3GPP TSG-RAN WG2 Meeting #117 ***R2-220xxxx***

Electronic Meeting, February 21 – March 3, 2022

**Agenda item:** 8.11.1

**Source:** ESA

**Title:** [Pre117-e][610][POS] Open issues on GNSS positioning integrity (ESA)

**Document for:**  Discussion

# 1. Introduction

The following email discussion has been triggered after RAN2#116bis-e:

**[Pre117-e][610][POS] Open issues on GNSS positioning integrity (ESA)**

The discussion below is mainly based on the open issues provided by the following contributions:

* R2-2201722 Summary of [Post116bis-e][628][POS] 37.355 running CR (Qualcomm)
* R2-2202005 Report of email discussion [Post116bis-e][634][POS] Positioning open issues list (Intel)
* R2-2201765 GNSS integrity – Extended Discussion (Stage 3) (Swift Navigation)

# 2. Contact Information

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| --- | --- |
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| ESA | Florin-catalin.grec@esa.int |
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# 3. Open issues

## 3.1 Summary Open Issues

- The below issues have been extracted from the R2-2202005 after cross-checking their status with R2-2201722 and R2-2201765.

- As a reminder, an open issue is an issue critical to the completion of the WI as marked in the R2-2202005.

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| **Topic** | **Open issues**  **Note:** Open Issues should be defined for aspects that need to be closed, important to make already agreed functionality work in a reasonable way. Not yet agreed optimizations that may not be needed shall not be listed as Open Issues. | **Related to the completion of WI?**  **The topic has to be removed from Rel-17 scope if the corresponding open issues cannot be resolved.** | **Remark** |
| **Stage 3 details** | #1. RAN2 to discuss whether to modify the existing GNSS-RealTimeIntegrity IE or create a new IE to accommodate the Alerts for the satellite/constellation specific DNUs under GNSS-GenericAssistData.  Discuss whether a Constellation DNU and per-signal DNU should be included in addition to the SV DNU. | Yes | **Status:** Discussion in R2-2201765. check the status of LPP email discussion 116bis-628 |
| #2. RAN2 to discuss whether or not the cross-covariance should be included for the Orbit and Clock integrity bounds and whether these bounds should be included as a new IE or within the existing SSR Orbit and Clock IEs. | Yes | **Status:** Discussion in R2-2201765. check the status of LPP email discussion 116bis-628 |
| #3. RAN2 to discuss whether the Residual Risk parameters proposed in Table 3.2-2 (R2-2201765) should be integrated into their corresponding SSR correction IEs or within a separate standalone IE. | Yes | **Status:** Discussion in R2-2201765. check the status of LPP email discussion 116bis-628 |
| #4: RAN2 to discuss whether a validity period needs to be defined for each of the bounds and what value ranges are appropriate if so. | Yes | **Status:** Discussion in R2-2201765. check the status of LPP email discussion 116bis-628 |
| #5: RAN2 to discuss which of the assistance data should be sent as periodic assistance data. | Yes | **Status:** Discussion in R2-2201765. check the status of LPP email discussion 116bis-628 |
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# 4. Open issues discussion

## 4.1 Open Issue 1: Update *GNSS-RealTimeIntegrity* or a new IE for DNU flag

R2-2201765 (ED 116bis-611) includes a first discussion on the need to add a new IE to accommodate the alerts for the satellite/constellation specific DNUs under GNSS-GenericAssistData. The possibility to reuse the existing *GNSS-RealTimeIntegrity* IE has been touched on as well in the past.

We also note that RAN2 already agreed that assistance data in GNSS-RealTimeIntegrity can be reused for GNSS integrity in R17.

Agreement captured in R2-2201722 116bis-628

Proposal2-11: The assistance data in GNSS-RealTimeIntegrity can be reused for GNSS integrity in R17

For completion, the GNSS-RealTimeIntegrity is copied below:

#### *GNSS-RealTimeIntegrity*

The IE *GNSS-RealTimeIntegrity* is used by the location server to provide parameters that describe the real-time status of the GNSS constellations. *GNSS-RealTimeIntegrity* data communicates the health of the GNSS signals to the mobile in real‑time.

The location server shall always transmit the *GNSS-RealTimeIntegrity* with the current list of unhealthy signals (i.e., not only for signals/SVs currently visible at the reference location), for any GNSS positioning attempt and whenever GNSS assistance data are sent. If the number of bad signals is zero, then the *GNSS-RealTimeIntegrity* IE shall be omitted.

-- ASN1START

GNSS-RealTimeIntegrity ::= SEQUENCE {

gnss-BadSignalList GNSS-BadSignalList,

...

}

GNSS-BadSignalList ::= SEQUENCE (SIZE(1..64)) OF BadSignalElement

BadSignalElement ::= SEQUENCE {

badSVID SV-ID,

badSignalID GNSS-SignalIDs OPTIONAL, -- Need OP

...

}

-- ASN1STOP

| *GNSS-RealTimeIntegrity* field descriptions |
| --- |
| ***gnss-BadSignalList***  This field specifies a list of satellites with bad signal or signals. |
| ***badSVID***  This field specifies the GNSS *SV‑ID* of the satellite with bad signal or signals. |
| ***badSignalID***  This field identifies the bad signal or signals of a satellite. This is represented by a bit string in *GNSS-SignalIDs*, with a one‑value at a bit position means the particular GNSS signal type of the SV is unhealthy; a zero‑value means healthy. Absence of this field means that all signals on the specific SV are bad. |

**Q1: Do you agree that GNSS-RealTimeIntegrity can be used as it already mentions the unhealthy satellites (therefore, implicitly, also the constellation) and the bad signals? If not, please clarify what the new IE would achieve that GNSS-RealTimeIntegrity cannot.**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA | Y |  | We think this IE represents a good structure for achieving the signalling of unhealthy satellites and even signals. Extension of this IE, if needed, seems more appropriate than duplication. |
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**Q2: Do you agree that a Constellation DNU needs included, in addition to SV DNU?**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA |  | N | In *GNSS-RealTimeIntegrity* constellation is not needed as badSVID can achieve that feature. |
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**Q3: Do you agree that a signal DNU needs to be included, in addition to SV DNU?**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA |  | N | In *GNSS-RealTimeIntegrity* constellation already includes this field. Of course, if RAN2 decides to define a new IE instead of using GNSS-RealTimeIntegrity than signal DNU should also be included. |
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## 4.2 Open Issue 2: Cross-covariance and inclusion of integrity bounds for Clock and Orbit in a new or existing IEs.

From pervious discussion it was not clear why these parameters, for the Orbit and Clock integrity bounds, lead to improved performance in accordance with the principle of operation. There was no strong preference expressed for including these parameters therefore more discussions were recommended.

**Q4: Do you agree that the cross-covariance terms should be included for the Orbit and Clock integrity bounds? Please clarify the reason for your choice.**

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| --- | --- | --- | --- |
| **Company** | **Yes** | **No** | **Comments** |
| ESA |  | Not yet | We think mean and variance are enough. Sending also the cross-covariance is increasing the size of the information to be signalled and its need/criticality is not stated until now. |
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**Q5: Do you agree that the integrity bounds should be included as a new IE or within the existing SSR Orbit and Clock IEs? Please clarify the reason for your choice.**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA | Y |  | We would like to include these parameters in existing IEs in order to minimize the number of new IEs. |
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## 4.3 Open Issue 3: Residual Risk parameters

RAN2 to discuss whether the Residual Risk parameters proposed in R2-2201765 should be integrated into their corresponding SSR correction IEs or within a separate standalone IE. These parameters are used to provide the residual risk parameters related to the satellite, constellation, ionosphere, and troposphere residual risk probabilities.

We first recall past agreements relevant to this point:

Proposal 5: RAN2 agrees to include the Integrity Residual Risk Parameters into their existing corresponding GNSS IEs (as per Appendix A (R2-2201761). This discussion is also subject to the Stage 3 outcomes regarding which Ies and associated fields to define for integrity.

The corresponding mapping between the Stage 2 and Stage 3 fields is shown in Table 3.2-2 extracted from R2-2201765. RAN2 has all agreed to add Mean Fault Duration parameters (in green).

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|  | **Stage 2 Fields (Table 8.1.2.1b-1)** | **Stage 3 Parameters (R2-2201214)** |
| **Integrity Residual Risk Parameters** | ***GNSS-Integrity-OrbitClockErrorBounds*** |
| Block 1 | Probably of Onset of Constellation Fault | *pConstellation* |
| Mean Constellation Fault Duration | *tConstellation* |
| Probability of Onset of Satellite Fault | *pSatellite* |
| Mean Satellite Fault Duration | *tSatellite* |
|  |  | ***GNSS-SSR-STEC-Correction*** |
| Block 2 | Probability of Onset of Ionosphere Fault | *pIonosphere* |
| Mean Ionosphere Fault Duration | *tIonosphere* |
|  | ***GNSS-SSR-GriddedCorrection*** |
| Probability of Onset of Troposphere Fault | *pTroposphere* |
| Mean Troposphere Fault Duration | *tTroposphere* |

**Table 3.2-2: Mapping between the Stage 2 and Stage 3 field descriptions for the Residual Risks.**

In previous discussions several companies have expressed their preference to keep satellite parameters in *GNSS-SSR-OrbitCorrections* IE and clock parameters in *GNSS-SSR-ClockCorrections* IE which raises objection to creation of the a new *GNSS-Integrity-OrbitClockErrorBounds* IE.

To make things simpler, we believe it would be easier to advance by splitting the table from above in two distinct blocks.

**Q6: Do you agree with the mapping from Stage 2 to Stage 3 in Table 3.2-2 for Block 1 parameters, and that these new parameters should be included in the corresponding IEs? Please detail your understanding.**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA |  | Not yet | We think the new parameters in Block 1 should be included in the corresponding IEs as suggested by an old agreement we have (recalled in the beginning of this section). Furthermore, we think the resolution of this point depends on Open Issue 2.  We understand the static nature of these parameters but we do not see any fundamental problem in repeating (unchanged) values at the rate of the GNSS-SSR-OrbitCorrections and GNSS-SSR-ClockCorrections. |
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**Q7: Do you agree with the mapping from Stage 2 to Stage 3 in Table 3.2-2 for Block 2 parameters, and that these new parameters should be included in the corresponding IEs? Please detail your understanding.**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA | Y |  | We think the new parameters in Block 2 should be included in the proposed IEs. |
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## 4.4 Open Issue 4: Validity period for each error bound and value ranges

In R2-2201214 there are certain common parameters proposed to accompany the bounds parameters to indicate validity and applicability of the bound.

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| ***validityPeriodSeconds***  This field specifies the Validity Duration in seconds. The integrity values are only valid for the time interval from *epochTime* to *epochTime* + *validityPeriod*.  Scale factor 1 s; range 1-86,400 s. |
| ***validityPeriodDays***  This field specifies the Validity Duration in days. The integrity values are only valid for the time interval from *epochTime* to *epochTime* + *validityPeriod*. A day is defined to be 86,400 seconds.  Scale factor 1 day; range 1-365 days. |

From past discussions two main options emerged:

* Option 1 – add two new parameters to denote the validity of the new integrity assistance data: ValidityPeriodSeconds and validityPeriodDays
* Option 2 – no need for an validity time as bounds are now included directly in the SSR assistance data

The bounds are valid until new data are received. If something happens between updates, we have the DNU flags. Therefore, the need for a validity time is unclear.

**Q8: Please express your preference for one of the two opinions and motivate your choice.**

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| **Company** | **OP1** | **OP2** | **Comments** |
| ESA |  | X | We think option 2 is enough and validity of bounds lasts until new data is received. |
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Another delegate raised the need for validityPeriodDays. Therefore,

**Q9: If you replied with OP1 at Q8, please clarify what validity parameters should we add.**

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| **Company** | **validityPeriodSeconds** | **validityPeriodDays** | **both** | **Comments** |
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## 4.5 Open Issue 5: Periodic Assistance data for GNSS integrity

It was acknowledged the need to discuss which of the assistance data should be sent as periodic assistance data. This procedure enables a target to request a server to send assistance data periodically. In Rel-16 37.355 specifications, periodic assistance data transfer is supported for HA GNSS (e.g., RTK) positioning only.

**Q10: Do you agree that periodic assistance data for GNSS integrity is needed?**

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| **Company** | **Yes** | **No** | **Comments** |
| ESA | Y |  | Essentially, GNSS integrity feature is an extension of the SSR feature and therefore we find naturally to include GNSS integrity assistance data in the list with Periodic Assistance Data |
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**Q11: Which assistance data should be sent as periodic assistance data?**

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| **Company** | **Comments** |
| ESA | We think new IEs for GNSS integrity need to be provided also periodic, same as it was the case for RTK and SSR features. However, we think that a more clear picture will emerge once we clarify the points from above as they impact Stage 3 and final list of new IEs needed in support of GNSS integrity. |
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