**3GPP TSG-SA5 Meeting #162 *S5-253988***

Goteborg, Sweden, 25 - 29 August 2025

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **28.554** | **CR** | **0243** | **rev** | **1** | **Current version:** | **19.4.1** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **x** | Core Network | **x** |

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| ***Title:*** | Rel-19 CR TS 28.554 Update the unit and type of the KPI | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, Ericsson | | | | | | | | | |
| ***Source to TSG:*** | SA5 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | TEI19 | | | | |  | ***Date:*** | | | 2025-08-15 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | The KPI template has been updated in S5‑252968 and further updated in S5-253404.  All KPIs definitions in TS 28.554 need to be updated based on the new KPI template. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Add b-1) and b-2) for each KPI definition. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The KPIs definitions are not align with the KPI template. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

|  |
| --- |
| **1st Change** |

## 6.2 Accessibility KPI

### 6.2.1 Mean registered subscribers of network and network slice through AMF

a) AMFMeanRegNbr.

b) This KPI describe the mean number of subscribers that are registered to a network slice instance. It is obtained by counting the subscribers in AMF that are registered to a network slice instance.

b-1) Integer

b-2) MEAN

c)



d) SubNetwork, NetworkSlice

### 6.2.2 Registered subscribers of network through UDM

a) UDMRegNbr.

b) This KPI describe the total number of subscribers that are registered to a network through UDM. It is corresponding to the measurement RM.RegisteredSubUDMNbrMean that counts subscribers registered in UDM.

b-1) Integer

b-2) MEAN

c)



d) SubNetwork

### 6.2.3 Registration success rate of one single network slice

a) RSR.

b) This KPI describes the ratio of the number of successfully performed registration procedures to the number of attempted registration procedures for the AMF set which related to one single network slice and is used to evaluate accessibility provided by the end-to-end network slice and network performance. It is obtained by successful registration procedures divided by attempted registration procedures.

b-1) Integer, percentage

b-2) RATIO

c)



Note: Above measurements with subcounter .*Type* should be defined in 3GPP TS 24.501 [4].

d) NetworkSlice

### 6.2.4 Partial DRB Accessibility for UE services

a) Partial DRB Accessibility

b) This KPI describes the DRBs setup success rate, including the success rate for setting up RRC connection and NG signalling connection. It is obtained as the succeess rate for RRC connection setup multiplied by the success rate for NG signalling connection setup multiplied by the success rate for DRB setup. The success rate for RRC connection setup and for NG signalling connection setup shall exclude setups with establishment cause mo-Signalling [5].

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Partial DRBAccessibility 5QI = (∑RRC.ConnEstabSucc.*Cause*/∑RRC.ConnEstabAtt.*Cause*) \* (∑UECNTXT.ConnEstabSucc.*Cause*/∑ UECNTXT.ConnEstabAtt.*Cause*) \* (DRB.EstabSucc.5QI/DRB.EstabAtt.5QI) \* 100

Partial DRB Accessibility SNSSAI = (∑RRC.ConnEstabSucc.*Cause*/∑RRC.ConnEstabAtt.*Cause*) \* (∑UECNTXT.ConnEstabSucc.*Cause*/∑ UECNTXT.ConnEstabAtt.*Cause*) \* (DRB.EstabSucc.SNSSAI/DRB.EstabAtt.SNSSAI) \* 100.

The sum over causes shall exclude the establishment cause mo-Signalling [5].

For KPI on SubNetwork level the measurement shall be the averaged over all NRCellCUs in the SubNetwork

d) SubNetwork, NRCellCU.

### 6.2.5 PDU session Establishment success rate of one network slice (S-NSSAI)

a) PDUSessionEstSR.

b) This KPI describes the ratio of the number of successful PDU session establishment request to the number of PDU session establishment request attempts for all SMF which related to one network slice (S-NSSAI) and is used to evaluate accessibility provided by the end-to-end network slice and network performance. It is obtained by the number of successful PDU session requests divided by the number of attempted PDU session requests.

b-1) Integer, percentage, 0-100

b-2) RATIO

c)



d) NetworkSlice

### 6.2.6 Maximum registered subscribers of network slice through AMF

a) AMFMaxRegNbr.

b) This KPI describe the maximum number of subscribers that are registered to a network slice. It is obtained by counting the subscribers in AMF that are registered to a network slice.

b-1) Integer

b-2) CUM

c)



d) NetworkSlice

### 6.2.7 Total DRB accessibility for UE services

a) Total DRB accessibility

b) This KPI describes the total DRBs accessibility obtained as the ratio of the number of successfully established DRBs and number of services intended to be setup by the end user that shall result into a DRB establishment via Initial Context setup procedure, Added DRB setup and RRC Resume procedure. The number of services intended to be setup by the end user that shall result into a DRB establishment via Initial Context setup procedure is obtained as number of attempted establishments of DRB via Initial Context setup procedure amplified by inverse of the UE-associated logical NG-connection success ratio further amplified by inverse of the RRC Connection setup state success ratio. The number of services intended to be setup by the end user that shall result into a DRB establishment via added DRB setup procedure is measured directly in gNB via number of attempted establishments of DRB via added DRB setup procedure. Finally the number of services intended to be setup by the end user that shall result into a DRB establishment via RRC Resume procedure is provided as number of attempted establishments of DRB via RRC Resume procedure amplified by inverse of the RRC Resume success ratio. The success rate for RRC connection setup and for UE-associated logical NG-connection setup shall exclude setups with establishment cause mo-Signalling [5]. The success rate for RRC resume shall exclude setups related to RNA update.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) DRBAccessibility 5QI = 100 \* (DRB.InitialEstabSucc.5QI + (DRB.EstabSucc.5QI-DRB.InitialEstabSucc.5QI) + DRB.ResumeSucc.5QI)/( DRB.InitialEstabAtt.5QI/((RRC connection setup success rate /100)\*( UE-associated logical NG-connection success ratio/100)) + (DRB.EstabAtt.5QI-DRB.InitialEstabAtt.5QI) + DRB.ResumeAtt.5QI/( RRC Resume success rate/100))

DRBAccessibility SNSSAI = 100 \* (DRB.InitialEstabSucc. SNSSAI + (DRB.EstabSucc. SNSSAI -DRB.InitialEstabSucc. SNSSAI) + DRB.ResumeSucc. SNSSAI)/( DRB.InitialEstabAtt. SNSSAI /((RRC connection setup success rate /100)\*( UE-associated logical NG-connection success ratio /100)) + (DRB.EstabAtt. SNSSAI -DRB.InitialEstabAtt. SNSSAI) + DRB.ResumeAtt. SNSSAI /( RRC Resume success rate/100))

Where:

RRC Resume success rate = 100\* ∑RRC.ResumeSucc.cause /∑(RRC.ResumeAtt.cause - RRC.ResumeFallbackToSetupAtt.cause), where all but the causes related to RNA update shall be included.

RRC connection setup success rate = 100\* (∑(RRC.ConnEstabSucc.Cause + RRC.ResumeSuccByFallback.cause) + RRC.ReEstabSuccWithoutUeContext) /(∑(RRC.ConnEstabAtt.Cause + RRC.ResumeFallbackToSetupAtt.cause) + RRC.ReEstabFallbackToSetupAtt)

UE-associated logical NG-connection success ratio = 100\*(∑UECNTXT.ConnEstabSucc.Cause/∑ UECNTXT.ConnEstabAtt.Cause)

The sum over causes shall exclude the establishment cause mo-Signalling [5].

The sum over causes for RRC resume shall exclude the causes related to RNA update [5].

For KPI on SubNetwork level the measurement shall be the averaged over all NRCellCUs in the SubNetwork

d) SubNetwork, NRCellCU.

### 6.2.8 Mean CM-Connected subscribers of network slice through AMF

a) AMFMeanCmConNbr.

b) This KPI describe the mean number of subscribers in a period that are not only registered to a network slice but also established a PDU session related to the network slice. And subscribers also have a NAS signalling connection with the AMF over N1. It is obtained by counting the subscribers in AMF that are showed "cm-connected" state for a network slice.

b-1) Integer

b-2) CUM

c)



d) NetworkSlice.

### 6.2.9 Maximum on-line subscribers of network slice through AMF

a) AMFMaxCmConNbr.

b) This KPI describe the maximum number of subscribers in a period that are not only registered to a network slice but also established a PDU session related to a network slice. And subscribers also have a NAS signalling connection with the AMF over N1. It is obtained by counting the subscribers in AMF that are showed "cm-connected" state for a network slice.

b-1) Integer

b-2) CUM

c)



d) NetworkSlice.

### 6.2.10 PFCP session established success rate of one network and one network slice

a) PFCPSessionEstSR.

b) This KPI describes the successful rate of PFCP session established in a network or a network slice e on the UPF.

It is used to evaluate the quality of user-plane connection established and the accessibility provided by the end-to-end network slice and network performance. It is obtained by the number of successful PFCP session requests divided by the number of attempted PFCP session requests.

b-1) Integer, percentage

b-2) RATIO

c)

d) Subnetwork, NetworkSlice.

### 6.2.11 Group-level N4 session establishment success rate of one 5G VN group

a) GrouplevelN4SessionEstSR.

b) This KPI describes the ratio of the number of successful group-level N4 session establishment request to the number of group-level N4 session establishment request attempts for all SMF related to one 5G VN group communication and is used to evaluate accessibility provided by the end-to-end network slice and network performance. It is obtained by the number of successful group-level N4 session requests divided by the number of attempted group-level N4 session requests.

b-1) Integer, percentage

b-2) RATIO

c)



d) NetworkSlice.

### 6.2.12 PDU session Establishment success rate of one 5G VN Group (InternalgroupID)

a) PDUSessionEstSR.

b) This KPI describes the ratio of the number of successful PDU session establishment request to the number of PDU session establishment request attempts for all SMF which related to one 5G VN Group (InternalgroupID) and is used to evaluate accessibility provided by the 5G VN Group and network performance. It is obtained by the number of successful PDU session requests divided by the number of attempted PDU session requests.

b-1) Integer, percentage, 0-100

b-2) RATIO

c)



\*100



d) NetworkSlice.

### 6.2.13 Positive Paging Rate

a) AMFPositivePagingRate.

b) The KPI describes the positive paging rate, i.e. the amount of paging requests that result in UEs transitioning from triggering a mobile terminated call (thus moving from Idle/Inactive to Connected Mode), w.r.t total number of paging requests. When Combined with , and (from all CUs, and their respective DUs, belonging to the same AMF), this ratio will be used to quantify the impact of false paging occasions, i.e. paging occasions that do not result in a UEs triggering mobile terminated calls, on network side paging resource utilisation as well as on UE’s power consumption : low rates will imply non optimal network resource utilisation and high UE wake up rate (wake up here is defined by Idle/Inactive to Connected mode transition) or equivalently higher UE power consumption.

b-1) Integer, percentage

b-2) RATIO

c) Below is the equation for AMFPositivePagingRate:

Measurement names:

d) AMF.

### 6.2.14 PDU Session Per Establishment Request Rate.

a) PDUSessionEstablishRatePerReqType

b) This metric shows the percentage of PDU establishment requests, per PDU Request Type, w.r.t all PDU establishment requests that a AMF receives from all UEs it serves.

b-1) Integer, percentage

b-2) RATIO

c) To measure the percentage of PDU establishment requests, per PDU Request Type:



Measurement names: ,

d) AMFFunction

### 6.2.15 PDU Session Per Establishment Request Reject Rate,.

a) PDUSessionRejectRateReqType

b) This metric shows the percentage of PDU establishment requests that get rejected by the AMF, w.r.t all PDU establishment requests that the same AMF receives from all UEs it serves, broken down by PDU Request Type.

b-1) Integer, percentage

b-2) RATIO

c) To measure the PDU establishment request Reject rate, per PDU Request Type :

Measurement names: ,

d) AMFFunction

6.2.16 MA PDU session Establishment success rate of network slice

a) MAPDUSessionEstSR.

b) This KPI describes the ratio of the number of successful MA PDU session establishment request to the number of MA PDU session establishment request attempts for all SMF which related to one network slice and is used to evaluate accessibility provided by the end-to-end network slice and network performance. It is obtained by the number of successful MA PDU session requests divided by the number of attempted MA PDU session requests.

b-1) Integer, percentage, 0-100

b-2) RATIO

c)



d) NetworkSlice

### 6.2.17 Extended DRX Negotiation Success Rate

a) eDRXNegotiationSuccessRate.

b) This KPI describes the ratio of the number of successfully performed registration procedures, where AMF configures extended DRX to UEs requesting this latter, to the number of attempted registration procedures, by those same UEs, requesting extended DRX to be configured to them. This KPI is used to evaluate accessibility performance to extended DRX feature for UEs requesting it.

b-1) Integer, percentage

b-2) RATIO

c)

d) AMF

## 6.3 Integrity KPI

### 6.3.1 Latency and delay of 5G networks

#### 6.3.1.0 Void

#### 6.3.1.1 Downlink latency in gNB-DU

a) DLLat\_gNBDU.

b) This KPI describes the gNB-DU part of the packet transmission latency experienced by an end-user. It is used to evaluate the gNB latency contribution to the total packet latency. It is the average (arithmetic mean) of the time from reception of IP packet to gNB-DU until transmission of first part of that packet over the air interface, for a packet arriving when there is no previous data in queue for transmission to the UE. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) DLLat\_gNBDU = DRB.RlcSduLatencyDl

or optionally DLLat\_gNBDU.*QoS* = DRB.RlcSduLatencyDl.QoS where QOS identifies the target QoS quality of service class.

or optionally DLLat\_gNBDU.*SNSSAI* = DRB.RlcSduLatencyDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) NRCellDU

#### 6.3.1.2 Integrated downlink delay in RAN

##### 6.3.1.2.1 Downlink delay in NG-RAN for a sub-network

a) DLDelay\_NR\_SNw.

b) This KPI describes the average packet transmission delay through the RAN part to the UE. It is used to evaluate delay performance of NG-RAN in downlink for a sub-network. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below are the equations for average “Integrated downlink delay in RAN” for this KPI on SubNetwork level. The “Integrated downlink delay in RAN” is the sum of average DL delay in gNB-CU-UP of the sub-network (DLDelay\_gNBCUUP\_SNw) and the average DL delay in gNB-DU of the sub-network (DLDelay\_gNBDU\_SNw):

DLDelay\_NR\_SNw = DLDelay\_gNBCUUP\_SNw + DLDelay\_gNBDU\_SNw

or optionally DLDelay\_ NR\_SNw.*QOS* = DLDelay\_gNBCUUP\_SNw.*QOS* + DLDelay\_gNBDU\_SNw.*QOS* where *QOS* identifies the target quality of service class.

or optionally DLDelay\_NR\_SNw.*SNSSAI* = DLDelay\_gNBCUUP\_SNw.*SNSSAI* + DLDelay\_gNBDU\_SNw.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) SubNetwork

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321[15]), this KPI is not available for UM mode.

##### 6.3.1.2.2 Downlink delay in NG-RAN for a network slice subnet

a) DLDelay\_NR\_Nss.

b) This KPI describes the average packet transmission delay through the RAN part to the UE. It is used to evaluate delay performance of NG-RAN in downlink for a network slice subnet. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average "Integrated downlink delay in RAN" for this KPI on NetworkSliceSubnet level. The "Integrated downlink delay in RAN" for network slice subnet is the sum of average DL delay in gNB-CU-UP of the network slice subnet (DLDelay\_gNBCUUP\_Nss) and the average DL delay in gNB-DU of the network slice subnet (DLDelay\_gNBDU\_Nss):

DLDelay\_NR\_Nss.*SNSSAI* = DLDelay\_gNBCUUP\_Nss.*SNSSAI* + DLDelay\_gNBDU\_Nss.*SNSSAI* where *SNSSAI* identifies the S-NSSAI that the network slice subnet supports.

d) NetworkSliceSubnet

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321[15]), this KPI is not available for UM mode.

#### 6.3.1.3 Downlink delay in gNB-DU

##### 6.3.1.3.1 Downlink delay in gNB-DU for a NRCellDU

a) DLDelay\_gNBDU\_Cell.

b) This KPI describes the average packet transmission delay through the gNB-DU part to the UE. It is used to evaluate delay performance of gNB-DU in downlink. It is the average packets delay time from arrival of an RLC SDU at the RLC ingress F1-U termination until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average DL delay in gNB-DU for a NRCellDU:

DLDelay\_gNBDU\_Cell = DRB.RlcSduDelayDl + DRB.AirIfDelayDl.

and optionally: DLDelay\_gNBDU.*QOS* = DRB.RlcSduDelayDl.*QOS* + DRB.AirIfDelayDl.*QOS* where *QOS* identifies the target quality of service class.

and optionally: DLDelay\_gNB.*SNSSAI* = DRB.RlcSduDelayDl.*SNSSAI* + DRB.AirIfDelayDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI

d) NRCellDU

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321[15]), this KPI is not available for UM mode.

##### 6.3.1.3.2 Downlink delay in gNB-DU for a sub-network

a) DLDelay\_gNBDU\_SNw.

b) This KPI describes the average packet transmission delay through the gNB-DU part to the UE. It is used to evaluate delay performance of gNB-DU in downlink for a sub-network. It is the weighted average packets delay time from arrival of an RLC SDU at the RLC ingress F1-U termination until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average DL delay in gNB-DU for a sub-network, where

- W is the measurement for the weighted average, one of the following:

- the DL data volume of the NR cell;

- the number of UL user data packets of the NR cell;

- any other types of weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321[15]), this KPI is not available for UM mode.

##### 6.3.1.3.3 Downlink delay in gNB-DU for a network slice subnet

a) DLDelay\_gNBDU\_Nss.

b) This KPI describes the average packet transmission delay through the gNB-DU part to the UE. It is used to evaluate delay performance of gNB-DU in downlink for a network slice subnet. It is the weighted average packets delay time from arrival of an RLC SDU at the RLC ingress F1-U termination until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average DL delay in gNB-DU for a network slice subnet, where

- W is the measurement for the weighted average, one of the following:

- the DL data volume of the NR cell;

- the number of DL user data packets of the NR cell;

- any other types of weight requested by the consumer of KPI;

- the #NRCellDU is the number of NRCellDU’s associated with the NetworkSliceSubnet.



d) NetworkSliceSubnet

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321[15]), this KPI is not available for UM mode.

#### 6.3.1.4 Downlink delay in gNB-CU-UP

##### 6.3.1.4.1 Downlink delay in gNB-CU-UP

a) DLDelay\_gNBCUUP.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP to the gNB-DU. It is used to evaluate the delay performance of gNB-CU-UP in downlink. It is the average packets delay from reception of IP packet in gNB-CU-UP until the time of arrival, at the gNB-DU, of the RLC SDU at the RLC ingress F1-U termination. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below the equation for average DL delay in a gNB-CU-CP:

DLDelay\_gNBCUUP = DRB. PdcpSduDelayDl + DRB.PdcpF1Delay

and optionally: DLDelay\_ gNBCUUP.*QOS* = DRB.PdcpSduDelayDl.*QOS* + DRB.PdcpF1Delay.*QOS* where *QOS* identifies the target quality of service class.

and optionally: DLDelay\_gNBCUUP.*SNSSAI* = DRB.PdcpSduDelayDl.*SNSSAI* + DRB.PdcpF1Delay.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) GNBCUUPFunction

e) In non-split gNB scenario, the value of DRB.PdcpF1Delay (optionally DRB.PdcpF1Delay.*QOS,* and optionally *DRB.PdcpF*1Delay.*SNSSAI)* is set to zero because there are no F1-interfaces in this scenario.

##### 6.3.1.4.2 Downlink delay in gNB-CU-UP for a sub-network

a) DLDelay\_gNBCUUP\_SNw.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP to the gNB-DU. It is used to evaluate the delay performance of gNB-CU-UP in downlink for a sub-network. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the time of arrival, at the gNB-DU, of the RLC SDU at the RLC ingress F1-U termination. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-CU-UP for a sub-network, where

- W is the measurement for the weighted average, one of the following:

- the DL data volume in gNB-CU-UP;

- the number of DL user data packets in gNB-CU-UP;

- any other types of weight requested by the consumer of KPI;

- the # GNBCUUPFunctions is the number of GNBCUUPFunctions’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

e) In non-split gNB scenario, the value of DRB.PdcpF1Delay (optionally DRB.PdcpF1Delay.*QOS,* and optionallyDRB.PdcpF1Delay.*SNSSAI)* is set to zero because there are no F1-interfaces in this scenario.

##### 6.3.1.4.3 Downlink delay in gNB-CU-UP for a network slice subnet

a) DLDelay\_gNBCUUP\_Nss.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP to gNB-DU. It is used to evaluate the delay performance of gNB-CU-UP in downlink for a network slice subnet. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the time of arrival, at the gNB-DU, of the RLC SDU at the RLC ingress F1-U termination.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-CU-UP for a network slice subnet, where

- W is the measurement for the weighted average, one of the following:

- the DL data volume in gNB-CU-UP;

- the number of DL user data packets in gNB-CU-UP;

- any other types of weight requested by the consumer of KPI;

- the # GNBCUUPFunctions is the number of GNBCUUPFunctions’s associated with the NetworkSliceSubnet.



d) NetworkSliceSubnet

e) In non-split gNB scenario, the value of DRB.PdcpF1Delay.*SNSSAI* is set to zero because there are no F1-interfaces in this scenario.

#### 6.3.1.5 Uplink delay in gNB-DU

##### 6.3.1.5.1 Uplink delay in gNB-DU for a NR cell

a) ULDelay\_gNBDU\_Cell.

b) This KPI describes the average packet transmission delay through the gNB-DU part from the UE in a NR cell. It is used to evaluate delay performance of gNB-DU in uplink. It is the average packet delay from when an UL RLC SDU was scheduled, as per the scheduling grant provided, until time when the RLC SDU is sent to PDCP or CU for split gNB. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-DU for a NRCellDU:

ULDelay\_gNBDU\_Cell = DRB.RlcDelayUI + DRB.AirIfDelayUI

and optionally: where *QOS* identifies the target quality of service class.

and optionally: where *SNSSAI* identifies the S-NSSAI.

d) NRCellDU

##### 6.3.1.5.2 Uplink delay in gNB-DU for a sub-network

a) ULDelay\_gNBDU\_SNw.

b) This KPI describes the average packet transmission delay through the gNB-DU part from the UE for a sub-network. It is used to evaluate delay performance of gNB-DU in uplink for a sub-network. It is the weighted average packet delay from when an UL RLC SDU was scheduled, as per the scheduling grant provided, until time when the RLC SDU is sent to PDCP or CU for split gNB. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-DU for a sub-network, where

- W is the measurement for the weighted average, one of the following:

- the UL data volume of the NR cell;

- the number of UL user data packets of the NR cell;

- any other types of weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

##### 6.3.1.5.3 Uplink delay in gNB-DU for a network slice subnet

a) ULDelay\_gNBDU\_Nss.

b) This KPI describes the average packet transmission delay through the gNB-DU part from the UE for a network slice subnet. It is used to evaluate delay performance of gNB-DU in uplink for a network slice subnet. It is the weighted average packet delay from when an UL RLC SDU was scheduled, as per the scheduling grant provided, until time when the RLC SDU is sent to PDCP or CU for split gNB.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-DU for a network slice subnet, where

- W is the measurement for the weighted average, one of the following:

- the UL data volume of the NR cell;

- the number of UL user data packets of the NR cell;

- any other types of weight requested by the consumer of KPI;

- the #NRCellDU is the number of NRCellDU’s associated with the NetworkSliceSubnet.



d) NetworkSliceSubnet

#### 6.3.1.6 Uplink delay in gNB-CU-UP

##### 6.3.1.6.1 Uplink delay in gNB-CU-UP

a) ULDelay\_gNBCUUP.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP from gNB-DU. It is used to evaluate delay performance of gNB-CU-UP in uplink. It is the average packet delay from when the RLC SDU is sent to PDCP or CU for split gNB, until time when the corresponding PDCP SDU was sent to the core network from gNB-CU-UP. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below the equation for average UL delay in a gNB-CU-CP:

and optionally: where *QOS* identifies the target quality of service class.

and optionally: where *SNSSAI* identifies the S-NSSAI.

d) GNBCUUPFunction

e) It is assumed that the F1 uplink delay is the same as the F1 downlink delay. In non-split gNB scenario, the value of DRB.PdcpF1Delay (optionally DRB.PdcpF1Delay.*QOS,* and optionally *DRB.PdcpF*1Delay.*SNSSAI)* is set to zero because there are no F1-interfaces in this scenario.

##### 6.3.1.6.2 Uplink delay in gNB-CU-UP for a sub-network

a) ULDelay\_gNBCUUP\_SNw.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP part from the gNB-DU for a sub-network. It is used to evaluate delay performance of gNB-CU-UP in uplink for a sub-network. It is the weighted average packet delay from when the RLC SDU is sent to PDCP or CU for split gNB, until time when the corresponding PDCP SDU was sent to the core network from gNB-CU-UP. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-CU-UP for a sub-network, where

- W is the measurement for the weighted average, one of the following:

- the UL data volume in gNB-CU-UP ;

- the number of UL user data packets in gNB-CU-UP ;

- any other types of weight requested by the consumer of KPI;

- the # GNBCUUPFunctions is the number of GNBCUUPFunctions’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

e) It is assumed that the F1 uplink delay is the same as the F1 downlink delay. In non-split gNB scenario, the value of DRB.PdcpF1Delay (optionally DRB.PdcpF1Delay.*QOS,* and optionallyDRB.PdcpF1Delay.*SNSSAI)* is set to zero because there are no F1-interfaces in this scenario.

##### 6.3.1.6.3 Uplink delay in gNB-CU-UP for a network slice subnet

a) ULDelay\_gNBCUUP\_Nss.

b) This KPI describes the average packet transmission delay through the gNB-CU-UP part from the gNB-DU for a network slice subnet. It is used to evaluate delay performance of gNB-CU-UP in uplink for a network slice subnet. It is the weighted average packet delay from when the RLC SDU is sent to PDCP or CU for split gNB, until time when the corresponding PDCP SDU was sent to the core network from gNB-CU-UP. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average UL delay in gNB-CU-UP for a network slice subnet, where

- W is the measurement for the weighted average, one of the following:

- the UL data volume in gNB-CU-UP;

- the number of UL user data packets in gNB-CU-UP;

- any other types of weight requested by the consumer of KPI;

- the # GNBCUUPFunctions is the number of GNBCUUPFunctions’s associated with the NetworkSliceSubnet.



d) NetworkSliceSubnet

e) It is assumed that the F1 uplink delay is the same as the F1 downlink delay. In non-split gNB scenario, the value of DRB.PdcpF1Delay.*SNSSAI* is set to zero because there are no F1-interfaces in this scenario.

#### 6.3.1.7 Integrated uplink delay in RAN

##### 6.3.1.7.1 Uplink delay in NG-RAN for a sub-network

a) ULDelay\_NR\_SNw.

b) This KPI describes the average packet transmission delay through the RAN part from the UE for a sub-network. It is used to evaluate delay performance of NG-RAN in uplink. It is the weighted average packet delay from when an UL RLC SDU was scheduled, as per the scheduling grant provided, until time when the corresponding PDCP SDU was sent to the core network from gNB-CU-UP. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below are the equations for average "Integrated uplink delay in RAN" for this KPI on SubNetwork level. The "Integrated uplink delay in RAN" is the sum of average UL delay in gNB-CU-UP of the sub-network (ULDelay\_gNBCUUP\_SNw) and the average UL delay in gNB-DU of the sub-network (ULDelay\_gNBDU\_SNw):

ULDelay\_NR\_SNw = ULDelay\_gNBCUUP\_SNw + ULDelay\_gNBDU\_SNw

or optionally ULDelay\_ NR\_SNw.*QOS* = ULDelay\_gNBCUUP\_SNw.*QOS* + ULDelay\_gNBDU\_SNw.*QOS* where *QOS* identifies the target quality of service class.

or optionally ULDelay\_NR\_SNw.*SNSSAI* = ULDelay\_gNBCUUP\_SNw.*SNSSAI* + ULDelay\_gNBDU\_SNw.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) SubNetwork

##### 6.3.1.7.2 Uplink delay in NG-RAN for a network slice subnet

a) ULDelay\_NR\_Nss.

b) This KPI describes the average packet transmission delay through the RAN part from the UE for a network slice subnet. It is used to evaluate delay performance of NG-RAN in uplink. It is the weighted average packet delay from when an UL RLC SDU was scheduled, as per the scheduling grant provided, until time when the corresponding PDCP SDU was sent to the core network from gNB-CU-UP. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) Below is the equation for average “Integrated uplink delay in RAN” for this KPI on NetworkSliceSubNet level. The “Integrated uplink delay in RAN” for network slice subnet is the sum of average UL delay in gNB-CU-UP of the network slice subnet (ULDelay\_gNBCUUP\_Nss) and the average UL delay in gNB-DU of the network slice subnet (ULDelay\_gNBDU\_Nss):

ULDelay\_NR\_Nss.*SNSSAI* = ULDelay\_gNBCUUP\_Nss.*SNSSAI* + ULDelay\_gNBDU\_Nss.*SNSSAI* where *SNSSAI* identifies the S-NSSAI that the network slice subnet supports.

d) NetworkSliceSubnet

#### 6.3.1.8 E2E delay for network slice

##### 6.3.1.8.1 Average e2e uplink delay for a network slice

a) DelayE2EUlNs.

b) This KPI describes the average e2e UL packet delay between the PSA UPF and the UE for a network slice. It is the weighted average packet delay from the time when an UL RLC SDU was scheduled at the UE until the time when the corresponding GTP PDU was received by the PSA UPF.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) This KPI is the weighted average of UL packet delay between PSA UPF and UE, for all N3 interfaces (modelled by EP\_N3 MOIs) and N9 interfaces (modelled by EP\_N9 MOIs) of all PSA UPFs supporting the network slice (modelled by NetworkSlice MOI) identified by the S-NSSAI.

This KPI is calculated in the equation below, where Wn3 and Wn9 are the measurements for the weighted average, Wn3 is one of the following:

- the data volume of UL GTP PDUs received by PSA UPF on the N3 interface;

- the number of UL GTP PDUs received by PSA UPF on the N3 interface;

- any other types of weight defined by the consumer of KPI.

And Wn9 is one of the following:

- the data volume of UL GTP PDUs received by PSA UPF on the N9 interface;

- the number of UL GTP PDUs received by PSA UPF on the N9 interface;

- any other types of weight defined by the consumer of KPI.

DelayE2EUlNs =



Where the *SNSSAI* identifies the S-NSSAI.

d) NetworkSlice.

##### 6.3.1.8.2 Average e2e downlink delay for a network slice

a) DelayE2EDlNs.

b) This KPI describes the average e2e DL packet delay between the PSA UPF and the UE for a network slice. It is the weighted average packet delay from the time when an GTP PDU has been sent by the PSA UPF until time when the corresponding RLC SDU was received by the UE.

b-1) Integer, time interval (0.1 mS)

b-2) MEAN

c) This KPI is the weighted average of DL packet delay between PSA UPF and UE, for all N3 interfaces (modelled by EP\_N3 MOIs) and N9 interfaces (modelled by EP\_N9 MOIs) of all PSA UPFs supporting the network slice (modelled by NetworkSlice MOI) identified by the S-NSSAI.

This KPI is calculated in the equation below, where Wn3 and Wn9 are the measurements for the weighted average, Wn3 is one of the following:

- the data volume of DL GTP PDUs transmitted by PSA UPF on the N3 interface;

- the number of DL GTP PDUs transmitted by PSA UPF on the N3 interface;

- any other types of weight defined by the consumer of KPI.

And Wn9 is one of the following:

- the data volume of DL GTP PDUs transmitted by PSA UPF on the N9 interface;

- the number of DL GTP PDUs transmitted by PSA UPF on the N9 interface;

- any other types of weight defined by the consumer of KPI.

DelayE2EDlNs =



Where the *SNSSAI* identifies the S-NSSAI.

d) NetworkSlice.

### 6.3.2 Upstream throughput for network and Network Slice Instance

a) UTSNSI.

b) This KPI describes the upstream throughput of one single network slice by computing the packet size for each successfully received UL packet through the network slice during each observing granularity period and is used to evaluate integrity performance of the end-to-end network slice. It is obtained by measuring the total number of upstream octets provided by N3 interface from NG-RAN to all UPFs, related to the single network slice, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



d) NetworkSlice, SubNetwork.

### 6.3.3 Downstream throughput for Single Network Slice Instance

a) DTSNSI.

b) This KPI describes the downstream throughput of one single network slice instance by computing the packet size for each successfully transmitted DL packet through the network slice instance during each observing granularity period and is used to evaluate integrity performance of the end-to-end network slice instance. It is obtained by measuring the total number of downstream octets provided by N3 interface from all UPFs to NG-RAN, related to the single network slice, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



d) NetworkSlice, SubNetwork.

### 6.3.4 Upstream Throughput at N3 interface

a) UGTPTN.

b) This KPI describes the throughput of incoming GTP data packets on the N3 interface (measured at UPF) which have been generated by the GTP-U protocol entity on the N3 interface, during a granularity period. This KPI is used to evaluate upstream GTP throughput integrity performance at the N3 interface. It is obtained by measuring the total number of octets GTP data packets upstream throughput provided by N3 interface from NG-RAN to UPF, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)

d) UPFFunction

### 6.3.5 Downstream Throughput at N3 interface

a) DGTPTN.

b) This KPI describes the throughput of downstream GTP data packets on the N3 interface (transmitted downstream from UPF) which have been generated by the GTP-U protocol entity on the N3 interface, during a granularity period. This KPI is used to evaluate integrity performance at N3 interface. It is obtained by measuring the total number of octets GTP data packets downstream throughput provided by N3 interface from UPF to NG-RAN, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)

d) UPFFunction

### 6.3.6 RAN UE Throughput

#### 6.3.6.1 Void

#### 6.3.6.2 RAN UE Throughput definition

To achieve a Throughput measurement (below examples are given for DL) that is independent of file size and gives a relevant result it is important to remove the volume and time when the resource on the radio interface is not fully utilized. (Successful transmission, buffer empty in figure 1).

Time (slots)

Data arrives to

empty DL buffer

First data is

transmitted to the UE

The send buffer is

again empty

**calulations since it**

**can be impacted**

**by packet size of**

**User Plane (UP) packets.**

ThpTimeDl

Failed transmission (

”

Block

error

”

)

Successful transmission,

buffer not empty

Successful transmission,

buffer empty

ThpVolDl =

∑

Total DL transferred volume =

∑

(kbits)

+

(kbits)

**UE Throughput in DL =**

**ThpVolDl / ThpTimeDl (kbits/s)**

No transmission, buffer not

empty (e.g. due to contention)



**The last slot shall always be removed from**

Figure 1

To achieve a throughput measurement that is independent of bursty traffic pattern, it is important to make sure that idle gaps between incoming data is not included in the measurements. That shall be done as considering each burst of data as one sample.

#### 6.3.6.3 DL RAN UE throughput

##### 6.3.6.3.1 DL RAN UE throughput for a NRCellDU

a) DlUeThroughput \_Cell.

b) This KPI describes the average DL RAN UE throughput for a NRCellDU. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average DL RAN UE throughput for a NRCellDU:

DlUeThroughput \_Cell = DRB.UEThpDl;

and optionally: DlUeThroughput \_Cell.*QOS* = DRB.UEThpDl.*QOS*, where *QOS* identifies the target quality of service class;

and optionally: DlUeThroughput \_Cell.*SNSSAI* = DRB.UEThpDl.*SNSSAI*, where *SNSSAI* identifies the S-NSSAI.

d) NRCellDU

##### 6.3.6.3.2 DL RAN UE throughput for a sub-network

a) DlUeThroughput \_SNw.

b) This KPI describes the average DL RAN UE throughput for a sub-network. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average DL RAN UE throughput for a sub-network, where

- W is the measurement for the weighted average, it is one of the following:

- the DL data volume of the NR cell;

- a weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

##### 6.3.6.3.3 DL RAN UE throughput for a network slice subnet

a) DlUeThroughput \_Nss.

b) This KPI describes the average DL RAN UE throughput for a network slice subnet.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average DL RAN UE throughput for a network slice subnet, where

- W is the measurement for the weighted average, it is one of the following:

- the DL data volume of the NR cell;

- a weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s associated with the NetworkSliceSubnet.

, where the *SNSSAI* identifies the S-NSSAI that the NetworkSliceSubnet supports.



d) NetworkSliceSubnet

#### 6.3.6.4 UL RAN UE throughput

##### 6.3.6.4.1 UL RAN UE throughput for a NRCellDU

a) UlUeThroughput\_Cell.

b) This KPI describes the average UL RAN UE throughput for a NRCellDU. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average UL RAN UE throughput for a NRCellDU:

UlUeThroughput \_Cell = DRB.UEThpUl;

and optionally: UlUeThroughput\_Cell.*QOS* = DRB.UEThpUl.*QOS*, where *QOS* identifies the target quality of service class;

and optionally: UlUeThroughput\_Cell.*SNSSAI* = DRB.UEThpUl.*SNSSAI*, where *SNSSAI* identifies the S-NSSAI.

d) NRCellDU

##### 6.3.6.4.2 UL RAN UE throughput for a sub-network

a) UlUeThroughput\_SNw.

b) This KPI describes the average UL RAN UE throughput for a sub-network. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average UL RAN UE throughput for a sub-network, where

- W is the measurement for the weighted average, it is one of the following:

- the UL data volume of the NR cell;

- a weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s in the SubNetwork.



and optionally KPI on SubNetwork level per QoS and per S-NSSAI:



d) SubNetwork

##### 6.3.6.4.3 UL RAN UE throughput for a network slice subnet

a) UlUeThroughput \_Nss.

b) This KPI describes the average UL RAN UE throughput for a network slice subnet.

b-1) Integer, kbit/s

b-2) MEAN

c) Below is the equation for average UL RAN UE throughput for a network slice subnet, where

- W is the measurement for the weighted average, it is one of the following:

- the UL data volume of the NR cell;

- a weight defined by the consumer of KPI

- the #NRCellDU is the number of NRCellDU’s associated with the NetworkSliceSubnet.

, where the *SNSSAI* identifies the S-NSSAI that the NetworkSliceSubnet supports.



d) NetworkSliceSubnet

### 6.3.7 Upstream throughput for 5G VN Group

a) UTSNSI\_5GVNGroup.

b) This KPI describes the upstream throughput of one 5G VN Group by computing the packet size for each successfully received UL packet during each observing granularity period and is used to evaluate integrity performance of the 5G VN Group. It is obtained by measuring the total number of upstream octets provided by N3 interface from NG-RAN to all UPFs, related to one 5G VN Group, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



*UTSNSI\_5GVNGroup* \*8



d) NetworkSlice, SubNetwork.

### 6.3.8 Downstream throughput for 5G VN Group

a) DTSNSI\_5GVNGroup.

b) This KPI describes the downstream throughput of one 5G VN Group by computing the packet size for each successfully transmitted DL packet through the 5G VN Group during each observing granularity period and is used to evaluate integrity performance of the 5G VN Group. It is obtained by measuring the total number of downstream octets provided by N3 interface from all UPFs to NG-RAN, related to one 5G VN Group, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



*DTSNSI\_5GVNGroup* \*8



d) NetworkSlice, SubNetwork.

### 6.3.9 Downstream throughput for a Network Slice at gNB

a) DlThroughputNSgNBNgU

b) This KPI describes the downstream throughput of a network slice instance at gNB/CU-UP end on the NgU interface. It is obtained by measuring the total number of downstream octets provided over NgU interface from UPF to NG-RAN, related to the single network slice, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



d) NetworkSliceSubnet, SubNetwork.

### 6.3.10 Upstream throughput for a Network Slice at gNB

a) UlThroughputNSgNBNgU

b) This KPI describes the upstream throughput of a network slice instance at gNB/CU-UP end on the NgU interface. It is obtained by measuring the total number of upstream octets provided over NgU interface from NG-RAN to UPF, related to the single network slice, divided by the granularity period (in milliseconds).

b-1) Integer, kbit/s

b-2) MEAN

c)



d) NetworkSliceSubnet, SubNetwork.

### 6.3.11 Capacity GTP

#### 6.3.11.1 UL GTP capacity between PSA UPF and NG-RAN

a) GTP.CapMaxUlPsaUpfNgran.

b) This KPI describes the maximum achievable UL GTP transmission rate between PSA UPF and NG-RAN.

b-1) Integer, kbit/s

b-2) MEAN

c) It is obtained by counting the UL available data volume between PSA UPF and NG-RAN for the measured 5QI or S-NSSAI for each time interval ([t, t + Δt]) during the collection period, taking the arithmetic peak value and then dividing it by Δt.

d) NetworkSlice, SubNetwork, UPFunction

#### 6.3.11.2 DL GTP capacity PSA UPF and NG-RAN

a) GTP.CapMaxDlPsaUpfNgran

b) This KPI describes the maximum achievable DL GTP transmission rate between PSA UPF and NG-RAN.

b-1) Integer, kbit/s

b-2) MEAN

c) It is obtained by counting the DL available data volume between PSA UPF and NG-RAN for the measured 5QI or S-NSSAI for each time interval ([t, t + Δt]) during the collection period, taking the arithmetic peak value and then dividing it by Δt.

d) NetworkSlice, SubNetwork, GNBCUUPFunction

#### 6.3.11.3 UL GTP capacity between PSA UPF and UE

a) GTP.CapMaxUlPsaUpfUe

b) This KPI describes the maximum achievable UL GTP transmission rate between PSA UPF and UE.

b-1) Integer, kbit/s

b-2) MEAN

c) It is obtained by counting the UL available data volume between PSA UPF and UE for the measured S-NSSAI for each time interval ([t, t + Δt]) during the collection period, taking the arithmetic peak value and then dividing it by Δt..

d) NetworkSlice, SubNetwork, UPFunction

#### 6.3.11.4 DL GTP capacity PSA UPF and UE

a) GTP.CapMaxDlPsaUpfUe

b) This KPI describes the maximum achievable DL GTP transmission rate between PSA UPF and UE.

b-1) Integer, kbit/s

b-2) MEAN

c) It is obtained by counting the DL available data volume between PSA UPF and UE for the measured S-NSSAI for each time interval ([t, t + Δt]) during the collection period, taking the arithmetic peak value and then dividing it by Δt.

d) NetworkSlice, SubNetwork, UPFunction

## 6.4 Utilization KPI

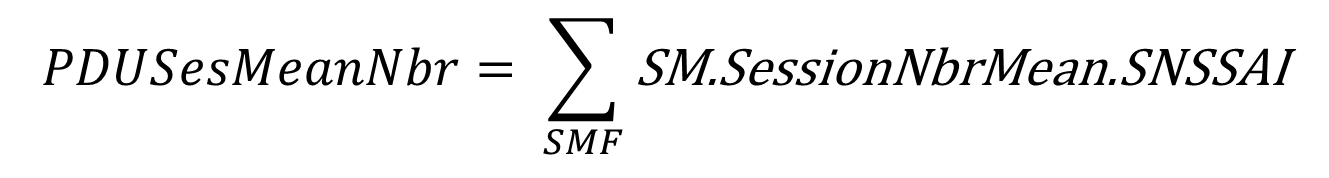
### 6.4.1 Mean number of PDU sessions of network and network Slice Instance

a) PDUSesMeanNbr.

b) This KPI describes the mean number of PDU sessions that are successfully established in a network slice . It is obtained by successful PDU session establishment procedures of SMFs which is related to the network slice .

b-1) Integer

b-2) MEAN

c) 

d) NetworkSlice

### 6.4.2 Virtualised Resource Utilization of Network Slice Instance

a) VirtualResUtilizaiton.

b) This KPI describes utilization of virtualised resource (e.g. processor, memory, disk) that are allocated to a network slice . It is obtained by the usage of virtualised resource (e.g. processor, memory, disk) divided by the system capacity that allocated to the network slice .

b-1) Integer, percentage

b-2) Ratio

Note: In the present document, this KPI is for the scenario when NF is not shared between different network slice .

c) 





d) NetworkSlice

### 6.4.3 PDU session establishment time of network slice

a) PDUEstTime.

b) This KPI describes the time of successful PDU session establishment which related to one single network slice and is used to evaluate utilization provided by the end-to-end network slice and network performance. It is obtained by measuring the time between the receipt by SMF from AMF of " Nsmf\_PDUSession\_UpdateSMContext Request ", which includes N2 SM information received from (R)AN to the SMF and the sending of a " Nsmf\_PDUSession\_CreateSMContext Request or Nsmf\_PDUSession\_UpdateSMContext Request " message from AMF to the SMF.

b-1) Integer, time interval (millisecond)

b-2) MEANc) PDUEstTime = SM.PduSessionTimeMean.SNSSAI

d) NetworkSlice

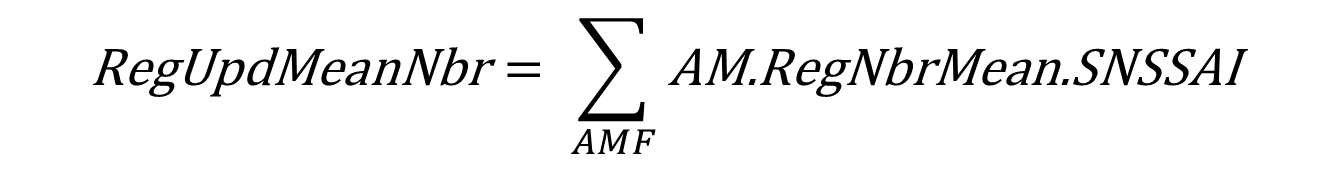
### 6.4.4 Mean number of successful periodic registration updates of Single Network Slice

a) RegUpdMeanNbr.

b) This KPI describes the mean number of successfully periodic registration updates in a network slice at the AMF. It is obtained by summing successful of periodic registration updates at the AMFs which is related to the network slice after registration accept by the AMF to the UE that sent the periodic registration update request.

b-1) Integer

b-2) MEAN

c) 

d) NetworkSlice

### 6.4.5 Maximum number of PDU sessions of network slice

a) PDUSesMaxNbr.

b) This KPI describes the maximum number of PDU sessions that are successfully established in a network slice. It is obtained by successful PDU session establishment procedures of SMFs which is related to the network slice.

b-1) Integer

b-2) CUM

c) 

d) NetworkSlice

### 6.4.6 PDU session establishment time of 5G VN Group

a) Group-levelPDUEstTime.

b) This KPI describes the time of successful PDU session establishment which related to one 5G VN Group and is used to evaluate utilization provided by the end-to-end network slice and network performance. It is obtained by measuring the time between the receipt by SMF from AMF of " Nsmf\_PDUSession\_UpdateSMContext Request ", which includes N2 SM information received from (R)AN to the SMF and the sending of a " Nsmf\_PDUSession\_CreateSMContext Request" or "Nsmf\_PDUSession\_UpdateSMContext Request" message from AMF to the SMF.

b-1) Integer, time interval (millisecond)

b-2) MEAN

c) Group-levelPDUEstTime = SM.PduSessionTimeMean.InternalgroupID

d) NetworkSlice

### 6.4.7 Mean number of MA PDU sessions of network slice

a) MaPDUSesMeanNbr.

b) This KPI describes the mean number of MA PDU sessions that are successfully established in a network slice. It is obtained by successful MA PDU session establishment procedures of SMFs which is related to the network slice.

b-1) Integer

b-2) MEAN

c) 

d) NetworkSlice

### 6.4.8 Maximum number of MA PDU sessions of network slice

a) MaPDUSesMaxNbr.

b) This KPI describes the maximum number of MA PDU sessions that are successfully established in a network slice. It is obtained by successful MA PDU session establishment procedures of SMFs which is related to the network slice.

b-1) Integer

b-2) CUM

c) 

d) NetworkSlice

### 6.4.9 Connected Mode RRM Relaxation Usage rate

a) ConnectedModeMeasRelaxationUsage.

b) This KPI describes the ratio of the number of UE side connected mode RRM relaxation sessions (such a session starts when UE sends a UAI with MeasRelaxationFulfilment-r17 IE with value True till it sends another UAI with MeasRelaxationFulfilment-r17 IE with value False) that conclude (these sessions conclude when the UE sends UAI with MeasRelaxationFulfilment-r17 IE with value False) to the number of all such sessions. This KPI is used to evaluate the utilization of this feature in the field.

b-1) Integer, percentage

b-2) RATIO

c)

d) NRCellCU

## 6.5 Retainability KPI

### 6.5.1 QoS flow Retainability

#### 6.5.1.1 Definition

a) QoSRetain\_R1, QoSRetain\_R2.

b) This KPI shows how often an end-user abnormally loses a QoS flow during the time the QoS flow is used. It is obtained by number of QoS flows with data in a buffer that was abnormally released, normalized with number of data session time units.

b-1) Integer, active release / second

b-2) MEAN

c) To measure QoS flow Retainability for a single QoS level (R1) is fairly straight forward.  
  
  
However to measure the QoS flow Retainability for UEs is not as straight forward. The measurement R1 is defined to look at the activity level of just one QoS level at the time, so to use this formula and measurements in an aggregated way to get QoS flow Retainability on UE level will not be accurate (e.g. for an UE with multiple QoS flows there might be QoS flows that are active at the same time, hence aggregating the QoS level measurements for session time will give a larger session time than the total UE session time. See picture below).  
  
  
Hence a measurement QoS flow Retainability on UE level is defined (R2) to provide a measurement for the overall QoS flow Retainability.



d) SubNetwork, NRCellCU

e) The definition of the service provided by 5GS is QoS flows.

#### 6.5.1.2 Extended definition

The retainability rate is defined as:



Number of abnormally released QoS flow with data in any of the buffers

[Releases/Session time]

To define (from a QoS flow Retainability point of view) if a QoS flow is considered active or not, the QoS flows can be divided into two groups:

- For QoS flows with bursty flow, a QoS flow is said to be active if there is user data in the PDCP queue in any of the directions or if any data (UL or DL) has been transferred during the last 100 ms.

- For QoS flows with continuous flow, the QoS flow (and the UE) is seen as being active in the context of this measurement as long as the UE is in RRC connected state, and the session time is increased from the first data transmission on the QoS flow until 100 ms after the last data transmission on the QoS flow.

A particular QoS flow is defined to be of type continuous flow if the mapped 5QI is any of {1, 2, 65, 66}.

### 6.5.2 DRB Retainability

#### 6.5.2.1 Definition

a) DRBRetain

b) This KPI shows how often an end-user abnormally loses a DRB during the time the DRB is active. It is obtained by number of DRBs that were abnormally released and that were active at the time of release, normalized with number of data session time units.

b-1) Integer, active release / second

b-2) MEAN

c) DRB Retainability for a single mapped 5QI level (R1) and for a single S-NSSAI (R1) are defined as:

and

d) SubNetwork, NRCellCU

e) The definition of the service provided by 5GS is DRBs.

#### 6.5.2.2 Extended definition

To define (from a DRB Retainability point of view) if a DRB is considered active or not, the DRB can be divided into two groups:

- For DRBs with bursty flow, a DRB is said to be active if any data (UL or DL) has been transferred during the last 100 ms.

- For DRBs with continuous flow, the DRB (and the UE) is seen as being active in the context of this measurement as long as the UE is in RRC connected state, and the session time is increased from the first data transmission on the DRB until 100 ms after the last data transmission on the DRB.

A particular DRB is defined to be of type continuous flow if the mapped 5QI is any of {1, 2, 65, 66}.

## 6.6 Mobility KPI

### 6.6.1 NG-RAN handover success rate

a) GRANHOSR.

b) A KPI that shows how often a handover within NR-RAN is successful, regardless if the handover was made due to bad coverage or any other reason. This KPI is obtained by successful handovers to the same or another gNB divided by attempted handovers to the same or another gNB. This KPI covers legacy Handover.

b-1) Integer, percentage

b-2) RATIO

c)

d) SubNetwork, NRCellCU.

### 6.6.2 Mean Time of Inter-gNB handover Execution of Network Slice

a) InterGNBHOMeanTime.

b) This KPI describes the time of successful Mean Time of Inter-gNB handover which related to one single network slice and is used to evaluate utilization provided by the end-to-end network slice and network performance. This KPI is obtained by measuring the time between the receipt by the Source NG-RAN from the Target NG-RAN of a “Release Resource" and the sending of a " N2 Path Switch Request " message from Source NG-RAN to the Target NG-RAN over a granularity period.

b-1) Integer, time interval (millisecond)

b-2) MEAN

d) Subnetwork

### 6.6.3 Successful rate of mobility registration updates of Single Network Slice

a) MobilityRegUpdateSR.

b) This KPI describes the successful rate of mobility registration updates in a network slice e at the AMF. This KPI is obtained by deviding the number of successful mobility registration updates at the AMFs by number of mobility registration update requests received by the AMFs of single network slice.

b-1) Integer, percentage

b-2) RATIO

d) NetworkSlice

### 6.6.4 5GS to EPS handover success rate

a) 5GSEPSHOSR.

b) A KPI that shows how often a handover from 5GS to EPS is successful, regardless if the handover was made due to bad coverage or any other reason. This KPI is obtained by successful handovers from 5GS to EPS system divided by the total number of handovers attempt’s from 5GS to EPS system.

b-1) Integer, percentage

b-2) RATIO

c)

d) SubNetwork, NRCellCU.

### 6.6.5 NG-RAN handover success rate for all handover types

a) GRANHOSRA.

b) A KPI that shows how often a handover within NR-RAN is successful, regardless if the handover was made due to bad coverage or any other reason. This KPI is obtained by successful handovers to the same or another gNB divided by attempted handovers to the same or another gNB. This KPI covers legacy Handover, Conditional Handover, DAPS Handover and LTM cell switch.

b-1) Integer, percentage

b-2) RATIO

c)

d) SubNetwork, NRCellCU.

## 6.7 Energy Efficiency (EE) KPI

### 6.7.1 NG-RAN data Energy Efficiency (EE)

#### 6.7.1.1 Definition

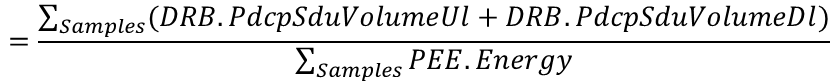
a) EEMN,DV.

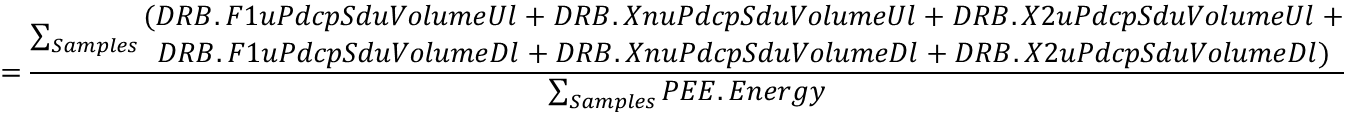
b) A KPI that shows mobile network data energy efficiency in operational NG-RAN. Data Volume (DV) divided by Energy Consumption (EC) of the considered network elements.

b-1) Integer, bit/J

b-2) RATIO

c) EEMN,DV

 - for non-split gNBs;

 - for split gNBs;

d) SubNetwork

e) The Data Volume (in kbits) is obtained by measuring amount of DL/UL PDCP SDU bits of the considered network elements over the measurement period. For split-gNBs, the Data Volume is calculated per Interface (F1-U, Xn-U, X2-U). The Energy Consumption (in kWh) is obtained by measuring the PEE.Energy of the considered network elements over the same period of time. The samples are aggregated at the NG-RAN node level. The 3GPP management system responsible for the management of the gNB (single or multiple vendor gNB) shall be able to collect PEE measurements data from all PNFs in the gNB, in the same way as the other PM measurements.

### 6.7.2 Network slice Energy Efficiency (EE)

#### 6.7.2.1 Generic Network Slice Energy Efficiency (EE) KPI



where:

- ‘Performance of network slice’ (Pns) is defined per type of network slice;

- ‘Energy Consumption of network slice’ (ECns) is defined independently from any type of network slice.

For one unit of ECns, the higher Pns is, the higher the generic network slice EE KPI is, i.e. the more energy efficient the network slice is.

#### 6.7.2.2 Energy efficiency of eMBB network slice

a) EEeMBB,DV

b) A KPI that shows the energy efficiency of network slices of type eMBB. The Pns for a network slice of type eMBB is obtained by summing up UL and DL data volumes at N3 interface(s) of the network slice.



, where *SNSSAI* identifies the S-NSSAI.

This KPI is obtained by the sum of UL and DL data volumes at N3 interface(s) of the network slice, divided by the energy consumption of the network slice.

b-1) Integer, bit/J

b-2) RATIO

c)



d) NetworkSlice

e) In case of redundant transmission paths over the N3 interface for high reliability communication (cf. TS 23.501 [7] clause 5.33.2), it is expected that the data volume is counted once. In particular:

- In case of Dual Connectivity based end to end Redundant User Plane Paths (cf. TS 23.501 [7] clause 5.33.2.1), in which a UE may set up two redundant PDU Sessions over the 5G network, the Data Volume related to only one PDU session is to be considered;

- In case of redundant transmission with two N3 tunnels between the PSA UPF and a single NG-RAN node (cf. TS 23.501 [7] figure 5.33.2.2-1) which are associated with a single PDU Session, the Data Volume related to only one N3 tunnel is to be considered;

- In case of two N3 and N9 tunnels between NG-RAN and PSA UPF for redundant transmission (cf. TS 23.501 [7] figure 5.33.2.2-2) associated with a single PDU Session, the Data Volume related to only one N3 tunnel is to be considered.

For the measurement of the energy efficiency of the 5G core network, the 3GPP management system in charge of collecting the data volume measurements listed here above shall consider them only once in case of redundant transmission over the N3 interface.

#### 6.7.2.2a Energy efficiency of eMBB network slice – RAN-based

##### 6.7.2.2a.1 Definition

a) EERANonlyeMBB,DV

b) A KPI that shows the energy efficiency of network slices of type eMBB based on NR measurements. The Pns for a network slice of type eMBB is obtained by summing up UL and DL data volumes at F1-U, Xn-U and X2-U interface(s) of gNBs, on a per S-NSSAI basis.

b-1) Integer, bit/J

b-2) RATIO

c)

For non-split gNBs:



, where:

- DRB.PdcpSduVolumeUl.*SNSSAI* is the Data Volume (amount of PDCP SDU bits) in the uplink delivered to PDCP layer per S-NSSAI - see TS 28.552 [4] clause 5.1.2.1.2.1,

- DRB.PdcpSduVolumeDl.*SNSSAI* is the Data Volume (amount of PDCP SDU bits) in the downlink delivered to PDCP layer per S-NSSAI - see TS 28.552 [4] clause 5.1.2.1.1.1.

For split gNBs:



, where:

- DRB.F1uPdcpSduVolumeDl.*SNSSAI* is the number of DL PDCP SDU bits sent to GNB-DU (F1-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.3,

- DRB.F1uPdcpSduVolumeUl.*SNSSAI* is the number of UL PDCP SDU bits entering the GNB-CU-UP from GNB-DU (F1-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.4,

- DRB.XnuPdcpSduVolumeDl.*SNSSAI* is the number of DL PDCP SDU bits sent to external gNB-CU-UP (Xn-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.3,

- DRB.XnuPdcpSduVolumeUl.*SNSSAI* is the number of UL PDCP SDU bits entering the GNB-CU-UP from external gNB-CU-UP (Xn-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.4,

- DRB.X2uPdcpSduVolumeDl.*SNSSAI* is the number of DL PDCP SDU bits sent to external eNB (X2-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.3,

- DRB.X2uPdcpSduVolumeUl.*SNSSAI* is the number of UL PDCP SDU bits entering the GNB-CU-UP from external eNB (X2-U interface) per S-NSSAI - see TS 28.552 [4] clause 5.1.3.6.2.4.

The final Network Slice EE KPI definition, based on Data Volume, for RAN-only eMBB type of network slice, would be defined as follows:



, where ECRANonlyns is the energy consumption of the RAN-only network slice over the same observation period.

NOTE: Void

d) NetworkSlice

#### 6.7.2.3 Energy efficiency of URLLC network slice

##### 6.7.2.3.1 Introduction

This KPI is defined with two variants.

##### 6.7.2.3.2 Based on latency of the network slice

a) EEURLLC,Latency

b) A KPI that shows the energy efficiency of network slices of type URLLC. The Pns for a network slice of type URLLC is the inverse of the average end-to-end User Plane (UP) latency of the network slice. In this KPI variant, latency are the only factor considered for evaluating the performance of network slice.



, where ‘Network slice mean latency’ is defined as the average end-to-end User Plane (UP) latency of the network slice, and where the average end-to-end User Plane (UP) latency for one S-NSSAI is defined by:



This KPI is obtained by the inverse of the average end-to-end User Plane (UP) latency of the network slice divided by the energy consumption of the network slice.

b-1) Integer, (0.1ms \* J)-1

b-2) RATIO

c)



d) NetworkSlice

##### 6.7.2.3.3 Based on both latency and Data Volume (DV) of the network slice

a) EEURLLC,DV,Latency

b) A KPI that shows the energy efficiency of network slices of type URLLC. The Pns for a network slice of type URLLC is the sum of UL and DL traffic volumes at N3 or N9 interface(s) on a per S-NSSAI basis multiplied by the inverse of the end-to-end User Plane (UP) latency of the network slice. In this KPI variant, data volume and latency are two factors considered for evaluating the performance of network slice. This KPI is applicable for the cases where, for example, the URLLC network slice is deployed and operators want to evaluate the Energy Efficiency of the slice at different periods of time, such as the busy hours in the morning and the idle hours in the mid night, in which both latency performance and the data volume performance can vary.



where





wN3 and wN9 are the weight for DVN3 and DVN9 respectively. wN3 and wN9 can be decided according to the deployment of PSA UPF. For example, in cases where PSA UPF has only N9 tunnels, such as the ones described in TS 23.501[7] clause 5.6.4 and clause 5.33.2.2, wN3 can be set to 0 and WN9 can be set to 1, so that only N9 interface is considered. In the cases where PSA UPF has only N3 tunnels, wN3 can be set to 1 and wN9 can be set to 0, so that only N3 interface is considered.

This KPI is obtained by the product of the sum of the weighted UL and DL traffic data volumes at N3 interface(s) or N9 interface of the PSA UPF of the network slice multiplied by the inverse of the end-to-end User Plane (UP) latency of the network slice, divided by the energy consumption of the network slice.

b-1) Integer, bit/(0.1ms\*J)

b-2) RATIO

c)



d) NetworkSlice

e) In case of redundant transmission paths for high reliability communication (TS 23.501 [7] clause 5.33.2), it is expected that the data volume is counted once. In particular:

- In case of Dual Connectivity based end to end Redundant User Plane Paths ( TS 23.501 [7] clause 5.33.2.1), in which a UE may set up two redundant PDU Sessions over the 5G network, the Data Volume related to only one PDU session is to be considered;

- In case of redundant transmission with two N3 tunnels between the PSA UPF and a single NG-RAN node (TS 23.501 [7] figure 5.33.2.2-1) which are associated with a single PDU Session, the Data Volume related to only one N3 tunnel is to be considered;

- In case of two N3 and N9 tunnels between NG-RAN and PSA UPF for redundant transmission ( TS 23.501 [7] figure 5.33.2.2-2) associated with a single PDU Session, the Data Volume related to only one of the multiple N3/N9 tunnels for redundant transmission connecting to PSA UPF is considered. The main reason for this is that, if the traffic is counted more than once, it will increase artificially the EEURLLC,DV,Latency KPI.

The 3GPP management system in charge of collecting the data volume measurements listed here above shall consider them only once in case of redundant transmission over the N3/N9 interface.

#### 6.7.2.4 Energy efficiency of MIoT network slice

##### 6.7.2.4.1 Based on the number of registered subscribers of the network slice

a) EEMIoT,RegSubs

b) A KPI that shows the energy efficiency of network slices of type MIoT. In this case, the Pns for a network slice of type MIoT is the maximum number of subscribers registered to the network slice.



, where *SNSSAI* identifies the S-NSSAI.

This KPI is obtained by the maximum number of registered subscribers to the network slice divided by the energy consumption of the network slice.

b-1) Integer, user/J

b-2) RATIO

c)



d) NetworkSlice

##### 6.7.2.4.2 Based on the number of active UEs in the network slice

a) EEMIoT,ActiveUEs

b) A KPI that shows the energy efficiency of network slices of type MIoT. In this case, the Pns for a network slice of type MIoT is the mean number of active UEs of the network slice.



, where *SNSSAI* identifies the S-NSSAI.

This KPI is obtained by the mean number of active UEs of the network slice divided by the energy consumption of the network slice.

b-1) Integer, UE/J

b-2) RATIO

c)



d) NetworkSlice

### 6.7.3 5G Energy Consumption (EC)

#### 6.7.3.1 NF Energy Consumption (EC)

##### 6.7.3.1.1 Definition

a) ECNF

b) This KPI describes the Energy Consumption (EC) of a 5G Network Function (NF). This KPI is obtained by summing up the energy consumption of PNF(s) and/or VNF(s) which compose the NF.

b-1) Integer, J

b-2) CUM

c)



- How a 5GC NF is composed of VNFs and PNFs is implementation specific. In particular, whether a VNF instance (respectively PNF) is shared or not between more than one NF is implementation specific. Hence, the case where a VNF instance (resp. PNF) is shared between multiple NFs is out of scope of the present document;

- ECPNF represents the Energy Consumption (EC) of a PNF;

- ECVNF represents the Energy Consumption (EC) of a VNF. It is obtained by summing up the Energy Consumption (EC) of all its constituent VNFCs;

- In the present document:

# ECPNF is measured according to ETSI ES 202 336-12 [10],

# it is considered that ECVNF cannot be measured hence is estimated. Therefore the resulting ECNF KPI is defined as:



##### 6.7.3.1.2 Estimated Virtualized Network Function (VNF) energy consumption

a) ECVNF,estimated

b) A KPI that gives an estimation of the energy consumption of a VNF. This KPI is obtained by summing up the estimated energy consumption of its constituent Virtualized Network Function Components (VNFC).

b-1) Integer, J

b-2) CUM

c) 

d) ManagedFunction

e) In the present document, the energy consumption of the VNFC is estimated as per clause 6.7.3.1.3.

##### 6.7.3.1.3 Estimated Virtualized Network Function Component (VNFC) energy consumption

a) ECVNFC,estimated

b) A KPI that gives an estimation of the energy consumption of a VNFC. In the present document, this KPI is obtained by taking the estimated energy consumption of the virtual compute resource instance on which the VNFC runs.

b-1) Integer, J

b-2) CUM

c) 

d) ManagedFunction

e) In the present document, the energy consumption of the virtual compute resource instance is estimated based on either:

- its mean vCPU usage, as per clause 6.7.3.1.4. The method for calculating ECVNFC,estimated is described in TS 28.310 [9] clause 6.3.2.2.1, or

- its mean vMemory usage, as per clause 6.7.3.1.5, or

- its mean vDisk usage, as per clause 6.7.3.1.6, or

- its I/O traffic volume, as per clause 6.7.3.1.7.

##### 6.7.3.1.4 Estimated virtual compute resource instance energy consumption based on mean vCPU usage

a) ECvirtualCompute,estimated,VCpuUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vCPU mean usage of the virtual compute resource instance X, by the sum of the vCPU mean usage of all virtual compute resource instances running on the same NFVI Node as X.

b-1) Integer, J

b-2) RATIO

c) 

d) ManagedFunction

e)

- VCpuUsageMean is the mean vCPU usage of the virtual compute resource instance during the observation period, provided by ETSI NFV MANO (see clause 7.1.2 of ETSI GS NFV-IFA 027 [11]),

-  is sum of the vCPU mean usage of all virtual compute resource instances running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.2 of ETSI GS NFV-IFA 027 [11]),

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10].

##### 6.7.3.1.5 Estimated virtual compute resource instance energy consumption based on mean vMemory usage

a) ECvirtualCompute,estimated,VMemoryUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vMemory mean usage of the virtual compute resource instance X, by the sum of the vMemory mean usage of all virtual compute resource instances running on the same NFVI Node as X.

b-1) Integer, J

b-2) RATIO

c)



d) ManagedFunction

e)

- VMemoryUsageMean is the mean memory usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

- is the sum of the mean memory usage of all virtual compute resource instances running on the same NFVI node during the same observation period, all separately provided by NFV MANO (see clause 7.1.4 of [11],

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10]. The measurement defined in TS 28.552 [6] clause 5.1.1.19.3 can be used to measure ECNFVINode,measured.

##### 6.7.3.1.6 Estimated virtual compute resource instance energy consumption based on mean vDisk usage

a) ECvirtualCompute,estimated,VDiskUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vDisk mean usage of the virtual compute resource instance X, by the sum of the vDisk mean usage of all virtual compute resource instances running on the same NFVI Node as X.

b-1) Integer, J

b-2) RATIO

c)



d) ManagedFunction

e)

- VDiskUsageMean is the mean disk usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

- is the sum of the mean disk usage of all virtual compute resource instances running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.6 of [11],

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10]. The measurement defined in TS 28.552 [6] clause 5.1.1.19.3 can be used to measure ECNFVINode,measured.

##### 6.7.3.1.7 Estimated virtual compute resource instance energy consumption based on I/O traffic volume

a) ECvirtualCompute,estimated,IOTrafficVolume

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the I/O traffic volume of the virtual compute resource instance X, by the sum of the I/O traffic volume of all virtual compute resource instances running on the same NFVI Node as X.

b-1) Integer, J

b-2) RATIO

c)



d) ManagedFunction

e)

- IOTrafficVolume is the sum of the incoming and outgoing traffic volumes of the virtual compute resource instance during the observation period, provided by NFV MANO.

- Incoming traffic volume is obtained by measuring the number of incoming bytes on virtual compute (VNetByteIncoming - cf. clause 7.1.8 of [11]) during the observation period.

- Outgoing traffic volume is obtained by measuring the number of outgoing bytes on virtual compute (VNetByteOutgoing - cf. clause 7.1.9 of [11]) during the observation period,



- is the sum of the incoming and outgoing traffic volumes of all virtual compute resource instances running on the same NFVI node during the same observation period, all separately provided by NFV MANO (see clause 7.1.8 and 7.1.9 of [11]),

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10]. The measurement defined in TS 28.552 [6] clause 5.1.1.19.3 can be used to measure ECNFVINode,measured.

#### 6.7.3.2 5GC Energy Consumption (EC)

##### 6.7.3.2.1 Definition

a) EC5GC

b) This KPI describes the Energy Consumption (EC) of the 5G Core Network (CN). It is obtained by summing up the Energy Consumption of all the Network Functions (ECNF) that compose the 5G core network. For the Energy Consumption (EC) of Network Functions, see clause 6.7.3.1.

b-1) Integer, J

b-2) CUM

c)



d) Subnetwork

#### 6.7.3.3 Network Slice Energy Consumption (EC)

a) ECns

b) This KPI describes the Energy Consumption (EC) of the network slice. It is obtained by summing up the Energy Consumption of all the Network Functions (ECNF) that compose the network slice.

b-1) Integer, J

b-2) CUM

c)



As a network slice may be composed of a RAN network slice subnet, a Transport Network (TN) network slice subnet and a 5GC network slice subnet, they all participate to the energy consumption of the network slice. However, the definition and way to measure the energy consumption of the TN segment is not in the scope of the present document.

The definition of ECns based on the following principles:

- For all gNBs in the network slice, clause 5.1.1.19.3 (PNF Energy consumption) of TS 28.552 [6] applies. This measurement is obtained according to the method defined in ETSI ES 202 336-12 [10] – clauses 4.4.3.1, 4.4.3.4, Annex A;

- In case a 5GC NF is composed of Virtualized Network Functions (VNF) and/or Physical Network Functions (PNF), clause 6.7.3.1 of this document defines the NF Energy Consumption (EC);

- In case a NF is dedicated to a network slice, the energy consumption of the NF is entirely attributable to the network slice;

- In case a NF is shared between multiple network slices, the participation of the NF to the energy consumption of the network slice has to be estimated, as it can't be measured:

- In case of a gNB shared between multiple network slices, the energy consumption attributable to each network slice is estimated as a proportion of the total gNB energy consumption, where the proportion is calculated as the data volume of the network slice relatively to the total data volume carried by the gNB,

- In case of a AMF shared between multiple network slices, the energy consumption attributable to each network slice is estimated as a proportion of the total estimated AMF energy consumption, where the proportion is calculated as the mean number of registered subscribers of the network slice relatively to the overall mean number of registered subscribers of the AMF during the same time period (see TS 28.552 [6] clause 5.2.1.1 for the definition of the mean number of registered subscribers),

- In case of a SMF shared between multiple network slices, the energy consumption attributable to each network slice is estimated as a proportion of the total estimated SMF energy consumption, where the proportion is calculated as the mean number of PDU sessions of the network slice relatively to the overall mean number of PDU sessions of the SMF during the same time period (see TS 28.552 [6] clause 5.3.1.1 for the definition of the mean number of PDU sessions),

- In case of a UPF shared between multiple slices, the energy consumption attributable to each network slice is estimated as a proportion of the total estimated UPF energy consumption, where the proportion is calculated as the data volume of the network slice relatively to the overall data volume of the UPF during the same time period.

- In case of a UPF with N3 interface(s), the data volume of the UPF is obtained by summing up, for all N3 interface(s), the number of octets of incoming GTP data packets on the N3 interface, from (R)AN to UPF (see TS 28.552 [6] clause 5.4.1.3) and the number of octets of outgoing GTP data packets on the N3 interface, from UPF to (R)AN (see TS 28.552 [6] clause 5.4.1.4)

- In case of a PSA UPF with no N3 interface(s), the data volume of the UPF is obtained by summing up, for all N9 interface(s), the number of octets of incoming GTP data packets on the N9 interface for PSA UPF (see TS 28.552 [6] clause 5.4.4.2.3) and the number of octets of outgoing GTP data packets on the N9 interface for PSA UPF (see TS 28.552 [6] clause 5.4.4.2.4)

- The case of other 5GC NFs shared between network slices is not addressed in the present document.

d) NetworkSlice

#### 6.7.3.4 NG-RAN Energy Consumption (EC)

##### 6.7.3.4.1 NG-RAN EC

a) ECNG-RAN

b) This KPI describes the Energy Consumption (EC) of the NG-RAN. It is obtained by summing up the Energy Consumption of all the gNBs that constitute the NG-RAN.

b-1) Integer, J

b-2) CUM

c)



d) Subnetwork

##### 6.7.3.4.2 gNB EC

a) ECgNB

b) This KPI describes the Energy Consumption (EC) of the gNB. It is obtained by summing up the Energy Consumption of all the Network Functions (NF) that constitute the gNB. For the Energy Consumption of Network Functions (ECNF), see clause 6.7.3.1.

b-1) Integer, J

b-2) CUM

c)



d) ManagedElement

### 6.7.4 5GC Energy Efficiency (EE)

#### 6.7.4.1 Generic 5GC Energy Efficiency (EE)KPI

, where:

- ‘Useful Output of 5GC’ (UsefulOutput5GC) is the useful output of 5GC. It can be defined differently, depending on which 5GC network functions are considered;

- ‘Energy Consumption of 5GC’ (EC5GC) is the Energy Consumption of 5GC.

For one unit of EC5GC, the higher UsefulOutput5GC is, the higher the generic 5GC EE KPI is, i.e. the more energy efficient the 5GC is.

#### 6.7.4.2 Energy Efficiency of 5GC based on the useful output of 5GC user plane

a) EE5GC,UO,UP,DV

b) A KPI that shows the energy efficiency of 5GC. This KPI is based on the useful output of 5GC user plane. The useful output of the 5GC user plane is obtained by summing up UL and DL data volumes at N3 interface(s).



This KPI is obtained by the sum of UL and DL data volumes at N3 interface(s), divided by the energy consumption of 5GC.

b-1) Integer, bit/J

b-2) RATIO

c)



d) SubNetwork

e) In case of redundant transmission paths over the N3 interface for high reliability communication (cf. TS 23.501 [7] clause 5.33.2), it is expected that the data volume is counted once. In particular:

- In case of Dual Connectivity based end to end Redundant User Plane Paths (see TS 23.501 [7] clause 5.33.2.1), in which a UE may set up two redundant PDU Sessions over the 5G network, the Data Volume related to only one PDU session is to be considered;

- In case of redundant transmission with two N3 tunnels between the PSA UPF and a single NG-RAN node (cf. TS 23.501 [7] figure 5.33.2.2-1) which are associated with a single PDU Session, the Data Volume related to only one N3 tunnel is to be considered;

- In case of two N3 and N9 tunnels between NG-RAN and PSA UPF for redundant transmission (see TS 23.501 [7] figure 5.33.2.2-2) associated with a single PDU Session, the Data Volume related to only one N3 tunnel is to be considered.

For the measurement of the energy efficiency of the 5G core network, the 3GPP management system in charge of collecting the data volume measurements listed here above shall consider them only once in case of redundant transmission over the N3 interface.

### 6.7.5 Energy efficiency evaluated from network availability

#### 6.7.5.1 Introduction

The KPI is defined from a network availability performance dimension perspective.

#### 6.7.5.2 Energy efficiency of cell based on availability

a) EECell,AvailAvgTimeCU

b) A KPI that shows the energy efficiency of a cell in a gNB based on availability performance. This KPI is obtained by dividing cell availability KPI by the average energy consumption per cell in a gNB over the same observation period.

b-1) Integer, sec/J

b-2) RATIO

c)

d) GNBCUCPFunction

e) The cell availability KPI is defined in clause 6.10.1.1.1. The average energy consumption per cell in a gNB is obtained by considering energy consumption of gNB (ECgNB) for a given time period and dividing it by total number of cells in a gNB that are operational in same time duration/period. ECgNB is defined in clause 6.7.3.4.2.

NOTE: The cell availability KPI is for the split gNB deployment scenario. The average energy consumption for cell is derived using a weighted average of ECgNB over the number of cells. The weight defined by the consumer of KPI.

### 6.7.6 Energy efficiency evaluated from network quality

#### 6.7.6.1 Introduction

These KPIs about energy efficiency evaluated from network quality performance perspective are defined with two variants for sub-network or network slice subnet.

#### 6.7.6.2 Energy efficiency of a sub-network based on DL UE throughput

a) EESNw,DLUeThroughput

b) A KPI that shows the energy efficiency of a sub-network based on DL UE throughput. This KPI is obtained by DL RAN UE throughput for a sub-network KPI divided by the average energy consumption per gNB of the sub-network over the same observation period.

b-1) Integer, kbit/(sec\*J)

b-2) RATIO

c)

d) SubNetwork

e) The DL RAN UE throughput for a sub-network KPI is defined in clause 6.3.6.3.2. The average energy consumption per gNB of the sub-network is obtained by summing up the Energy Consumption (ECgNB) of all the gNBs that constitute the sub-network and then dividing the result by the total number of gNBs present in the sub-network. ECgNB is defined in clause 6.7.3.4.2. The use of ECper gNB of sub-network in the denominator enables this KPI to be used to compare the EE of sub-networks of different sizes/scales.

NOTE: The average energy consumption for gNB is derived using a weighted average of the energy consumption of ECgNB over the number of gNBs present in the subnetwork. The weight defined by the consumer of KPI.

#### 6.7.6.3 Energy efficiency of a sub-network based on UL UE throughput

a) EESNw,ULUeThroughput

b) A KPI that shows the energy efficiency of a sub-network based on UL UE throughput. This KPI is obtained by UL RAN UE throughput for a sub-network KPI divided by the average energy consumption per gNB of the sub-network over the same observation period.

b-1) Integer, kbit/(sec\*J)

b-2) RATIO

c)

d) SubNetwork

e) The UL RAN UE throughput for a sub-network KPI is defined in clause 6.3.6.4.2. The average energy consumption per gNB of the sub-network is obtained by summing up the Energy Consumption (ECgNB) of all the gNBs that constitute the sub-network and then dividing the result by the total number of gNBs present in the sub-network. ECgNB is defined in clause 6.7.3.4.2. The use of ECper gNB of sub-network in the denominator enables this KPI to be used to compare the EE of sub-networks of different sizes/scales.

NOTE: The average energy consumption for gNB is derived using a weighted average of the energy consumption of ECgNB over the number of gNBs present in the subnetwork. The weight defined by the consumer of KPI.

#### 6.7.6.4 Energy efficiency of a network slice subnet based on DL UE throughput

a) EENss,DLUeThroughput

b) A KPI that shows the energy efficiency of a network slice subnet based on DL UE. This KPI is obtained by DL RAN UE throughput for a network slice subnet KPI divided by the average energy consumption per gNB of the network slice subnet over the same observation period.

b-1) Integer, kbit/(sec\*J)

b-2) RATIO

c)

d) NetworkSliceSubnet

e) The DL RAN UE throughput for a network slice subnet KPI is defined in clause 6.3.6.3.3. The average energy consumption per gNB of the network slice subnet is obtained by summing up the Energy Consumption (ECgNB) of all the gNBs that constitute the network slice subnet and then dividing the result by the total number of gNBs present in the network slice subnet. ECgNB is defined in clause 6.7.3.4.2. The use of ECper gNB of Nss in the denominator enables this KPI to be used to compare the EE of network slice subnets of different sizes/scales.

NOTE: The average energy consumption for gNB is derived using a weighted average of the energy consumption of ECgNB over the number of gNBs present in the network slice subnet. The weight defined by the consumer of KPI.

#### 6.7.6.5 Energy efficiency of a network slice subnet based on UL UE throughput

a) EENss,ULUeThroughput

b) A KPI that shows the energy efficiency of a network slice subnet based on UL UE throughput. This KPI is obtained by UL RAN UE throughput for a network slice subnet KPI divided by the average energy consumption per gNB of the network slice subnet over the same observation period.

b-1) Integer, kbit/(sec\*J)

b-2) RATIO

c)

d) NetworkSliceSubnet

e) The UL RAN UE throughput for a network slice subnet KPI is defined in clause 6.3.6.3.3. The average energy consumption per gNB of the network slice subnet is obtained by summing up the Energy Consumption (ECgNB) of all the gNBs that constitute the network slice subnet and then dividing the result by the total number of gNBs present in the network slice subnet. ECgNB is defined in clause 6.7.3.4.2. The use of ECper gNB of Nss in the denominator enables this KPI to be used to compare the EE of network slice subnets of different sizes/scales.

NOTE: The average energy consumption for gNB is derived using a weighted average of the energy consumption of ECgNB over the number of gNBs present in the network slice subnet. The weight defined by the consumer of KPI.

### 6.7.7 gNB Estimated Carbon Emission (ECE)

#### 6.7.7.1 Definition

a)

b) This KPI provides the Estimated Carbon Emission of a gNB (ECEgNB) over a time period. The Estimated Carbon Emission of a gNB (ECEgNB) is the Energy Consumption of the gNB (ECgNB) multiplied by the Carbon Emission Factor of the energy source which powers the gNB (CEF). The CEF of the energy supply is the sum of all CEFs of its energy sources as configured in energySourceCef (see TS 28.310 [9]). The KPI object, i.e., ManagedElement is associated with EnergySupplyInfo through IOC EnergyInfoGroup as described in TS 28.310[9].

b-1) Integer, kg CO2eq

b-2) CUM

c) This calculation formula is obtained as:

, where:

ECgNB is the Energy Consumption of the gNB as defined in TS 28.554 clause 6.7.3.4.2. Its unit is kWh;

CEFgNB indicates Carbon Emission Factor. The CEF of the energy supply is the sum of all CEFs of its energy sources as configured in energySourceCef (see TS 28.310 [9]). Its unit is kg CO2eq/kWh.

d) ManagedElement

NOTE: This KPI is applicable for the gNBs that are powered using single energy supply. The accuracy of this KPI is dependent on the accuracy of the CEF information configured by the operator.

## 6.8 Reliability KPI

### 6.8.1 Definition

Reliability is defined (see TS 22.261 [13] clause 3.1) in the context of network layer packet transmissions, as the percentage value of the packets successfully delivered to a given system entity within the time constraint required by the targeted service out of all the packets transmitted.

#### 6.8.1.1 Packet transmission reliability KPI in DL on Uu

a) DLRelPSR\_Uu

b) This KPI describes the Reliability based on Packet Success Rate(PSR) Percentage between gNB and UE. It is used to evaluate the Uu interface reliability contribution to the total network downlink reliability. It is the percentage of RLC SDU packets which are successfully received in UE out of the total RLC SDU packets transmitted by gNB. It is a measure of the DL packet delivery success i.e. PSR% over Uu interface. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Below is the equation for downlink Reliability in RAN based on PSR percentage between gNB and UE.

DLRelPSR\_Uu = × 100 , where N(T1,drbid) & Dloss(T1,drbid) are as defined in TS 38.314.

or optionally DLRelPSR\_Uu.QoS = × 100, where QoS

identifies the target QoS quality of service class.

or optionally DLRelPSR\_Uu.SNSSAI = × 100,

where SNSSAI identifies the S-NSSAI.

d) NRCellDU

#### 6.8.1.2 Packet transmission reliability KPI in UL on Uu

a) ULRelPSR\_Uu

b) This KPI describes the Reliability based on Packet Success Rate Percentage between UE and gNB. It is used to evaluate the Uu interface reliability contribution to the total network uplink reliability. It is the percentage of PDCP SDU packets which are successfully received in gNB out of the total PDCP SDU packets transmitted by UE. It is a measure of the UL packet delivery success i.e. PSR% over Uu interface. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) ULRelPSR\_Uu = DRB.PacketSuccessRateUlgNBUu × 100 , where DRB\_PacketSuccessRateUlgNBUu is as defined in TS 28.552 [6].

or optionally ULRelPSR\_Uu.QoS = DRB.PacketSuccessRateUlgNBUu.QOS × 100, where QoS identifies the target QoS quality of service class.

or optionally ULRelPSR\_Uu.SNSSAI = DRB.PacketSuccessRateUlgNBUu.SNSSAI × 100, where SNSSAI identifies the S-NSSAI.

d) NRCellCU

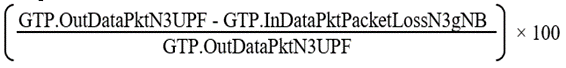
#### 6.8.1.3 Packet transmission reliability KPI in DL on N3

a) DLRelPSR\_N3

b) This KPI describes the Reliability based on Packet Success Rate(PSR) Percentage between UPF and gNB. It is used to evaluate the N3 interface reliability contribution to the total network downlink reliability. It is the percentage of GTP data PDUs which are successfully received by gNB out of the total GTP data PDUs transmitted by UPF over N3 interface. It is a measure of the DL packet delivery success i.e. PSR% over N3 interface. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) DLRelPSR\_N3 = 

where GTP.OutDataPktN3UPF, GTP.InDataPktPacketLossN3gNB are as defined in TS 28.552

or optionally,

DLRelPSR\_N3.QoS = 

where QoS identifies the target QoS quality of service class.

or optionally,

DLRelPSR\_N3.SNSSAI = 

where SNSSAI identifies the S-NSSAI.

d) UPFFunction, GNBCUUPFunction

#### 6.8.1.4 Packet transmission reliability KPI in UL on N3

a) ULRelPSR\_N3

b) This KPI describes the Reliability based on Packet Success Rate(PSR) Percentage between gNB and UPF. It is used to evaluate the N3 interface reliability contribution to the total network uplink reliability. It is the percentage of GTP data PDUs which are successfully received by UPF out of the total GTP data PDUs transmitted by gNB over N3 interface. It is a measure of the UL packet delivery success i.e. PSR% over N3 interface. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

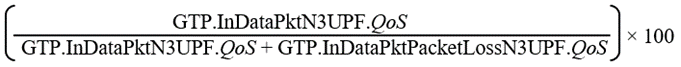
b-1) Integer, percentage, 0-100

b-2) RATIO

c) ULRelPSR\_N3 = 

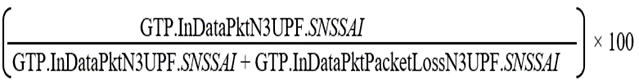
where GTP.InDataPktN3UPF , GTP.InDataPktPacketLossN3UPF are as defined in TS 28.552

or optionally,

ULRelPSR\_N3.QoS = 

where QoS identifies the target QoS quality of service class.

or optionally,

ULRelPSR\_N3.SNSSAI = 

where SNSSAI identifies the S-NSSAI.

d) UPFFunction

#### 6.8.1.5 Packet transmission reliability KPI in DL on F1-U

a) DLRelPSR\_F1u

b) This KPI describes the Reliability based on Packet Success Rate(PSR) Percentage between gNB-CU-UP and gNB-DU. It is a measure of the DL packet delivery success i.e. PSR% over F1-U interface. It provides the fraction of PDCP SDU packets that are successfully received at the gNB-DU. It is calculated as the percentage of GTP data PDU sequence numbers which are successfully received in gNB-DU out of the total GTP data PDU sequence numbers transmitted by gNB-CU-UP to gNB-DU over F1-U interface. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Below is the equation for downlink Reliability in F1 interface based on PSR percentage between gNB-CU-UP and gNB-DU.

DLRelPSR\_F1u = (*DRB.F1UPacketSuccessRateDl*)×100,

or optionally DLRelPSR\_F1u.*QoS* = (*DRB.F1UPacketSuccessRateDl.QoS*)×100, where QoS identifies the target QoS quality of service class.

or optionally DLRelPSR\_F1u.*SNSSAI* = (*DRB.F1UPacketSuccessRateDl.SNSSAI*)×100, where SNSSAI identifies the S-NSSAI.

d) GNBCUUPFunction

#### 6.8.1.6 Packet transmission reliability KPI in UL on F1-U

a) ULRelPSR\_F1u

b) This KPI describes the Reliability based on Packet Success Rate(PSR) Percentage between gNB-CU-UP and gNB-DU. It is a measure of the UL packet delivery success i.e. PSR% over F1-U interface. It provides the fraction of PDCP SDU packets that are successfully received at the gNB-CU-UP. It is calculated as the percentage of GTP data PDU sequence numbers which are successfully received in gNB-CU-UP out of the total GTP data PDU sequence numbers transmitted by gNB-DU over F1-U interface to gNB-CU-UP. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Below is the equation for uplink Reliability in F1 interface based on PSR percentage between gNB-CU-UP and gNB-DU.

ULRelPSR\_F1u = ,

or optionally ULRelPSR\_F1u.*QoS* = , where QoS identifies the target QoS quality of service class.

or optionally ULRelPSR\_F1u.*SNSSAI* = , where SNSSAI identifies the S-NSSAI.

d) GNBCUUPFunction.

#### 6.8.1.7 Reliability KPI in RAN with time constraint over Uplink air-interface(Uu)

a) RelPktsTCUL\_Uu

b) This KPI describes the packet transmission reliability considering a time constraint/delay threshold (as required for a service) in uplink over the air (Uu) interface in RAN. It is the percentage of MAC SDU packets/transport blocks that are transmitted over the air interface in uplink and successfully received within the required time constraint/delay threshold out of the total MAC SDU packets/transport blocks that are transmitted over air interface in uplink. It is a percentage value (%). This KPI can optionally be split into per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Below is the equation for Reliability KPI in RAN with a time constraint/delay threshold in UL over Uu Interface.

RelPktsTCUL\_Uu = [DRB.AirIfDelayDistUL.Bin\_Filter ÷ I(T)] × 100 , where

I(T) is Total number of UL MAC SDUs and is as defined in Table 4.2.1.2.2-2 in TS 38.314 [12].

DRB.AirIfDelayDistUL\_Bin\_Filter is as defined in TS 28.552 [6], clause 5.1.1.1.9.

d) NRCellDU

#### 6.8.1.8 Reliability KPI in RAN with time constraint over Downlink air-interface(Uu)

a) RelPktsTCDL\_Uu

b) This KPI describes the packet transmission reliability considering a time constraint/delay threshold (as required for a service) in downlink over the Uu interface in RAN. It is the percentage of RLC SDU packets that are transmitted over the air interface in downlink and positively acknowledged within the required time constraint/delay threshold, out of the total RLC SDU packets transmitted over air interface in downlink. It is a percentage value (%). This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in EN-DC architecture) and per S-NSSAI.

b-1) Integer, percentage, 0-100

b-2) RATIO

c) Below is the equation for Reliability KPI in RAN with time constraint or delay threshold (denoted as TC) in DL over Uu Interface.

c.1) RelPktsTCDL\_Uu = [(DRB.AirIfDelayDist.Bin\_Filter)/(N(T,drbid) + Dloss(T,drbid))] × 100, where

N(T,drbid) and Dloss(T,drbid) are as defined in Table 4.2.1.5.1-2 in TS 38.314 [12].

DRB.AirIfDelayDist\_Bin\_Filter is as defined in clause 5.1.1.1.2 in TS 28.552 [6].

Optionally RelPktsTCDL\_Uu.QoS = [(DRB.AirIfDelayDist.Bin\_QoS)/(N(T,drbid).QoS + Dloss(T,drbid).QoS)] × 100, where QoS identifies the target QoS quality of service class.

Optionally RelPktsTCDL\_Uu.SNSSAI = [(DRB.AirIfDelayDist.Bin\_SNSSAI)/(N(T,drbid).SNSSAI + Dloss(T,drbid).SNSSAI)] × 100, where SNSSAI identifies the S-NSSAI.

d) NRCellDU

#### 6.8.1.9 End to end Downlink reliability KPI of URLLC Network Slice

a) PURLLC,ReliabilityDL,PSR

b) A packet success rate percentage (PSR%) based reliability of a network slice is a uni-directional performance characteristic of the slice. This KPI describes the end to end reliability of a URLLC network slice in downlink direction based on PSR%. It is obtained by multiplying PSR% based downlink reliability of Uu interface and N3 interface which are defined in clause 6.8.1.1 and clause 6.8.1.3 respectively. It is a percentage value (%).

b-1) Integer, percentage

b-2) RATIO

c) Below is the equation for end to end reliability of a URLLC network slice in downlink direction

PURLLC,ReliabilityDL,PSR = PSRDL,Uu × PSRDL,N3

Where,

PSRDL,Uu is equal to DLRelPSR\_Uu.SNSSAI which is as defined in clause 6.8.1.1.

PSRDL,N3 is equal to DLRelPSR\_N3.SNSSAI which is as defined in clause 6.8.1.3.

d) NetworkSlice.

#### 6.8.1.10 End to end Uplink reliability KPI of URLLC Network Slice

a) PURLLC,ReliabilityUL,PSR

b) A packet success rate percentage (PSR%) based reliability of a network slice is a uni-directional performance characteristic of the slice. This KPI describes the end to end reliability of a URLLC network slice in uplink direction based on PSR%. It is obtained by multiplying PSR% based uplink reliability of Uu interface and N3 interface which are defined in clause 6.8.1.2 and clause 6.8.1.4 respectively. It is a percentage value (%).

b-1) Integer, percentage

b-2) RATIO

c) Below is the equation for end to end reliability of a URLLC network slice in uplink direction

PURLLC,ReliabilityUL,PSR = PSRUL,Uu × PSRUL,N3

Where,

PSRUL,Uu is equal to ULRelPSR\_Uu.SNSSAI which is as defined in clause 6.8.1.2.

PSRUL,N3 is equal to ULRelPSR\_N3.SNSSAI which is as defined in clause 6.8.1.4.

d) NetworkSlice.

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| --- |
| **End of Change** |