**3GPP TSG-RAN WG2 Meeting #119 electronic *R2-XXXXXXX***

**Online, August 17 - 26th, 2022**

**Agenda Item: 8.7.3**

**Source: Thales**

**Title: [POST119-e][108][R18 NR-NTN] NW verified UE location (Thales)**

**Work item Rel-18 NR-NTN-enh**

**Document for: Discussion**

# Introduction

This document aims to pursue the discussion around the agenda item 8.7.3 “*Network verified UE location*” of the 119-e RAN 2 meeting.

* [POST119-e][108][R18 NR-NTN] NW verified UE location (Thales)

Scope: discuss the main principles of the verification procedure (e.g. criteria, performance) and identify potential solutions considering proposals in contributions submitted to RAN2#119-e

Intended outcome: email discussion summary

Deadline: Long

The discussion will take place in 2 phases:

* A first phase to collect views on some proposals based on initial companies inputs: deadline for comments = FRIDAY 16th September 23:59 (UTC)
* A second phase for the moderator to prepare the summary based companies feedbacks: deadline for comments = FRIDAY 23th September 23:59 (UTC)

# Context

## 2.1 Recall of TR 38.882 recommendations

The verification should be performed independently from the location information reported by UE.

The UE location information for the study is considered verified if the reported UE location is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size), enabling country discrimination and selection of an appropriate core network in order to support all the regulatory services (i.e. emergency call, lawful intercept, public warning, charging/billing).

The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.

The study in [RAN2,RAN1,RAN3], which will study and evaluate solutions for the network to verify UE reported location information, shall consider the following aspects:

- The scenario of single satellite (or HAPS) in view by the UE at a time is considered with higher priority.

- Multiple satellite (or HAPS) in view by the UE may be considered if time allows

- Assume that the UE is attached to a network (so that its context has been set up in the network) for the purpose of positioning

- Different solutions or positioning methods for NGSO, GSO or HAPS are not precluded

- When considering solutions based on positioning methods, existing 3GPP defined RAT dependent positioning methods shall be considered as baseline. Other methods are not precluded.

- Solutions using existing NG-RAN architecture and procedures shall be considered

## 2.2 List of TDOCs and related proposals submitted to RA2#119-e agreements on network verified UE location

|  |  |  |
| --- | --- | --- |
| [**R2-2207074**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207074.zip) | OPPO | Proposal 1 Satellite at a given time is considered as a TRP.  Proposal 2 A moving satellite at multiple time instance is modeled as multiple TRPs.  Proposal 3 TRP’s location is obtained through satellite’s ephemeris information.  Proposal 4 Time difference between satellite-based TRPs should be under network’s control. |
| [**R2-2208775**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Inbox/R2-2208775.zip) | THALES | Proposal 0-1: The UE location information is considered verified if the reported GNSS position is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size).  Proposal 0-2: Given that the Network may determine multiple possible UE locations due to error/geometrical ambiguities, the reported GNSS position should be consistent with at least one of the multiple possible UE location.  Proposal 0-3: The consistency may be based on a distance threshold (e.g. < 10 km) or a verification area as per implementation  Proposal 0-4: RAN2 should consider, as starting point, the re-use of the LCS framework of the LMF network for the network verification procedure.  Proposal 1: UE assisted and network assisted methods can be considered as part of Network verified UE location study in RAN2 on the basis that UE reported information as part of 3GPP defined functions can be trusted if not derived exclusively from information provided by non 3GPP defined function.  Proposal 2: The network verification of the UE reported location may combine one or several 3GPP defined RAT dependent positioning methods (e.g. Multi RTT, DL/UL-TDOA, DL-AoA, NR E-CID, etc.)..  Proposal 3: The network verification procedure should not impact significantly the latency of the targeted regulated services (e.g. public warning system, lawful interception, emergency services, charging…).  Proposal 4: The network verification procedure may be network triggered based on a command received from the network (AMF) or event triggered, after a given procedure such as RACH.  Proposal 5: Wait for RAN1 outcomes on the performances in order to investigate further the multi-RTT solution at RAN2 level  Proposal 6: a mono-RTT approach can be adopted for the GEO satellite case  Proposal 7: Timing Advance (TA) value as applied by the UE (on the service link) in order to align the UL/DL subframe at the gNB air interface can be reported through a RRC message along with the frame/subframe number associated to TA value.  Proposal 8: The precision of the Timing Advance (TA) reported value (as applied by the UE on the service link) needs to be further investigated. RAN2 should send an LS to RAN1 about the performance of the technique in a single satellite context.  Proposal 9: Wait for RAN1 outcomes on the performances in order to investigate further the positioning method based on the Timing Advance (TA) value reporting (as applied by the UE on the service link) at RAN2 level |
| [**R2-2207274**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207274.zip) | Intel Corporation | Proposal 1: RAN2 to confirm NG-RAN assisted positioning methods (NR-ECID, UL-TDOA, UL-AoA) can be considered as network based assessment.  Proposal 2: RAN2 to discuss whether UE assisted/LMF based positioning methods (DL TDOA, DL-AoD, Multi-RTT) can be considered as network based assessment, or whether the information from UE can be trusted.  Proposal 3: For NTN positioning, RAN2 sends a LS to RAN1 and asks whether the accuracy of NR E-CID measurements can meet the requirements.  Proposal 4: send a LS to RAN1 and ask whether the UL-AoA and DL-AoD positioning methods can still be feasible in NTN scenario.  Proposal 5: send a LS to RAN1 and ask whether “single satellite (or HAPS) in view by the UE at a time” can be considered as a TRP when applying DL-TDOA/ UL-TDOA positioning methods.  Proposal 6: send a LS to RAN1 and ask whether Multi-RTT positioning method can be applied in NTN.  Proposal 7: RAN2 to consider reusing TA reporting for the purpose of network verified UE location.  Proposal 8: the potential enhancements could be RAN transfers the TA value to LMF, or RAN2 needs to consider reporting TA value in LPP message. |
| [**R2-2207296**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207296.zip) | NEC Telecom MODUS Ltd. | Proposal 1: RAN2 discuss and clarify the expected level of maliciousness of UEs and their capacity to tamper UE location  Proposal 2: Network verified UE location should not be used automatically for every UE reported location  Proposal 3: If a method used by the network is not contradictory with the location provided by the UE, then the latter should be trusted by the network  Proposal 4: After passing a verification following a network verified location, the location provided by the UE should only be trusted for a period of time. |
| [**R2-2207302**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207302.zip) | MediaTek Inc. | Proposal 1: Multi-RTT method with UE using its location and the satellite ephemeris to calculate and report the UE-specific TA to the network at different times over a verification period of a few seconds is the baseline for network-based UE location verification. |
| [**R2-2207326**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207326.zip) | Nokia, Nokia Shanghai Bell | Proposal 1: The verification method should be performed independently from the location information, reported by the UE (coarseLocationInfo). The NW does not need to wait for coarseLocationInfo reporting to begin its assessment.  Proposal 2: NW assesses two-dimensional UE location when it verifies UE’s geo-position.  Proposal 3: The extra latency introduced by the UE position verification should be kept as short as possible and should be below 1 s. More accurate value is FFS.  Proposal 4: RAN2 considers UL-TDOA and DL-TDOA based methods to be applied with specific modifications for NTN.  Proposal 5: RAN2 considers also other relevant methods, like Multi-RTT and angle of arrival.  Proposal 6: RAN2 asks RAN1 to study how DL-TDOA, UL-TDOA, multi-RTT or angle of arrival methods can be used for network verification of the user location.  Proposal 7: RAN2 provides RAN1 with the responses to the questions discussed within section 2 and 3 of this paper. |
| [**R2-2207444**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207444.zip) | Apple | Proposal 1: Confirm the RAN2 work focuses on the existing RAN mechanism for the UE reported location verification.  Proposal 2: Confirm the country level discrimination for UE location verification is sufficient.  Proposal 3: NTN NW can identify the UE located country via the serving beam for the UE dedicated transmission in case each beam covers only one country.  Proposal 4: From the signaling and NW architecture perspective, the existing NR positioning method can work well to verify the UE reported location.  Proposal 5: Evaluation on the positioning performance including using single satellite case should be studied in RAN1 first. |
| [**R2-2207482**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207482.zip) | Huawei, HiSilicon | Proposal 1: RAN2 to agree that the UE location verification is done by LMF by reusing the legacy LCS procedures.  Proposal 2: Send an LS to SA2 to ask if there is any issue with RAN2 conclusion.  Proposal 3: RAN2 to further discuss which positioning method can be used to verify UE location. |
| [**R2-2207634**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207634.zip) | vivo | Proposal 1: For the scope of UE location verification, RAN2 confirms which of the following WFs to go by taking into account their pros and cons:  - WF1: Enhance existing positioning method(s) in NG-RAN (TS 38.305) on top of the verification mechanism based on the LCS framework (already supported in R17 NTN);  - WF2: introduce RAN-based verification methods, which can be supported independently by RAN (w/o dependency on legacy LCS framework).  Proposal 2: Send LS to RAN1, informing RAN1 of the RAN2 conclusion on which WF to adopt, and asking RAN1 to carry out the study on the enhancements to POS methods in NG-RAN that are needed for this NTN-specific NW verification purpose (e.g. RS type, measurement to report, TRP aspects, etc.). |
| [**R2-2207645**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207645.zip) | China Telecom | Proposal 1: RAN2 evaluates TDOA and multi-RTT methods for network verified location in NTN.  Proposal 2: Introduce the indication of NTN network verified UE location purpose in measurement configuration and report. |
| [**R2-2207675**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207675.zip) | Spreadtrum Communications | Proposal 1: gNB should verify the UE location.  Proposal 2: gNB shall inform AMF to trigger the traditional position procedure. |
| [**R2-2207779**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207779.zip) | Samsung R&D Institute UK | Proposal 1: The network-based location verification solution uses assistance information from CN to verify UE-generated location information.  Proposal 2: RAN2 send an LS to SA2 for feedback on potential assistance information from CN to aid in Network verified UE location via NWDAF analytics. |
| [**R2-2207866**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207866.zip) | Lenovo | Proposal 1: RAN2 to confirm that the network verification accuracy requirement is at least in the range between 5-10 km for NTN. FFS whether additional accuracy requirements need to be defined for other services, e.g., emergency services.  Proposal 2: The single satellite case has been prioritized based on the conclusions of the TR 38.882, and further study is required regarding the impact to the overall positioning procedures, e.g., the types of positioning methods to perform NTN RAT-dependent positioning to assist in the verification process. RAN1 coordination may be required.  Proposal 3: RAN2 to further study in coordination with SA2 on which of the network entities which may trigger, initiate, and perform the network UE location verification procedure, e.g., using the NI-LR LCS procedure. Send LS to SA2.  Proposal 4: RAN2 to support low latency network verification procedures taking into account the extended propagation delays of NTN by considering at least the following:  • Mechanisms to reduce LCS NG-RAN and core network signalling, e.g., identifying the need and benefits of supporting a local LMF in the NTN NG-RAN.  • Identify the frequency of the network verification procedures to avoid unnecessary/redundant triggering of the verification.  • Identify the validity of the provided verified network UE location  Proposal 5: RAN2 to consider RAN-based solutions for UE location verification purposes in coordination with the RAN1.  Proposal 6: Study the impact on UE location verification using different multi-connectivity NTN architectures on positioning procedures and verification procedures, e.g., including the use of multi-satellites or TN and NTN connectivity scenario.  Proposal 7: In case of a mixed multi-connectivity scenario involving TN NG-RAN and NTN NG-RAN, the verification procedure does not involve NTN NG-RAN and can be based on the UE cell-ID of TN NG-RAN. |
| [**R2-2207915**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2207915.zip) | Xiaomi | Proposal 1: Both NG-RAN and core network to verify the UE location should be considered.  Proposal 2: RAN2 confirms that the existing 3GPP RAT dependent positioning methods shall be considered as baseline for UE location verification.  Proposal 3: The RAT-dependent positioning including DL-TDOA, UL-TDOA and multi-RTT should be considered for UE location verification.  Proposal 4: For gNB verifying the UE location, the gNB triggers the LMF to perform the RAT-dependent positioning procedure.  Proposal 5: For the NGSO, the RAT-dependent positioning only involved the gNB and UE can be considered for UE location verification. |
| [**R2-2208022**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208022.zip) | Deutsche Telekom, Huawei, HiSilicon | Proposal 1: RAN2 to investigate whether and how the NTN network can instruct the UE to report reference TN PLMN identities for UE location verification.  Proposal 2: RAN2 to take this solution into consideration when evaluating the need for Network verified UE location specification support in Rel-18. |
| [**R2-2208328**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208328.zip) | NTT DOCOMO INC. | Proposal. RAN2 wait for RAN1 and start discussion on signalling for network verified UE location upon RAN1 have listed candidate solutions or concluded specific solutions. |
| [**R2-2208376**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208376.zip) | CATT | Proposal 1: RAN group level study on UE location verification should follow the recommendation of the RAN level study as specified in the TR 38.882.  Proposal 2: Exchange of TRP info between NG-RAN and LMF may need to be adjusted due to the moving of the TRPs, the details could be left to WI phase.  Proposal 3: Wait for SA2 and RAN3 to decide which node is responsible for UE location verification, NG-RAN or 5GC.  Proposal 4: For LEO case, whether and how to support the positioning procedure during inter-cell, inter-satellite handover should be further discussed.  Proposal 5: Solutions for LEO case should be prioritized, GEO, HAPS cases could be deprioritized.  Proposal 6: Existing positioning methods, e.g. ECID, UL/DL TDOA, UL/DL AOA, could be considered for UE location verification. The details should be evaluated in RAN1 firstly.  Proposal 7: RAN2 should discuss if implementation based solution in NG-RAN is possible for UE location verification. |
| [**R2-2208444**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208444.zip) | CMCC | Proposal 1: existing 3GPP defined RAT dependent positioning methods, e.g., UL/DL TDOA, UL/DL AOA, multi-RTT can be considered as baseline.  Proposal 2: it is propose that RAN2 start to perform the normative work of signalling framework/flow design of RAN based positioning method for the UE location verification in NTN scenario.  Proposal 3: it is proposed to limit the network based assessment in the granularity of 5-10 km, which is similar to TN macro cell size and study the solutions of reporting the TN cell information or Virtual Cell detected by UE.  Proposal 4: If a given UE is regarded as malicious, as the reported location information is always “fake”, it is reasonable for the gNB to trigger the UE release procedure and recall the resource allocated to the UE.  Proposal 5: the gNB can distribute and share the UE’s credit status according the maintained verification result for the UE to neighbour gNBs or CN. |
| [**R2-2208546**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208546.zip) | ZTE Corporation, Sanechips | Proposal 1: RAN2 prioritize single satellite (or HAPS) scenarios in NW verified UE location discussion.  Proposal 2: RAN2 to further study below options as candidate solutions for NW verified UE location in NTN:   * Opt1: UE Rx-Tx time difference measurement in different time instance for single satellite scenario * Opt2: TA report with potential enhancements to allow multiple TA report   Proposal 3: RAN1’s confirmation is needed to evaluate whether options in P2 can fulfilled the accuracy requirement.  Proposal 4: UE can be tagged with reliability flag based on verification outcome to help reduce the frequency of verification procedure. |
| [**R2-2208674**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119-e/Docs/R2-2208674.zip) | Ericsson | Proposal 1: RAN2 to investigate the achievable accuracy of the angle of arrival method, and of the E-CID based on measurements on the same satellite as well as hybrid combinations.  Proposal 2: The UE can be provided an IDLE mode measurement configuration for NW location verification, measurements are delivered to the NW after security have been enabled. |

For the 119-e RAN 2 meeting, companies made the above proposals. Some of its proposals are already covered by recent agreements that can be found in the next section 2.3.

## 2.3 RAN1#110 agreements on network verified UE location

Agreements:

1. The following 3GPP defined RAT dependent positioning methods shall be considered as starting point for the study on Network verified UE location in case of NGSO based NTN deployment:

- Multi-RTT

- DL/UL-TDOA

Note-1: Other methods (e.g. AoA based) are not precluded

Note-2: RAT independent positioning methods are not under the scope of the study

1. For evaluating positioning performance in NTN, the following metrics apply.

• Horizontal accuracy:

- Horizontal accuracy is the difference between a calculated horizontal position by the network and the actual horizontal position of a UE (for evaluation purposes)

- At least CDFs of horizontal positioning errors are used as a performance metrics in NR positioning evaluations

- At least the following percentiles of positioning error is analyzed 50%, 67%, 80%, 90%, 95%

1. The following parameters are assumed for the evaluation of RAT dependent positioning methods study in NTN: *(see Annex 5.1)*

## 2.4 RAN2#119-e agreements on network verified UE location

Agreements:

1. The UE location information is considered verified if the reported GNSS position is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size) (it is assumed that there is no RAN2 spec impact due to this)
2. RAN2 should consider, as starting point, the re-use of the LCS framework of the LMF network for the network verification procedure. Send an LS to SA2 indicating RAN2 assumption on this
3. The network verification of the UE reported location may combine one or several 3GPP defined RAT dependent positioning methods (e.g. Multi RTT, DL/UL-TDOA, DL-AoA, NR E-CID, etc.).

LS sent to SA2 (R2-2208779):

“RAN2 is considering the re-use of the LCS framework of the LMF for the network verification of UE reported location information in NTN.

RAN2 would like to inform SA2 about this agreement and ask for any related feedback.”

## 2.5 RAN3#117-e agreements on network verified UE location

Agreements:

1. The verification is performed in the CN.
2. If the reported UE location is not correct, the CN will take necessary action and Release-17 behavior can be kept as baseline. FFS on new cause value.
3. RAN3 wait for RAN1/2 progress on the specific position method to be used for verification.

# Discussion

There are issues and proposals which were not resolved in RAN2#109e due to time-limited discussion and due to a lack of main principles accepted by the participants.

## 3.1 Verification procedure

## 3.1.1 Purpose

Reading the proposals listed in the 2.2 section, it is not clear yet what the verification UE location procedure aims to.

* **Opt1**: An alternative procedure of location for the CN with lower accuracy requirements than GNSS (i.e. 5-10 km). This option is based on Nokia R2-2207326 P2, Lenovo R2-2207866 P1, CMCC R2-2208444 P3.
* **Opt2**: A procedure to confirm that the UE GNSS position reported is located in given areas (i.e. in calculated areas defined by a geometric path or points with uncertainty of 5-10 km). This option is based on Thales R2-2208775 P0-2
* **Opt3**: A procedure used only for geographic country discrimination (i.e. assuming that an UE is verified if the cell beam cover only a country). This option is based on Apple R2-2207444 P2 and P3.

In R2-2208775, Thales highlights that in some cases the gNB could have several possible positions. For example with a multi-RTT approach in the case of a single satellite at different time step (*Figure 1: multi-RTT solution)* or in the GSO case (*Figure* 2: mono-RTT solution).

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| Figure 1: multi-RTT solution | Figure 2: mono-RTT solution |

In R2-2207444, Apple seems to agree with Opt3 and asks whether or not country discrimination is sufficient.

**Question 3.1.1-1 : Please provide your recommended ranking on the below options as purpose of the verification procedure.**

* **Opt1**: Provide a UE location with a lower accuracy (i.e. 5-10 km) than GNSS.
* **Opt2**: Confirm that the UE GNSS position reported is located in a given area (i.e. defined by a geometric path or points with uncertainty of 5-10 km).
* **Opt3**: Provide only geographic country discrimination (i.e. assuming that an UE is verified if the cell beam cover only a country).

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | Agree with option 2 | Option 1: We think that it is challenging to perform a location procedure with only satellite within a short duration and able to provide a 5-10km accuracy.  Option2: We think it is important to define flexible methods . Best case scenario, we can compute an accurate UE location. Worst case scenario (i.e. complex geometry, lake of information,…), we have a way to define areas in which the UE could be located.  Option 3: We’re not opposed if the purpose of the verification procedure is only to verify (not to locate). |
| Hispasat | Option 2 | Ranking: Option 2, Option 1, Option 3.  Scope should focus on the verification of an existing more exact location, which may also include the proper positioning as per in Option 1. Option 2 is preferable for simplicity; complete location may require higher resources and delays which may affect services. Option 3 does not cover the expected services, only CN/Operator selection. |
| vivo | Option 1 | We think Option 1 should be in the right way, and it is in line with current RAN1 progress on evaluating/selecting a POS method with acceptable positioning accuracy for this verification purpose.  For Option 2, we understand it still requires NTN to acquire a UE location via related POS method by the NW itself (as in Option 1), and then judge how much the location acquired deviates from the given area, when UE reported GNSS info is regarded as not trusted. However, we wonder what Spec impact is needed for such judgement on the deviation from given area as indicated in Option 2, and whether it can be up to NW implementation. This further depends on which NW node is supposed to judge the deviation and do the verification, and also relates to whether there is a need for the location info to be transferred between RAN and LMF. Note that in Rel-17 SA2 already decided that LMF will not provide UE location info to the RAN, making such verification at RAN impossibly achieved. Therefore, we wonder how Option 2 above actually works, and would like to focus on Option 1 first before getting clear on all necessary details needed by Option 2. |
| CATT | Option2 | Option 1 is not the purpose, it’s just part of the verification procedure.  Option 2 is aligned with the WID, the purpose of the UE location verification is to verify whether the reported UE location info is reliable or not. RAT dependent positioning mechanism(s) may be adopted, for which 5-10km accuracy is sufficient for verification.  Option 3 is a kind of requirement or use case of the location verification, cross country discrimination could be achieved by the option 2. And the option 2 could also be applied for any other use cases. |
| Xiaomi | Option 2 and Option 1 | We think the option 2 aligns with the WID and option 1 also can be supported if Option 2 is agreed. |
| OPPO | Option 2 |  |
| Docomo | Option 2 | Preference: Option 2 > Option 1 > Option 3.  Option 1: Aren’t proponents of Opt1 intending to use the provided UE location for “confirming that the UE GNSS position reported is located in a given area”(Opt2)..?  Option 2: Most aligns with the recommendation by TR 38.882.  Option 3: We understand Apple (R2-220744) provided this purpose as that only in case NTN cell does not cover multiple countries, thus it is not appropriate to extend this purpose to be also applied to multi-country coverage case. (Note that it was SA2 that raised an issue of potential multi-country coverage, so we cannot revert this.) |

## 3.1.2 Triggering

RAN2 agreed to consider re-using, as starting point, the LCS Framework of the AMF/LMF network for the network verification procedure. This does not exclude discussing other ways to trigger verification. Also, it is not decided where the verification calculation are performed (i.e RAN or CN).

In R2-2207915, Xiaomi submitted the following proposal : “*Both NG-RAN and core network to verify the UE location should be considered.”*

In R2-2207675, Spreadtrum Communications supports that the gNB should verify the UE location.

**Question 3.1.2-1: Should an additional request from LMF to RAN be introduced in the NRPPa protocol to trigger the UE location verification ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | Agree |  |
| Hispasat | Agree |  |
| vivo | No | In current Rel-17 Spec, it is AMF that triggers the LCS procedure for such NTN specific verification purpose. This question is also related to which NW node finally performs the verification, which should be decided first. Currently, we fail to see why the legacy way (i.e. AMF initiation) cannot work, and why a new trigger as proposed above has to be introduced. |
| CATT | Disagree | According to the agreement achieved in RAN3#117-e.   |  | | --- | | The verification is performed in the CN. |   The entity to perform location verification is already decided by RAN3, there is no need to discuss this question in RAN2 again. |
| Xiaomi | Disagree | For the NG-RAN to verify the UE location, we think the request from RAN to LMF in the NRPPa to trigger LCS procedure is needed. |
| OPPO | No | We are confused about the question. Shouldn’t it be “from RAN to LMF” if the intention was to have RAN verify location (i.e. RAN as LCS client)? So far, we think the baseline assumption is sufficient, i.e. CN to trigger the procedure. |
| Docomo | Disagree | Same view as CATT. |

**Question 3.1.2-2: Please share your views on other ways to trigger a verification procedure ? (e. g. RAN related event )?**

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| --- | --- |
| **Company** | **Comments/Suggestions** |
| Thales | An early triggering of the verification procedure on the RAN side to reduce the possible latency may be studied (for example, the RAN could start to collect information to verify the UE location just after a UE has been attached). |
| Hispasat | RAN events (change of serving cell, coverage modifications…) may be considered. |
| Xiaomi | RAN can trigger the UE location verification when RAN acquires the UE GNSS location. |

## 3.1.3 Reuse of Location Services

RAN2 agreed to consider re-using, as starting point, the LCS Framework of the LMF network for the network verification procedure.

In R2-2208444, CMCC proposes that RAN2 start to perform the normative work of signaling framework.



Figure 3: Location Service Support by NG-RAN (TS 38.305, Figure 5.2.1)

NG-RAN and UE rely respectively on LPP and NRPPa protocols to perform the exchange of data necessary for positioning methods with LMF (see TS 38.305).

Currently LMF does not support combinations of positioning methods. RAN could also perform part of computations of positioning methods. RAN might not have all the information from the UE to perform verification calculations since the information is centralized at the LMF level.

**Question 3.1.3-1 : Should RAN performs additional processing to support the LMF in the verification of the UE location (e. g. combination of several positioning methods).**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | Agree |  |
| Hispasat | Agree |  |
| vivo | No | It is unclear what such “combination” actually refers to. Also, RAN1 has not decided to consider any forms of combinations in their evaluation, so the feasibility or any detail of such “combination” has not been justified. At least the feasiblity and necessity for such “combination”should be evaluated first by RAN1, perhpas after evaluation on each single POS method on the table. |
| CATT | Only if needed. | This question can be discussed only if the positioning methods have been determined. However, at present, there is no agreement on using combination of several positioning methods for location verification, that the legacy processing seems enough. |
| Xiaomi | Disagree | The legacy LCS procedure already supports combination at some level, and whether the enhancements are needed or not should be evaluated by RAN1. |
| OPPO |  | Not clear what kind of additional processing is referred here. We don’t see why LMF cannot combine multiple positioning methods. |

## 3.1.4 Comparison criteria

RAN 1 is currently evaluating several positioning methods to support the UE location verification. RAN 2 should discuss some criteria corresponding to possible access layer impact.

Agreements and recommendations from TR 38.882 considers verified a reported UE location within 5-10 km.

Also, during the last online meeting RAN2#119-e, RAN2 started to discuss about the proposal 3 of the R2-XX from Thales :

*The network verification procedure should not impact significantly the latency impact of the multi-RTT computation on delay of the targeted regulated services (e.g. public warning system, lawful interception, emergency services, charging…) must be further studied.*

*- QC/Lenovo are fine*

*- Nokia wonders what “significantly” means*

*- Ericsson wonders why we need to list these services specifically. Ericsson thinks that verification can be done in the CN without the RAN knowing what happens*

In R2-2207326, Nokia and submitted the following proposal : “The extra latency introduced by the UE position verification should be kept as short as possible and should be below 1 s. More accurate value is FFS.”

NOTE that depending on the satellite orbit, the LEO satellite visibility duration is in the order of 5 to 20 minutes. We could consider that positioning methods with one satellite could take more than few seconds to perform the verification.

**Question 3.1.4-1 : Can companies provide their views on the bellow list of possible comparison criteria to assess candidate solutions to support the verification of UE location ?**

* **Latency ( response time )**
* **A metric that characterize the consistency of GNSS position with network based assessment.**
* **Signalling impact**
* **..**

|  |  |
| --- | --- |
| **Company** | **Comments/Suggestions** |
| Thales | Latency: a target maximum duration should be defined  Metric: it could be a 2D position difference or a dilution of precision (DOP) term between the GNSS position and the calculated UE positions.  Signalling impact: MAC or RRC signalling ? |
| Hispasat | Latency: maximum to be defined, based on final services.  Metric: Accuracy as minimum 2D position difference from actual (real) GNSS position.  Signalling impact: also related with latency, number of final operations to be implemented in the calculation and elements involved. Also consider the least difference to existing implemented methods. |
| vivo | We think Accuracy is needed. Per RAN1 agreements, it is clear that they have already taken positioning accuracy as the metric for evaluation and candidate solution comparison.  As to latency, we first don’t think a service-associated latency needs to be considered. Also, this aspect on latency is also under consideration in RAN1 evaluation. We need to first wait for RAN1 conclusions on whether such latency aspect really matters and needs for intentional consideration, before taking any RAN2 conclusion.  Generally speaking, except for accuracy, we currently don’t think other metrics really need to be further considered for candidate comparison. |
| CATT | We support these criteria in principle.  Latency: In case of single satellite scenario, the possible measurement time, which contains serval measurement time points, is the mainly influence factor. The latency is impact by the evaluation from RAN1.  Metric: In Rel-18, 2D positioning is enough for the target use case, for example, country discrimination.  Signalling impact: We suggest changing this bullet as “Specification impact”. |
| Xiaomi | We think the metric and signalling impact should be considered. Whether the latency is considered should be determined by the SA2 since the use cases to verify UE location are from SA2. |
| Docomo | We support these criteria.  Small comment on metric: It is slightly incorrect to include "GNSS location" in the criterion, because this work assumes the GNSS location can be tampered with. Thus "A metric that characterize the consistency of the network based assessment with the actual UE location" is fine. |

**Question 3.1.4-2: What would be an acceptable latency for the verification procedure ? Does it depend on the targeted services ?**

|  |  |
| --- | --- |
| **Company** | **Comments/Suggestions** |
| Thales | It could be interesting to have two options depending on the targeted services.   * Opt1: for targeted regulated services (e.g. public warning system, lawful interception, emergency services, charging…) with more flexible verification to ensure low latency verification. * Opt2: for other services with a verification that could be carried out during the use of the service |
| Hispasat | Latency is an important method, but final selection should be based on the method with the least latency that can comply with the required accuracy. Agree that latency tolerance may vary from methods, but only one procedure should be chosen (with a concrete latency measure). |
| vivo | See comments earlier in Q3.1.4-1. |
| CATT | Firstly, we agree to separate the discussion on targeted services. We suggest involving SA2 to discuss whether the regulated services could be carried out before or during the UE location is verified.  Secondly, the possible measurement time is the mainly influence factor. Considering the interval between these measurement time points will influence the positioning accuracy, which should wait for the evaluation from RAN1. |
| Xiaomi | We think the acceptable latency should be determined by SA2. |
| OPPO | Different services may have different requirement on latency, but in any case, we should aim at low latency positioning. |
| Docomo | The latency should be dependent on services, or common but the most strict among targeted services.  Annex A in TR38.882 can be a good starting point, i.e. no regulatory requirement for LI, PWS, nor Charging, but for emergency calls, the delay should be comparable with a typical call set-up; less than a second. |

## 3.1.5 Validity period

NGSO or UE can move with considerable speed (LEO satellite, UE in a plane). In few minutes, measurements could change due to handover or a UE on the move.

Also, the redundant verification could lead to latency issues.

In R2-2207296, NEC Telecom MODUS Ltd. submitted the following proposal : *“After passing a verification following a network verified location, the location provided by the UE should only be trusted for a period of time.”*

In R2-2208546, ZTE Corporation and Sanechips wants to introduce flag on verified UE to reduce the frequency of verification procedure.

**Question 3.1.5-1: Can companies share their views on the period during which the UE location is considered reliable after the execution of the network verification procedure ?**

|  |  |
| --- | --- |
| **Company** | **Comments/Suggestions** |
| Thales | It should be configurable but we think that this question should be addressed to SA2. |
| Hispasat | Configurable in CN, and deployment driven. Depending on system architecture (e.g. beam size) and services included by the operator/regulator, lifetime may vary. |
| vivo | We think whether such a validity period is really needed should be first discussed, and this is related to whether the location verification mechanism should be periodically performed or one-shot/event triggered. So, we think it is currently too early to decide such details on what such validity period should be, before deciding whether it is really needed and seeing how the whole mechanism actually works. |
| CATT | No need to restrict a validity period.  In case of location verification, the CN know when to do it, one time or periodically. RAN2 only need to do measurement and report after receiving the indication or request from CN. This question should be determined by SA2. |
| Xiaomi | It should be discussed by SA2. |
| OPPO | We think this should be up to CN and no need to discuss this in RAN2. |
| Docomo | We think it will be fine to simply ask SA2, or rather to raise the same question in SA2 (not via LS). |

## 3.1.6 Reliability of UE reported Information

The TR 38.882 [1] recommends to consider solution based on positioning methods and existing 3GPP defined RAT dependent positioning methods shall be considered as baseline. Also, the document recommends that the verification should be performed independently from the location information reported by the UE (e.g. GNSS)

In R2-2207296 (NEC Telecom MODUS Ltd), R2-2207274 (Intel Corporation), R2-2207779 (Samsung R&D Institute UK), R2-2208328 (NTT DOCOMO INC), R2-2208546 (ZTE Corporation, Sanechips) express concern about the reliability of UE information reported.

The RAT positioning methods are listed in the TS 38.305 [2] in the table *4.3.1-1: Supported versions of UE positioning methods.* Some of these methods are UE-assisted.

During the last plenary meeting #96, it was mentioned orally that 3GPP defined functions shall be considered as trustworthy.

**Question 3.1.6-1: Can the UE reported information (e.g. TA) as part of 3GPP defined network or UE based functions be trusted if not derived exclusively from information provided by non 3GPP defined function (e.g GNSS) ?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | Agree |  |
| Hispasat | Agree |  |
| vivo | Disagree with comments | We don’t think this question makes much sense, as the answer could be different case by case, depending on what specific info is to be reported by the UE.  In addition, we think whether the TA related POS method really needs to be supported for this verification purpose should depend on RAN1 evaluation results. If RAN1 concludes not (e.g. DL-TDOA is sufficient), it makes no sense to discuss this question and any forms of TA related POS methods any longer. Also, even if RAN1 concludes the TA related POS method is needed, we would like to prioritize those existing positioning methods as much as possible, instead of introducing new mechanism (e.g. method based on UE TA reporting as discussed later in subclause 3.1.7), unless necessity is fully justified. |
| CATT | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Not decided by RAN2 | Whether trusted or not trusted should be decided by SA3. This is not the domain of RAN2. |
| Docomo | Disagree | It is safer if RAN2 do not preclude to separately ask SA3 whether a certain reporting can be trusted. As for TAR, we are wondering if it is easy to report a wrong value of TA if a malicious UE can tamper with its GNSS information, because the TA value is derived just from the ephemeris and the GNSS. |

## 3.1.7 Timing Advance Reporting

UE have the ability adjust its uplink transmission by reporting a Timing Advance Report (TAR) contained in the MAC PDU (MAC Control Element).

The length of the field is 14 bits (see TS 38.321, clause 6.1.3.56).

Also, the TAR is triggered if any of the following events occur (see TS 38.321, clause 5.4.8):

-     upon indication from upper layers to trigger a Timing Advance report;

-     upon configuration or reconfiguration of *offsetThresholdTA* by upper layers, if the UE has not previously reported Timing Advance value to current Serving Cell;

-     if the variation between current information about Timing Advance and the last reported information about Timing Advance is equal to or larger than *offsetThresholdTA*, if configured.

The Timing Advance Report is a candidate measurement to be used for the Multi-RTT positioning method as MediaTek Inc. mentions it in R2-2207302 *“Proposal 1: Multi-RTT method with UE using its location and the satellite ephemeris to calculate and report the UE-specific TA to the network at different times over a verification period of a few seconds is the baseline for network-based UE location verification.”*

In R2-2208775, Thales asks that the precision of the Timing Advance (TA) reported needs to be further investigated. RAN2 should send an LS to RAN1 about the performance of the technique in a single satellite context.

**Question 3.1.7-1: Should RAN2 send a LS to RAN 1 asking to evaluate the granularity required for TA to be used in the multi-RTT positioning method ?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | Agree |  |
| Hispasat | Agree |  |
| vivo | Disagree | Our understanding is that RAN1 has already set evaluation assumption with candidate solutions decided, and will discuss simulation results in the next meeting. So, it is fully up to RAN1 on the candidate positioning methods, and there is no need to send LS at this stage.  Also, we fail to understand the feasibility to use the TA reporting information: now that UE GNSS is regarded as not trusted with the verification procedure initiated, how can the TA value in the TAR, which is just calculated based on UE’s GNSS info, be trusted and used for verification purpose? |
| CATT | Maybe | But the positioning method seems not multi-RTT anymore. The multi-RTT is calculated by the Rx and Tx time of SRS and PRS. Maybe a new RAT dependent positioning method, e.g. Multi-TA, can be introduced. |
| Xiaomi | Disagree | We think RAN1 can discuss it directly since the positioning method is in RAN1 scope. |
| OPPO | See comments | We should first ask SA3 whether TA reporting is trustable before asking RAN1 to work on the detailed design. |
| Docomo | Disagree | We are not sure what to discuss first in RAN2. Proponents can raise the multi-TA method directly on the RAN1 table. |

**Question 3.1.7-2: Companies are invited to provide their views on the need for signalling enhancement to report high accuracy TA calculated by the UE (e.g. through an RRC message) ?**

|  |  |
| --- | --- |
| **Company** | **Comments/Suggestions** |
| Thales | Ok but we should wait for RAN1 recommendations. |
| Hispasat | Ok, but when consensus in RAN1 about using this method. |
| vivo | Too early to decide. First await the down-selection among positioning methods to be done by RAN1. |
| CATT | Wait for the evaluation from RAN1. |
| Xiaomi | Wait for the RAN1 conclusion on the positioning methods. |
| OPPO | Before SA3 confirms TA reporting is trustable. |
| Docomo | Ok if RAN1 requests. |

## 3.1.8 Terrestrial Network assisted methods

Deutsche Telekom , Huawei , HiSilicon suggested in R2-2208022 to take in consideration how NTN network can instruct the UE to report TN PLMN identities for UE location verification :

*“As it is assumed that the UE is connected to the NTN when it has reported its GNSS based location, the NTN can instruct the UE via RRC signalling to perform measurements, identification and reporting of TN neighbouring cells”*

*“For instance, if a UE reported its location to be in Germany (based on GNSS location information), it will not be able to read and report a Greek PLMN ID (MCC/MNC) from a particular TN frequency; thus, possible cases of malicious UEs can be identified and prevented properly”*

**Question 3.1.8-1: Could RAN2 evaluate which information related to Terrestrial Network could be used for UE location verification (e.g. PLMN identities, MCC, MNC) ?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
| Thales | - | The main priority remains to have a generic NTN solution. The use case for such proposal should be clarified. |
| Hispasat | Disagree | If TN network is available, no NTN location verification may be needed. Solutions in this study should focus on the worst scenario possible, only NTN coverage and no terrestrial assistance. |
| vivo | - | We may first wait for RAN1 evaluation on whether related existing POS methods in NG-RAN are already sufficient to accomplish this verification purpose. If so, we may not need to consider extra mechanism. |
| CATT | Tend to disagree | What if there is no TN in this region? Additionally, this may have extra requirements on UE capability. |
| Xiaomi | Disagree | A solution for all scenarios is preferred. |
| OPPO | Disagree | This is not a generic solution and should be deprioritized. |
| Docomo | Disagree | We should focus on general solutions, i.e. these applicable even where no TN coverage can be found. |

## 3.1.9 Other

**Question 3.1.9-1: Do companies have other proposals to be discuss as part of his e-mail discussions**

|  |  |
| --- | --- |
| **Company** | **Comments/Suggestions** |
| CATT | Before evaluate and determine the positioning methods, we should limit and clarify the positioning scenarios, e.g. NGSO, GSO or HAPS. For their different moving characteristic may have influence on the selection of positioning method, procedure and so on. |
|  |  |

# 3. Summary and Proposals

# 4. References

1. 3GPP TR 38.882 “Study on requirements and use cases for network verified UE location for Non-Terrestrial-Networks (NTN) in NR”, v18.0.0
2. 3GPP TS 38.305 “NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN”, v17.1.0
3. 3GPP Contribution "Discussion on network verified UE location", R2-2207074, OPPO
4. 3GPP Contribution "Network verified UE location aspects", R2-2208775, THALES
5. 3GPP Contribution "Discussion on network verified UE location", R2-2207274, Intel Corporation
6. 3GPP Contribution "Assumptions on Network verified location", R2-2207296, NEC Telecom MODUS Ltd.
7. 3GPP Contribution "On Network Verified UE Location in NR-NTN", R2-2207302, MediaTek Inc.
8. 3GPP Contribution "Considerations on NW-verified UE location", R2-2207326, Nokia, Nokia Shanghai Bell
9. 3GPP Contribution "Consideration on NTN Network Verified UE Location", R2-2207444, Apple
10. 3GPP Contribution "Discussion on the network verfied UE location", R2-2207482, Huawei, HiSilicon
11. 3GPP Contribution "Discussion on NW verification of UE location in Rel-18 NR NTN", R2-2207634, vivo
12. 3GPP Contribution "Discussion of Network verified UE location in NTN", R2-2207645, China Telecom
13. 3GPP Contribution "Discussion on UE location verify procedure", R2-2207675, Spreadtrum Communications
14. 3GPP Contribution "Network Verified UE Location", R2-2207779, Samsung R&D Institute UK
15. 3GPP Contribution "On NTN NW verified UE location aspects", R2-2207866, Lenovo
16. 3GPP Contribution "Discussion on network verified UE location", R2-2207915, Xiaomi
17. 3GPP Contribution "UE location verification in NTN", R2-2208022, Deutsche Telekom, Huawei, HiSilicon
18. 3GPP Contribution "Discussion on Network Verified UE Location", R2-2208328, NTT DOCOMO INC.
19. 3GPP Contribution "Discussion on UE Location Verification", R2-2208376, CATT
20. 3GPP Contribution "Consideration on UE Location Verification via Network", R2-2208444, CMCC
21. 3GPP Contribution "Consideration on NW verified UE location", R2-2208546, ZTE Corporation, Sanechips
22. 3GPP Contribution "R18 NR NTN Network verified UE location", R2-2208674, Ericsson

# 5. Annex

## 5.1 Parameters for evaluation of RAT

**3GPP TSG RAN meeting #97-e**

**e-meeting, Sept 12 - 16th, 2022**

**RP-222019** *revised RP-221746*

**Status report for WI NR NTN (Non-Terrestrial Networks) enhancements**

**The following parameters are assumed for the evaluation of RAT dependent positioning methods study in NTN:**

|  |  |
| --- | --- |
| **Parameter** | **Description/Value** |
| **Scenarios** | Rural, LOS |
| **Satellite Orbit** | 600km, optional: 1200km |
| **Satellite parameters** | Reuse Set-1satellite parameters as in table 6.1.1.1-1/2 of TR38.821 |
| **Channel model/ Delay spread** | Based on section 6.7.2 of TR 38.811 |
| **FR/Carrier frequency** | FR1: 2GHz, S-band (n256). Optional: FR2 |
| **BW** | To be reported by companies |
| **Subcarrier spacing, kHz** | 15 for FR1, optional: 120 kHz for FR2 |
| **Number of satellite in view** | 1 for single satellite case, |
| **Orbit inclination** | To be reported by companies |
| **UE type** | Handheld terminal, Optional: VSAT |
| **UE related parameters** | Handheld UE characteristics as in Table 6.1.1.1-3 of TR38.821 with update of polarization, Tx/Rx antenna gain, and antenna type and configuration as agreed under AI 9.12.1 |
| **Positioning signals (Note 1)** | To be reported |
| **Reference Signal Physical Structure and Resource Allocation (RE pattern)** | To be reported |
| **RS type of sequence/number of ports** | To be reported |
| **Number of symbols used per occasion** | To be reported |
| **number of occasions used per positioning estimate** | To be reported |
| **Time window for measurement collection** | To be reported |
| **Interference modelling (ideal muting, or other)** | To be reported |
| **Reference Signal Transmission Bandwidth** | To be reported |
| **Reference point for timing measurement** | Satellite |
| **Description of positioning technique / applied positioning algorithm** | To be reported |
| **UE speed** | 3km/h |
| **Maximum timing measurement error** | To be reported |
| **Performance metrics** | Horizontal accuracy (UE 2D position accuracy) |
| **Additional notes, if any** | Note 1: Time-related measurements can be performed via other downlink and uplink signals than PRS and SRS    Note 2: The corresponding link budget should also be reported and the verification procedure should be done within the restriction of minimum elevation angle for service, e.g., 30 degree for LEO |

# 6. Contact information

|  |  |
| --- | --- |
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