

# 3GPP TS 32.451 V17.0.0 (2022-04)

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*Technical Specification*

**3rd Generation Partnership Project;  
Technical Specification Group Services and System Aspects;  
Telecommunication management;  
Key Performance Indicators (KPI) for Evolved Universal  
Terrestrial Radio Access Network (E-UTRAN);  
Requirements  
(Release 17)**

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Keywords

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E-UTRAN, management, performance

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## Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- 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.

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## Introduction

The present document is part of a multi-part deliverable covering the 3<sup>rd</sup> Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; as identified below:

- 32.451: Key Performance Indicators (KPI) for E-UTRAN; Requirements;
- 32.450: Key Performance Indicators (KPI) for E-UTRAN; Definitions.

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# 1 Scope

The present document specifies requirements (business level requirements, specification level requirements and use case descriptions) related to Key Performance Indicators (KPIs) for E-UTRAN.

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## 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] ITU-T Recommendation E.800: "Terms and Definitions related to Quality of Service and Network Performance including Dependability".
- [2] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [3] ETSI ES 203 228 V1.1.7 (2016-11): "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [2] 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 [2].

### 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [2] 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 [2].

|         |  |
|---------|--|
| DRX     | Discontinuous Reception                    |
| eNB     | E-UTRAN Node B                             |
| EE      | Energy Efficiency                          |
| EPS     | Evolved Packet System                      |
| E-RAB   | E-UTRAN Radio Access Bearer                |
| E-UTRAN | Evolved UTRAN                              |
| GBR     | Guaranteed Bit Rate                        |
| KPI     | Key Performance Indicator                  |
| KQI     | Key Quality Indicator                      |
| LTE     | Long Term Evolution                        |
| RAT     | Radio Access Technology                    |
| TTI     | Transmission Time Interval                 |
| UE      | User Equipment                             |
| UMTS    | Universal Mobile Telecommunications System |

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## 4 KPI overview

The following KPI categories are covered by the present document:

- Accessibility (see the definition in [1]).
- Retainability (see the definition in [1]).
- Integrity (see the definition in [1]).
- Availability
- Mobility
- Energy Efficiency

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## 5 Requirements

### 5.1 KPI Category “Accessibility”

#### 5.1.1 E-RAB Accessibility

##### 5.1.1.1 Business level requirements

If an end user cannot access a service it is hard to charge for the service. Also, if it happens often that an end-user cannot access the provided service, the end-user might change wireless subscription provider, i.e. loss of income for the network operator.

Hence, to have a good accessibility of the services is important from a business point of view. This measurement assists the network operator with information about the accessibility provided to their customers.

##### 5.1.1.2 Specification level requirements

The accessibility of an end-user application covers a wider area than just the E-UTRAN part. Hence it is important to realize that a KPI for this in E-UTRAN shall be limited to the parts that E-UTRAN has control of, i.e. the E-UTRAN KPI shall be defined so that it indicates the E-UTRAN contribution to the end-user impact, NOT attempt to take responsibility of the whole end-to-end part of service accessibility.

The service provided by E-UTRAN for this KPI shall be E-RAB.

It shall be possible to measure the accessibility of E-RABs in E-UTRAN.

Accessibility measurement should be available as a success rate for the attempts.

As for defining an attempt, it shall be considered an attempt first when the eNodeB can be certain that is a request for an E-RAB.

As for defining a success, it shall be considered a success when the eNodeB have completed its task to setup resources and the result of the E-RAB establishment can be informed to the requester of the E-RAB.

The KPI shall be available per QoS group.

##### 5.1.1.3 Use case description

In providing end-user services to wireless end-users, the first step is to get access to the wireless service. First after access to the service has been performed, the service can be used.

If an accessibility measurement is not considered OK, then the network operator can investigate which steps that are required to improve the accessibility towards their customers.

This measurement should be used for observing the impact of E-UTRAN on end-users service accessibility.

## 5.2 KPI Category “Retainability”

### 5.2.1 E-RAB Retainability

#### 5.2.1.1 Business level requirements

If an end user is interrupted often during use of a service, or the service is aborted during use, the time the service is not provided could be hard to charge for. Also if it happens often that an end-user is interrupted or aborted at service use it might change wireless subscription provider, i.e. loss of income for the network operator.

Hence to have a good retainability of the services is important from a business point of view. This measurement assists the network operator with information about the retainability provided to their customers.

#### 5.2.1.2 Specification level requirements

The retainability of an end-user application covers a wider area than just the E-UTRAN part. Hence it is important to realize that a KPI for this in E-UTRAN shall be limited to the parts that E-UTRAN has control of, i.e. the E-UTRAN KPI shall be defined so that it indicates the E-UTRAN contribution to the end-user impact, NOT attempt to take responsibility of the whole end-to-end part of service retainability.

The service provided by E-UTRAN for this KPI shall be E-RAB.

Since the keep-alive possibilities of E-RABs, i.e. DRX are available, it is probable that E-RABs are kept alive much longer than they are used for transmitting data. With an extreme setting of this keep-alive functionality it can lead to that basically all E-RAB releases are doomed to be abnormal (the normal system releases do not exist if keep-alive is set very long).

Hence the definition is to only count it as abnormal releases when there was actually an impact on the end-user.

The preferred normalization of abnormal releases of the service shall be time unit of transfer between abnormal releases, i.e. abnormal releases per served session time.

The KPI shall be available per QoS group.

#### 5.2.1.3 Use case description

When a service is used it is important that it is not interrupted or aborted.

If a retainability measurement is not considered OK, then the network operator can investigate which steps that are required to improve the retainability towards their customers.

This measurement should be used for observing the impact of E-UTRAN on end-users service retainability.

#### 5.2.1.4 Specification level requirements

The retainability of an end-user application covers a wider area than just the E-UTRAN part. Hence it is important to realize that a KPI for this in E-UTRAN shall be limited to the parts that E-UTRAN has control of, i.e. the E-UTRAN KPI shall be defined so that it indicates the E-UTRAN contribution to the end-user impact, NOT attempt to take responsibility of the whole end-to-end part of service retainability.

The service provided by E-UTRAN for this KPI shall be E-RAB.

Since the keep-alive possibilities of E-RABs, i.e. DRX are available, it is probable that E-RABs are kept alive much longer than they are used for transmitting data. With an extreme setting of this keep-alive functionality it can lead to that basically all E-RAB releases are doomed to be abnormal (the normal system releases do not exist if keep-alive is set very long).

Hence the definition is to only count it as abnormal releases when there was actually an impact on the end-user.

The preferred normalization of abnormal releases of the service shall be time unit of transfer between abnormal releases, i.e. abnormal releases per served session time.

The KPI shall be available per QoS group.

From QoS perspective it is important to focus also on call duration as in some cases wrong quality perceived by the end user is not fully reflected by drop ratio nor retainability KPI. Typical case is when due to poor radio conditions the end user redials (the call was terminated normally) to the same party to secure the quality. But in this case the drop ratio KPI will not show any degradation. Secondly, although the call is dropped the end user may or may not redial depending on dropped call duration compared to the case when the call would be normally released. It is therefore highly recommended to monitor distribution of duration of normally and abnormally released calls.

## 5.3 KPI Category “Integrity”

### 5.3.1 E-UTRAN IP Throughput

#### 5.3.1.1 Business level requirements

If an end user often experiences low quality during use of a service, the end-user might change wireless subscription provider, i.e. loss of income for the network operator.

Hence to have a good integrity of the services is important from a business point of view. This measurement assists the network operator with information about the integrity provided to their customers.

#### 5.3.1.2 Specification level requirements

The integrity of an end-user application covers a wider area than just the E-UTRAN part. Hence it is important to realize that a KPI for this in E-UTRAN shall be limited to the parts that E-UTRAN has control of, i.e. the E-UTRAN KPI shall be defined so that it indicates the E-UTRAN contribution to the end-user impact, NOT attempt to take responsibility of the whole end-to-end part of service integrity.

The service provided by E-UTRAN for this KPI shall be delivery of IP packets.

To make the measurement on a Black Box level for the eNB it should be measured on IP level (i.e. volume part in throughput measurement shall be IP volume).

The measurements shall be defined so that impact of file size is excluded.

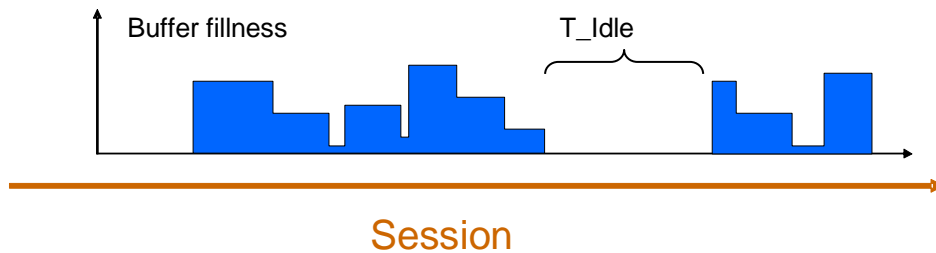
E.g. Current speed allows maximum 1 500 B per TTI:

- 1) Transfer time for 1 500 Byte is then 1 TTI.
- 2) Transfer time for 1 501 Byte is then 2 TTIs.

Hence the measurement can be size dependent, unless care is taken, even if the service is the same in both cases. Hence a method to exclude this is required.

The measurement shall be defined so that impact of burstyness on incoming data flow is excluded (i.e. time when the eNodeB does not have anything to transmit shall not be included in any calculations, see T\_Idle in figure below).





The measurements shall be defined so that impact of transport network problems are excluded (from the eNodeB this will just look like a bursty application since the transport network is not dimensioned to continuously fill the radio interface).

The measurements shall be defined so that impact from methods used to reduce the rate of the packet flow to the eNB, e.g. Rate Policing in the Core Network, is excluded (from the eNodeB this will just look like a bursty application since the incoming user plane data will not come often enough to continuously fill the radio interface).

If methods to reduce the rate of the packet flow are performed by the eNB, e.g. rate shaping, it shall be possible to see this in the Throughput KPI. These samples shall be possible to filter out from the other “non rate shaped” samples.

The KPI shall be available per QoS group

### 5.3.1.3 Use case description

When a service is used it is important that the quality of the service is acceptable. E.g. for non-GBR services, one of the important integrity measurements is Throughput.

If an integrity measurement is not considered OK, then the network operator can investigate which steps that are required to improve the quality provided to their customers.

This measurement should be used for observing the impact of E-UTRAN on end-users service integrity.

## 5.3.2 E-UTRAN IP Latency

### 5.3.2.1 Business level requirements

If an end user often experiences low quality during use of a service, the end-user might change wireless subscription provider, i.e. loss of income for the network operator.

Hence to have a good integrity of the services is important from a business point of view. This measurement assists the network operator with information about the integrity provided to their customers.

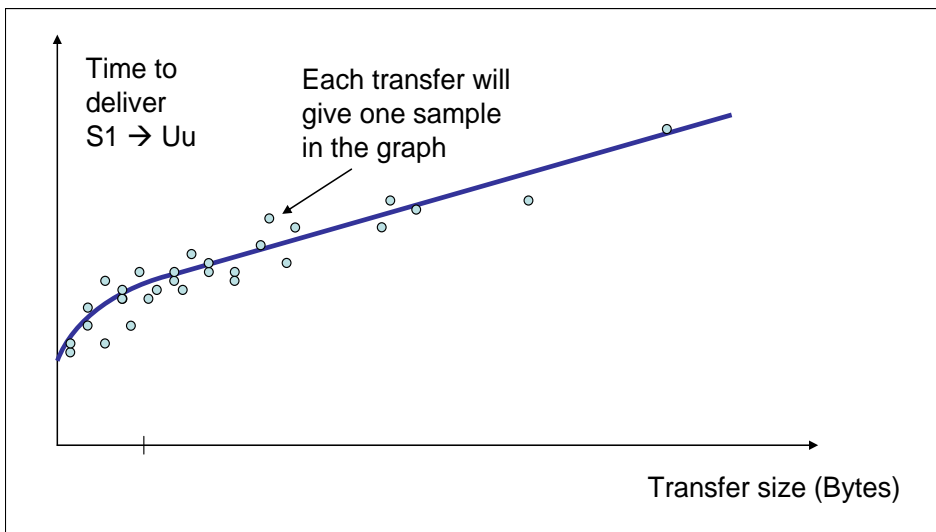
### 5.3.2.2 Specification level requirements

The integrity of an end-user application covers a wider area than just the E-UTRAN part. Hence it is important to realize that a KPI for this in E-UTRAN shall be limited to the parts that E-UTRAN has control of, i.e. the E-UTRAN KPI shall be defined so that it indicates the E-UTRAN contribution to the end-user impact, NOT attempt to take responsibility of the whole end-to-end part of service integrity.

The service provided by E-UTRAN for this KPI shall be delivery of IP packets.

To make the measurement on a Black Box level for the eNB it should be measured on IP level (i.e. volume time start to elaps when IP packet is received)

For Latency it can be dependent on packet size of the measured sample. E.g. a 10 Byte packet is delivered faster than a 1500 Byte packet. Hence a method to exclude packet size is wanted.



Hence, the measurement can be size dependent, unless care is taken, even if the performance of the eNodeB is the same in both cases. A method to exclude this is required.

The KPI shall be available per QoS group.

### 5.3.2.3 Use case description

When a service is used it is important that the quality of the service is acceptable. For e.g. non-GBR services one of the important integrity measurements is Latency.

If an integrity measurement is not considered OK, then the network operator can investigate which steps that are required to improve the quality provided to their customers.

This measurement should be used for observing the impact of E-UTRAN on end-users service integrity.

## 5.4 KPI Category “Availability”

### 5.4.1 E-UTRAN Cell Availability

#### 5.4.1.1 Business level requirements

If the radio network is not available to the end users it is hard to charge for the service. Also if it happens often that there is no availability, the end-user might change wireless subscription provider, i.e. loss of income for the operator.

Hence, to have a good availability of the radio network is important from a business point of view. This measurement assists the operator with information about the availability in their radio network.

#### 5.4.1.2 Specification level requirements

It shall be possible to measure the percentage of time that the wireless service is considered available for end-users in a cell. If measured on larger area than cell, then the cell values can be aggregated to e.g. network level.

As for defining the E-UTRAN Cell Availability, it shall be considered available when the eNB can provide any kind of service (E-RABs between UE and Core Network) in the area.

#### 5.4.1.3 Use case description

In providing end-user services to wireless end-users, the first step is to make it possible for the end-user to access the wireless service, i.e. to make the radio network available for the end-users.

If an availability measurement is not considered OK, then the network operator can investigate which steps that are required to improve the availability towards their services.

Note that the quality of the service provided is covered in Integrity and the possibility to access to a service is covered in Accessibility.

This measurement should be used for observing the E-UTRAN availability.

## 5.5 KPI Category "Mobility"

### 5.5.1 E-UTRAN Mobility

#### 5.5.1.1 Business level requirements

If an end user is interrupted often during use of a service or the service is aborted during use, the time the service is not provided could be hard to charge for. Also if it happens often that an end-user is interrupted or aborted at service use it might change wireless subscription provider, i.e. loss of income for the operator.

Hence, to have a good retainability of the services is important from a business point of view.

#### 5.5.1.2 Specification level requirements

It shall be possible to measure the handover success rate in E-UTRAN. The measurements shall be available to map towards end-user services. The measurement shall include both Intra E-UTRAN and Inter RAT handovers. The measurement shall be available on cell level.

The measurement shall include both the preparation and execution phase of Handovers.

"Entering preparation phase" is defined as the point of time when the source eNB attempts to prepare resources for an UE in a neighboring cell.

"Success of execution phase" is defined as the point of time when the source eNB receives information that the UE successfully is connected to the target cell.

#### 5.5.1.3 Use case description

When a service is used it is important that it is not interrupted or aborted. One of the fault cases in a radio system for this is handovers/mobility.

If a mobility measurement is not considered OK, then the network operator can investigate which steps that are required to improve the mobility towards their services.

This measurement should be used for observing the impact of mobility in E-UTRAN on end-users.

## 5.6 KPI Category "Energy Efficiency"

### 5.6.1 E-UTRAN data Energy Efficiency

#### 5.6.1.1 Business level requirements

Being able to measure the data energy efficiency of E-UTRAN is key for mobile network operators willing to control their OPEX and, in particular, their network energy OPEX. This measurement assists mobile network operators in that effort.

### 5.6.1.2 Specification level requirements

Mobile Network data Energy Efficiency ( $EE_{MN,DV}$ ) is the ratio between the performance indicator ( $DV_{MN}$ ) and the energy consumption ( $EC_{MN}$ ) when assessed during the same time frame, see ETSI ES 203 228 [3] clause 5.3 Mobile Network Energy efficiency metrics.

$$EE_{MN,DV} = \frac{DV_{MN}}{EC_{MN}}$$

where  $EE_{MN,DV}$  is expressed in bit/J.

For packet switched services, the  $DV_{MN}$  shall be measured using network counters for data volume related to the aggregated traffic in the set of base stations considered in the E-UTRAN under test. These measurements value (in kb/s) shall be multiplied by the time duration of the measurement T (in sec) to obtain the data volume  $DV_{MN}$  in kbits.  $DV_{MN}$  includes only the payload data volumes for DL and UL.

In case of RAN sharing, these measurements cannot be obtained on a per Participating Operator basis.

### 5.6.1.3 Use case description

Assessment of data energy efficiency in mobile access networks is very important for operators.

If a data energy efficiency measurement is not considered OK, then the operator can investigate which steps that are required to improve the data energy efficiency in the mobile access networks.

This measurement should be used for observing the impact of E-UTRAN on data energy efficiency of mobile access networks.

## Annex A (informative): Change history

| Change history |       |           |      |     |  |        |        |
|----------------|-------|-----------|------|-----|--|--------|--------|
| Date           | TSG # | TSG Doc.  | CR   | Rev | Subject/Comment                                  | Old    | New    |
| Dec 2008       | SP-42 | SP-080720 |      |     | Presentation to SA for information               | 0.3.0  | 1.0.0  |
| Mar 2009       | SP-43 | SP-090066 | --   | --  | Presentation to SA for approval                  | 2.0.0  | 8.0.0  |
| Dec 2009       | -     | -         | -    | -   | Update to Rel-9 version                          | 8.0.0  | 9.0.0  |
| 2011-03        | -     | -         | -    | -   | Update to Rel-10 version (MCC)                   | 9.0.0  | 10.0.0 |
| 2012-09        | -     | -         | -    | -   | Update to Rel-11 version (MCC)                   | 10.0.0 | 11.0.0 |
| 2014-10        | -     | -         | -    | -   | Update to Rel-12 version (MCC)                   | 11.0.0 | 12.0.0 |
| 2016-01        | -     | -         | -    | -   | Update to Rel-13 version (MCC)                   | 12.0.0 | 13.0.0 |
| 2017-04        | SA#75 | -         | -    | -   | Promotion to Release 14 without technical change | 13.0.0 | 14.0.0 |
| 2018-06        | -     | -         | -    | -   | Update to Rel-15 version (MCC)                   | 14.0.0 | 15.0.0 |
| 2018-12        | SA#82 | SP-181039 | 0005 | 1   | Add missing energy efficiency KPI for E-UTRAN    | 15.0.0 | 15.1.0 |

| Change history |         |           |      |     |     |  |             |
|----------------|---------|-----------|------|-----|-----|--|-------------|
| Date           | Meeting | TDoc      | CR   | Rev | Cat | Subject/Comment  | New version |
| 2019-09        | SA#85   | SP-190747 | 0006 | 1   | B   | Add new specifications level requirement related to extended monitoring of the retainability for the QCI1 services | 16.0.0      |
| 2022-04        | -       | -         | -    | -   | -   | Update to Rel-17 version (MCC)   | 17.0.0      |