**3GPP T****SG-RAN WG2 Meeting #115-e R2-210xxxx**

**E-Meeting: August 09-27, 2021**

**Agenda item: 8.10.3.1**

**Source: Qualcomm Incorporated**

**Title: [Pre115-e][102][NTN] Summary of AI 8.10.3.1 - LCS aspects only**

**Document for: Discussion and Decision**

# Introduction

This document provides summary of agenda item 8.10.3.1 covering only the LCS aspects as per the following.

* [Pre115-e][102][NTN] Summary of AI 8.10.3.1 - LCS aspects only (Qualcomm)

# Discussion

## Coarse UE location report

Regarding reporting of the UE’s location with accuracy of 2 km or more cell radius during initial access, followings are proposed in different contributions [1], [2], [3], [4], [6], [7] and [9].

1. *Truncated GNSS coordinate (i.e., X MSB bits out of Y bits of longitude/latitude) is reported as coarse location information with 2km or more radius accuracy before AS security is established, e.g. during initial access. [1]*
2. *the following information is provided in SIB to enable calculation of zone ID, i.e. geographical origin coordinates, zone length and width ( ~4km or more to fulfil the requirement), ZoneNumPerRow. UE reports zone ID in RRCSetupComplete message or using MAC CE. [2]*
3. *The UE shall report its location by selecting a virtual cell identifier, where the identifier can be mapped to a quantized location on a earth-fixed coordinate system [3].*
4. *RAN2 DO NOT work on any solution to ensure that the CGI constructed by NG-RAN can correspond to a fixed geographical area comparable with a TN cell with a radius of ~2km or more [4].*
5. *Acquiring the UE location with an accuracy comparable to TN cell granularity before AS security is possible from RAN2’s perspective but the reliability of such information should be confirmed by SA3 [6].*
6. *RAN2 to agree that UE reports its location info directly in the initial access mode, i.e. via RRCSetupComplete message and or RRCResumeComplete to NR-RAN. RAN2 to discuss what the UE’s location info is and agree that UE’s location info is coarse geographical location info [7]*
7. *The UE-based VC ID determination and the UE’s reporting of the VC ID instead of the GNSS-based location alleviate privacy and security concerns, especially when security has not been activated [9].*

Note that RAN2 spent significant amount of time and made the following agreement in RAN2#114e.

*RAN2 will work on a solution to ensure that the CGI constructed by NG-RAN can correspond to a fixed geographical area comparable with a TN cell with a radius of ~2km or more.*

Consequently, RAN2 has asked SA3 following question in [5].

*RAN2 would like to ask SA3 whether there is privacy concern if a UE reports the location information to NG-RAN with ~2km radius accuracy before AS security is established, e.g. during initial access.*

Rapporteur thinks RAN2 should stick to the agreement unless there is major concern from SA3.

1. If SA3 replies with concern on reporting UE location with any granularity during initial access, RAN2 will revisit agreement/solution for reporting UE location during initial access.
2. RAN2 decide on definition of coarse UE location information, whether it is (1) Truncated GNSS coordinate (i.e., X MSB bits out of 24 bits of longitude/latitude) or (2) v2x like zone ID or (3) virtual cell identifier.

Following proposals regarding how to carry UE location during initial access are brought up in [1], [2] and [7].

1. *The coarse location information is reported in Msg5 [1].*
2. *UE reports zone ID in RRCSetupComplete* message *or using MAC CE [2].*
3. *RAN2 to agree that UE reports its location info directly in the initial access mode, i.e. via RRCSetupComplete message and or RRCResumeComplete to NR-RAN [7]*

Based on majority support, Rapporteur suggests following.

1. The coarse location information is reported in Msg5, i.e., via *RRCSetupComplete*/*RRCResumeComplete* message.

**Configuration and granularity of coarse location information**

The granularity of the coarse location information may need to be configured by network based on different scenario, e.g., the cell coverage is across international border or in the middle of the ocean.

Following is proposal from [1].

*Truncated GNSS coordinate (i.e., X MSB bits out of Y bits of longitude/latitude) is reported as coarse location information with 2km or more radius accuracy before AS security is established, e.g. during initial access (here, value of X can be configured by network).*

Following is proposal from [2].

*the following information is provided in SIB to enable calculation of zone ID, i.e. geographical origin coordinates, zone length and width ( ~4km or more to fulfil the requirement), ZoneNumPerRow.*

Following is proposal from [9]

*If the UE is required to determine and report the virtual cell ID, the gNB broadcasts in System Information the assistance information such as information about hierarchical regions.*

Rapporteur suggests following.

1. For coarse UE location reporting during initial access, the location granularity (i.e., accuracy to be 2 km radius or x>2 km radius) is indicated to UE via SIB.

**Validation of UE’s coarse location information**

Regarding how network can verify UE’s reported location, following is proposed in [3].

*The UE shall transmit uplink reference signal (e.g. SRS) and report the time difference between transmitted uplink reference signal and received downlink reference signal. The reporting may be done within the RRCSetupComplete message.*

*FFS: Whether further measurement need to be reported by the UE (e.g. Tx-Rx time difference to non-serving satellites, if it can receive the signal)*

Rapporteur thinks existing LCS framework can be used by network to verify UE’s location if needed. Rapporteur suggests following.

1. RAN2 decide if any enhancements to validate the UE’s coarse location information is needed.

## UE location reporting in RRC\_CONNECTED

**Granularity of UE location report**

Following is proposal from [1]

*NG-RAN can obtain a GNSS location from the UE after AS security is established using existing signalling method, i.e., by configuring includeCommonLocationInfo in the corresponding reportConfig.*

Following is proposal from [2]

*RAN2 to discuss how to support zone ID reporting in connected mode, and the following options can be considered:*

Following is proposal from [6]

*RAN2 prefer to acquire UE location information with an accuracy comparable to TN cell granularity after AS security is activated.*

*To ensure that the CGI constructed by NG-RAN can correspond to a fixed geographical area comparable with a TN cell with a radius of ~2km or more, UE can either report the CGI of detected TN cell as assistance information or report the location information directly using the following ASN.1.*

*-- ASN1START*

*Ellipsoid-Point ::= SEQUENCE {*

 *latitudeSign ENUMERATED {north, south},*

 *degreesLatitude INTEGER (0..8191), -- 13 bit field*

 *degreesLongitude INTEGER (-8192..8191) -- 14 bit field*

*}*

*-- ASN1STOP*

The coarse location information is clarified in proposal 1. In addition to CGI mapping, the gNB may need the finer UE location information for other purposes such as measurement configuration and UL scheduling. Rapporteur suggests following

1. RAN2 decide whether the UE reports coarse UE location information (as defined by proposal 1) or full GNSS coordinates to gNB in RRC\_CONNECTED, i.e., after AS security has been established.

**Location report transmission**

[1] proposes that existing measurement reporting procedure can be used for periodic and event trigger-based location reporting.

1. *NG-RAN can obtain a GNSS location from the UE after AS security is established using existing signalling method, i.e., by configuring includeCommonLocationInfo in the corresponding reportConfig* ***[1].***
2. After AS security is established, gNB can obtain a GNSS-based location information from the UE using existing signalling method, i.e., by configuring *includeCommonLocationInfo* in the corresponding *reportConfig*.

**Location report trigger:**

Following is a question in RAN3 LS [8]

***Question 3:*** *RAN3 welcomes any feedback from RAN2 on the described case (i.e. the gNB to trigger inter-AMF handover when crossing country borders).*

It is agreed in RAN2#112e meeting that location-based measurement event is supported. The details are FFS but it is possible that if UE moves and crosses the country border, it can trigger the measurement report which can include UE’s current location information. In addition, periodic measurement report as existing procedure in NR can be configured to make sure the UE does not stay in a new location for a longer duration undetected. For this purpose, the signalling enhancement to configure location-based measurement and periodic measurement together can be considered. This can be sufficient for gNB to decide if it wants to trigger inter-AMF handover.

Following proposals are brought up in different contributions.

1. *Periodic measurement reporting and location-based measurement event are sufficient to update gNB on location of mobile UEs in RRC\_CONNECTED* ***[1].***
2. *RAN2 to discuss how to support zone ID reporting in connected mode, and the following options can be considered* ***[2]:***

*Option 1: network can request UE to report zone ID;*

*Option 2: UE can report zone ID when some condition is met, e.g. UE has moved to another zone.*

1. *Respond to RAN3 that with the assistance information or location information in proposal 6, gNB is able to know when the UE moves across the country border, in case the serving NTN cell serves more than one country* ***[6].***
2. *RAN2 to agree that UE responds its location info per NG-RAN’s request in RRC\_CONNECTED mode. RAN2 to agree that NG-RAN may obtain UE’s location info periodically or event triggered in RRC\_CONNECTED mode* ***[7].***

Rapporteur suggests following.

1. Periodic reporting and location-based event triggered reporting are configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED.
2. RAN2 discuss whether UE location reporting upon request from the gNB is necessary.

# Conclusion

Following observation and proposals are made.

Observation 1. If SA3 replies with concern on reporting UE location with any granularity during initial access, RAN2 will revisit agreement/solution for reporting UE location during initial access.

Proposal 1 RAN2 decide on definition of coarse UE location information, whether it is (1) Truncated GNSS coordinate (i.e., X MSB bits out of 24 bits of longitude/latitude) or (2) v2x like zone ID or (3) virtual cell identifier.

Proposal 2 The coarse location information is reported in Msg5, i.e., via *RRCSetupComplete*/*RRCResumeComplete* message.

Proposal 3 For coarse UE location reporting during initial access, the location granularity (i.e., accuracy to be 2 km radius or x>2 km radius) is indicated to UE via SIB.

Proposal 4 RAN2 decide if any enhancements to validate the UE’s coarse location information is needed.

Proposal 5 RAN2 decide whether the UE reports coarse UE location information (as defined by proposal 1) or full GNSS coordinates to gNB in RRC\_CONNECTED, i.e., after AS security has been established.

Proposal 6 After AS security is established, gNB can obtain a GNSS-based location information from the UE using existing signalling method, i.e., by configuring *includeCommonLocationInfo* in the corresponding *reportConfig*.

Proposal 7 Periodic reporting and location-based event triggered reporting are configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED.

Proposal 8 RAN2 discuss whether UE location reporting upon request from the gNB is necessary.

# references

[1] R2-2107567, “Discussion on RAN3 LS reply on UE location” Qualcomm Incorporated.

[2] R2-2107343, “Discussion on V2X-like zone ID”, Huawei, HiSilicon.

[3] R2-2107150, “Virtual cells for network verified UE position in NTN networks”, Fraunhofer IIS; Fraunhofer HHI; Thales.

[4] R2-2107077, “Discussion on UE location aspects in NTN”, OPPO.

[5] R2-2106543, "New LS on UE location aspects in NTN", RAN2#115e, 19-27 May 2021.

[6] R2-2108606, “TAC update and UE location report”, ZTE corporation, Sanechips.

[7] R2-2107316, “Further Discussion on LCS and TAC aspects in NTN”, CATT.

[8] R2-2106941, “Reply LS on UE location aspects in NTN (R3-212917; contact: Qualcomm)”, RAN3.

[9] R2-2107284, “Area Management in an NTN”, Samsung Research America, Thales, Rakuten Mobile, and Apple.