**3GPP TSG-RAN WG2 Meeting #124 *R2-23xxxxx***

**Chicago, USA, November 13th – 17th, 2023**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.305** | **CR** |  | **rev** | **-** | **Current version:** | **17.6.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](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)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network |  | Core Network | **x** |

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|  | | | | | | | | | | |
| ***Title:*** | Bluetooth AoA/AoD support | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | TEI18 | | | | |  | ***Date:*** | | | 2023-11-01 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *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 can be 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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Extension of the Bluetooth positioning method with support for AoA/AoD | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Enable Bluetooth AoA/AoD based on the agreement in RAN2  RAN1#123bis  Agreements:  Support Bluetooth AoA/AoD positioning in the LPP Bluetooth positioning method.  Introduce BT AoA/AoD measurements in LPP.  FFS if further BT control information can be captured in our specs.  and outcome of email discussion  [Post123bis][403][POS] BT AoA/AoD (Ericsson)  Scope: Draft and review a CR implementing the agreements from RAN2#123bis on Bluetooth AoA/AoD positioning.  Intended outcome: Report and CR to next meeting  Deadline: Long | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Bluetooth AoA/AoD is not supported in LPP. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 4.3.7, 8.6, 8.6.1, 8.6.2, 8.6.2.1, 8.6.2.2. 8.6.3, 8.6.3.1, 8.6.3.2, 8.6.3.3 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | | Based on text proposals in email discussion summary R2-231xxxxx | | | | | | | | |

*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 TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.501 "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 22.071: "Location Services (LCS); Service description, Stage 1".

[4] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

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

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

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

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

[9] Global Navigation Satellite System GLONASS Interface Control Document, Version 5, 2002.

[10] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.0, June 17, 2008.

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

[12] RTCM 10402.3, RTCM Recommended Standards for Differential GNSS Service (v.2.3), August 20, 2001.

[13] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[14] 3GPP TS 38.331: "NR Radio Resource Control (RRC) protocol specification".

[15] OMA-AD-SUPL-V2\_0: "Secure User Plane Location Architecture Approved Version 2.0".

[16] OMA-TS-ULP-V2\_0\_6: "UserPlane Location Protocol Approved Version 2.0.6".

[17] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer – Measurements".

[18] 3GPP TS 36.302: "Evolved Universal Terrestrial Radio Access (E-UTRA); Services provided by the physical layer".

[19] 3GPP TS 36.355: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)".

[20] BDS-SIS-ICD-B1I-3.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 3.0)", February, 2019.

[21] IEEE 802.11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications"

[22] Bluetooth Special Interest Group: "Bluetooth Core Specification v4.2", December 2014.

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

[24] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation".

[25] 3GPP TS 36.305: "Stage 2 functional specification of User Equipment (UE) positioning in E‑UTRA".

[26] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[27] 3GPP TS 38.455: "NG-RAN; NR Positioning Protocol A (NRPPa)".

[28] 3GPP TS 29.518: "5G System; Access and Mobility Management Services; Stage 3".

[29] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[30] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[31] RTCM 10403.3, "RTCM Recommended Standards for Differential GNSS Services (v.3.3)", October 7, 2016.

[32] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[33] 3GPP TS 29.572: "Location Management Services; Stage 3".

[34] BDS-SIS-ICD-B1C-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Version 1.0)", December, 2017

[35] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[36] IS-QZSS-L6-001, Quasi-Zenith Satellite System Interface Specification – Centimetre Level Augmentation Service, Cabinet Office, November 5, 2018.

[37] 3GPP TS 38.215: "NR; Physical layer – Measurements".

[38] 3GPP TS 38.401: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NG-RAN; Architecture description".

[39] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[40] 3GPP TS 38.212: "NR; Multiplexing and channel coding".

[41] 3GPP TS 24.571: "Control plane Location Services (LCS) procedures".

[42] 3GPP TS 37.355: "Technical Specification Group Radio Access Network; LTE Positioning Protocol (LPP)".

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

[44] BDS-SIS-ICD-B2a-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B2a (Version 1.0)", December, 2017.

[45] BDS-SIS-ICD-B3I-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B3I (Version 1.0)", February, 2018.

[xx] Bluetooth Special Interest Group: "Bluetooth Core Specification v5.4", February 2023.

*NEXT CHANGE*

4.3.7 Bluetooth positioning

The Bluetooth positioning method makes use of Bluetooth to determine the location of the UE. Three modes are supported:

- the UE measures received signals from Bluetooth [22] beacons, associated to beacon identifiers,

- the UE transmits a Bluetooth Continuous Tone Extension (CTE) signal to enable Bluetooth beacons to estimate AoA from the UE [xx]

- the UE, based on assistance data from the positioning server about Bluetooth beacon’s antenna configuration, estimates AoD from the Bluetooth beacons. [xx].

Using the measurement results and a references database, the location of the UE is calculated. The Bluetooth methods may be combined with other positioning methods (e.g. WLAN) to improve positioning accuracy of the UE.

The operation of the Bluetooth positioning method is described in clause 8.6.

*NEXT CHANGE*

8.6 Bluetooth positioning

8.6.1 General

In the Bluetooth positioning method, the UE position is estimated with the knowledge of geographical coordinate of reference Bluetooth beacons. This is accomplished by collecting a certain amount of measurements from UE's Bluetooth receiver and/or from the receiver of the Bluetooth beacons, and applying a location determination algorithm using databases of the estimated position’s references points, reference points antenna configuration and orientation.

The UE Bluetooth measurements may include:

- Bluetooth beacon's Received Signal Strength (RSSI).

- Bluetooth beacon's estimated AoD (azimuth and zenith angles).

The Bluetooth beacon measurements may include:

- Bluetooth beacon's estimated AoA (azimuth and zenith angles).

Three positioning modes are supported:

- *Standalone*:  
The UE performs Bluetooth position measurements and location computation.

- *UE-assisted*:  
The UE provides Bluetooth position measurements with or without assistance from the network to the LMF for computation of a location estimate by the network.

- *UE-based*:  
The UE performs Bluetooth position measurements and computation of a location estimate with network assistance.

8.6.2 Information to be transferred between NG-RAN/5GC Elements

This clause defines the information that may be transferred between LMF and UE.

8.6.2.1 Information that may be transferred from the LMF to UE

Table 8.6.2.1-1 lists Bluetooth transmission parameters that LMF may suggest to the UE to consider for UE-assisted Bluetooth AoA positioning. LMF may instead only request to the UE to provide its Bluetooth transmission parameters used for UE-assisted Bluetooth AoA positioning.

NOTE: The provision of these elements and the usage of these elements by the UE depend on the NG-RAN/5GC and UE capabilities, respectively.

**Table 8.6.2.1-2: Suggested UE Bluetooth AoA transmission parameters that may be transferred from LMF to the UE**

|  |
| --- |
| **Information** |
| Transmission configuration (advertising periodicities, PHY type, TX power, CTE length and repetition) |

The AoA transmission configuration is described in more detail in 8.6.2.2.

Table 8.6.2.1-2 lists assistance data for both UE-assisted and UE-based modes that may be sent from the LMF to the UE to support Bluetooth AoD positioning.

NOTE: The provision of these assistance data elements and the usage of these elements by the UE depend on the NG-RAN/5GC and UE capabilities, respectively.

**Table 8.6.2.1-2: Assistance data that may be transferred from LMF to the UE**

|  |  |  |
| --- | --- | --- |
| **Information** | **UE-assisted** | **UE-based** |
| **Bluetooth beacon list:** |  |  |
| Bluetooth advertising address | Yes | Yes |
| Geographical coordinate | Yes | Yes |
| Antenna array orientation (LCS to GCS translation) | Yes | Yes |
| Antenna array configuration (antenna relative location and polarization) and antenna switching pattern | Yes | Yes |
| Transmission configuration (advertising periodicities, PHY type, CTE type, length and repetition) | Yes | Yes |

8.6.2.1.1 Bluetooth beacon advertising address

This assistance data provides the Bluetooth advertising address btAddr of the Bluetrooth beacon [xx].

8.6.2.1.2 Bluetooth beacon locatiom

This assistance data provides the location of the Bluetooth beacon [xx].

8.6.2.1.3 Bluetooth beacon antenna array orientation

This assistance data provides the Bluetooth antenna array orientation of the Bluetooth beacon by parameters bearing, downtilt and slant for the translation of a Local Coordinate System (LCS) to a Global Coordinate System (GCS).

8.6.2.1.4 Bluetooth beacon antenna array configuration and switching pattern

This assistance data provides the Bluetooth antenna array configuration of the Bluetooth beacon, where each the antenna of the array is characterized by a relative position to an antenna array reference point and a polarization, and the antenna switching pattern lists the order antennas are used for transmissions [xx]. One generic antenna array and three parameterized antenna arrays can be defined (linear, rectangular or circular).

8.6.2.1.5 Bluetooth beacon AoD transmission configuration

This assistance data provides the Bluetooth beacon AoD transmission configuration parameters for the primary and secondary advertising periodicities, Bluetooth PHY type (1 or 2 Msymbol/s), CTE type (1 us or 2 us switching slot lengths), CTE length (8 to 160 us) and CTE repeated transmission instants (1 - 16).

8.6.2.2 Information that may be transferred from the UE to LMF

The information that may be signalled from the UE to the LMF is summarized in Table 8.6.2.2-1.

**Table 8.6.2.2-1: Information that may be transferred from the UE to the LMF**

|  |  |  |
| --- | --- | --- |
| **Information** | **UE‑Assisted** | **Standalone** |
| **Bluetooth Location Information** |  |  |
| MAC Address | Yes | No |
| Received Signal Strength (RSSI) | Yes | No |
| Time Stamp | Yes | No |
| Measurement characteristics | Yes | No |
| AoD angles (azimuth and zenith | Yes | No |
| **UE Location Information** |  |  |
| UE position estimate with uncertainty shape | No | Yes |
| Position Time Stamp | No | Yes |
| Location Source (method(s) used to compute location) | No | Yes |
| UE AoA transmission configuration |  |  |
| Address and address type | Yes | No |
| Primary and secondary channel advertising periodicity | Yes | No |
| Primary and secondary advertising periodicity | Yes | No |
| TX Power | Yes | No |
| CTE transmission configuration | Yes | No |

Bluetooth AoA positioning is enabled by the UE transmitting Bluetooth periodic advertising with a CTE, configured by the following parameters:

* UE advertisement address that can be of three different types - public (MAC address), random-static (static random number) or random-private-resolvable (regularly updated random number).
* primary channel advertising periodicity, related to the Bluetooth beacon acquisition time of the UE Bluetooth signal.
* periodic advertising interval on the secondary advertising channel, related to how often the Bluetooth beacons will be able to estimate AoA of the UE
* TX power related to how strong the UE Bluetooth signal is received at the Bluetooth beacons.
* CTE length (16 – 160 us) of every CTE transmission

CTE repeated transmissions instants (1-16) each transmission instant.8.6.2.2.1 Standalone mode

In Standalone mode, the UE reports the latitude, longitude and possibly altitude, together with an estimate of the location uncertainty, if available.

The UE should also report an indication of Bluetooth method and possibly other location methods have been used to calculate a fix.

8.6.2.2.2 UE-assisted mode

In UE-assisted mode, the UE should either report:

- The MAC addresses of the measured Bluetooth beacons and one or more of.

- associated RSSI

- associated AoD, assisted by the positioning server

or transmit:

- periodic advertisements with CTE to enable Bluetooth beacon AoA estimation

8.6.2.2.3 UE-based mode

In UE-based mode using Bluetooth AoD, the UE reports the estimated location coordinates together with an estimate of the location uncertainty, if available.

The UE should also report an indication that Bluetooth method is used and possibly other positioning methods used to calculate the fix.8.6.3 Bluetooth Positioning Procedures

8.6.3.1 Capability Transfer Procedure

The Capability Transfer procedure for Bluetooth positioning is described in clause 7.1.2.1.

8.6.3.2 Assistance Data Transfer Procedure

The purpose of this procedure is to enable the UE to request Bluetooth AoD assistance data from the LMF (e.g., as part of a positioning procedure) and the LMF to provide assistance data to the UE (e.g., as part of a positioning procedure).

8.6.3.2.1 LMF initiated Assistance Data Delivery

Figure 8.6.3.2.1-1 shows the Assistance Data Delivery operations for the network-assisted Bluetooth AoD method when the procedure is initiated by the LMF

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**Figure 8.6.3.2.1: LMF-initiated Assistance Data Delivery Procedure**

(1) The LMF determines that assistance data needs to be provided to the UE (e.g., as part of a positioning procedure) and sends an LPP Provide Assistance Data message to the UE. This message may include any of the Bluetooth assistance data defined in clause 8.6.2.1.

8.6.3.2.2 UE initiated Assistance Data Transfer

Figure 8.6.3.2.2-1 shows the Assistance Data Transfer operations for the network-assisted Bluetooth AoD method when the procedure is initiated by the UE.

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**Figure 8.6.3.2.2-1: UE-initiated Assistance Data Transfer Procedure**

(1) The UE determines that certain Bluetooth assistance data is desired (e.g., as part of a positioning procedure when the LMF provided assistance data are not sufficient for the UE to fulfil the request) and sends a LPP Request Assistance Data message to the LMF. This request includes an indication of which specific Bluetooth assistance data is requested.

(2) The LMF provides the requested assistance data in a LPP Provide Assistance Data message, if available at the LMF. The entire set of assistance data may be delivered in one or several LPP messages. In this case, this step may be repeated by the LMF several times. If any of the UE requested assistance data in step (1) are not provided in step 2, the UE shall assume that the requested assistance data are not supported, or currently not available at the LMF. If none of the UE requested assistance data in step (1) can be provided by the LMF, return any information that can be provided in an LPP message of type Provide Assistance Data which includes a cause indication for the not provided assistance data.

8.6.3.3 Location Information Transfer Procedure

The purpose of this procedure is to enable the LMF to request position measurements or location estimate from the UE, or to enable the UE to provide location measurements to the LMF for position calculation.

The purpose can also be to enable LMF to request or suggest UE Bluetooth AoA configuration and enable the UE to provide the Bluetooth AoA configuration it will use to enable Bluetooth beacons to provide AoA measurements to LMF.

8.6.3.3.1 LMF initiated Location Information Transfer Procedure

Figure 8.6.3.3.1-1 shows the Location Information Transfer operations for the Bluetooth method when the procedure is initiated by the LMF.

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**Figure 8.6.3.3.1-1: LMF-initiated Location Information Transfer Procedure**

(1) The LMF sends a LPP Request Location Information message to the UE for invocation of Bluetooth positioning. This request includes positioning instructions such as the positioning mode (UE-assisted, Standalone), specific requested UE measurements if any, quality of service parameters (accuracy, response time) , request/suggestion of UE Bluetooth AoA transmission configuration.

(2) The UE performs the requested measurements and possibly calculates its own location. The UE sends an LPP Provide Location Information message to the LMF before the Response Time provided in step (1) elapsed. If the UE is unable to perform the requested measurements, or if the Response Time provided in step 1 elapsed before any of the requested measurements have been obtained, the UE returns any information that can be provided in an LPP message of type Provide Location Information which includes a cause indication for the not provided location information.

Alternatively, for AoA, the UE provides Bluetooth AoA transmission configuration that it will use in an LPP Provide Location Information message to the LMF before the Response Time provided in step (1) elapsed.8.6.3.3.2 UE-initiated Location Information Delivery Procedure

Figure 8.6.3.3.2-1 shows the Location Information delivery operations for the Bluetooth method when the procedure is initiated by the UE.

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**Figure 8.6.3.3.2-1: UE-initiated Location Information Delivery Procedure**

(1) The UE sends an LPP Provide Location Information message to the LMF. The Provide Location Information message may include UE Bluetooth information or location estimate already available at the UE. For AoA, the UE provides Bluetooth AoA transmission configuration in a Provide Location Information message that it will use. Specifically, the UE will trigger such a message when it has changed Bluetooth advertising address – only applicable for the random-private-resolvable address type.