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1 Scope

This document specifies the performance measurements for 5G networks including network slicing. Performance measurements for NG-RAN (clause 5.1) as well as for 5GC (clause 5.2 to 5.6) are defined in this document. Related KPIs are defined to those measurements in TS 28.554 [8].

The performance measurements for NG-RAN applies also to NR option 3 in many cases, but not to the RRC connection related measurements which are handled by E-UTRAN for NR option 3 (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].

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.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 32.401: "Telecommunication management; Performance Management (PM); Concept and requirements".

[3] 3GPP TS 32.404: "Performance Management (PM); Performance measurements - Definitions and template".

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

[5] IETF RFC 5136: "Defining Network Capacity".

[6] 3GPP TS 38.473: "NG-RAN; F1 Application Protocol (F1AP)".

[7] 3GPP TS 23.502: "Procedures for the 5G System".

[8] 3GPP TS 28.554: “Management and orchestration; 5G end to end Key Performance Indicators (KPI)”.

[9] 3GPP TS 32.425: “Performance Management (PM); Performance measurements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN)”

[10] 3GPP TS 32.451: "Key Performance Indicators (KPI) for Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Requirements”

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3 Definitions, abbreviations and measurement family

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

IP Latency: the time it takes to transfer a first/initial packet in a data burst from one point to another.

Mapped 5QI: In case when a single 5QI is assigned to the DRB, the mapped 5QI refers to the 5QI that is used for a DRB within the gNB.

NOTE 1: In this case the mapped 5QI is used for separating certain measurements per QoS class.

NOTE 2: Individual QoS flows into a common 5QI is specified in TS 38.473 [6].

Packet Delay: the time it takes to transfer any packet from one point to another.

Packet Drop Rate: share of packets that were not sent to the target due to congestion or traffic management and should be seen as a part of the packet loss rate.

Packet Loss Rate: share of packets that could not be received by the target including packets droped, packets lost in transmission and packets received in wrong format.

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3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1], 3GPP 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 3GPP TR 21.905 [1] and 3GPP TS 23.501 [4].

kbit	kilobit (1000 bits)
NG-RAN	Next Generation Radio Access Network
NSI	Network Slice Instance

3.4 Measurement family

The measurement names defined in the present document are all beginning with a prefix containing the measurement family name. This family name identifies all measurements which relate to a given functionality and it may be used for measurement administration.

The list of families currently used in the present document is as follows:

- DRB (measurements related to Data Radio Bearer)
- RRC (measurements related to Radio Resource Control)
- UECNTX (measurements related to UE Context)
- RRU (measurements related to Radio Resource Utilization)
- RM (measurements related to Registration Management)
- SM (measurements related to Session Management)
- GTP (measurements related to GTP Management)
- IP (measurements related to IP Management)
- PA (measurements related to Policy Association)

4 Concepts and overview

5 Performance measurements for 5G Network Functions

5.1 Performance measurements for gNB

5.1.1 Performance measurements valid for all gNB deployment scenarios

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 to get a reponse back on a HARQ transmission in the downlink direction. The measurement is optionally split into subcounters per QoS level (mapped 5QI or QCI in NR option 3).

b) DER (n=1)

c) This measurement is obtained as: sum of (time when the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or time when the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode, minus time when corresponding RLC SDUs arriving at MAC lower SAP) divided by total number of RLC SDUs transmitted to UE successfully. Separate counters are optionally maintained for each mapped 5QI (or QCI for option 3).

d) Each measurement is an integer representing the mean delay in microseconds. The number of measurements is equal to one. If the optional QoS level measurement is perfomed, the number of measurements is equal to the number of mapped 5QIs.

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

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).

5.1.1.2 Radio resource utilization

5.1.1.2.1 DL Total PRB Usage

a) This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the downlink for any purpose.

b) SI

c) This measurement is obtained as: $M(T) = \left\lfloor \frac{M1(T)}{P(T)} * 100 \right\rfloor$, where $M(T)$ is the DL total PRB usage, which is percentage of PRBs used, averaged during time period T with value range: 0-100%; $M1(T)$ is a count of

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full physical resource blocks and all PRBs used for DL traffic transmission shall be included; $P(T)$ is total number of PRBs available for DL traffic transmission during time period T ; and T is the time period during which the measurement is performed.

d) A single integer value from 0 to 100.

e) RRU.PrbTotDl, *which indicates the DL PRB Usage for all traffic*

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for monitoring the load of the radio physical layer.

5.1.1.2.2 UL Total PRB Usage

a) This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the uplink for any purpose.

b) SI

c) This measurement is obtained as: $M(T) = \left\lfloor \frac{M1(T)}{P(T)} * 100 \right\rfloor$, where $M(T)$ is the UL total PRB usage, which is percentage of PRBs used, averaged during time period T with value range: 0-100%; $M1(T)$ is a count of full physical resource blocks and all PRBs used for UL traffic transmission shall be included; $P(T)$ is total number of PRBs available for UL traffic transmission during time period T ; and T is the time period during which the measurement is performed.

d) A single integer value from 0 to 100.

e) RRU.PrbTotUl, *which indicates the UL PRB Usage for all traffic*

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for monitoring the load of the radio physical layer.

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5.1.1.2.3 Distribution of DL Total PRB Usage

a) This measurement provides the distribution of samples with total usage (in percentage) of physical resource blocks (PRBs) on the downlink in different ranges. This measurement is a useful measure of whether a cell is under high loads or not in the scenario which a cell in the downlink may experience high load in certain short times (e.g. in a second) and recover to normal very quickly.

b) CC

c) Each measurement sample is obtained as: $M[n] = \left\lfloor \frac{M1[n]}{P[n]} * 100 \right\rfloor$, where $M[n]$ is total PRB usage at sample n for DL, which is a percentage of PRBs used, averaged during time period t_n with value range: 0-100%; $M1[n]$ is a count of full physical resource blocks and all PRBs used for DL traffic transmission shall be included; $P(n)$ is the total number of PRBs available for DL traffic transmission during time period t_n and n is the sample with time period t_n during which the measurement is performed.

Distribution of total PRB usage is calculated in the time-frequency domain only. The reference point is the Service Access Point between MAC and L1. The distribution of PRB usage provides the histogram result of the samples collected during time period T.

Depending on the value of the sample, the proper bin of the counter is increased. The number of samples during one measurement period is provided by the operator.

d) A set of integers. Each representing the (integer) number of samples with a DL total PRB percentage usage in the range represented by that bin.

e) RRU.PrbTotDlDist.BinX, which indicates the distribution of DL PRB Usage for all traffic.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for monitoring the load of the radio physical layer.

5.1.1.2.4 Distribution of UL Total PRB Usage

a) This measurement provides the distribution of samples with total usage (in percentage) of physical resource blocks (PRBs) on the uplink in different usage ranges. This measurement is a useful measure of whether a cell is under high loads or not in the scenario which a cell in the uplink may experience high load in certain short times (e.g. in a second) and recover to normal very quickly.

b) CC

c) Each measurement sample is obtained as: $M[n] = \left\lfloor \frac{M1[n]}{P[n]} * 100 \right\rfloor$, where $M[n]$ is total PRB usage at sample n for UL, which is a percentage of PRBs used, averaged during time period t_n with value range: 0-100%; $M1[n]$ is a count of full physical resource blocks and all PRBs used for UL traffic transmission shall be included; $P(n)$ is the total number of PRBs available for UL traffic transmission during time period t_n and n is the sample with time period t_n during which the measurement is performed.

Distribution of total PRB usage is calculated in the time-frequency domain only. The reference point is the Service Access Point between MAC and L1. The distribution of PRB usage provides the histogram result of the samples collected during time period T.

Depending on the value of the sample, the proper bin of the counter is increased. The number of samples during one measurement period is provided by the operator.

d) A set of integers, each representing the (integer) number of samples with a UL PRB percentage usage in the range represented by that bin.

e) RRU.PrbTotUlDist.BinX, which indicates the distribution of UL PRB Usage for all traffic.

f) NRCellDU

g) Valid for packet switched traffic

h) 5GS

i) One usage of this measurement is for monitoring the load of the radio physical layer.

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 NR option 3).

b) DER(N=1)

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