Generic Network Slice Template
Version 1.0
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1 Introduction

1.1 Overview

The purpose of this document is to provide the standardised list of attributes that can characterise a type of network slice. Network slicing is the key feature of the 5G networks and enables to build dedicated logical networks on a shared infrastructure. These dedicated networks would permit the implementation of tailor-made functionality and network operation specific to the needs of each slice customer, rather than a one-size-fits-all approach as witnessed in the current and previous mobile generations which would not be economically viable.

1.2 Relationship to existing standards

3GPP

The attributes listed in this document are based on the open and published 3GPP specifications as listed in the Section 1.6. 3GPP Release 15. This first release supporting 5G and network slicing, is taken as basis.

1.3 Scope

The scope of this document is to provide the description of:

- Generic network Slice Template (GST); attributes that can characterise a type of network slice.
- Examples of Network Slice Types (NESTs) with a recommended minimum set of attributes and their suitable values.

1.4 Definitions

Term	Description
Network Slice	A logical network that provides specific network capabilities and network characteristics [1]
Network Slice Instance	A set of Network Function instances and the required resources (e.g. compute, storage and networking resources) form a deployed Network Slice [1]
Network Slice Subnet	A representation of the management aspects of a set of Managed Functions and the required resources (e.g. compute, storage and networking resources) [25]
Network Slice Subnet Instance	An instance of Network Slice Subnet representing the management aspects of a set of Managed Function instances and the used resources (e.g. compute, storage and networking resources) [25]
Service Continuity	The uninterrupted user experience of a service, including the cases of IP address and/or anchoring point change [1]

1.5 Abbreviations

Term	Description
5GAA	5G Automotive Association
5GS	5G System
5QI	5G QoS identifier
AECID	Adaptive Enhanced Cell Identity
AN	Access Network
AoA	Angle of Arrival
API	Application programming interface
APN	Access Point Name
BS	Base Station
CID	Cell ID
CN	Core Network
CPE	Customer premises equipment
CSC	Communication Service Customer
CSP	Communication Service Provider
CUPS	Control and User Plane Separation
DL	Down Link
DN	Data Network
DNN	Data Network Name
DSL	Digital Subscriber Line
DV	Data Volume
E2E	End to End
EC	Energy Consumption
ECID	Enhanced Cell ID
EPC	Evolved Packet Core
EPS	Evolved Packet System
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
FGML5G	Machine Learning for Future Networks including 5G
GBR	Guaranteed Bit Rate
GERAN	GSM/Edge Radio Access Network
GFBR	Guaranteed Flow Bit Rate
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GRE	Generic Routing Encapsulation
GST	Generic Slice Template
HARQ	Hybrid automatic repeat request
IMS	IP Multimedia System
IOPS	Isolated E-UTRAN Operation for Public Safety

Term	Description
IoT	Internet of Things
KPI	Key Performance Indicators
KQI	Key Quality Indicators
L2TP	Layer 2 Tunnelling Protocol
LTE-M	Long Term Evolution for Machines
MDBV	Maximum Data Burst Volume
MC	Mission-Critical
MCC	Mobile Country Code
MCD	Mission-Critical Data
MCI	Mission-Critical Interworking
MCPTT	Mission-Critical Push-To-Talk
MCVideo	Mission-Critical Video
MEC	Multi-access Edge Computing
MFBR	Maximum Flow Bit Rate
MIoT	Massive IoT
MMTel	Multimedia Telephony Service
MNC	Mobile Network Code
MNO	Mobile Network Operator
MTU	Maximum Transmission Unit
NB-IoT	Narrowband IoT
NEF	Network Exposure Function
NEST	NEtwork Slice Type
NF	Network Function
NOP	Network Operator
NR	New Radio
NSC	Network Slice Customer
NSI	Network Slice Instance
NSP	Network Slice Provider
NSS	Network Slice Subnet
NSSI	Network Slice Subnet Instance
NSST	Network Slice Subnet Template
OTDOA	Observed Time Difference of Arrival
PDB	Packet Delay budget
PER	Packet Error Rate
PDU	Protocol Data Unit
QoS	Quality of Service
RAN	Radio Access Network
RAT	Radio Access Type

Term	Description
RF	Radio Frequency
RSTD	Reference Signal Time Difference
SC-PTM	Single Cell Point to Multipoint
SDO	Standards developing organizations
SLA	Service Level Agreement
SMF	Session Management Function
SSC	Session Service Continuity
SST	Slice/Service Type
TN	Transmission Network
TRxP	Transmission Reception Point
TSN	Time-Sensitive Networking
UE	User Equipment
UDM	User Data Management
UL	Uplink
UDR	User Data Register
UL	Up Link
UPF	User Plan Function
URLLC	Ultra-Reliable Low Latency Communication
UTRAN	Universal Terrestrial Radio Access Network
VM	Virtual Manachine
VPN	Virtual Private Network

1.6 References

Ref	Doc Number	Title
1	3GPP TS 23.501	System Architecture for the 5G System; Stage 2 (Rel-15)
2	RFC2119	“Key words for use in RFCs to Indicate Requirement Levels”, S. Bradner, March 1997. Available at http://www.ietf.org/rfc/rfc2119.txt
3	3GPP TR 22.804	Study on Communication for Automation in Vertical domains (CAV)
4	3GPP TS 38.101	NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone
5	3GPP TS 36.104	Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception
6	3GPP TR 22.904	Study on user centric identifiers and authentication
7	IEEE 1588	Precision Time Protocol
8	IEEE 802.1	TSN
9	ETSI GS MEC 016	Mobile Edge Computing (MEC); UE application interface
10	3GPP TS 23.214	Architecture enhancements for control and user plane separation of EPC nodes
11	3GPP TS 29.244	Interface between the Control Plane and the User Plane nodes

Ref	Doc Number	Title
12	3GPP TS 29.561	5G System; Interworking between 5G Network and external Data Networks; Stage 3
13	3GPP TS 23.032	Universal Geographical Area Description (GAD)
14	3GPP TS 33.501	Security architecture and procedures for 5G System
15	3GPP TS 23.379	Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2
16	3GPP TS 23.282	Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2
17	3GPP TS 23.281	Functional architecture and information flows to support Mission Critical Video (MCVideo); Stage 2
18	3GPP TS 23.401	General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access
19	3GPP TS 33.401	3GPP System Architecture Evolution (SAE); Security architecture
20	3GPP TS 23.283	Mission Critical Communication Interworking with Land Mobile Radio Systems
21	ETSI EN 302 636-4-1	Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality
22	GSMA IR.92	IMS Profile for Voice and SMS
23	3GPP TS 38.101-1	NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone
24	3GPP TR 23.799	Study on Architecture for Next Generation System
25	3GPP TS 28.530	Aspects; Management and orchestration; Concepts, use cases and requirements
26	ETSI ES 203 228	Environmental Engineering (EE); Assessment of mobile network energy efficiency

1.7 Conventions

If the document includes binding material, this section shall contain the following statement, and RFC 2119 shall be included as a reference:

“The key words “must”, “must not”, “required”, “shall”, “shall not”, “should”, “should not”, “recommended”, “may”, and “optional” in this document are to be interpreted as described in RFC2119 [2].”

2 Network Slicing

Network slicing is one of the key features of 5G. 3GPP defined network slice as a logical network that provides specific network capabilities and network characteristics [1]. The network slice can be tailored based on the specific requirements adhered to a Service Level

Agreement (SLA) agreed between Network Slice Customer (NSC) and Network Slice Provider (NSP).

A network slice could span across multiple parts of the network (e.g. terminal, access network, core network and transport network). A network slice comprises of dedicated and/or shared resources, e.g. in terms of processing power, storage, and bandwidth and is isolated from the other network slices.

2.1 Roles in network slicing

Multiple roles related to network slicing are displayed in Figure 1. Each role and the responsibilities need to be clearly defined. In this document the following roles are used:

- **Communication Service Customer (CSC)**: Uses communication services, e.g. end user, tenant, vertical [25].
- **Communication Service Provider (CSP)**: Provides communication services. Designs, builds and operates its communication services. The CSP provided communication service can be built with or without network slice [25].
- **Network Operator (NOP)**: Provides network services. Designs, builds and operates its networks to offer such services [25].
- **Network Slice Customer (NSC)**: The Communication Service Provider (CSP) or Communication Service Customer (CSC) who uses Network Slice
- **Network Slice Provider (NSP)**: The Communication Service Provider (CSP) or Network Operator (NOP) who provides Network Slice as a Service

Note: Depending on actual scenarios an organisation can play one or several roles simultaneously (e.g. company can be CSP and NOP).

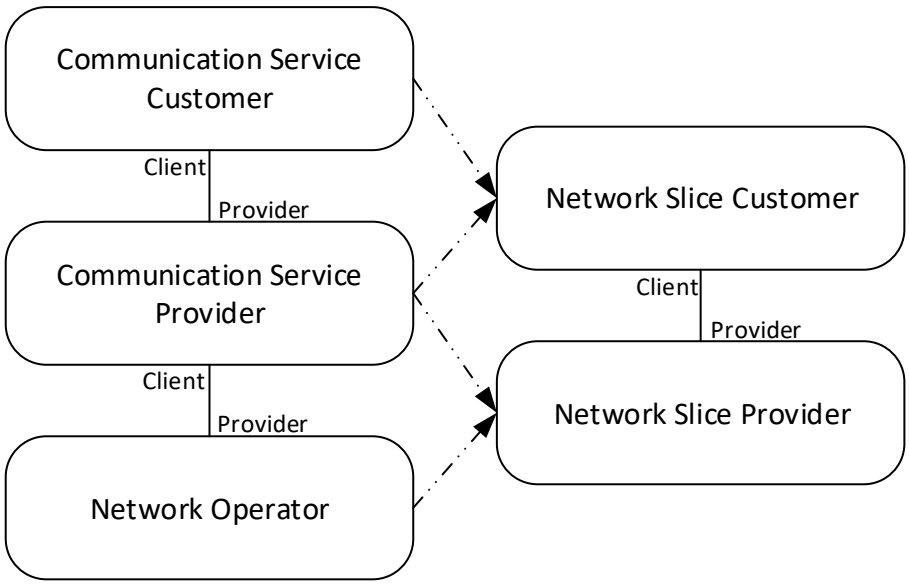

Figure 1: Model roles in network slicing

2.2 Generic network Slice Template (GST)

The Generic Network Slice Template (GST) is a set of attributes that can characterise a type of network slice. One or more NSIs (Network Slice Instance) can be created out of the same type based on the requirements. GST is generic and is not tied to any specific network deployment.

The NEtwork Slice Type (NEST) is a GST filled with values.

Figure 2 places the GST and NEST in the context of the network slice lifecycle.

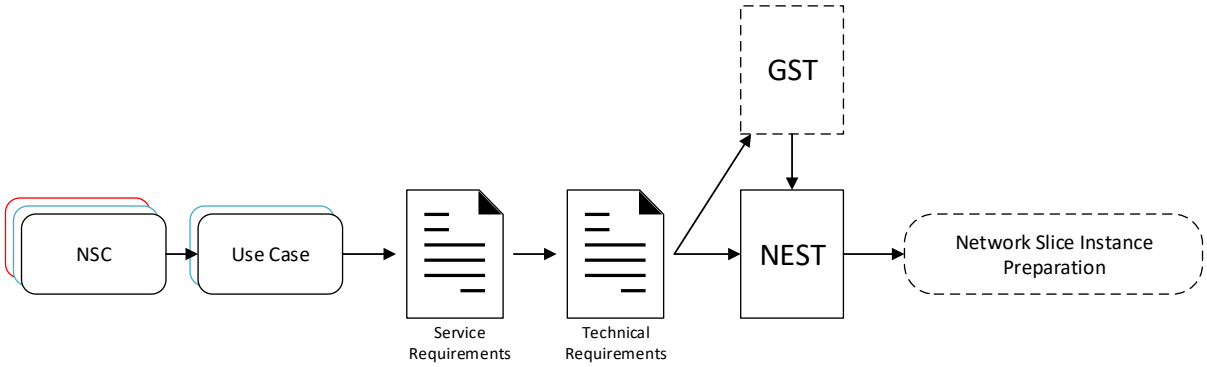

Figure 2: GST and NEST in context of the network slice lifecycle

3 GST Attributes

3.1 Attribute presence

Each attribute has a defined presence in the GST:

- Mandatory – the attribute's value must be present
- Conditional – the attribute's value is mandatory if a certain condition exists
- Optional – the attribute's value doesn't need to be present

3.2 Attribute categories and tagging

In general, attributes can be categorised into character attributes and scalability attributes. An attribute can be either a character or a scalability attribute but not both:

- **Character attributes** - characterise a slice (e.g. throughput, latency, Application Program Interfaces (APIs), etc.) and are independent of the Network Slice Customer (NSC) and the Network Slice Provider (NSP).
- **Scalability attributes** - provide information about the scalability of the slice (e.g. number of terminals, etc.) and are specific for the NSC and the NSP.

Note: Different use cases and network slice designs could result in some attributes being a character or a scalability attribute (e.g. coverage), but never both at the same time.

Character attributes can be further tagged. Tags are used as labels attached to the attributes to give additional information about the nature of each attribute. Each attribute could have multiple tags. The following tags apply to the character attributes:

- **Performance related** - specify the KPIs (Key Preformance Indicators) supported by a slice (e.g. throughput, latencies, etc.). Performance related attributes are relevant before the slice is instantiated.
- **Function related** – specify functionality provided by the slice (e.g. positioning, prediction, etc.). Function related attributes are relevant before the slice is instantiated.
- **Operation related** - specify which methods are provided to the NSC in order to operate the slice. Operation related attributes are relevant after the slice is instantiated. Furthermore, operation related attributes comprise control and management aspects.

3.3 Exposure Attributes:

The way the attributes interact with the NSC can be used for tagging:

- **API** – these attributes provide an API to the NSC in order to get access to the slice capabilities. Many of the functional- and operational related attributes provide APIs to the NSC.
- **KPI** – these attributes provide certain performance capabilities (e.g. throughput and delay).

3.4 Attributes

3.4.1 Availability

Void

Editor's Note: This attribute will be added to the document in the subsequent versions

3.4.2 Coverage

This attribute specifies the coverage area of the network slice - the area where the terminals can access a particular network slice.

Parameters	
Value	Integer
Measurement unit	NA
Example	1: Global 2: National 3: Regional 4: Local (outdoor) 5: Local (indoor)
Tags	Character Attribute/ Operation Scalability Attribute* KPI

*Depends on the use case, this attribute can be also scalability attribute.

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 1 Coverage Table

Additional Information

There are different proposals on how to describe the coverage area of the network slice:

Based on base station location and coverage

Location and coverage of the Base Stations (BSs), known by the NSP, is used. Coverage is the described by listing the base stations and/or sectors via which the network slice is provided. Based on the example provided in the following figure the list looks: {13, 17, 18, 23, 27, 28, and 33}.

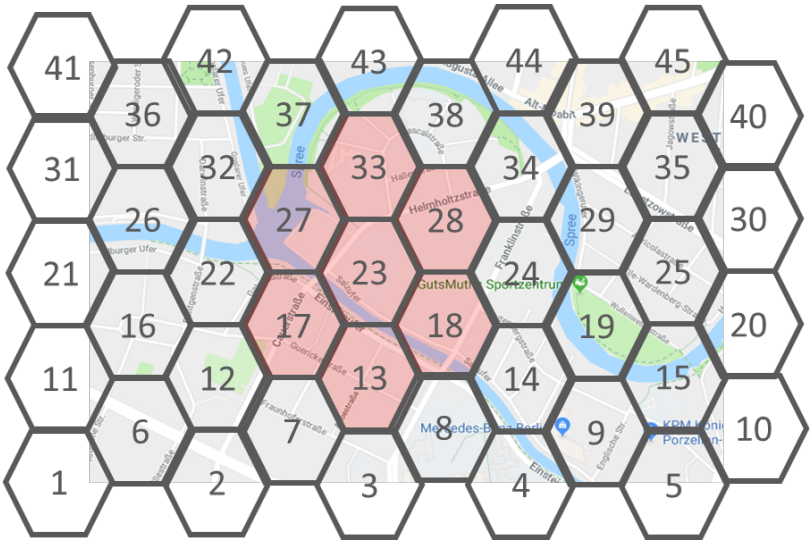

Figure 3: Coverage based on base station locations and coverage

The advantages of this approach are:

- It is easier for the NSP to describe the coverage as it is based on real deployments.

The disadvantages are:

- Requires processing in order to determine the coverage regions of the base stations
- Deployment information is provided to the NSC
- Deployment changes require changes in the coverage descriptions

Generic based on geographical partitioning

This approach requires partitioning a geographical region into a set of zones/grids, which for better resource usage consists of defining a regular set of zones of predetermined

dimensions. Coverage is then described by the zone numbers in which the network slice should be available. For the example shown in the following figure the list is: {9, 10, 15, and 16}.

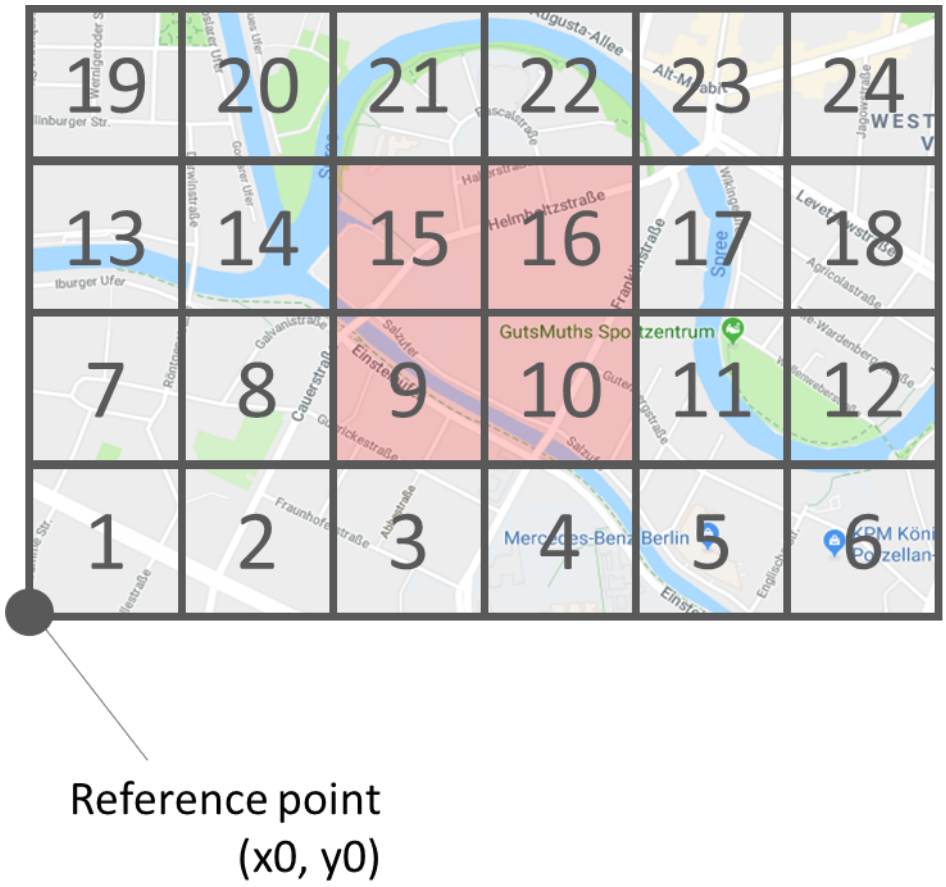

Figure 4: Coverage based on geographical partitioning

It is up to the NSP to map the required coverage with BSs based on their location and coverage.

The advantages of this approach are:

- Hides deployment information from the NSC
- Independent of the network deployment, e.g. independent of deployment changes

The disadvantages are:

- Mapping of the defined coverage with real coverage and the respective base station
- It is not guaranteed that the defined coverage is available, e.g. coverage may not be provided in certain desired areas

3.4.3 Delay tolerance

Provide the NSC with service delivery flexibility, especially for the vertical services that are not chasing a high system performance. For instance, the service will be delivered once the mobile system has sufficient resources or during the off-peak hours. For this type of traffic, it

is not too critical how long it takes to deliver the amount of data, e.g. within hours, days, weeks, etc.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 2 Delay Tolerance Table

Additional information

In principle, relevant mechanisms are available. For instance, this type of traffic could be scheduled for transmission in dedicated times of the day when the traffic load is low or this traffic could get an own traffic class which is de-prioritized over all other traffic.

Certain traffic flows, should reach the end user within certain latency boundary. At the same time, there are use cases that are less sensitive to delay variations, giving the mobile system some level of flexibility in scheduling traffic. For instance, in automotive industry, (non-critical) software/firmware update could be deprioritised and delivered when traffic is low such as during off-peak hours.

3.4.4 Deterministic communication

This attribute defines if the network slice supports deterministic communication for periodic user traffic. Periodic traffic refers to the type of traffic with periodic transmissions.

Availability

This parameter describes if the network slice supports deterministic communication.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Performance KPI

Parameter Presence	
Mandatory	X
Conditional	
Optional	

Table 3 Deterministic Communication Table

Periodicity

This parameter provides a list of periodicities supported by the network slice.

Parameters	
Value	{Float, Float, Float…}
Measurement unit	Seconds
Example	Motion control /printing machine): $2*10^3$ seconds Motion control (machine tool): $500*10^6$ seconds
Tags	Character attributes / Performance KPI

Parameter Presence	
Mandatory	
Conditional	X
Optional	

Table 4 Periodicity Table

Note: This parameter is present when the “Availability” is set to 1.

Additional information

Periodically traffic, is a transmission interval (in which a single packet is transmitted) that is repeated. For example, a transmission occurs every 15 ms. Reasons for a periodical transmission can be the periodic update of a position or the repeated monitoring of a characteristic parameter.

Note: That a transmission of a temperature every 15 minutes is a periodical transmission. However, most periodic intervals in communication for automation are rather short. The transmission is started once and continues unless a stop command is provided [3].

Determinism refers to whether the delay between transmission of a message and receipt of the message at the destination address is stable (within bounds). Usually, communication is called deterministic if it is bounded by a given threshold for the latency/transmission time [3].

It should be noted that a network slice could support multiple periodicities. It is then a matter of resource scheduling and the identification of the different packets in order to treat them in a way to not disturb their periodicity.

This attribute should not be mixed up with periodic communication demand in which periodically a specific amount of date (not only a single packet) needs to be transmitted. Hence, there is no periodicity between the single data packets but there is a periodicity between activities of a customer or device.

(R)AN/TN/CN (Radio Access Network/transit Network/Core Network) may use this attribute to optimize the scheduling and performance.

3.4.5 Downlink throughput per network slice

Is the achievable data rate of the network slice in downlink that is available ubiquitously across the coverage area of the slice?

Guaranteed downlink throughput

This attribute describes the guaranteed data rate supported by the network slice in downlink.

Parameters	
Value	Float
Measurement unit	kbps
Example	0 (not specified) 10 Mbps
Tags	Scalability attribute KPI

Parameter Presence	
Mandatory	X
Conditional	
Optional	

Table 5 Guaranteed Downlink Throughput Table

Maximum downlink throughput

This attribute defines the maximum data rate supported by the network slice in downlink.

Parameters	
Value	Integer
Measurement unit	kbps
Example	100 Mbps 20 Gbps
Tags	Scalability attributes KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 6 Maximum Downlink Throughput Table

Note: Either maximum downlink throughput per network slice or Maximum downlink throughput per UE shall be present.

Additional information

This attribute might be used to set throughput guarantees per network slice.

Maximum throughput can be used to offer different network slice contract qualities level, e.g. gold, silver and bronze which have different maximum throughput values.

3.4.6 Downlink throughput per UE

Guaranteed downlink throughput

This attribute describes the guaranteed data rate supported by the network slice per UE (User Equipment) in downlink, which is required to achieve a sufficient quality experience (dependent on the selected service type) and can be seen as a guaranteed throughput. If the value is 0, best effort traffic is expected where no minimum throughput is guaranteed.

Parameters	
Value	Integer
Measurement unit	kbps
Example	180 Kbps for VoIP traffic 40.000-75.000 Kbps for entry level VR 25.000 Kbps for cloud gaming 0 (not specified)
Tags	Character attribute / Performance KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 7 Guaranteed Downlink Throughput per UE Table

Maximum downlink throughput

This attribute describes the maximum data rate supported by the network slice per UE in downlink. These parameters could be used to offer different contract qualities like gold, silver and bronze.

Parameters	
Value	Integer
Measurement unit	kbps
Example	Bronze customer: 50.000 Kbps Silver customer: 400.000 Kbps Gold customer: 1.000.000 Kbps latency.
Tags	Character attribute /Performance KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 8 Maximum Downlink Throughput per UE Table

Note: Either Maximum downlink throughput per network slice or Maximum downlink throughput per UE must be present.

Additional information

This attribute might be used to set different guarantees in terms of throughput experienced by the customer in downlink.

Minimum throughput can be defined in order to guarantee a minimum performance required to achieve a sufficient quality experience (dependent on the selected service type).

Maximum throughput can be used to offer different contract quality level, e.g. gold, silver and bronze which have different maximum throughput values.

Orchestrator may use this attribute to orchestrate the resources and (R)AN/CN may use this attribute to optimize the scheduling.

3.4.7 Energy efficiency

This attribute describes the energy efficiency of the network slice, i.e. the ratio between the performance indicator, in terms of data volume (DV), and the energy consumption (EC) when assessed during the same time frame [26].

The energy efficiency is evaluated only when the network is running.

Network slice energy efficiency

Parameters	
Value	Integer
Measurement unit	Bit / Joule
Example	180 b/J (Dense urban area) 40 b/J (Urban area) 2 b/J (Rural area)
Tags	Character attributes / Operational

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 9 Energy Efficiency Table

Time frame of the measurement

The time frame of the measurement shall be one of the alternatives:

- Weekly measurement: equals to 7 days.
- Monthly measurement: equals to 30 days.
- Yearly measurement: equals to 365 days.

The minimum duration is therefore one week: monthly and yearly measurements are extensions of the basic week test.

Parameters	
Value	Integer
Measurement unit	day
Example	1: Weekly measurement 2: Monthly measurement 3: Yearly measurement
Tags	Character attributes / Operational

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 10 Measurement Parameters Table

Note: This parameter shall be present if Network slice energy efficiency is used.

Additional information

The Energy Consumption of the network slice can be measured by means of metering information provided by utility suppliers or by mobile network integrated measurement systems. Moreover, sensors can be used to measure site and equipment energy consumption. The energy consumption is based on site granularity and includes therefore all the equipment.

3.4.8 Group communication support

This parameter describes which type of group communication is provided by the network slice.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: not available 1: Single Cell Point to Multipoint (SC-PTM) 2: Broadcast/Multicast 3: Broadcast/Multicast + SC-PTM
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 11 Group Communication Support Table

3.4.9 Isolation level

Isolation is one of the key expectations of network slicing. A network slice instance may be fully or partly, logically and/or physically, isolated from another network slice instance 0. This attribute describes different types of isolation:

- Physical – network slices are physically separated (e.g. different rack, different hardware, different location, etc.)
    - Process and threads isolation
    - Physical memory isolation
    - Physical network isolation
- Logical – network slices are logically separated.
    - Virtual resources isolation – a network slice has access to specific range of resources that do not overlap with other network slices (e.g. VM isolation)
    - Network functions isolation – NF (Network Function) is dedicated to the NSC, but virtual resources are shared

- Tenant/Service Isolation – NSC data are isolated from other NSCs, but virtual resources and NFs are shared

Note: How to convey a slice with a mix of physical and logical isolation levels in different slice subnets is for FFS.

Isolation

Parameters	
Value	Integer
Measurement unit	NA
Example	0: No Isolation 1: Physical Isolation 2: Logical Isolation
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 12 Isolation Level Table

Physical Isolation

Parameters	
Value	Integer
Measurement unit	NA
Example	0: Process and threads Isolation 1: Physical memory Isolation 2: Physical network isolation
Tags	Character attribute / Functional

Parameter Presence	
Mandatory	
Conditional	X
Optional	

Table 13 Physical Isolation Table

Note: This parameter must be present when “Isolation” is set to 1.

Logical Isolation

Parameters	
Value	Integer
Measurement unit	NA
Example	1: Virtual resource isolation 2: Network Function isolation 3: Tenant/Service isolation
Tags	Character attribute / Functional

Parameter Presence	
Mandatory	
Conditional	X
Optional	

Table 14 Logical Isolation Table

Note: This parameter must be present when “Isolation” is set to 2.

Additional Information

Weak network slice isolation and connection may compromise the entire 5G security, e.g. sensitive data, managed inside a network slice, could be exposed to applications running in other network slices services, through side channel attacks. This risk is even higher since isolation is distributed over each of the security domains of the underlying 5G security architecture. An additional complexity comes from the fact that monitoring and management of such a chain of connections among each of the security domains might not be properly handled.

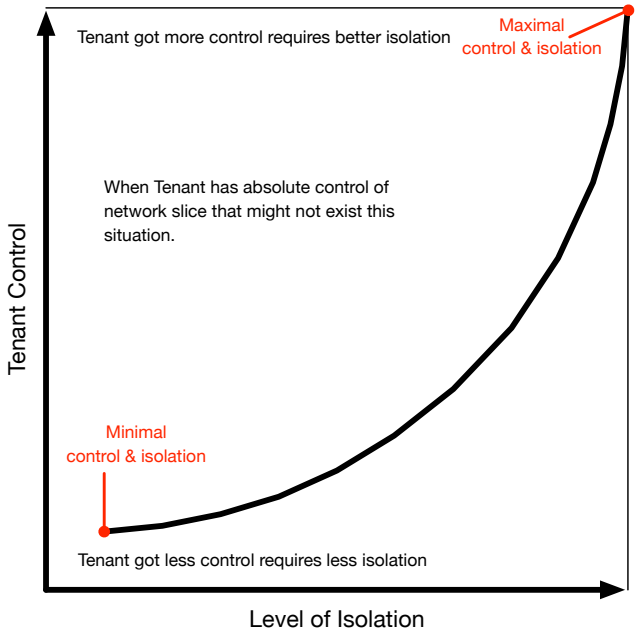

Figure 5 Relation between Tenant Control and Isolation

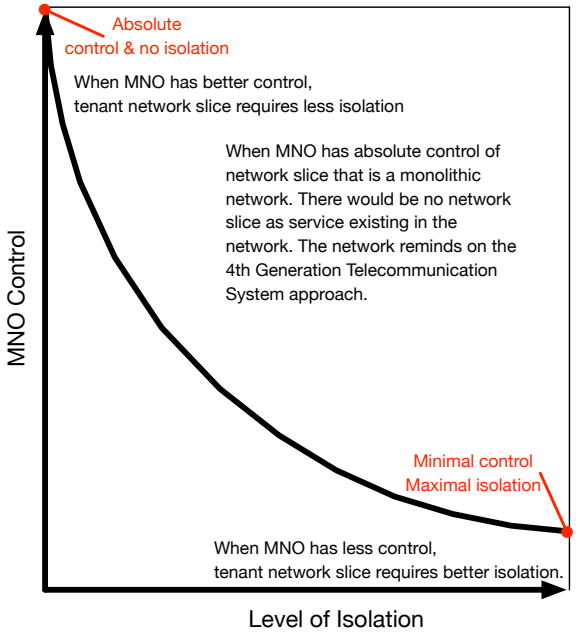

Figure 6 Relation between MNO Control and Isolation

Inter-tenant/Slice Isolation

Infrastructure sharing by multiple network operators will require strict isolation at multiple levels to ensure the expected security level. Various aspects of control-plane, data-plane and resource isolation must be guaranteed to ensure zero correlation among different slices/tenant operations. Tenant/slice isolation is important to ensure a reliable and warranted service assurance, together with data and communication integrity and confidentiality. Therefore, inter-tenant/slice isolation security of sensitive data, should at least be equal to physically separated networks.

3.4.10 Location based message delivery

This attribute describes the delivery of information in a particular geographic region.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 15 Location Based Message Table

Additional Information

This attribute describes the location-based delivery of information, e.g. GeoNetworking [21].

This is not related to the geographical spread of the network slice itself. This attribute can be used to distribute information, e.g. signalling messages, to terminals within a specific geographical area.

3.4.11 Maximum supported packet size

This attribute describes the maximum packet size supported by the network slice and may be important for URLLC (Ultra-Reliable Low Latency Communication) and MIoT (Massive IoT), or to indicate a supported maximum transmission unit (MTU).

Parameters	
Value	Integer
Measurement unit	Bytes
Example	eMBB 1500 Bytes IoT 40 Bytes URLLC 160 Bytes for 5 ms latency.
Tags	Character attribute /Performance KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 16 Maximum Packet Size Table

Additional Information

This attribute might serve different purposes:

- Limitation of the packet size to achieve the required latencies for instance in Industry 4.0 or energy use cases
- To improve the radio performance in case many very small packets are transmitted by a large number of devices as like for MIoT use cases
- To indicate the MTU provided by the network slice

A UE or a server that uses this network slice needs to be aware of the limitation, which could be operational, or performance nature. For instance, the network does not guarantee the SLA if packets are bigger than the specified size or too large packets could be fragmented which will increase latency.

(R)AN/CN may use this attribute to optimize scheduling and performance, especially for URLLC case and very small packets. Transport of very small packets is very inefficient in some technologies. Knowledge about the maximum supported packet size might help to improve the efficiency, e.g. by scheduling resources more efficiently.

3.4.12 Mission critical support

Mission-critical (MC) leads to a priority of the network slice relative to others, for C-plane (Control Plane) and U-plane (User Plane) decisions. This is relative to a customer provider relationship and to a PLMN (Public land Mobile Network)

Parameters	
Value	Binary
Measurement unit	NA
Example	0: non-mission-critical 1: mission-critical
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 17 Mission Critical Support Table

Mission-critical capability support

This parameter specifies what capabilities are available to support mission-critical services. More than one capability may be supported at once. This parameter is optional when "Mission critical support" is set to 1 (meaning mission-critical slice).

Parameters	
Value	{Integer, Integer, Integer, …}
Measurement unit	NA
Example	1: Inter-user prioritization 2: Pre-emption 3: Local control
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 18 Mission Critical Capabilities Table

Note: This attribute must be present when "Mission critical support" is set to 1.

Inter-user prioritization capability provides admission and the scheduling of priorities for PS (Packet Service) users over non-PS users, and different priorities among PS users.

Pre-emption capability allows non-PS users to be pre-empted by PS users, and a PS user to be pre-empted by another PS user.

Local control capability allows dynamic and temporary assignment of inter-user prioritization and pre-emption levels to local PS users (e.g. local to an incident).

Mission-critical service support

This attribute specifies whether or not the network slice supports mission-critical push-to-talk (MCPTT) [15], mission-critical data (MCData) [16], mission-critical video (MCVideo) [17], Isolated E-UTRAN Operation for Public Safety (IOPS) [18], [19] or mission-critical interworking [20].

Parameters	
Value	{Integer, Integer, Integer, …}
Measurement unit	NA
Example	1: MCPTT 2: MCData 3: MCVideo 4: IOPS 5: MC interworking

Parameters	
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 19 Mission Critical Service Support

Note: This attribute must be present when “Mission critical support” is set to 1.

3.4.13 MMTel support

This attribute describes whether the network slice supports IP Multimedia Subsystem (IMS) and Multimedia Telephony Service MMTel. This parameter describes whether the GSMA PRD IR.92 0 compliant MMTel deployment is supported in the network slice.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 20 MMTel Support Table

3.4.14 Network Slice Customer network functions

A NSC can own some Network Functions (e.g. User Plan Function (UPF), User Data Management, UDM). This attribute provides a list of network functions to be provided by the NSC. If the list is empty, the NSC is not expected to provide any network function relevant for the network slice instance.

Parameters	
Value	{String, String, String, …}
Measurement unit	NA
Example	UPF UDM/AUSF

Parameters	
	AF PCF
Tags	Character attribute / Functional / Operational

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 21 Network Functions Table

Additional information

The NSC who owns a unique Mobile Country Code (MCC) and a unique Mobile Network Code (MNC), stores all the subscriber information in its own User Data Management (UDM). This UDM can be connected to multiple networks within the same country.

3.4.15 Number of connections

This attribute describes the maximum number of concurrent sessions supported by the network slice.

Parameters	
Value	Integer
Measurement unit	NA
Example	100.000 sessions 10.000.000 sessions
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 22 Number of Connections Table

Note: Either Number of connections or Number of terminals shall be present.

3.4.16 Number of terminals

This attribute describes the maximum number of terminals supported by the network slice.

Parameters	
Value	Integer
Measurement unit	NA
Example	100.000 terminals 10.000.000 terminals (sensors)
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 23 Number of Terminals Table

Note: Either Number of connections or Number of terminals shall be present.

Additional information

This is an important input to scale the network slice and provides enough resources to the network slice. It is a significant difference if the network slice is used to serve 10 users or 1.000.000 users.

3.4.17 Performance monitoring

This attribute provides the capability for NSC and NOP to monitor Key Quality Indicators (KQIs) and Key Performance Indicators (KPIs). KQIs reflect the end-to-end service performance and quality while KPIs reflect the performance of the network.

Availability

This parameter contains a list of KQIs and KPIs available for monitoring. If the list is empty this attribute is not available in the network slice and the other parameters might be ignored.

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	Service Request Success Rate
Tags	Character attribute / Functional / Operational

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 24 Performance Availability Table

Monitoring sample frequency

This parameter describes how often the KQIs and KPIs are monitored.

Parameters	
Value	Integer
Measurement unit	NA
Example	1: per second 2: per minute 3: per-hour 4: conditional, e.g. in case a defined threshold is crossed
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 25 Monitoring Frequency Table

Note: Only the KQIs of communication services offered by the NSP can be monitored. For over the top services, the NSP is not able to access the KQIs.

Additional information

Only the KQIs of communication services offered by the network operator can be monitored. For over the top services, the network operator is not able to access the KQIs

3.4.18 Performance prediction

This attribute defines the capability to allow the mobile system to predict the network and service status. Predictive QoS (Quality of Service) can be done for various Key Quality Indicators (KQIs) and Key Performance Indicators (KPIs). KQIs reflect the end-to-end service performance and quality, while KPIs reflect the performance of the network. The prediction is done for a specific point of time in the future and for a specific geolocation.

Note: Only the KQIs of communication services offered by the NSP can be predicted. For over the top services, the NSP is not able to access the KQIs.

Availability

This parameter contains a list of KQIs and KPIs available for prediction. If the list is empty, the attribute is not available in the network slice and the other parameters might be ignored.

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	1: Throughput 2: Latency 3: Service Request Success Rate
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 26 Performance Availability Table

Prediction frequency

This parameter describes how often KQIs and KPIs prediction values are provided.

Parameters	
Value	Integer
Measurement unit	NA
Example	1: per second 2: per minute 3: per-hour
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 27 Performance Prediction Frequency Table

Additional information

This attribute recently raised a lot of attention and different organisations as like 5GAA (5G Automotive Association) and ITU-T (Machine Learning for Future Networks including 5G (FG ML5G)) are looking at it. Towards the NSC; an API would be provided allowing the NSC to send a request (e.g. KPI prediction for a certain geo-location and a certain time in the future) and receiving the prediction.

Predictive QoS is an important feature allowing NSP to inform the service in advance about a quality drop. Predictive QoS can be applied to various KPIs, e.g. coverage, throughput, latency, etc. and KQIs.

Performance prediction could be implemented in different ways:

- Active prediction – network actively informs the NSC and/or the terminal proactively about the predicted values. Alternatively, the NSC and/or terminal are only informed in case the predicted KPI or KQI value crossed a defined threshold.
- Passive prediction – the NSC and/or terminal requests prediction from the network via APIs provided by the network.

It should be noted that performance prediction is not a pure action between NSC and the mobile system, but between terminal (like the car) and the mobile system.

A prediction (request as well as reply) is always associated with a point of time in the future and a geolocation. A prediction provided by the network slice to the terminal and/or customer (prediction reply) should always be associated with a confidence interval to give an idea about how reliable the prediction is. The reliability depends on many parameters, e.g. which KPI to predict, look ahead of time, etc.

3.4.19 Positioning support

This attribute describes if the network slice provides geo-localization methods or supporting methods.

Availability

This parameter describes if this attribute is provided by the network slice and contains a list of positioning methods provided by the slice. If the list is empty this attribute is not available in the network slice and the other parameters might be ignored.

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	1: CID 2: E-CID (LTE and NR) 3: OTDOA (LTE and NR) 4: RF fingerprinting 5: AECID 6: Hybrid positioning 7: NET-RTK
Tags	Character attribute / Functional API

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 28 Positioning Support Table

Prediction frequency

This parameter describes how often location information is provided. This parameter simply defines how often the customer is allowed to request location information. This is not related to the time it takes to determine the location, which is a characteristic of the positioning method.

Parameters	
Value	Integer
Measurement unit	NA
Example	1: per second 2: per minute 3: per-hour 4: conditional, e.g. in case a specific area is entered or left
Tags	Character attribute / Functional API

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 29 Prediction Frequency Table

Accuracy

This parameter describes the accuracy of the location information. Accuracy depends on the respective positioning solution applied in the network slice.

Parameters	
Value	Float
Measurement unit	meter
Example	+/- 1m +/- 0,01m
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 30 Prediction Accuracy Table

Additional Information

Many use cases have a strong demand for the capability of positioning (geo-localisation) devices. Different NSC may have different requirements in terms of accuracy, energy efficiency, indoor/outdoor support, and cost, etc. For some of the use cases, positioning techniques will have to work reliably under challenging conditions, e.g. deep indoors.

It should be noted that either for some use cases, such as many IoT use cases, GPS (Global Positioning Service) or other Global Navigation Satellite Systems (GNSS) are not an option because of the high energy consumption or because simple devices are not equipped with the suitable receiver.

For other use cases, e.g. automotive, GNSS is a suitable positioning solution for most of the times although there are a number of situations where this is not accessible e.g. tunnels, indoors, etc. Hence, it is beneficial to combine the advantages of these systems with the positioning capabilities of 5G to provide a solution that meets the NSC scenarios.

In general, the different positioning methods can be categorized into precise positioning, cellular-based positioning and new radio (NR)-based positioning.

Cellular positioning refers to positioning methods in which the cellular network is determining the position of the terminal. The following cellular positioning technologies can be used:

- Cell ID (CID) is the basic method which utilizes cellular system knowledge about the serving cell of a specific user; the user location area is thus associated with the serving CID.
- Enhanced Cell ID (E-CID) refers to a network-based method assisted by the UE. This method utilizes CIDs, Radio Frequency RF measurements from multiple cells, timing advance, and Angle of Arrival (AoA) measurements.
- Observed Time Difference of Arrival (OTDOA) is a UE-assisted method based on reference signal time difference (RSTD) measurements conducted on downlink positioning reference signals received from multiple locations, where the user location is calculated by multi-alteration.
- RF fingerprinting is a method of finding a user position by mapping RF measurements obtained from the UE onto an RF map, where the map is typically based on detailed RF predictions or site surveying results
- Adaptive Enhanced Cell Identity (AECID) is a method that enhances the performance of RF fingerprinting by extending the number of radio properties that are used, where at least CIDs, timing advance, RSTD, and AoA may be used in addition to received signal strengths, and where the corresponding databases are automatically built up

by collecting high-precision OTDOA and A-GNSS positions, tagged with measured radio properties.

The following table provides an overview about the characteristics of the different cellular positioning methods.

Positioning Method	Environment Limitations	UE Impact	Site Impact	System Impact	Response Time (RAN)	Horizontal uncertainty	Vertical Uncertainty
CID Proximity location	No	No	No	Small	Very low	High	NA
E-CID	No	Small	Small	Medium	Low	Medium	NA
E-CID/AoA	Rich multipath	Small	Large	Medium	Low	Medium	NA
RF fingerprinting	Rural	Small	Small	Large	Low/medium	Low/medium	Medium
AECID	No	Small	Small	Medium	Low	Low/medium	Medium
UTDOA	Suburban/Rural	Small	Large	Large	Medium	<100m	Medium
OTDOA	Rural	Medium	Medium	Medium	Medium	<100m	Medium
A-GNSS	Indoor	Large	Small	Medium	Medium/high	<5m	<20m

Table 31 Characteristics of cellular positioning methods

3.4.20 Radio spectrum

Defines the radio spectrum supported by the network slice. This is important information, as some terminals might be restricted in terms of frequencies to be used.

Parameters	
Value	{String, String, String, …}
Measurement unit	NA
Example	n1 n77 n38
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 32 Radio Spectrum Table

Additional information

This attribute simply tells which frequencies can be used to access the network slice.

3GPP TS 38.101 [4] standardised 5G NR operating bands as follows:

NR operating band	Uplink (UL) *operating band* BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) *operating band* BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex Mode
n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
n2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
n7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
n12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
n20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
n34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD
n38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
n39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
n41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD
n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
n70	1695 MHz – 1710 MHz	1995 MHz – 2020 MHz	FDD
n71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
n75	N/A	1432 MHz – 1517 MHz	SDL
n76	N/A	1427 MHz – 1432 MHz	SDL
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD
n80	1710 MHz – 1785 MHz	N/A	SUL

n81	880 MHz – 915 MHz	N/A	SUL
n82	832 MHz – 862 MHz	N/A	SUL
n83	703 MHz – 748 MHz	N/A	SUL
n84	1920 MHz – 1980 MHz	N/A	SUL
n86	1710 MHz – 1780MHz	N/A	SUL

E-UTRA is designed to operate in the operating bands defined in table below [5].

Narrow Band – IoT (NB-IoT) is designed to operate in the E-UTRA operating bands 1, 2, 3, 4, 5, 8, 11, 12, 13, 14, 17, 18, 19, 20, 21, 25, 26, 28, 31, 41, 66, 70, 71, 72, 73, 74, 85.

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
4	1710 MHz – 1755 MHz	2110 MHz – 2155 MHz	FDD
5	824 MHz – 849 MHz	869 MHz – 894MHz	FDD
6 (NOTE 1)	830 MHz – 840 MHz	875 MHz – 885 MHz	FDD
7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
9	1749.9 MHz – 1784.9 MHz	1844.9 MHz – 1879.9 MHz	FDD
10	1710 MHz – 1770 MHz	2110 MHz – 2170 MHz	FDD
11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
13	777 MHz – 787 MHz	746 MHz – 756 MHz	FDD
14	788 MHz – 798 MHz	758 MHz – 768 MHz	FDD
15	Reserved	Reserved	FDD
16	Reserved	Reserved	FDD
17	704 MHz – 716 MHz	734 MHz – 746 MHz	FDD
18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD
20	832 MHz – 862 MHz	791 MHz – 821 MHz	
21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD

22	3410 MHz – 3490 MHz	3510 MHz – 3590 MHz	FDD
23[1]	2000 MHz – 2020 MHz	2180 MHz – 2200 MHz	FDD
24	1626.5 MHz – 1660.5 MHz	1525 MHz – 1559 MHz	FDD
25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
27	807 MHz – 824 MHz	852 MHz – 869 MHz	FDD
28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
29	N/A	717 MHz – 728 MHz	FDD (NOTE 2)
30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD
31	452.5 MHz – 457.5 MHz	462.5 MHz – 467.5 MHz	FDD
32	N/A	1452 MHz – 1496 MHz	FDD (NOTE 2)
33	1900 MHz – 1920 MHz	1900 MHz – 1920 MHz	TDD
34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD
35	1850 MHz – 1910 MHz	1850 MHz – 1910 MHz	TDD
36	1930 MHz – 1990 MHz	1930 MHz – 1990 MHz	TDD
37	1910 MHz – 1930 MHz	1910 MHz – 1930 MHz	TDD
38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
43	3600 MHz – 3800 MHz	3600 MHz – 3800 MHz	TDD
44	703 MHz – 803 MHz	703 MHz – 803 MHz	TDD
45	1447 MHz – 1467 MHz	1447 MHz – 1467 MHz	TDD
46	5150 MHz – 5925 MHz	5150 MHz – 5925 MHz	TDD (NOTE 3, NOTE 4)
47	5855 MHz – 5925 MHz	5855 MHz – 5925 MHz	TDD
48	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD
49	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD (NOTE 8)
50	1432 MHz - 1517 MHz	1432 MHz - 1517 MHz	TDD
51	1427 MHz - 1432 MHz	1427 MHz - 1432 MHz	TDD
52	3300 MHz - 3400 MHz	3300 MHz - 3400 MHz	TDD
65	1920 MHz – 2010 MHz	2110 MHz – 2200 MHz	FDD

66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD (NOTE 5)
67	N/A	738 MHz – 758 MHz	FDD (NOTE 2)
68	698 MHz – 728 MHz	753 MHz – 783 MHz	FDD
69	N/A	2570 MHz – 2620 MHz	FDD (NOTE 2)
70	1695 MHz – 1710 MHz	1995 MHz – 2020 MHz	FDD[6]
71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
72	451 MHz – 456 MHz	461 MHz – 466 MHz	FDD
73	450 MHz – 455 MHz	460 MHz – 465 MHz	FDD
74	1427 MHz – 1470 MHz	1475 MHz – 1518 MHz	FDD
75	N/A	1432 MHz – 1517 MHz	FDD (NOTE 2)
76	N/A	1427 MHz – 1432 MHz	FDD (NOTE 2)
85	698 MHz – 716 MHz	728 MHz – 746 MHz	FDD

NOTE 1: Band 6, 23 are not applicable.

NOTE 2: Restricted to E-UTRA operation when carrier aggregation is configured. The downlink operating band is paired with the uplink operating band (external) of the carrier aggregation configuration that is supporting the configured Pcell.

NOTE 3: This band is an unlicensed band restricted to licensed-assisted operation using Frame Structure Type 3.

NOTE 4: Band 46 is divided into four sub-bands as in Table 5.5-1A.

NOTE 5: The range 2180 – 2200 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured.

NOTE 6: The range 2010-2020 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured and TX-RX separation is 300 MHz. The range 2005-2020 MHz of the DL operating band is restricted to E-UTRA operation when carrier aggregation is configured and TX-RX separation is 295 MHz.

NOTE 7: Void

NOTE 8: This band is restricted to licensed-assisted operation using Frame Structure Type 3.

3.4.21 Reliability

Void

Editor's Note: This attribute will be added to the document in the subsequent versions

3.4.22 Root cause investigation

Root cause investigation is the capability provided to NSC to understand or investigate the root cause of network service performance degradation or failure.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: not available 1: passive investigation 2: active investigation
Tags	Character attribute / Functional / Operational API

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 33 Root Cause Investigation Table

Additional information

This attribute could be implemented in different facets: passive investigation or activate investigation.

In passive investigation, the NSC is informed about the root cause of the network service performance degradation or failure in case there is a problem with the network slice.

In active investigation, if something is wrong in the network, a NSC could perform investigation itself, for instance call for the log files of different technical domain, to understand where the problem is, then it is not just an API telling the NSC if there is a problem or not.

It should be clear that this attribute is only about the investigation of a problem. This attribute does not provide any means to solve the problem.

3.4.23 Session and Service Continuity support

The attribute defines the continuity of a Protocol Data Unit (PDU) session. The following three Session and Service Continuity (SSC) modes are specified [1]:

- SSC mode 1 - the network preserves the connectivity service provided to the UE (the IP address is preserved)
- SSC mode 2 - the network may release the connectivity service delivered to the UE and release the corresponding PDU Session (the network may release IP address(es) that had been allocated to the UE)
- SSC mode 3 - changes to the user plane can be visible to the UE, while the network ensures that the UE suffers no loss of connectivity service (the IP address is not preserved in this mode when the PDU Session Anchor changes)

- None – UE loses the connectivity service

Parameters	
Value	Integer, Integer, Integer
Measurement unit	NA
Example	0: none 1: SSC mode 1 2: SSC mode 2 3: SSC mode 3
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 34 Service Continuity Table

3.4.24 Simultaneous use of the network slice

This attribute describes whether a network slice can be simultaneously with other network slice and if so, which group the network slice belongs to.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: Can be used with any slice 1: Can be used with slices with same SST value 2: Can be used with any slice with same SD value 3: Cannot be used with another slice 4-15: operator defined class
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 35 Simultaneous NS Table

3.4.25 Slice quality of service parameters

This attribute defines all the QoS relevant parameters supported by the network slice. For some of these parameters 3GPP has already defined standard values [1]. By preselecting a 5G QoS Identifier (5QI) these parameters will automatically be filled out with the standardised values. A list of available 5QIs and the standardised values can be found in Additional Information.

3GPP 5QI

A 5QI is a scalar used as a reference to 5G QoS characteristics defined in clause [1], i.e. access node-specific parameters that control QoS forwarding treatment for the QoS Flow (e.g. scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration, etc.).

Standardized 5QI values have one-to-one mapping to a standardized combination of 5G QoS characteristics as [1], see Additional Information.

The 5G QoS characteristics for pre-configured 5QI values are pre-configured in the Access Network (AN). The 5G QoS characteristics for QoS Flows with dynamically assigned 5QI are signalled as part of the QoS profile [1].

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	1,2,3…See 5QI value in the table below 100 - 200: Other (customised)
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 36 Slice Quality Table

Resource Type

The Resource Type determines if dedicated network resources related QoS Flow-level Guaranteed Flow Bit Rate (GFBR) value are permanently allocated [1]. This value needs to be provided for each customised 5QI value selected.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: GBR (Mission Critical Video user plane) 1: Delay critical GBR (Intelligent Transport Systems) 2: Non-GBR (Voice, AR)
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 37 Resource Type Table

Priority Level

The Priority level associated with 5G QoS characteristics indicates a priority in scheduling resources among QoS Flows. The Priority level shall be used to differentiate between QoS Flows of the same UE, and it shall also be used to differentiate between QoS Flows from different UEs. Once all QoS requirements up to GFBR are fulfilled for all the Guaranteed Bit Rate (GBR) QoS Flows, the Priority Level may also be used to distribute resources between GBR QoS Flows (for rates above GFBR up to MFBR, Maximum Flow Bit Rate) and non-GBR QoS Flows, in an implementation specific manner. The lowest Priority level value corresponds to the highest Priority [1]. This value needs to be provided for each customised 5QI value selected.

Parameters	
Value	Float
Measurement unit	Seconds
Example	10 - IMS signalling 30 – Real time gaming
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 38 Priority Level Table

Packet Delay Budget

The Packet Delay Budget (PDB) defines an upper bound for the time that a packet may be delayed between the UE and the UPF, that terminates the N6 interface. For a certain 5QI the value of the PDB is the same in UL (Uplink) and DL (Downlink). In the case of 3GPP access, the PDB is used to support the configuration of scheduling and link layer functions (e.g. the setting of scheduling priority weights and HARQ (Hybrid Automatic Repeat request) target operating points) [1].

If the value is set to 0, no special measures are used to bring latency down to a minimum required by low-latency use cases.

This value needs to be provided for each customised 5QI value selected.

Parameters	
Value	Float
Measurement unit	Seconds
Example	Cooperative driving: $20*10^3$ seconds Virtual reality: 10 – $30*10^3$ seconds
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 39 Packet Delay Budget Table

Packet Error Rate

The Packet Error Rate (PER) defines an upper bound for the rate of PDUs (e.g. IP packets) that have been processed by the sender but that are not successfully delivered by the corresponding receiver. The purpose of the PER is to allow for the appropriate link layer, protocol configurations (e.g. RLC and HARQ in RAN of a 3GPP access). For all 5QIs the value of the PER is the same in UL and DL. For GBR QoS Flows with Delay critical GBR resource type, a packet which is delayed more than PDB (but which complies with the GFBR and MDBV (Maximum Data Burst Volume) requirements) is counted as lost, and included in the PER. Delayed packets are not included in the PER if a GBR QoS Flow with a Delay

critical resource type is exceeding the GFBR and the Maximum Data Burst Volume [1]. This value needs to be provided for each customised 5QI value selected.

Parameters	
Value	Integer
Measurement unit	NA
Example	10-6 – mission critical data 10-2 V2X messaging
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 40 Packet Error Rate Table

Jitter

Jitter is defined as a variation in the delay of received packets. At the sending side, packets are sent in a continuous stream with the packets spaced evenly apart. Due to network congestion, improper queuing, or configuration errors, this steady stream can become lumpy, or the delay between each packet can vary instead of remaining constant.

Parameters	
Value	Float
Measurement unit	Seconds
Example	
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 41 Jitter Table

Maximum Packet Loss Rate

The Maximum Packet Loss Rate (UL, DL) indicates the maximum rate for lost packets of the QoS flow that can be tolerated in the uplink (UL) and downlink (DL) direction.

Note: The Maximum Packet Loss Rate (UL, DL) can only be provided for a GBR QoS flow belonging to voice media.

Parameters	
Value	Integer
Measurement unit	Percentage (%)
Example	
Tags	Character attribute / Functional / Operational KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 42 Max Packet Loss Rate Table

Additional Information

3GPP has already defined standardized 5QI to QoS characteristics mapping. As long as these classes are used, the 5G (or the 3GPP) system is able to support these requirements. For different combinations of QoS characteristics it needs to be checked if and how they can be supported.

For low latency there are measures discussed within the context of 5G to enable low latency communication. However, not sure what is the limit of these measures and if all requirements can be met.

Orchestrator may use this attribute to orchestrate the resources and (R)AN/CN may use this attribute to optimize the scheduling.

The parameter of this attribute can be filled separately. However, by selecting an already specified standardized 5QI the relevant parameters might be filled automatically.

3GPP TS 23.501 **Error! Reference source not found.** standardised 5G QoS values as f ollows:

5QI Value	Resource Type	Default Priority Level	Packet Delay Budget	Packet Error Rate	Default Maximum Data Burst Volume (NOTE 2)	Default Averaging Window	Example Services
1	GBR	20	100 ms	10^{-2}	N/A	2000 ms	Conversational Voice

2	NOTE 1	40	150 ms	10^{-3}	N/A	2000 ms	Conversational Video (Live Streaming)
3		30	50 ms	10^{-3}	N/A	2000 ms	Real Time Gaming, V2X messages Electricity distribution – medium voltage, Process automation - monitoring
4		50	300 ms	10^{-6}	N/A	2000 ms	Non-Conversational Video (Buffered Streaming)
65		7	75 ms	10^{-2}	N/A	2000 ms	Mission Critical user plane Push To Talk voice (e.g., MCPTT)
66		20	100 ms	10^{-2}	N/A	2000 ms	Non-Mission-Critical user plane Push To Talk voice
67		15	100 ms	10^{-3}	N/A	2000 ms	Mission Critical Video user plane
75		25	50 ms	10^{-2}	N/A	2000 ms	V2X messages
5	Non-GBR	10	100 ms	10^{-6}	N/A	N/A	IMS Signalling
6	NOTE 1	60	300 ms	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	10^{-3}	N/A	N/A	Voice, Video (Live Streaming) Interactive Gaming
8		80					Video (Buffered Streaming) TCP-based

			300 ms	10^{-6}	N/A	N/A	(e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9		90					
69		5	60 ms	10^{-6}	N/A	N/A	Mission Critical delay sensitive signalling (e.g., MC-PTT signalling)
70		55	200 ms	10^{-6}	N/A	N/A	Mission Critical Data (e.g. example services are the same as QCI 6/8/9)
79		65	50 ms	10^{-2}	N/A	N/A	V2X messages
80		68	10 ms	10^{-6}	N/A	N/A	Low Latency eMBB applications Augmented Reality
81	Delay Critical GBR	11	5 ms	10^{-5}	160 B	2000 ms	Remote control (see TS 22.261 [2])
82		12	10 ms NOTE 5	10^{-5}	320 B	2000 ms	Intelligent transport systems
83		13	20 ms	10^{-5}	640 B	2000 ms	Intelligent Transport Systems
84		19	10 ms	10^{-4}	255 B	2000 ms	Discrete Automation
85		22	10 ms	10^{-4}	1358 B NOTE 3	2000 ms	Discrete Automation

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: This MDBV value is intended to avoid IP fragmentation on an IPv6 based, IPSec protected, and GTP tunnel to the 5G-AN node.

NOTE 4: A delay 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.

NOTE 5: The jitter for this service is assumed to be 20 ms according to TS 22.261

Table 43 Standardized 5QI to QoS characteristics mapping

3.4.26 Support for non-IP traffic

This attribute provides non-IP Session support (Ethernet session and forwarding support) of communication devices.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 44 Non-IP traffic Support Table

Additional information

The most important case is to support packet exchange in the power deferential protection:

- Transmission between a mobile device, customer premises equipment (CPE) and UPF
- Between adjacent UPF.

Core Network (UPF) may use Ethernet session and forwarding to transmit package as customized network slice ability to fully meet the communication requirement of some vertical industries application scenarios.

There are mechanisms for DNN (data network name) described in [1].

A DNN is equivalent to an APN and both identifiers have an equivalent meaning and carry the same information.

The DNN may be used e.g. to:

- Select a Session Management Function or SMF and UPF(s) for a PDU Session.
- Select N6 interface(s) for a PDU Session.
- Determine policies to apply to this PDU Session.

Today some scenarios of industries have requirements for which protocol transport between communications devices need to support Non-IP sessions, such as, power differential protection.

End to End 5G network slicing needs to support the Ethernet session and forwarding to transmit package as customized network slice ability to fully meet the communication requirement of the power differential protection.

3.4.27 Supported access technologies

This attribute defines which access technologies are supported by the network slice.

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	1: GERAN 2: UTRAN 3: E-UTRA 4: NR 5: LTE-M 6: NB-IoT 7: Wi-Fi 8: Bluetooth 9: Fixed access, e.g. DSL, Fibre
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 45 Access Technologies Table

3.4.28 Supported device velocity

Maximum speed supported by the network slice at which a defined QoS and seamless transfer between TRxPs (Transmission Reception Point(s)), which may belong to different deployment layers and/or radio access technologies (multi-layer /-RAT), can be achieved.

Parameters	
Value	Integer
Measurement unit	Kilometres per hour (km/h)
Example	1: Stationary: 0 km/h 2: Pedestrian: 0 km/h to 10 km/h 3: Vehicular: 10 km/h to 120 km/h 4: High speed vehicular: 120 km/h to 500 km/h
Tags	Character attribute / Performance KPI

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 46 Device Velocity Table

Additional information

For non-low latency requirements, the expected speeds might not be a problem. More important is the support of URLLC services under high mobility scenarios.

Orchestrator may use this attribute to orchestrate the resources and network functions. If value is set to 0, it means no mobility is supported (e.g., the UE is not moving).

3.4.29 Synchronicity

This attribute provides synchronicity of communication devices. Two cases are most important in this context:

- Synchronicity between a base station and a mobile device and
- Synchronicity between mobile devices.

Availability

The synchronicity between devices over PC5 in absence of the network is not in scope of this attribute.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: not available 1: between BS and UE 2: between BS and UE & UE and UE
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 47 Synchronicity Availability Table

Accuracy

This parameter describes the accuracy of the synchronicity.

Parameters	
Value	Float
Measurement unit	seconds
Example	0,0000001 seconds (1µs)
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 48 Synchronicity Accuracy Table

Additional Information

Today these requirements are met by the deploying cable connections/networks as like industrial Ethernet systems or fieldbuses. These networks are normally closed solutions by a single vendor in which all the equipment is perfectly aligned. Based on standards like IEEE 802.1 AS [9] or IEEE 1588 [8] very high synchronicity can be achieved in the networks.

3.4.30 Terminal density

This attribute describes the maximum number of connected and/or accessible devices per unit area (per km2) supported by the network slice.

Parameters	
Value	Integer
Measurement unit	Number per km2
Example	10.000 devices per km^2 for some industry 4.0 use cases (but this is required a campus coverage only) 1.000.000 devices per km^2 for MIoT use cases
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 49 Terminal Density Table

Additional information

Most of the required densities can be supported with 5G. Most challenging are the MIoT use cases for which it is not sure if the required device densities can be fulfilled.

This attribute describes the maximum number of users/terminals supported per area. In case fewer users are present at moment, the network slice can be scaled down, e.g. resources can be released and for instance be used by other network slices.

3.4.31 Uplink throughput per network slice

The achievable data rate of the network slice instance in uplink that is available ubiquitously across the coverage area of the network slice.

Guaranteed uplink throughput

This attribute describes the guaranteed data rate supported by the network slice in uplink. There are services (e.g. emergency services) where guaranteed uplink throughput is required.

Parameters	
Value	Integer
Measurement unit	Bytes
Example	0 (not specified) 10 Mbps
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 50 Guaranteed Uplink Throughput Table

Maximum uplink throughput

This attribute describes the maximum data rate supported by the network slice in uplink.

Parameters	
Value	Integer
Measurement unit	Bytes
Example	100 Mbps 10 Gbps
Tags	Scalability attribute

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 51 Maximum Uplink Throughput Table

Note: Either Maximum uplink throughput per network slice or Maximum uplink throughput per slice shall be present.

Additional information

This attribute might be used to set throughput guarantees per network slice (and not per user).

Minimum throughput can be defined to guarantee a minimum performance required to achieve a sufficient quality experience (dependent on the selected service type).

Maximum throughput can be used to offer different network slice contract qualities level, e.g. gold, silver and bronze which have different maximum throughput values.

3.4.32 Uplink throughput per UE

Guaranteed uplink throughput

This attribute describes the guaranteed data rate supported by the network slice per UE in uplink, required to achieve a sufficient quality experience (dependent on the selected service type). If the value is 0, best effort traffic is expected where no minimum throughput is guaranteed.

Parameters	
Value	Integer
Measurement unit	kbps
Example	180 Kbps for VoIP traffic 75.000 Kbps for entry level VR latency.
Tags	Character attribute / Functional KPI

Parameter Presence	
Mandatory	
Conditional	
Optional	X

Table 52 Guaranteed Uplink Throughput per UE Table

Maximum uplink throughput

This attribute describes the maximum data rate supported by the network slice per UE in uplink. These parameters could be used in order to offer different contract qualities like gold, silver and bronze.

Parameters	
Value	Integer
Measurement unit	kbps
Example	Bronze customer: 10.000 Kbps Silver customer: 100.000 Kbps Gold customer: 200.000 Kbps
Tags	Character attribute / Functional KPI

Attribute Presence	
Mandatory	
Conditional	X
Optional	

Table 53 Maximum Uplink Throughput per UE Table

Note: Either Maximum uplink throughput per network slice or Maximum uplink throughput per UE must be present.

Additional information

This attribute might be used to set different guarantees in terms of throughput experienced by the customer in uplink.

Minimum throughput can be defined in order to guarantee a minimum performance required to achieve a sufficient quality experience (dependent on the selected service type).

Maximum throughput can be used to offer different contract qualities level, e.g. gold, silver and bronze which have different maximum throughput values.

Orchestrator may use this attribute to orchestrate the resources and (R)AN/CN may use this attribute to optimize the scheduling.

3.4.33 User management openness

This attribute describes the capability for the NSC to manage their users or groups of users' network services and corresponding requirements. For instance, if NSC Y orders a network slice which is capable to support X users of Y, then Y should be capable to decide which X users could use this network slice. Hence, Y could manage the users, in terms of add, modify or delete users to receive network services provided by the specific network slice.

Parameters	
Value	Binary
Measurement unit	NA
Example	0: not supported 1: supported
Tags	Character attribute / Functional / Operational API

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 54 User Management Table

3.4.34 User data access

Data access

The attribute defines how the network slice (or mobile network) should handle the user data. The options are as follows:

- The device has access to the Internet
- All data traffic is routed to the private network (e.g. via tunnelling mechanism such as L2TP, VPN Virtual Private Network, tunnel, etc.)
- All data traffic stays local and the devices do not have access to the Internet or private network

Parameters	
Value	{Integer, Integer, Integer…}
Measurement unit	NA
Example	0: Direct internet access 1: Termination in the private network 2: Local traffic (no internet access)
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	X
Conditional	
Optional	

Table 55 User Data Access Table

Tunnelling mechanism

The attribute defines the tunnelling mechanism; how the user data can be delivered to the external private data network. 3GPP TS 29.561 [12] lists the interworking with data networks and tunnelling mechanism used.

Parameters	
Value	{Integer, Integer, Integer...}
Measurement unit	NA
Example	0: L2TP Tunnel 1: GRE Tunnel 2: VPN Tunnel 3: Label bases routing 4: Other
Tags	Character attribute / Functional

Parameter Presence	
Mandatory	
Conditional	X
Optional	

Table 56 Tunnelling Mechanism Table

Note: This parameter is present if User data Access is 1(Termination in the private network).

Additional information

Many solutions are already available today like Control and User Plane Separation (CUPS) [10], [11], N6 tunnelling mechanism [12], etc.

3.4.35 V2X communication mode

This parameter describes if the V2X communication mode is supported by the network slice.

Parameters	
Value	Integer
Measurement unit	NA
Example	0: NO 1: YES-EUTRA 2: YES- NR 3: YES -NR and E-UTRA
Tags	Character attribute / Functional

Attribute Presence	
Mandatory	
Conditional	
Optional	X

Table 57 V2X Communication Mode Table

4 NEST

Different requirements for the services that a network slice instance should support result to different NESTs. This section lists the most common NESTs with the minimum set of the attributes.

All attributes are grouped based on the following groups:

- Character Attributes - the attribute's value is in the NEST.
- Scalability attributes - the attribute's value for scalability attributes depends on actual business case and each NSP is responsible for filling in the values.

4.1 NEST with IMS support

The Table 58 list the minimum set of attributes needed for NEST network slice instance where IMS services (MMTel and RCS) are supported. To provide the seamless service continuity, N26 interface and SSC mode 1 must be used.

Attribute	Attribute presence	Value
Character Attributes		
Coverage	Mandatory	2 (or 1 if roaming agreements are in place)
Delay tolerance	Mandatory	0
Deterministic communication	Mandatory	0
Isolation level	Mandatory	0
Group communication support	Mandatory	0
Location based message delivery	Mandatory	0
Maximum supported packet size	Optional	1500 (or 9000 if jumbo packets are supported)
Mission-critical support	Mandatory	0
MMTel support	Mandatory	1
Session and Service Continuity support	Mandatory	1
Slice quality of service parameters	Mandatory	1,2,5,6,7,8, 9
Support for non-IP traffic	Mandatory	0
Supported access technologies	Optional	4*

Attribute	Attribute presence	Value
User management openness	Mandatory	0
User data access	Mandatory	0
Scalability Attributes		
Downlink throughput per network slice	Conditional	
Number of connections	Conditional	
Number of terminals	Conditional	
Radio spectrum	Optional	
Supported access technologies	Optional	
Uplink throughput per network slice	Conditional	

Table 58 List of attributes needed for NEST with IMS support

Note: *Other radio access types are FFS.

Annex A Document Management

Document History

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