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**Title: [DRAFT] Summary of Agenda Item 8.11.5 - GNSS positioning integrity**

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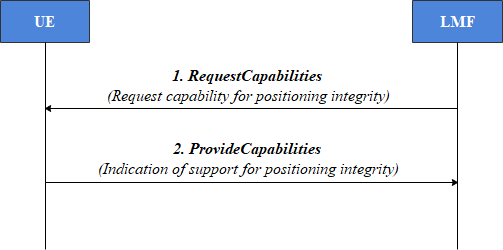
# 1 Introduction

This document aims to provide a summary of papers submitted to AI 8.11.5 (GNSS Positioning Integrity) in RAN2 #114e, which captures the main issues that have been raised by more companies, in order to identify proposals that RAN2 can discuss to at least reach some preliminary agreements for this topic.

# 2 Identified Issues for GNSS Positioning Integrity

## 2.1 Capability for GNSS Positioning Integrity Support

Several papers have mentioned that capability transfer procedures should be enhanced, such that LMF and UE can exchange information about capability to support positioning capability [1][2][5][9][11][13]. In particular, it is highlighted that the LPP messages *RequestCapabilities* and *ProvideCapabilities* can be used to request and indicate capability information respectively:



Moreover, it is proposed in [9] that positioning capability information should at least indicate whether integrity PLs can be provided and also the range of TIR values for which the integrity algorithm, if implemented, can provide valid PLs. On the other hand, [8] has introduced the concept of “integrity level classification” to reflect the required integrity performance of the system, which could be used to indicate the capability for integrity support as well. The rapporteur suggests RAN2 can first agree that integrity capability transfer over LPP is needed, and detailed contents of capability information can be FFS:

**Proposal 1: RAN2 confirms that LPP messages *RequestCapabilities* and *ProvideCapabilities* are used to transfer capability information of positioning integrity support. FFS the contents of capability information for positioning integrity support.**

## 2.2 Liaison with RTCM

During RAN2 #113bis-e, possibility of liaising with RTCM has been briefly discussed. Several companies have expressed the interest of liaising with RTCM for positioning integrity [3][8][9][11][14]. It is known that the standard body of RTCM (Radio Technical Commission for Maritime Services) SC-134 is currently also developing message to support GNSS positioning for various use cases, in parallel to the work in 3GPP. As there could be some commonalities in terms of concepts and functions for integrity support between the two SDOs, it is indeed beneficial if 3GPP and RTCM can cooperate to specify a unified solution for positioning integrity support without too much fragmentation in terms of solutions. However, companies seem to have different views on the scope of such liaison. For instance, [3] has mentioned that 3GPP RAN2 may share TR 38.857 with RTCM SC134, [8] thinks that 3GPP could liaise with RTCM SC104 on the work done in Rel-16 for QZSS SSR, and [11] think RAN2 can first agree on the assistance data in Table 1 of [11] and then ask RTCM to provide feedback. The rapporteur tends to think we can first confirm that liaison with RTCM is beneficial and needed, and the exact scope of such liaison can be FFS.

**Proposal 2: RAN2 confirms that liaison with RTCM for GNSS positioning integrity support is beneficial from RAN2’s perspective. FFS the scope of such liaison if RAN2 agrees to liaise with RTCM.**

## 2.3 Network-Assisted and UE-Assisted Integrity Methods

Depending on whether integrity result is derived at the UE or at the network (i.e. LMF) and the entity providing assistance data, the integrity methods can be classified into:

* Network-assisted integrity method (a.k.a. UE-based integrity): Assistance data is provided from LMF to UE, and the integrity result is derived by UE)
* UE-assisted integrity method (a.k.a. network-based integrity): Assistance data is provided from UE to LMF, and the integrity result is derived by LMF.

In [1], it proposes that integrity method should be determined by the LMF. The rapporteur thinks this should be straightforward and RAN2 can first confirm that both of these methods will be supported by Rel-17.

**Proposal 3: RAN2 confirms that both Network-assisted integrity method (integrity is derived by UE) and UE-assisted integrity method (integrity is derived by LMF) will be specified in Rel-17. LMF may determine the integrity method to be applied. FFS how these methods will be supported in Rel-17.**

It is noted that [2][3][5] have highlighted that assistance data of feared event can vary depending on the integrity method. For instance, it is proposed by [3] that:

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| * For UE-based positioning integrity, the assistance data transferred from LMF to UE contains at least the following: Feared events in the GNSS assistance data, Feared events during positioning data transmission and GNSS feared events * For UE-assisted positioning integrity, the assistance data transferred from UE to LMF contains at least UE feared events (e.g. GNSS measurement errors, HW/SW faults in UE) |

Similarly, [2] has mentioned the following:

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| * For UE-based positioning, the following integrity assistance information that may be transferred from LMF to UE should be considered:   + Feared events in the GNSS Assistance Data, e.g. validity or quality flags for existing assistance information;   + Feared events during positioning data transmission, e.g. CRC, data authentication/signature;   + GNSS feared events, e.g. satellite health/quality flags, ionospheric indicator, tropospheric indicator, multipath, spoofing, interference. * For LMF-based positioning, the following integrity assistance information that may be transferred from UE to LMF should be considered:   + UE feared events, e.g. GNSS receiver measurement error. For example, a refined measurement quality can be introduced for the carrier phase measurement, code-phase measurement, etc., which indicates the measurement quality with a higher percentile error bound or the long term error distribution. |

It seems [2] has assumed that only UE-based positioning is only considered for Network-assisted integrity method, while LMF-based positioning is only considered for UE-assisted integrity methods. In other words, the entity derives the position estimate is always the same as the entity deriving the integrity result. This is aligned with what has been proposed in [14]: **RAN2 shall consider that an entity which is responsible for the estimate location calculation should also handle the positioning integrity calculation.** Therefore, the rapporteur would like to confirm this is the common assumption/understanding among companies in RAN2.

**Proposal 4: In Rel-17, RAN2 only considers UE-based positioning for Network-Assisted Integrity method and LMF-based positioning for UE-Assisted Integrity method.**

## 2.4 Positioning Integrity QoS Requirements

During the SI phase, RAN2 has defined a set of positioning integrity KPIs (including AL, TIR and TTA) that can be provided to the integrity computing entity, and so that integrity result can be derived properly to check if the requirements are met. In TR 38.857, the integrity requirements of different use cases are captured. It was proposed in [8][15] that integrity requirement should be associated to QoS requirement, and hence RAN2 should send LS to SA1, SA2, and CT4, so these groups can take integrity related QoS into account in their specifications. Similarly, [2] also proposes that LS should be sent to SA1/SA2 (and put CT1/CT4 in cc) in order to specify integrity KPIs.

As aforementioned, [8] has also proposed the concept of “integrity level classification”:

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| Fig. 1 A simple example of integrity level classification   * **No integrity**: It can mean that the system has no means to assess the integrity level of the positioning estimation. As there is no systematic way, there is no way to justify the reliability and/or timeliness (actuality) of the obtained position estimation from the UE or the network. * **Low integrity**: It can mean that the integrity KPIs and thresholds are defined; however, the AL and PL are set with large offset such that the system rarely has any issue with unavailability or misleading operation. The position error can also be quite high while both the network and the UE are not alerted about it. * **Medium integrity**: It can mean that the integrity KPIs and thresholds are defined, and the AL and PL are set such that sometimes the system may provide failure errors due to unavailability of proper position estimation, or notifying on the potential of misleading information, etc. * **High integrity:** It can mean that the integrity KPIs and thresholds are defined, and the AL and PL are set such tight that unless the positioning error is below some small amount, the system would not accept the performance and there is a need to repeat the measurement or add extra positioning technique to improve the position estimation. So as long as the system reports a position estimation, it is quite highly guaranteed that it is a very reliable value. |

The rapporteur thinks whether “integrity level classification” should be supported requires some further discussions in RAN2. For the time being, we can first confirm integrity requirements are associated to QoS.

**Proposal 5: RAN2 confirms positioning integrity requirements are associated to QoS, and send LS to SA1, SA2, CT1, and CT4 for relevant specification work. FFS whether the concept of “integrity level classification” should be supported in Rel-17.**

Another aspect relating to integrity requirements is what KPI parameters should be provided to the integrity computing entity (which is either UE or LMF depending on the integrity method) via LPP. It was mentioned by [2][3][7][11] that AL, TIR, and TTA should be provided. On the other hand, [9] mentions that a set of TIRs should be included in the message providing such requirement, while AL, TTA, and integrity availability are not necessary unless integrity event flagging is adopted as one of the reporting modes.

**Proposal 6: RAN2 confirms that positioning integrity requirement information (a.k.a. KPIs) including AL, TIR, and TTA can be provided to the integrity computing entity (either UE or LMF) over LPP. FFS the need of TIR set.**

## 2.5 Positioning Integrity Results Reporting

In TR 38.857, we have identified two modes of positioning integrity result reporting:

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| * **Mode 1 of Integrity Result Reporting : PL Reporting**   The integrity computing entity calculates the PL, based on the measurement, assistance information and TIR. Then, the calculated PL is directly reported to where the LCS client resides (Network or UE). Hence, the integrity computing entity does not judge whether the positioning system is still available, it simply provides whatever PL value it has obtained. It is left to the LCS client itself to determine if the positioning system is still available based on the reported PL.   * **Mode 2 of Integrity Result Reporting : Integrity Event Flagging**   The integrity computing entity calculates the PL, based on the measurement, assistance information and TIR. Then, the integrity computing entity further compares the calculated PL with the given AL to determine if the positioning system is still available to offer trustable position estimation. Thus, the integrity computing entity may only have to report a binary flag (0 and 1) to indicate whether the positioning system is available or not. Thus, in this case the LCS client can be directly informed about the system availability, without conducting further evaluation by itself. |

It was explicitly/implicitly mentioned by [2][3][4][7][8][12] that both of these reporting modes should be supported, in order to provide some flexibility depending on the use case. In light of this, both [4] and [7] have proposed a new indicator that should be introduced in LPP in order to indicate which mode is to be applied. Moreover, several papers (including [2] and [7] ) have pointed out that *RequestLocationInformation* and *ProvideLocationInformation* in LPP can be used to support integrity result reporting. Also, [9] generally thinks that only Mode 1 is needed, but Mode 2 could be supported if it is reported along with PL.

It is noted that [2] further proposes that a finer granularity for Mode 2 reporting, so the “degree of integrity risk” could be indicated as well. Also, [11] believes “achievable KPI” should be reported instead of flagging the integrity event, which are the actual KPIs that were achieved during the integrity computation. From the rapporteur perspective, RAN2 should be able to first agree that at least Mode 1 and Mode 2 can be supported in Rel-17 as they are already identified in the SI phase. The other types of reporting can be leave to FFS for the time being.

Additionally, some mechanisms associating to integrity result reporting have been proposed. [4] proposes a timer based on TTA for the UE to check if positioning system is still available, while [12] suggests that reporting mechanism can be optimized by conditional or adjustable reporting interval, to reduce radio resource usage. The rapporteur thinks these are options for optimizations that can be discussed later.

**Proposal 7: RAN2 confirms that at least integrity result reporting mode 1 (PL reporting) is supported in Rel-17. The messages *RequestLocationInformation* and *ProvideLocationInformation* in LPP are used for signalling relating to integrity result reporting. FFS if other types of reporting (including Mode 2) and/or optimization mechanisms are needed.**

## 2.6 Assistance Data of Feared Events

In order to calculate the integrity results, some assistance data relating to feared events are needed. As mentioned previously, several papers including [2][3][5] have pointed out certain types of feared events that should be considered in different integrity methods. However, these papers are still quite high-level and did not provide much details about exactly what information should be conveyed as the assistance data of feared events. In [7], it was pointed out that many error sources relating to satellite faults are already supported by existing LPP, and therefore RAN2 should first identify what information is necessary but not yet supported. On the other hand, [11] has provided a very detailed list of parameters that can be provided as assistance data for integrity support. In contrast, [9] has made some observations indicating that the usefulness of the assistance data is really hinge on the algorithm that is implemented for integrity monitoring, and it is preferrable to liaise with RTCM for specifications of assistance data parameters. In addition, [6] has proposed that UE should be able to report feared events relating to GNSS local environment, by methods such as crowd-sourcing.

Apparently, the views on what feared event parameters should be included in the assistance data are still quite diverged in RAN2. Also, due to the high complexity nature of this issue, it requires more extensive discussion in RAN2 to narrow down the scope and identify the parameters that should be specified in Rel-17. Given that there are some prospects of liaison with RTCM (according to Proposal 2), the rapporteur tends to think that for now we can postpone this issue and focus on specification of more fundamental functionalities to support positioning integrity (e.g. information transfer for integrity requirement and integrity result delivery) in Rel-17. The scope of feared event assistance data may become more clear if we can receive more information from RTCM in the near future.

**Proposal 8: RAN2 confirms that assistance information for positioning integrity may include:**

**- Feared events in the GNSS Assistance Data**

**- Feared events in transmitting the data to the UE**

**- GNSS feared events**

**- UE feared events**

**RAN2 continues to discuss details about assistance data parameters required for GNSS positioning integrity support after RAN2 #114e. Possible liaison with RTCM may be taken into account.**

# 3 Conclusion

This document provides a summary of papers submitted to AI 8.11.5 for RAN2 #114e. In order for RAN2 to make some meaningful progress for GNSS positioning integrity in this WI, we tend to focus on issues that are potentially easier for RAN2 to reach consensus. We have the following proposals:

**Proposal 1: RAN2 confirms that LPP messages *RequestCapabilities* and *ProvideCapabilities* are used to transfer capability information of positioning integrity support. FFS the contents of capability information for positioning integrity support.**

**Proposal 2: RAN2 confirms that liaison with RTCM for GNSS positioning integrity support is beneficial from RAN2’s perspective. FFS the scope of such liaison if RAN2 agrees to liaise with RTCM.**

**Proposal 3: RAN2 confirms that both Network-assisted integrity method (integrity is derived by UE) and UE-assisted integrity method (integrity is derived by LMF) will be specified in Rel-17. LMF may determine the integrity method to be applied. FFS how these methods will be supported in Rel-17.**

**Proposal 4: In Rel-17, RAN2 only considers UE-based positioning for Network-Assisted Integrity method and UE-assisted positioning for UE-Assisted Integrity method.**

**Proposal 5: RAN2 confirms positioning integrity requirements are associated to QoS, and send LS to SA1, SA2, CT1, and CT4 for relevant specification work. FFS whether the concept of “integrity level classification” should be supported in Rel-17.**

**Proposal 6: RAN2 confirms that positioning integrity requirement information (a.k.a. KPIs) including AL, TIR, and TTA can be provided to the integrity computing entity (either UE or LMF) over LPP. FFS the need of TIR set.**

**Proposal 7: RAN2 confirms that at least integrity result reporting mode 1 (PL reporting) is supported in Rel-17. The messages *RequestLocationInformation* and *ProvideLocationInformation* in LPP are used for signalling relating to integrity result reporting. FFS if other types of reporting (including Mode 2) and/or optimization mechanisms are needed.**

**Proposal 8: RAN2 confirms that assistance information for positioning integrity may include:**

**- Feared events in the GNSS Assistance Data**

**- Feared events in transmitting the data to the UE**

**- GNSS feared events**

**- UE feared events**

**RAN2 continues to discuss details about assistance data parameters required for GNSS positioning integrity support after RAN2 #114e. Possible liaison with RTCM may be taken into account.**

# 4 References

[1] R2-2104843, Discussion on methodologies for network-assisted and UE-assisted integrity, vivo

[2] R2-2105218, Discussion on network-assisted and UE-assisted integrity, Huawei, HiSilicon

[3] R2-2105308, Discussion on procedures and signalling for GNSS positioning integrity InterDigital, Inc.

[4] R2-2105524, Discussion on supporting positioning integrity in RAN, OPPO

[5] R2-2105563, Discussion on signalling and procedures for GNSS positioning integrity, Xiaomi

[6] R2-2105735, UE-aided detection of threat to GNSS systems and assistance data signaling, Fraunhofer IIS; Fraunhofer HHI; Ericsson discussion

[7] R2-2105874, Positioning Integrity Support in LPP, Nokia, Nokia Shanghai Bell

[8] R2-2105970, On GNSS Integrity, Ericsson

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[14] R2-2106428, Discussion on positioning integrity data calculation and LS to RTCM, ZTE Corporation, Sanechips

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