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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 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

Intellectual Property Rights....2
Legal Notice....2
Modal verbs terminology....2
Foreword....5
1 Scope....6
2 References....6
3 Definitions, symbols and abbreviations....7
3.1 Definitions....7
3.2 Symbols....7
3.3 Abbreviations....7
4 Control of UE/E-UTRAN measurements....7
5 Measurement capabilities for E-UTRA....8
5.1 UE measurement capabilities....8
5.1.1 Reference Signal Received Power (RSRP)....9
5.1.2 Void....9
5.1.3 Reference Signal Received Quality (RSRQ)....10
5.1.4 UTRA FDD CPICH RSCP....10
5.1.5 UTRA FDD carrier RSSI....10
5.1.6 UTRA FDD CPICH Ec/No....11
5.1.7 GSM carrier RSSI....11
5.1.8 Void....11
5.1.9 UTRA TDD P-CCPCH RSCP....11
5.1.10 CDMA2000 1x RTT Pilot Strength....11
5.1.11 CDMA2000 HRPD Pilot Strength....11
5.1.12 Reference signal time difference (RSTD)....12
5.1.13 UE GNSS Timing of Cell Frames for UE positioning....12
5.1.14 UE GNSS code measurements....12
5.1.14A UE GNSS carrier phase measurements....12
5.1.15 UE Rx – Tx time difference....13
5.1.16 IEEE 802.11 WLAN RSSI....13
5.1.17 MBSFN Reference Signal Received Power (MBSFN RSRP)....13
5.1.18 MBSFN Reference Signal Received Quality (MBSFN RSRQ)....14
5.1.19 Multicast Channel Block Error Rate (MCH BLER)....14
5.1.20 CSI Reference Signal Received Power (CSI-RSRP)....14
5.1.21 Sidelink Reference Signal Received Power (S-RSRP)....15
5.1.22 Sidelink Discovery Reference Signal Received Power (SD-RSRP)....15
5.1.23 Reference signal-signal to noise and interference ratio (RS-SINR)....16
5.1.24 Received Signal Strength Indicator (RSSI)....16
5.1.25 SFN and subframe timing difference (SSTD)....17
5.1.26 Narrowband Reference Signal Received Power (NRSRP)....17
5.1.27 Narrowband Reference Signal Received Quality (NRSRQ)....18
5.1.28 Sidelink Received Signal Strength Indicator (S-RSSI)....18
5.1.29 PSSCH Reference Signal Received Power (PSSCH-RSRP)....18
5.1.30 Channel busy ratio (CBR)....19
5.1.31 Channel occupancy ratio (CR)....19
5.1.32 NR SS reference signal received power (NR-SS-RSRP)....20
5.1.33 NR SS reference signal received quality (NR-SS-RSRQ)....21
5.1.34 SFN and frame timing difference (SFTD)....22
5.1.35 NR SS signal-to-noise and interference ratio (NR-SS-SINR)....22
5.2 E-UTRAN measurement abilities....22
5.2.1 DL RS TX power....23
5.2.2 Received Interference Power....23
5.2.3 Thermal noise power....23

5.2.4 Timing advance (T_{ADV}) 23
5.2.5 eNB Rx – Tx time difference 24
5.2.6 E-UTRAN GNSS Timing of Cell Frames for UE positioning 24
5.2.7 Angle of Arrival (AoA) 24
5.2.8 UL Relative Time of Arrival ($T_{UL-RTOA}$) 24

Annex A (informative): Change history 25

History 27

Foreword

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1 Scope

The present document contains the description and definition of the measurements done at the UE and network in order to support operation in idle mode and connected mode.

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 36.201: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Layer – General Description ".

[3] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation".

[4] 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding ".

[5] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures ".

[6] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification".

[7] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification ".

[8] 3GPP2 CS.0005-D v1.0 "Upper Layer (Layer 3) Signaling Standard for CDMA2000 Spread Spectrum Systems Release D".

[9] 3GPP2 CS.0024-A v3.0 "cdma2000 High Rate Packet Data Air Interface Specification"

[10] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception ".

[11] 3GPP TS 36.355: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)"

[12] 3GPP TS 36.455: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol A (LPPa)"

[13] 3GPP TS 36.459: "Evolved Universal Terrestrial Radio Access (E-UTRA); SLm Application Protocol (SLmAP)"

[14] 3GPP TS 36.111: "Evolved Universal Terrestrial Radio Access (E-UTRA); Location Measurement Unit (LMU) performance specification; Network Based Positioning Systems in E-UTRAN"

[15] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std.".

[16] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode ".

[17] 3GPP TS 38.213: "NR; Physical layer procedures for control".

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, the following symbols apply:

Ec/No Received energy per chip divided by the power density in the band

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].

1x RTT	CDMA2000 1x Radio Transmission Technology
CPICH	Common Pilot Channel
E-SMLC	Enhanced Serving Mobile Location Centre
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN
FDD	Frequency Division Duplex
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile communication
HRPD	CDMA2000 High Rate Packet Data
LMU	Location Measurement Unit
P-CCPCH	Primary Common Control Physical Channel
RSCP	Received Signal Code Power
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSSI	Received Signal Strength Indicator
RSTD	Reference Signal Time Difference
SRS	Sounding Reference Signal
TDD	Time Division Duplex
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network

4 Control of UE/E-UTRAN measurements

In this chapter the general measurement control concept of the higher layers is briefly described to provide an understanding on how L1 measurements are initiated and controlled by higher layers.

With the measurement specifications L1 provides measurement capabilities for the UE and E-UTRAN. These measurements can be classified in different reported measurement types: intra-frequency, inter-frequency, inter-system, traffic volume, quality and UE internal measurements (see the RRC Protocol [7]).

In the L1 measurement definitions, see chapter 5, the measurements are categorised as measurements in the UE (the messages for these will be described in the MAC Protocol [6] or RRC Protocol [7] or LPP Protocol [11]) or measurements in the E-UTRAN (the messages for these will be described in the Frame Protocol or LPPa Protocol [12]).

To initiate a specific measurement, the E-UTRAN transmits a 'RRC connection reconfiguration message' to the UE including a measurement ID and type, a command (setup, modify, release), the measurement objects, the measurement quantity, the reporting quantities and the reporting criteria (periodical/event-triggered), see [7] or E-SMLC transmits an 'LPP Request Location Information message' to UE, see [11].

When the reporting criteria are fulfilled the UE shall answer with a 'measurement report message' to the E-UTRAN including the measurement ID and the results or an 'LPP Provide Location Information message' to the E-SMLC, see [11].

For idle mode, the measurement information elements are broadcast in the System Information.

5 Measurement capabilities for E-UTRA

In this chapter the physical layer measurements reported to higher layers are defined.

5.1 UE measurement capabilities

The structure of the table defining a UE measurement quantity is shown below.

Column field	Comment
Definition	Contains the definition of the measurement.
Applicable for	States in which state(s) it shall be possible to perform this measurement. The following terms are used in the tables: RRC_IDLE; RRC_CONNECTED; Intra-frequency appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an intra-frequency cell; Inter-frequency appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an inter-frequency cell Inter-RAT appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an inter-RAT cell.

5.1.1 Reference Signal Received Power (RSRP)

Definition	Reference signal received power (RSRP), is defined as the linear average over the power contributions (in [W]) of the resource elements that carry cell-specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 according to TS 36.211 [3] shall be used. If the UE can reliably detect that R_1 is available, it may use R_1 in addition to R_0 to determine RSRP. If higher layers indicate measurements based on discovery signals, the UE shall measure RSRP in the subframes in the configured discovery signal occasions. For frame structure 1 and 2, if the UE can reliably detect that cell-specific reference signals are present in other subframes, the UE may use those subframes in addition to determine RSRP. The reference point for the RSRP shall be the antenna connector of the UE. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding RSRP of any of the individual diversity branches.
Applicable for	RRC_IDLE intra-frequency, RRC_IDLE inter-frequency, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

NOTE 1: The number of resource elements within the considered measurement frequency bandwidth and within the measurement period that are used by the UE to determine RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.2 Void