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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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where:

x the first digit:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document specifies end-to-end Key Performance Indicators (KPIs) for the 5G network and network slicing.

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] Void.

[3] ITU-T Recommendation E.800: "Definitions of terms related to quality of service".

[4] 3GPP TS 24.501: " Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[5] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[6] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[7] 3GPP TS 23.501: " System Architecture for the 5G System; Stage 2".

[8] ETSI ES 203 228 V1.2.1 (2017-04): "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

[9] 3GPP TS 28.310: "Management and orchestration; Energy efficiency of 5G".

3 Definitions and abbreviations

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].

3.2 Abbreviations

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

EE	Energy Efficiency
kbit	kilobit (1000 bits)
RTT	Round Trip Time

4 End to end KPI concept and overview

The following KPI categories are included in the present document:

- Accessibility (see the definition in [3]).
- Integrity (see the definition in [3]).
- Utilization.
- Retainability (see the definition in [3]).
- Mobility.
- Energy Efficiency.

5 KPI definitions template

a) Name (Mandatory): This field shall contain the name of the KPI.

b) Description (Mandatory): This field shall contain the description of the KPI.
Within this field it should describe if the KPI is focusing on network or user view. This filed should also describe the logical KPI formula to derive the KPI. For example, a success rate KPI's logical formula is the number of successful events divided by all events. This field should also show the KPI unit (e.g., kbit/s, millisecond) and the KPI type (e.g., mean, ratio).

c) Formula definition (Optional):
This field should contain the KPI formula using the 3GPP defined measurement names.
This field can be used only when the measurement(s) needed for the KPI formula are defined in 3GPP TS for performance measurements (TS 28.552 [6]). This field shall clarify how the aggregation shall be done, for the KPI object level(s) defined in d).

d) KPI Object (Mandatory):
This field shall contain the DN of the object instance where the KPI is applicable, including the object where the measurement is made. The DN identifies one object instance of the following IOC:

- `NetworkSliceSubnet`
- `SubNetwork`
- `NetworkSlice`
- `NRCellDU`
- `NRCellCU`

e) Remark (Optional):
This field is for additional information reqquired for the KPI definition,
e.g. the definition of a call in UTRAN.

6 End to end KPI definitions

6.1 KPI Overview

The KPI categories defined in [2] will be reused by the present document.

6.2 Accessibility KPI

6.2.1 Mean registered subscribers of network and network slice through AMF

a) AMFMeanRegNbr.

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

$$AMFMeanRegNbr = \sum_{AMF} RegisteredSubNbrMean.SNSSAI$$

c)

d) SubNetwork, NetworkSlice

6.2.2 Registered subscribers of network through UDM

a) UDMRegNbr.

b) This KPI describes the total number of subscribers that are registered to a network through UDM. It is corresponding to the measurement RM.RegisteredSubUDMNbrMean that counts subscribers registered in UDM. It is an Integer. The KPI type is CUM.

c) UDMRegNbr = $\sum_{UDM} RegisteredSubUDMNbrMean$

d) SubNetwork

6.2.3 Registration success rate of one single network slice

a) RSR.

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

c)

$$\text{RSR} = \frac{\sum_{Type} \text{AMF.5GSRegisSucc.}Type}{\sum_{Type} \text{AMF.5GSRegisAtt.}Type} * 100\%$$

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

d) NetworkSlice

6.2.4 DRB Accessibility for UE services

a) DRB Accessibility

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

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

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

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

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

d) SubNetwork, NRCellCU.

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

a) PDUSessionEstSR.

b) This KPI describes the ratio of the number of successful PDU session establishment request to the number of PDU session establishment request attempts for 5G network for the SMF which related to one network slice (S-NSSAI) and is used to evaluate accessibility provided by the end-to-end network slice and network performance. It is obtained by the number of successful PDU session requests divided by the number of attempted PDU session requests. It is a percentage. The KPI type is RATIO.

c) $$\text{PDUSessionEstSR} = \frac{\text{SM.PduSessionCreationSucc.SNSSAI}}{\text{SM.PduSessionCreationReq.SNSSAI}}$$

d) NetworkSlice

6.3 Integrity KPI

6.3.1 Latency and delay of 5G networks

6.3.1.0 Void

6.3.1.1 Downlink latency in gNB-DU

a) DLLat_gNB-DU.

b) This KPI describes the gNB-DU part of the packet transmission latency experienced by an end-user. It is used to evaluate the gNB latency contribution to the total packet latency. It is the average (arithmetic mean) of the time from reception of IP packet to gNB-DU until transmission of first part of that packet over the air interface, for a packet arriving when there is no previous data in queue for transmission to the UE. It is a time interval (0.1 mS). The KPI type is MEAN. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in NR option 3) and per S-NSSAI.

c) DLLat_gNB-DU = DRB.RlcSduLatencyDl

or optionally DLLat_gNB-DU.*QoS* = DRB.RlcSduLatencyDl.QoS where QOS identifies the target QoS quality of service class.

or optionally DLLat_gNB-DU.*SNSSAI* = DRB.RlcSduLatencyDl.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) NRCellDU

6.3.1.2 Integrated downlink delay in RAN

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

a) DLDelay_NR_SNw.

b) This KPI describes the average packet transmission delay through the RAN part to the UE. It is used to evaluate delay performance of NG-RAN in downlink for a sub-network. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode. It is a time interval (0.1 ms). The KPI type is MEAN. This KPI can optionally be split into KPIs per QoS level (mapped 5QI or QCI in NR option 3) and per S-NSSAI.

c) Below are the equations for average "Integrated downlink delay in RAN" for this KPI on SubNetwork level. The "Integrated downlink delay in RAN" is the sum of average DL delay in gNB-CU-UP of the sub-network (DLDelay_gNBCUUP_SNw) and the average DL delay in gNB-DU of the sub-network (DLDelay_gNBDU_SNw):

DLDelay_NR_SNw = DLDelay_gNBCUUP_SNw + DLDelay_gNBDU_SNw

or optionally DLDelay_ NR_SNw.*QOS* = DLDelay_gNBCUUP_SNw.*QOS* + DLDelay_gNBDU_SNw.*QOS* where *QOS* identifies the target quality of service class.

or optionally DLDelay_NR_SNw.*SNSSAI* = DLDelay_gNBCUUP_SNw.*SNSSAI* + DLDelay_gNBDU_SNw.*SNSSAI* where *SNSSAI* identifies the S-NSSAI.

d) SubNetwork

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

a) DLDelay_NR_Nss.

b) This KPI describes the average packet transmission delay through the RAN part to the UE. It is used to evaluate delay performance of NG-RAN in downlink for a network slice subnet. It is the weighted average packets delay from reception of IP packet in gNB-CU-UP until the last part of an RLC SDU packet was received by the UE according to received HARQ feedback information for UM mode or until the last part of an RLC SDU packet was received by the UE according to received RLC ACK for AM mode. It is a time interval (0.1 ms). The KPI type is MEAN.

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

DLDelay_NR_Nss.*SNSSAI* = DLDelay_gNBCUUP_Nss.*SNSSAI* + DLDelay_gNBDU_Nss.*SNSSAI* where *SNSSAI* identifies the S-NSSAI that the network slice subnet supports.

d) NetworkSliceSubnet

6.3.1.3 Downlink delay in gNB-DU

6.3.1.3.1 Downlink delay in gNB-DU for a NRCellDU

a) DLDelay_gNBDU_Cell.

b) This KPI describes the average packet transmission delay through the gNB-DU part to the UE. It is used to evaluate delay performance of gNB-DU in downlink. It is the average packets delay time from arrival of an RLC SDU at the RLC ingress F1-U termination until the last part of an RLC SDU packet was received by the UE