**3GPP TSG-RAN4 Meeting #94-e *R4-2002274***

**Online, , 24th Feb 2020 - 6th Mar 2020**

|  |
| --- |
| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **36.171** | **CR** | **0017** | **rev** | **1** | **Current version:** | **15.0.0** |  |
|  |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network |  |

|  |
| --- |
|  |
| ***Title:***  |  Draft CR of TS 36.171 for introducing NavIC in LTE – performance part |
|  |  |
| ***Source to WG:*** | Reliance Jio, CEWiT, Huawei, ISRO, Qualcomm, Saankhya Labs Private Limited, Tejas Networks Ltd. |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | LCS\_NAVIC-Perf |  | ***Date:*** | 2020-03-04 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-16 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)Rel-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | In RAN#85, LCS\_NAVIC work item was approved for A-GNSS suport for NavIC constellation in LTE Release-16. This change request captures the minimum performance requirements expected from GNSS receivers supporting NavIC constellation. |
|  |  |
| ***Summary of change:*** | NavIC Navigation Satellite System position related information is introduced based on NavIC ICD. 1. New references, symbols, abbreviations items for NavIC.2. Table 4.1: relative signal power level for two signal type for NavIC L5.3. Test parameters on reference signal power level for NavIC in section 6 to evaluate minimum performance requirements. |
|  |  |
| ***Consequences if not approved:*** | No support for NavIC in E-UTRA |
|  |  |
| ***Clauses affected:*** | 2, 3.2, 3.3, 4.7, 4.8, 6.2, annex B.1.5.2, annex C, annex E |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | - R4-2000071 |

**---------------------------- START OF CHANGE ----------------------**

# 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 TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[2] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

[3] 3GPP TS 36.571-1: "Evolved Universal Terrestrial Radio Access (E-UTRA); and Evolved Packet Core (EPC); User Equipment (UE) conformance specification for UE positioning; Part 1: Terminal conformance".

[4] 3GPP TS 36.355: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)".

[5] 3GPP TS 36.302: "Evolved Universal Terrestrial Radio Access (E-UTRA); Services provided by the physical layer".

[6] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements".

[7] 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".

[8] IS-GPS-200, Revision D, Navstar GPS Space Segment/Navigation User Interfaces, March 7th, 2006.

[9] P. Axelrad, R.G. Brown, "GPS Navigation Algorithms", in Chapter 9 of "Global Positioning System: Theory and Applications", Volume 1, B.W. Parkinson, J.J. Spilker (Ed.), Am. Inst. of Aeronautics and Astronautics Inc., 1996.

[10] S.K. Gupta, "Test and Evaluation Procedures for the GPS User Equipment", ION-GPS Red Book, Volume 1, p. 119.

[11] 3GPP TS 36.509: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Special conformance testing functions for User Equipment (UE)".

[12] IS-GPS-705, Navstar GPS Space Segment/User Segment L5 Interfaces, September 22, 2005.

[13] IS-GPS-800, Navstar GPS Space Segment/User Segment L1C Interfaces, September 4, 2008.

[14] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.1, July 31, 2009.

[15] Galileo OS Signal in Space ICD (OS SIS ICD), Draft 0, Galileo Joint Undertaking, May 23rd, 2006.

[16] Global Navigation Satellite System GLONASS Interface Control Document, Version 5.1, 2008.

[17] Specification for the Wide Area Augmentation System (WAAS), US Department of Transportation, Federal Aviation Administration, DTFA01-96-C-00025, 2001.

[18] BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I(Version 1.0), China Satellite Navigation Office, December 2012.

[19] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities".

[xx] IRNSS Signal-In-Space (SPS) Interface Control Document (ICD) for standard positioning service version 1.1, Aug 2017.

[yy] 3GPP TS 37.355: " LTE Positioning Protocol (LPP)".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TS 36.101 [1], 3GPP TS 36.104 [2] and the following apply:

**Horizontal Dilution Of Precision (HDOP):** measure of position determination accuracy that is a function of the geometrical layout of the satellites used for the fix, relative to the receiver antenna

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

B1I BeiDou B1I navigation signal with carrier frequency of 1561.098 MHz.

E1 Galileo E1 navigation signal with carrier frequency of 1575.420 MHz.

E5 Galileo E5 navigation signal with carrier frequency of 1191.795 MHz.

E6 Galileo E6 navigation signal with carrier frequency of 1278.750 MHz.

G1 GLONASS navigation signal in the L1 sub-bands with carrier frequencies 1602 MHz ± k × 562.5 kHz.

G2 GLONASS navigation signal in the L2 sub-bands with carrier frequencies 1246 MHz ± k × 437.5 kHz.

k GLONASS channel number, k = -7…13.

L1 C/A GPS or QZSS L1 navigation signal carrying the Coarse/Acquisition code with carrier frequency of 1575.420 MHz.

L1C GPS or QZSS L1 Civil navigation signal with carrier frequency of 1575.420 MHz.

L2C GPS or QZSS L2 Civil navigation signal with carrier frequency of 1227.600 MHz.

L5 GPS or QZSS or NavIC L5 navigation signal with carrier frequency of 1176.450 MHz.

**G** Geometry Matrix.

 Measured pseudo-range of satellite *i* of GNSSm.

**W** Weighting Matrix.

 Line of sight unit vector from the user to the satellite *i* of GNSSm.

 State vector of user position and clock bias.

## 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

A-GNSS Assisted Global Navigation Satellite System

A-GPS Assisted - Global Positioning System

AWGN Additive White Gaussian Noise

BDS BeiDou Navigation Satellite System

C/A Coarse/Acquisition

DUT Device Under Test

ECEF Earth Centred, Earth Fixed

ECI Earth-Centered-Inertial

E-SMLC Enhanced Serving Mobile Location Centre

E-UTRA Evolved UMTS Terrestrial Radio Access

E-UTRAN Evolved UMTS Terrestrial Radio Access Network

eNB E-UTRAN Node B

FDD Frequency Division Duplex

GEO Geostationary Earth Orbit

GLONASS GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (Engl.: Global Navigation Satellite System)

GNSS Global Navigation Satellite System

GPS Global Positioning System

GSS GPS System Simulator

HDOP Horizontal Dilution Of Precision

ICD Interface Control Document

IGSO Inclined Geosynchronous Satellite Orbit

IRNSS Indian Regional Navigation Satellite System

IS Interface Specification

LOS Line Of Sight

LPP LTE Positioning Protocol

MEO Medium Earth Orbit

NavIC NAVigation with Indian Constellation

QZSS Quasi-Zenith Satellite System

RRC Radio Resource Control

SBAS Space Based Augmentation System

SFN System Frame Number

SS FDD System simulator

SV Space Vehicle

TDD Time Division Duplex

TLM TeLeMetry word. It contains an 8-bits preamble (10001011)

TOW Time Of Week

TTFF Time To First Fix

UE User Equipment

WLS Weighted Least Square

WGS‑84 World Geodetic System 1984

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4.8 UEs supporting multiple signals

For UEs supporting multiple signals, different minimum performance requirements may be associated with different signals. The satellite simulator shall generate all signals supported by the UE. Signals not supported by the UE do not need to be simulated. The relative power levels of each signal type for each GNSS are defined in Table 4.1. The individual test scenarios in clause 6 define the reference signal power level for each satellite. The power level of each simulated satellite signal type shall be set to the reference signal power level defined in each test scenario in clause 6 plus the relative power level defined in Table 4.1.

Table 4.1: Relative signal power levels for each signal type for each GNSS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Galileo | GPS/Modernized GPS | GLONASS | QZSS | SBAS | BDS | NavIC |
| Signal power levels relative to reference power levels | E1 | 0 dB | L1 C/A | 0 dB | G1 | 0 dB | L1 C/A | 0 dB | L1 | 0 dB | B1I | D1 | 0 dB | L5 | 0 dB |
| D2 | +5 dB |  |  |
| E6 | +2 dB | L1C | +1.5 dB | G2 | -6 dB | L1C | +1.5 dB |  |  |  |  |  |  |  |
| E5 | +2 dB | L2C | -1.5 dB |  |  | L2C | -1.5 dB |  |  |  |  |  |  |  |
|  |  | L5 | +3.6 dB |  |  | L5 | +3.6 dB |  |  |  |  |  |  |  |

NOTE 1: For test cases which involve “Modernized GPS”, the satellite simulator shall also generate the GPS L1 C/A signal if the UE supports “GPS” in addition to “Modernized GPS”.

NOTE 2: The signal power levels in the Test Parameter Tables represent the total signal power of the satellite per channel not e.g. pilot and data channels separately.

NOTE 3: For test cases which involve "BDS", D1 represents MEO/IGSO satellites B1I signal type and D2 represents GEO satellites B1I signal type.

NOTE 4: For test cases involving NavIC all satellites are either GEO or IGSO as per ICD [xx]

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## 6.2 Nominal Accuracy

Nominal accuracy requirement verifies the accuracy of A-GNSS position estimate in ideal conditions. The primarily aim of the test is to ensure good accuracy for a position estimate when satellite signal conditions allow it.This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal. If SBAS is to be tested one additional satellite shall be generated. If NavIC is to be tested one NavIC satellite shall be generated. AWGN channel model is used. The number of simulated satellites for each constellation is as defined in Table 6.8.

Table 6.7: Test parameters

| System | Parameters | Unit | Value |
| --- | --- | --- | --- |
|  | Number of generated satellites per system | - | See Table 6.8 |
| Total number of generated satellites  | - | 6 or 7(2) |
| HDOPRange | - | 1.4 to 2.1 |
| Propagation conditions  | - | AWGN |
| GNSS coarse time assistance error range | seconds | ±2 |
| GPS(1) | Reference signal power level for all satellites | dBm | -128.5 |
| Galileo | Reference signal power level for all satellites | dBm | -127 |
| GLONASS | Reference signal power level for all satellites | dBm | -131 |
| QZSS | Reference signal power level for all satellites | dBm | -128.5 |
| SBAS | Reference signal power level for all satellites | dBm | -131 |
| BDS | Reference signal power level for all satellites | dBm | -133 |
| NavIC | Reference signal power level for all satellites | dBm | -129 |
| NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE capabilities.NOTE 2: 7 satellites apply only for SBAS or NavIC case. |

If QZSS is supported, one of the GPS satellites will be replaced by a QZSS satellite with respective signal support. If SBAS is supported, the SBAS satellite with the highest elevation will be added to the scenario. If NavIC is supported, the NavIC satellite with the highest elevation will be added to the scenario.

Table 6.8: Satellite allocation

|  |  |
| --- | --- |
|  | Satellite allocation for each constellation |
| GNSS 1(1) | GNSS 2(1) | GNSS 3(1) | SBAS | NavIC |
| Single constellation | 6 | -- | -- | 1 | 1 |
| Dual constellation | 3 | 3 | -- | 1 | 1 |
| Triple constellation | 2 | 2 | 2 | 1 | 1 |
| NOTE 1: GNSS refers to global systems i.e., GPS, Galileo, GLONASSand BDS. |

### 6.2.1 Minimum requirements (nominal accuracy)

The position estimates shall meet the accuracy and response time requirements in Table 6.9.

Table 6.9: Minimum requirements

| System | Success rate | 2-D position error | Max response time |
| --- | --- | --- | --- |
| All | 95 % | 15 m | 20 s |

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## B.1.4 Reference and UE locations

There is no limitation on the selection of the reference location, consistent with achieving the required HDOP for the Test Case. For each test instance the reference location shall change sufficiently such that the UE shall have to use the new assistance data. The uncertainty of the semi-major axis is 3 km. The uncertainty of the semi-minor axis is 3 km. The orientation of major axis is 0 degrees. The uncertainty of the altitude information is 500 m. The confidence factor is 68 %.

For every Test Instance in each TTFF test case, the UE location shall be randomly selected to be within 3 km of the Reference Location. The Altitude of the UE shall be randomly selected between 0 m to 500 m above WGS‑84 reference ellipsoid. These values shall have uniform random distributions.

For test cases which include satellites from regional systems, such as QZSS, NavIC and SBAS, the reference location shall be selected within the defined coverage area of the systems.

### B.1.5.2 UE supports other A-GNSSs

In the case of test cases in clause 6 (UE supports other GNSSs), the satellite constellation shall consist of 24 satellites for GLONASS; 27 satellites for GPS, Modernized GPS and Galileo; 3 satellites for QZSS; 2 satellites for SBAS; 35 satellites for BDS (5 GEO, 27 MEO, 3 IGSO) and 7 satellites for NavIC (3GEO, 4 IGSO). Almanac assistance data shall be available for all these satellites. At least 7 of the satellites per GPS, Modernized GPS, Galileo, GLONASS and BDS constellation shall be visible to the UE (that is, above 15 degrees elevation with respect to the UE). At least 1 of the satellites for QZSS shall be within 15 degrees of zenith; at least 1 of the satellites of NavIC shall be visible to the UE above 15 degrees elevation angle over NavIC service area. (Service area as defined in ICD [xx]) and at least 1 of the satellites for SBAS shall be visible to the UE. For BDS with reference location in Asia, at least 1 of the visible satellites shall be a GEO (above 15 degrees elevation with respect to the UE).All other satellite specific assistance data shall be available for all visible satellites. In each test, signals are generated for only 6 satellites (or 7 if SBAS is included). The HDOP for the test shall be calculated using these satellites. The simulated satellites for GPS, Modernized GPS, Galileo, GLONASS and BDS shall be selected from the visible satellites for each constellation consistent with achieving the required HDOP for the test. For BDS with reference location in Asia, 1 of the simulated satellites shall be a GEO. For NavIC with reference location in the NavIC service area as defined in [xx], the simulated satellite shall be an IGSO.

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# E.2 GNSS Assistance Data

a) **GNSS- Reference Time IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.2: GNSS- Reference Time IE

|  |  |  |
| --- | --- | --- |
| Information Element | All tests except Sensitivity Fine Time Assistance | Sensitivity Fine Time Assistance test |
| GNSS-ReferenceTime |  |  |
| > gnss-SystemTime |  |  |
| >> gnss-TimeID | Yes | Yes |
| >> gnss-DayNumber | Yes | Yes |
| >> gnss-TimeOfDay | Yes | Yes |
| >> gnss-TimeOfDayFrac-msec | Yes | Yes |
| >> notificationOfLeapSecond | Yes ifgnss-TimeID = ‘glonass’ | Yes ifgnss-TimeID = ‘glonass’ |
| >> gps-TOW-Assist  | Yes ifgnss-TimeID = ‘gps’ | Yes ifgnss-TimeID = ‘gps’ |
| > referenceTimeUnc | Yes | No |
| > gnss-ReferenceTimeForOneCell | No | Yes |
| >> networkTime |  | Yes |
| >>> secondsFromFrameStructureStart |  | Yes |
| >>> fractionalSecondsFromFrameStructureStart |  | Yes |
| >>> frameDrift |  | Yes |
| >>> cellID |  | Yes |
| >>>> physCellId |  | Yes |
| >>>> cellGlobalIdEUTRA |  | Yes |
| >> referenceTimeUnc |  | Yes |

b) **GNSS-ReferenceLocation IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.3: GNSS-ReferenceLocation IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-ReferenceLocation | ThreeDlocation |

c) **GNSS-IonosphericModel IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.4: GNSS-IonosphericModel IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-IonosphericModel | KlobucharModelParameter |
|  | NeQuickModelParameter(1) |
| NOTE 1: Only required if GNSSs supported include Galileo. |

d) **GNSS-TimeModelList IE.** This information element is only required for multi system tests, and is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.5: GNSS-TimeModelList IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-TimeModelList |  |
|  | GnssTOIDFor each GNSS included in the test. |
|  | DeltaT |

e) **GNSS-NavigationModel IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.6: GNSS-NavigationModel IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-NavigationModel |  |

Table E.7: GNSS Clock and Orbit Model Choices

|  |  |
| --- | --- |
| GNSS | Clock and Orbit Model Choice |
| GPS | Model-2 |
| Modernized GPS | Model-3 |
| GLONASS | Model-4 |
| QZSS QZS-L1 | Model-2 |
| QZSS QZS-L1C/L2C/L5 | Model-3 |
| SBAS | Model-5 |
| Galileo | Model-1 |
| BDS | Model-6 |
| NavIC | Model-8 |

f) **GNSS-AcquisitionAssistance IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.8: GNSS-AcquisitionAssistance IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-AcquisitionAssistance |  |

g) **GNSS-Almanac IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.9: GNSS-Almanac IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-Almanac |  |

Table E.10: GNSS Almanac Choices

|  |  |
| --- | --- |
| GNSS | Almanac Model Choice |
| GPS | Model-2 |
| Modernized GPS | Model-3,4 |
| GLONASS | Model-5 |
| QZSS QZS-L1 | Model-2 |
| QZSS QZS-L1C/L2C/L5 | Model-3,4 |
| SBAS | Model-6 |
| Galileo | Model-1 |
| BDS | Model-7 |
| NavIC | Model-8 |

h) **GNSS-UTC-Model IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.11: GNSS-UTC-Model IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-UTC-Model |  |

Table E.12: GNSS UTC Model Choices

|  |  |
| --- | --- |
| GNSS | UTC Model Choice |
| GPS | Model-1 |
| Modernized GPS | Model-2 |
| GLONASS | Model-3 |
| QZSS QZS-L1 | Model-1 |
| QZSS QZS-L1C/L2C/L5 | Model-2 |
| SBAS | Model-4 |
| Galileo | Model-1 |
| BDS | Model-5 |
| NavIC | Model-2 |

i) **GNSS-AuxiliaryInformation IE.** This information element is defined in subclause 6.5.2.2 of 3GPP TS 37.355 [yy].

Table E.13: GNSS-AuxiliaryInformation IE

|  |  |
| --- | --- |
| Name of the IE | Fields of the IE |
| GNSS-AuxiliaryInformation |  |

**--------------------------- END OF CHANGE ----------------------**