3GPP TSG-RAN WG2 Meeting #113-e***R2-21xxxxx***

Electronic, Jan 25 – Feb 05, 2021

**Agenda item:** 8.11.3.1

**Source:** Swift Navigation

**Title:** [AT113-e][601][POS] Integrity text proposal

**Document for:**  Discussion, Agreement

# 1. Introduction

This document provides the discussion topics and text proposals for the following email discussion:

 **[AT113-e][601][POS] Integrity text proposal (Swift)**

Scope: Continue discussion of the remaining open issues on integrity, taking into account contributions to agenda items 8.11.3.1 and 8.11.3.2, and develop an agreeable text proposal

Intended outcome: Updated TP

Deadline:  Tuesday 2021-02-02 1200 UTC

The purpose is to produce an agreeable TP. The deadline for first round comments is **28 January 2021 2200 UTC**, allowing time for a final review before the official email deadline (2020-02-02).

# 2. Background

This discussion addresses the remaining open issues for the Integrity text proposal, taking into account the contributions submitted to agenda items 8.11.3.1 and 8.11.3.2.

## 2.1 Agenda Item 8.11.3.1 (General topics)

The reference Tdocs for agenda item 8.11.3.1 are listed below:

1. [**R2-2100596**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100596.zip) [Post112-e][618][POS] – Integrity Text Proposal, Swift Navigation
2. [**R2-2100719**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100719.zip) Text Proposals of Definitions Relating to Positioning Integrity Modes, Nokia Nokia Shanghai Bell
3. [**R2-2101390**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101390.zip) On RAT-dependent integrity use cases and error categories, Ericsson
4. [**R2-2101504**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101504.zip) Recommendations for the Integrity Text Proposal , Swift Navigation, Intel Corporation

## 2.2 Agenda Item 8.11.3.2 (Methodologies)

The reference Tdocs for agenda item 8.11.3.2 are listed below, noting that the text and proposals prepared by ESA in the ‘Summary of AI 8.11.3.2 Methodologies for network-assisted and UE-assisted integrity’ [15] are the primary source of inputs which are treated in the discussion below.

1. [**R2-2100106**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100106.zip) Discussion on Methodology for Integrity, OPPO
2. [**R2-2100376**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100376.zip) Discussion on Methodologies for network-assisted & UE-assisted integrity, InterDigital, Inc.
3. [**R2-2100674**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100674.zip) Discussion on the methodologies for network-assisted and UE-assisted integrity, Spreadtrum

Communications

1. [**R2-2100686**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100686.zip) Discussion on methodologies for network-assisted and UE-assisted integrity, Vivo
2. [**R2-2100720**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100720.zip) Positioning Integrity Result Reporting, Nokia, Nokia Shanghai Bell
3. [**R2-2100812**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100812.zip) Discussion on methodologies for positioning integrity, Xiaomi
4. [**R2-2101087**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101087.zip) UE Detection and Signalling of Perceived Threats to GNSS systems, Fraunhofer IIS, Fraunhofer HHI
5. [**R2-2101228**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101228.zip) Discussion of network-assisted and UE-assisted integrity, Huawei, HiSilicon
6. [**R2-2101391**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101391.zip) GNSS Integrity Methodologies Ericsson
7. [**R2-2101437**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101437.zip) Text Proposal to methodologies for GNSS position integrity, ESA
8. [**R2-2101436**](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101436.zip) Summary of AI 8.11.3.2 Methodologies for network-assisted and UE-assisted integrity, ESA

## 2.3 Baseline text

The latest version of the Integrity text proposal was provided in [1]. Other companies also used this TP as the baseline for their contributions to agenda items 8.11.3.1 and 8.11.3.2. Therefore, the text in [1] continues to be used as baseline for addressing the remaining open issues in this email discussion. For traceability and completeness, the proposals which accompanied the text proposal in [1] have been recorded in Table 1.

**Table 1: Summary of proposals presented in R2-2100596 [1].**

Proposal 1: Agree to adopt the term feared event in the TP.

Proposal 2: Agree to remove the term hazardous from the AL definition but adopt the term for general use in the TP.

Proposal 3: Agree to adopt the updated definitions of MI, HMI and Integrity Event in Section 3.1.

Proposal 4: Agree to adopt the AGV examples in Table 9.2.4.

Proposal 5: Agree to adopt the Rail text in Section 9.2.2.

Proposal 6: Rename ‘External feared events’ to ‘GNSS feared events’ in the draft TP and include the following Editor’s Note: ‘GNSS feared events are those which occur external to the UE and potentially impact the quality and availability of the GNSS signals.’

Proposal 7: Rename ‘Feared events in transmitting data to the UE’ to ‘Feared events during positioning data transmission’.

Proposal 8: Rename ‘error sources’ to ‘feared events’.

Proposal 9: Retain the hardware and software faults for UE feared events, noting specification impacts, if any, are FFS.

Proposal 10: Rename Section 9.3.1.1 to ‘A-GNSS Feared Events’

Proposal 11: The integrity models/algorithms for mitigating feared events for GNSS positioning integrity are defined by the service implementation and therefore out of scope of this study.

Proposal 12: Add LMF feared events (9.3.1.1.5) for consideration in the study, noting the specification impacts, if any, are FFS.

Proposal 13: Rename ‘Feared events in the assistance data’ to ‘feared events in the GNSS Assistance Data’.

Proposal 14: Rename ‘Incorrection computation by the provider’ to ‘incorrect computation of the GNSS Assistance Data’.

Proposal 15: Rename ‘External feared event impacting the provider’ to ‘External feared event impacting the GNSS Assistance Data’.

Proposal 16: Agree to include a table summarizing the UE-based and UE-assisted considerations for supporting positioning integrity in 3GPP.

Proposal 17: Agree that triggering alerts is out of scope of the study, FFS as part of the WI.

Proposal 18: Agree that the LPP signaling procedures should be studied for exchanging information between the LMF and the UE to support positioning integrity determination.

Proposal 19: Agree that signaling of integrity assistance data from the GNSS corrections provider (external source) to the LMF is implementation defined and therefore out of scope.

Proposal 20: Agree that signaling requirements (a)(b)(c)(d) (Section 9.4.1.1.1) should be studied for exchanging positioning integrity information.

Proposal 21: Agree to the proposed updates to the table of feared events (Table 9.4.1.1).

Proposal 22: Agree to the proposed updates to table (9.4.1.1.1) for the UE-based and UE-assisted considerations.

Proposal 23: Agree to adopt the text proposal (Section 4 below) as baseline for the TR.

# 3. Discussion [AT113-e][601][POS]

The text and proposals submitted to agenda items 8.11.3.1 and 8.11.3.2 will be handled under three categories:

1. **Already identified for consideration in the baseline TP**
2. **Proposed text changes to the TP**
3. **May require further discussion**

## 3.1 Already identified for consideration in the baseline TP

In the Methodologies summary prepared by ESA [15] the conclusions were divided into ‘*proposals that may be agreeable’* and ‘*proposals that may require further discussion’*. To further streamline this email discussion, many of the proposals in both categories have already been identified for consideration as part of the normative work. A consolidated list of proposals is therefore provided in Table 2.

**Table 2: Moderator summary of proposals from [15] which have already been identified for consideration in the baseline TP [1].**

*NOTE: the numbering of proposals and references are from [15].*

Proposal 2: RAN2 supports detection and reporting of positioning related errors at UE and LMF

Proposal 3: For UE-based integrity method, the assistance data from LMF to UE should include the faults of correction data, feared events in transmitting the data to the UE and external feared events.

Proposal 4: For UE-assisted integrity method, UE needs to send UE feared events to LMF.

Proposal 5: Study the assistance information required for gNB or UE for integrity measurement reporting.

Proposal 9: RAN2 study UE-based solution for integrity, which includes procedures of:

1) LMF sending KPI to UE (for MT-LR),

2) LMF sending assistance information to UE, and

3) UE report integrity result to LMF (for MT-LR).

Proposal 10: RAN2 study UE-assisted solution for integrity, which includes procedures of:

1) UE sending KPI to LMF (for MO-LR),

2) UE sending assistance information to LMF, and

3) LMF report integrity result to UE (for MO-LR).

Proposal 11: UE will calculate the PL for UE-based positioning, while LMF will calculate the PL for LMF-based positioning.

Proposal 13: Integrity capability should be studied in WI.

Proposal 14: To study whether integrity information can be transmitted by existed signal modification without architecture change and new interface introduced.

Proposal 16: RAN2 supports mechanisms for recovering from positioning failure conditions/errors detected at UE and LMF

Proposal 17: For A-GNSS positioning method, Rel-16 Capability Transfer procedure in LPP shall be reused to indicate the UE´s positioning integrity capabilities.

Proposal 18: Integrity KPIs are provided to the UE by the LMF using Assistance Data transfer procedure.

Proposal 19: For UE-based positioning integrity, the Rel-16 assistance data transfer procedure can be reused for the integrity assistance data transfer, for UE-assisted positing integrity, how to transfer integrity assistance data to LMF need to be further studied.

Proposal 20: The Rel-16 LPP location information transfer procedure can be reused for integrity KPIs [3][6][8], integrity results [3][6] and integrity measurements delivering [6].

Proposal 21: Support signalling procedures for UE-assisted integrity (i.e. LMF-based) and network-assisted integrity (i.e. UE-based) as a baseline. Details are FFS.

Proposal 24: Study the enhancement for the quality of service (QoS) metrics for integrity as proposed in [8].

Proposal 25: Study the system framework for positioning integrity and adopt the baseline provided in [8].

**Question 1: Do you agree that the proposals listed in Table 2 should be resolved as part of the normative work?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | Yes | The majority of topics in these proposals have already been identified as FFS in the baseline TP, or are topics relating to specific normative decisions. Therefore, we believe that each of these proposals can be resolved as part of the normative work. We do not see a need to restate or further address these proposals as part of the current study. |
| Intel | Yes | The details of how to support integrity, e.g. procedures, signalling, necessary information, etc can be resolved during WI phase. |
| Fraunhofer | Yes | We could resolve them during the WI phase |
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## 3.2 Proposed text changes to the TP

### 3.2.1 Submissions to AI 8.11.3.1

This section individually addresses the Tdoc submissions to AI 8.11.3.1.

* **R2-2100596 [Post112-e][618][POS] – Integrity Text Proposal, Swift Navigation [1]**
* This is the baseline TP adopted in this email discussion which was described in Section 2.3 above.
* **R2-2100719 Text Proposals of Definitions Relating to Positioning Integrity Modes, Nokia, Nokia Shanghai Bell [2]**

The following proposals were made:

* **Proposal 1: In this SI, RAN2 should only consider the GNSS positioning cases wherein both positioning integrity result and positioning estimation are derived in either UE or network.**
* **Proposal 2: Endorse the text proposal for TR 38.857 in the appendix.**

*First Text Proposal*

**Integrity Computing Entity:** The logical entity responsible in computing the positioning integrity results based on assistance information and integrity KPIs provided by the LCS client. Such entity can reside in either UE or LMF.

**Network-Based Integrity:** The positioning integrity mode where the integrity computing entity resides in the network side (e.g. LMF) to derive integrity results.

**UE-Based Integrity:** The positioning integrity mode where the integrity computing entity resides in the UE to derive integrity results

*Next Text Proposal*

**Table 9.4.1.1.1: Summary of UE-Based and LMF-Based positioning integrity mode considerations for supporting MO-LR and MT-LR in 3GPP.**

NOTE: The table provides a summary of considerations and the final details and specification impacts are FFS in the WI.

\*NOTE: Examples of KPIs are the TIR, AL, TTA. Examples of Integrity results are the PL, Integrity Availability and KPIs.

\*\*NOTE: From LMF to UE does not mean the integrity assistance information is generated by the LMF.

\*\*\*NOTE: Both positioning integrity derivation and positioning estimation are conducted at either UE or LMF.

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| --- | --- | --- | --- | --- | --- |
| **Positioning Integrity Mode\*\*\*** | **Location service type** | **Source of KPIs\*** | **Source of Integrity results\*** | **Positioning Integrity assistance information\*\*** | **Specification impact** |
| UE-based integrity | MO-LR | UE internal implementation | UE internal implementation | From LMF to UE:  - Feared events in the GNSS Assistance Data  - Feared events in transmitting the data to the UE  - GNSS feared events | Procedure to transfer Integrity assistance information from LMF to UE |
| MT-LR | From LMF | From UE | From LMF to UE:  - Feared events in the GNSS Assistance Data  - Feared events in transmitting the data to the UE  - GNSS feared events | Procedure to transfer Integrity assistance information and KPIs from LMF to UE  Procedure to transfer Integrity results from UE to LMF |
| Network-based integrity | MO-LR | From UE | From LMF | From GNSS corrections provider (external source) to LMF:  - Feared events in the GNSS Assistance Data  - Feared events in transmitting the data to the UE  - GNSS feared events  From UE to LMF:  - UE feared events | Procedure to transfer Integrity assistance information and KPIs from UE to LMF  Procedure to transfer Integrity results from LMF to UE |
| MT-LR | LMF implementation | LMF internal implementation | From GNSS corrections provider (external source) to LMF:  - Feared events in the GNSS Assistance Data  - Feared events in transmitting the data to the UE  - GNSS feared events  From UE to LMF:  - UE feared events | Procedure to transfer Integrity assistance information from UE to LMF |

*End of Text Proposal*

**Question 2: Do you agree to add the text proposals in R2-2100719?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | We think the **Integrity Computing Entity** definition could be useful. For the other definitions however (i.e., **UE-Based Integrity and Network-Based Integrity**), we think extensive discussion and consensus has already taken place to align the existing terminology with the study objectives, i.e., **‘network-assisted (UE-Based)’** and **‘UE-assisted (LMF-Based)’**. We are concerned that altering these definitions at this late stage of the study may lead to confusion and inconsistencies with the objectives and remaining text. We think these terms can be further discussed and resolved as part of the normative work when defining and agreeing to the actual signaling procedures and IEs. |
| Intel | No | There is no big difference between **‘network-assisted (UE-Based)’** and **‘UE-assisted (LMF-Based)’** and “**UE-Based Integrity and Network-Based Integrity**”. Considering we already have extensive discussion on the terminologies, and then could prefer to keep existing terms. |
| Fraunhofer | Partly | The assistance data regarding GNSS feared events (Jamming/interference/spoofing) also needs to be sent to the network by capable UEs. We are fine with the text as long as  ‘GNSS feared events’ is added to assistance data from UE to LMF. This applies both for UE-based and for NW-based. |
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* **R2-2101390 On RAT-dependent integrity use cases and error categories, Ericsson [3]**

The following proposals were made:

* **Proposal 1: RAN2 to agree to the TP in A.1.**
* **Proposal 2: RAN2 to agree to consider adding RAT-dependent error categories on a high level**

## A1. Use cases TP for the TR 38.357

*First Text Proposal*

### 9.2.3 Industrial IoT

In contrast to consumer-oriented Internet of Things (IoT), Industrial IoT (IIoT) use cases predominantly focus on operational, safety, and financially beneficial applications of the IoT ecosystem for businesses, infrastructure, and various industries. IIoT positioning integrity/reliability requirements are essential given various safety, payment, and regulatory critical applications. There are many outdoor IIoT devices/UEs employing GNSS-based positioning in various industries that include, but not limited to: Construction, Agriculture/forestry/fishing (smart farming), Oil/Gas industries, and Smart cities (traffic, electric and water systems, waste management, public safety, schools) derived from [1][20]. The ACIA white paper [22] provides some use cases and requirements on 5G positioning in general. An illustrative example relating to Automated Guided Vehicles (AGV) is provided below.

*Next Text Proposal*

## A2. Error categories TP for the TR 38.357

*Start of Text Proposal*

### 9.3.2 RAT-Dependent

#### 9.3.2.1 Generic aspects

This section describes generic feared events for RAT-dependent positioning.

* Feared events in the RAT-dependent Assistance Data
  + Configured AD such as TRP location information, beam information, relative time difference information, etc is incorrect
* Feared events during positioning data transmission
  + This is partly the same as for GNSS positioning, even more similar if the AD is seen as originating from an entity separate from LMF, such as OAM or 5G-RAN via NRPPa.
* RAT-dependent feared events
  + RAN TRP feared events such as antennas being reoriented, relative time differences drifting
  + Local environment feared events such as multipath, interference, jamming, spoofing
* UE feared events
  + DL-PRS measurement errors
  + Hardware faults -same/similar to GNSS
  + Software faults – same/similar to GNSS
* LMF feared events
  + Hardware faults -same/similar to GNSS
  + Software faults – same/similar to GNSS

##### 9.3.2.1.1 Feared events in the RAT-dependent Assistance Data

###### a) Incorrect RAT-dependent Assistance Data

Several RAT-dependent positioning methods rely on provided assistance data. If the assistance data contain incorrect data, this can lead to incorrect computation of the PL and a potential integrity event.

##### 9.3.2.1.2 Feared events during positioning data transmission

###### a) Data integrity faults

Data tampering e.g., spoofing can also affect the quality and integrity of the positioning services provided by 5GS. For instance, the interface between 5G-RAN and 5GS may be vulnerable to malicious attacks.

##### 9.3.2.1.3 RAT-dependent feared events

Editor’s Note:GNSS feared events are those which occur external to the UE and potentially impact the quality and availability of the GNSS signals.

* + RAN TRP feared events such as antennas being reoriented, relative time differences drifting
  + Local environment feared events such as multipath, interference, jamming, spoofing

**a) RAN**

###### a) RAN TRP feared events

RAN TRPs can suffer physical abuse causing the TRP location to change, the TRP beams becoming reoriented, relative time difference estimates impacts etc

###### c) Local Environment feared events

Multipath

Multipath is one of the most significant errors incurred in the RAT-dependent receiver measurement process. The magnitude of multipath errors varies rapidly and significantly depending on the environment the receiver is located, cellular network deployment, receiver signal processing, antenna gain pattern, and signal characteristics.

Interference

The interference can be separated into two categories

* Unintentional interference from nearby radio base stations and devices operational in the same or adjacent frequency carriers.
* Intentional RFI is the deliberate action of causing interference to degrade or block reception of RAT-dependent positioning signals.

##### 9.3.2.1.4 UE feared events

UE specific errors are not possible to mitigate with assistance data from the network, the UE is responsible for mitigating these feared events locally, based on implementation.

###### a) DL-PRS receiver measurement error

Measurement errors are also induced by the receiver tracking loops, so this is an inherent noise within the receiver which causes jitter in the signal.

###### b) Hardware faults

Editor’s Note: FFS

###### c) Software faults

Editor’s Note: FFS

##### 9.3.1.1.5 LMF Feared Events

Editor’s Note: FFS

###### a) Hardware Faults

###### b) Software Faults

*End of Text Proposal*

**Question 3: Do you agree to include the text proposal from R2-2101390?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | We strongly encourage that future studies be undertaken to extend positioning integrity work to RAT-Dependent. We acknowledge however that the scope of the study was updated as follows at RAN#89-e:  NOTE 4: Objective 2 is applicable to GNSS positioning methods.  Therefore, while we think the contents of R2-2101390 is useful and pertinent to future discussions on RAT-Dependent, we feel the current TP should only focus on addressing what is in scope of the SI objectives and, therefore, what can realistically be achieved within scope of the normative work.  A potential alternative to this proposal is to add back the original headings for RAT-Dependent Error Sources (i.e., 9.3.2) and Methodologies (i.e., 9.4.2) and include an editor’s note as the only text for each section, e.g.,:  Editor’s Note: RAT-Dependent positioning integrity is not addressed within the scope of this study but should be considered in future releases by extending the concepts and signaling introduced in this study.  We are supportive of the updated text for the IIoT Use Case in Section 9.2.3. |
| Intel | No | RAT dependent integrity has been ruled out from the SI scope, and therefore we should not spend efforts on this. |
| Fraunhofer | No | Since RAT dependent integrity has been taken out of the SI scope, we suggest not to put this text. |
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* **R2-2101504 Recommendations for the Integrity Text Proposal , Swift Navigation, Intel Corporation [4]**

The following proposals were made:

* **Proposal 1: Agree to the proposed recommendations for positioning integrity.**
* **Proposal 2: Agree to the text proposal for inclusion in the TR.**

*Start of Text Proposal*

## 10.10 Enhancements of signaling & procedures for positioning integrity

The following enhancements of signaling & procedures to support positioning integrity determination are recommended, including the following aspects:

* + Define the specific list of RAT-Independent positioning integrity feared events to be addressed in the 3GPP specifications.
  + Signaling & procedures to support positioning integrity determination:
    - The assistance information IEs that will be used to mitigate the feared events;
    - The details of the LPP signaling to transport the positioning integrity assistance information.
  + Support of integrity for UE-Based and UE-Assisted RAT-Independent positioning.

*End of Text Proposal*

**Question 4: Do you agree to include the text proposal submitted in R2-2101504?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | Yes | We believe these recommendations sufficiently capture the topics which need to be resolved as part of the normative work, including the topics discussed in Question 1 above. |
| Intel | Yes |  |
| Fraunhofer | Yes |  |
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### 3.2.2 Submissions to Agenda Item 8.11.3.2

This section addresses the specific proposals from the Methodologies summary [15] which requested text changes.

* **Proposal 1: Include a new section in clause 9.4 of the TR to capture the uncertainty of the GNSS ranging measurements (Annex A5).**

*Start of Text Proposal*

##### 9.4.1.1.2 Uncertainty of the ranging measurement

The uncertainty of all the ranging measurements, together with system data, is an input required by every integrity algorithms and is needed to compute integrity results i.e., PLs.

The following formula can be used to statistically describe the overall error contribution for each GNSS measurement. In other words, the **total uncertainty for measurements** performed by the UE to each visible ith satellite can be expressed as:

Where

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| --- | --- | --- |
| **Quality indicator** | **Meaning** | **Observation** |
|  | Total uncertainty for measurements obtained from satellite i represented as UERE. |  |
|  | Uncertainty of the combined orbit, clock, and bias corrections. Could also be expressed as | These terms are derived in real time based on measurements collected at stations part of GNSS CORS reference network. |
|  | Uncertainty of the ionosphere model |
|  | Uncertainty of the troposphere model |
|  | Uncertainty of the measurements in the given environment and receiver noise. Multipath is the dominant term here. | It is computed by the UE. Is perhaps the most difficult to determine as the value is dependent on UE environment, multipath, possible spoofing and jamming, and measurement quality. |

* Uncertainty of the ranging measurements in UE-based

GNSS receiver, present in the UE, aided by the information provided by the network, performs ranging on GNSS signals, compute its position, and estimates the trustworthiness of the location estimate (integrity). For this purpose, the LMF provides to the UE quality indicators using LPP Periodic Assistance Data Transfer procedure.

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| --- | --- | --- |
| ***LMF sends to UE*** | ***UE computes*** | ***Observation*** |
| , , | Total uncertainty for satellite i  Uncertainty of the measurements in the given environment and due to receiver characteristics (function of multipath, thermal noise, etc.) | Of course, these quality indicators/variance needs to be provided together with the associated SSR IEs (see specification impact item further below) |

Specification impacts resume to a possible extension of GNSS-SSR IE by additional fields, representative to the quality of each GNSS error here modelled as SSR: GNSS-SSR-OrbitCorrections, GNSS-SSR-ClockCorrections, GNSS-SSR-CodeBias, GNSS-SSR-PhaseBias, etc. Alternatively, a new IE collecting quality indicators flags for all GNSS SSR IEs could be defined.

* Uncertainty of the ranging measurements in UE-assisted

GNSS receiver, present in the UE, performs ranging on GNSS signals, and sends the measurements to the LMF for location and position integrity estimation. For this purpose, the UE can use LPP Location Information Transfer (*A-GNSS-RequestLocationInformation* and *A-GNSS-ProvideLocationInformation*).

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| --- | --- | --- |
| ***UE sends to LMF*** | ***LMF knows*** | ***LMF computes*** |
| Option 1: (if estimated by UE)  Option 2: or information that may help the LMF estimate (e.g. *GNSS-MeasurementList* IE and in particular *mpathDet* field) | , , | Total uncertainty for satellite i  [and] |

A first specification impact could be the possible extension of *GNSS-MeasuremntList* IE by additional quality flags, if any. In this scenario, the UE can send to LMF information about the quality of the measurements using *GNSS-MeasurementList* IE. With this additional information, the LMF can estimate the total uncertainty of the ranging measurements.

The 37.355 includes period reporting of Assistance Data with direction from LMF to UE. Periodic reporting of measurements from UE to LMF may also need to be supported.

*End of Text Proposal*

**Question 5: Do you agree to include the text proposal describing the ‘Uncertainty of the ranging measurement’?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | We think it is more suitable to bring forward this submission as part of the normative work, given it is attempting to define specific parameters for inclusion as part of the specifications. It is not yet clear how to correctly interpret these parameters in the integrity context. Therefore, resolving this discussion will also require further details on the broader signaling framework and IE definitions, which are reserved for the normative work. |
| Intel | No | Agree with Swift. Such details should be discussed in WI phase. |
| Fraunhofer | No | Agree with Swift and Intel. |
|  |  |  |

* **Proposal 6: Include the TP from Annex A4 in clause 9 of TR 38.857**

*Start of Text Proposal*

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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 | ~~FFS~~  Cross-check GNSS position with RAT-depedent positon  Assistance information: Trustable time reference, Data Authentication / Signature |
| 4. UE feared events | GNSS receiver measurement error | FFS |
| Hardware faults | \* |
| Software faults | \* |
| 5. LMF feared events | Hardware faults | \* |
| Software faults | \* |

*End of Text Proposal*

**Question 6: Do you agree to include the text proposal from ESA to update the example of the Local Environment GNSS feared event?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | Partly | We think the text ‘**Assistance information: Trustable time reference, Data Authentication / Signature**’ is fine as a potential example. But we suggest to remove the text ‘**Cross-check GNSS position with RAT-dependent position**’ as this seems to be an implementation/algorithm consideration rather than an example of assistance information. |
| Intel | Partly | Agree with Swift. ‘**Cross-check GNSS position with RAT-dependent position**’ is solution instead of assistance data, and therefore should be removed. |
| Fraunhofer | Yes | Agree with the assistance information suggested by ESA. The method could be captured elsewhere or left implementation specific. |
|  |  |  |

* **Proposal 8: RAN2 to agree to the TP in A2 (A1 in [9])**

*Start of Text Proposal*

|  |  |  |
| --- | --- | --- |
| **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 | Regionalized indicator of multipath, interference, jamming, spoofing, etc |
| 4. UE feared events | GNSS receiver measurement error | Similar to GNSS local environment feared events |
| Hardware faults | \* |
| Software faults | \* |
| 5. LMF feared events | Hardware faults | \* |
| Software faults | \* |

*End of Text Proposal*

**Question 7: Do you agree to include the text proposal from Ericsson to update the example of Local Environment GNSS feared events and GNSS receiver measurement error?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | Partly | We think the Local environment feared event text (‘**Regionalized indicator of multipath, interference, jamming, spoofing, etc’**) could be combined with the ESA examples in Question 5 above. We disagree with including the text ‘**Similar to GNSS local environment feared events’** given UE feared events are not correlated between devices so a regional indicator would not be applicable. |
| Intel |  | Ok to add (‘**Regionalized indicator of multipath, interference, jamming, spoofing, etc’**). |
| Fraunhofer | Yes | Agree with the Swift and Intel. |
|  |  |  |

* **Proposal 23: Use UE measurements to enable integrity methods for local RAT-dependent and UE feared events and agree to the TP in Annex A3 (A.2 of [9]).**

*Start of Text Proposal*

9.4.2 RAT-Dependent

This section addresses some generic RAT-dependent integrity methods

*9.4.2.1 Generic RAT-Dependent Integrity Methods*

The 3GPP specifications can be extended to support the determination of positioning integrity, by defining information elements and signaling procedures to transport assistance information to mitigate feared events. A summary of the RAT-dependent feared events studied in Section 9.3.2 is provided in Table 9.4.2.1 below, including examples of the types of assistance information to be considered for inclusion in LPP

Editor’s Note: The LPP IEs and procedures for positioning integrity will be defined in the WI.

**Table 9.4.2.1: Summary of generic RAT-dependent feared events and integrity assistance information considerations (FFS).**

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.

|  |  |  |
| --- | --- | --- |
| **Feared Event Category** | **Feared Event** | **Examples of positioning integrity assistance information (FFS)** |
| 1. Feared events in the RAT-dependent Assistance Data | Incorrect information about RAN positioning configurations | Validity or quality flags for existing assistance information |
| 2. Feared events during positioning data transmission | Data integrity faults | Data corruption check, e.g. CRC |
| Data Authentication / Signature |
| 3. RAT-dependent feared events | RAN TRP feared events  e.g. reoriented TRP antennas, relative time difference errors | RAN TRP configuration quality flags |
| Local Environment feared events, e.g. Multipath, Spoofing, Interference | Regionalized indicator of multipath, interference, jamming, spoofing, etc |
| 4. UE feared events | DL-PRS receiver measurement error | Similar to RAT-dependent feared events |
| Hardware faults | \* |
| Software faults | \* |
| 5. LMF feared events | Hardware faults | \* |
| Software faults | \* |

9.4.1.1.1 Signaling considerations

The following LPP signaling was identified in the study, for consideration in the WI:

1. Signaling to determine the positioning integrity capability
2. Signaling to deliver the KPIs and integrity results
3. Signaling to deliver the integrity assistance information to the UE
4. Signaling to deliver the integrity information related to the positioning measurements from the UE to the LMF

Table 9.4.1.1.1 summarizes the UE-based and UE-assisted considerations for supporting positioning integrity in the 3GPP specifications, with respect to the feared events identified in Table 9.4.1.1 and the signaling considerations above.

**Table 9.4.2.1.1: Summary of network-assisted (UE-Based) and UE-assisted (LMF-Based) considerations for supporting positioning integrity in 3GPP.**

NOTE: The table provides a summary of considerations and the final details and specification impacts are FFS in the WI.

\*NOTE: Examples of KPIs are the TIR, AL, TTA. Examples of Integrity results are the PL, Integrity Availability and KPIs.

\*\*NOTE: From LMF to UE does not mean the integrity assistance information is generated by the LMF.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Positioning Mode** | **Location service type** | **Source of KPIs\*** | **Source of Integrity results\*** | **Positioning Integrity assistance information\*\*** | **Specification impact** |
| Network assisted (UE-based): Positioning integrity result is derived by the UE | MO-LR | UE internal implementation | UE internal implementation | From LMF to UE:  - Feared events in the RAT-dependent Assistance Data  - Feared events in transmitting the data to the UE  - RAT-dependent feared events | Procedure to transfer Integrity assistance information from LMF to UE |
| MT-LR | From LMF | From UE | From LMF to UE:  - Feared events in the RAT-dependent Assistance Data  - Feared events in transmitting the data to the UE  - RAT-dependent feared events | Procedure to transfer Integrity assistance information and KPIs from LMF to UE  Procedure to transfer Integrity results from UE to LMF |
| UE assisted (LMF-based): Positioning integrity result is derived by the LMF | MO-LR | From UE | From LMF | From NG-RAN or OAM to LMF:  - Feared events in the RAT-dependent Assistance Data  - Feared events in transmitting the data to the UE  - RAT-dependent feared events  From UE to LMF:  - UE feared events | Procedure to transfer Integrity assistance information and KPIs from UE to LMF  Procedure to transfer Integrity results from LMF to UE |
| MT-LR | LMF implementation | LMF internal implementation | From NG-RAN or OAM to LMF:  - Feared events in the RAT-dependent Assistance Data  - Feared events in transmitting the data to the UE  - RAT-dependent feared events  From UE to LMF:  - UE feared events | Procedure to transfer Integrity assistance information from UE to LMF |

9.4.2.1.2 Summary of RAT-dependent Positioning Integrity Methods

The detection of feared events is necessary to support the implementation of positioning integrity. Assistance information and associated IEs can be optionally sent between the LMF and the UE to mitigate the feared events. LPP signaling considerations for UE-based and UE-assisted positioning integrity have been examined in this section to support the use cases in Section 9.2. To ensure that the system meets the integrity goals and requirements, it must be systematically validated, possibly including compliance to relevant industry functional safety specifications such as ISO-26262. Integrity validation is considered outside the scope of the 3GPP specification as it concerns a specific integrity system implementation.

*End of Text Proposal*

**Question 8: Do you agree to include the RAT-Dependent text proposed in R2-2101391?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | Refer to our comments and suggestions in response to Question 3. |
| Intel | No | RAT dependent integrity has been ruled out. |
| Fraunhofer | No | RAT-dependent integrity was not the scope of this study item, so should not be captured. |
|  |  |  |

## 3.3 May require further discussion

The remaining proposals from the Methodologies summary [15] are addressed below.

* **Proposal 7: RAN2 shall enable the capability of employing local environment feared events detected by the UE to assist other UEs in the same region. The signaling mechanism to enable the UE to report the detected local environment feared events and the assistance data to other UEs from LMF shall be specified. How the UE detects the threat and how the LMF processes the received information shall be left implementation specific.**

**Question 9: Do you agree to further address Proposal 7 as part of the study?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | We think this topic is captured by including the suggested text changes as part of our responses to Questions 6 and 7. |
| Intel | No | We only need to specify what should be reported for local Environment feared events. But how to use it by LMF should be network implementation. |
| Fraunhofer | Yes | We strongly support that the UE should be able to report the detected local environment feared events. How it does it and how the NW uses it could be left implementation dependent.  The text changes suggested in response to Question 6 and 7 do not make it sufficiently clear that the capable UEs monitor local environment and report feared events (like spoofing/jamming/interference from other legitimate systems).  The proposal also makes it clear what is the logic behind collecting these data. |
|  |  |  |

* **Proposal 12: LMF decides whether to choose network-assisted or UE-assisted integrity.**

**Question 10: Do you agree with addressing Proposal 12 as part of the study?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | The UE should be capable of initiating the transaction. The signaling procedures will be resolved as part of the normative work. |
| Intel |  | It is related to UE capability, e.g. whether the UE can support all of them or not. Can be decided in WI phase. |
| Fraunhofer | No | This does not have to be resolved now – can be left for normative work. |
|  |  |  |

* **Proposal 15: Two possible integrity result reporting modes (PL Reporting and Integrity Event Flagging) could be captured in the TR with some descriptions.**

**Question 11: Do you agree with addressing Proposal 15 as part of the study?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | Partly | We think these modes and descriptions are quite helpful, but the PL Reporting description may need clarification. In essence, the TIR only applies to HMI, so depending on the system implementation, the correct interpretation of the PL without a defined AL may not be well defined. This means that at least for some implementations it is not useful to just output the PL alone without also specifying the corresponding AL. This comes from the fact that the AL is not simply a threshold but is typically used as a design assumption/parameter in the implementation of the integrity algorithm.  If there is a general consensus to include these proposals we can update the text to reflect the point above. Equally, these modes could also be brought forward for discussion as part of the normative work where this general topic needs to be addressed anyway. |
| Intel | Yes | Seems the proposal is to capture these two possible integrity result reporting modes in the TR. That is fine to us. But the details can be discussed in the WI phase. |
|  |  |  |
|  |  |  |

* **Proposal 22: RAN2 supports simultaneous use of alternative positioning methods (RAT-dependent and hybrid of RAT-dependent and RAT-independent) at UE and RAN for improving positioning accuracy and integrity.**

**Question 12: Do you agree with addressing Proposal 22 as part of the study?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Swift Navigation | No | Refer to our comments and suggestions in response to Question 3. |
| Intel | No | RAT dependent has been ruled out. |
| Fraunhofer | No | As far as we understand, the LMF could have two or more positioning methods running in parallel. Then the simultaneous use of two methods could be an implementation issue. |
|  |  |  |

# 4. Conclusion

# 5. Text Proposal

The baseline TP will be updated based on the feedback from the questions above.

# 6. References

1. **[R2-2100596](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100596.zip)** [Post112-e][618][POS] – Integrity Text Proposal, Swift Navigation
2. [**R2-2100719**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100719.zip) Text Proposals of Definitions Relating to Positioning Integrity Modes, Nokia Nokia Shanghai Bell
3. [**R2-2101390**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101390.zip) On RAT-dependent integrity use cases and error categories, Ericsson
4. [**R2-2101504**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101504.zip) Recommendations for the Integrity Text Proposal , Swift Navigation, Intel Corporation
5. [**R2-2100106**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100106.zip) Discussion on Methodology for Integrity OPPO
6. [**R2-2100376**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100376.zip) Discussion on Methodologies for network-assisted & UE-assisted integrity, InterDigital, Inc.
7. [**R2-2100674**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100674.zip) Discussion on the methodologies for network-assisted and UE-assisted integrity, Spreadtrum

Communications

1. [**R2-2100686**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100686.zip) Discussion on methodologies for network-assisted and UE-assisted integrity, Vivo
2. [**R2-2100720**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100720.zip) Positioning Integrity Result Reporting, Nokia, Nokia Shanghai Bell
3. [**R2-2100812**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100812.zip) Discussion on methodologies for positioning integrity, Xiaomi
4. [**R2-2101087**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101087.zip) UE Detection and Signalling of Perceived Threats to GNSS systems, Fraunhofer IIS, Fraunhofer HHI
5. [**R2-2101228**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101228.zip) Discussion of network-assisted and UE-assisted integrity, Huawei, HiSilicon
6. [**R2-2101391**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101391.zip) GNSS Integrity Methodologies Ericsson
7. [**R2-2101437**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2101437.zip) Text Proposal to methodologies for GNSS position integrity, ESA
8. [**R2-2101436**](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101436.zip) Summary of AI 8.11.3.2 Methodologies for network-assisted and UE-assisted integrity, ESA