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Universal Mobile Telecommunications System (UMTS);
LTE;
Universal Terrestrial Radio Access (UTRA)
and Evolved UTRA (E-UTRA);
User Equipment (UE) performance requirements
for RAT-Independent Positioning Enhancements
(3GPP TS 37.171 version 13.1.0 Release 13)

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Contents

Foreword

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

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1 Scope

The present document establishes the minimum performance requirements for RAT-Independent Positioning Enhancements (e.g. MBS positioning technology) for FDD or TDD mode of UTRA and E-UTRA for the User Equipment (UE).

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

[2] ETSI TR 102 273-1-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 1: Uncertainties in the measurement of mobile radio equipment characteristics; Sub-part 2: Examples and annexes".

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

[4] 3GPP TS 36.509: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Special conformance testing functions for User Equipment (UE)".

[5] 3GPP TS 36.942: Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios".

[6] 3GPP TS 25.331: "Radio Resource Control (RRC); Protocol specification".

[7] ATIS-0500027: "Recommendations for Establishing Wide Scale Indoor Location Performance", May 2015.

[8] 3GPP TS 34.109: "Terminal logical test interface; Special conformance testing functions ".

[9] 3GPP TS 37.571-1: "Universal Terrestrial Radio Access (UTRA) and Evolved UTRA (E-UTRA) and Evolved Packet Core (EPC); User Equipment (UE) conformance specification for UE positioning; Part 1: Conformance test specification ".

[10] 3GPP TS 36.521-1: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing ".

3 Definitions, abbreviations and test tolerances

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].

AWGN	Additive White Gaussian Noise
EPA	Extended Pedestrian A
E-UTRA	Evolved UMTS Terrestrial Radio Access
FDD	Frequency Division Duplex
LPP	LTE Positioning Protocol
MBS	Metropolitan Beacon System
RRC	Radio Resource Control
TDD	Time Division Duplex
UE	User Equipment
UTRA	UMTS Terrestrial Radio Access

3.3 Test tolerances

The requirements given in the present document make no allowance for measurement uncertainty. The test specification 3GPP TS 37.571 -1 [9] will define test tolerances. These test tolerances are individually calculated for each test. The test tolerances are then added to the limits in the present document to create test limits. The measurement results are compared against the test limits as defined by the shared risk principle.

Shared Risk is defined in ETSI TR 102 273-1-2 [2], subclause 6.5.

4 General

4.1 Introduction

The present document defines the minimum performance requirements for UEs that support RAT Independent positioning technologies.

4.2 MBS Measurements

4.2.1 General

Clause 4.2 describes the measurements performed by the UE for MBS positioning.

4.2.2 MBS measurement parameters

The measurement parameters are the MBS code phase measurements contained in the *TBS-MeasurementInformation* IE provided in the LPP message of type PROVIDE LOCATION INFORMATION [3] for LTE, and the *UE Positioning AddPos measured results* IE in the MEASUREMENT REPORT message for UTRA [6].

4.2.3 MBS Measurement time

For LTE, MBS measurement time is defined as the time starting from the moment that the UE has received the LPP message of type REQUEST LOCATION INFORMATION, and ending when the UE starts sending the LPP message of type PROVIDE LOCATION INFORMATION on the Uu interface. The response times specified for all test cases are based on new measurements unless otherwise stated, i.e. the UE shall not re use any information on measurements or other aiding data that was previously acquired or calculated and stored internally in the UE. A dedicated test message 'RESET UE POSITIONING STORED INFORMATION' has been defined in TS 36.509 [4] clause 6.9 for the purpose of deleting this information.

For UTRA, MBS measurement time is defined as the time starting from the moment that the UE has received the final RRC measurement control message containing reporting criteria different from "No Reporting" sent before the UE sends the measurement report containing the MBS measured results, and ending when the UE starts sending the measurement report containing the measured result on the Uu interface. The response times specified for all test cases are based on new measurements unless otherwise stated, i.e. the UE shall not re use any information on measurements or other aiding data that was previously acquired or calculated and stored internally in the UE. A dedicated test message 'RESET UE POSITIONING STORED INFORMATION' has been defined in TS 34.109 [8] clause 5.4 for the purpose of deleting this information.

The measurements for n MBS beacons, enabled across the slots of an MBS transmission period [7], shall be available at the UE by T_{MBS_meas}, where T_{MBS_meas} can be expressed as:

$$T_{MBS\_meas} = \tau + 10 \times ceil(n/10) \times T_{MBS\_TP} + T_{Proc} \quad \text{ms}$$

where

T_{MBS_meas} is the total time for detecting and measuring n beacons

τ is the elapsed time from the trigger of the measurement to the start of the first MBS transmission period

T_{MBS_TP} is the MBS transmission period (1 second)

T_{Proc} is the processing time, an upper-bound for which can be given as $10 \times ceil(n/10) \times T_{MBS\_slot}$ where T_{MBS_slot} is the duration of a MBS slot (100 ms) with continuous MBS transmissions

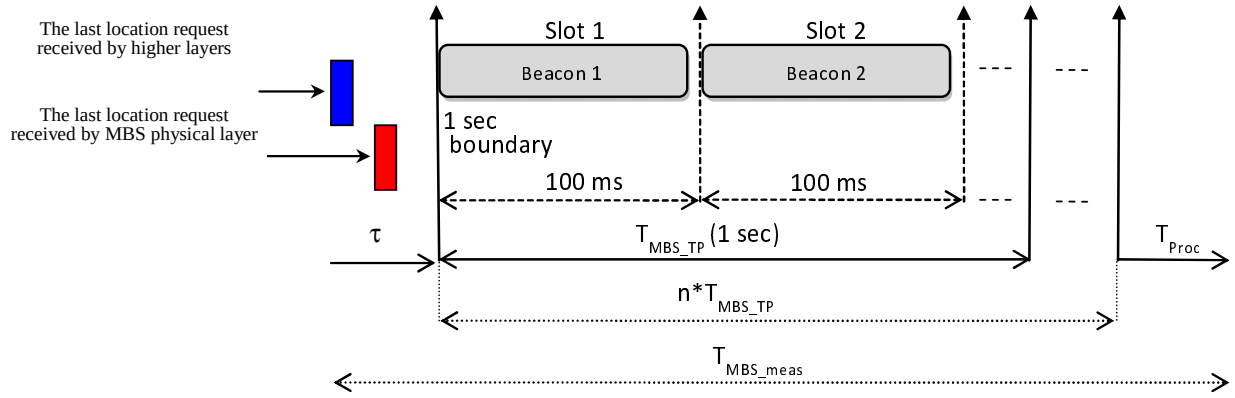

Figure 4.2.3-1: MBS Measurement Time

For this requirement, the assumption is that there is zero frequency offset for the beacons and the UEs have a minimum of 13 parallel correlators.

The test case requirements for MBS Measurement time can be found in clause A.3.

4.2.4 RRC states for MBS measurements

For LTE, the minimum MBS performance requirements are specified in clause 5 for RRC_CONNECTED state.

For UTRA, the minimum MBS performance requirements are specified in clause 5 for different RRC states that include Cell_DCH and Cell_FACH.

4.2.5 MBS Measurement Error Definitions

The code phase measurement error is defined as the difference between the actual code phase for a given MBS beacon, and the estimated code phase for that beacon, as reported in the LPP message of type PROVIDE LOCATION INFORMATION for LTE [3], and the *UE Positioning AddPos measured results* IE in the MEASUREMENT REPORT

message for UTRA [6]. This difference has to then be adjusted for the measurement bias introduced by the UE clock to provide the final code phase measurement error.

5 MBS minimum performance requirements

5.1 General

The minimum performance requirements specified in clause 5 apply for UEs that support MBS. This section applies to requirements for both for UTRA and E-UTRA.

The code phase accuracy requirements in this clause are statistical in nature and pertain to the 90th percentile of the distribution.

The measurement time for each requirement shall be T_{MBS_meas} as described in clause 4.2.3. This clause does not include nor consider delays occurring in the various signalling interfaces of the network.

5.2 Sensitivity

A Sensitivity requirement is essential for verifying the performance of MBS receiver in weak signal conditions. In order to test the most stringent signal levels for the beacons the Sensitivity test case is performed in AWGN channel. This test case verifies the UE MBS performance at the lowest expected signal levels.

In MBS deployments, target sensitivity levels of -130 dBm (at the UE antenna connector, across the signal bandwidth) are used.

The minimum requirements for Sensitivity are shown in Table 5.2-1.

Table 5.2-1: Requirements for Sensitivity

MBS Configuration	Signal Strength (dBm)	Code phase measurement accuracy (ms)
TB1 (2 MHz) [7]	-130	1.66×10^{-4}

The test case requirements for Sensitivity measurement accuracy can be found in clause A.4.2.

5.3 Nominal Accuracy

The Nominal Accuracy requirement verifies the UE MBS performance under ideal conditions. The primary aim of the test is to ensure good accuracy when the MBS signal conditions allow it.

In this requirement AWGN channel model is used and the signal level is above the noise floor.

The minimum requirements for Nominal are shown in Table 5.3-1.

Table 5.3-1: Requirements for Nominal Accuracy

MBS Configuration	Signal Strength (dBm)	Code phase measurement accuracy (ms)
TB1 (2 MHz) [7]	-30	5.0×10^{-5}

The test case requirements for Nominal measurement accuracy can be found in clause A.4.2.

5.4 Dynamic Range

The Dynamic Range requirement is targeted at testing the performance of the MBS receiver under time varying signal conditions. This test case is important for a system such as MBS where the time slotting of beacons is used.

The maximum signal level of a MBS beacon is expected to be -30 dBm (at the UE antenna connector). This can be shown theoretically by assuming a TX power of +40 dBm and a minimum coupling loss between the transmitter and the UE of 70 dB [5].

For this requirement, the power level of the MBS beacons shall be alternated between the strongest and the weakest expected levels across consecutive slots in the MBS transmission period.

The minimum requirements for Dynamic Range are shown in Table 5.4-1.

Table 5.4-1: Requirements for Dynamic Range

MBS Configuration	Signal Strength (dBm)	Code phase measurement accuracy (ms)
TB1 (2 MHz) [7]	-30	5.0×10^{-5}
	-130	1.66×10^{-4}

The test case requirements for Dynamic Range measurement accuracy can be found in clause A.4.2.

5.5 Multipath

The purpose of the test case is to verify the receiver's tolerance to multipath.

The pedestrian channel model used in TS 37.571-1 [9], captured in Annex B of TS 36.521-1 [10] is used for assessing the MBS performance under the multipath scenario, specifically the Extended Pedestrian A (EPA) with a maximum Doppler frequency of 5 Hz (EPA 5Hz).

The minimum requirements for the Multipath scenario are shown in Table 5.5-1.

Table 5.5-1: Requirements for Multipath scenario

MBS Configuration	Direct Path Signal Strength (dBm)	Code phase measurement accuracy (ms)
TB1 (2 MHz) [7]	-30	1.66×10^{-4}

The test case requirements for Multipath measurement accuracy can be found in clause A.4.3.

Annex A (normative): Test Case Requirements

A.1 Purpose of annex

This Annex specifies test specific parameters for some of the functional requirements in clause 5. The tests provide additional information to how the requirements should be interpreted for the purpose of conformance testing. The tests in this Annex are described such that one functional requirement may be tested in one or several test and one test may verify several requirements. Some requirements may lack a test.

The conformance tests are specified in clauses A.3 and A.4. Statistical interpretation of the requirements is described in clause A.2.

A.2 Requirement classification for statistical testing

Requirements in the present document are either expressed as absolute requirements with a single value stating the requirement, or expressed as a success rate. There are no provisions for the statistical variations that will occur when the parameter is tested.

Annex A outlines the tests in more detail and lists the test parameters needed. The test will result in an outcome of a test variable value for the device under test (DUT) inside or outside the test limit. Overall, the probability of a "good" DUT being inside the test limit(s) and the probability of a "bad" DUT being outside the test limit(s) should be as high as possible. For this reason, when selecting the test variable and the test limit(s), the statistical nature of the test is accounted for.

The statistical nature depends on the type of requirement. Some have large statistical variations, while others are not statistical in nature at all. When testing a parameter with a statistical nature, a confidence level is set. This establishes the probability that a DUT passing the test actually meets the requirements and determines how many times a test has to be repeated and what the pass and fail criteria are. Those aspects are not covered by TS 37.171. The details of the tests on how many times to run it and how to establish confidence in the tests are described in TS 37.571-1 [9]. This Annex establishes the variable to be used in the test and whether it can be viewed as statistical in nature or not.

A.3 UE Measurement Procedures

A.3.1 MBS Measurement reporting delay test case

A.3.1.1 Test Purpose and Environment

The purpose of the test is to verify that the MBS measurements meet the measurement time requirements specified in clause 4.2.3 in an environment with fading propagation conditions (EPA 5 Hz). This test can be used for both UTRA and E-UTRA testing.

In this test case there is one beacon transmitted in one beacon slots in the MBS beacon transmission period (see Figure 4.2.3-1). The position of the beacon in the beacon transmission period is static for the duration of the test. In other slots there are no simulated beacons. The beacon has centre frequency of 925.977 MHz. The beacon has transmitted signal strength of -30 dBm. The beacon is transmitted with code phase (delay) of 1.6678×10^{-4}ms, corresponding to 50 m.

The UE shall perform and report the MBS measurements for the beacon within 12000 ms, starting from the receipt of the location request.

NOTE: The MBS measurement time in the test is derived from the following expression: $T_{MBS\_meas} = \tau + 10 \times ceil(n/10) \times T_{MBS\_TP} + T_{Proc}$ ms, where n=1, τ is one second, T_{MBS_TP} is one second and T_{Proc} is one second.

The beacon is of type TB1 (2 MHz) specified in clause 9 of the MBS ICD [7] and the data transmitted is in Type 2 packets specified in clause 9.6.3 of the MBS ICD [7] with the following data fields: The MBS Transmitter ID and the Slot Index shall be set to the MBS slot number; All other beacon payload data shall be populated with zeros [7].

The beacon shall use a PN code chosen from the PN code list for TB1 [7].

Table A.3.1.1-1: General test parameters for measurement reporting delay

Parameter	Unit	Value	Comment
Centre Frequency	MHz	925.977	
RF Channel	N/A	EPA 5 Hz	
MBS Beacon Configuration	N/A	TB1 (2 MHz)	
MBS Data Packet Type	N/A	Type 2	
Beacon PN Code	Integer	Chosen from the PN code list for TB1	
Beacon transmitted Code Phase (delay)	ms	1.6678×10^{-4}	Corresponds to 50 m. Constant per beacon for the duration of the test.
Beacon Signal Strength	dBm	-30	

Table A.3.1.1-2: MBS Beacon Payload fields for measurement reporting delay

Parameter	Unit	Value	Comment
TxID	Integer	Equal to Slot number	
Slot Index	Integer	Equal to Slot number	
All other fields	N/A	0	

A.3.1.2 Test Requirements

The MBS measurement reporting delay shall fulfil the requirements in clause 4.2.3.

A.4 Measurement Performance Requirements

A.4.1 General

Unless explicitly stated otherwise:

- Reported measurements shall be within defined range of accuracy limits defined in clause 5 for at least 90 % of the reported cases. If multiple measurement performance requirements are verified in the same test, the reported measurements for each requirement shall be within defined range of accuracy limits of the corresponding requirement defined in clause 5 for at least 90% of the reported cases.

- Measurements are performed in RRC_CONNECTED state.

A.4.2 MBS Code Phase Measurement Accuracy Requirements in AWGN

A.4.2.1 Test Purpose and Environment

The purpose of this test is to verify that the MBS Code Phase measurement accuracy is within the specified limits. This single test will verify the requirements in clauses 5.2, 5.3 and 5.4 for MBS measurements. The channel type for this test is AWGN, as specified in the appropriate sub-clause of clause 5. This test can be used for both UTRA and E-UTRA testing.

In each test, there is one beacon transmitted in each of four consecutive beacon slots. The position of first of the four consecutive beacons in the beacon transmission period can be any slot, but it is static for the duration of the test. In other slots there are no simulated beacons. All beacons are in the same time slotted RF channel, with centre frequency of 925.977 MHz. All beacons are of type TB1 (2 MHz) [7] and the data transmitted is in Type 2 packets with the following data fields: The MBS Transmitter ID and the Slot Index shall be set to the MBS slot number; All other beacon payload data shall be populated with zeros.

In the four slots containing beacon transmissions, every other slot shall contain a beacon with the higher signal strength beacon, and the other slots shall contain a beacon with the lower signal strength.

The higher power beacons (-30 dBm) shall have code phase delay of 1.6678×10^{-4} ms (corresponding to 50 m) and the lower power beacons (-130 dBm) shall have code phase delay of 5.00346×10^{-3} ms (corresponding to 1500 m).

Each of the beacons shall use a unique PN code chosen from the PN code list for TB1 [7].

Table A.4.2.1-1: General test parameters for Code Phase measurement Accuracy

Parameter	Unit	Value	Comment
Centre Frequency	MHz	925.977	
RF Channel	N/A	AWGN	
MBS Beacon Configuration	N/A	TB1 (2 MHz)	
MBS Packet Type	N/A	Type 2	
Beacon PN Code	Integer	Chosen from the PN code list for TB1	
-30 dBm beacon transmitted Code Phase (delay)	ms	1.6678×10^{-4}	Corresponds to 50 m. Constant per beacon for the duration of the test.
-130 dBm beacon transmitted Code Phase (delay)	ms	5.00346×10^{-3}	Corresponds to 1500 m. Constant per beacon for the duration of the test.
T_{MBS_meas}	ms	12000	

Table A.4.2.1-2: MBS Beacon Payload fields for Code Phase measurement Accuracy

Parameter	Unit	Value	Comment
TxID	Integer	Equal to Slot number	
Slot Index	Integer	Equal to Slot number	
All other fields	N/A	0	

A.4.2.2 Test Requirements

The MBS Code Phase measurement accuracy shall fulfil the requirements in clauses 5.2, 5.3 and 5.4.

A.4.3 MBS Code Phase Measurement Accuracy Requirements in Multipath

A.4.3.1 Test Purpose and Environment

The purpose of this test is to verify that the MBS Code Phase measurement accuracy is within the specified limits. This test will verify the requirements in clause 5.5 for MBS measurements. The channel type for the test is specified in clause 5.5. This test can be used for both UTRA and E-UTRA testing.

In this test, there is one beacon transmitted in each of two chosen slots. The position of the beacons in the beacon transmission period is static for the duration of the test. In other slots there are no simulated beacons. Both beacons are in the same time slotted RF channel, with centre frequency of 925.977 MHz. All beacons are of type TB1 (2 MHz) [7] and the data transmitted is in Type 2 packets with the following data fields: The MBS Transmitter ID and the Slot Index shall be set to the MBS slot number; All other beacon payload data shall be populated with zeros.

Both beacon slots shall contain a beacon with the signal strength listed in clause 5.5.

The beacons shall have code phase delay of 1.6678×10^{-4} ms (corresponding to 50 m).

Each of the beacons shall use a unique PN code chosen from the PN code list for TB1 [7].

Table A.4.3.1-1: General test parameters for Code Phase measurement Accuracy in Multipath

Parameter	Unit	Value	Comment
Centre Frequency	MHz	925.977	
RF Channel	N/A	EPA 5 Hz	
MBS Beacon Configuration	N/A	TB1 (2 MHz)	
MBS Packet Type	N/A	Type 2	
Beacon PN Code	Integer	Chosen from the PN code list for TB1	
-30 dBm beacon transmitted Code Phase (delay)	ms	1.6678×10^{-4}	Corresponds to 50 m. Constant per beacon for the duration of the test.
T_{MBS_meas}	ms	12000	

Table A.4.3.1-2: MBS Beacon Payload fields for Code Phase measurement Accuracy

Parameter	Unit	Value	Comment
TxID	Integer	Equal to Slot number	
Slot Index	Integer	Equal to Slot number	
All other fields	N/A	0	

A.4.3.2 Test Requirements

The MBS Code Phase measurement accuracy shall fulfil the requirements in clause 5.5.

Annex B (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2016-04	RAN4#78 bis	R4-162662				TS skeleton created from 3GPP TS template.	0.0.1
2016-05	RAN4#78 bis	R4-164435				The text proposal in R4-162662 agreed at RAN4#78bis is included.	0.1.0
2016-05	RAN4#78 bis	R4-164777				The test proposals in R4-164437, R4-164646 and R4-164647 are included.	0.2.0
2016-06	RAN#72	RP-160891				TS agreed in R4-164777, with the version number incremented to 1.0.0, the date and Table of Contents updated and the change history updated. Editorial changes from MCC were also included.	1.0.0
2016-06	RAN#72					TR approved by RAN plenary	13.0.0
2016-12	RP-74	RP-162396	0001	2	F	Removal of square brackets from MBS measurement accuracy requirements	13.1.0

History

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