3GPP TSG-RAN WG2 Meeting #115-e***R2-21xxxxx***

Electronic, Aug 16 – 27, 2021

**Agenda item:** X.XX.X

**Source:** Swift Navigation (Rapporteur)

**Title:** [Post114-e][601][POS] GNSS integrity assistance information, KPIs, and reporting of integrity results (Swift)

**Document for:**  Discussion, Agreement

# 1. Introduction

This document is to trigger the following email discussion:

* [Post114-e][601][POS] GNSS integrity assistance information, KPIs, and reporting of integrity results (Swift)

Scope: Discuss the contents of GNSS integrity assistance information, the signalled KPIs, and reporting of the integrity results.

Intended outcome: Report to next meeting

Deadline: Long

Companies are asked to provide their views on the stated topics and questions. It is anticipated that this email discussion will be undertaken in multiple phases in order to prepare the final report.

The topics are grouped into 3 categories corresponding to the email discussion scope:

1. Contents of the GNSS integrity assistance information
2. Contents of the signaled KPIs
3. Contents and reporting of the integrity results

First round feedback is due **Friday 25-Jun-2021 23:59 UTC** before the inactive period commences in July.

# 2. Contents of the GNSS integrity assistance information

At RAN2#114-e the following proposal was made [1]:

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. Possible liaison with RTCM may be taken into account.

Therefore, the focus of this section is to:

1. Discuss which of the feared events need to be addressed as part of the WI in order to support GNSS positioning integrity determination in 3GPP;
2. Discuss which assistance data parameters need to be specified as part of the WI in order to mitigate the impact of the feared events identified in (a).

## 2.1 Feared event considerations

First, we revisit the summary of the A-GNSS feared events and integrity assistance information considerations identified in Table 9.4.1.1 in the Study [2]:

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| **Feared Event Category** | **Feared Event** | **Examples of positioning integrity assistance information (FFS)** |
| 1. Feared events in the GNSS Assistance Data | Incorrect computation of the GNSS Assistance Data, e.g. software bug, corrupt or lost data | Validity or quality flags for existing assistance information |
| External feared event impacting the GNSS Assistance Data, e.g. satellite, atmospheric or local environment feared events (Category 3) impacting the GNSS reference stations in the GNSS correction provider's network. |
| 2. Feared events during positioning data transmission | Data integrity faults | Data corruption check, e.g. CRC |
| Data Authentication / Signature |
| 3. GNSS feared events | Satellite feared events  e.g. bad signal-in-space or bad broadcast navigation data | Satellite health or quality flags |
| Atmospheric feared events | Ionospheric indicator |
| Tropospheric indicator |
| Local Environment feared events, e.g. Multipath, Spoofing, Interference | Assistance information: Trustable time reference, Data Authentication / Signature, Regionalized indicator of multipath, interference, jamming, spoofing, etc |
| 4. UE feared events | GNSS receiver measurement error | *e.g., GNSS-MeasurementList* |
| Hardware faults | \* |
| Software faults | \* |
| 5. LMF feared events | Hardware faults | \* |
| Software faults | \* |
| NOTE: The positioning integrity assistance information IEs are FFS as part of the WI.  **\***NOTE: The UE or LMF are responsible for mitigating these feared events locally, outside the scope of the specifications. | | |

Table 1: Summary of A-GNSS feared events and integrity assistance information considerations [2].

Five categories of feared events are identified in Table 1:

1. Feared events in the GNSS Assistance Data
2. Feared events during positioning data transmission
3. GNSS feared events
4. UE feared events
5. LMF feared events

Question 1: Please identify which of the feared event categories in Table 1 need to be addressed in the WI in order to support GNSS positioning integrity determination in 3GPP. Explain your reasoning.

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| Company | Feared Event Category  Yes / No / FFS | | | | | Comments |
| 1) | 2) | 3) | 4) | 5) |
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## 2.2 GNSS integrity assistance data parameters

GNSS integrity messages can be sent as assistance data between the LMF and the UE. At RAN2#114-e there were several integrity messages / indicators proposed in the contributions, including the proposals in [8][11][12][13]. Before the messages can be defined, the rapporteur suggests that RAN2 first agree on the A-GNSS positioning techniques (e.g. RTK/PPP/PPP-RTK [17]) that should be supported in the WI, and therefore which of these techniques require integrity information to be sent in the assistance data. Then we can begin defining the contents of these messages in future discussions.

Question 2: Please indicate (Yes/No) which of the A-GNSS positioning techniques (RTK / PPP / PPP-RTK) in LPP should support integrity?

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| **Company** | **RTK** | **PPP** | **PPP-RTK** | **Comments** |
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Question 3: Which of the A-GNSS positioning techniques (RTK / PPP / PPP-RTK) in LPP require additional assistance data to be defined to support integrity? Please explain your reasoning.

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| **Company** | **RTK** | **PPP** | **PPP-RTK** | **Comments** |
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The topic of interoperability has also been raised in [11][13] given traditional integrity systems such as SBAS are typically specified end-to-end, including using a prescribed set of algorithms, whereas 3GPP typically requires interoperability at the interface level between different vendors (of the UE and LMF) whose implementations may differ.

*Note: The Rapporteur believes that although this may seem like a trivial point, it is important to have clear consensus on the scope of interoperability. It may have impacts on the normative work as additional considerations may need to be given to ensure a broader degree of interoperability than has been demonstrated in existing systems where implementation details and user algorithms are prescribed in the standard.*

Question 4: How should the topic of interoperability with respect to integrity be handled in the specifications?

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Question 5: Any other comments?

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# 3. Contents of the signalled KPIs

During the SI phase, RAN2 has defined a set of positioning integrity KPIs (including AL, TIR and TTA) that can be provided to the entity that computes the integrity. The following proposals were presented for discussion at RAN2#114-e [1]:

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.

It has been discussed in the contributions [1][4][5][7][9][13][15] that the *RequestLocationInformation* and *ProvideLocationInformation* procedures in LPP can be reused to transfer the KPIs between the LMF and the UE. It has been further discussed in [1][4][10][12] whether the KPIs can be associated to the QoS, and if so, whether the required signaling should be discussed with CT4.

The rapporteur suggests that we first discuss and agree on the preferred procedures for transferring the KPIs before determining what (if any) LSs are required for defining the signalling.

Question 6: Do you agree that the RequestLocationInformation and ProvideLocationInformation procedures in LPP should be used transfer the KPIs (TIR, AL and TTA)? Explain your reasoning.

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Question 7: Do you agree that the KPIs can be associated to the QoS signalling? Explain your reasoning.

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Question 8: Any other comments?

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# 4. Contents and reporting of the integrity results

At RAN2#114-e the following proposal was made [1]:

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.

Modes 1 and 2 (described below) have being considered in many of the contributions [1][4][5][6][9][10][11][13]. Other types of reporting have also been suggested, including adding more categories of availability to Mode 2 [4] and sending the Achieved KPIs [13] (e.g. the degree of accomplishment of the KPIs [11]). It has also been discussed in [1][4][5][7][9][15] that the *RequestLocationInformation* and *ProvideLocationInformation* procedures in LPP can be used to report the integrity results.

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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. |

The rapporteur suggests that RAN2 should first discuss what information may be included in the integrity results in order to satisfy the GNSS positioning integrity objectives of the WI. Then we can determine if / how the integrity results can be differentiated into different modes as part of the specifications.

Question 9: Please indicate what information should be included in the integrity results? Describe your reasoning.

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| **Company** | **Protection Level** | **Integrity Flag(s)** | **Other** | **Comments** |
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Question 10: Do you agree that the RequestLocationInformation and ProvideLocationInformation procedures in LPP should be used to report the integrity results?

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Question 11: Any other comments?

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# 5. References

1. R2-2106453, [Pre114-e][609][POS] Summary on agenda item 8.11.5 on GNSS integrity (Nokia), Nokia.
2. TR 38.857, 3GPP TSG RAN Study on NR Positioning Enhancements; (Release 17), V2.0.0.
3. R2-2104843, Discussion on methodologies for network-assisted and UE-assisted integrity, vivo.
4. R2-2105218, Discussion on network-assisted and UE-assisted integrity, Huawei, HiSilicon .
5. R2-2105308, Discussion on procedures and signalling for GNSS positioning integrity, InterDigital, Inc.
6. R2-2105524, Discussion on supporting positioning integrity in RAN, OPPO.
7. R2-2105563, Discussion on signalling and procedures for GNSS positioning integrity, Xiaomi.
8. R2-2105735, UE-aided detection of threat to GNSS systems and assistance data signaling, Fraunhofer IIS; Fraunhofer HHI; Ericsson.
9. R2-2105874, Positioning Integrity Support in LPP, Nokia, Nokia Shanghai Bell.
10. R2-2105970, On GNSS Integrity, Ericsson.
11. R2-2105985, Guiding framework on integrity concepts for A-GNSS positioning, ESA.
12. R2-2106085, Considerations on GNSS positioning integrity support, Qualcomm Incorporated.
13. R2-2106105, Proposals on GNSS integrity assistance information, Swift Navigation.
14. R2-2106371, Consideration on the signalling design for Positioning Integrity, Samsung Electronics.
15. R2-2106427, Discussion on positioning integrity transportation, ZTE Corporation, Sanechips.
16. R2-2106428, Discussion on positioning integrity data calculation and LS to RTCM, ZTE Corporation, Sanechips.
17. TR 38.305, Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN, Release 16.