**3GPP TSG- Meeting #**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** | **2** | **Current version:** |  |  |
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| *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 |  |

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| ***Title:***  |  |
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| ***Source to WG:*** |  |
| ***Source to TSG:*** | SA5 |
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| ***Work item code:*** |  |  | ***Date:*** |  |
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| ***Category:*** |  |  | ***Release:*** |  |
|  | *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 canbe 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)* |
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| ***Reason for change:*** | ‘NR option 3’ is one of the 5G architecture options used in TR 38.801 for study, which shows the architecture where the LTE eNB is connected to the EPC with Non-standalone NR. When it turns into normative work, this architecture is renamed as EN-DC (E-UTRA-NR Dual Connectivity) architecture as defined in TS 37.340 clause 4.1.2. Therefore, it is proposed to replace ‘NR option 3’ with ‘EN-DC’ to keep alignment with TS 37.340. Similar for option 4, i.e., NR- E-UTRA Dual Connectivity (NE-DC); option 7, i.e., NG-RAN E-UTRA-NR Dual Connectivity (NGEN-DC).NOTE: Similar change for TS 28.554 in R19 was apporved in SA5 #156 meeting. The approved contribution is S5-245055. |
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| ***Summary of change:*** | 1. Replace ‘NR option 3’ with ‘EN-DC’.
2. Replace ‘option 4’ with ‘NE-DC’
3. Replace ‘option 7’ with ‘NGEN-DC’
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| ***Consequences if not approved:*** | The use of ‘NR option 3/4/7’ is not normatively correct. |
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| ***Clauses affected:*** | 5.1.1.1.1, 5.1.1.1.2, 5.1.1.1.3, 5.1.1.1.4, 5.1.1.1.5, 5.1.1.1.6, 5.1.1.1.7, 5.1.1.1.9, 5.1.1.2.5, 5.1.1.2.7, 5.1.1.2.9, 5.1.1.2.10, 5.1.1.3.1, 5.1.1.3.2, 5.1.1.3.3, 5.1.1.3.4, 5.1.1.3.5, 5.1.1.3.6, 5.1.1.3.7, 5.1.1.10.3, 5.1.1.10.4, 5.1.1.23.1, 5.1.1.23.2, 5.1.1.23.3, 5.1.1.23.4, 5.1.1.35, 5.1.2.1.1.2, 5.1.2.1.2.2, 5.1.2.2.1, 5.1.3.1.1, 5.1.3.1.2, 5.1.3.1.3, 5.1.3.2.1, 5.1.3.2.2, 5.1.3.3.1, 5.1.3.3.2, 5.1.3.3.3, 5.1.3.3.4, 5.1.3.3.5, 5.1.3.3.6, 5.1.3.4.2, 5.1.3.4.3, 5.1.3.6.1, 5.1.3.6.2, 5.1.3.10.1, 5.1.3.10.2, 5.1.3.10.3, A.4 |
|  |  |
|  | **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 ...  |
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| ***Other comments:*** |  |
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| ***This CR's revision history:*** | Revision of S5-246618 |

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| **1st Change** |

# 1 Scope

This document specifies the performance measurements for 5G networks including network slicing. Performance measurements for NG-RAN are defined in this document (clause 5.1), and some L2 measurement definitions are inherited from TS 38.314 [29]. The performance measurements for 5GC are all defined in this document (clause 5.2 to 5.6). Related KPIs are defined to those measurements are defined in TS 28.554 [8].

The performance measurements for NG-RAN applies also to EN-DC described in TS 37.340 [60]in many cases, but not to the RRC connection related measurements which are handled by E-UTRAN for EN-DC (those are measured according to TS 32.425 [9] and related KPIs in TS 32.451 [10]).

The performance measurements are defined based on the measurement template as described in TS 32.404 [3].

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## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], TS 23.501 [4] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 23.501 [4].

CHO Conditional Handover

CLI Cross Link Interference

DAPS Dual Active Protocol Stack

GP Guard Period

HO Handover

ITI Interrupted Transmission Indication

kbit kilobit (1000 bits)

LHO Legacy Handover

LTM L1/L2 Triggered Mobility

MA PDU Multi-Access PDU

MN Master Node.

MPQUIC Multi-Path QUIC

MPTCP Multi-Path TCP Protocol

NG-RAN Next Generation Radio Access Network

RNA RAN-based Notification Area

PI Performance Indicator

PMF Performance Measurement Function

SA PDU Single-Access PDU

SDT Small Data Transmission

SN Secondary Node.

SRS Sounding Reference Signal

TEID Tunnel Endpoint IDentifier

EN-DC E-UTRA-NR Dual Connectivity

NGEN-DC NG-RAN E-UTRA-NR Dual Connectivity

NE-DC NR-E-UTRA Dual Connectivity

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| **Next Change** |

#### 5.1.1.1 Packet Delay

##### 5.1.1.1.1 Average delay DL air-interface

a) This measurement provides the average (arithmetic mean) time it takes for packet transmission over the air-interface in the downlink direction. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained as: sum of (point in time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of HARQ ACK from UE for UM mode or point in time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of RLC ACK for AM mode, minus time when corresponding RLC SDU part arriving at MAC layer) divided by total number of RLC SDUs transmitted to UE successfully. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a real representing the mean delay in 0.1 millisecond. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.AirIfDelayDl\_Filter,
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321 [61]), this measurement is not available for UM mode.

##### 5.1.1.1.2 Distribution of delay DL air-interface

a) This measurement provides the distribution of the time it takes for packet transmission over the air-interface in the downlink direction. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by 1) calculating the DL delay for an RLC SDU packet by: point in the time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of HARQ ACK for UM mode or point in time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of RLC ACK for AM mode, minus the time when corresponding RLC SDU part arriving at MAC layer; and 2) incrementing the corresponding bin with the delay range where the result of 1) falls into by 1 for the counters. If the RLC SDU needs retransmission (for Acknowledged Mode) the delay will still include only one contribution (the original one) to this measurement. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer representing the number of RLC SDU packets measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.AirIfDelayDist.Bin\_Filter, where Bin indicates a delay range which is vendor specific;

Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

NOTE: If the HARQ process is configured with disabled HARQ feedback for NTN (refer to 38.321 [61]),this measurement is not available for UM mode.

##### 5.1.1.1.3 Average delay UL on over-the-air interface

a) This measurement provides the average (arithmetic mean) over-the-air packet delay on the uplink. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained according to the definition in TS 38.314 [29], named "Average over-the-air interface packet delay in the UL per DRB per UE". The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a real representing the mean delay in 0.1 millisecond. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.AirIfDelayUl\_Filter,

Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.1.4 Average RLC packet delay in the UL

a) This measurement provides the average (arithmetic mean) RLC packet delay on the uplink, ie the delay within the gNB-DU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained according to the definition in TS 38.314 [29], named "Average RLC packet delay in the UL per DRB per UE". The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a real representing the mean delay in the unit 0.1 milliseconds. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.RlcDelayUl\_Filter,

Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.1.5 Average PDCP re-ordering delay in the UL

a) This measurement provides the average (arithmetic mean) PDCP re-ordering delay on the uplink, ie the delay within the gNB-CU-UP. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained according to the definition in TS 38.314 [29], named "Average PDCP re-ordering delay in the UL per DRB per UE. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a real representing the mean delay in the unit 0.1 milliseconds. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.PdcpReordDelayUl\_Filter,

Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.1.6 Distribution of DL delay between NG-RAN and UE

a) This measurement provides the distribution of DL packet delay between NG-RAN and UE, which is the delay incurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU) and the delay over Uu interface. This measurement is calculated per PLMN ID and per 5QI and per supported S-NSSAI.

b) DER (n=1).

c) The measurement is obtained by the following method:

 The gNB performs the GTP PDU packet delay measurement for QoS monitoring per the GTP PDU monitoring packets received from UPF, and records the following time stamps and information included in the GTP-U header of each GTP PDU monitoring response packet (packet i) sent to UPF (see 23.501 [4] and 38.415 [31]):

- The DL Delay Result from NG-RAN to UE indicating the downlink delay measurement result which is the sum of the delay incurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU) and the delay over Uu interface (see 38.415 [31], and the DL Delay Result is denoted by$ DRdl$ in the present document);

- The 5QI and S-NSSAI associated to the GTP PDU monitoring response packet.

 The gNB increments the corresponding bin with the delay range where the $DRdl$ falls into by 1 for the counters.

 The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer representing the number of GTP PDUs measured with the delay within the range of the bin.The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.DelayDlNgranUeDist.Bin\_Filter, where Bin indicates a delay range which is vendor specific;

Where filter is a combination of PLMN ID and QoS level and S-NSSAI.

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellCU (for non-split and 2-split scenario);
GNBCUUPFunction (for 3-split scenario).

g) Valid for packet switched traffic.

h) 5GS.

##### 5.1.1.1.7 Distribution of UL delay between NG-RAN and UE

###### 5.1.1.1.7.1 Distribution of UL delay between NG-RAN and UE (excluding D1)

a) This measurement provides the distribution of UL packet delay between NG-RAN and UE, which includes the delay occurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU) and the delay over Uu interface (excluding the D1 UL PDCP delay occurred in the UE). This measurement is calculated per PLMN ID and per 5QI and per supported S-NSSAI.

b) DER (n=1).

c) The measurement is obtained by the following method:

 The gNB performs the GTP PDU packet delay measurement for QoS monitoring for the GTP PDU monitoring packets received from UPF, and records the following time stamps and information included in the GTP-U header of each GTP PDU monitoring response packet (packet i,sent to UPF) for which the D1 UL PDCP Delay measurement is not included (see 23.501 [4] and 38.415 [31]):

- The UL Delay Result from UE to NG-RAN indicating the uplink delay measurement result which is the sum of the delay incurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU) and the delay over Uu interface (see 38.415 [31], and the UL Delay Result is denoted by$ DRul$ in the present document);

- The 5QI and S-NSSAI associated to the GTP PDU monitoring response packet.

 The gNB increments the corresponding bin with the delay range where the $DRul $falls into by 1 for the counters.

 The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer representing the number of GTP PDUs measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.DelayUlNgranUeDist.*BinFilter*, where *Bin* indicates a delay range which is vendor specific and *Filter* is a combination of PLMN ID and QoS level and S-NSSAI.
The QoS level represents the mapped 5QI or QCI.

f) NRCellCU (for non-split and 2-split scenario);
GNBCUUPFunction (for 3-split scenario).

g) Valid for packet switched traffic.

h) 5GS.

###### 5.1.1.1.7.2 Distribution of UL delay between NG-RAN and UE (including D1)

a) This measurement provides the distribution of UL packet delay between NG-RAN and UE, which includes the delay occurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU), the delay over Uu interface and the D1 UL PDCP delay occurred in the UE. This measurement is calculated per PLMN ID and per 5QI and per supported S-NSSAI.

b) DER (n=1).

c) The measurement is obtained by the following method:

 The gNB performs the GTP PDU packet delay measurement for QoS monitoring for the GTP PDU monitoring packets received from UPF, and records the following time stamps and information included in the GTP-U header of each GTP PDU monitoring response packet (packet i, sent to UPF) for which the D1 UL PDCP Delay measurement is included (see 23.501 [4] and 38.415 [31]):

- The UL Delay Result from UE to NG-RAN indicating the uplink delay measurement result which is the sum of the delay incurred in NG-RAN (including the delay at gNB-CU-UP, on F1-U and on gNB-DU), the delay over Uu interface and the D1 UL PDCP delay occurred in the UE (see 38.415 [31], and the UL Delay Result is denoted by$ DRul$ in the present document);

- The 5QI and S-NSSAI associated to the GTP PDU monitoring response packet.

 The gNB increments the corresponding bin with the delay range where the $DRul $falls into by 1 for the counters.

 The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer representing the number of GTP PDUs measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.DelayUlNgranUeIncD1Dist.*Bin*.*Filter*, where *Bin* indicates a delay range which is vendor specific, and *Filter* is a combination of PLMN ID and QoS level and S-NSSAI.
The QoS level represents the mapped 5QI or QCI.

f) NRCellCU (for non-split and 2-split scenario);
GNBCUUPFunction (for 3-split scenario).

g) Valid for packet switched traffic.

h) 5GS.

##### 5.1.1.1.8 DL packet delay between NG-RAN and PSA UPF

5.1.1.1.8.1 Average DL GTP packet delay between PSA UPF and NG-RAN

a) This measurement provides the average DL GTP packet delay between PSA UPF and NG-RAN. This measurement is split into subcounters per 5QI and subcounters per S-NSSAI. This measurement is only applicable to the case the PSA UPF and NG-RAN are time synchronised.

b) DER (n=1).

c) The measurement is obtained by the following method:

The UPF samples the GTP packets for QoS monitoring based on the policy provided by OAM or SMF.

NOTE: The sampling rate may vary for different S-NSSAI and different 5QIs, and the specific sampling rate is up to implementation unless given by the QoS monitoring policy.

 For each DL GTP PDU (packet i) encapsulated with QFI, TEID, and QMP indicator for QoS monitoring, the gNB records the following time stamps and information (see 23.501 [4] and 38.415 [31]):

- T1 received in the GTP-U header indicating the local time that the DL GTP PDU was sent by the PSA UPF;

- T2 that the DL GTP PDU was received by NG-RAN;

- The 5QI and S-NSSAI associated to the DL GTP PDU.

 The gNB counts the number (N) of DL GTP PDUs encapsulated with QFI, TEID, and QMP indicator for each 5QI and each S-NSSAI respectively, and takes the following calculation for each 5QI and each S-NSSAI:

$$\frac{\sum\_{i=1}^{N}(T2\_{i}-T1\_{i})}{N}$$

d) Each measurement is a real representing the average delay in microseconds.

e) GTP.DelayDlPsaUpfNgranMean.*5QI, where 5QI* identifies the 5QI;
GTP.DelayDlPsaUpfNgranMean.*SNSSAI, where SNSSAI* identifies the S-NSSAI.

f) EP\_N3 (contained by GNBCUUPFunction).

g) Valid for packet switched traffic.

h) 5GS.

5.1.1.1.8.2 Distribution of DL GTP packet delay between PSA UPF and NG-RAN

a) This measurement provides the distribution of DL GTP packet delay between PSA UPF and NG-RAN. This measurement is split into subcounters per 5QI and subcounters per S-NSSAI. This measurement is only applicable to the case the PSA UPF and NG-RAN are time synchronised.

b) DER (n=1).

c) The measurement is obtained by the following method:

The UPF samples the GTP packets for QoS monitoring based on the policy provided by OAM or SMF.

NOTE: The sampling rate may vary for different S-NSSAI and different 5QIs, and the specific sampling rate is up to implementation unless given by the QoS monitoring policy.

 For each DL GTP PDU (packet i) encapsulated with QFI, TEID, and QMP indicator for QoS monitoring, the gNB records the following time stamps and information (see 23.501 [4] and 38.415 [31]):

- T1 received in the GTP-U header indicating the local time that the DL GTP PDU was sent by the PSA UPF;

- T2 that the DL GTP PDU was received by NG-RAN;

- The 5QI and S-NSSAI associated to the DL GTP PDU.

 The gNB 1) takes the following calculation for each DL GTP PDU (packet i) encapsulated with QFI, TEID, and QMP indicator for each 5QI and each S-NSSAI respectively, and 2) increment the corresponding bin with the delay range where the result of 1) falls into by 1 for the subcounters per 5QI and subcounters per S-NSSAI.

$$T2\_{i}-T1\_{i}$$

d) Each measurement is an integer representing the number of GTP PDUs measured with the delay within the range of the bin.

e) GTP.DelayDlPsaUpfNgranDist.*5QI*.*Bin,* Where *Bin* indicates a delay range which is vendor specific, and *5QI* identifies the 5QI;
GTP.DelayDlPsaUpfNgranDist.*SNSSAI.bin,* Where *Bin* indicates a delay range which is vendor specific, and *SNSSAI* identifies the S-NSSAI.

f) EP\_N3 (contained by GNBCUUPFunction).

g) Valid for packet switched traffic.

h) 5GS.

##### 5.1.1.1.9 Distribution of delay over Uplink air-interface(Uu)

a) This measurement provides the distribution of the time it takes for packet/transport-block transmission over the air-interface in the uplink direction. The measurement is filterable per PLMN ID and per QoS level (mapped 5QI or QCI inEN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by calculating the uplink delay for a MAC SDU packet/transport-block by: calculating the time difference between the point in time when the UL MAC SDU is successfully sent to RLC (i.e. tSucc(i,drbid) as defined in TS 38.314 [29], Table 4.2.1.2.2-2) and the point in time when the UL MAC SDU is scheduled in MAC layer as per the scheduling grant provided (i.e. tSched(i,drbid) as defined in TS 38.314 [29], Table 4.2.1.2.2-2) and then incrementing the corresponding (time constraint/delay threshold) bin by 1 where the result of above subtraction falls into. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer representing the number of MAC SDU packets/transport-blocks whose measured delay is within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

e) DRB.AirIfDelayDistUL\_Bin or DRB.AirIfDelayDistUL\_Bin\_Filters

Where Bin indicates a time constraint/delay threshold range.

Where filter is either of PLMN ID, QoS level and S-NSSAI or a combination thereof.

PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

NOTE: Number of bins and the range for each bin is left to implementation.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and for performance assurance for URLLC services.

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| **Next Change** |

##### 5.1.1.2.5 Mean DL PRB used for data traffic

a) This measurement provides the number of physical resource blocks (PRBs) in average used in downlink for data traffic. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI and subcounters per supported PLMN ID.

b) SI.

c) Each measurement is obtained as the averagenumber (arithmetic mean) of all PRBs used for DL data traffic transmission per S-NSSAI and per PLMN ID during a time period *T.*

d) Each measurement is a single integer value. If the optional measurements are performed, the number of measurements is equal to the number of QoS levels and the number of supported S-NSSAIs and the number of supported PLMN.

e) RRU.PrbUsedDl, or optionally RRU.PrbUsedDl.*QoS,* where the *QoS* identifies the target quality of service class and RRU.PrbUsedDl.*SNSSAI*, where SNSSAI identifies the S-NSSAI, and RRU.PrbUsedDl.PLMN, where PLMN identifies the PLMN ID.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for monitoring the DL PRB load of the radio physical layer per S-NSSAI.

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| --- |
| **Next Change** |

##### 5.1.1.2.7 Mean UL PRB used for data traffic

a) This measurement provides the number of physical resource blocks (PRBs) in average used in uplink for data traffic. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI and subcounters per supported PLMN ID.

b) SI

c) Each measurement is obtained as the average number (arithmetic mean) of all PRBs used for UL data traffic transmission per S-NSSAI and per PLMN ID during a time period *T.*

d) Each measurement (number of PRBs) is a single integer value. If the optional measurements are performed, the number of measurements is equal to the number of QoS levels and the number of supported S-NSSAIs and the number of supported PLMN.

e) RRU.PrbUsedUl, or optionally RRU.PrbUsedUl.*QoS,* where the *QoS* identifies the target quality of service class *and* RRU.PrbUsedUl.*SNSSAI*, where *SNSSAI* identifies the S-NSSAI, and RRU.PrbUsedUl.PLMN, where PLMN identifies the PLMN ID.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for monitoring the UL PRB load of the radio physical layer per S-NSSAI.

|  |
| --- |
| **Next Change** |

##### 5.1.1.2.9 Peak DL PRB used for data traffic

a) This measurement provides the maximum number of PRBs used in downlink for data traffic. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI and subcounters per supported PLMN ID.

b) SI.

c) Each measurement is obtained by sampling at a pre-defined interval, the PRBs used for DL data traffic transmission per S-NSSAI and per PLMN ID during a time period *T*, and selecting the sample with the maximum value from the samples collected in a given period.

d) Each measurement is a single integer value. If the optional measurements are performed, the number of measurements is equal to the number of QoS levels and the number of supported S-NSSAIs and the number of supported PLMNs.

e) RRU.MaxPrbUsedDl, or optionally RRU.MaxPrbUsedDl.*QoS,* where the *QoS* identifies the target quality of service class and RRU.MaxPrbUsedDl.*SNSSAI*, where SNSSAI identifies the S-NSSAI, and RRU.MaxPrbUsedDl.*PLMN*, where *PLMN* identifies the PLMN ID.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for monitoring the DL PRB load of the radio physical layer per S-NSSAI to support RRM resources optimization (see TS 28.313 [30]).

|  |
| --- |
| **Next Change** |

##### 5.1.1.2.10 Peak UL PRB used for data traffic

a) This measurement provides the number of PRBs used in uplink for data traffic. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI and subcounters per supported PLMN ID.

b) SI

c) Each measurement is obtained by sampling at a pre-defined interval, the PRBs used for UL data traffic transmission per S-NSSAI and per PLMN ID during a time period *T*, and selecting the sample with the maximum value from the samples collected in a given period.

d) Each measurement (number of PRBs) is a single integer value. If the optional measurements are performed, the number of measurements is equal to the number of QoS levels and the number of supported S-NSSAIs and the number of supported PLMNs.

e) RRU.MaxPrbUsedUl, or optionally RRU.MaxPrbUsedUl.*QoS,* where the *QoS* identifies the target quality of service class *and* RRU.MaxPrbUsedUl.*SNSSAI*, where *SNSSAI* identifies the S-NSSAI, and RRU.MaxPrbUsedUl.*PLMN*, where *PLMN* identifies the PLMN ID.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for monitoring the UL PRB load of the radio physical layer per S-NSSAI to support RRM resources optimization (see TS 28.313 [30]).

|  |
| --- |
| **Next Change** |

#### 5.1.1.3 UE throughput

##### 5.1.1.3.1 Average DL UE throughput in gNB

a) This measurement provides the average UE throughput in downlink. This measurement is intended for data bursts that are large enough to require transmissions to be split across multiple slots. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI, and subcounters per PLMN ID, and subcounters per BWP. In the case of per BWP, the UE data volume refers to the total volume scheduled for each Active BWP with same bandwith except UEs with activated supplemental aggregated carrier(s).

b) DER(N=1)

c) This measurement is obtained according to the following formula based on the "ThpVolDl" and "ThpTimeDl" defined below. Separate counters are maintained for each mapped 5QI (or QCI for EN-DC) and for each supported S-NSSAI, and for each PLMN ID , and for each Active BWP.

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl>0$, $\frac{\sum\_{UEs}^{}\sum\_{}^{}ThpVolDl}{\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl}$×1000 [kbit/s]

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl=0$, 0 [kbit/s]

For small data bursts, where all buffered data is included in one initial HARQ transmission, , otherwise 

|  |  |
| --- | --- |
| ThpTimeDl | The time to transmit a data burst excluding the data transmitted in the slot when the buffer is emptied. A sample of "ThpTimeDl" for each time the DL buffer for one DataRadioBearer (DRB) is emptied. |
|  | The point in time after T2 when data up until the second last piece of data in the transmitted data burst which emptied the RLC SDU available for transmission for the particular DRB was successfully transmitted, as acknowledged by the UE.  |
|  | The point in time when the first transmission begins after a RLC SDU becomes available for transmission, where previously no RLC SDUs were available for transmission for the particular DRB. |
|  | The RLC level volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolDl is the data volume, counted on RLC SDU level, in kbit successfully transmitted (acknowledged by UE) in DL for one DRB during a sample of ThpTimeDl. (It shall exclude the volume of the last piece of data emptying the buffer). |

d) Each measurement is a real value representing the throughput in kbit per second. The number of measurements is equal to one. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter and BWP subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs, and the number of Active BWPs.

e) The measurement name has the form
DRB.UEThpDl, or optionally DRB.UEThpDl.*QOS,* where *QOS* identifies the target quality of service class, and DRB.UEThpDl.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEThpDl.*PLMN,* where *PLMN* identifies the PLMN ID, and DRB.UEThpDl.BWP, where BWP identifies the Active BWP.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.2 Distribution of DL UE throughput in gNB

a) This measurement provides the distribution of the UE throughput in downlink. This measurement is intended for data bursts that are large enough to require transmissions to be split across multiple slots. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSA, and subcounters per PLMN ID.

b) DER(N=1)

c) Considering there are n samples during measurement time T and each sample has the same time period tn, the measurement of one sample is obtained by the following formula for a measurement period tn:

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl>0$, $\frac{\sum\_{UEs}^{}\sum\_{}^{}ThpVolDl}{\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl}$×1000 [kbit/s]

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeDl=0$, 0 [kbit/s]

For small data bursts, where all buffered data is included in one initial HARQ transmission, , otherwise 

|  |  |
| --- | --- |
| ThpTimeDl | The time to transmit a data burst excluding the data transmitted in the slot when the buffer is emptied. A sample of "ThpTimeDl" for each time the DL buffer for one DataRadioBearer (DRB) is emptied. |
|  | The point in time after T2 when data up until the second last piece of data in the transmitted data burst which emptied the RLC SDU available for transmission for the particular DRB was successfully transmitted, as acknowledged by the UE.  |
|  | The point in time when the first transmission begins after a RLC SDU becomes available for transmission, where previously no RLC SDUs were available for transmission for the particular DRB. |
|  | The RLC level volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolDl is the data volume, counted on RLC SDU level, in kbit successfully transmitted (acknowledged by UE) in DL for one DRB during a sample of ThpTimeDl. (It shall exclude the volume of the last piece of data emptying the buffer). |

Alternatively, for small data bursts, that are successfully transmitted in any given slot (i.e. the requirement that data bursts need to span across several slots excluding transmission of the last piece of the data in a data burst does not apply). where all buffered data is included in one initial HARQ transmission, fraction of the slot time ($ThpTimeDL)$$ThpTimeUL)$ may be counted and obtained by the formula:



|  |  |
| --- | --- |
| *slot* | Duration of the slot |
| *TBVol* | Volume of the TB related to one slot burst |
| *PaddingVol* | Volume of padding bits added into Transport Block related to one slot burst. |

For each measurement sample, the bin corresponding to the DL throughput experienced by the UE is incremented by one. Separate counters are maintained for each mapped 5QI (or QCI for EN-DC) and for each supported S-NSSAI.

d) A set of integers, each representing the (integer) number of samples with a DL UE throughput in the range represented by that bin. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs.

e) The measurement name has the form
DRB.UEThpDlDist.Bin where Bin represents the bin, or optionally DRB.UEThpDlDist.Bin.*QOS,* where *QOS* identifies the target quality of service class, and DRB.UEThpDlDist.Bin*.SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEThpDlDist.Bin.*PLMN,* where *PLMN* identifies the PLMN ID.

NOTE: Number of bins and the range for each bin is left to implementation

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.3 Average UL UE throughput in gNB

a) This measurement provides the average UE throughput in uplink. This measurement is intended for data bursts that are large enough to require transmissions to be split across multiple slots. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI, and subcounters per PLMN ID, and subcounters per BWP. In the case of per BWP, the UE data volume refers to the total volume scheduled for each Active BWP with same bandwith except UEs with activated supplemental aggregated carrier(s).

B) DER(N=1)

c) This measurement is obtained according to the following formula based on the "ThpVolUl" and "ThpTimeUl" defined below. Separate counters are maintained for each mapped 5QI (or QCI for EN-DC) and for each supported S-NSSAI, and for each PLMN ID, and for each Active BWP.

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl>0$, $\frac{\sum\_{UEs}^{}\sum\_{}^{}ThpVolUl}{\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl}$×1000 [kbit/s]

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl=0$, 0 [kbit/s]

For small data bursts, where all buffered data is included in one initial HARQ transmission otherwise:



|  |  |
| --- | --- |
| ThpTimeUl | The time to transmit a data burst excluding the data transmitted in the slot when the buffer is emptied. A sample of "ThpTimeUl" for each time the UL buffer for one DataRadioBearer (DRB) is emptied. |
|  | The point in time when the data up until the second last piece of data in data burst has been successfully received for a particular DRB  |
|  | The point in time when transmission is started for the first data in data burst for a particular DRB. |
|  | The RLC level volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolUl is the data volume counted on RLC SDU level in kbit received in UL for one DRB during a sample of ThpTimeUl, (It shall exclude the volume of the last piece of data emptying the buffer). |

d) Each measurement is a real value representing the throughput in kbit per second. The number of measurements is equal to one. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter and BWP subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs, and the number of Active BWPs.

e) The measurement name has the form
DRB.UEThpUl, or optionally DRB.UEThpUl.*QOS,* where *QOS* identifies the target quality of service class and DRB.UEThpUl.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEThpUl.*PLMN,* where *PLMN* identifies the PLMN ID, and DRB.UEThpUl.BWP, where BWP identifies the Active BWP.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.4 Distribution of UL UE throughput in gNB

a) This measurement provides the distribution of the UE throughput in uplink. This measurement is intended for data bursts that are large enough to require transmissions to be split across multiple slots. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI, and subcounters per PLMN ID.

b) DER(N=1)

c) Considering there are n samples during measurement time T and each sample has the same time period tn, the measurement of one sample is obtained by the following formula for a measurement period tn:

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl>0$, $\frac{\sum\_{UEs}^{}\sum\_{}^{}ThpVolUl}{\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl}$×1000 [kbit/s]

If $\sum\_{UEs}^{}\sum\_{}^{}ThpTimeUl=0$, 0 [kbit/s]

For small data bursts, where all buffered data is included in one initial HARQ transmission otherwise:



|  |  |
| --- | --- |
| ThpTimeUl | The time to transmit a data burst excluding the data transmitted in the slot when the buffer is emptied. A sample of "ThpTimeUl" for each time the UL buffer for one DataRadioBearer (DRB) is emptied. |
| T1 | The point in time when the data up until the second last piece of data in data burst has been successfully received for a particular DRB  |
| T2 | The point in time when transmission is started for the first data in data burst for a particular DRB. |
| ThpVolUL | The RLC level volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolUl is the data volume counted on RLC SDU level in kbit received in UL for one DRB during a sample of ThpTimeUl, (It shall exclude the volume of the last piece of data emptying the buffer). |

Alternatively, for small data bursts, that are successfully transmitted in any given slot (i.e. the requirement that data bursts need to span across several slots excluding transmission of the last piece of the data in a data burst does not apply). where all buffered data is included in one initial HARQ transmission, fraction of the slot time ($ThpTimeUL)$ may be counted and obtained by the formula:



|  |  |
| --- | --- |
| *slot* | Duration of the slot |
| *TBVol* | Volume of the TB related to one slot burst |
| *PaddingVol* | Volume of padding bits added into Transport Block related to one slot burst. |

For each measurement sample, the bin corresponding to the UL throughput experienced by the UE is incremented by one. Separate counters are maintained for each mapped 5QI (or QCI for EN-DC) and for each supported S-NSSAI, and for each PLMN ID.

d) A set of integers, each representing the (integer) number of samples with a UL UE throughput in the range represented by that bin. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs.

e) The measurement name has the form
DRB.UEThpUlDist.Bin where Bin represents the bin, or optionally DRB.UEThpUlDist.Bin.*QOS,* where *QOS* identifies the target quality of service class, and DRB.UEThpUlDist.Bin.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEThpUlDist.Bin.*PLMN,* where *PLMN* identifies the PLMN ID.

NOTE: Number of bins and the range for each bin is left to implementation

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.5 Percentage of unrestricted DL UE data volume in gNB

a) This measurement provides the percentage of DL data volume for UEs in the cell that is classified as unrestricted, i.e., when the volume is so low that all data can be transferred in one slot and no UE throughput sample could be calculated. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI, and subcounters per PLMN ID.

b) SI.

c) For periods when no data is transferred at all *Percentage Unrestricted Volume DL = 0*, otherwise:

 

|  |  |
| --- | --- |
| ThpUnresVolDl | The volume of a data burst that is transmitted in the slot when the buffer is emptied (which could be the only slot needed to transmit the data burst) and not included in the UE throughput measurement. A sample for ThpUnresVolDl is the data volume counted on RLC SDU level in kbits sent in DL for one DRB. |
| ThpVolDl | The volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolDl is the data volume counted on RLC SDU level in kbits sent in DL for one DRB.  |

d) Each measurement is a single integer value from 0 to 100. The number of measurements is equal to one. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs.

e) The measurement name has the form
DRB.UEUnresVolDl or optionally DRB.UEUnresVolDl.*QOS,* where *QOS* identifies the target quality of service class, or DRB.UEUnresVolDl.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEUnresVolDl.*PLMN,* where *PLMN* identifies the PLMN ID.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.6 Percentage of unrestricted UL UE data volume in gNB

a) This measurement provides the percentage of UL data volume for UEs in the cell that is classified as unrestricted, i.e., when the volume is so low that all data can be transferred in one slot and no UE throughput sample could be calculated. The UE data volume refers to the total volume scheduled for each UE regardless if using only primary- or also supplemental aggregated carriers. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI, and subcounters per PLMN ID.

b) SI

c) For periods when no data is transferred at all *Percentage Unrestricted Volume UL = 0*, otherwise:



|  |  |
| --- | --- |
| ThpUnresVolUl | The volume of a data burst that is transmitted in the slot when the buffer is emptied (which could be the only slot needed to transmit the data burst) and not included in the UE throughput measurement. A sample for ThpUnresVolUl is the data volume counted on RLC SDU level in kbits received in UL for one DRB. |
| ThpVolUl | The volume of a data burst, excluding the data transmitted in the slot when the buffer is emptied. A sample for ThpVolUl is the data volume counted on RLC SDU level in kbits received in UL for one DRB.  |

d) Each measurement is a single integer value from 0 to 100. The number of measurements is equal to one. If the optional QoS level subcounter and S-NSSAI subcounter and PLMN ID subcounter measurements are performed, the number of measurements is equal to the number of mapped 5QIs and the number of supported S-NSSAIs, and the number of PLMN IDs.

e) The measurement name has the form
DRB.UEUnresVolUl or optionally DRB.UEUnresVolUl.*QOS,* where *QOS* identifies the target quality of service class , and DRB.UEUnresVolUl.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and DRB.UEUnresVolUl.*PLMN,* where *PLMN* identifies the PLMN ID.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.3.7 Average DL UE buffered Throughput per DRB

a) This measurement provides the average down link buffered UE throughput per DRB on NRCellCU. The DRBs are mapped with the same 5QI for NR SA or mapped with the same QCI for EN-DC. This measurement is intended for throughput per UE and bearer independent of traffic patterns and packet size. The measurement is based on Desired buffer size communicated within DDDS from DU to CU UP and is intended for services with burst duration spanning over the time interval of a couple of consequent DDDSs. For very bursty traffic with burst duration within the interval of one DDDS the measured values can be unprecise and cannot be compared across vendors. Initial buffering time in CU and on F1, meant as time interval the first PDCP SDU of the new burst is received in CU until this first part is received in DU, is excluded. The monitoring is supported also in DC scenario and in NSA option3a and 3x.

b) DER(N=1);

c) This measurement is obtained by the following formula for a measurement period:

$$\frac{\sum\_{}^{}ThroughputVolume}{\sum\_{}^{}ThroughputTime} [kbits/s]$$

where each ThroughputVolume and ThroughputTime is intended to represent one DL burst as explained in the Fig. 5.1.1.3.7-1, Fig. 5.1.1.3.7-3, Fig. 5.1.1.3.7-5 and Table 5.1.1.3.7-2, Table 5.1.1.3.7-4, Table 5.1.1.3.7-6 for DRB (SA, NSA option 3a), split DRB (DC), split DRB (NSA option 3x), respectively. Separate counters are maintained for each mapped 5QI (or QCI for EN-DC).



Figure 5.1.1.3.7-1 Average DL buffered UE throughput per DRB (SA, NSA option 3a)

Table 5.1.1.3.7-2 DRB (SA, NSA option 3a)

|  |  |
| --- | --- |
| T0’ | First PDCP SDU of the new burst arrived to CU and there are not any other PDCP SDUs in CU UP waiting for transmission to DU nor the ones mapped to PDCP PDUs and sent to DU are in the DU buffer.  |
| T1’ | First PDCP PDU has been received in DU after T0’ (can be obtained as point in time when PDCP PDU sent from CU to DU plus F1 delay). |
| T2’ | The buffer in DU gets empty after T0’. |
| ThroughputTime | T2’ – T1’ [ms]See NOTE 1.The Achievable DRB throughput is obtained as the “Desired buffer size for data radio bearer” as part of last DDDS feedback [TS 38.425[56]] divided with the DDDS reporting period time interval. In case the desired buffer size is 0 and an PDCP PDU sent to DU it is considered it will be spent the whole time interval in the buffer of DU until desired buffer size >0 is reported in the next DDDS feedback. See NOTE 2. |
| ThroughptVolume | The PDCP SDU volume in bits successfully transmitted (acknowledged by DDDS) in DL to UE per bearer and one burst (consisting of PDCP SDU 1, 2 and 3 in example in Fig. 5.1.1.3.7-1). |
| NOTE 1: Contribution of the given PDCP SDU*i* to ThroughputTime, i.e. the time period the PDCP PDUi related to the PDCP SDUi will spend in the buffer of DU enitity, is obtained as volume of the PDCP PDUi divided with Achievable DRB throughput of the UE.In case in the point of time the PDCP PDU*i* is sent to DU while the previous one still kept in the DU buffer the time period these two PDCP SDUs will spend in DU buffer is cumulated, i.e. obtained as sum of volume of the PDCP PDUi and PDCP PDUi-1 divided with Achievable DRB throughput.NOTE 2: The precision of the measured ThroughputTime may be impacted with the precision of the measured F1 delay in case of not time synchronized CU and DU when it is obtained as F1 RTT/2. |



Figure 5.1.1.3.7-3: Average DL buffered UE throughput per split DRB (DC)

Table 5.1.1.3.7-4 Split DRB (DC)

|  |  |
| --- | --- |
| T0 | First PDCP SDU of the new burst arrived to CU and there are not any other PDCP SDUs in CU UP waiting for transmission to DU nor the ones mapped to PDCP PDUs and sent to DU are in the DU buffer for any of the legs relevant to the bearer. |
| T1 | First PDCP PDU has been received in DU1 of the first leg after T0 (can be obtained as point in time when PDCP PDU sent from CU to DU1 plus F1 delay). |
| T2 | First PDCP PDU has been received in DU2 of the second leg after T0 (can be obtained as point in time when PDCP PDU sent from CU to DU2 plus F1 delay). |
| T3 | The buffer in DU1 of the first leg gets empty after T0. |
| T4 | The buffer in DU2 of the second leg gets empty after T0 |
| ThroughputTime | T4 – T1 [ms]See NOTE 1.The Achievable DRB throughput is obtained as the “Desired buffer size for data radio bearer” as part of last DDDS feedback [TS 38.425 [56]] divided with the DDDS reporting period time interval. In case the desired buffer size is 0 and an PDCP PDU sent to DU it is considered it will be spent the whole time interval in the buffer of DU until desired buffer size >0 is reported in the next DDDS feedback. See NOTE 2. |
| ThroughputVolume | The PDCP SDU volume in bits successfully transmitted (acknowledged by DDDS) in DL to UE per bearer and one burst (consisting of PDCP SDU 1, 2, 3 and 4 in example in Fig. 5.1.1.3.7-3). |
| NOTE 1: Contribution of the given PDCP SDUi to ThroughputTime, i.e. the time period the PDCP PDUi related to the PDCP SDUi will spend in the buffer of DU related leg is obtained as volume of the PDCP PDUi divided with Achievable DRB throughput. In case in the point of time the PDCP PDU*i* is sent to DU while the previous one still kept in the DU buffer of the same leg the time period these two PDCP SDUs will spend in DU buffer is cumulated, i.e. obtained as sum of volume of the PDCP PDUi and PDCP PDUi-1 divided with Achievable DRB throughput.NOTE 2: The precision of the measured ThroughputTime may be impacted with the precision of the measured F1 delay in case of not time synchronized CU and DU when it is obtained as F1 RTT/2. |

****

Figure 5.1.1.3.7-5: Average DL buffered UE throughput per split DRB (NSA option 3x)

Table 5.1.1.3.7-6 Split DRB (NSA option 3x)

|  |  |
| --- | --- |
| T0 | First PDCP SDU of the new burst arrived to CU and there are not any other PDCP SDUs in CU UP waiting for transmission to DU/MeNB nor the ones mapped to PDCP PDUs and sent to DU/MeNB are in the DU/MeNB buffer for any of the legs relevant to the bearer. |
| T1 | First PDCP PDU has been received in DU of the first leg after T0 (can be obtained as point in time when PDCP PDU sent from CU to DU plus F1 delay). |
| T2 | First PDCP PDU has been received in MeNB of the second leg after T0 (can be obtained as point in time when PDCP PDU sent from CU to MeNB plus X2 delay). |
| T5 | The buffer in DU of the first leg gets empty after T0. |
| T6 | The buffer in MeNB of the second leg gets empty after T0 |
| ThroughputTime | T6 – T1 [ms]The Achievable DRB throughput is obtained as the “Desired buffer size for data radio bearer” as part of last DDDS feedback [TS 38.425[56]] divided with the DDDS reporting period time interval. In case the desired buffer size is 0 and an PDCP PDU sent to DU it is considered it will be spent the whole time interval in the buffer of DU until desired buffer size >0 is reported in the next DDDS feedback. In case of split DRB NSA option 3x to calculate the Achievable DRB throughput for LTE leg the “Desired buffer size for E-RAB” as part of last DDDS feedback [TS 36.425 [57]] reported from MeNB to CU UP via X2 interface is considered.Note; The precision of the measured ThroughputTime may be impacted with the precision of the measured F1/X2 delay in case of not time synchronized CU and DU when it is obtained as F1/X2 RTT/2. |
| ThroughputVolume | The PDCP SDU volume in bits successfully transmitted (acknowledged by DDDS) in DL to UE per bearer and one burst (consisting of PDCP SDU 1, 2, 3 and 4 in example in Fig. 5.1.1.3.7-5). |
| NOTE 1: Contribution of the given PDCP SDUi to ThroughputTime, i.e. the time period the PDCP PDUi related to the PDCP SDUi will spend in the buffer of DU related leg is obtained as volume of the PDCP PDUi divided with Achievable DRB throughput. In case in the point of time the PDCP PDU*i* is sent to DU while the previous one still kept in the DU buffer of the same leg the time period these two PDCP SDUs will spend in DU buffer is cumulated, i.e. obtained as sum of volume of the PDCP PDUi and PDCP PDUi-1 divided with Achievable DRB throughput. |

d) Each measurement is a real value representing the throughput in kbit per second. The number of measurements is equal to one. If the optional QoS level subcounter is performed, the number of measurements is equal to the number of mapped 5Q and QCIs for EN-DC.

e) The measurement name has the form
DRB.PDCP.UEThpDl, or optionally DRB.PDCP.UEThpDl.*QOS,* where *QOS* identifies the target quality of service class.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

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| **Next Change** |

##### 5.1.1.10.3 Number of released active DRBs

a) This measurement provides the number of abnormally released DRBs that were active at the time of release. DRBs with bursty flow are seen as being active if there is user data in the PDCP queue in any of the directions or if any DRB data on a Data Radio Bearer (UL or DL) has been transferred during the last 100 ms. DRBs with continuous flow are seen as active DRBs in the context of this measurement, as long as the UE is in RRC connected state. DRBs used in 3GPP option 3 shall not be covered in this measurement
The measurement is split into sub counters per mapped 5QI and per S-NSSAI.

b) CC

c) On

- transmission by the NG-RAN of a PDU SESSION RESOURCE RELEASE RESPONSE message for the PDU release initiated by the AMF with the exception of corresponding PDU SESSION RESOURCE RELEASE COMMAND message with "Cause" equal to "Normal Release" or "User inactivity", "Load balancing TAU required", "Release due to CN-detected mobility", "O&M intervention", or-

- transmission by the NG-RAN of a PDU SESSION RESOURCE MODIFY RESPONSE message for the PDU modification initiated by the AMF with the exception of corresponding PDU SESSION RESOURCE MODIFY REQUEST message with the "Cause" equal to "Normal Release", or

- transmission by the NG-RAN of a PDU SESSION RESOURCE NOTIFY message with the exception of "Cause" equal to "Normal Release", "Handover Cancelled" or a successful mobility activity (e.g., cause "Successful Handover), or

- transmission by the NG-RAN of a UE CONTEXT RELEASE COMPLETE for the UE context release initiated by the NG-RAN with the exception of the corresponding UE CONTEXT RELEASE REQUEST message with the cause equal to "Normal Release" or "User inactivity", "Partial handover", "Successful handover", or

- transmission by the NG-RAN of a UE CONTEXT RELEASE COMPLETE message for the UE context release initiated by the AMF with the exception of the corresponding UE CONTEXT RELEASE COMMAND message with "Cause" equal to "Normal Release", "Handover Cancelled" or a successful mobility activity (e.g., cause "Successful Handover", or "NG Intra system Handover triggered"), or

- receipt by the NG-RAN of a PATH SWITCH REQUEST ACKNOWLEDGE or PATH SWITCH REQUEST FAILED message by which some or all DRBs in the corresponding PATH SWITCH REQUEST need to be released, or

- transmission of a NG RESET ACKNOWLEDGE message to AMF; or

- receipt of a NG RESET ACKNOWLEDGE message from AMF,

Any of the UL or DL DRBs release using the RRCReconfiguration message (see TS 38.331[20]) sent to the UE, triggers the corresponding counter to increment by 1.

DRBs with bursty flow are considered 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. DRBs with continuous flow are seen as active DRBs in the context of this measurement, as long as the UE is in RRC connected state. Each corresponding DRB to release is added to the relevant measurement per mapped 5QI and S-NSSAI.

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

d) Each measurement is an integer value. The number of measurements is equal to the number of mapped 5QI levels plus the number of S-NSSAIs.

e) The measurements name has the form DRB.RelActNbr.*5QI,* where *5QI* identifies the mapped 5QIandDRB.RelActNbr.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI.

f) NRCellCU

g) Valid for packet switched traffic

h) 5GS

i) This measurement is to support the Retainability KPI "DRB Retainability" defined in TS 28.554 [8].

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| **Next Change** |

##### 5.1.1.10.4 In-session activity time for DRB

a) This measurement provides the aggregated active session time for DRBs in a cell. The measurement is split into sub counters per mapped 5QI and per S-NSSAI. DRBs used in 3GPP EN-DC shall not be covered in this measurement.

b) CC

c) Number of "in session" seconds aggregated for DRBs with a certain mapped 5QI level or for a certain S-NSSAI, where "in session" has the following definitions:

- DRBs with bursty flow is said to be "in session" 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 that DRB.

- DRBs with continuous flow are seen as being "in session" 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}.

d) Each measurement is an integer value. The number of measurements is equal to the number of mapped 5QI levels plus the number of S-NSSAIs.

e) The measurement name has the form DRB.SessionTime.*5QI,* where *5QI* identifies the mapped 5QIandDRB.SessionTime.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI.

f) NRCellCU

g) Valid for packet switched traffic

h) 5GS

i) This measurement is to support the Retainability KPI "DRB Retainability" defined in TS 28.554 [8].

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| **Next Change** |

#### 5.1.1.23 Number of Active UEs

##### 5.1.1.23.1 Mean number of Active UEs in the DL per cell

a) This measurement provides the mean number of active UEs in the DL in an NRCellDU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1).

c) This measurement is obtained by aggregating the measurement "Mean number of Active UEs in the DL per DRB per cell" (see clause 4.2.1.3.2 in TS 38.314 [29]). The measurement is performed per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.MeanActiveUeDl\_Filter,
where filter is a combination of PLMN ID and QoS level and *S-NSSAI*,

where PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or/and QCI level, and *S-NSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.23.2 Max number of Active UEs in the DL per cell

a) This measurement provides the max number of active UEs in the DL in an NRCellDU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1).

c) This measurement is defined according to measurement "Max number of Active UEs in the DL per DRB per cell" (see clause 4.2.1.3.3 in TS 38.314 [29]). The measurement is performed per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.MaxActiveUeDl\_Filter,
where filter is a combination of PLMN ID and QoS level and *S-NSSAI*,

where PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or/and QCI level, and *S-NSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.23.3 Mean number of Active UEs in the UL per cell

a) This measurement provides the mean number of active UEs in the UL in an NRCellDU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by aggregating the measurement "Mean number of Active UEs in the UL per DRB per cell" (see clause 4.2.1.3.4 in TS 38.314 [29]). The measurement is performed per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.MeanActiveUeUl\_Filter,
where filter is a combination of PLMN ID and QoS level and *S-NSSAI*,

where PLMN ID represents the PLMN ID, QoS represents the mapped 5QI or/and QCI level, and *S-NSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.23.4 Max number of Active UEs in the UL per cell

a) This measurement provides the max number of active UEs in the UL in an NRCellDU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC), subcounters per S-NSSAI and per supported PLMN ID.

b) DER (n=1)

c) This measurement is defined by the measurement "Max number of Active UEs in the UL per DRB per cell" (see clause 4.2.1.3.5 in TS 38.314 [29]). The measurement is performed per PLMN ID and per QoS level (mapped 5QI or/and QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels multiplied by the number of supported S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.MaxActiveUeUl\_Filter,
where filter is a combination of *PLMN ID* and *QoS* level and *S-NSSAI,*
where *PLMN ID* represents the PLMN ID, *QoS* represents the mapped 5QI or/and QCI level, and *SNSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.23.5 Mean number of Active UEs per cell

a) This measurement provides the mean number of active UEs in an NRCellDU. This measurement refers to UEs for which there is data available for transmission for the UL for DRBs, or there is data available for transmission for the DL for DRBs, or both. This measurement can’t be calculated from the Mean number of active UEs in the DL per cell and Mean number of active UEs in the UL per cell according to 2 out of 3 approach. The measurement is calculated per PLMN ID and per supported S-NSSAI.

b) DER (n=1).

c) This measurement is obtained by aggregating the measurement "Mean number of Active UEs per cell" (see clause 4.2.1.3.6 in TS 38.314 [29]). The measurement is performed per PLMN ID and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] ≤ 100.

e) The measurement name has the form DRB.MeanActiveUe\_Filter,
where filter is a combination of *PLMN ID* and *S-NSSAI,*
where *PLMN ID* represents the PLMN ID, and *S-NSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.1.23.6 Max number of Active UEs per cell

a) This measurement provides the max number of active UEs in an NRCellDU. This measurement refers to UEs for which there is data available for transmission for the UL for DRBs, or there is data available for transmission for the DL for DRBs, or both. This measurement can’t be calculated from the Max number of active UEs in the DL per cell and Max number of active UEs in the UL per cell according to 2 out of 3 approach. The measurement is calculated per PLMN ID and per supported S-NSSAI.

b) DER (n=1).

c) This measurement is defined according to measurement "Max number of Active UEs per cell " (see clause 4.2.1.3.7 in TS 38.314 [29]). The measurement is performed per PLMN ID and per supported S-NSSAI.

d) Each measurement is a single integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of supported S-NSSAIs.

[Total No. of measurement instances] x [No. of filter values for all measurements] ≤ 100.

e) The measurement name has the form DRB.MaxActiveUe\_Filter,
where filter is a combination of *PLMN ID* and *S-NSSAI,*
where *PLMN ID* represents the PLMN ID, and *S-NSSAI* represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

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| **Next Change** |

#### 5.1.1.35 DL Packet Loss rate on Uu

a) This measurement provides the DL Packet (i.e., RLC SDU) Loss rate on Uu interface for an NR cell. The measurement is split into subcounters per PLMN ID per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) CC.

c) This measurement is obtained based on the following parameters defined in TS 38.314 [29]:

|  |  |
| --- | --- |
| $$Dloss(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which at least a part has been transmitted over the air but not positively acknowledged, and it was decided during time period $T$ that no more transmission attempts will be done. If transmission of a packet might continue in another cell, it shall not be included in this count. |
| $$N(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged during time period $T$.  |
| $$T$$ | Time Period during which the measurement is performed. |
| $$drbid$$ | The identity of the measured DRB. |

The gNB takes the following calculation for each PLMN ID per mapped 5QI and per supported S-NSSAI:

$$\frac{\sum\_{}^{}\left(Dloss\left(T,drbid\right)\right)\*1000000}{\sum\_{}^{}\left(N\left(T,drbid\right)+Dloss\left(T,drbid\right)\right)}$$

d) Each measurement is an integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

e) DRB.PacketLossRateUu.*Filter*,
Where *Filter* is a combination of PLMN ID and QoS level and S-NSSAI.
The QoS level represents the mapped 5QI or QCI.

f) NRCellDU

g) Valid for packet switched traffic.

h) 5GS.

##### 5.1.1.35.1 DL Packet Loss rate with delay threshold on Uu

a) This measurement provides the DL Packet (i.e., RLC SDU) Loss rate including any packets not successfully transmitted or packets successfully received but delayed more than a delay threshold that can be used when the resource type of corresponding QoS Flow is Delay-critical GBR (clause 5.7.3.4 in TS 23.501 [4]) on Uu interface for an NR cell. The measurement is split into subcounters per PLMN ID per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) CC.

c) This measurement is obtained based on the following parameters defined in TS 38.314 [29]:

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| $$Dloss(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which at least a part has been transmitted over the air but not positively acknowledged, and it was decided during time period $T$ that no more transmission attempts will be done. If transmission of a packet might continue in another cell, it shall not be included in this count. |
| $$Dexd(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which is transmitted over air interface and positively acknowledged but the DL delay of the RLC SDU is more than corresponding delay threshold during time period T.The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1.1 as follows "point in time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of HARQ ACK from UE for UM mode or point in time when the last part of an RLC SDU packet was sent to the UE which was consequently confirmed by reception of RLC ACK for AM mode, minus time when corresponding RLC SDU part arriving at MAC layer".Delay threshold of this measurement can be determined by NW implementation (e.g. configured by OAM). |
| $$N\\_dt(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged and delayed no more than the corresponding delay threshold during time period $T$. The delay threshold is as defined in NOTE. |
| $$T$$ | Time Period during which the measurement is performed, Unit: minutes. |
| $$drbid$$ | The identity of the measured DRB. |

The gNB takes the following calculation for each PLMN ID per mapped 5QI and per supported S-NSSAI:

$$\frac{\sum\_{}^{}[Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right)]\*1000000}{\sum\_{}^{}(N\\_dt\left(T,drbid\right)+Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right))}$$

d) Each measurement is an integer value. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.

e) DRB.PacketLossRateWithDelayThresholdUu.*Filter*,
Where *Filter* is a combination of PLMN ID and QoS level and S-NSSAI.
The QoS level represents the mapped 5QI or QCI.

f) NRCellDU

g) Valid for packet switched traffic.

h) 5GS.

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| **Next Change** |

5.1.2.1.1.2 DL Cell PDCP SDU Data Volume on X2 Interface

a) This measurement provides the Data Volume (amount of PDCP SDU bits) in the downlink delivered on X2 interface in DC-scenarios. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC).
The unit is Mbit.

b) CC.

c) This measurement is obtained by counting the number of bits transferred in the downlink through X2 interface. The measurement is performed at the PDCP SDU level. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC).

d) Each measurement is an integer value representing the number of bits measured in Mbits (1MBits=1000\*1000 bits). The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.PdcpSduVolumeX2DL\_Filter.

Where filter is a combination of PLMN ID and QoS level.

Where *PLMN ID* represents the PLMN ID, *QoS* representes the mapped 5QI or the QCI level.

f) NRCellCU.

g) Valid for packet switched traffic..

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and in the energy efficency (EE) area.

NRCellCU in non-split NG-RAN deployment scenarios represents NRCell.

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| **Next Change** |

5.1.2.1.2.2 UL Cell PDCP SDU Data Volume on X2 Interface

a) This measurement provides the Data Volume (amount of PDCP SDU bits) in the uplink delivered on X2 interface in NSA scenarios. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC).
The unit is Mbit.

b) CC

c) This measurement is obtained by counting the number of bits transferred in the uplink through X2 interface. The measurement is performed at the PDCP SDU level. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC).

d) Each measurement is an integer value representing the number of bits measured in Mbits (1MBits=1000\*1000 bits). The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.PdcpSduVolumeX2UL\_Filter.

Where filter is a combination of PLMN ID and QoS level.

Where *PLMN ID* represents the PLMN ID, *QoS* representes the mapped 5QI or the QCI level.

f) NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and in the energy efficency (EE) area.

NRCellCU in non-split NG-RAN deployment scenarios represents NRCell.

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| **Next Change** |

##### 5.1.2.2.1 UL PDCP SDU Success Rate

a) This measurement provides the fraction of PDCP SDU packets which are successfully received at gNB. It is a measure of the UL packet delivery success including any packet success in the air interface and in the gNB. Only user-plane traffic (DTCH) and only PDCP SDUs that have entered PDCP (and given a PDCP sequence number) are considered. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) SI.

c) This measurement is obtained as: Number of successfully received UL PDCP sequence numbers, representing packets that are successfully delivered to higher layers, of a data radio bearer, divided by Total number of UL PDCP sequence numbers of a bearer, starting from the sequence number of the first packet delivered by UE PDCP to gNB until the sequence number of the last packet. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the success rate. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurements are performed, the measurements are equal to the number of mapped 5QIs or the number of supported S-NSSAIs.

e) The measurement name has the form DRB.PacketSuccessRateUlgNBUu and optionally DRB.PacketSuccessRateUlgNBUu.*QOS* where *QOS* identifies the target quality of service class, and DRB.PacketSuccessRateUlgNBUu.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) NRCellCU

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and for reliability KPI.

Note : NRCellCU in non-split NG-RAN deployment scenarios represents NRCell.

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| **Next Change** |

#### 5.1.3.1 Packet Loss Rate

##### 5.1.3.1.1 UL PDCP SDU Loss Rate

a) This measurement provides the fraction of PDCP SDU packets which are not successfully received at gNB-CU-UP. It is a measure of the UL packet loss including any packet losses in the air interface, in the gNB-CU and on the F1-U interface. Only user-plane traffic (DTCH) and only PDCP SDUs that have entered PDCP (and given a PDCP sequence number) are considered. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) SI.

c) This measurement is obtained as: 1000000\* Number of missing UL PDCP sequence numbers, representing packets that are not delivered to higher layers, of a data radio bearer, divided by Total number of UL PDCP sequence numbers (also including missing sequence numbers) of a bearer, starting from the sequence number of the first packet delivered by UE PDCP to gNB-CU-UP until the sequence number of the last packet. If transmission of a packet might continue in another cell, it shall not be included in this count. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the loss rate multiplied by 1E6. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurements are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.PacketLossRateUl and optionally DRB.PacketLossRateUl.*QOS* where *QOS* identifies the target quality of service class, and DRB.PacketLossRateUl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

##### 5.1.3.1.2 UL F1-U Packet Loss Rate

a) This measurement provides the fraction of PDCP SDU packets which are not successfully received at gNB-CU-UP. It is a measure of the UL packet loss on the F1-U interface. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per supported S-NSSAI.

b) SI

c) This measurement is obtained as: 1000000\* Number of missing UL GTP sequence numbers (TS 29.281), representing packets that are not delivered to higher layers, of a data radio bearer, divided by Total number of UL GTP sequence numbers (also including missing sequence numbers) of a bearer, starting from the GTP sequence number of the first packet delivered by gNB-DU to gNB-CU-UP until the GTP sequence number of the last packet. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the loss rate multiplied by 1E6. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.F1UpacketLossRateUl and optionally DRB.F1UPacketLossRateUl.*QOS* where *QOS* identifies the target quality of service class, and DRB.F1UPacketLossRateUl.S*NSSAI* where *SNSSAI* identifies the S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.1.3 DL F1-U Packet Loss Rate

a) This measurement provides the fraction of PDCP SDU packets which are not successfully received at the gNB-DU). It is a measure of the DL packet loss on the F1-U interface. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) SI

c) This measurement is obtained as: 1000000\* Number of missing DL GTP sequence numbers (TS 29.281), representing packets that are not delivered to lower layers, of a data radio bearer, divided by Total number of DL GTP sequence numbers (also including missing sequence numbers) of a bearer, starting from the sequence number of the first packet delivered by gNB-CU-UP to gNB-DU until the GTP sequence number of the last packet. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the loss rate multiplied by 1E6. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.F1UpacketLossRateDl .and optionally DRB.F1UPacketLossRateDl.*QOS* where *QOS* identifies the target quality of service class, and DRB.F1UPacketLossRateDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

#### 5.1.3.2 Packet Drop Rate

##### 5.1.3.2.1 DL PDCP SDU Drop rate in gNB-CU-UP

a) This measurement provides the fraction of PDCP SDU packets which are dropped on the downlink, due to high traffic load, traffic management etc in the gNB-CU-UP. Only user-plane traffic (DTCH) is considered. A dropped packet is one whose context is removed from the gNB-CU-UP without any part of it having been transmitted on the F1-U or Xn-U or X2-U interface. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

NOTE: this measurement may include packets that were supposed to be sent via the eUtran air interface if using NR split bearerEN-DC, NE-DC or NGEN-DC.

b) SI.

c) This measurement is obtained as: 1000000\*Number of dropped DL PDCP SDU packets whose contexts are removed from the gNB-CU-UP without any part of it having been transmitted on the F1-U or Xn-U or X2-U interface, of a data radio bearer, divided by Number of DL PDCP SDU packets for data radio bearers that have entered PDCP-SAP after being decoded from GTP-U packets. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the drop rate multiplied by 1E6. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.PdcpPacketDropRateDl and optionally DRB.PdcpPacketDropRateDl.*QOS*
where *QOS* identifies the target quality of service class, and DRB.PdcpPacketDropRateDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

##### 5.1.3.2.2 DL RLC SDU Packet Drop Rate in gNB-DU

a) This measurement provides the fraction of RLC SDU packets which are dropped on the downlink, due to high traffic load, traffic management etc in the gNB-DU. Only user-plane traffic (DTCH) is considered. A dropped packet is one whose context is removed from the gNB-DU without any part of it having been transmitted on the air interface. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) SI.

c) This measurement is obtained as: 1000000\*Number of dropped DL RLC SDU packets whose contexts are removed from the gNB-DU without any part of it having been transmitted on the air interface of a data radio bearer, divided by Number of DL RLC SDU packets (as decoded from PDCP-PDUs received via GTP-U packets) for data radio bearers that were received from gNB-CU-UP. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the drop rate multiplied by 1E6. The number of measurements is equal to one. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.RlcPacketDropRateDl and optionallyDRB.RlcPacketDropRateDl.*QOS*
where *QOS* identifies the target quality of service class, and DRB.RlcPacketDropRateDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

#### 5.1.3.3 Packet delay

##### 5.1.3.3.1 Average delay DL in CU-UP

a) This measurement provides the average (arithmetic mean) PDCP SDU delay on the downlink within the gNB-CU-UP, for all PDCP packets. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained as: sum of (time when sending a PDCP SDU to the gNB-DU at the egress PDCP layer on F1-U/Xn-U, minus time of arrival of the same packet at NG-U ingress IP termination) divided by total number of PDCP SDUs arriving at NG-U ingress IP termination. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI.

d) Each measurement is a real representing the mean delay in 0.1 millisecond. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.PdcpSduDelayDl\_Filter,
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.3.2 Average delay DL on F1-U

a) This measurement provides the average (arithmetic mean) GTP packet delay DL on the F1-U interface. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained as: the time when receiving a GTP packet from the gNB-DU at the ingress GTP termination of GNBCUUPFunction, minus time when the same packet was sent to gNB-DU from the GTP egress termination of GNBCUUPFunction, minus feedback delay time (including queuing delay) in gNB-DU, obtained result is divided by two.. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI.



Figure 5.1.3.3.2-1 Average delay DL on F1U

d) Each measurement is a real representing the mean delay in 0.1 millisecond. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
 [Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.PdcpF1DelayDl\_Filter,
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

NOTE : The NR RAN container (DL USER DATA/ DL DATA DELIVERY STATUS) carried in the GTP-U packet over the F1-U interface is used for the measurement.

##### 5.1.3.3.3 Average delay DL in gNB-DU

a) This measurement provides the average (arithmetic mean) RLC SDU delay on the downlink within the gNB-DU, for initial transmission of all RLC packets. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained as: sum of (time when the last part of an RLC SDU was scheduled and sent to the MAC layer for transmission over the air, minus time of arrival of the same packet at the RLC ingress F1-U termination) divided by total number of RLC SDUs arriving at the RLC ingress F1-U termination. If the RLC SDU needs retransmission (for Acknowledged Mode) the delay will still include only one contribution (the original one) to this measurement. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI.

d) Each measurement is a real representing the mean delay in 0.1 millisecond. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form DRB.RlcSduDelayDl,
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.3.4 Distribution of delay DL in CU-UP

a) This measurement provides the distribution of PDCP SDU delay on the downlink within the gNB-CU-UP, for all PDCP packets. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by 1) calculating the DL delay within the gNB-CU-UP for a PDCP SDU packet by: the time when sending a PDCP SDU to the gNB-DU at the egress PDCP layer on F1-U/Xn-U, minus time of arrival of the same packet at NG-U ingress IP termination; and 2) incrementing the corresponding bin with the delay range where the result of 1) falls into by 1 for the counters. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI.

d) Each measurement is an integer representing the number of PDCP SDU packets measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.PdcpSduDelayDlDist.Bin\_Filter, where Bin indicates a delay range which is vendor specific;
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.3.5 Distribution of delay DL on F1-U

a) This measurement provides the distribution of GTP packet delay DL on the F1-U interface. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by 1) calculating the DL delay on F1-U for a GTP packet by: the time when receiving a GTP packet delivery status message from the gNB-DU at the egress GTP termination, minus time when sending the same packet to gNB-DU at the GTP ingress termination, minus feedback delay time in gNB-DU, obtained result is divided by two; and 2) incrementing the corresponding bin with the delay range where the result of 1) falls into by 1 for the counters. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI.

d) Each measurement is an integer representing the number of GTP packets measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.GtpF1DelayDlDist.Bin\_Filter, where Bin indicates a delay range which is vendor specific;
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) GNBCUUPFunction

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.3.6 Distribution of delay DL in gNB-DU

a) This measurement provides the distribution of RLC SDU delay on the downlink within the gNB-DU, for initial transmission of all RLC packets. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by 1) calculating the delay on the downlink within the gNB-DU for a RLC SDU packet by: the time when the last part of an RLC SDU was scheduled and sent to the MAC layer for transmission over the air, minus time of arrival of the same packet at the RLC ingress F1-U termination; and 2) incrementing the corresponding bin with the delay range where the result of 1) falls into by 1 for the counters. The measurement is performed per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI. If the RLC SDU needs retransmission (for Acknowledged Mode) the delay will still include only one contribution (the original one) to this measurement.

d) Each measurement is an integer representing the number of RLC SDU packets measured with the delay within the range of the bin. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of S-NSSAIs.
[Total No. of measurement instances] x [No. of filter values for all measurements] (DL and UL) ≤ 100.

e) DRB.RlcSduDelayDlDist.Bin\_Filter, where Bin indicates a delay range which is vendor specific;
Where filter is a combination of PLMN ID and QoS level and S-NSSAI.
Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or QCI level, and SNSSAI represents S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

#### 5.1.3.4 IP Latency measurements

##### 5.1.3.4.1 General information

This clause defines the DL latency in gNB-DU. DL latency measurements for CU-UP and F1-U are not defined.

##### 5.1.3.4.2 Average IP Latency DL in gNB-DU

a) This measurement provides the average IP Latency in DL (arithmetic mean) within the gNB-DU, when there is no other prior data to be transmitted to the same UE in the gNB-DU. The measurement is optionally split into subcounters per QoS level and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained as: sum of (time when the first piece of an RLC SDU transmitted on the air interface, minus time of arrival of the same packet at the RLC ingress F1-U termination, for IP packets arriving when there is no other prior data to be transmitted to the same UE in the gNB-DU) divided by total number of RLC SDUs arriving at the RLC ingress F1-U termination when there is no other prior data to be transmitted to the same UE in the gNB-DU. Separate counters are optionally maintained for each mapped 5QI (or QCI for EN-DC) and for each S-NSSAI.

d) Each measurement is a real representing the average latency in 0.1 millisecond. The number of measurements is equal to one. If the optional QoS level subcounters and S-NSSAI subcounters are measurement is performed, the number of measurements is equal to the sum of number of supported mapped 5QIs and the number of S-NSSAIs.

e) The measurement name has the form DRB.RlcSduLatencyDl,
optionally DRB.RlcSduLatencyDl.*QOS* where *QOS* identifies the target quality of service class, and
optionally DRB.RlcSduLatencyDl.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

##### 5.1.3.4.3 Distribution of IP Latency DL in gNB-DU

a) This measurement provides the distribution of IP Latency in DL within the gNB-DU, when there is no other prior data to be transmitted to the same UE in the gNB-DU. The measurement is split into subcounters per QoS level and subcounters per S-NSSAI.

b) DER (n=1)

c) This measurement is obtained by 1) calculating the latency on the downlink within the gNB-DU for a RLC SDU packet by: time when the first piece of an RLC SDU transmitted on the air interface, minus time of arrival of the same packet at the RLC ingress F1-U termination, for IP packets arriving when there is no other prior data to be transmitted to the same UE in the gNB-DU; and 2) incrementing the corresponding bin with the latency range where the result of 1) falls into by 1 for the subcounters per QoS level (mapped 5QI or QCI in EN-DC) and subcunters per S-NSSAI.

d) Each measurement is an integer representing the number of RLC SDU packets measured with the latency within the range of the bin.

e) DRB.RlcSduLatencyDlDist.*bin*.*QOS,* where *QOS* identifies the target quality of service class, and *Bin* indicates a latency range which is vendor specific;
DRB.RlcSduLatencyDlDist.*bin*.*SNSSAI,* where *SNSSAI* identifies the S-NSSAI, and *Bin* indicates a latency range which is vendor specifics.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

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#### 5.1.3.6 PDCP data volume measurements

##### 5.1.3.6.1 PDCP PDU data volume Measurement

5.1.3.6.1.1 DL PDCP PDU Data Volume

a) This measurement provides the Data Volume (amount of PDCP PDU bits) in the downlink delivered from GNB-CU to GNB-DU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

b) CC.

c) This measurement is obtained by counting the number of DL PDCP PDU bits sent to GNB-DU. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

The measurements of DL Cell PDCP PDU Data Volume in Dual-Connectivity scenarios is not included.

d) Each measurement is an integer value representing the number of bits measured in Mbits (1MBits=1000\*1000 bits). The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form QosFlow.PdcpPduVolumeDL\_Filter.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

5.1.3.6.1.2 UL PDCP PDU Data Volume

a) This measurement provides the Data Volume (amount of PDCP PDU bits) in the uplink delievered from GNB-DU to GNB-CU. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI. The unit is Mbit (1MBits=1000\*1000 bits).

b) CC

c) This measurement is obtained by counting the number of bits entering the GNB-CU. The measurement is performed at the PDCP PDU level. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

The measurements of UL Cell PDCP PDU Data Volume in Dual-Connectivity scenarios is not included.

d) Each measurement is an integer value representing the number of bits measured in Mbits. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form QosFlow.PdcpPduVolumeUl\_Filter.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

##### 5.1.3.6.2 PDCP SDU data volume Measurement

5.1.3.6.2.1 DL PDCP SDU Data Volume

This measurement provides the Data Volume (amount of PDCP SDU bits) in the downlink delivered to PDCP layer. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

The unit is Mbit.

b) CC

c) This measurement is obtained by counting the number of bits entering the NG-RAN PDCP layer. The measurement is performed at the PDCP SDU level. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the number of bits measured in Mbits. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form QosFlow.PdcpSduVolumeDl\_Filter.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

5.1.3.6.2.2 UL PDCP SDU Data Volume

a) This measurement provides the Data Volume (amount of PDCP SDU bits) in the uplink delivered from PDCP layer to SDAP layer or UPF. The measurement is calculated per PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.
The unit is Mbit.

b) CC.

c) This measurement is obtained by counting the number of bits leaving the NG-RAN PDCP layer. The measurement is performed at the PDCP SDU level. The measurement is performed per configured PLMN ID and per QoS level (mapped 5QI or QCI in EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value representing the number of bits measured in Mbits. The number of measurements is equal to the number of PLMNs multiplied by the number of QoS levels or multiplied by the number of supported S-NSSAIs.
[Total no. of measurement instances] x [no. of filter values for all measurements] (DL and UL) ≤ 100.

e) The measurement name has the form QosFlow.PdcpSduVolumeUL\_Filter.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

5.1.3.6.2.3 DL PDCP SDU Data Volume per interface

a) This measurement provides the Data Volume (amount of PDCP SDU bits) in the downlink delivered from GNB-CU-UP to GNB-DU (F1-U interface), to external gNB-CU-UP (Xn-U interface) and to external eNB (X2-U interface). The measurement is calculated per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI and per PLMN ID, and reported per Interface (F1-U, Xn-U, X2-U).

b) CC

c) This measurement is obtained by counting the number of DL PDCP SDU bits sent to GNB-DU (F1-U interface), sent to external gNB-CU-UP (Xn-U interface) and sent to external eNB (X2-U interface). The measurement is performed in GNB-CU-UP per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI and per PLMN ID, and reported per interface (F1-U, Xn-U, X2-U).

d) Each measurement is an integer value representing the number of bits measured in Mbits (1MBits=1000\*1000 bits). The number of measurements is equal to the number of QoS levels per interface plus the number of S-NSSAIs per interface plus the number of PLMN ID.

e) The measurement names have the form DRB.F1uPdcpSduVolumeDL\_Filter.

Where filter is a combination of PLMN ID and QoS level and S-NSSAI. (F1-U interface measurements) (Xn-U interface measurements)

Where filter is a combination of PLMN ID and QoS level. (X2-U interface measurements)

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or the QCI level, and SNSSAI represents S-NSSAI.:

f) EP\_F1U (F1-U interface), EP\_XnU (Xn-U interface), EP\_X2U (X2-U interface).

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and in the energy efficency (EE) area.

5.1.3.6.2.4 UL PDCP SDU Data Volume per interface

a) This measurement provides the Data Volume (amount of PDCP SDU bits) in the uplink delivered to GNB-CU-UP from GNB-DU (F1-U interface), from external gNB-CU-UP (Xn-U interface) and from external eNB (X2-U interface). The measurement is calculated per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI and per PLMN ID, and reported per Interface (F1-U, Xn-U, X2-U).

b) CC.

c) This measurement is obtained by counting the number of UL PDCP SDU bits entering the GNB-CU-UP from GNB-DU (F1-U interface), from external gNB-CU-UP (Xn-U interface) and from external eNB (X2-U interface). The measurement is performed in GNB-CU-UP per QoS level (mapped 5QI or QCI in EN-DC) and per S-NSSAI and per PLMN ID, and reported per Interface (F1-U, Xn-U, X2-U).

d) Each measurement is an integer value representing the number of bits measured in Mbits (1MBits=1000\*1000 bits). The number of measurements is equal to the number of QoS levels per interface plus the number of S-NSSAIs per interface plus the number of PLMN ID.

e) The measurement names have the form DRB.F1uPdcpSduVolumeUL\_Filter.

Where filter is a combination of PLMN ID and QoS level and S-NSSAI. (F1-U interface measurements) (Xn-U interface measurements)

Where filter is a combination of PLMN ID and QoS level. (X2-U interface measurements)

Where PLMN ID represents the PLMN ID, QoS representes the mapped 5QI or the QCI level, and SNSSAI represents S-NSSAI.:

f) EP\_F1U (F1-U interface), EP\_XnU (Xn-U interface), EP\_X2U (X2-U interface).

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality) and in the energy efficency (EE) area.

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#### 5.1.3.10 Packet measurements

##### 5.1.3.10.1 Total number of UL PDCP SDU Packets

a) This measurement provides the total number of PDCP SDU packets which are expected received at gNB-CU-UP. Only user-plane traffic (DTCH) and only PDCP SDUs that have entered PDCP (and given a PDCP sequence number) are considered. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) CC.

c) This measurement is obtained as: Total number of UL PDCP sequence numbers (also including missing sequence numbers) of a bearer, starting from the sequence number of the first packet delivered by UE PDCP to gNB-CU-UP until the sequence number of the last packet. If transmission of a packet might continue in another cell, it shall not be included in this count. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value. If the optional QoS and S-NSSAI level measurements are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.TotalPdcpPacketUl and optionally DRB.TotalPdcpPacketUl.QOS where QOS identifies the target quality of service class, and DRB. TotalPdcpPacketUl.SNSSAI where SNSSAI identifies the S-NSSAI.

f) GNBCUUPFunction.

 NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

##### 5.1.3.10.2 Total number of DL PDCP SDU Packets in gNB-CU-UP

a) This measurement provides the total number of DL PDCP SDU packets for data radio bearers that have entered PDCP-SAP (after being decoded from GTP-U packets) in the gNB-CU-UP. Only user-plane traffic (DTCH) is considered. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) CC.

c) This measurement is obtained as: Number of DL PDCP SDU packets for data radio bearers that have entered PDCP-SAP (after being decoded from GTP-U packets). Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mpped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB.TotalPdcpSDUPacketDl and optionally DRB.TotalPdcpSDUPacketDl.*QOS*
where *QOS* identifies the target quality of service class, and DRB.TotalPdcpSDUPacketDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) GNBCUUPFunction.

NRCellCU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality). NRCellCU measurement applies only for 2-split deployment.

##### 5.1.3.10.3 Total number of DL RLC SDU Packets in gNB-DU

a) This measurement provides the total number of RLC SDU packets which are received on the downlink in the gNB-DU from gNB-CU-UP (after being decoded from PDCP-PDUs received via GTP-U packets). Only user-plane traffic (DTCH) is considered. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in EN-DC), and subcounters per supported S-NSSAI.

b) CC.

c) This measurement is obtained as: the total Number of DL RLC SDU packets (as decoded from PDCP-PDUs received via GTP-U packets) for data radio bearers that were received from gNB-CU-UP. Separate counters are optionally maintained for mapped 5QI (or QCI for EN-DC) and per supported S-NSSAI.

d) Each measurement is an integer value. If the optional QoS and S-NSSAI level measurement are performed, the measurements are equal to the number of mapped 5QIs and the number of supported S-NSSAIs.

e) The measurement name has the form DRB. TotalRlcSDUPacketDl and optionallyDRB.TotalRlcSDUPacketDl.*QOS*
where *QOS* identifies the target quality of service class, and DRB.TotalRlcSDUPacketDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

f) NRCellDU.

g) Valid for packet switched traffic.

h) 5GS.

i) One usage of this measurement is for performance assurance within integrity area (user plane connection quality).

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| **Next Change** |

# A.4 Monitoring of UL and DL user plane delay in NG-RAN

Satisfying low packet delay is of prime concern for some services, particularly conversational services like speech and instant messaging. As the performance in UL and DL differs, it is important for operators to be able to monitor the UL and DL user plane delay separately. With performance measurements allowing the operator to obtain or derive the UL and DL user plane delay information separately, the operators can pinpoint the services performance problems to specific problems in UL or DL.

The DL delay monitoring in gNB refers to the delay of any packet within NG-RAN, including air interface delay until the UE receives the packet. A gNB deployed in a split architecture, the user plane delay will occur in gNB-CU-UP, on the F1 interface, in gNB-DU and on the air interface. Therefore, the delay measurements related to the four segments needs to be monitored for the DL delay to pinpoint where end user impact from packet delay occurs.

The average DL delay needs to be measured to give a general indication of the delay performance; further more the delay distributions (into bins with delay ranges) need to be measured, to tell the occurrences about the packets with each certain range of delay and better reflect the user experience.

The UL delay monitoring in gNB refers to the delay of any packet within NG-RAN, including air interface delay until the packet leaves gNB-CU-UP. There are 4 components associated to UL delay (UL over-the-air interface delay, gNB-DU delay, F1-U delay, CU-UP delay). Therefore, the delay measurements related to these four segments needs to be monitored for the UL delay to pinpoint where end user impact from packet delay occurs. The beamforming capabilities of the NRCellDU and of the UE can be different. This might create a difference in the successful reception probability of the DL data transmitted by the gNB-DU, versus the UL data transmitted by the UE as the later might involve more retransmission than the former one. This will increase the UL over-the-air delay compared to the DL over-the-air delay.

For multi-operator RAN sharing scenario, different operators may have different requirements on the packet delay. It is of great importance to enable each operator to monitor the packet delay within its PLMN, also it helps the operators to pinpoint the network and service performance problems in a specific PLMN.

Different network slices may have different requirements on the delay, so the delay needs to be measured for each S-NSSAI.

To further pinpoint a detected delay performance problem, the packet delay measurement separation may be based on mapped 5QI (or for QCI in case of EN-DC).

NOTE: It is an asumtion that the DL/UL delay on the F1 interface is equal, only DL measurement is defined.

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| **End of Change** |