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Contents

Foreword

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1 Scope

The present document contains the description and definition of the measurements performed by network or the UE that are transferred over the standardised interfaces in order to support NR radio link operations, radio resource management (RRM), network operations and maintenance (OAM), minimization of drive tests (MDT) and self-organising networks (SON).

Only the differences relative to TS 28.552 v16.2.0 [2] are specified in this specification.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
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[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 28.552: "5G performance measurements".

[3] 3GPP TS 38.331: "Radio Resource Control (RRC) protocol specification".

[4] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

4 Layer 2 measurements

4.1 General

All the per DRB per cell measurements and per DRB per UE measurements can be aggregated into per QoS level per cell and per PLMN ID per cell by network implementation. All the performance measurements for gNB defined in TS 28.552 [2] 5.1 can be calculated into per PLMN ID level by network implementation. Per QoS level refers to per mapped 5QI for NR SA or per QCI for EN-DC.

4.2 NR measurements performed by the gNB

4.2.1 Measurements valid for all gNB deployment scenarios

4.2.1.1 Received Random Access Preambles

4.2.1.1.1 Received Random Access Preambles per cell

A use case for this measurement is RACH configuration optimization, where Received Random Access Preambles is signalled across an OAM interface.

Protocol Layer: MAC

Table 4.2.1.1.1-1: Definition for Received Random Access Preambles per cell

Definition	Received Random Access Preambles per cell. This measurement is applicable to PRACH. The reference point is the Service Access Point between MAC and L1. The measured quantity is the number of received Random Access preambles during a time period over all PRACHs configured in a cell. The measurement is done separately for: - Dedicated preambles - Randomly selected preambles in the low range - Randomly selected preambles in the high range. The unit of the measured value is [/s].

4.2.1.1.2 Received Random Access Preambles per SSB

A use case for this measurement is RACH configuration optimization, where Received Random Access Preambles is signalled across an OAM interface.

Protocol Layer: MAC

Table 4.2.1.1.2-1: Definition for Received Random Access Preambles per SSB

Definition	Received Random Access Preambles per SSB. This measurement is applicable to PRACH. The reference point is the Service Access Point between MAC and L1. The measured quantity is the number of received Random Access preambles during a time period over all PRACHs configured in the SSB of the cell. The measurement is done separately for: - Dedicated preambles - Randomly selected preambles in the low range - Randomly selected preambles in the high range. The unit of the measured value is [/s].

4.2.1.2 Packet delay

4.2.1.2.1 General

Packet delay includes RAN part of delay and CN part of delay.

The RAN part of DL packet delay measurement comprises:

- D1 (DL delay in over-the-air interface), referring to Average delay DL air-interface in TS 28.552 [2] 5.1.1.1.1.
- D2 (DL delay on gNB-DU), referring to Average delay in RLC sublayer of gNB-DU in TS 28.552 [2] 5.1.3.3.3.
- D3 (DL delay on F1-U), referring to Average delay on F1-U in TS 28.552 [2] 5.1.3.3.2.
- D4 (DL delay in CU-UP), referring to Average delay DL in CU-UP in TS 28.552 [2] 5.1.3.3.1.

The DL packet delay measurements, i.e. D1 (the DL delay in over-the-air interface), D2 (the DL delay in gNB-DU), D3 (the DL delay on F1-U) and D4 (the DL delay in CU-UP), should be measured per DRB per UE.

NOTE: The delay measurements D1, D2 and D4 are also applicable for EUTRA in case of EN-DC related DL delay measurements on the MN side.

The RAN part (including UE) of UL packet delay measurement comprises:

- D1 (UL PDCP packet average delay, as defined in clause 4.3.1.1).
- D2.1 (average over-the-air interface packet delay, as defined in 4.2.1.2.2).
- D2.2 (average RLC packet delay, as defined in 4.2.1.2.3).
- D2.3 (average delay UL on F1-U, it is measured using the same metric as the average delay DL on F1-U defined in TS 28.552 [2] clause 5.1.3.3.2).
- D2.4 (average PDCP re-ordering delay, as defined in 4.2.1.2.4).

The UL packet delay measurements, i.e. D1(UL PDCP packet average delay), D2.1(average over-the-air interface packet delay), D2.2(average RLC packet delay), D2.3(average delay UL on F1-U) and D2.4(average PDCP re-ordering delay), should be measured per DRB per UE. The unit of D1, D2.1, D2.2, D2.3 and D2.4 is 0.1ms.

NOTE: The delay measurements D1, D2.1, D2.2 and D2.4 are also applicable for EUTRA in case of EN-DC related UL delay measurements on the MN side.

For non CU-UP and DU split case, RAN part of packet delay excludes the delay at FI-U interface, i.e. D2.3 and D3.

If network disables the PDCP re-ordering function, the value of Average PDCP re-ordering delay i.e. D2.4 should be set to 0.

For the QoS monitoring in TS 23.501 [4], RAN informs the RAN part of UL packet delay measurement, or the RAN part of DL packet delay measurement, or both to the CN.

4.2.1.2.2 Average over-the-air interface packet delay in the UL per DRB per UE

The objective of this measurement is to measure air interface UL packet delay for OAM performance observability or for QoS verification of MDT or for the QoS monitoring as defined in TS 23.501 [4].

Protocol Layer: MAC

Table 4.2.1.2.2-1: Definition for Average over-the-air packet delay in the UL per DRB per UE

Definition	Average over-the-air packet delay in the UL per DRB per UE. This measurement is applicable for EN-DC and SA. This measurement refers to packet delay for DRBs. This measurement provides the average (arithmetic mean) time it takes to successfully receive a transport block from the time of UL transmission indicated in scheduling grant. Detailed Definition: $M(T, drbid) = \left\lfloor \frac{\sum_{\forall i} tSucc(i,drbid) - tSched(i,drbid)}{I(T)} \right\rfloor$, where explanations can be found in the table 4.2.1.2.2-2 below.

Table 4.2.1.2.2-2: Parameter description for Average over-the-air packet delay in the UL per DRB per UE

$M(T, drbid)$	Over-the-air packet delay in the UL per DRB per UE, averaged during time period T. Unit: 0.1 ms.
$tSched(i, drbid)$	The point in time when the UL MAC SDU i is scheduled in MAC layer as per the scheduling grant provided.
$tSucc(i, drbid)$	The point in time when the UL MAC SDU i is successfully sent to RLC.
i	A UL MAC SDU that arrives at the MAC during time period T.
$I(T)$	Total number of UL MAC SDUs i.
T	Time Period during which the measurement is performed
$drbid$	The identity of the measured DRB.

4.2.1.2.3 Average RLC packet delay in the UL per DRB per UE

The objective of this measurement is to measure RLC delay in the UL for OAM performance observability or for QoS verification of MDT or for the QoS monitoring as defined in TS 23.501 [4].

Protocol Layer: RLC

Table 4.2.1.2.3-1: Definition for Average RLC packet delay in the UL per DRB per UE

Definition	Average RLC delay in the UL per DRB per UE. This measurement is applicable for EN-DC and SA. This measurement refers to packet delay for DRBs. For CU-UP and DU split scenario or DC scenario, this measurement refers to the RLC delay on each DU or RAN node. This measurement provides the average (arithmetic mean) time it takes from the RLC PDU including the first part of an RLC SDU is received to the RLC SDU is sent to PDCP or CU-UP for split gNB. Detailed Definition: $M(T, drbid) = \left[\frac{\sum_{\forall i} tSent(i, drbid) - tReceiv(i, drbid)}{I(T)}\right]$, where explanations can be found in the table 4.2.1.2.3-2 below.

Table 4.2.1.2.3-2: Parameter description for Average RLC packet delay in the UL per DRB per UE

$M(T, drbid)$	RLC delay in the UL per DRB per UE, averaged during time period T. Unit: 0.1 ms.
$tReceiv(i, drbid)$	The point in time when the UL RLC PDU including the first part of the UL RLC SDU i is received.
$tSent(i, drbid)$	The point in time when the UL RLC SDU i is sent to PDCP or CU-UP for split gNB.
i	A UL RLC SDU that is received by the RLC during time period T.
$I(T)$	Total number of UL RLC SDUs i.
T	Time Period during which the measurement is performed
$drbid$	The identity of the measured DRB.

4.2.1.2.4 Average PDCP re-ordering delay in the UL per DRB per UE

The objective of this measurement is to measure PDCP re-ordering delay in the UL for OAM performance observability or for QoS verification of MDT or for the QoS monitoring as defined in TS 23.501 [4].

Protocol Layer: PDCP

Table 4.2.1.2.4-1: Definition for Average PDCP re-ordering delay in the UL per DRB per UE

Definition	Average PDCP re-ordering delay in the UL per DRB per UE. This measurement is applicable for EN-DC and SA. This measurement refers to packet delay for DRBs. This measurement provides the average (arithmetic mean) time it takes from the point a PDCP PDU is received to the PDCP SDU is sent to upper SAP. Detailed Definition: $M(T, drbid) = \left\lfloor \frac{\sum_{\forall i} tSent(i,drbid) - tReceiv(i,drbid)}{I(T)} \right\rfloor$, where explanations can be found in the table 4.1.1.2.4-2 below.

Table 4.2.1.2.4-2: Parameter description for Average PDCP re-ordering delay in the UL per DRB per UE

$M(T, drbid)$	PDCP re-ordering delay in the UL per DRB per UE, averaged during time period T. Unit: 0.1 ms.
$tReceiv(i, drbid)$	The point in time when the UL PDCP PDU including the UL PDCP SDU i is received.
$tSent(i, drbid)$	The point in time when the UL PDCP SDU i is sent to upper SAP.
i	A UL PDCP SDU that is received by the PDCP during time period T.
$I(T)$	Total number of UL PDCP SDUs received during time period T.
T	Time Period during which the measurement is performed
$drbid$	The identity of the measured DRB.

4.2.1.3 Number of active UEs in RRC_CONNECTED

4.2.1.3.1 General

The objective of the measurement is to measure the number of active UEs per QoS level for OAM performance observability or for SON functions e.g., mobility load balancing. It is intended to be part of a calculation to determine the bitrate UEs achieve when they are active, i.e. when applications are transmitting and receiving data. The measurements are applicable for both non-split gNB and split gNB deployment scenario.

4.2.1.3.2 Mean number of Active UEs in the DL per DRB per cell

Protocol Layer: MAC, RLC

Table 4.2.1.3.2-1: Definition for Mean number of Active UEs in the DL per DRB per cell

Definition	Mean number of Active UEs in the DL per DRB per cell. The DRBs are mapped with the same 5QI for NR SA or mapped with the same QCI for EN-DC. This measurement refers to UEs for which there is data available for transmission for the DL for DRBs. Detailed Definition: $M(T, drbid, p) = \frac{\left\lfloor \frac{\sum_{\forall i} N(i,drbid)}{I(T,p)} * 10 \right\rfloor}{10}$, where explanations can be found in the table 4.2.1.3.2-2 below.

Table 4.2.1.3.2-2: Parameter description for Mean number of Active UEs in the DL per DRB per cell

$M(T,drbid,p)$	Mean number of Active UEs in the DL per DRB per cell, averaged during time period T. Unit: 0.1.
$N(i,drbid)$	Number of UEs for which there is data available for transmission for the DL in MAC or RLC protocol layers for a Data Radio Bearer of traffic class at sampling occasion i. Data available for transmission includes data for which HARQ transmission has not yet terminated.
i	Sampling occasion during time period T. A sampling occasion shall occur once every p seconds.
p	Sampling period length. Unit: second. The sampling period shall be at most 0.1 s.
$I(T,p)$	Total number of sampling occasions during time period T.
T	Time Period during which the measurement is performed, Unit: second.
$drbid$	The DRBs mapped with the same 5QI for NR SA or mapped with the same QCI for EN-DC.

4.2.1.3.3 Max number of Active UEs in the DL per DRB per cell

Protocol Layer: MAC, RLC

Table 4.2.1.3.3-1: Definition for Max number of Active UEs in the DL per DRB per cell

Definition	Maximum number of Active UEs in the DL per DRB per cell. The DRBs are mapped with the same 5QI for NR SA or mapped with the same QCI for EN-DC. This measurement refers to UEs for which there is data available for transmission for the DL for DRBs. Detailed Definition: $M(T,drbid,p) = \max_{T}(N(i,drbid))$, where explanations can be found in the table 4.2.1.3.3-2 below.

Table 4.2.1.3.3-2: Parameter description for Max number of Active UEs in the DL per DRB per cell

$M(T,drbid,p)$	Maximum number of Active UEs in the DL per DRB per cell, averaged during time period T. Unit: Integer.
$N(i,drbid)$	Number of UEs for which there is data available for transmission for the DL in MAC or RLC protocol layers for a Data Radio Bearer of traffic class at sampling occasion i. Data available for transmission includes data for which HARQ transmission has not yet terminated.
i	Sampling occasion during time period T. A sampling occasion shall occur once every p seconds.
p	Sampling period length. Unit: second. The sampling period shall be at most 0.1 s.
T	Time Period during which the measurement is performed, Unit: second.
$drbid$	The DRBs mapped with the same 5QI for NR SA or mapped with the same QCI for EN-DC.

4.2.1.3.4 Mean number of Active UEs in the UL per DRB per cell

Protocol Layer: MAC