5G System Edge Computing overview:

For 3GPP 5G Edge Computing, it is essential that the *Application Clients* (**AC**s) residing on the **UE** are able to locate and connect with the most suitable *Application Server* (**AS**) available in the **Edge Data Network (EDN)**, depending on the needs of the Application.

The *Edge Enabler Layer* (**EEL**) exposes **API**s to support **such Capabilities**.

The *Application Layer* (AL) is a "Consumer" of 3GPP specified 5G System "Edge Computing" Capabilities.

The **3GPP 5G Edge Computing Capabilities** are typically organized as follows:

- ***Edge Enabler Layer* (EEL), specified in 3GPP**
- ***Edge Hosting Environment* (EHE) (details outside the scope of 3GPP);**
- ***3GPP Transport Layer* (TL), specified in 3GPP 5GS Architecture**
- ***Edge Management Layer* (EML), specified in 3GPP**

The Edge Computing Features defined in this specification are applicable to PLMN(s) & to SNPN(s) as 3GPP Transport Layer (TL).

In 5GS Architecture Edge Computing specification, ***when PLMN is mentioned, it is also applicable for SNPN*** unless stated otherwise.

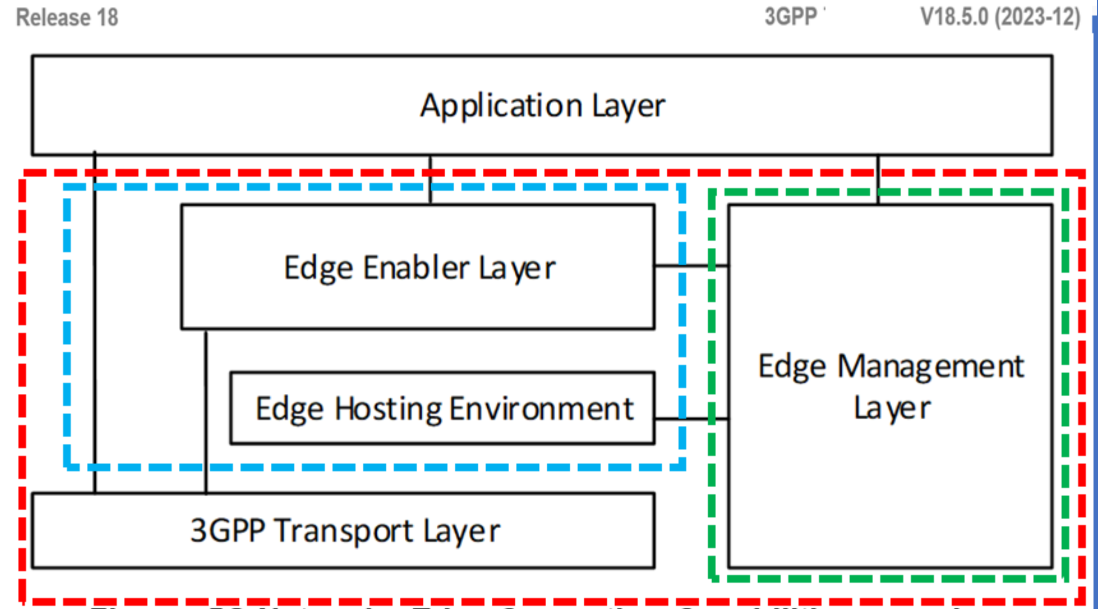

Figure: 5G Networks Edge Computing Capabilities overview

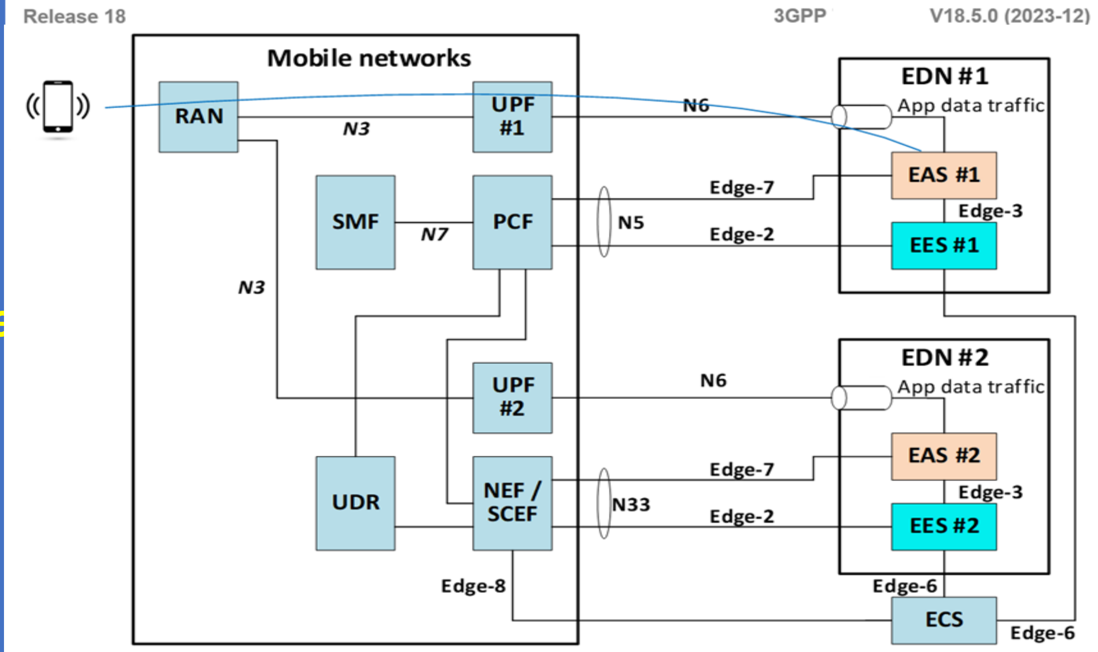

Figure: 5G Edge Computing Networks

Annex 4.1 5GS Architecture enabling Edge Applications enhancements on **Network Layer**

5G Architecture for enabling Edge Applications **Deployment Models for different *Data Networks* (DNs) implem.**

Option 1. Use of Non-dedicated Data Network (DN)

Option 2. Use of Edge-dedicated Data Network (DN)

Option 3. Use of Local Area Data Network (LADN).

The PLMN supporting Edge Computing Services provides connection to one (1) or multiple Data Networks (DNs)

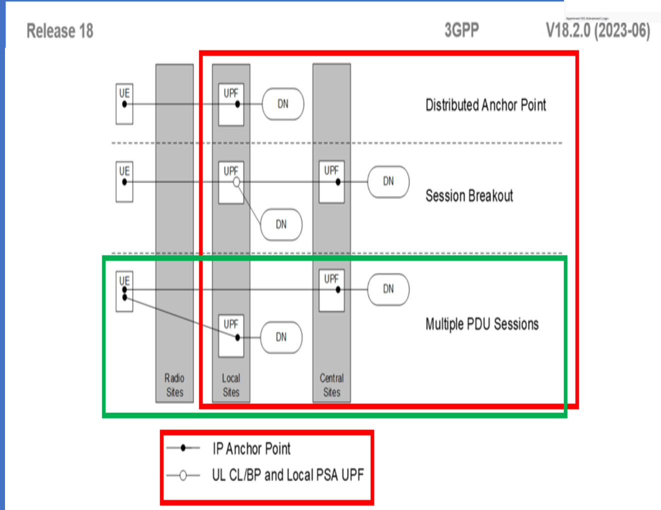

Figure: 5GS CN Connectivity Models to DN for Edge Computing

Option 1. Use of Non-dedicated Data Network (DN)

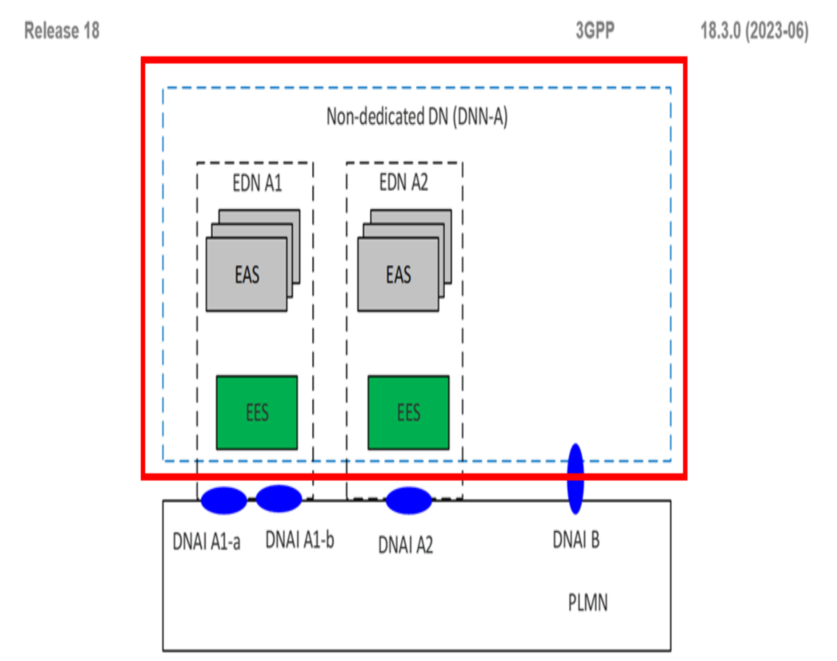

Figure: 5G Architecture for enabling Edge Applications Data Network (DN) Deployment Model for use of Non-dedicated DN

Option 2. Use of Edge-dedicated Data Network (DN)

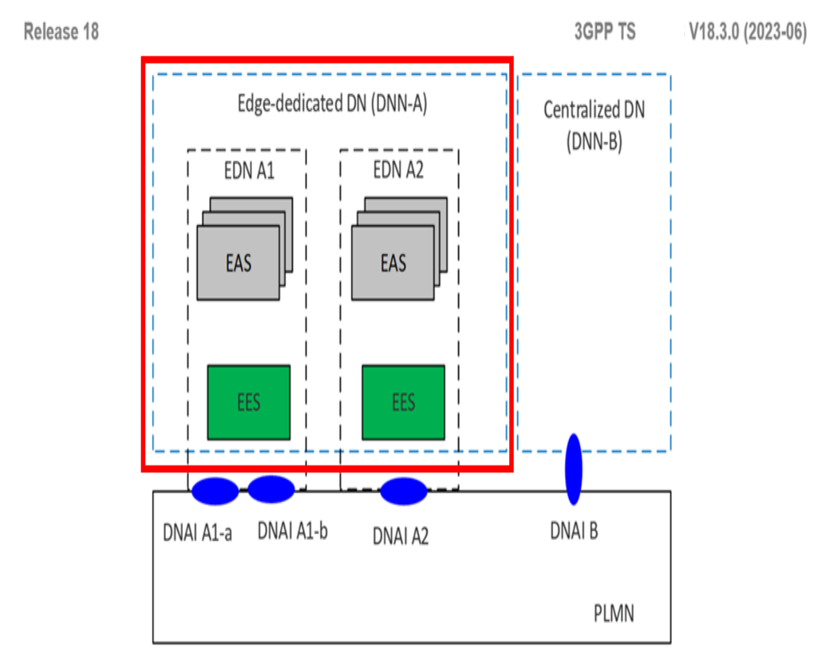

Figure: 5G Architecture for enabling Edge Applications Data Network (DN) Deployment Model for use of Edge -dedicated Data Network (DN)

Option 3. Use of Local Area Data Network (LADN)

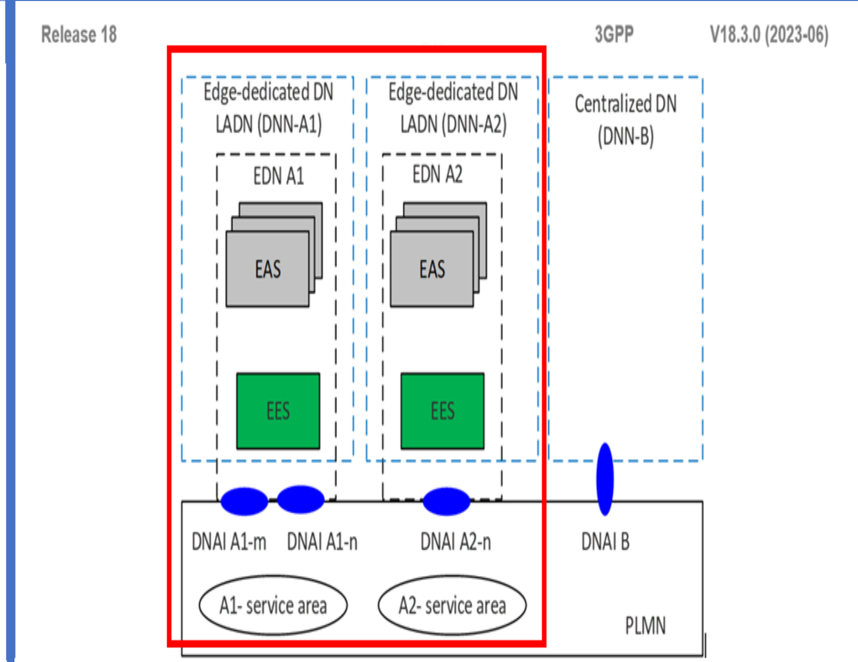

Figure: 5G Architecture for enabling Edge Applications Data Network (DN) Deployment Model for use of Local Area Data Network (LADN)

5QI Value	Resource Type	Default Priority Level	Packet Delay Budget (NOTE 3)	Packet Error Rate	Default Maximum Data Burst Volume (NOTE 2)	Default Averaging Window	Example Services
1	GBR	20	100 ms (NOTE 11, NOTE 13)	10^{-2}	N/A	2000 ms	Conversational Voice
2	(NOTE 1)	40	150 ms (NOTE 11, NOTE 13)	10^{-3}	N/A	2000 ms	Conversational Video (Live Streaming)
3		30	50 ms (NOTE 11, NOTE 13)	10^{-3}	N/A	2000 ms	Real Time Gaming, V2X messages (see TS 23.287 [121]). Electricity distribution – medium voltage, Process automation monitoring
4		50	300 ms (NOTE 11, NOTE 13)	10^{-6}	N/A	2000 ms	Non-Conversational Video (Buffered Streaming)
65 (NOTE 9, NOTE 12)		7	75 ms (NOTE 7, NOTE 8)	10^{-2}	N/A	2000 ms	Mission Critical user plane Push To Talk voice (e.g. MCPTT)
66 (NOTE 12)		20	100 ms (NOTE 10, NOTE 13)	10^{-2}	N/A	2000 ms	Non-Mission-Critical user plane Push To Talk voice
67 (NOTE 12)		15	100 ms (NOTE 10, NOTE 13)	10^{-3}	N/A	2000 ms	Mission Critical Video user plane
75 (NOTE 14)							
71		56	150 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-6}	N/A	2000 ms	"Live" Uplink Streaming (e.g. TS 26.238 [76])
72		56	300 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-4}	N/A	2000 ms	"Live" Uplink Streaming (e.g. TS 26.238 [76])
73		56	300 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-8}	N/A	2000 ms	"Live" Uplink Streaming (e.g. TS 26.238 [76])
74		56	500 ms (NOTE 11, NOTE 15)	10^{-8}	N/A	2000 ms	"Live" Uplink Streaming (e.g. TS 26.238 [76])
76		56	500 ms (NOTE 11, NOTE 13, NOTE 15)	10^{-4}	N/A	2000 ms	"Live" Uplink Streaming (e.g. TS 26.238 [76])
5	Non-GBR	10	100 ms NOTE 10, NOTE 13)	10^{-6}	N/A	N/A	IMS Signalling
6	(NOTE 1)	60	300 ms (NOTE 10, NOTE 13)	10^{-6}	N/A	N/A	Video (Buffered Streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7		70	100 ms (NOTE 10, NOTE 13)	10^{-3}	N/A	N/A	Voice, Video (Live Streaming) Interactive Gaming
8		80	300 ms (NOTE 13)	10^{-6}	N/A	N/A	Video (Buffered Streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9		90					
10		90	1100ms (NOTE 13) (NOTE 17)	10^{-6}	N/A	N/A	Video (Buffered Streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.) and any service that can be used over satellite access type with these characteristics
69 (NOTE 9, NOTE 12)		5	60 ms (NOTE 7, NOTE 8)	10^{-6}	N/A	N/A	Mission Critical delay sensitive signalling (e.g. MC-PTT signalling)
70 (NOTE 12)		55	200 ms (NOTE 7, NOTE 10)	10^{-6}	N/A	N/A	Mission Critical Data (e.g. example services are the same as 5QI 6/8/9)
79		65	50 ms (NOTE 10, NOTE 13)	10^{-2}	N/A	N/A	V2X messages (see TS 23.287 [121])
80		68	10 ms (NOTE 5, NOTE 10)	10^{-6}	N/A	N/A	Low Latency eMBB applications Augmented Reality
82	Delay-critical GBR	19	10 ms (NOTE 4)	10^{-4}	255 bytes	2000 ms	Discrete Automation (see TS 22.261 [2])
83		22	10 ms (NOTE 4)	10^{-4}	1354 bytes (NOTE 3)	2000 ms	Discrete Automation (see TS 22.261 [2]); V2X messages (UE - RSU Platooning, Advanced Driving: Cooperative Lane Change with low LoA. See TS 22.186 [111], TS 23.287 [121])
84		24	30 ms (NOTE 6)	10^{-5}	1354 bytes (NOTE 3)	2000 ms	Intelligent transport systems (see TS 22.261 [2])
85		21	5 ms (NOTE 5)	10^{-5}	255 bytes	2000 ms	Electricity Distribution- high voltage (see TS 22.261 [2]). V2X messages (Remote Driving. See TS 22.186 [111], NOTE 16, see TS 23.287 [121])
86		18	5 ms (NOTE 5)	10^{-4}	1354 bytes	2000 ms	V2X messages (Advanced Driving: Collision Avoidance, Platooning with high LoA. See TS 22.186 [111], TS 23.287 [121])
87		25	5 ms (NOTE 4)	10^{-3}	500 bytes	2000 ms	Interactive Service - Motion tracking data, (see TS 22.261 [2])
88		25	10 ms (NOTE 4)	10^{-3}	1125 bytes	2000 ms	Interactive Service - Motion tracking data, (see TS 22.261 [2])
89		25	15 ms (NOTE 4)	10^{-4}	17000 bytes	2000 ms	Visual content for cloud/edge/split rendering (see TS 22.261 [2])
90		25	20 ms (NOTE 4)	10^{-4}	63000 bytes	2000 ms	Visual content for cloud/edge/split rendering (see TS 22.261 [2])

NOTE 1: A packet which is delayed more than PDB is not counted as lost, thus not included in the PER.
NOTE 2: It is required that default MDBV is supported by a PLMN supporting the related 5QIs.
NOTE 3: The Maximum Transfer Unit (MTU) size considerations in clause 9.3 and Annex C of TS 23.060 [56] are also applicable. IP fragmentation may have impacts to CN PDB, and details are provided in clause 5.6.10.
NOTE 4: A static value for the CN PDB of 1 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface. When a dynamic CN PDB is used, see clause 5.7.3.4.
NOTE 5: A static value for the CN PDB of 2 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface. When a dynamic CN PDB is used, see clause 5.7.3.4.
NOTE 6: A static value for the CN PDB of 5 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface. When a dynamic CN PDB is used, see clause 5.7.3.4.
NOTE 7: For Mission Critical services, it may be assumed that the UPF terminating N6 is located "close" to the 5G_AN (roughly 10 ms) and is not normally used in a long distance, home routed roaming situation. Hence a static value for the CN PDB of 10 ms for the delay between a UPF terminating N6 and a 5G_AN should be subtracted from this PDB to derive the packet delay budget that applies to the radio interface.
NOTE 8: In both RRC Idle and RRC Connected mode, the PDB requirement for these 5QIs can be relaxed (but not to a value greater than 320 ms) for the first packet(s) in a downlink data or signalling burst in order to permit reasonable battery saving (DRX) techniques.
NOTE 9: It is expected that 5QI-65 and 5QI-69 are used together to provide Mission Critical Push to Talk service (e.g. 5QI-5 is not used for signalling). It is expected that the amount of traffic per UE will be similar or less compared to the IMS signalling.
NOTE 10: In both RRC Idle and RRC Connected mode, the PDB requirement for these 5QIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.
NOTE 11: In RRC Idle mode, the PDB requirement for these 5QIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.
NOTE 12: This 5QI value can only be assigned upon request from the network side. The UE and any application running on the UE is not allowed to request this 5QI value.
NOTE 13: A static value for the CN PDB of 20 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.
NOTE 14: This 5QI is not supported in this Release of the specification as it is only used for transmission of V2X messages over MBMS bearers as defined in TS 23.285 [72] but the value is reserved for future use.
NOTE 15: For "live" uplink streaming (see TS 26.238 [76]), guidelines for PDB values of the different 5QIs correspond to the latency configurations defined in TR 26.939 [77]. In order to support higher latency reliable streaming services (above 500ms PDB), if different PDB and PER combinations are needed these configurations will have to use non-standardised 5QIs.
NOTE 16: These services are expected to need much larger MDBV values to be signalled to the RAN. Support for such larger MDBV values with low latency and high reliability is likely to require a suitable RAN configuration, for which, the simulation scenarios in TR 38.824 [112] may contain some guidance.
NOTE 17: The worst case one way propagation delay for GEO satellite is expected to be ~270ms, ,~ 21 ms for LEO at 1200km, and 13 ms for LEO at 600km. The UL scheduling delay that needs to be added is also typically 1 RTD e.g. ~540ms for GEO, ~42ms for LEO at 1200km, and ~26 ms for LEO at 600km. Based on that, the 5G-AN Packet delay budget is not applicable for 5QIs that require 5G-AN PDB lower than the sum of these values when the specific types of satellite access are used (see TS 38.300 [27]). 5QI-10 can accommodate the worst case PDB for GEO satellite type.

NOTE: It is preferred that a value less than 64 is allocated for any new standardised 5QI of Non-GBR resource type. This is to allow for option 1 to be used as described in clause 5.7.1.3 (as the QFI is limited to less than 64).

QCI	Resource Type	Priority Level	Packet Delay Budget (NOTE 13)	Packet Error Loss Rate (NOTE 2)	Example Services
1 (NOTE 3)	GBR	2	100 ms (NOTE 1, NOTE 11)	10^{-2}	Conversational Voice
2 (NOTE 3)		4	150 ms (NOTE 1, NOTE 11)	10^{-3}	Conversational Video (Live Streaming)
3 (NOTE 3, NOTE 14)		3	50 ms (NOTE 1, NOTE 11)	10^{-3}	Real Time Gaming, V2X messages Electricity distribution - medium voltage (e.g. clause 7.2.2 of TS 22.261 [51]) Process automation - monitoring (e.g. clause 7.2.2 of TS 22.261 [51])
4 (NOTE 3)		5	300 ms (NOTE 1, NOTE 11)	10^{-6}	Non-Conversational Video (Buffered Streaming)
65 (NOTE 3, NOTE 9, NOTE 12)		0.7	75 ms (NOTE 7, NOTE 8)	10^{-2}	Mission Critical user plane Push To Talk voice (e.g., MCPTT)
66 (NOTE 3, NOTE 12)		2	100 ms (NOTE 1, NOTE 10)	10^{-2}	Non-Mission-Critical user plane Push To Talk voice
67 (NOTE 3, NOTE 12)		1.5	100 ms (NOTE 1, NOTE 10)	10^{-3}	Mission Critical Video user plane
75 (NOTE 14)		2.5	50 ms (NOTE 1)	10^{-2}	V2X messages
71		5.6	150ms (NOTE 1, NOTE 16)	10^{-6}	"Live" Uplink Streaming (e.g. TS 26.238 [53])
72		5.6	300ms (NOTE 1, NOTE 16)	10^{-4}	"Live" Uplink Streaming (e.g. TS 26.238 [53])
73		5.6	300ms (NOTE 1, NOTE 16)	10^{-8}	"Live" Uplink Streaming (e.g. TS 26.238 [53])
74		5.6	500ms (NOTE 1, NOTE 16)	10^{-8}	"Live" Uplink Streaming (e.g. TS 26.238 [53])
76		5.6	500ms (NOTE 1, NOTE 16)	10^{-4}	"Live" Uplink Streaming (e.g. TS 26.238 [53])
5 (NOTE 3)	Non-GBR	1	100 ms (NOTE 1, NOTE 10)	10^{-6}	IMS Signalling
6 (NOTE 4)		6	300 ms (NOTE 1, NOTE 10)	10^{-6}	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7 (NOTE 3)		7	100 ms (NOTE 1, NOTE 10)	10^{-3}	Voice, Video (Live Streaming) Interactive Gaming
8 (NOTE 5)		8	300 ms (NOTE 1)	10^{-6}	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9 (NOTE 6)		9			
69 (NOTE 3, NOTE 9, NOTE 12)		0.5	60 ms (NOTE 7, NOTE 8)	10^{-6}	Mission Critical delay sensitive signalling (e.g., MC-PTT signalling, MC Video signalling)
70 (NOTE 4, NOTE 12)		5.5	200 ms (NOTE 7, NOTE 10)	10^{-6}	Mission Critical Data (e.g. example services are the same as QCI 6/8/9)
79 (NOTE 14)		6.5	50 ms (NOTE 1, NOTE 10)	10^{-2}	V2X messages
80 (NOTE 3)		6.8	10 ms (NOTE 10, NOTE 15)	10^{-6}	Low latency eMBB applications (TCP/UDP-based); Augmented Reality

NOTE 1: A delay of 20 ms for the delay between a PCEF and a radio base station should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface. This delay is the average between the case where the PCEF is located "close" to the radio base station (roughly 10 ms) and the case where the PCEF is located "far" from the radio base station, e.g. in case of roaming with home routed traffic (the one-way packet delay between Europe and the US west coast is roughly 50 ms). The average takes into account that roaming is a less typical scenario. It is expected that subtracting this average delay of 20 ms from a given PDB will lead to desired end-to-end performance in most typical cases. Also, note that the PDB defines an upper bound. Actual packet delays - in particular for GBR traffic - should typically be lower than the PDB specified for a QCI as long as the UE has sufficient radio channel quality.

NOTE 2: The rate of non congestion related packet losses that may occur between a radio base station and a PCEF should be regarded to be negligible. A PELR value specified for a standardized QCI therefore applies completely to the radio interface between a UE and radio base station.

NOTE 3: This QCI is typically associated with an operator controlled service, i.e., a service where the SDF aggregate's uplink / downlink packet filters are known at the point in time when the SDF aggregate is authorized. In case of E-UTRAN this is the point in time when a corresponding dedicated EPS bearer is established / modified.

NOTE 4: If the network supports Multimedia Priority Services (MPS) then this QCI could be used for the prioritization of non real-time data (i.e. most typically TCP-based services/applications) of MPS subscribers.

NOTE 5: This QCI could be used for a dedicated "premium bearer" (e.g. associated with premium content) for any subscriber / subscriber group. Also in this case, the SDF aggregate's uplink / downlink packet filters are known at the point in time when the SDF aggregate is authorized. Alternatively, this QCI could be used for the default bearer of a UE/PDN for "premium subscribers".

NOTE 6: This QCI is typically used for the default bearer of a UE/PDN for non privileged subscribers. Note that AMBR can be used as a "tool" to provide subscriber differentiation between subscriber groups connected to the same PDN with the same QCI on the default bearer.

NOTE 7: For Mission Critical services, it may be assumed that the PCEF is located "close" to the radio base station (roughly 10 ms) and is not normally used in a long distance, home routed roaming situation. Hence delay of 10 ms for the delay between a PCEF and a radio base station should be subtracted from this PDB to derive the packet delay budget that applies to the radio interface.

NOTE 8: In both RRC Idle and RRC Connected mode, the PDB requirement for these QCIs can be relaxed (but not to a value greater than 320 ms) for the first packet(s) in a downlink data or signalling burst in order to permit reasonable battery saving (DRX) techniques.

NOTE 9: It is expected that QCI-65 and QCI-69 are used together to provide Mission Critical Push to Talk service (e.g., QCI-5 is not used for signalling for the bearer that utilizes QCI-65 as user plane bearer). It is expected that the amount of traffic per UE will be similar or less compared to the IMS signalling.

NOTE 10: In both RRC Idle and RRC Connected mode, the PDB requirement for these QCIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

NOTE 11: In RRC Idle mode, the PDB requirement for these QCIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

NOTE 12: This QCI value can only be assigned upon request from the network side. The UE and any application running on the UE is not allowed to request this QCI value.

NOTE 13: Packet delay budget is not applicable on NB-IoT or when Enhanced Coverage is used for WB-E-UTRAN (see TS 36.300 [19]).

NOTE 14: This QCI could be used for transmission of V2X messages as defined in TS 23.285 [48].

NOTE 15: A delay of 2 ms for the delay between a PCEF and a radio base station should be subtracted from the given PDB to derive the packet delay budget that applies to the radio interface.

NOTE 16: For "live" uplink streaming (see TS 26.238 [53]), guidelines for PDB values of the different QCIs correspond to the latency configurations defined in TR 26.939 [54]. In order to support higher latency reliable streaming services (above 500ms PDB), if different PDB and PELR combinations are needed these configurations will have to use non-standardised QCIs.

QCI	Resource Type	Priority Level	Packet Delay Budget (NOTE B1)	Packet Error Loss Rate (NOTE B2)	Maximum Data Burst Volume (NOTE B1)	Data Rate Averaging Window	Example Services
82 (NOTE B6)	GBR	1.9	10 ms (NOTE B4)	10^{-4} (NOTE B3)	255 bytes	2000 ms	Discrete Automation (TS 22.278 [38], clause 8 bullet g, and TS 22.261 [51], table 7.2.2-1, "small packets")
83 (NOTE B6)		2.2	10 ms (NOTE B4)	10^{-4} (NOTE B3)	1354 bytes (NOTE B5)	2000 ms	Discrete Automation (TS 22.278 [38], clause 8 bullet g, and TS 22.261 [51], table 7.2.2-1, "big packets")
84 (NOTE B6)		2.4	30 ms (NOTE B7)	10^{-5} (NOTE B3)	1354 bytes (NOTE B5)	2000 ms	Intelligent Transport Systems (TS 22.278 [38], clause 8, bullet h, and TS 22.261 [51], table 7.2.2).
85 (NOTE B6)		2.1	5 ms (NOTE B8)	10^{-5} (NOTE B3)	255 bytes	2000 ms	Electricity Distribution- high voltage (TS 22.278 [38], clause 8, bullet i, and TS 22.261 [51], table 7.2.2 and Annex D, clause D.4.2).

NOTE B1: The PDB applies to bursts that are not greater than Maximum Data Burst Volume.

NOTE B2: This Packet Error Loss Rate includes packets that are not successfully delivered over the access network plus those packets that comply with the Maximum Data Burst Volume and GBR requirements but which are not delivered within the Packet Delay Budget.

NOTE B3: Data rates above the GBR, or, bursts larger than the Maximum Data Burst Volume, are treated as best effort, and, in order to serve other packets and meet the PELR, this can lead to them being discarded.

NOTE B4: A delay of 1 ms for the delay between a PCEF and a radio base station should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

NOTE B5: This Maximum Data Burst Volume value is set to 1354 bytes to avoid IP fragmentation on an IPv6 based, IPSec protected GTP tunnel to the eNB (the value is calculated as in Annex C of TS 23.060 [12] and further reduced by 4 bytes to allow for the usage of a GTP-U extension header).

NOTE B6: This QCI is typically associated with a dedicated EPS bearer.

NOTE B7: A delay of 5 ms for the delay between a PCEF and a radio base station should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

NOTE B8: A delay of 2 ms for the delay between a PCEF and a radio base station should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

Remarks & Questions?