3GPP TSG-RAN WG2 #111-e Draft R2-2008262

Electronic Meeting, August 17 - 28, 2020

Agenda Item: 8.11.3.1

Source: Swift Navigation

Title: [AT111-e][607][POS] Summary of email discussion on Integrity definitions, KPIs, and use cases (Swift)

Document for: Discussion, Decision

# 1 Introduction

This document extends the initial email discussion from R[2-2008256](file:///E:\WORK\1%203GPP\Meeting\RAN2%20111-e\2%20During\Docs\R2-2008256.zip) [1] as follows:

* [AT111-e][607][POS] Integrity definitions, KPIs, and use cases (Swift)

Scope: Discuss proposals and attempt to reach consensus on definitions, KPIs, and use cases for positioning integrity.

Intended outcome: Summary with potential agreeable TP, in R[2-2008256](file:///E:\WORK\1%203GPP\Meeting\RAN2%20111-e\2%20During\Docs\R2-2008256.zip). Extension to further converge and produce a text proposal in R2-2008262, with attention to anticipated specification impact.

Deadline: Thursday 2020-08-20 1100 UTC – extended to Thursday 2020-08-27 1200 UTC

The following topics are proposed for agreement.

# 2 Integrity KPIs Definitions

The following agreement was made online for [1]:

Agreements:

* Start from the definitions of the four candidate KPIs. Additional definitions can be added when needed.

It was proposed to adopt the Target Integrity Risk (TIR), Alert Limit (AL), Protection Level (PL) and Time-to-Alert (TTA) as KPIs. However, the final definitions and the decision on whether these terms constitute KPIs within the context of 3GPP were both FFS.

The following definitions are therefore proposed. Please comment if you agree with the integrity definitions and whether to include the definitions as KPIs within the specification.

<-----------------------------------------Start of text proposal------------------------------------------->

**Target Integrity Risk (TIR)**

The probability that the positioning error exceeds the Alert Limit (AL) without warning the user within the Time-to-Alert (TTA).

**Alert Limit (AL)**

The maximum allowable positioning error such that the positioning system is available for the intended application. If the positioning error in any dimension or combination of dimensions (e.g. horizontal or vertical) is beyond the AL, operations are hazardous and the positioning system should be declared unavailable for the intended application to prevent loss of integrity.

**Protection level (PL)**

The PL is a bound on the positioning error that ensures that, the probability per unit of time of the true error being greater than the AL and the PL being less than or equal to the AL, for longer than the TTA, is less than the required TIR.

**Time-to-Alert (TTA)**

The maximum allowable elapsed time from when the positioning error exceeds the Alert Limit (AL) until the equipment annunciates a corresponding alert.

NOTE: The TIR, AL and TTA are design parameters that are fixed and defined for a particular implementation, whereas the PL is a real time output of the positioning system.

<------------------------------------------End of text proposal------------------------------------------->

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| **Company** | **Do you agree with the Integrity Definitions? Please propose alternatives if not.** | **Do you agree that the Integrity Definitions are KPIs?** |
| CATT | **Target Integrity Risk (TIR)**  The probability that the positioning error exceeds the Alert Limit (AL) without warning the user within the Time-to-Alert (TTA), required according to the location service.  **Alert Limit (AL)**  The maximum allowable positioning error such that the positioning system is available for the location service. If the positioning error in any dimension or combination of dimensions (e.g. horizontal or vertical) is beyond the AL, operations are hazardous and the positioning system should be declared unavailable for the intended application to prevent loss of integrity.  NOTE: The TIR, AL and TTA are design parameters that are fixed and defined for service level, whereas the PL is a real time output of the positioning system. | Agree |
| Swift Navigation | Yes, we agree with the text proposal definitions. | There has been discussion of what constitutes a KPI. To resolve this, we need a working definition of what is a KPI. Our view is that a KPI is a measurable and quantifiable property of a system that indicates its level of performance.  In the field of integrity, as we are dealing with very rare events, we are rarely able to directly measure the integrity performance experimentally (e.g. TIR of 10^-7/hr would require >1142 years of experimental data). Therefore, we propose to extend the idea of a KPI to performance indicators of a system that can be verified through direct measurement OR analysis.  Given this definition it is clear that the performance of an integrity system is indicated by what TIR, AL and TTA it can achieve.  In contrast the PL is a real-time output of the system that is related to and necessary to quantify the KPIs but in itself is not strictly a KPI under this definition.  Therefore, we propose **TIR, AL** and **TTA** as the KPIs. PL however is an important definition that should nonetheless be included in the SI. |
| InterDigital | Our proposals and comments in this document come from our contribution R2-2007588.  For PL, “per unit of time” is not clear. What are typical units assumed for “unit of time”?  In the Note, “PL is a real time output”, but it is not clear how and which component in the network updates the PL. It is also not clear whether the update will be done by UE or the network. | A proposal for the definition of TTA: Recovery time, where this is the time given by application/location service to the network to recover from a positioning failure. The network can configure in the UE a time duration, which is related to the recovery time, to recover from a positioning failure. If the network/UE cannot recover within the recovery time, an alert is raised. |
| vivo | We also think the definition of Protection Level is confusion and it is not aligned with the definition of TTA. The definition of PL use” for longer than the TTA”, TTA is not related to annunciate the alert, but indicates how long the position error exists before recovery. We may decouple the PL with TTA. | We propose **TIR, AL** and **TTA** as the KPIs as we discussed in the online meeting PL is a real time output, so PL isn’t a KPI. |
| Nokia | Agree with the definitions of TIR, AL and TTA  For PL, we propose the following definition:  “**Protection Level:** Statistical error bound computed so as to guarantee that the probability of the absolute position error exceeding said number is smaller than or equal to the target integrity risk”.  A definition of PL explained in terms of PL is not good. | We fully support the comment from Swift.  It is important to distinguish KPIs from requirements and agree on the definition and usage of KPIs. A KPI is a measurable quantity for which a target value has been defined. PL, being calculated by the positioning system, cannot be considered as a KPI according to this definition. Requirements express the positioning based application expectations with respect to the integrity system. |
| Huawei, HiSilicon | Agree with most of the definitions. But we have several concerns:   1. Use “Integrity Risk” instead of “Target Integrity Risk”. Not sure the meaning of “target” here. 2. Suggest to change the definition of AL as follows:   AL for a certain measurement is the error tolerance not to be exceeded without issuing an alert, which represents the largest position error allowable for safe operation. More precisely, AL can be further categorized as Horizontal Alert Limit (HAL) and Vertical Alert Limit (VAL), to capture the maximum allowable horizontal and vertical position error, respectively.  PL should be defined separately for the horizontal plane (Horizontal Protection Level, HPL) and the vertical direction (Vertical Protection Level, VPL). Same consideration should be made for AL. | Yes. |
| Intel | Agree to define TIR, AL and TTA as KPIs. PL can be further discussed. | Agree. |
| ESA | **TTA:**  The PL is associated to the computed position so it can be assumed to be computed at the same place, by the UE (UE-based) or by the Network (Network-based). Hence, in the definition of TTA, “until the equipment” may be confusing, we can use “until the function providing position integrity” or “until the UE or the Network” instead:  **Time-to-Alert (TTA)**  The maximum allowable elapsed time from when the positioning error exceeds the Alert Limit (AL) until the function providing position integrity annunciates a corresponding alert.  **TIR:**  The TIR is usually defined as a probability during a period of time, which is linked to the “per unit of time” that appears in the definition of the PL. This can be clarified including a note in the definition.  **Target Integrity Risk (TIR)**  The probability that the positioning error exceeds the Alert Limit (AL) without warning the user within the Time-to-Alert (TTA), required according to the location service.  Note: The TIR is usually defined as a probability rate per some time unit (e.g. per hour, per second or per independent sample)  **PL:**  With respect to the two ways of defining the PL (the one in the start text proposal and the one used by Nokia and in other contributions), just to note a couple of things:   * Both are mathematically compatible as long as the same integrity risk probability is not employed in both:   + P(ε > PL) < **Irisk**   + Prob per unit of time (((ε> AL) & (PL<=AL)) for longer than TTA) < **required TIR**   Irisk doesn’t have to be equal to the required TIR, but in practice the approach is usually to compute the PL for an Irisk equal to the required TIR and then use the obtained PL to compare it with the AL, this approach is conservative as it leads to a better final TIR (because errors greater than the PL but lower than the AL won’t be taken into account).   * The definition in the start text proposal links the PL, AL, TIR and TTA between them. We consider that we need to explain this link in the definitions. So, if the definition of the PL does not include it, then we would need to put it in other place. * We agree with Huawei on that we should also need to define the horizontal and vertical protection levels. It could be done adding a note to the PL definition or with additional definitions.   As a way forward we propose:  **Protection level (PL)**  The PL is a statistical upper-bound of the positioning error that ensures that, the probability per unit of time of the true error being greater than the AL and the PL being less than or equal to the AL, for longer than the TTA, is less than the required TIR.  NOTE: When the PL bounds the positioning error in the horizontal plane or on the vertical axis then it is called Horizontal Protection Level (HPL) or Vertical Protection Level (VPL) respectively.  **AL:**  Some user applications may require an AL, others only an HAL, others both, an HAL and a VAL, etc. Hence, the following sentence in the AL definition “*If the positioning error in any dimension or combination of dimensions (e.g. horizontal or vertical) is beyond the AL*” may be a confusing. We consider that the sentence proposed by Huawei is clearer in this aspect: “*More precisely, AL can be further categorized as Horizontal Alert Limit (HAL) and Vertical Alert Limit (VAL), to capture the maximum allowable horizontal and vertical position error, respectively*”.  Besides, we think that we should also need to define HAL and VAL. | We support the extended idea of KPI that has been proposed.  We also agree on that the PL in itself is not strictly a KPI under this definition and that the integrity performance is indicated by the TIR, AL and TTA that can be achieved, but then we consider that an additional KPI will be needed to measure the required PL availability (i.e. PL<AL 99% of the time), in order to cope with the “always raising an alert” case (that is, if a PL of 10 km is always being provided it will bound all the possible errors and satisfy any required TIR-AL-TTA, but the PL will always be greater than the AL and service will be always unavailable). |
| Apple | For TIR, I share the same view as Huawei that the term could be simplified as “IR”. AL, TTA, and TIR are all considered QoS objectives from the positioning applications. There is no need to emphasize one of them as a “target”, but not the other two. We also feel that those names can be further improved to be 3GPP friendly, for example, TIR is actually can be changed to “Integrity failure probability”. But we can discuss the exact names in a later stage. | Agree with SwiftNav that   * TIR, AL, TTA are KPIs * PL reflects the real-time status of positioning system, and is an important definition |

Further, it was agreed that additional definitions can be added based on contribution-led priorities. Please identify additional definitions to be considered, and why.

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| **Company** | **Definitions** | **Why is the definition(s) relevant to the integrity study and protocol/specifications?** |
| Swift Navigation | Adapted from [4]:  **Integrity:** The Integrity of a positioning system is a measure of the trust that can be placed in the correctness of the positioning error supplied by the positioning system, including the ability to provide timely and valid alerts to the UE and/or the user when the positioning error does not fulfil the condition for intended operation.  **Hazard:** Apotential source of harm caused by malfunctioning behaviour of the positioning system.  **Feared Event:** Feared Events are considered to be all possible events (i.e. of natural, systemic or operational nature) that can cause the computed positioning error to deviate from the true position, regardless of whether a specific Fault can be identified in one of the positioning systems or not.  **Fault:** A Feared Event that occurs intrinsic to the positioning system, i.e. caused by the malfunction of one of the elements of the positioning system.  **Fault-free:** A Feared Event is considered Fault-free when it is not caused by a malfunction of the positioning system. Typically, Fault-free Feared events are conditions when the positioning system inputs are erroneous e.g. a GNSS satellite failure  or abnormal atmospheric condition.  **Misleading Information (MI):** A MI event occurs when, the positioning system being declared available, the positioning error exceeds the PL but not the alert AL.  **Hazardous Misleading Information (HMI):** A HMI event occurs when, the positioning system being declared available, the positioning error exceeds the AL without annunciating an alert within the TTA.  **Integrity Event:** An Integrity Event occurs when the positioning system outputs Misleading Information (MI) or Hazardous Misleading Information (HMI).  **Protection level (PL)**  The PL is a bound on the positioning error that ensures that, the probability per unit of time of the true error being greater than the AL and the PL being less than or equal to the AL, for longer than the TTA, is less than the required TIR. | These definitions establish core integrity principles which can be commonly applied to the three study objectives, regardless of the positioning technology or methods. It is necessary to have these definitions to fully contextualize the definitions of the KPIs. |
| InterDigital | Positioning failure | It is not a part of KPI, but it should be explained in the note, to demonstrate how the KPIs can be tied to a failure event |
| Nokia | The list of definition should be limited to those needed to characterize events or define the requirements. the final list can only be drawn up when we have better defined the use cases and their specific potential requirements. We can just decide on the TIR, AL, PL and TTA for now but focus on the high level solution and impacts to positioning architecture, protocol, interfaces and RAN2 specifications first. |  |
| Huawei, HiSIilicon | Definition should be given on the basis of need-to-define on the process when we are writing the TR. Currently, we think the definition for Integrity, Protection level, AL, IR, TTA are needed. |  |
| Intel | Agree with Swift. | The definitions are need to provide the whole picture of the integrity although they are not KPIs. |
| ESA | We consider that the definitions proposed by Swift establish core integrity principles that will be needed but if there is not a quick convergence we should focus, as Nokia comments, on the high level solution and impacts to positioning architecture, protocol, interfaces and RAN2 specifications first, and include new definitions in the TR on a need-to-define basis.  Following the need-to-define approach, besides the definition of TIR, AL, PL and TTA, we think that at least the definition of “Integrity” is also needed to clarify its meaning in the positioning context. |  |
| Apple | Agree to follow the “need-to-define” approach, and we need a clear definition of “Integrity” first. |  |

# 3 Integrity Use Cases

It was proposed in [1] to illustrate the application of integrity to the safety-critical, liability-critical and commercial applications [e.g. TR 22.872], including Automotive, Industrial IOT and Rail, with additional use cases to be considered case-by-case.

Please indicate (e.g. (a) (c) etc) which of the following use cases should be prioritized for inclusion in the baseline TR:

1. **Automotive/Road**
2. **Industrial IoT**
3. **Rail**
4. **Aerial**
5. **Emergency and Mission Critical**
6. **Location Based Services**
7. **eHealth**
8. **Maritime**

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| **Company** | **Which use cases do you propose should be prioritized?** e.g. (a) (c) etc | **Additional use case suggestions?** |
| CATT | a, b, c, g, e, f |  |
| Swift Navigation | (a) (c)  There is broad industry consensus on the framework for TIR, TTA, AL, PL which is a use case agnostic framework. The use cases are important to illustrate these concepts in practice as well as to understand the threshold values for the KPIs. However, we strongly believe that setting threshold values or services levels for integrity should be out of scope for this study as ultimately it does not impact the specification and can be implementation-defined. Therefore, we propose to include the use cases in the SI purely for illustrative rather than normative purposes.  We think the most important illustrative use cases are (a) and (c), as these are the most well understood and stringent use cases currently under consideration. |  |
| InterDigital | (a),(b),(c)  Regarding (b), integrity will be needed for positioning targeting moving robots in a factory, i.e., AGV, for prevention of accidents. |  |
| vivo | (a),(b),(c)  Route area use cases should be studied in priority. And IIoT is an important work item in 3GPP and reliability is commecial requirement for IIoT. |  |
| Nokia | (a), (b), (e), (f) |  |
| Sumitomo Electric | (a), (b), (c)  We share same view as InterDigital. In addition to the automotive and Rail, we think that AGV in factory is an important use case for us to avoid accidents. |  |
| Huawei, HiSilicon | (a)(b)(c)(d)(e)(f)(g)(h) | No. |
| Intel | As described in 22.872 “integrity” and “time to alert” are specified for safety-critical or liability-critical applications, and then all of the use cases listed could fit “safety-critical or liability-critical applications”.  However, we should focus on limited scenario, esp considering the range of KPIs are tightly related to use cases. We do not have time to analyze all potential use cases.  Therefore b should be high priority since b is one of main objective in the SI. |  |
| ESA | (a) (b) and (c)  We think that the use cases in the SI are for illustrative purposes, they will help to explain the use case agnostic framework defined by PL, TIR, AL and TTA and to see the range of values that may be required by the users. We consider that the integrity threshold values or service levels that can be achieved (for a certain achieved positioning service level) depend on the implementation of the function providing integrity (computing the PL) and that having different thresholds or service levels for integrity won’t have any impact on the specification, the changes in the specifications will be the same. So we think that setting different service levels can be left out of the scope of this study. |  |
| Apple | (a) (b) (e) |  |

# 4 Protocol Impact

What are the protocol/specification implications that need to be addressed in the Study for the proposed Integrity Definitions and Use Cases?

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| **Company** | **Protocol/specification impacts to be addressed in the Study?** |
| CATT | 1. TS 22.261 section 7.3.2 should be updated to introduce the integrity requirement of service level. 2. Which positioning methods are supposed to support integrity (e. g The Table 4.3.1-1: Supported versions of UE positioning methods in TS38.305). |
| Swift Navigation | * As our strong view is that service levels and threshold values are out of scope for this SI, we do not recommend to amend TS 22.261. * This current SI should inform the direction of the future WI which will recommend changes to TS 37.355 to include the necessary IEs to support integrity. Specific impacts should be addressed as part of the WI, not this SI. * We agree with CATT that the positioning methods supporting integrity should be enumerated in TS 38.305 as part of this SI. |
| InterDigital | The protocols that may be impacted as a result of supporting integrity are LPP, NRPPa and RRC. This study should address the impacts on these protocols when supporting integrity for different positioning methods.  We also agree with CATT and Swift that TS 38.305 should list the positioning methods supporting integrity. |
| vivo | TS22.872 defination of integrity and use cases of positioning need update with integrity KPIs. |
| Nokia | * The potential impacts on LPP should be analyzed in the SI, and introduced in TS 37.355 during the WI phase. In particular, we think the signaling aspects should be examined:   + Signaling of parameters relating to integrity (e.g. KPIs) from LMF to UE, or vice versa.   Since integrity benefits from being calculated from the combination of several positioning methods, we do not recommend defining which of them support integrity or not (in TS38.305). this should be left to implementation. |
| Huawei, HiSilicon | * RAN imapcts   + 38.305, 37.355 and 38.455 impacts:   + Capture the integrity definitions   + Capture the integrity assistance data that required to be transferred to UE or LMF   + Capture measurements for integrity   + Capture general procedure for support of integrity * SA specs impacts: * SA1 needs to capture the integrity definitions and use cases. * SA2 needs to specify the system level procedure for integrity * CT specs impacts: * CT4 needs to define the QoS in the LCS request * CT4 needs to define the alert from LMF to LCS client * OMA impacts: * OMA needs to define the QoS for integrity and alert, similar to the CT imapcts |
| Intel | In SI, we only need to identify the potential impact on positioning related specifications. As listed by other companies, stage2, stage 3 will likely be affected. The analysis should be captured in the TR. But we do not need to change stage 2/3 specification in SI phase. |
| ESA | Potential impacts on LPP (37.355) and NRPPa (38.455).  TS 38.305 will need to enumerate the positioning methods supporting integrity. Nevertheless, in principle any function providing positioning based on a positioning method or combination of methods has the capability of also providing integrity. This means that all the supported positioning methods have the potential to also support integrity.  TS 23.032 Universal Geographical Area Description (GAD) – depends on outcome on UE-based/UE-assisted analysis.  We consider that the integrity service levels that can be achieved depend on the implementation of the function providing integrity and that having different service levels for integrity won’t have any impact on the specification, the changes in the protocols will be the same. So we think that setting service levels can be left out of the scope of this SI and out of the WI. |
| Apple | For specification impact, we think SA1 and/or SA2 may need to be involved to define high-level system requirements and architectue for positioning integrity.  For impact of RAN specificaiton, I think LPP and NRPPa spec will be impacted. But I agree with Intel that at SI stage, we do not need to discuss details on how to revise spec in SI. |

# 4 Skeleton TR

The Skeleton TR was discussed in Agenda Item 8.11.1 with the following outcome:

* Skeleton to be addressed in the continuation of email discussion [607] (to be discussed later).

Taking into consideration the skeleton proposals in [2], [3, 4] and the email/online discussions from [1], an updated skeleton is proposed for consideration:

🡨---------------------------------------Start of text proposal-----------------------------------------🡪

9 Positioning integrity and reliability

*From objective 2: Includes solutions necessary to support integrity and reliability of assistance data and position information:*

9.1 Integrity Overview – Background Information

9.1.1 Integrity Definitions

9.1.2 Integrity Concepts

9.2 Use Cases

9.3 Positioning Integrity Error Categories

9.3.1 RAT-Independent

9.3.1 RAT-Dependent

9.4 Positioning Integrity Methods

9.4.1 RAT-Independent

9.4.1 RAT-Dependent

9.5 Procedure and protocol impact analysis

🡨----------------------------------------End of text proposal-----------------------------------------🡪

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| **Company** | **Do you agree with the proposed Skeleton?** |
| Swift Navigation | Yes. |
| Vivo | Yes |
| Nokia | Yes |
| Huawei, HiSilicon | Yes |
| Intel | Yes |
| ESA | Yes. A note on 9.3. – analysis shall not stop at categories only. Any error source properly analysed, linked to a RAT-dependent or RAT-independent positioning method, shall be included in the TR. |

# 5 Conclusion

# 6 References

1. R2-2008256 [AT111-e][607][POS] Summary of email discussion on Integrity definitions, KPIs,

and use cases, Swift Navigation.

1. R[2-2006671](file:///E:\WORK\1%203GPP\Meeting\RAN2%20111-e\2%20During\Docs\R2-2006671.zip) Skeleton proposals for TR38.857, CATT.
2. R[2-2006542](file:///E:\WORK\1%203GPP\Meeting\RAN2%20111-e\2%20During\Docs\R2-2006542.zip) Proposed table of contents - Section 9 (positioning integrity) - TR 38.857, Swift

Navigation, Ericsson, Intel Corporation.

1. R[2-2006541](file:///E:\WORK\1%203GPP\Meeting\RAN2%20111-e\2%20During\Docs\R2-2006541.zip) TP for Study on Positioning Integrity and Reliability, Swift Navigation, Deutsche

Telekom, u-blox, Ericsson, Mitsubishi Electric, Intel Corporation, CATT, UIC.