3GPP TSG-RAN WG2 Meeting #131 R2-25xxxxx

Bengaluru, India, August 25-29, 2025

Agenda Item: 8.1.1

Source: Qualcomm Incorporated (Rapporteur)

Title: LPP open issues for feature "AI/ML for NR air interface"

Document for: Discussion, Decision

# Introduction

This document continues the discussion on the LPP open issues as summarized in R2-2504130 from RAN2#130 [1] and is part of the following email discussion.

* [POST130][025][AI PHY] 37.355 CR (Qualcomm)

 Intended outcome: agree to CR and open issues list and inputs

 Deadline: long

Status updates of the LPP Open Issues are highlighted in turquoise in Section 2 below (and are also summarized in Annex A).

Feedback on the issues list, status update and additional issues (if any) is requested in Section 3.

Companies are invited to provide feedback on the open issues list by: **1st August 2025.**

NOTE: A parallel discussion is undertaken for the running CR in 'R2-25xxxxx\_([POST130][025][AI PHY] LPP Running CR Discussion)\_v00' which is in the same email discussion folder as this document.

# Open issues for specification 37.355 (LPP)

### Common NR Positioning Information Elements (Clause 6.4.3)

##### **Open issue LPP-1:Applicability of *dl-PRS-ResourcePrioritySubset***

**Issue description:**

The IE *NR-DL-PRS-Info* also includes method specific information (for DL-AoD). If DL-PRS assistance data are needed for NR AI/ML positioning, it needs to be clarified that the *dl-PRS-ResourcePrioritySubset* is not applicable to NR AI/ML positioning.

**Status in running CR:**

Captured as "Editor's Note".

**Relevant Agreements:**

From RAN1#119 (see Annex in LPP running CR [3] for the full list of RAN1 and RAN2 agreements for Case 1):

|  |
| --- |
| **Agreement**For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE. For info #7, RAN1 study, if necessary, choose one alternative from the following:[…] |

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA are applicable to NR AI/ML positioning Case 1, the IE *NR-DL-PRS-Info* is also applicable. This implies that the *dl-PRS-ResourcePrioritySubset*(which provides a priority for measurement reporting in UE-assisted DL-AoD) is not applicable to NR AI/ML positioning Case 1.

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The field dl-PRS-ResourcePrioritySubset in IE NR-DL-PRS-Info should be ignored for NR AI/ML positioning. Remove corresponding 'Editor's Note' from the running CR. |

Updated accordingly in \_v02 of the running CR [3].

##### **Open issue LPP-2:Applicability of IE *NR-DL-PRS-ProcessingCapability***

**Issue description:**

In the case of capabilities for multiple NR positioning methods are provided, the IE *NR-DL-PRS-ProcessingCapability* applies across the NR positioning methods and the target device shall indicate the same values for the capabilities in IEs *NR-DL-TDOA-ProvideCapabilities*, *NR-DL-AoD-ProvideCapabilities*, and *NR-Multi-RTT-ProvideCapabilities*.

If the IE *NR-DL-PRS-ProcessingCapability* is applicable to NR AI/ML positioning, it needs to be clarified whether the above also applies to *NR-AI-ML-PositioningProvideCapabilities*.

**Status in running CR:**

Captured as "Editor's Note" (without changes to the current specification text).

**Relevant Agreements:**

R2-2503308 (R1-2502979): LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#120bis.

The above RAN1 feature list includes some DL-PRS Resource capabilities (58-2-3/3a/3b), however, all in yellow highlight (indicating that they are not yet final).

Whether the *NR-DL-PRS-ProcessingCapability*are applicable to NR AI/ML positioning Case 1 or not is currently unclear (most capabilities in this IE are primarily for UE-assisted mode). In addition, if the capabilities should be applicable, it is unclear whether the same values as in IEs *NR-DL-TDOA-ProvideCapabilities*, *NR-DL-AoD-ProvideCapabilities*, and *NR-Multi-RTT-ProvideCapabilities* shall be indicated.

**Proposed resolution:**

Wait for further RAN1 input and keep the "Editor's Note" in the running CR.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| Regarding the applicability of IE NR-DL-PRS-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now. |

LS from RAN1 [4]:

R2-2504952 (R1-2504675), "LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#121" with attachment R1-2504673.

This includes:

58-2-4: DL PRS Processing Capability for UE-based positioning Case 1

The above feature is a subset of IE *NR-DL-PRS-ProcessingCapability* (only the Rel-16 part seems needed (so far)). However, it seems a UE can signal different values for Case 1 than for the other NR positioning methods (although, still in yellow highlight in [4]):

Note: If UE does not provide [this FG] but the UE supports Case 1, FG 13-1 indicates the DL PRS processing capabilities common across all positioning methods including UE-based positioning Case 1.]

The above Note (if confirmed) implies that an AI/ML positioning specific IE of *NR-DL-PRS-ProcessingCapability* will be needed, which however, may mostly be a copy of the existing *NR-DL-PRS-ProcessingCapability* IE*.*

The status is kept "open" for further input from RAN1.

##### **Open issue LPP-3: Applicability of *NR-DL-PRS-QCL-ProcessingCapability***

**Issue description:**

In the case of capabilities for multiple NR positioning methods are provided, the IE *NR-DL-PRS-QCL-ProcessingCapability* applies across the NR positioning methods and the target device shall indicate the same values for the capabilities in IEs *NR-DL-TDOA-ProvideCapabilities*, *NR-DL-AoD-ProvideCapabilities*, and *NR-Multi-RTT-ProvideCapabilities*.

If the IE *NR-DL-PRS-QCL-ProcessingCapability* is applicable to NR AI/ML positioning, it needs to be clarified whether the above also applies to *NR-AI-ML-PositioningProvideCapabilities*.

**Status in running CR:**

Captured as "Editor's Note" (without changes to the current specification text).

**Relevant Agreements:**

R2-2503308 (R1-2502979): LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#120bis.

The above RAN1 feature list includes some DL-PRS Resource capabilities (58-2-3/3a/3b), however, all in yellow highlight (indicating that they are not yet final).

Whether the *NR-DL-PRS-QCL-ProcessingCapability* are applicable to NR AI/ML positioning Case 1 or not is currently unclear (most capabilities are primarily for UE-assisted mode). In addition, if the capabilities should be applicable, it is unclear whether the same values as in IEs *NR-DL-TDOA-ProvideCapabilities*, *NR-DL-AoD-ProvideCapabilities*, and *NR-Multi-RTT-ProvideCapabilities* shall be indicated.

**Proposed resolution:**

Wait for further RAN1 input and keep the "Editor's Note" in the running CR.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| Regarding the applicability of IE NR-DL-PRS-QCL-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now. |

LS from RAN1 [4]:

R2-2504952 (R1-2504675), "LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#121" with attachment R1-2504673.

This includes:

58-2-5: Support of SSB from neighbour cell as QCL source of a DL PRS for UE-based positioning Case 1.

58-2-6: Support of DL PRS from serving/neighbour cell as QCL source of a DL PRS for UE-based positioning Case 1.

The above 2 features are the same as already supported in IE *NR-DL-PRS-QCL-ProcessingCapability.* However, it is not clear whether the UE shall signal the same values across all NR positioning methods, including Case 1.

The status is kept "open" for further input from RAN1.

##### **Open issue LPP-4: Applicability of *NR-DL-PRS-ResourcesCapability***

**Issue description:**

The IE *NR-DL-PRS-ResourcesCapability* defines the DL-PRS Resources capability for each positioning method.

However, most capabilities are primarily for UE-assisted mode. Whether and which DL-PRS Resources capabilities are needed for UE-based direct NR AI/ML positioning depends on RAN1.

**Status in running CR:**

Captured as "Editor's Note" (without changes to the current specification text).

**Relevant Agreements:**

R2-2503308 (R1-2502979): LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#120bis.

The above RAN1 feature list includes some DL-PRS Resource capabilities (58-2-3/3a/3b), however, all in yellow highlight (indicating that they are not yet final).

However, this indicates that DL-PRS Resource capabilities specifically for NR AI/ML Positioning Case 1 are going to be defined.

**Proposed resolution:**

Wait for further RAN1 input and keep the "Editor's Note" in the running CR.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| Regarding the applicability of IE NR-DL-PRS-ResourcesCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now. |

LS from RAN1 [4]:

R2-2504952 (R1-2504675), "LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#121" with attachment R1-2504673.

This includes:

58-2-3: DL PRS Resources for UE-based positioning Case 1.

58-2-3a: DL PRS Resources for UE-based positioning Case 1 on a band

58-2-3b: DL PRS Resources for UE-based positioning Case 1 on a band combination

The above 3 features are (so far) the same as already supported in IE *NR-DL-PRS-ResourcesCapability.*

The status is kept "open" for further input from RAN1.

##### **Open issue LPP-5: Applicability of *NR-On-Demand-DL-PRS-Configurations-Selected-IndexList***

**Issue description:**

In the case of available on-demand DL-PRS configurations for multiple NR positioning methods are provided, the IE *NR-On-Demand-DL-PRS-Configurations* shall be present in only one of *NR-Multi-RTT-ProvideAssistanceData*, *NR-DL-AoD-ProvideAssistanceData*, or *NR-DL-TDOA-ProvideAssistanceData.*

If on-demand DL-PRS is applicable to NR AI/ML positioning, it needs to be clarified whether the above also applies to *NR-AI-ML-PositioningProvideAssistanceData*.

**Status in running CR:**

Captured as "Editor's Note" in IEs *NR-On-Demand-DL-PRS-Configurations-Selected-IndexList*, *NR-DL-TDOA-ProvideAssistanceData, NR-DL-AoD-ProvideAssistanceData.*

**Relevant Agreements:**

From RAN1#119 (see Annex in LPP running CR [3] for the full list of RAN1 and RAN2 agreements):

|  |
| --- |
| **Agreement**For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE. For info #7, RAN1 study, if necessary, choose one alternative from the following:[…] |

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the on-demand DL-PRS feature, and associated assistance data and signalling is also applicable to NR AI/ML positioning Case 1. Since the on-demand DL-PRS configurations can then be included in the assistance data for each NR positioning method (incl. NR AI/ML positioning), they need to be provided only once in the case of multiple NR positioning methods are requested and an index indicates the applicable configuration(s) for each method. There seems no reason why NR AI/ML positioning Case 1 should not follow the same logic.

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-On-Demand-DL-PRS-Configurations-Selected-IndexList is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3, 6.5.10.1, and 6.5.11.1 can be removed. |

Updated accordingly in \_v02 of the running CR [3].

##### **Open issue LPP-6:Applicability of *NR-PRU-DL-Info***

**Issue description:**

Currently, the IE *NR-PRU-DL-Info* is primarily used for NR carrier phase positioning.

If the IE *NR-PRU-DL-Info* is also applicable to NR AI/ML positioning, the IE description needs to be generalized.

**Status in running CR:**

Captured as "Editor's Note" in IE *NR-PRU-DL-Info.*

**Relevant Agreements:**

From RAN1#119 (see Annex in LPP running CR [3] for the full list of RAN1 and RAN2 agreements):

|  |
| --- |
| **Agreement**For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE. For info #7, RAN1 study, if necessary, choose one alternative from the following:[…] |

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the IE *NR-PRU-DL-Info* is also applicable:

|  |  |
| --- | --- |
| 14 | PRU measurements together with the location information of the PRU |

Therefore, the IE description should be generalized (i.e., not specific to carrier phase measurements).

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| [LPP-6] The IE NR-PRU-DL-Info is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3 can be removed. FFS if more PRUs are needed to be included for training purposes. |

Updated accordingly in \_v02 of the running CR [3].

The FFS in the agreement above is captured as new issue LPP-6a.

##### **Open issue LPP-6a (new):Number of PRUs in *NR-PRU-DL-Info***

**Issue description:**

Currently, the IE *NR-PRU-DL-Info* provides PRU measurements for a single PRU. However, the issue was raised at RAN2#130 whether more PRUs are needed to be included for training purposes.

If more PRUs are needed, a LMF can always provide multiple Provide Assistance Data messages. However, the Request Assistance Data message may need to include an indication of e.g., number of PRUs requested (if needed).

**Proposed resolution:**

Companies to provide contributions to the following meeting on whether more PRUs are needed to be included for training purposes, and if so, the corresponding signalling details.

##### **Open issue LPP-7:Applicability of *NR-SelectedDL-PRS-IndexList***

**Issue description:**

In the case of assistance data for multiple NR positioning methods are provided, the IE *NR-DL-PRS-AssistanceData* shall be present in only one of *NR-Multi-RTT-ProvideAssistanceData*, *NR-DL-AoD-ProvideAssistanceData*, or *NR-DL-TDOA-ProvideAssistanceData*.

If the IE *NR-DL-PRS-AssistanceData* is applicable to NR AI/ML positioning, it needs to be clarified whether the above also applies to *NR-AI-ML-PositioningProvideAssistanceData*.

**Status in running CR:**

Captured as "Editor's Note" in IEs *NR-SelectedDL-PRS-IndexList*, *NR-DL-TDOA-ProvideAssistanceData, NR-DL-AoD-ProvideAssistanceData.*

**Relevant Agreements:**

From RAN1#119 (see Annex in LPP running CR [3] for the full list of RAN1 and RAN2 agreements):

|  |
| --- |
| **Agreement**For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE. For info #7, RAN1 study, if necessary, choose one alternative from the following:[…] |

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the *NR-DL-PRS-AssistanceData* and associated signalling is also applicable to NR AI/ML positioning Case 1. Since the *NR-DL-PRS-AssistanceData* can then be included in the assistance data for each NR positioning method (incl. NR AI/ML positioning), they need to be provided only once in the case of multiple NR positioning methods are requested and an index indicates the applicable configuration(s) for each method. There seems no reason why NR AI/ML positioning Case 1 should not follow the same logic.

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| NR-SelectedDL-PRS-IndexList is applicable to AI/ML positioning Case 1. |

Updated accordingly in \_v02 of the running CR [3].

### NR AI/ML Positioning Information Elements (Clause 6.5.13)

##### **Open issue LPP-8: Details of IE *NR-AI-ML-PositioningProvideAssistanceData***

**Issue description:**

This IE defines the assistance data for NR AI/ML positioning Case 1. According to RAN1#119 agreements, the assistance data should be analogous to DL-TDOA assistance data:

|  |  |  |
| --- | --- | --- |
| **Agreement**For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE. For info #7, RAN1 study, if necessary, choose one alternative from the following:* Alternative 1. Info #7 is provided implicitly via associated ID.
	+ Associated ID is signaled by LMF to indicate whether info #7 is consistent between training and inference.
* Alternative 2. Info #7 can be provided either implicitly or explicitly by LMF. Note: no UE capability is introduced on whether info #7 is provided implicitly or explicitly, and the UE can request info #7 to be provided explicitly or implicitly.
	+ If provided implicitly, associated ID is signaled by LMF to indicate whether info #7 is consistent between training and inference.
* Alternative 3. Info #7 is **not** be provided from LMF to UE.
	+ If info #7 is not provided, UE may assume info #7 is consistent between training and inference.
* Alternative 4. Info #7 is provided explicitly from LMF to UE.

|  |  |
| --- | --- |
| 7 | Geographical coordinates of the TRPs served by the gNB (include a transmission reference location for each DL-PRS Resource ID, reference location for the transmitting antenna of the reference TRP, relative locations for transmitting antennas of other TRPs) |

 |

**Status in running CR:**

The running CR currently includes all assistance data from UE-based DL-TDOA, except the *NR-PeriodicAssistData* (which is only for carrier phase positioning and not included in the RAN1 agreement), together with an Editor's Note. The RAN1 agreement refers to the information in Stage 2 (38.305):

|  |  |
| --- | --- |
|   | **Information** |
| 1 | Physical cell IDs (PCIs), global cell IDs (GCIs), ARFCN, and PRS IDs of candidate NR TRPs for measurement |
| 2 | Timing relative to the serving (reference) TRP of candidate NR TRPs |
| 3 | DL-PRS configuration of candidate NR TRPs |
| 4 | Indication of which DL-PRS Resource Sets across DL-PRS positioning frequency layers are linked for DL-PRS bandwidth aggregation |
| 5 | SSB information of the TRPs (the time/frequency occupancy of SSBs) |
| 6 | Spatial direction information (e.g. azimuth, elevation etc.) of the DL-PRS Resources of the TRPs served by the gNB |
| 7 | Geographical coordinates of the TRPs served by the gNB (include a transmission reference location for each DL-PRS Resource ID, reference location for the transmitting antenna of the reference TRP, relative locations for transmitting antennas of other TRPs) |
| 8 | Fine Timing relative to the serving (reference) TRP of candidate NR TRPs |
| 9 | PRS-only TP indication |
| 10 | The association information of DL-PRS resources with TRP Tx TEG ID |
| 11 | LOS/NLOS indicators |
| 12 | On-Demand DL-PRS-Configurations, possibly together with information on which configurations are available for DL-PRS bandwidth aggregation |
| 13 | Validity Area of the Assistance Data |
| 14 | PRU measurements together with the location information of the PRU |
| 15 | Data facilitating the integrity results determination of the calculated location |
| 16 | TRP beam/antenna information (including azimuth angle, zenith angle and relative power between PRS resources per angle per TRP) |
| 17 | Expected Angle Assistance information |
| 18 | PRS priority list |

[1] Table 8.12.2.1.0-1 in 38.305, Use equipment (UE) positioning in NG-RAN (Release 18), v18.3.0

[2] Table 8.11.2.1.0-1 in 38.305, Use equipment (UE) positioning in NG-RAN (Release 18), v18.3.0

NOTE: Items #7, 16-18 (assistance data for DL-AoD) are still under discussion in RAN1.

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the *NR-AI-ML-PositioningProvideAssistanceData* should include (at least) all the assistance data IEs currently defined for UE-based DL-TDOA. This needs to be revised once additional RAN1 agreements are available.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-AI-ML-PositioningProvideAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. |

Agreement from RAN1#121:

|  |
| --- |
| Working AssumptionFor AI/ML based positioning Case 1, regarding info #7 in the assistance information from legacy UE-based DL-TDOA, it can be provided as in legacy UE-based DL-TDOA or implicitly.AgreementAbove Working Assumption is confirmed. |

The current version of the running CR includes all assistance data from UE-based DL-TDOA. The status is kept "open" in case additional input will be received from RAN1 which requires updates of the *NR-AI-ML-PositioningProvideAssistanceData*.

The "implicit provisioning" of info#7 in the RAN1 agreement above is discussed in the parallel running CR discussion.

##### **Open issue LPP-9: Details of IE *NR-AI-ML-PositioningRequestAssistanceData***

**Issue description:**

The IE *NR-AI-ML-PositioningRequestAssistanceData* is used by the target device to request assistance data from a location server for NR AI/ML direct positioning (e.g., during an ongoing LPP session or via MO-LR).

This IE should be analogous to the *NR-AI-ML-PositioningProvideAssistanceData.* I.e., the "Request" must match the "Provide".

For the *NR-AI-ML-PositioningProvideAssistanceData*, see issue #LPP-8.

**Status in running CR:**

The running CR currently includes all assistance data from UE-based DL-TDOA, except the *NR-PeriodicAssistData* (which is only for carrier phase positioning), together with an Editor's Note (see issue #LPP-8).

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the *NR-AI-ML-PositioningRequestAssistanceData* should include (at least) all the assistance data IEs currently defined for UE-based DL-TDOA. This needs to be revised once additional RAN1 agreements are available.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-AI-ML-PositioningRequestAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. |

Agreement from RAN1#121:

|  |
| --- |
| Working AssumptionFor AI/ML based positioning Case 1, regarding info #7 in the assistance information from legacy UE-based DL-TDOA, it can be provided as in legacy UE-based DL-TDOA or implicitly.AgreementAbove Working Assumption is confirmed. |

The current version of the running CR includes all assistance data from UE-based DL-TDOA. The status is kept "open" in case additional input will be received from RAN1 which requires updates of the *NR-AI-ML-PositioningProvideAssistanceData/NR-AI-ML-PositioningRequestAssistanceData*.

##### **Open issue LPP-10: Details of IE** ***NR-AI-ML-PositioningProvideLocationInformation***

**Issue description:**

The IE *NR-AI-ML-PositioningProvideLocationInformation* provides the results of the inference operation. This should comprise the location coordinates (which are reported in *CommonIEsProvideLocationInformation*) together with the time stamp (as for any UE-based method). However, for the NR positioning methods, batch reporting was introduced in Rel-17 (i.e., up to 32 instances (location results) can be reported at once). One issue here is whether batch reporting should also be applicable to NR AI/ML positioning.

**Status in running CR:**

Captured as "Editor's Note" in IE *NR-AI-ML-PositioningProvideLocationInformation.*

**Proposed resolution:**

The IE *NR-AI-ML-PositioningProvideLocationInformation* includes at least the location coordinates together with time stamp (as for any UE-based method). Any additional elements depend on further RAN1 progress.

Since NR AI/ML positioning also falls into the category of "NR positioning methods" (e.g., measurements are based on NR DL-PRS), it seems consequent that batch reporting is also applicable to NR AI/ML positioning (in the same way as UE-based DL-TDOA and DL-AoD).

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-AI-ML-PositioningProvideLocationInformation contains (at least) the time stamp for the location coordinates (which are reported in CommonIEsProvideLocationInformation). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. |

The status is kept "open" in case additional input will be received from RAN1 which requires updates of the *NR-AI-ML-PositioningProvideLocationInformation*.

##### **Open issue LPP-10a:Applicability of "batch reporting" for AI/ML positioning.**

**Status Update: Open after RAN2#130.**

Not discussed at RAN2#130 and no further RAN1 input is available.

##### **Open issue LPP-11: Details of IE *NR-AI-ML-PositioningRequestLocationInformation***

**Issue description:**

The IE *NR-AI-ML-PositioningRequestLocationInformation* includes information on the location request. Per agreement from RAN2#129:

|  |
| --- |
| * Existing LPP procedures related to Location Information Transfer (RequestLocationInformation/ ProvideLocationInformation messages) are used for providing and requesting the results of the UE sided model inference operation. The detail stage 3 message extension can be discussed while drafting the stage 3 CR.
 |

**Status in running CR:**

The running CR currently includes only the common *AssistanceAvailability* flag (which is included in all LPP positioning methods for which assistance data are defined), together with an "Editor's Note" in IE *NR-AI-ML-PositioningRequestLocationInformation.*

**Proposed resolution:**

Companies to provide contributions to the following meeting on additional positioning instructions for IE *NR-AI-ML-PositioningRequestLocationInformation* (if any).

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-AI-ML-PositioningRequestLocationInformation contains (at least) the AssistanceAvailability flag. Additional details/information can be discussed via company contributions. |

The status is kept "open" for additional company contributions (if any).

##### **Open issue LPP-12: Details of IE *NR-AI-ML-PositioningProvideCapabilities***

**Issue description:**

The IE *NR-AI-ML-PositioningProvideCapabilities* indicates support for NR AI/ML direct positioning (i.e., Case 1) and provides the NR AI/ML positioning capabilities ("applicable functionality") to the location server.

|  |
| --- |
| RAN2#126:* The LPP Capability Transfer procedures (RequestCapabilities/ProvideCapabilities messages) are used to indicate supported AI/ML positioning capabilities. FFS how to handle dynamic capabilities, depending on further RAN1 progress and understanding of the functionality.

RAN2#128:* For POS Case 1, RAN2 confirm that the existing unsolicited UE capability report mechanism in LPP can support UE to report the applicable functionality in both “proactive” and “reactive” as a baseline.
	+ Proactive case: When the applicability change, UE can send an unsolicited LPP ProvideCapabilities message to LMF.
	+ Reactive case: If the applicability changes based on the configuration in LPP ProvideAssistanceData message in step 3, UE can send an unsolicited LPP ProvideCapabilities message to LMF. Configuration details are FFS.

RAN2#129bis:* UE reports the applicable functionality to the LMF by the LPP provide capabilities message without any additional LMF control.
 |

**Status in running CR:**

The IE *NR-AI-ML-PositioningProvideCapabilities* currently includes the common LPP capabilities and assistance data supported (per *NR-AI-ML-PositioningProvideAssistanceData* (which are the same as in *NR-DL-TDOA-ProvideAssistanceData*)).

DL-PRS capabilities depend on further RAN1 agreements and are not included yet (see #LPP-2/3/4).

Captured as "Editor's Note" in IE *NR-AI-ML-PositioningProvideCapabilities.*

**Proposed resolution:**

Given that all assistance information for UE-based DL-TDOA (other than info #7) are applicable to NR AI/ML positioning Case1, the *NR-AI-ML-PositioningProvideCapabilities* should include (at least) all the capabilities currently defined for UE-based DL-TDOA.

**Status Update: Open after RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| The IE NR-AI-ML-PositioningProvideCapabilities contains (at least) all capabilities from UE-based DL-TDOA as starting point, except the capability related to DL-PRS processing (see #LPP-2/3/4). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. |

LS from RAN1 [4]:

R2-2504952 (R1-2504675), "LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#121" with attachment R1-2504673.

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| For **NR\_AIML\_Air**,It is RAN1 understanding that RAN2 will include listing of corresponding ADs as per RAN1 agreement for providing all assistance data of UE-based DL-TdoA (FG 58-2-2).  |

58-2-1: UE-based positioning Case 1 [for inference]

58-2-2: Support reception of AD for UE-based positioning Case 1

Given that RAN2 agreed to introduce "AI/ML Positioning Case 1" as a separate/new LPP positioning method, the above two capabilities are "automatically" supported per existing LPP principles in the current version of the running CR.

The status is kept "open" in case additional input will be received from RAN1.

##### **Open issue LPP-13:Location server error causes**

**Issue description:**

The IE *NR-AI-ML-Positioning-Error* is used by the location server or target device to provide NR AI/ML positioning error reasons to the target device or location server, respectively.

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| RAN2#128:* As a baseline, if the AIML based positioning method becomes non-applicable when LMF requests UE location estimation, UE cannot perform the AIML based positioning, and reply with LPP Providelocationinformation message with error cause. FFS if other fallback options are considered.

RAN2#129* The content of error cause is discussed while drafting stage3 CRs.
 |

**Status in running CR:**

The IE *NR-DL-AI-ML-LocationServerErrorCauses* currently includes the error causes from DL-TDOA.

Captured as "Editor's Note" in IE *NR-DL-AI-ML-LocationServerErrorCauses.*

**Proposed resolution:**

Companies to provide contributions to the following meeting on error causes for IE *NR-DL-AI-ML-LocationServerErrorCauses* (the proposed error causes should be accompanied by some justification (e.g., why needed? Expected receiver behaviour? etc.)

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

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| --- |
| Reuse the existing NR-DL-TDOA-LocationServerErrorCauses structure for AI/ML positioning Case 1, and do not introduce additional error causes in NR-DL-AI-ML-LocationServerErrorCauses. |

##### **Open issue LPP-14:Target device error causes**

**Issue description:**

The IE *NR-AI-ML-Positioning-Error* is used by the location server or target device to provide NR AI/ML positioning error reasons to the target device or location server, respectively.

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| RAN2#128:* As a baseline, if the AIML based positioning method becomes non-applicable when LMF requests UE location estimation, UE cannot perform the AIML based positioning, and reply with LPP Providelocationinformation message with error cause. FFS if other fallback options are considered.

RAN2#129* The content of error cause is discussed while drafting stage3 CRs.
 |

**Status in running CR:**

The IE *NR-DL-AI-ML-TargetDeviceErrorCauses* currently includes the error causes from DL-TDOA.

Captured as "Editor's Note" in IE *NR-DL-AI-ML-TargetDeviceErrorCauses.*

**Proposed resolution:**

Companies to provide contributions to the following meeting on error causes for IE *NR-DL-AI-ML-TargetDeviceErrorCauses* (the proposed error causes should be accompanied by some justification (e.g., why needed? Expected receiver behaviour? etc.)

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

|  |
| --- |
| Introduce ‘DL AIML positioning not available’ as new target device error cause for AI/ML positioning case 1, to indicate UE cannot perform positioning method (e.g. model not available and performance monitoring outcome not available). |

Above error cause is added to the running CR \_v02 [3].

Company contributions (if any) can propose additional details.

##### **Open issue LPP-15:Applicability of Positioning Integrity to AI/ML positioning**

**Issue description:**

Per RAN1 agreement: "For AI/ML based positioning Case 1, all assistance information from legacy UE-based DL-TDOA, other than info #7, can be provided from LMF to UE."

The RAN1 agreement already includes info #15 for positioning integrity:

*Data facilitating the integrity results determination of the calculated location*

However, companies have different views on whether this implies support for integrity.

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

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| --- |
| (LPP-15) positioning Integrity is supported for AI/ML positioning Case 1 |

Agreement from RAN1#121:

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| --- |
| Working AssumptionFor AI/ML based positioning Case 1, regarding info #7 in the assistance information from legacy UE-based DL-TDOA, it can be provided as in legacy UE-based DL-TDOA or implicitly.AgreementAbove Working Assumption is confirmed. |

Since the current version of the running CR includes all assistance data from UE-based DL-TDOA, there are no additional LPP impacts.

##### **Open issue LPP-16:Signalling of Monitoring Outcome**

**Issue description:**

In terms of monitoring for AI/ML positioning, RAN1 agrees to support:

* Option A: The target UE side performs monitoring metric calculation. The target UE may signal the monitoring outcome to the LMF.
* the content of monitoring outcome includes at least an indication that the target UE cannot perform the Case 1 positioning method.

This includes all the sub-options A-1, A-2 and A-3. The details are upon RAN1 still, but there are expected RAN2 impact.

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| **Agreement (RAN1#116bis)**For model performance monitoring of AI/ML positioning Case 1, for model performance monitoring metric calculation in label-based model monitoring, study the feasibility, benefits, and potential specification impact of the following options with regard to how to generate information on ground truth label: * Option A. The target UE side performs monitoring metric calculation.
	+ Option A-1. At least information on ground truth label of the target UE is generated by LMF and provided to the target UE.
		- In one example, target UE and/or gNB sends measurement (e.g., legacy measurement) to LMF so that LMF can derive the information on ground truth label.
	+ Option A-2. At least position calculation assistance data (e.g., existing information for UE-based positioning method) is provided from LMF to the target UE.
	+ Option A-3. Reuse Rel-18 assistance data transfer framework from LMF to the target UE, where the PRU measurement (e.g., legacy measurement) and the corresponding PRU location are sent via LMF to the target UE.
	+ Option A-4. PRU measurement (and the corresponding PRU location if not already known at the UE-side) are sent from PRU to the target UE side.
		- Note: Option A-4 can be realized by implementation in a manner transparent to specification if the PRU sends information to the target UE side in a proprietary method.
* Option B. The LMF performs monitoring metric calculation.
	+ Option B-1. at least inference result (i.e., the model output corresponding to target UE’s channel measurement) of the target UE is sent by the target UE to LMF.
	+ Option B-2. PRU’s channel measurement is sent via LMF to the target UE, and the inference result (i.e., the model output corresponding to PRU’s channel measurement) is sent by the target UE to LMF.

Note: exact method to perform the monitoring metric calculation is up to implementation. Note: Other options are not precluded. |

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| **Conclusion (RAN1#118)** For model performance monitoring of AI/ML positioning Case 1, for model performance monitoring metric calculation in label-based model monitoring,* Option A-4 can be realized by implementation in a manner transparent to specification specification if the PRU sends information to the target UE side in a proprietary method. No further discussion on Option A-4.
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| **Agreement (RAN1#119)**For model performance monitoring of AI/ML positioning Case 1, support at least: * Option A. The target UE side performs monitoring metric calculation.
	+ The target UE may signal the monitoring outcome to the LMF.
	+ FFS: content of monitoring outcome
* FFS: Option B
 |

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| **Agreement (RAN1#120bis)**For model performance monitoring of AI/ML positioning Case 1, “FFS: content of monitoring outcome” in RAN1#119 agreement is resolved by:* the content of monitoring outcome includes at least an indication that the target UE cannot perform the Case 1 positioning method.
 |

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

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| --- |
| No new LPP message is introduced for performance monitoring purposes |

Handled via LPP#14 (Target device error causes).

LS from RAN1 [5] (see also Annex B):

R2-2504998 (R1-2505073), "LS on Rel-19 AI/ML positioning higher layer parameters list Post RAN1#121" with attachment R1-2505074.

Row 4:

* At least an indication that the target UE cannot perform the Case 1 positioning method
* It is up to RAN2 to decide

No additional LPP impacts.

##### **Open issue LPP-17:Signalling of "ground-truth label" information**

**Issue description:**

Following up on sub-option A-1 (see #LPP-16), RAN1 agreed that:

Option A-1. At least information on ground truth label of the target UE is generated by LMF and provided to the target UE.

The details on whether a new message or existing message is used to provide the ground truth label to the target UE is also expected to have RAN2 impact.

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| **Agreement (RAN1#120)**For AI/ML based positioning Case 1, from RAN1 perspective, when the label data of location is generated by LMF and transferred from LMF to UE, label and quality indicator of label can be provided by reusing existing IEs. * From RAN1 perspective, the existing IE can use one of the geographic shapes defined in TS 23.032. The location estimate uncertainty and confidence (if included with the geographic shapes) can serve as quality indicator of the label.
 |

**Status Update: Resolved at RAN2#130.**

Agreement from RAN2#130:

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| (LPP-17): A target UE can obtain the "ground-truth label" information via existing MO-LR procedures. No additional RAN2 specification impacts are foreseen |

LS from RAN1 [5] (see also Annex B):

R2-2504998 (R1-2505073), "LS on Rel-19 AI/ML positioning higher layer parameters list Post RAN1#121" with attachment R1-2505074.

Row 5:

* LMF sends target UE location info, including quality indicator and time stamp
* LMF sends the ground truth label (i.e., location info) to UE. It is up to RAN2 to decide whether the ground truth label is sent to UE via LPP or other protocol.

No additional LPP impacts.

##### **Open issue LPP-18 (new):Consistency between training and inference**

**Issue description:**

At RAN2#130, contribution R2-2503403 "Discussion on consistency between training and inference for AI POS", vivo et al. was discussed which resulted in the following agreement:

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| To ensure the consistency between training and inference, the UE should be able to request assistance data associated with a specific group of TRPs. FFS the request associated information in on demand prs request. |

**Proposed resolution:**

Companies to provide contributions to the following meeting on details for "the request associated information in on demand prs request".

# Discussion

Companies are invited to provide comments on the open issues list, proposed resolutions, status updates, etc. Additional open issues (if any) can also be suggested in the Table below, e.g., based on running CR review in the discussion 'R2-25xxxxx\_([POST130][025][AI PHY] LPP Running CR Discussion)\_v00'.

|  |  |  |
| --- | --- | --- |
| Company | Issue # | Comments |
| Huawei, HiSilicon | 2,3,4 | We understand that even if RAN1 has agreed on the UE feature list for Pos Case 1, it is unclear whether these IEs are common for all positioning methods, or whether to introduce AI/ML positioning specific IEs (e.g. copy existing IEs for AI/ML positioning purpose).We are ok to keep this open, and further input from RAN1 may be needed. |
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# References

1. R2-2504130, "LPP open issues for feature "AI/ML for NR air interface", Qualcomm Incorporated (Rapporteur). RAN2#130.
2. R2-2504129: "Running CR for AI/ML Positioning Accuracy Enhancements" v01, Qualcomm Incorporated (Rapporteur). RAN2#130.
3. R2-25xxxxx: "Running CR for AI/ML Positioning Accuracy Enhancements" v02, Qualcomm Incorporated (Rapporteur). RAN2#131.
4. R2-2504952 (R1-2504675), "LS on updated Rel-19 RAN1 UE features lists for NR after RAN1#121".
5. R2-2504998 (R1-2505073), "LS on Rel-19 AI/ML positioning higher layer parameters list Post RAN1#121".

# Annex A: Summary of LPP Open Issues and Status

|  |  |  |  |
| --- | --- | --- | --- |
| Issue | RAN2 Agreement | Status | Action |
| LPP#1 | Applicability of *dl-PRS-ResourcePrioritySubset* | The field dl-PRS-ResourcePrioritySubset in IE NR-DL-PRS-Info should be ignored for NR AI/ML positioning. Remove corresponding 'Editor's Note' from the running CR. | Closed | Updated in \_v02 of running CR |
| LPP#2 | Applicability of IE *NR-DL-PRS-ProcessingCapability* | Regarding the applicability of IE NR-DL-PRS-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now.  | Open | Wait for final RAN1 feature list |
| LPP#3 | Applicability of *NR-DL-PRS-QCL-ProcessingCapability* | Regarding the applicability of IE NR-DL-PRS-QCL-ProcessingCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now. | Open | Wait for final RAN1 feature list |
| LPP#4 | Applicability *of NR-DL-PRS-ResourcesCapability* | Regarding the applicability of IE NR-DL-PRS-ResourcesCapability to NR AI/ML positioning Case 1, wait for further RAN1 input and keep the current "Editor's Note" in the running CR for now. | Open | Wait for final RAN1 feature list |
| LPP#5 | Applicability of NR-On-Demand-DL-PRS-Configurations-Selected-IndexList | The IE NR-On-Demand-DL-PRS-Configurations-Selected-IndexList is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3, 6.5.10.1, and 6.5.11.1 can be removed. | Closed | Updated in \_v02 of running CR |
| LPP#6 | Applicability of *NR-PRU-DL-Info* | [LPP-6] The IE NR-PRU-DL-Info is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3 can be removed. FFS if more PRUs are needed to be included for training purposes | Closed.The FFS is captured as new issue #6a. | Updated in \_v02 of running CR |
| LPP#6a (new) | Number of PRUs in *NR-PRU-DL-Info* | The IE NR-PRU-DL-Info is also applicable to NR AI/ML positioning Case 1. The corresponding Editor's Notes in clause 6.4.3 can be removed. FFS if more PRUs are needed to be included for training purposes | Open (only the FFS part) | Company contributions (if any) |
| LPP#7 | Applicability of *NR-SelectedDL-PRS-IndexList* | NR-SelectedDL-PRS-IndexList is applicable to AI/ML positioning Case 1. | Closed | Updated in \_v02 of running CR |
| LPP#8 | Details of IE NR-AI-ML-PositioningProvideAssistanceData | The IE NR-AI-ML-PositioningProvideAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.[RAN1#121] For AI/ML based positioning Case 1, regarding info #7 in the assistance information from legacy UE-based DL-TDOA, it can be provided as in legacy UE-based DL-TDOA or implicitly. | Open | Wait for further RAN1 input (if any) |
| LPP#9 | Details of IE *NR-AI-ML-PositioningRequestAssistanceData* | The IE NR-AI-ML-PositioningRequestAssistanceData contains (at least) all assistance data elements from UE-based DL-TDOA as starting point. This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now.[RAN1#121] For AI/ML based positioning Case 1, regarding info #7 in the assistance information from legacy UE-based DL-TDOA, it can be provided as in legacy UE-based DL-TDOA or implicitly. | Open | Wait for further RAN1 input (if any) |
| LPP#10 | Details of IE *NR-AI-ML-PositioningProvideLocationInformation* | The IE NR-AI-ML-PositioningProvideLocationInformation contains (at least) the time stamp for the location coordinates (which are reported in CommonIEsProvideLocationInformation). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. | Open | Wait for further RAN1 input (if any) |
| LPP#10a | Applicability of "batch reporting" for AI/ML positioning. |  | Open | Company contributions (if any) |
| LPP#11 | Details of IE *NR-AI-ML-PositioningRequestLocationInformation* | The IE NR-AI-ML-PositioningRequestLocationInformation contains (at least) the AssistanceAvailability flag. Additional details/information can be discussed via company contributions. | Open | Company contributions (if any) |
| LPP#12 | Details of IE *NR-AI-ML-PositioningProvideCapabilities* | The IE NR-AI-ML-PositioningProvideCapabilities contains (at least) all capabilities from UE-based DL-TDOA as starting point, except the capability related to DL-PRS processing (see #LPP-2/3/4). This will be revised when additional RAN1 input is available. The current Editor's Note is kept for now. | Open | Related to #2/3/4 |
| LPP#13 | Location server error causes | Reuse the existing NR-DL-TDOA-LocationServerErrorCauses structure for AI/ML positioning Case 1, and do not introduce additional error causes in NR-DL-AI-ML-LocationServerErrorCauses. | Closed | No additional LPP impacts. |
| LPP#14 | Target device error causes | Introduce ‘DL AIML positioning not available’ as new target device error cause for AI/ML positioning case 1, to indicate UE cannot perform positioning method (e.g. model not available and performance monitoring outcome not available). | Closed | Updated in \_v02 of running CR. |
| LPP#15 | Applicability of Positioning Integrity to AI/ML positioning | (LPP-15) positioning Integrity is supported for AI/ML positioning Case 1 | Closed | No additional LPP impacts. |
| LPP#16 | Signalling of Monitoring Outcome | No new LPP message is introduced for performance monitoring purposes | Closed | No additional LPP impacts. |
| LPP#17 | Signalling of "ground-truth label" information | (LPP-17): A target UE can obtain the "ground-truth label" information via existing MO-LR procedures. No additional RAN2 specification impacts are foreseen | Closed | No additional LPP impacts. |
| LPP#18 (new) | Consistency between training and inference | To ensure the consistency between training and inference, the UE should be able to request assistance data associated with a specific group of TRPs. FFS the request associated information in on demand prs request. | Open | Company contributions (if any) |

# Annex B: AI/ML positioning higher layer parameters list Post RAN1#121

The RAN1 LS [5]

R2-2504998 (R1-2505073), "LS on Rel-19 AI/ML positioning higher layer parameters list Post RAN1#121".

includes two parameters for Case 1:

**(1) "At least an indication that the target UE cannot perform the Case 1 positioning method"**

* FFS for RAN2
* Agreement
	+ For model performance monitoring of AI/ML positioning Case 1, support at least:

 Option A. The target UE side performs monitoring metric calculation.

 The target UE may signal the monitoring outcome to the LMF.

 FFS: content of monitoring outcome

 FFS: Option B

* Agreement
	+ For model performance monitoring of AI/ML positioning Case 1, “FFS: content of monitoring outcome” in RAN1#119 agreement is resolved by:

the content of monitoring outcome includes at least an indication that the target UE cannot perform the Case 1 positioning method.

This parameter is covered by LPP-14 and LPP-16.

**(2) "LMF sends target UE location info, including quality indicator and time stamp"**

* LMF sends the ground truth label (i.e., location info) to UE. It is up to RAN2 to decide whether the ground truth label is sent to UE via LPP or other protocol.
* Agreement
	+ For AI/ML based positioning Case 1, from RAN1 perspective, when the label data of location is generated by LMF and transferred from LMF to UE, label and quality indicator of label can be provided by reusing existing IEs.
	+ From RAN1 perspective, the existing IE can use one of the geographic shapes defined in TS 23.032. The location estimate uncertainty and confidence (if included with the geographic shapes) can serve as quality indicator of the label.

This parameter is covered by LPP-17.