**3GPP TSG RAN WG2 Meeting #116bis-e R2-2200438**

**Electronic meeting, 17st – 25th Jan, 2022**

**Source: Huawei, HiSilicon**

**Title: Summary of [AT116bis-e][614][POS] PRUs (Huawei)**

**Agenda item: 8.11.5**

**Document for:** **Discussion and Decision**

# Introduction

This questionnaire is to handle the following email discussion for PRU

* [AT116bis-e][614][POS] PRUs (Huawei)

      Scope: Discuss the contributions on PRUs in AIs 8.11.7/8.11.8 and the related LSs in R2-2200139/R2-2200140, determine agreeable way forward, and analyse RAN2 spec impact.  Draft a reply LS to SA2 if needed.

      Intended outcome: Report to Monday CB session, and approvable LS if one is needed

      Deadline:  Friday 2022-01-21 1600 UTC

The following contributions have been submitted to the meeting for the discussion on PRU.

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| Num | Tdoc | Proposal |
| [1] | R2-2200283, Intel | **Proposal 1: RAN2 confirms to complete MO-LR based PRU solution in Rel-17, assuming RAN1 can provide information on “antenna orientation information ” and “correction information” on time. ;**  **Proposal 2: Introduce following stage 3 changes for MO-LR based PRU solution:**   * **Introduce PRU capability in LPP message *ProvideCapabilities*;** * **Add request of known location information in LPP message *RequestLocationInformation;*** * **Add known location information in LPP message *ProvideLocationInformation;*** * **Add request of antenna orientation information in LPP message *RequestLocationInformation;*** * **Add antenna orientation information in LPP message *ProvideLocationInformation;*** * **Add correction information in LPP message *ProvideAssistanceData*;** |
| [2] | R2-2200429, Huawei, HiSilicon | ***Proposal7*: Reuse the exiting IE to provide the timing calibration information to the UE for UE-based positioning.**  ***Proposal8*: Enhance the LPP Request/Provide location information message to support the transfer of PRU antenna orientation information.**  ***Proposal9*: Enhance the LPP capability transfer procedure to support the transfer of PRU antenna orientation information.**  ***Proposal10:* Re-use the existing LPP procedure for the PRUs to provide the positioning measurements and the locations**. |
| [3] | R2-2200712, Xiaomi | **Proposal 1: Whether perform MO-LR, MT-LR and NI-LR to acquire the assistance information from PRU is based on PRU and network implementation.**  **Proposal 2: The PRU can send MO-LR request to the LMF to indicate that there is an available PRU in the network.**  **Proposal 3: The LMF can acquire the PRU information based on OAM configuration.**  **Proposal 4: The PRU capabilities include positioning measurements, known location and antenna orientation.**  **Proposal 5: The LMF should indicate UE to report its known location and/or location based on PRS measurement when the LMF acquires the PRU location by LPP request location information message.** |
| [4] | R2-2200916, SONY | **Proposal 1: PRU with known location support the following functionalities: Location uncertainty information, stationary status, providing positioning measurement and/or estimated Tx/Rx Timing error report.** |
| [5] | R2-2200994, Lenovo | **Proposal 1: LMF is responsible for the management of the PRU (e.g., configuration) via existing procedures in Rel-17.**  **Proposal 2: SA2 Impacts related to PRU access and registration (if required) can be further revisited in Rel-18.**  **Proposal 3: The PRU UE can report its known available location information to the LMF via:**   1. **LPP signalling;** 2. **RRC signalling (e.g. using *CommonLocationInfo* message) via gNB.** 3. **Offline/pre-configured location calibration**   **Proposal 4: Support reporting of the known location information source by PRU UE (e.g., RAT-independent methods, manual/offline/preconfigured location, etc.) to the LMF.**  **Proposal 5: PRU UE to support change/update of the location information to the LMF. FFS the signalling (e.g., solicited/unsolicited request) and any relevant event-triggered criteria.**  **Proposal 6: PRU UEs can include positioning QoS information as part of its location estimate report to determine the quality/uncertainty of the location estimate. FFS whether existing IE may be reused, or any new information is needed (e.g., confidence levels).**  **Proposal 7: LMF may provide DL-PRS differential correction information via a new posSIB to assist UEs in compensating differential errors for UE-based positioning. Actual correction information may be finalized pending RAN1’s reply LS.** |
| [6] | R2-2201064, Ericsson | **Proposal 1 Introduce basic PRU functionality by adding a new location information type that enables LMF to configure a device, subject to capability, to report both a location estimate and positioning measurements.**  **Proposal 2 Agree to the text proposal in Appendix A that introduces the new location information type locationEstimateAndMeasurementsRequired with an associated capability** |
| [7] | R2-2201087, MTK, Apple | **Proposal 1:** For PRU operation in Rel-17, RAN2 considers PRU-specific operations only for the case where the PRU initiates an MO-LR.  **Proposal 2:** In Rel-17, RAN2 makes no specification changes to support PRU functionality, except for assistance data enhancements if requested by RAN1. |
| [8] | R2-2201191, IDC | **Proposal 1:** Support assignment and usage of identifiers related to PRU operation (e.g. PRU ID, LPP session ID for PRU) when transferring any LPP signalling/messages between LMF and PRU  **Proposal 2:** New capability information related to PRU operation includes at least positioning method used for determining its known location, accuracy/uncertainty of location information, and capability for detecting measurement errors  **Proposal 3:** LPP capability transfer procedure is used to transfer of new capability information related to PRU operation between PRU UE and LMF.  **Proposal 4:** New assistance data related to PRU operation includes at least correction information (e.g. timing offset), validity conditions (e.g. list of cells where the assistance data is valid) for operation of PRU and evaluation conditions (e.g. RSRP thresholds)  **Proposal 5:** LPP assistance data transfer procedure is used to transfer new assistance data related to PRU operation to PRU UE  **Proposal 6:** Request for location information sent to UE related to PRU operation includes whether to send measurement report (UE-assisted mode) or measurement report and location estimates (UE-assisted+UE-based mode)  **Proposal 7:** LPP location information transfer procedure is used for transferring request/provide location information messages related to PRU operation between PRU UE and LMF |
| [9] | R2-2200331, vivo | **Proposal 1: With LPP enhancements in MO-LR/MT-LR/NI-LR procedure, the LMF can control and manage PRUs and make use of PRU’s location measurements to calculate the correction information.**  **Proposal 2: The ProviceCapabilities message can be enhanced to indicate the PRU capability to LMF, e.g., whether the UE has PRU functionality.**  **Proposal 3: The PRU can be in the stationary or moving state.**  **Proposal 4: To achieve the real-time mapping between position measurement and known location information for moving PRU, Request/ProvideLocationInformaiton messages are used to transmit PRU’s known location information and position measurement.**  **Proposal 5: RAN2 to discuss whether to postpone the PRU discussion to Rel-18 when SA2 has studied the support of PRUs.** |
| [10] | R2-2200965, QC | **Proposal 1:** RAN2 waits for the outcome of the SA2 Rel-18 eLCS\_Ph3 Study Item and any PRU support in RAN2 is postponed to Rel-18.  **Proposal 2:** In Rel-17, RAN2 makes no specification changes to support PRU functionality.  **Proposal 3:** The current PRU text in the baseline Stage 2 [9] is removed from Rel-17. |

Contact Information

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| --- | --- |
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Background

During R1 discussion, agreements on PRU has been made with the LS R2-2106920 sent to R2:

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| RAN1 has started working on Rel-17 WI on NR Positioning Enhancements [1]. During working on the WI, RAN1 has made the following agreement in RAN1#105:   |  | | --- | | Agreement:  Send an LS to RAN2/RAN3 (cc SA2), including the following content:   * RAN1 has evaluated the use of positioning reference units (PRUs) with known locations for positioning and observes improvements in using PRUs for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly requests RAN2/RAN3 (cc SA2) to determine if and what specification enhancements are adopted for PRUs for positioning. * Notes:   + The term “positioning reference unit (PRU)” is only used as a terminology in this discussion. PRU does not necessarily mean an introduction of a new network node.   + PRU may support, at least, some of the Rel-16 positioning functionalities of UE, if agreed, which is up to RAN2. The positioning functionalities may include, but not limited to, the following:     1. Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)     2. Transmit the UL SRS signals for positioning   + PRU may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the PRU is known, the information may also be requested by the LMF. | |

RAN2 discussed how to support PRU, and following agreements have been made:

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| RAN2#115e:  Agreements:  Proposal 1 (modified): For purposes of RAN2 discussion, the PRU functionality as described in the RAN1 LS can be considered as UE with known location (to some degree of accuracy) at least (16/17).  PRU modelled as a gNB can be discussed in RAN3 (no RAN2 action).  Agreement:  RAN2 confirm that the PRU considered as a UE supports the normal LPP procedures for assistance data transfer and location information transfer.  RAN2#116e:  Agreement:  Proposal 5: Regarding the handling of the PRU topic, agree the following way forward:  (1) Send an LS to SA2 asking SA2 whether the MT-LR or MO-LR location procedures as currently specified in TS 23.273 can be used to enable an LMF obtaining location measurements from PRUs (via LPP) and to trigger SRS transmission of PRUs (via NRPPa), or whether an LMF needs to be enabled to instigate location procedures for a PRU (e.g., LPP, NRPPa procedures) without receiving a location request for the PRU from an AMF (i.e., in the absence of an MT-LR or MO-LR for the PRU), and if so, whether support can be provided as part of Release 17.  (2) Send an LS to RAN1 asking RAN1 whether the LMF determined "correction information" obtained from PRU measurements need to be provided to target UEs for UE-based mode of operation, and if so, ask RAN1 to provide further details on the specific "correction information" which need to be provided to target UEs. In addition, ask RAN1 to provide further details on the "PRU antenna orientation information" which should be provided to an LMF.  LS to be progressed by email (extension of [AT116-e][615], to approve by email by EOM).  Agreements:  Proposal 3: RAN2 confirm that the PRU considered as a UE supports the normal LPP procedures for PRU capability transfer.  Proposal 1 (modified): RAN2 confirms that a PRU can support at least the following functionality (as described in the RAN1 LS), dependent on PRU capability:  - Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences) to an LMF.  - Transmit the UL SRS signals for positioning.  - FFS known location information and antenna orientation information |

After the discussion in R2, the following LS to SA2, RAN1, Cc RAN3 was approved:

R2-2111488 Response LS on Positioning Reference Units (PRUs) for enhancing positioning performance

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| **1. Overall Description:**  RAN2 thanks RAN1 for their LS on Positioning Reference Units (PRUs) for enhancing positioning performance.  RAN2 discussed support of PRUs as described in the RAN1 LS R2-2106920 (R1-2106326, S2-2105263). Based on the information provided by RAN1, RAN2's current understanding is that a PRU is a device with a priori known location (to some degree of accuracy at least) and which perfoms location measurements at this known location. In addition, the PRU can transmit SRS to enable TRPs to measure and report UL positioning measurements from PRUs at known location. The PRU or TRP measurements can then be compared by a location server with the measurements expected to determine "correction information" for other nearby target devices. The location measurements for other target devices may then be corrected based on the previously determined "correction information".  Further, RAN2 discussed the modelling of PRUs and agreed that the PRU can be considered (at least) as a UE (from LMF perspective). However, since the PRU location measurements are needed by an LMF itself different views exist in RAN2 on how this can be enabled in the current LCS architecture.  Some companies in RAN2 believe that PRU support has no impact on SA2 and CT specifications and think that the MT-LR procedures as currently specified in TS 23.273 can also be instigated by an LMF (e.g., an LMF may initiate a location request to a GMLC) or existing MO‑LR procedures as specified in TS 23.273 can be instigated by a PRU for enabling an LMF to obtain PRU location measurements or transmit UL-SRS.  Other companies in RAN2 believe that an LMF needs to be enabled to instigate location procedures for a PRU (e.g., LPP, NRPPa procedures) without receiving a location request for the PRU from an AMF (i.e., in the absence of an MT-LR or MO-LR for the PRU). These companies also believe that this effectively means that the LMF should act as an "LCS Client" for PRUs.  However, since the LCS procedures and overall architecture are in the realm of SA2, RAN2 would like to confirm with SA2 whether PRU support as described by RAN1 can be provided with the current LCS framework as specified by SA2 (e.g., TS 23.273) or whether any changes would be required.  In addition, RAN2 discussed whether the LMF determined "correction information" obtained from PRU measurements needs to be provided to target UEs for UE-based mode of operation. As mentioned by RAN1 in the LS, a PRU may provide "antenna orientation information" to an LMF and RAN2 would like to ask RAN1 to provide further details of the "PRU antenna orientation information".  **2. Actions:**  **To SA2 group.**  **ACTION:**  RAN2 kindly asks SA2 whether the MT-LR or MO-LR location procedures as currently specified in TS 23.273 can be used to enable an LMF obtaining location measurements from PRUs (via LPP) and to trigger SRS transmission of PRUs (via NRPPa), or whether an LMF needs to be enabled to instigate location procedures for a PRU (e.g., LPP, NRPPa procedures) without receiving a location request for the PRU from an AMF (i.e., in the absence of an MT-LR or MO-LR for the PRU), and if so, whether support can be provided as part of Release 17.  **To RAN1 group.**  **ACTION:** RAN2 kindly asks RAN1 whether the LMF determined "correction information" obtained from PRU measurements need to be provided to target UEs for UE-based mode of operation, and if so, kindly asks RAN1 to provide further details on the specific "correction information" which need to be provided to target UEs. RAN2 also kindly asks RAN1 to provide further details on the "PRU antenna orientation information" which should be provided to an LMF. |

SA2 replied RAN1, RAN2 LSs in S2-2109104 and S2-2109105.

S2-2109104

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| Regarding the questions listed in the LS:  *“RAN2 kindly asks SA2 whether the MT-LR or MO-LR location procedures as currently specified in TS 23.273 can be used to enable an LMF obtaining location measurements from PRUs (via LPP) and to trigger SRS transmission of PRUs (via NRPPa), or whether an LMF needs to be enabled to instigate location procedures for a PRU (e.g., LPP, NRPPa procedures) without receiving a location request for the PRU from an AMF (i.e., in the absence of an MT-LR or MO-LR for the PRU), and if so, whether support can be provided as part of Release 17.”*  SA2 would like to provide the following answers.  If a PRU is considered as a normal UE and has registered to the network, then a normal MO-LR, MT-LR, or NI-LR could be used to locate the PRU, where the LMF will initiate the positioning procedure, as defined in TS 23.273, clause 6.11. The procedure will trigger the UE to enter into CM-connected mode, i.e. page the UE if it is currently unreachable. However, the LMF may have no knowledge of which UEs act as PRUs and may therefore be unable to control and manage PRUs or make use of measurements provided by PRUs.  Furthermore, in release 17 and previous releases, SA2 has not specified a procedure for LMF to initiate a positioning procedure for a UE without an external trigger.  SA2 has finished R17 work on 5G\_eLCS\_Ph2, therefore it is not possible to study this topic in this release. SA2 may study support of PRUs in Release 18 in which case a better solution may be available later. |

S2-2109105

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| SA2 thanks RAN1 for their LS on Positioning Reference Units (PRUs) for enhancing positioning performance.  SA2 discussed the PRU and agreed to include the objective of how to support the PRU in Rel-18 eLCS\_Ph3 Study Item, considering SA2 Rel-17 is already frozen and more time is needed to study how to support the PRU in SA2.   1. SA2 also notice d that RAN2 is under discussion of how to support PRUs in Rel-17 and is considering solutions which may or may not have impacts to SA2. SA2 does not have enough time in Rel-17 to comment on such solutions at the present time but expects that a solution or solutions preferable to SA2 should be possible in Release 18.   **2. Actions:**  **To RAN1 and RAN2 group.**  **ACTION:** SA2 kindly asks RAN1 and RAN2 to take the above information into account. |

# Discussion

Support of PRU in RAN2 for R17

As can be seen from the LS from SA2, due to the conclusion of the R17 in SA2 and the lack of time, PRU will not be discussed and finished in R17 and will potentially be discussed in R18.

Under this background, in [10], the following has been proposed

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| **Proposal 1:** RAN2 waits for the outcome of the SA2 Rel-18 eLCS\_Ph3 Study Item and any PRU support in RAN2 is postponed to Rel-18.  **Proposal 2:** In Rel-17, RAN2 makes no specification changes to support PRU functionality.  **Proposal 3:** The current PRU text in the baseline Stage 2 [9] is removed from Rel-17. |

In [7], it is also mentioned that we don't need to make any R2 changes in R17 regarding PRU

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| **Proposal 2:** In Rel-17, RAN2 makes no specification changes to support PRU functionality, except for assistance data enhancements if requested by RAN1. |

In [9], it is proposed that we postpone PRU to R18

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| **Proposal 5: RAN2 to discuss whether to postpone the PRU discussion to Rel-18 when SA2 has studied the support of PRUs.** |

While from the view of the moderator, although SA2 has clear indication that they will not work on PRU in R18, the support for PRU from RAN’s perspective has already been confirmed by R1. Thus, R2 still needs to complete the work for PRU in R17 from R2’s prespective.

Thus, we first would like to ask the following question regarding whether to support PRU from RAN’s perspective in R17.

###### Question0: Companies are welcomed to downselect from the following options:

* ***Option1: RAN2 makes no change to support the PRU functionality in R17 except for the assistance data if requested by R1***
* ***Option2: RAN2 makes no specification change to support PRU functionlaity***
* ***Option3: RAN2 should complete the work of PRU from RAN2’s perspective***

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| **Company** | **Yes/No** | **Comments** |
| Apple | Option 1 | To reiterate, we think PRU functionality can be fully supported without any stage-3 changes in RAN2. |
| Ericsson | Option 1 | As already concluded by RAN2, the described PRU functionality can be supported by existing LPP procedures. The only minor addition to LPP is the introduction of a new location information type to enable a requestion for both location and position measurements, and an associated capability. |
| Intel | Option 3 | MO-LR solution has no SA2 impact, and can be completed in Rel-17. But we agree that the changes are minor, i.e. introduce new location information, PRU capability, etc. The details of assistance data should come from RAN1. |
| Nokia | Option 3 | We have the same view as Intel. We think it is possible to add some baseline functionality in Rel-17 and still be able to continue the efforts in Rel-18 taking into account the study from SA2 also and build up on top of the Rel-17 functionality. We must not throw away the efforts put in so far by RAN1 and RAN2 on PRU. |
| Xiaomi | Option 3 | We agree with Intel that at least MO-LR solution to support PRU should be considered in RAN2. |
| Lenovo, Motorola Mobility | Option 3 | We also believe that the changes to be made to support PRUs can be handled by RAN2 using existing signalling as was discussed in previous meetings. |
| Huawei, HiSIlicon | Option3 | We think PRU should be complete from RAN2’s perspective. Anything left for SA2 to finish can be done in R18 and if there is any RAN impacts, CRs can be used to add the functionality in RAN |

###### Question0 Summary:

TBD

Support for MO-LR for PRU

In [1], it has been argued that *MO-LR based solution (the PRU capability is contained in LPP message) has no SA2 impact,* which means that RAN2 can make independent decision on this in spite of the SA2 LS. Also, it has been indicated in the SA2 LS that *the LMF may have no knowledge of which UEs act as PRUs and may therefore be unable to control and manage PRUs or make use of measurements provided by PRUs*.

In [3], the following has also been proposed for MO-LR

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| **Proposal 1: Whether perform MO-LR, MT-LR and NI-LR to acquire the assistance information from PRU is based on PRU and network implementation.**  **Proposal 2: The PRU can send MO-LR request to the LMF to indicate that there is an available PRU in the network.** |

In [7], the following has been proposed

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| **Proposal 1:** For PRU operation in Rel-17, RAN2 considers PRU-specific operations only for the case where the PRU initiates an MO-LR. |

###### Question1: Do companies agree that MO-LR should be supported for PRU?

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| **Company** | **Yes/No** | **Comments** |
| Apple | Yes |  |
| Ericsson | Yes | As described in [6] and Observation 3 “MO-LR and MT-LR procedures for device-based location estimation reporting to LMF are already supported in SA2 and can serve as a baseline for the PRU functionality” – a baseline of UE-based positioning with either MO-LR or MT-LR can be extended by LMF to add the possibility of providing both a location estimate and poitioning measurements from the target device. |
| Intel | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei, HiSIlicon | No | We wonder what will be the use case for PRU to perform MO-LR. If the motivation is from SA2’s perspective, e.g., PRU’s registration in LMF, it is better for SA2 to decide on this. |

###### Question1 Summary:

TBD

Antenna Orientation Information

Based on the original R1 LS, the following has been mentioned about the antenna orientation information for PRU to be reported to the LMF

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| * + 1. Transmit the UL SRS signals for positioning   PRU may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the PRU is known, the information may also be requested by the LMF. |

Hence, it has been clarily mentioned that the PRU can report the antenna orientation information to the LMF when requested by LMF

[2] has proposed the following:

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| ***Proposal8*: Enhance the LPP Request/Provide location information message to support the transfer of PRU antenna orientation information.** |

###### Question2: Do companies agree that PRU can report PRU antenna orientation information to the LMF upon LMF request with Request/ProvideLocationInformation?

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| **Company** | **Yes/No** | **Comments** |
| Apple | No | That information can be provided to LMF directly from OAM. |
| Ericsson | Yes with modifications | A target device, subject to support of a new capability, can report its orientation if RAN2 designs an extension to the existing location estimate |
| Intel | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei, HiSIlicon | Yes |  |

###### Question2 Summary:

TBD

PRU known location

In [3], it has been metioned that *the PRU may obtain its location based on the PRS measurement, thus the PRU may have two locations, one is the known location and the other is calculated based on PRS measurement. Therefore, the LMF should indicate which location is required when the LMF acquires the PRU location by LPP request location information message.*

In [4], the following has been provided

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| **Proposal 1: PRU with known location support the following functionalities: Location uncertainty information, stationary status, providing positioning measurement and/or estimated Tx/Rx Timing error report.** |

In [5], the following observation and proposal have been made:

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| **Proposal 3: The PRU UE can report its known available location information to the LMF via:**   1. **LPP signalling;** 2. **RRC signalling (e.g. using *CommonLocationInfo* message) via gNB.** 3. **Offline/pre-configured location calibration**   **Proposal 4: Support reporting of the known location information source by PRU UE (e.g., RAT-independent methods, manual/offline/preconfigured location, etc.) to the LMF.**  **Proposal 5: PRU UE to support change/update of the location information to the LMF. FFS the signalling (e.g., solicited/unsolicited request) and any relevant event-triggered criteria.**  **Proposal 6: PRU UEs can include positioning QoS information as part of its location estimate report to determine the quality/uncertainty of the location estimate. FFS whether existing IE may be reused, or any new information is needed (e.g., confidence levels).** |

In [8], measurement result is also mentioned that it can be sent along with known location

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| **Proposal 6:** Request for location information sent to UE related to PRU operation includes whether to send measurement report (UE-assisted mode) or measurement report and location estimates (UE-assisted+UE-based mode) |

In [9], it has also been mentined that PRU can be either mobile or stationary and there is a timestampe associated with the location

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| **Proposal 3: The PRU can be in the stationary or moving state.**  **Proposal 4: To achieve the real-time mapping between position measurement and known location information for moving PRU, Request/ProvideLocationInformaiton messages are used to transmit PRU’s known location information and position measurement.** |

In [3], it has been mentioned that

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| Considering the PRU with known location, the known location is precise and then can be used to improve positioning accuracy, it is a reasonable assumption that the PRU will static or semi-static, if PRU is moving, we are not sure the precise know location will be guaranteed.  If the PRU is static or semi-static, the LMF can acquire the PRU information based on OAM configuration. In other words, based on the OAM configuration, the LMF will know there is an available PRU in the network.  **Proposal 3: The LMF can acquire the PRU information based on OAM configuration.** |

###### Question3: Do comapanies agree that LMF can know the UE’s “known” by (a) LPP report, (b) RRC report, or (c) offline/preconfiguration?

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| **Company** | **Options (a), (b), or (c)** | **Comments** |
| Apple | c | OAM |
| Ericsson | a | It is already supported in LPP that a target device can report its location via the *CommonIEsProvideLocationInformation* IE, *locationEstimate* field. Furthermore, the stationarity status of the device can be provided by the *velocityEstimate* field, and the time stamp by the *locationTimestamp* field. |
| Intel | A |  |
| Nokia | A | Some comments on the discussions above. No need to differentiate between known location and determined location. Requirement is for LMF to be able to know the PRU location. For Rel-17, we can focus on stationary PRU. |
| Xiaomi | a and c | If PRU is moving, we are not clear how to acquire the known location, we should first study stationary PRU, and the know location can be provided to LMF by OAM and LPP message. |
| Lenovo, Motorola Mobility | a,b, and c | Option b can also easily be supported based on the existing RRC specification. |
| Huawei, HiSIlicon | A and c |  |

###### Question3 Summary:

Proposals from the summary on PRU known location above have been further made on what should be reported along with the PRU’s known location. Companies are invited to answer the following question

###### Question4: If the known location can be reported to the LMF, do companies agree that UE can also report the following with the known location?

1. ***Location uncertainting information, i.e., the QoS information***
2. ***Stationary/mobility status***
3. ***Positioning measurement for the known location***
4. ***Estimated Tx/Rx timing error report***
5. ***timeStamp***

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| **Company** | **Options (a),(b), (c), (d), (e)** | **Comments** |
| Apple | none | As mentioned above, all the relevant information about PRU can and should be provided directly to LMF from OAM.  Furthermore, regarding “stationary/mobile status”, that discussion should happen in RAN1 first. |
| Ericsson | **(a),(b), (c), (d), (e)** | These are already supported by LPP except that (a), (b) and (e) can be handled in one transaction and (c), (d) and (e) can be handled in a separate transactions since the location information type can only be either location estimate or location measurements, not both. In this context for PRU functionality, the target device should be configured to provide both location estimate and positioning measurements associate to the same time, and therefore the little extension of a new location information type to require both location estimate and positioning measurements to be reported is the only thing that is needed. |
| Intel | C | Should be decided by RAN1. C has been indicated in RAN1 LS. |
| Nokia | **C** | It also depends on confirmation of support for MO-LR procedure for getting PRU location information. If agreed, we should reuse as much as possible the signaling capability for a provide location information (depending on whether there are any shortlisting of positioning methods to be supported for PRU support in Rel-17). |
| Xiaomi | **c** | C is baseline, others can be FFS. |
| Lenovo, Motorola Mobility | **(a), (b), (c), (e)** | RAN1 has already indicated that known location should be provided. It is well understood that the provided known location by the UE has associated uncertainty which will affect the computation of differential corrections. A reasonable design to support the functionality in a workable manner is to include at least options (a), (b) and (e) in addition to (c). |
| Huawei, HiSilicon | **E** | But we think reporting e can already be supported by the current spec |

###### Question4 Summary:

*TBD*

PRU capabilities

In [3], it has been argued that for PRU capabilities, it should include: *positioning measurements, known location and antenna orientation*.

While in [2], it is argued that the antenna orianration capabitliy should be added

In [8], the following is proposed for the PRU capability

|  |
| --- |
| **Proposal 2:** New capability information related to PRU operation includes at least positioning method used for determining its known location, accuracy/uncertainty of location information, and capability for detecting measurement errors |

###### Question5: Do companies agree that the UE capabilities for PRU include the followings?

1. ***Positioning measurements***
2. ***Known location***
3. ***Antenna orientation***
4. ***Accuracy/uncertainty of the known location***

|  |  |  |
| --- | --- | --- |
| **Company** | **Options (a),(b,(c), (d)** | **Comments** |
| Apple | none |  |
| Ericsson | See comment | Since the described PRU functionality is already to a large extent supported by LPP, there are already some capabilities ready, while some needs to be added:   1. Already handled per positioning method, as well as via the location information type. The new location information type for the combination of (a) and (b) needs to be added 2. Already handled via the via the location information type 3. New extension to the *CommonIEsProvideLocationInformation* to represent the target device orientation should be combined with a new capability in the CommonIEs Request/ProvideCapabilities 4. See (b) – already handled in the same way as location estimates. |
| Intel |  | To our understanding, the PRU must be able to report know location. And based legacy LPP capability, the LMF will know what positioning measurements the PRU can support. Therefore we do not see the need to introduce a, b. The only thing we need to introduce is whether the UE supports PRU or not. The details can be discussed in RAN1 based on their feature list discussion. |
| Nokia |  | Question is not very clear. We assume the issue here is to decide what new UE capability signaling is needed and what is mandatory vs optional? If so, we can revisit this later after agreeing on a way forward for PRU support for Rel-17. Agree with Intel that this is also a UE feature discussion in RAN1 also. |
| Xiaomi | a,b | At least a and b should be supported by PRU. |
| Lenovo, Motorola Mobility |  | We agree as a baseline that there should be separate PRU capability for a UE. The PRU can therefore share similar capabilities as a normal UE, which is indicated by Options (a), (b) (in UE-based positioning), and (d). The only new capability is the sharing of antenna orientation information, which according Q2.3 seems reasonable. |
| Huawei, HiSIlicon | B and c | B and C are the new features for PRU |

###### Question5 Summary:

*TBD*

Others

In [5], the following has been argued

|  |
| --- |
| The discussion has thus far focused on the LMF compensation of the Tx/Rx timing errors, which are especially relevant for the UE-assisted positioning methods. The LMF may also share the differential corrections with UEs performing UE-based positioning in the proximity of the reference UEs since the positioning calculation is performed at the UE. In this case, the LMF may have already compensated for the differential corrections related to e.g., DL-RSTD measurements and can therefore directly share the differential corrections to UEs performing UE-based positioning, e.g., via a new dedicated posSIB that carries the differential error corrections, which can be used by the UE for range error compensation.  **Observation 4: Similar to UE-assisted methods, UE-based positioning methods can benefit from receiving differential correction information derived from the LMF and PRU UE.**  The content of the actual correction information can be further understood pending further information from any reply LS sent from RAN1.  **Proposal 7: LMF may provide DL-PRS differential correction information via a new posSIB to assist UEs in compensating differential errors for UE-based positioning. Actual correction information may be finalised pending RAN1’s reply LS.** |

While in [2], it has been provided that the differential correction information does not need to be explicated indicated, but can be implicitly included in the assistance information

|  |
| --- |
| ***Proposal7*: Reuse the exiting IE to provide the timing calibration information to the UE for UE-based positioning.** |

In [8], it is proposed that correction information for timing offsets should be provided

|  |
| --- |
| **Proposal 4:** New assistance data related to PRU operation includes at least correction information (e.g. timing offset), validity conditions (e.g. list of cells where the assistance data is valid) for operation of PRU and evaluation conditions (e.g. RSRP thresholds) |

However, based on the LS from R2 to R1, R2 has already asked R1 on whether to support this, with the following:

|  |
| --- |
| **To RAN1 group.**  **ACTION:** RAN2 kindly asks RAN1 whether the LMF determined "correction information" obtained from PRU measurements need to be provided to target UEs for UE-based mode of operation, and if so, kindly asks RAN1 to provide further details on the specific "correction information" which need to be provided to target UEs. RAN2 also kindly asks RAN1 to provide further details on the "PRU antenna orientation information" which should be provided to an LMF. |

###### Question6: Do comapanies agree that whether differential correction information should be provided to UE-based positioning methods should be up to R1 to decide?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Apple | Maybe | Does RAN1 have time for that discussion in Rel-17? |
| Ericsson | No | This could be a discussion for Rel 18 since it is more specific and beyond natural extensions of LPP that can be considered possible given the Rel 17 WID. |
| Intel | Yes | We do not need to decide this on behalf of RAN1. They can decide what to do. |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei,HiSIlicon | Yes |  |

###### Question6 Summary:

In [5], the following has been proposed for the management of the PRUs in the wireless network

|  |
| --- |
| During the RAN2#115-e [AT115-e][610][3] and RAN2#116-e [Offline-615][4] discussions, the management of PRUs was discussed under the following broadly categorised options:   * Option 1: SA2-related impacts on PRU Access and registration.   + Registration at LMF or AMF   + Using supplementary service messages * Option 2: RAN2 only impacts (using existing signalling and LPP procedures),   The configuration of the PRU as a UE should be more dynamic and fluid, which would align well with using existing LPP procedures as mentioned in Option 2 without any further SA2 input in Rel-17. This would be in some sense a similar approach to current MDT operations, where the gNB would take of the management and configuration of UEs performing MDT. The PRU UE can therefore use similar procedures as normal UE, with the only difference is that the LMF consumes location information rather than an External LCS client. On Option 2, the LMF could instigate the PRU-related procedures via the GMLC using MT-LR.  In this case, depending on the UE capability the LMF need not require for an external trigger to manage the PRU UE. Additionally, given the latest SA2 reply RAN2 should at least make the LMF responsible for the management of PRUs in Rel-17.  **Proposal 1: LMF is responsible for the management of the PRU (e.g., configuration) via existing procedures in Rel-17.**  **Proposal 2: SA2 Impacts related to PRU access and registration (if required) can be further revisited in Rel-18.** |

From the moderator’s view, the above discussions are not up to R2 to decide and should be further discussed in SA2

###### Question7: Do companies agree that the following issues should be discussed in SA2?

* ***Management of PRU***
* ***PRU access and registration***

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Apple | Maybe | That’s for SA2 to decide |
| Ericson | N/A | This is not a discussion in RAN2 |
| Intel | N/A | Leave it to SA2. SA2 has sent LS to us, they will work on it in R18. |
| Nokia | N/A | If the motivation of the question is whether we have to discuss these aspects for PRU support in Rel-17 in RAN2, no, we do not have to discuss this in RAN2 now. Whether SA2 must discuss this or not can be taken up directly in SA2. |
| Xiaomi |  | RAN2 don’t need to discuss it. |
| Lenovo, Motorola Mobility | See comments | These can issues related to PRU management can be simply noted. |
| Huawei, HiSIlicon | Yes | Can be discussed in SA2 |

###### Question7 Summary:

In [8], the following has been proposed

|  |
| --- |
| **Proposal 1:** Support assignment and usage of identifiers related to PRU operation (e.g. PRU ID, LPP session ID for PRU) when transferring any LPP signalling/messages between LMF and PRU |

###### Question8: Do companies agree that identifiers related to PRU operations are needed when transferring LPP signaling?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Apple | no |  |
| Ericsson | No | The described PRU functionality can be handled with the existing LPP identifiers |
| Intel |  | Depends on the solution. If the LMF gets the information on PRU from OAM, then the identifier is needed. Otherwise, e.g. for MO-LR solution, the LMF just needs to know whether the UE can act as PRU or not. We do not need PRU ID. |
| Nokia | No | This seems to be related to PRU management, which is not necessary to be standardized in Rel-17. If PRU acts as UE and registers just as normal UE would and uses MO-LR procedure, then we don’t see the need for any new identifiers. |
| Xiaomi | Maybe | Share the same view with Intel. |
| Lenovo, Motorola Mobility | No | Do not see a strong need to achieve the basic functionality of PRU operation. |
| Huawei, HiSilicon | No |  |

###### Question8 Summary:

In [6], the following has been proposed for a new location information type for PRU with the text proposal in Appendix 1:

|  |
| --- |
| **Proposal 1 Introduce basic PRU functionality by adding a new location information type that enables LMF to configure a device, subject to capability, to report both a location estimate and positioning measurements.**  **Proposal 2 Agree to the text proposal in Appendix A that introduces the new location information type locationEstimateAndMeasurementsRequired with an associated capability** |

###### Question9: Do companies agree that a new location information type as shown in Appendix A needs to be introduced?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Apple | no |  |
| Ericsson | Yes | The new location information type means that devices can report aligned location estimate and positioning measurements, which is enabling the PRU functionality |
| Intel | Yes |  |
| Nokia | No | We can revisit this later after agreeing on the high level solution for PRU support for Rel-17 first. |
| Xiaomi | No | We think LMF should configure PRU to report known location and positioning measurements. |
| Lenovo, Motorola Mobility | Maybe | Seems reasonable as the PRU supports both current location types, i.e location estimate required and location measurements required. |
| Huaweo, HiSIlicon | No |  |

###### Question9 Summary:

TBD

# Conclusions

# Appendix A: Text proposal for PRU

Text proposal for PRU in [6]

================================CHANGE BEGIN==================================

– *CommonIEsProvideCapabilities*

The *CommonIEsProvideCapabilities* carries common IEs for a Provide Capabilities LPP message Type.

-- ASN1START

CommonIEsProvideCapabilities ::= SEQUENCE {

...,

[[

segmentationInfo-r14 SegmentationInfo-r14 OPTIONAL, -- Cond Segmentation

lpp-message-segmentation-r14 BIT STRING { serverToTarget (0),

targetToServer (1) } OPTIONAL

]],

[[

locationEstimateAndMeasurementReporting ENUMERATED { supported} OPTIONAL,

]]

}

-- ASN1STOP

| **Conditional presence** | **Explanation** |
| --- | --- |
| *Segmentation* | This field is optionally present, need OP, if *lpp-message-segmentation-req* has been received from the location server with bit 1 (*targetToServer*) set to value 1. The field shall be omitted if *lpp‑message‑segmentation-req* has not been received in this location session, or has been received with bit 1 (*targetToServer*) set to value 0. |

| ***CommonIEsProvideCapabilities* field descriptions** |
| --- |
| ***segmentationInfo***  This field indicates whether this *ProvideCapabilities* message is one of many segments, as specified in clause 4.3.5. |
| ***lpp-message-segmentation***  This field, if present, indicates the target device's LPP message segmentation capabilities.  If bit 0 is set to value 1, it indicates that the target device supports receiving segmented LPP messages; if bit 0 is set to value 0 it indicates that the target device does not support receiving segmented LPP messages.  If bit 1 is set to value 1, it indicates that the target device supports sending segmented LPP messages; if bit 1 is set to value 0 it indicates that the target device does not support sending segmented LPP messages. |

*[…]*

– *CommonIEsRequestLocationInformation*

The *CommonIEsRequestLocationInformation* carries common IEs for a Request Location Information LPP message Type.

-- ASN1START

CommonIEsRequestLocationInformation ::= SEQUENCE {

locationInformationType LocationInformationType,

triggeredReporting TriggeredReportingCriteria OPTIONAL, -- Cond ECID

periodicalReporting PeriodicalReportingCriteria OPTIONAL, -- Need ON

additionalInformation AdditionalInformation OPTIONAL, -- Need ON

qos QoS OPTIONAL, -- Need ON

environment Environment OPTIONAL, -- Need ON

locationCoordinateTypes LocationCoordinateTypes OPTIONAL, -- Need ON

velocityTypes VelocityTypes OPTIONAL, -- Need ON

...,

[[

messageSizeLimitNB-r14 MessageSizeLimitNB-r14 OPTIONAL -- Need ON

]],

[[

segmentationInfo-r14 SegmentationInfo-r14 OPTIONAL -- Need ON

]]

}

LocationInformationType ::= ENUMERATED {

locationEstimateRequired,

locationMeasurementsRequired,

locationEstimatePreferred,

locationMeasurementsPreferred,

...,

[[

locationEstimateAndMeasurementsRequired-r17

]]

}

PeriodicalReportingCriteria ::= SEQUENCE {

reportingAmount ENUMERATED {

ra1, ra2, ra4, ra8, ra16, ra32,

ra64, ra-Infinity

} DEFAULT ra-Infinity,

reportingInterval ENUMERATED {

noPeriodicalReporting, ri0-25,

ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64

}

}

TriggeredReportingCriteria ::= SEQUENCE {

cellChange BOOLEAN,

reportingDuration ReportingDuration,

...

}

ReportingDuration ::= INTEGER (0..255)

AdditionalInformation ::= ENUMERATED {

onlyReturnInformationRequested,

mayReturnAditionalInformation,

...

}

QoS ::= SEQUENCE {

horizontalAccuracy HorizontalAccuracy OPTIONAL, -- Need ON

verticalCoordinateRequest BOOLEAN,

verticalAccuracy VerticalAccuracy OPTIONAL, -- Need ON

responseTime ResponseTime OPTIONAL, -- Need ON

velocityRequest BOOLEAN,

...,

[[ responseTimeNB-r14 ResponseTimeNB-r14 OPTIONAL -- Need ON

]],

[[ horizontalAccuracyExt-r15 HorizontalAccuracyExt-r15 OPTIONAL, -- Need ON

verticalAccuracyExt-r15 VerticalAccuracyExt-r15 OPTIONAL -- Need ON

]]

}

HorizontalAccuracy ::= SEQUENCE {

accuracy INTEGER(0..127),

confidence INTEGER(0..100),

...

}

VerticalAccuracy ::= SEQUENCE {

accuracy INTEGER(0..127),

confidence INTEGER(0..100),

...

}

HorizontalAccuracyExt-r15 ::= SEQUENCE {

accuracyExt-r15 INTEGER(0..255),

confidence-r15 INTEGER(0..100),

...

}

VerticalAccuracyExt-r15 ::= SEQUENCE {

accuracyExt-r15 INTEGER(0..255),

confidence-r15 INTEGER(0..100),

...

}

ResponseTime ::= SEQUENCE {

time INTEGER (1..128),

...,

[[ responseTimeEarlyFix-r12 INTEGER (1..128) OPTIONAL -- Need ON

]],

[[ unit-r15 ENUMERATED { ten-seconds, ... } OPTIONAL -- Need ON

]]

}

ResponseTimeNB-r14 ::= SEQUENCE {

timeNB-r14 INTEGER (1..512),

responseTimeEarlyFixNB-r14 INTEGER (1..512) OPTIONAL, -- Need ON

...,

[[ unitNB-r15 ENUMERATED { ten-seconds, ... } OPTIONAL -- Need ON

]]

}

Environment ::= ENUMERATED {

badArea,

notBadArea,

mixedArea,

...

}

MessageSizeLimitNB-r14 ::= SEQUENCE {

measurementLimit-r14 INTEGER (1..512) OPTIONAL, -- Need ON

...

}

-- ASN1STOP

| **Conditional presence** | **Explanation** |
| --- | --- |
| *ECID* | The field is optionally present, need ON, if E-CID or NR E-CID is requested. Otherwise it is not present. |

| ***CommonIEsRequestLocationInformation* field descriptions** |
| --- |
| ***locationInformationType***  This IE indicates whether the server requires a location estimate or measurements. For '*locationEstimateRequired*', the target device shall return a location estimate if possible, or indicate a location error if not possible. For '*locationMeasurementsRequired*', the target device shall return measurements if possible, or indicate a location error if not possible. For '*locationEstimatePreferred*', the target device shall return a location estimate if possible, but may also or instead return measurements for any requested position methods for which a location estimate is not possible. For '*locationMeasurementsPreferred*', the target device shall return location measurements if possible, but may also or instead return a location estimate for any requested position methods for which return of location measurements is not possible. For '*locationEstimateAndMeasurementRequired*', the target device shall return a location estimate if possible, or indicate a location error if not possible, and shall return measurements if possible or indicate a location error if not possible. |
| ***triggeredReporting***  This IE indicates that triggered reporting is requested and comprises the following subfields:  - ***cellChange***: If this field is set to TRUE, the target device provides requested location information each time the primary cell has changed.  - ***reportingDuration***: Maximum duration of triggered reporting in seconds. A value of zero is interpreted to mean an unlimited (i.e. "infinite") duration. The target device should continue triggered reporting for the *reportingDuration* or until an LPP *Abort* or *LPP Error* message is received.  The *triggeredReporting* field should not be included by the location server and shall be ignored by the target device if the *periodicalReporting* IE or *responseTime* IE or *responseTimeNB* IE is included in *CommonIEsRequestLocationInformation.* |
| ***periodicalReporting***  This IE indicates that periodic reporting is requested and comprises the following subfields:  - ***reportingAmount*** indicates the number of periodic location information reports requested. Enumerated values correspond to 1, 2, 4, 8, 16, 32, 64, or infinite/indefinite number of reports. If the *reportingAmount* is '*infinite/indefinite'*, the target device shou-ld continue periodic reporting until an LPP *Abort* message is received. The value '*ra1*' shall not be used by a sender.  - ***reportingInterval*** indicates the interval between location information reports and the response time requirement for the first location information report. Enumerated values ri0-25, ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64 correspond to reporting intervals of 1, 2, 4, 8, 10, 16, 20, 32, and 64 seconds, respectively. Measurement reports containing no measurements or no location estimate are required when a *reportingInterval* expires before a target device is able to obtain new measurements or obtain a new location estimate. The value '*noPeriodicalReporting*' shall not be used by a sender. |
| ***additionalInformation***  This IE indicates whether a target device is allowed to return additional information to that requested. If this IE indicates '*onlyReturnInformationRequested'* then the target device shall not return any additional information to that requested by the server. If this IE indicates '*mayReturnAdditionalInformation'* then the target device may return additional information to that requested by the server. If a location estimate is returned, any additional information is restricted to that associated with a location estimate (e.g. might include velocity if velocity was not requested but cannot include measurements). If measurements are returned, any additional information is restricted to additional measurements (e.g. might include E-CID measurements if A-GNSS measurements were requested but not E-CID measurements). |
| ***qos***  This IE indicates the quality of service and comprises a number of sub-fields. In the case of measurements, some of the sub-fields apply to the location estimate that could be obtained by the server from the measurements provided by the target device assuming that the measurements are the only sources of error. Fields are as follows:  - ***horizontalAccuracy*** indicates the maximum horizontal error in the location estimate at an indicated confidence level. The '*accuracy*' corresponds to the encoded uncertainty as defined in TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in TS 23.032 [15].  - ***verticalCoordinateRequest*** indicates whether a vertical coordinate is required (TRUE) or not (FALSE)  - ***verticalAccuracy*** indicates the maximum vertical error in the location estimate at an indicated confidence level and is only applicable when a vertical coordinate is requested. The '*accuracy*' corresponds to the encoded uncertainty altitude as defined in TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in TS 23.032 [15].  - ***responseTime***  - ***time*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation*. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 128. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 1280 seconds. If the *periodicalReporting* IE is included in *CommonIEsRequestLocationInformation*, this field should not be included by the location server and shall be ignored by the target device (if included).  - ***responseTimeEarlyFix*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation* containing early location measurements or an early location estimate. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 128. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 1280 seconds. When this IE is included, a target should send a *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing early location information according to the *responseTimeEarlyFix* IE and a subsequent *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing final location information according to the *time* IE. A target shallomit sending a *ProvideLocationInformation* if the early location information is not available at the expiration of the time value in the *responseTimeEarlyFix* IE. A server should set the *responseTimeEarlyFix* IE to a value less than that for the *time* IE. A target shall ignore the *responseTimeEarlyFix* IE if its value is not less than that for the *time* IE.  - ***unit*** indicates the unit of the *time* and *responseTimeEarlyFix* fields. Enumerated value '*ten-seconds*' corresponds to a resolution of 10 seconds. If this field is absent, the unit/resolution is 1 second.  - ***velocityRequest*** indicates whether velocity (or measurements related to velocity) is requested (TRUE) or not (FALSE).  - ***responseTimeNB*** If the *periodicalReporting* IE or *responseTime* IE is included in *CommonIEsRequestLocationInformation*, this field should not be included by the location server and shall be ignored by the target device (if included).  - ***timeNB*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation*. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 512. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 5120 seconds.  - ***responseTimeEarlyFixNB*** indicates the maximum response time as measured between receipt of the *RequestLocationInformation* and transmission of a *ProvideLocationInformation* containing early location measurements or an early location estimate. If the *unit* field is absent, this is given as an integer number of seconds between 1 and 512. If the *unit* field is present, the maximum response time is given in units of 10-seconds, between 10 and 5120 seconds. When this IE is included, a target should send a *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing early location information according to the *responseTimeEarlyFixNB* IE and a subsequent *ProvideLocationInformation* (or more than one *ProvideLocationInformation* if location information will not fit into a single message) containing final location information according to the *timeNB* IE. A target shall omit sending a *ProvideLocationInformation* if the early location information is not available at the expiration of the time value in the *responseTimeEarlyFixNB* IE. A server should set the *responseTimeEarlyFixNB* IE to a value less than that for the *timeNB* IE. A target shall ignore the *responseTimeEarlyFixNB* IE if its value is not less than that for the *timeNB* IE.  - ***unitNB*** indicates the unit of the *timeNB* and *responseTimeEarlyFixNB* fields. Enumerated value '*ten-second*' corresponds to a resolution of 10 seconds. If this field is absent, the unit/resolution is 1 second.  - ***horizontalAccuracyExt*** indicates the maximum horizontal error in the location estimate at an indicated confidence level. The '*accuracyExt*' corresponds to the encoded high accuracy uncertainty as defined in TS 23.032 [15] and 'confidence' corresponds to confidence as defined in TS 23.032 [15]. This field should not be included by the location server and shall be ignored by the target device if the *horizontalAccuracy* field is included in QoS.  - ***verticalAccuracyExt*** indicates the maximum vertical error in the location estimate at an indicated confidence level and is only applicable when a vertical coordinate is requested. The '*accuracyExt*' corresponds to the encoded high accuracy uncertainty as defined in TS 23.032 [15] and '*confidence*' corresponds to confidence as defined in TS 23.032 [15]. This field should not be included by the location server and shall be ignored by the target device if the *verticalAccuracy* field is included in QoS.  All QoS requirements shall be obtained by the target device to the degree possible but it is permitted to return a response that does not fulfill all QoS requirements if some were not attainable. The single exception is *time* and *timeNB* which shall always be fulfilled – even if that means not fulfilling other QoS requirements.  A target device supporting NB-IoT access shall support the *responseTimeNB* IE*.*  A target device supporting HA GNSS shall support the *HorizontalAccuracyExt*, *VerticalAccuracyEx*, and *unit* fields.  A target device supporting NB-IoT access and HA GNSS shall support the *unitNB* field. |
| ***environment***  This field provides the target device with information about expected multipath and non line of sight (NLOS) in the current area. The following values are defined:  - badArea: possibly heavy multipath and NLOS conditions (e.g. bad urban or urban).  - notBadArea: no or light multipath and usually LOS conditions (e.g. suburban or rural).  - mixedArea: environment that is mixed or not defined.  If this field is absent, a default value of 'mixedArea' applies. |
| ***locationCoordinateTypes***  This field provides a list of the types of location estimate that the target device may return when a location estimate is obtained by the target. |
| ***velocityTypes***  This fields provides a list of the types of velocity estimate that the target device may return when a velocity estimate is obtained by the target. |
| ***messageSizeLimitNB***  This field provides an octet limit on the amount of location information a target device can return.  - ***measurementLimit*** indicates the maximum amount of location information the target device should return in response to the *RequestLocationInformation* message received from the location server. The limit applies to the overall size of the LPP message at LPP level (LPP Provide Location Information), and is specified in steps of 100 octets. The message size limit is then given by the value provided in *measurementLimit* times 100 octets. |
| ***segmentationInfo***  This field indicates whether this *RequestLocationInformation* message is one of many segments, as specified in clause 4.3.5 |

==================================CHANGE ENDS================================