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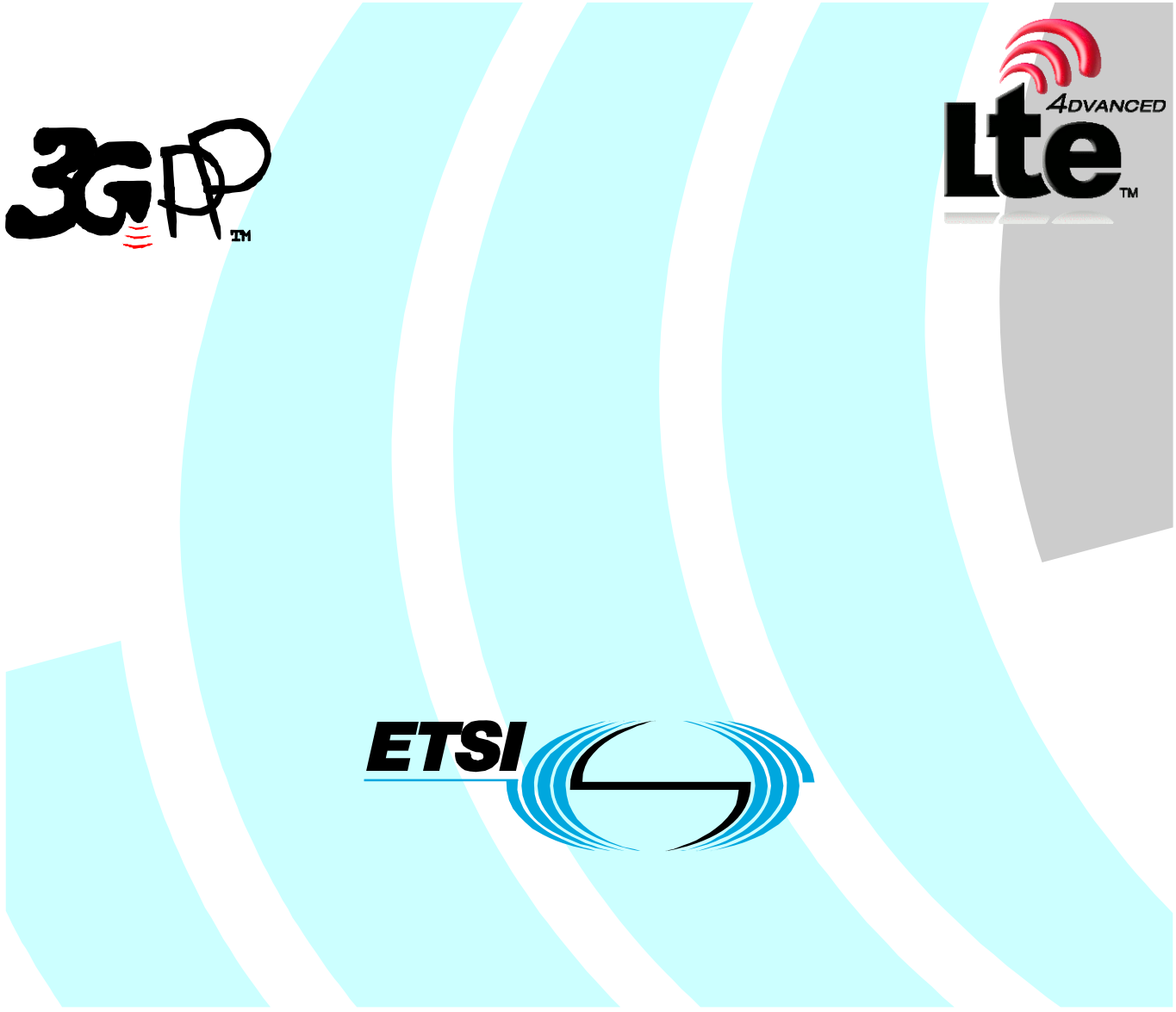
Technical Specification

LTE;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Layer 2 - Measurements
(3GPP TS 36.314 version 10.0.0 Release 10)



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Foreword

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

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Contents

Foreword

This Technical Specification has been produced by the 3rd 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.

1 Scope

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

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 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification ".

[3] 3GPP TS 36.322: "Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Link Control (RLC) protocol specification".

[4] 3GPP TS 36.323: "Evolved Universal Terrestrial Radio Access (E-UTRA); Packet Data Convergence Protocol (PDCP) specification".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions 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 Symbols

For the purposes of the present document, symbols apply locally in the subclause where they are defined.

3.3 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].

BCCH	Broadcast Control Channel
DRB	Data Radio bearer
DCCH	Dedicated Control Channel
DTCH	Dediicated Traffic Channel
HARQ	Hybrid Acknowledge Request
PCCH	Paging Control Channel
PRB	Physical Resource Block

QCI	Quality of service Class Identifier.
SRB	Signalling Radio Bearer.
TTI	Time Transmission Interval

4 Layer 2 measurements

4.1 E-UTRAN measurements

4.1.1 PRB usage

The objective of the PRB usage measurements is to measure usage of time and frequency resources. A use case is cell load balancing, where PRB usage is used for information signalled across the X2 interface. Another use-case is OAM performance observability.

4.1.1.1 Total PRB usage

Protocol Layer: MAC

Definition	Total PRB usage is calculated in the time-frequency domain only. The reference point is the Service Access Point between MAC and L1. The measurement is done separately for: - DL - UL Detailed Definitions: $M(T) = \left\lfloor \frac{M1(T)}{P(T)} * 100 \right\rfloor$, where explanations can be found in the table 4.1.1.1-1 below.

Table 4.1.1.1-1

$M(T)$	Total PRB usage. Percentage of PRBs used, averaged during time period T. Value range: 0-100%
$M1(T)$	A count of full physical resource blocks. For the DL, all PRBs used for transmission shall be included. For the UL, all PRBs allocated for transmission shall be included.
$P(T)$	Total number of PRBs available during time period T.
T	The time period during which the measurement is performed.

4.1.1.2 PRB usage per traffic class

Protocol Layer: MAC

Definition	PRB usage per traffic class. This measurement is an aggregate for all UEs in a cell, and is applicable to Dedicated Traffic Channels (DTCH). The reference point is the Service Access Point between MAC and L1. The measurement is done separately for: - DL DTCH, for each QCI. - UL DTCH, for each QCI Detailed Definitions: $M1(qci,T) = \sum_{\forall t} \sum_{\forall p \in S(t)} \frac{1}{W(p)} * X(t) * \frac{B(t,qci)}{B(t)}$, where explanations can be found in the table 4.1.1.2-1 below. $M(qci) = \left\lfloor \frac{M1(qci,T)}{P(T)} * 100 \right\rfloor$, where explanations can be found in the table 4.1.1.2-2 below.

Table 4.1.1.2-1

$M1(qci,T)$	Absolute PRB usage per traffic class. A count of full or partial physical resource blocks.
T	The time period during which the measurement is performed (in TTIs)
t	A transport block in time period T that contain DTCH data. Initial transmissions and HARQ retransmissions shall be counted.
$S(t)$	The set of physical resource blocks used for transmission of transport block t.
$W(p)$	The number of transport blocks that are currently sharing PRB p.
$B(t,qci)$	The total number of DTCH bits for DTCHs with QCI = qci, carried in transport block t
$B(t)$	The total number of DTCH and DCCH bits carried in transport block t.
$X(t)$	If multiplexing is taken into account: $X(t)=1$ always. If multiplexing is not taken into account: $X(t)=1$ if transport block t carries data corresponding to only one QCI and: $X(t)=0$ otherwise. It is up to implementation if to take multiplexing into account or not.

Table 4.1.1.2-2

$M(qci)$	PRB usage per traffic class. Percentage of PRBs used for a certain qci, averaged during time period T. Value range: 0-100%
$P(T)$	Total number of PRBs available during time period T.

4.1.1.3 Void

4.1.1.4 Void

4.1.1.5 Void

4.1.2 Received Random Access Preambles

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

Protocol Layer: MAC

Definition	Received Random Access Preambles. 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].

4.1.3 Number of active UEs

The objective of the measurement is to measure number of active UEs per QCI for OAM performance observability. 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.

4.1.3.1 Number of Active UEs in the DL per QCI

Protocol Layer: MAC, RLC, PDCP

Definition	Number of Active UEs in the DL per QCI. This measurement refers to UEs for which there is buffered data for the DL for DRBs. The measurement is done separately per QCI. Detailed Definition: $M(T,qci,p)=\left\lfloor \frac{\sum_{\forall i} N(i,qci)}{I(T,p)} \right\rfloor$,where explanations can be found in the table 4.1.3.1-1 below.

Table 4.1.3.1-1

$M(T,qci,p)$	Number of Active UEs in the DL per QCI, averaged during time period T. Unit: Integer.
$N(i,qci)$	Number of UEs for which there is buffered data for the DL in MAC, RLC or PDCP protocol layers for a Data Radio Bearer of traffic class with QCI = qci at sampling occasion i. In RLC and PDCP layers, buffered data corresponds to *data available for transmission* according to the definitions in TS 36.322 and TS 36.323. Buffered data 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.

4.1.3.2 Number of Active UEs in the UL per QCI

Protocol Layer: MAC

Definition	Number of Active UEs in the UL per QCI. This measurement refers to UEs for which there is buffered data for the UL for DRBs. The measurement is done separately per QCI. Detailed Definition: $M(T,qci,p)=\left\lfloor \frac{\sum_{\forall i} N(i,qci)}{I(T,p)} \right\rfloor$ where explanations can be found in the table 4.1.3.2-1 below.

NOTE: For this measurement, the expected accuracy is dependent on application scenario, cell load UE configuration and how DRBs are distributed over logical channel groups.

Table 4.1.3.2-1

$M(T,qci,p)$	Number of Active UEs in the UL per QCI, averaged during time period T. Unit: Integer.
$N(i,qci)$	Number of UEs for which there is buffered data for the UL in MAC, RLC or PDCP protocol layers for a Data Radio Bearer of traffic class with QCI = qci at sampling occasion. i This is a Node B estimation that is expected to be based on Buffer Status Reporting, provided semi-persistent grants and progress of ongoing HARQ transmissions (by including buffered data for which HARQ transmission has not yet terminated in buffered data). In addition, the eNB can use the analysis of received data in the estimation. In such case, when QCI cannot be determined at the time of the sampling occasion, eNB can determine QCI after successful reception of data.
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.

4.1.4 Packet Delay

4.1.4.1 Packet Delay in the DL per QCI

The objective of this measurement is to measure L2 Packet Delay for OAM performance observability.

Protocol Layer: MAC, RLC, PDCP

Definition	Packet Delay in the DL per QCI. This measurement refers to packet delay for DRBs. For arrival of packets the reference point is PDCP upper SAP. For successful reception the reference point is MAC lower SAP. The measurement is done separately per QCI. Detailed Definition: $M(T,qci) = \left\lfloor \frac{\sum_{\forall i} tAck(i) - tArriv(i)}{I(T)} \right\rfloor$,where explanations can be found in the table 4.1.4.1-1 below.

Table 4.1.4.1-1

$M(T,qci)$	Packet Delay in the DL per QCI, averaged during time period T. Unit: Integer ms.
$tArriv(i)$	The point in time when PDCP SDU i arrives.
$tAck(i)$	The point in time when the last piece of PDCP SDU *i* was received by the UE according to received HARQ feedback information.
i	A PDCP SDU that arrives at the PDCP upper SAP during time period T. PDCP SDU for which HARQ acknowledgement is not received for all parts shall not be included in the calculation.
$I(T)$	Total number of PDCP SDUs i.
T	Time Period during which the measurement is performed

4.1.5 Data Loss

4.1.5.1 Packet Discard Rate in the DL per QCI

The objective of this measurement is to measure packets that are dropped due to congestion, traffic management etc, for OAM performance observability.

Protocol Layer: MAC, RLC, PDCP

Definition	Packet Discard Rate in the DL per QCI. This measurement refers to discard for DRBs. One packet corresponds to one PDCP SDU. The reference point is PDCP upper SAP. The measurement is done separately per QCI. Detailed Definition: $M(T,qci) = \left\lfloor \frac{Ddisc(T,qci) * 1000000}{N(T,qci)} \right\rfloor$,where explanations can be found in the table 4.1.5.1-1 below.

NOTE: Packet loss is expected to be small or very small The statistical accuracy of an individual discard rate measurement result is dependent on how many packets has been received, and thus the time for the measurement.

Table 4.1.5.1-1

$M(T,qci)$	Packet Discard Rate in the DL per QCI, averaged during time period T. Unit: number of discarded packets per received packets * 10^6, Integer.
$Ddisc(T,qci)$	Number of DL packets, for which no part has been transmitted over the air, of a data radio bearer with QCI = qci , that are discarded during time period T in the PDCP, RLC or MAC layers due to reasons other than hand-over.
$N(T,qci)$	Number of DL packets of bearer with QCI = qci that has entered PDCP upper SAP during time period T (NOTE).
T	Time Period during which the measurement is performed, Unit: minutes (NOTE).

4.1.5.2 Packet Uu Loss Rate in the DL per QCI

The objective of this measurement is to measure packets that are lost at Uu transmission, for OAM performance observability.

Protocol Layer: MAC, RLC, PDCP

Definition	Packet Uu Loss Rate in the DL per QCI. This measurement refers to packet loss for DRBs. One packet corresponds to one PDCP SDU. The measurement is done separately per QCI. Detailed Definition: $M(T,qci) = \left\lfloor \frac{Dloss(T,qci) * 1000000}{N(T,qci) + Dloss(T,qci)} \right\rfloor$, where explanations can be found in the table 4.1.5.2-1 below.

NOTE: Packet loss is expected to be upper bounded by the PELR of the QCI which takes values between 10^{-6} and 10^{-2}. The statistical accuracy of an individual packet loss rate measurement result is dependent on how many packets have been received, and thus the time for the measurement.

Table 4.1.5.2-1

$M(T,qci)$	Packet Uu Loss Rate in the DL per QCI. Unit: number of lost packets per transmitted packets * 10^6, Integer.
$Dloss(T,qci)$	Number of DL packets, of a data radio bearer with QCI = qci, 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.
$N(T,qci)$	Number of DL packets, of a data radio bearer with QCI = qci, which has been transmitted over the air and positively acknowledged during time period T.
T	Time Period during which the measurement is performed, Unit: minutes (NOTE).

4.1.5.3 Packet Loss Rate in the UL per QCI

The objective of this measurement is to measure packets that are lost in the UL, for OAM performance observability.

Protocol Layer: PDCP

Definition	Packet Loss Rate in the UL per QCI. This measurement refers to packet loss for DRBs. One packet corresponds to one PDCP SDU. Reference point is the PDCP upper SAP. The measurement is done separately per QCI. Detailed Definition: $M(T,qci) = \left\lfloor \frac{Dloss(T,qci) * 1000000}{N(T,qci)} \right\rfloor$, where explanations can be found in the table 4.1.5.3-1 below.

NOTE: Packet loss is expected to be upper bounded by the PELR of the QCI which takes values between 10^{-6} and 10^{-2}. The statistical accuracy of an individual packet loss rate measurement result is dependent on how many packets have been received, and thus the time for the measurement.

Table 4.1.5.3-1

$M(T,qci)$	Packet Loss Rate in the UL per QCI. Unit: number of lost packets per transmitted packets * 10^6, Integer.
$Dloss(T,qci)$	Number of missing UL PDCP sequence numbers, representing packets that are not delivered to higher layers, of a data radio bearer with QCI = qci during time period T. If transmission of a packet might continue in another cell, it shall not be included in this count.
$N(T,qci)$	Total number of UL PDCP sequence numbers (also including missing sequence numbers) of a bearer with QCI = qci, starting from the sequence number of the first packet delivered by PDCP upper SAP to higher layers until the sequence number of the last packet during time period T.
T	Time Period during which the measurement is performed, Unit: minutes (NOTE).

4.1.6 Scheduled IP Throughput

The objective of this measurement is to measure over Uu the IP throughput independent of traffic patterns and packet size. This measurement is mainly intended for data bursts that are large enough to require transmissions to be split across multiple TTIs. The measurement is performed per QCI per UE. Initial buffering time in UE or eNB is excluded.

4.1.6.1 Scheduled IP Throughput in DL

Protocol Layer: PDCP, RLC, MAC

Definition	Scheduled IP Thoughput in DL. Throughput of PDCP SDU bits in downlink for packet sizes or data bursts that are large enough to require transmissions to be split across several TTIs, by excluding transmission of the last piece of data in a data burst. Only data transmission time is considered, i.e. when data transmission over Uu has begun but not yet finished. Each measurement is a real value representing the throughput in kbits/s. The measurement is performed per QCI per UE. For successful reception, the reference point is MAC upper SAP. This measurement is obtained by the following formula for a measurement period: $\text{If} \sum \text{ThpTimeDl} > 0, \ \frac{\sum \text{ThpVolDl}}{\sum \text{ThpTimeDl}} \text{x} 1000 [\text{kbits/s}]$, where $\text{If} \sum \text{ThpTimeDl} = 0, \ \ 0 \ [\text{kbits/s}]$ For small data bursts, where all buffered data is included in one initial HARQ transmission, $ThpTimeDl = 0$, otherwise $ThpTimeDl = T1 - T2 \ [ms]$ Explanations of the parameters can be found in the table 4.1.6.1-1 below.

Table 4.1.6.1-1

$ThpTimeDl$	The time to transmit a data burst excluding the last piece of data transmitted in the TTI when the buffer is emptied. A sample of 'ThpTimeDl' for each time the DL buffer for one E-RAB is emptied.
$T1$	The point in time after T2 when data up until the second last piece of data in the transmitted data burst which emptied the PDCP SDU available for transmission for the particular E-RAB was successfully transmitted, as acknowledged by the UE.
$T2$	The point in time when the first transmission begins after a PDCP SDU becomes available for transmission, where previously no PDCP SDUs were available for transmission for the particular E-RAB.
$ThpVolDl$	The volume of a data burst, excluding the data transmitted in the TTI when the buffer is emptied. A sample for ThpVolDl is the data volume, counted on PDCP SDU level, in kbits successfully transmitted (acknowledged by UE) in DL for one E-RAB during a sample of ThpTimeDl. It shall exclude the volume of the last piece of data emptying the buffer.

4.1.6.2 Scheduled IP Throughput in UL

Protocol Layer: PDCP, RLC, MAC

Definition	Scheduled IP Throughput in UL. eNB estimate of the throughput of PDCP SDU bits in uplink for packet sizes or data bursts (where a UL data burst is the collective data received while the eNB estimate of the UE buffer size is continuously above zero) that are large enough to require transmissions to be split across several TTIs, by excluding transmission of the last piece of data. Only data transmission time is considered, i.e. when data transmission over Uu has begun but not yet finished. Each measurement is a real value representing the throughput in kbits/s. The measurement is performed per QCI per UE. For successful reception, the reference point is MAC upper SAP. This measurement is obtained by the following formula for a measurement period: $\text{If} \sum \text{ThpTimeUl} > 0, \ \frac{\sum \text{ThpVolUl}}{\sum \text{ThpTimeUl}} \text{x} 1000 [\text{kbits/s}]$, where $\text{If} \sum \text{ThpTimeUl} = 0, \ \ 0 \ [\text{kbits/s}]$ For small data bursts, where all buffered data is included in one initial HARQ transmission $ThpTimeUl = 0$ otherwise : $ThpTimeUl = T1 - T2 \ [ms]$ Explanations of the parameters can be found in the table 4.1.6.2-1 below.

Table 4.1.6.2-1

$ThpTimeUl$	The time to transmit a data burst excluding the data transmitted in the TTI when the buffer is emptied. A sample of 'ThpTimeUl' for each time the UL buffer for one E-RAB 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 E-RAB
$T2$	The point in time when transmission is started for the the first data in data burst for a particular E-RAB.
$ThpVolUl$	The volume of a data burst, excluding the data transmitted in the TTI when the buffer is emptied. A sample for ThpVolUl is the data volume counted on PDCP SDU level in kbits received in UL for one E-RAB during a sample of ThpTimeUl, (It shall exclude the volume of the last piece of data emptying the buffer).

Annex A (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2008-12	RP-42	RP-081034	-	-	v1.0.0 was approved as v8.0.0 and put under CR control	1.0.0	8.0.0
2009-01					Keywords added, white space trimmed, file properties set	8.0.0	8.0.1
2009-03	RP-43	RP-090127	0001	-	Packet Loss Rate Measurements	8.0.1	8.1.0
	RP-43	RP-090127	0002	1	36.314 Rapporteur Updates	8.0.1	8.1.0
	RP-43	RP-090127	0003	1	Correction to the definition of the Number of active UEs per QCI	8.0.1	8.1.0
	RP-43	RP-090127	0004	-	Correction to the sampling of number of active Ues	8.0.1	8.1.0
	RP-43	RP-090127	0005	-	Inclusion of SRB0 for PRB usage for SRB	8.0.1	8.1.0
	RP-43	RP-090127	0007	-	Total PRB Usage Detail Definition	8.0.1	8.1.0
2009-06	RP-44	RP-090512	0009	-	Removal of measurements not reflected in interface specifications	8.1.0	8.2.0
	RP-44	RP-090512	0010	-	Correction to the minimum measurement time for data loss measurements	8.1.0	8.2.0
	RP-44	RP-090512	0011	-	Correction to the definition of PDCP SDU Delay measurement	8.1.0	8.2.0
2009-12	RP-46	RP-091314	0019	-	CR on the PRB usage per traffic class taking multiple antenna transmission into account	8.2.0	8.3.0
2009-12	RP-46	-	-	-	Upgrade to the Release 9 - no technical change	8.3.0	9.0.0
2010-06	RP-48	RP-100556	0020	-	Throughput Measurement	9.0.0	9.1.0
2010-12	RP-50	-	-	-	Upgrade to Release 10 - no technical change	9.1.0	10.0.0

History

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