3GPP TSG-RAN WG2 Meeting #109bis-e***R2-20xxxxx***

Online, April 20 – 30, 2020

**Agenda item:** 6.8.2.4

**Source:** Ericsson

**Title:** Email discussion report: [AT109bis-e][602][POS] LPP ASN.1 structural issues (Ericsson)

**Document for:**  Discussion and Decision

# 1. Introduction

This document summarizes the following email discussion:

* [[AT109bis-e][602][POS] LPP ASN.1 structural issues (Ericsson)

Status: Started

Scope: Initial discussion on the issues raised in R2-2003144

Intended outcome: Report of potential easy agreements and remaining open issues (R2-2003983) suitable for capture in the LPP ASN.1 issue list

Deadline: Comments by Tuesday 2020-04-28 1000 UTC; output document Wednesday 2020-04-29 1000 UTC

2 Discussion about LPP ASN.1 structural issues

Different structural issues and aspects are addressed in the following subsections. As dfiscussed in RAN2-109-e, the guiding metric when comparing different representation is ASN.1 PER-encoded examples. Suggested proposals are adopted from [1].

2.1 Association of DL-PRS AD and UE-Based AD

DL-PRS is fundamental is the NR positioning assistance data, and in the case of UE-based positioning, there is a need to provide additional assistance data of TRP location, beam information and relative time differences of DL-PRS transmissions – the UE-based assistance data.

The DL-PRS AD is represented in a hierarchy:

* 1-4 Positioning Frequency Layers (PFL)
  + 1-64 TRPs
    - 1-2 DL-PRS Resource Sets
      * 1-64 DL-PRS Resources

The following figure illustrate the highest two levels of the hierarchy in an example with two PFLs.



In case of UE-based positioning, the UE is also configured with UE-based assistance data, and each TRP of the DL-PRS AD needs to be associated to elements of the UEB AD. Two options are discussed in [1]:

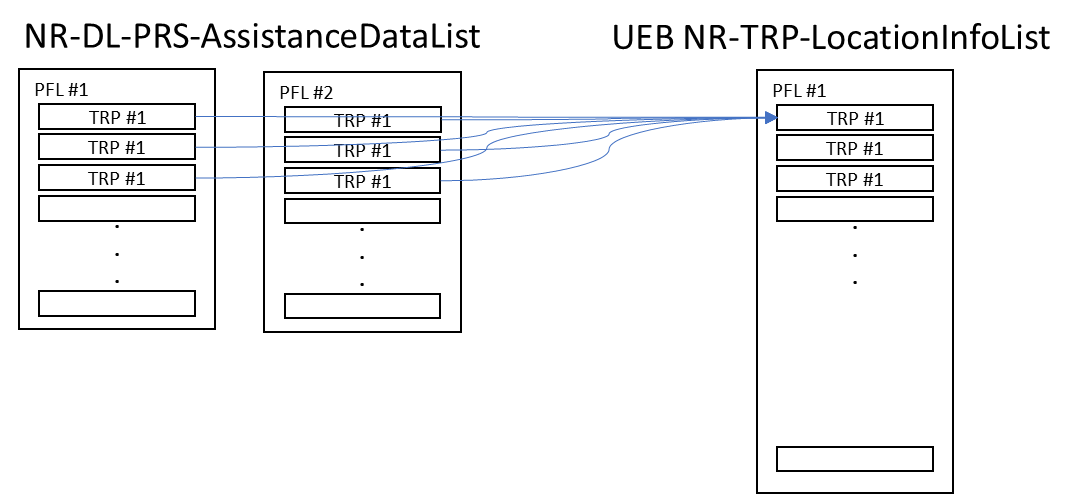
**Option 1.1: Matching UEB AD hierarchy (37.355 V16.0.0.)**

The UEB AD is represented by an hierarchy of exactly the same size as DL-PRS AD



**Option 1.2: Linear UEB AD hierarchy**

By listing only the unique elements in TRP lists, and introducing references from elements in the DL-PRS AD hierarchy to the TRP list elements, the representation can be very compact as illustrated by the following example based on an example with three sectors per TRP and two frequency layers. Groups of six TRPs from the DL-PRS AD only need to refer to one TRP location:



The cost is the pointer (list index) from each TRP in the DL-PRS AD hierarchy to the UEB AD TRP list.

In [1] these two representations are compared in terms of PER-encoded bytes in two examples, a minimalistic example which gives the same size, and the 3GPP Indoor Open Office scenario for FR2, which gives Option 1.1: 6.4 kBytes, and Option 1.2: 5.5 kBytes – a reduction in size of 13% or in absolute terms a reduction of more than three SI messages if using Option 1.2 instead of Option 1.1.

Companies are asked to Provide their opinion and preference on the two representations of UE-basedAD

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| 1.1 Representation of UE-based assistance data | |
| Company | Comments |
| Ericsson | We are concerned about the combined size of the AD and find it necessary to take any opportunity to ensure that the AD is as compact and efficiently represented as possible. Therefore, we prefer Option 1.2 with linear UE-based assistance data. |
| Qualcomm | The structure of the UE-based assistance data should be the same as for the assistance data for UE-assisted. A different structure for assistance data elements which are used/belong together should be avoided, since it only creates confusion and complicates implementation.  I also don’t think the proposal in Annex 1 can work in a general case because it rigidly ties 4 different types of assistance data (TRP location, beam info, RTD info and PRS Info) to indices in the PRS Assistace Data. When different types of assistance data are received separately (e.g. via broadcast from a previous serving cell or from the current serving cell at a previous time or simply in different LPP messages), the UE will not be able to reliably associate the assistance data for the same TRPs using the indices received for the PRS Assistance Data.  I’m also not quite clear about the motivation. Why should different TRPs have the same assistance data? However, if a duplication is possible/likely in practice, an index could be used within each type of assistance data. As an example:  NR-TRP-LocationInfo-r16 ::= SEQUENCE (SIZE (1..4)) OF NR-TRP-LocationInfoPerFreqLayer-r16  NR-TRP-LocationInfoPerFreqLayer-r16 ::= SEQUENCE {      referencePoint-r16          ReferencePoint-r16              OPTIONAL,   -- Cond NotSameAsPrev      trp-LocationInfoList-r16    SEQUENCE (SIZE (1..64)) OF TRP-LocationInfoElement-r16,      ...  }  TRP-LocationInfoElement-r16 ::= SEQUENCE {      trp-id-r16                     TRP-ID-r16,      trp-Index                   INTEGER (1..maxTRPs)                   OPTIONAL,      trp-Location-r16               RelativeLocation-r16                    OPTIONAL,   -- Need OP      trp-DL-PRS-ResourceSets-r16     SEQUENCE (SIZE(1..2)) OF                                        DL-PRS-ResourceSets-TRP-Element-r16 OPTIONAL,   -- Need OP      ...  }  The *trp-Index* would be included and the *trp-Location* and the *trp-DL-PRS-ResourceSets* would be excluded when location info for another TRP is referenced. The *trp-Index* can be defined for both previous sequences in the above ASN.1 (since there is an implicit ordering). There is then no longer any dependence on other assistance data. |
| Ericsson | I dont agree that “structure of the UE-based assistance data should be the same as for the assistance data for UE-assisted”. No technical arguments have been shared motivating this statement. For example, the TDOA signal measurement report follow a linear structure similar to what we suggest for UE-based AD, and that has been working fine already for LTE.  We do not see the case where AD is distributed via a combination of unicast and broadcast from different cells as the typical case. The typical case is more likely to be the self-contained case where all AD is either distributed via unicast or broadcast from the same cell without any cross-references. However, if an operator would like to do something like that, the linear structure can be completely filled up with the same number of TRPs in both.  Not sure about the motivation? That several TRPs can be co-located is an obvious example, since the hierarchy implies that a site with several frequency layers would correspond to one TRP per frequency layer at this site. This is the example we have encoded in our contribution to illustrate the improvement gains.  Thanks for the third option, it would be interesting if you also could provide PER-encoded examples to enable a comparison. Also, since you suggest this change to a matching structure, would you really need to keep the TRP-ID in each element. Instead, it is possible to retrieve the TRP-ID from the associated DL-PRS TRP. |
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From [1], the following related proposals are adopted:

1. **Change the UE-based assistance data structure to linear lists and agree to the text proposals in Annex 1.**
2. **There is no need to include the TRP-ID in the UEB AD hierarchy. It is obtained by association via the references to the DL-PRS AD hierarchy.**

2.2 Representation of beam directions

UE-based AD may include information about the antenna beam directions in the network. At RAN2-109-e, two different representations of beam directions were discussed:

* **Option 2.1**: 0.1 degrees resolution
* **Option 2.2**: 1 degrees resolution with an optional refinement to 0.1 degrees.

This is not a measurement, but a configuration and is related to how accurate an operator can determine the main direction of the installed antenna beams in the network. To determine antenna beam directions as precisely as 0.1 degrees means specific operator efforts, and if antenna beam directions are known at a 1 degree resolution, then Option 2.1 means signing overhead, while Option 2.2 is more appropriate.

The two representations were used in [1] to PER-encode two examples, one where the operator has determined the antenna beam directions with a 0.1 degree resolution, and one with a 1 degree resolution for the 3GPP IOO scenario. In the former case, both Option 2.1 and Option 2.2 gives the same number of PER-encoded bytes, while in the latter case, Option 2.2 gives an 18% reduction in PER-encoded bytes compared to Option 2.1 – or a difference in absolute terms of more than one SI message.

In light of the new information about the impact on PER-encoded size reduction from Option 2.2 compared to Option 2.1, companies are asked to comment of the suitable ASN.1 representation for beam directions

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| 2.1 Beam direction representation of either 0.1 degrees or 1 degrees with an optional 0.1 degree refinement | |
| Company | Comments |
| Ericsson | Again, we are concerned about the combined size of the AD and our understanding and experience is that in many cases the operator only is able to determine the antenna beam direction configuration of a 1 degree resolution.  RAN1 has discussed the angle measurement accuracy, and disclosed that a 0.1 degree resolution is appropriate for angle measurements. However, RAN1 is not discussing the resolution of configuration parameters such as the beam direction.  Option 2.2 provides a much more efficient coding in this case which has a significant impact on the size of the AD. We therefore prefer the more efficient coding of Option 2.2. |
| Qualcomm | A single value for a field would always be preferred if possible, since simpler.  I do not see the relation between signalling granularity and e.g., accuracy or operation and maintenance efforts. A network can still provide the beams with e.g., 10 or 120 degrees granularity, if desired. Option 2.2 is more efficient if and only if the information content is reduced, but this is not a new finding. With the same information content, Option 2.2 would be less efficient. Therefore, we have a preference to keep Option 2.1. However, if companies think Option 2.2 (split into 2 fields) is preferred, we are also O.K. |
| Ericsson | Well, it is quite a different OPEX effort to estimate beam directions at a 0.1 degree resolution, and since in many cases a 1 degree resolution should be sufficient and can be obtained with much less OPEX, then it is relevant to ensure that the benefits of reduced AD size should be enabled.  As seen in the PER-encoded example, the cost of the optionality bit is negligible, while Option 2.2 provides significant AD size reduction benefits for the operators in cases when the reduced resolution is sufficient. |
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1. **Introduce a 1 degree resolution and an optional 0.1 degree refinement for beam direction representation and agree to the text proposal in Annex 2.**

2.3 Cartesian relative coordinates

The baseline representation of TRP coordinates is based on a reference point and relative coordinates in relation to the reference point in delta latitutde-longitude-height. This is most suitable to represent macro and micro deployments, but not very suitable not very efficient to represent indoor deployments such as the indoor open office. In such an environment, it is more appropriate to define a reference point such as a lower left coordinate, and then define relative XYZ coordinates in relation to the reference point.

The relative location of a TRP etc can then instead be a choice between the IE in baseline and a new IE with a cartesian XYZ coordinate as in the following:

-- ASN1START

RelativeLocationLoLaAlt-r16 ::= SEQUENCE {

milli-arc-second-units-r16 ENUMERATED { mas0-03, mas0-3, mas3, mas30, ...},

height-units-r16 ENUMERATED {mm, cm, m, ...},

delta-latitude-r16 Delta-Latitude-r16,

delta-longitude-r16 Delta-Longitude-r16,

delta-height-r16 Delta-Height-r16,

locationUNC-r16 LocationUncertainty-r16 OPTIONAL, -- Need OP

...

}

RelativeLocation-r16 ::= CHOICE {

relativeLocationLoLaAlt-r16 RelativeLocationLoLaAlt-r16,

relativeLocationxyz-r16 RelativeLocationXYZ-r16

}

RelativeLocationXYZ-r16 ::= SEQUENCE {

xyz-units-r16 ENUMERATED {cm, dm, ...},

delta-x-r16 INTEGER (0..4095),

delta-y-r16 INTEGER (0..4095),

delta-z-r16 INTEGER (0..4095),

locationUNC-r16 LocationUncertainty-r16 OPTIONAL, -- Need OP

...

}

-- ASN1STOP

In 3GPP IOO example in [1], PER-encoded 187 bytes is needed for the current baseline representation of relative coordinates, and 152 bytes for the proposed alternative cartesian representation of relative coordinates. The main driver for an alternative representation of relative locations is convenience for the operator.

Companies are asked to provide comments about possible and relevant representations of relative locations for DL-PRS transmission entities. Basically, which of the below options company prefer.

* **Option 3.1**. Current structure with a relative location only in delta latitutde-longitude-height
* **Option 3.2.** A choice of two relative location alternatives, either delta latitutde-longitude-height or delta cartesian XYZ.

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| 3.1 Relative location representation also in local Cartesian coordinates | |
| Company | Comments |
| Ericsson | NR positioning is expected to provide benefits in a wide range of scenarios and use cases. Some of these are supported by outdoor deployment where relative TRP locations naturally are represented by delta latitude-longitude-height. Other situations such as indoor deployments are much more conveniently represented by relative cartesian coordinates. Therefore, we find it natural to ensure that both representations are possible so we support Option 3.2 |
| Qualcomm | We don’t see the need/requirement for introducing a new relative XYZ coordinate system. A UE has to report a location in one of the existing GAD shapes using lat/long/alt, and not some relative XYZ coordinates. |
| Ericsson | Good comment – naturally, the location reporting should also be updated to include the possibility to report in relative cartesian XYZ coordinates. In a typical indoor environment, a position in lat/long/alt make little sense and would need to be converted into local XYZ in the application anyway. |
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1. **RAN2 to discuss and agree to an alternative cartesian relative position representation.**
2. **RAN2 to agree to the text proposal in Annex 3.**

2.4 UEB high level AD structuring

As discussed in the email discussion, there is now one grouping of UE-based assistance data information in the IE *NR-PositionCalculationAssistanceData-r16* as part of the AD provided to the target device point to point and a different grouping of the UE-based assistance data information in the IEs *NR-UEB-TRP-LocationData-r16* and *NR-UEB-TRP-RTD-Info-r16* provided via broadcast.

The coding standard in LPP to date is to compile the pos SIBs based on existing IEs. Therefore it seems more natural and clear to group the UE-based assistance data in the IEs *NR-UEB-TRP-LocationData-r16* and *NR-UEB-TRP-RTD-Info-r16* for both peer to peer and broadcast.

Companies are asked to provide comments about the UE-based assistance data grouping and if it is relevant to have one and the same grouping of the information no matter how the assistance data is distributed. In particular, consider the following two options:

* **Option 4.1**. One grouping based on IE *NR-PositionCalculationAssistanceData-r16* for peer to peer unicast AD distribution and a different grouping based on the IEs *NR-UEB-TRP-LocationData-r16* and *NR-UEB-TRP-RTD-Info-r16* broadcast distribution
* **Option 4.2**. The same grouping based on the IEs *NR-UEB-TRP-LocationData-r16* and *NR-UEB-TRP-RTD-Info-r16* for both peer to peer unicast and broadcast distribution

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| 4.1 UE-based assistance data grouping | |
| Company | Comments |
| Ericsson | We prefer to follow the practice of one representation and grouping of information that is used both in per to peer unicast and broadcast – the practice we have followed this far In LPP.  Already when the UE-based positioning was discussed via email, different groupings were discussed, and QC stressed that “The field/IE names are typically selected to describe its content”. Clearly, the IE names *NR-UEB-TRP-LocationData-r16* and *NR-UEB-TRP-RTD-Info-r16* are examples of that, while the IE name *NR-PositionCalculationAssistanceData-r16*  is not, instead something that the receiver is supposed to use the data for.  We are in favor of one and the same grouping of information and support Option 4.2.  The combined text proposal for Option 4.2 and 5.1 can be as follows, with a new IE introduced in 6.4.3: |
| –                      *NR-Pos-ProvideAssistanceData*  The IE *NR-Pos-ProvideAssistanceData* is used by the location server to provide assistance data to enable UE‑assisted and UE-based NR downlink positioning. It may also be used to provide NR positioning specific error reason.  -- ASN1START  NR-Pos-ProvideAssistanceData-r16 ::= SEQUENCE {      nr-DL-PRS-AssistanceData-r16            NR-DL-PRS-AssistanceData-r16     OPTIONAL,   -- Need ON  nr-UEB-TRP-LocationData-r16 NR-UEB-TRP-LocationData-r16 OPTIONAL, -- Cond UEB  nr-UEB-TRP-RTD-Info-r16 NR- UEB-TRP-RTD-Info-r16 OPTIONAL, -- Cond UEB      nr-Pos-Error-r16                       NR-Pos-Error-r16                OPTIONAL,   -- Need ON      ...  }  -- ASN1STOP   | **Conditional presence** | **Explanation** | | --- | --- | | *UEB* | The field is mandatory present for UE based NR positioning; otherwise it is not present. | | | |
| Ericsson | In this way we can maintain a clear specification that follows the coding standards that we have adopted to date |
| Qualcomm | I’m not clear about the question/issue. We usually define fields as needed, and group them into IEs as appropriate. If a group of fields is needed at several places, we typically define a separate (common) IE. |
| Ericsson | The issue is clarity. I do not see a strong motivation for grouping information differently for peer to peer and broadcast distributions, when the same grouping can be used in both. That also implies that these IEs are moved into the now collapsed 6.4.3 which makes them being naturally placed, and we avoid defining an IE we do not need any longer (the *NR-PositionCalculationAssistanceData-r16* IE – which also has a name not describing its content – something that QC has said is not how names should be selected) |
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1. **Represent UEB AD grouped into *NR-UEB-TRP-LocationData* and *NR-UEB-TRP-RTD-Info* for both unicast and broadcast of assistance data**

2.5 NR DL-PRS Assistance Data

With the agreement to separate the NR positioning support in LPP over several positioning methods comes an issue about how to provide the DL-PRS AD. If only one positioning method is configured, then it is not so important, but if there are several methods configured, then it makes sense to place the DL-PRS AD more central. As before, there exists an index IE to point at what parts of the DL-PRS assistance data that is relevant per positioning method if it is relevant.

Three options were discussed during the email discussion concerning the final check of the running CR:

* **Option 5.1.** Lift up DL-PRS AD one level to *ProvideAssistanceData* as *nr-DL-PRS-ProvideAssistanceData*:

    [[  nr-DL-PRS-ProvideAssistanceData-r16     NR-DL-PRS-ProvideAssistanceData-r16             OPTIONAL,   -- Need ON

        nr-Multi-RTT-ProvideAssistanceData-r16  NR-Multi-RTT-ProvideAssistanceData-r16   OPTIONAL,   -- Need ON

        nr-DL-AoD-ProvideAssistanceData-r16     NR-DL-AoD-ProvideAssistanceData-r16       OPTIONAL,   -- Need ON

        nr-DL-TDOA-ProvideAssistanceData-r16    NR-DL-TDOA-ProvideAssistanceData-r16   OPTIONAL    -- Need ON

    ]]

* **Option 5.2.** Include *nr-DL-PRS-AssistanceData* in the common provide assistance data

CommonIEsProvideAssistanceData ::= SEQUENCE {

            ...,

            [[

                            segmentationInfo-r14                        SegmentationInfo-r14                            OPTIONAL        -- Need ON

            ]],

            [[

                            periodicAssistanceData-r15            PeriodicAssistanceDataControlParameters-r15

                                                                                                                                                                                                                                                   OPTIONAL        -- Cond PerAD

            ]],

            [[

                nr-DL-PRS-AssistanceData-r16               NR-DL-PRS-AssistanceData-r16             OPTIONAL,   -- Need ON

            ]]

}

* **Option 5.3.** Include *nr-DL-PRS-AssistanceData* per positioning method with conditional presence

NR-DL-TDOA-ProvideAssistanceData-r16 ::= SEQUENCE {

            nr-DL-PRS-AssistanceData-r16                    NR-DL-PRS-AssistanceData-r16                          OPTIONAL,       -- Cond NotProvidedInOtherMethod

            nr-SelectedDL-PRS-IndexList-r16 SEQUENCE (SIZE (1..nrMaxFreqLayers)) OF NR-SelectedDL-PRS-PerFreq-r16 OPTIONAL,-- Need ON

            nr-PositionCalculationAssistanceData-r16

                                                             NR-PositionCalculationAssistanceData-r16      OPTIONAL,       -- Cond UEB

            nr-DL-TDOA-Error-r16                            NR-DL-TDOA-Error-r16                         OPTIONAL,       -- Need ON

            ...

}

The nice things with Option 5.1 is that it becomes more clear and readable, that it allows a separate DL PRS error, and that it also will include the UE-based assistance data in a clearly common place. Also, Option 5.2 separates the DL PRS data from the positioning methods, and could have DL-PRS specific errors as part of some common structure, but it makes the common structure less clean. It is also possible as in Option 5.3 to place the DL-PRS in the positioning methods with a conditional presence so that it only needs to be provide once, but then without the possibility of a separate DL PRS error message, and a more messy structure.

Companies are asked to comment on the suitable placmement of the DL-PRS AD in the LPP structure to make it a clean and clear representation, and indicate their preferred option among the three options presented

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| 5.1 DL-PRS AD placement in the LPP message structure for provisioning of location information | |
| Company | Comments |
| Ericsson | We consider Option 5.1 as the most clear and readable placement and it also allow a specific error message for NR DL-PRS – this central component in NR positioning.  For text proposal, see previous issue, where a new IE generic for NR positioning is added to 6.4.3. |
| Qualcomm | Option 5.2. should not be an option, since *NR-DL-PRS-ProvideAssistanceData* is not Common Positioning.  Option 5.1 creates confusion, since it appears that *NR-DL-PRS-ProvideAssistanceData* is a position method. It also violates the request/response pairing.  There is no functional difference between Option 5.1 and 5.3, but Option 5.3 follows LPP design principles. |
| Ericsson | In our understanding the fact that an IE is included in the *ProvideAssistanceData* does not mean that it appears to be a positioning method. There are already instances of *CommonIEsProvideAssistanceData* and *EPDU-Sequence* in *ProvideAssistanceData*, and they are not appearing as positioning methods.  In our understanding, both 5.1 and 5.3 follows the LPP design principles. 5.1 addresses the concerns raised in different email discussions about lack of clarity, while 5.3 still have these issues. We also have agreed to a framework where separate positioning methods can refer to different parts of the common DL-PRS AD and it will be much more clear if the DL-PRS AD is lifted up and handled separately as identified by several companies.  Maybe as you suggest it would also be relevant to include some DL-PRS specific requests in a corresponding IE *nr-DL-PRS-RequestAssistanceData* to handle DL-PRS-specific request information. The positioning method specific requests could still be there in addition. That could also open up for a better granularity in the UEB request. Right now, the UE for example can only indicate that it requests “posCalc” for DL-TDOA, which probably will trigger the server to provide location and RTD but not beam info, and with AoD a request for posCalc would mean that the server provides location and beam info but not RTD. It would be more clear if the UE could request location, beam info and RTD via individual bits instead and that could be part of this DL-PRS specific request assistance data |
| – *NR-DL-PRS-RequestAssistanceData*  The IE *NR-DL-PRS-RequestAssistanceData* is used by the target device to request NR DL-PRS assistance data from a location server.  -- ASN1START  NR-DL-PRS-RequestAssistanceData-r16 ::= SEQUENCE {  nr-PhysCellId-r16 NR-PhysCellId-r16 OPTIONAL,  nr-AdType-r16 BIT STRING { dl-prs (0), locInfo (1), beamInfo (2), rtdInfo (3) } (SIZE (1..8)),  ...  }  -- ASN1STOP   | ***NR-DL-PRS-RequestAssistanceData* field descriptions** | | --- | | ***nr-PhysCellId***  This field specifies the NR physical cell identity of the current primary cell of the target device. | | ***nr-AdType***  This field indicates the requested assistance data. *dl-prs* means requested assistance data is *NR-DL-PRS-AssistanceData*, *locInfo* means requested assistance data is *NR-TRP-LocationInfo*, *beamInfo* means requested assistance data is *NR-DL-PRS-BeamInfo* and *rtdInfo* means requested assistance data is *NR-RTD-Info* for UE based positioning. | | | |
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1. **Introduce DL-PRS AD as an IE *NR-DL-PRS-ProvideAssistanceData* as part of the *ProvideAssistanceData* IE**

2.6 Reference TRP indication

The discussion about TRP reference indication in [1] is already part of the email discussion #601 and is therefore omitted here.

# 3. Other Issues

Any other LPP ASN.1 structural issues which do not fit into the section 2 above?

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| Company | Issue |
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# 4. Summary

# 5. References

[1] R2-2003144, “Important LPP structural aspects”, Ericsson

Annex 1: Text Proposal for 37.355 Subsection 6.4.16.4.1 Common Lower-Level IEs

*[…]*

*- NR-TRP-LocationInfo*

The IE *NR-TRP-LocationInfo* is used by the location server to provide the coordinates of the antenna reference points for a set of TRPs. For each TRP, the ARP location can be provided for each associated PRS Resource ID per PRS Resource Set.

-- ASN1START

NR-TRP-LocationInfo-r16 ::= SEQUENCE {

referencePoint-r16 ReferencePoint-r16 OPTIONAL, -- Cond NotSameAsPrev

trp-LocationInfoList-r16 SEQUENCE (SIZE (0..255)) OF TRP-LocationInfoElement-r16,

...

}

NR-TRP-LocationInfoPerFreqLayer-r16 ::= SEQUENCE {

referencePoint-r16 ReferencePoint-r16 OPTIONAL, -- Cond NotSameAsPrev

trp-LocationInfoList-r16 SEQUENCE (SIZE (1..64)) OF TRP-LocationInfoElement-r16,

...

}

TRP-LocationInfoElement-r16 ::= SEQUENCE {

trp-Location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

trp-DL-PRS-ResourceSets-r16 SEQUENCE (SIZE(1..2)) OF

DL-PRS-ResourceSets-TRP-Element-r16 OPTIONAL, -- Need OP

...

}

DL-PRS-ResourceSets-TRP-Element-r16 ::= SEQUENCE {

dl-PRS-ResourceSetARP-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

dl-PRS-Resource-ARP-List-r16 SEQUENCE (SIZE(1..64)) OF

DL-PRS-Resource-ARP-Element-r16 OPTIONAL, -- Need OP

...

}

DL-PRS-Resource-ARP-Element-r16 ::= SEQUENCE {

dl-PRS-Resource-ARP-location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

...

}

-- ASN1STOP

| **Conditional presence** | **Explanation** |
| --- | --- |
| *NotSameAsPrev* | The field is mandatory present in the first entry of the *NR-TRP-LocationInfoPerFreqLayer* list; otherwise it is optionally present, need OP. |

| ***NR-TRP-LocationInfo* field descriptions** |
| --- |
| ***referencePoint***  This field specifies the reference point used to define the TRP location in the *trp-LocationInfoList*. If this field is absent, the reference point is the same as in the previous entry of the *NR-TRP-LocationInfoPerFreqLayer* list. |
| ***trp-LocationInfoList***  This field provides the antenna reference point locations of the DL-PRS Resources for the TRPs. The list index is the reference used from the DL-PRS assistance data to associate a TRP of the DL-PRS to an element in this list. This field comprises the following sub-fields:  - ***trp-Location***: This field provides the location of the TRP relative to the *referencePoint* location. If this field is absent the TRP location coincides with the *referencePoint* location.  - ***trp-DL-PRS-ResourceSets***: This field provides the antenna reference point location(s) of the DL-PRS Resource Set(s) associated with this TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resource Set(s) coincides with the *trp-Location* location. This field comprises the following sub-fields:  - ***dl-PRS-ResourceSetARP***: This field provides the antenna reference point location of the DL-PRS Resource Set relative to the *trp-Location* location. If this field is absent, the antenna reference point location of this DL-PRS Resource Set coincides with the *trp-Location* location.  - ***dl-PRS-Resource-ARP-List***: This field provides the antenna reference point location(s) of the DL-PRS Resource(s) associated with this resource set of the TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resources coincides with the *dl-PRS-ResourceSetARP* location. This field comprises the following sub-fields:  - ***dl-PRS-Resource-ARP-location***: This field provides the antenna reference point location of the DL-PRS Resource associated with the DL-PRS Resource Set of the TRP relative to the *dl-PRS-ResourceSetARP* location. If this field is absent, the antenna reference point location of this DL-PRS Resource coincides with the *dl-PRS-ResourceSetARP* location. |

*[…]*

– *NR-DL-PRS-BeamInfo*

The IE *NR-DL-PRS-BeamInfo* is used by the location server to provide spatial direction information of the DL-PRS Resources. The list index is the reference used from the DL-PRS assistance data to associate a TRP of the DL-PRS to an element in this list.

-- ASN1START

NR-DL-PRS-BeamInfo-r16 ::= SEQUENCE (SIZE (0..255)) OF NR-DL-PRS-BeamInfo-r16

NR-DL-PRS-BeamInfo-r16 ::= SEQUENCE {

lcs-gcs-translation-parameter-r16 LCS-GCS-Translation-Parameter-r16 OPTIONAL, -- Need OP

dl-prs-BeamInfoSet-r16 DL-PRS-BeamInfoSet-r16,

...

}

DL-PRS-BeamInfoSet-r16 ::= SEQUENCE (SIZE(1..2)) OF DL-PRS-BeamInfoResourceSet-r16

DL-PRS-BeamInfoResourceSet-r16 ::= SEQUENCE (SIZE(1..64)) OF DL-PRS-BeamInfoElement-r16

DL-PRS-BeamInfoElement-r16 ::= SEQUENCE {

dl-PRS-Azimuth-r16 INTEGER (0..3599),

dl-PRS-Elevation-r16 INTEGER (0..1800) OPTIONAL, -- Need ON

...

}

LCS-GCS-Translation-Parameter-r16 ::= SEQUENCE {

alpha-r16 INTEGER (0..3599),

beta-r16 INTEGER (0..3599),

gamma-r16 INTEGER (0..3599),

...

}

-- ASN1STOP

| ***NR-DL-PRS-Beam-Info* field descriptions** |
| --- |
| ***lcs-gcs-translation-parameter***  This field provides the angles α (bearing angle), β (downtilt angle) and γ (slant angle) for the translation of a Local Coordinate System (LCS) to a Global Coordinate System (GCS) as defined in TR 38.901 [x]. If this field is absent, the *dl-PRS-Azimuth* and *dl-PRS-Elevation* are provided in a GCS. |
| ***dl-prs-BeamInfoSet***  This field provides the DL-PRS beam information for each DL-PRS Resource of the DL-PRS Resource Set associated with this TRP. |
| ***dl-PRS-Azimuth***  This field specifies the azimuth angle of the boresight direction in which the DL-PRS Resources associated with this DL-PRS Resource ID in the DL-PRS Resource Set are transmitted.  For a Global Coordinate System (GCS), the azimuth angle is measured counter-clockwise from geographical North.  For a Local Coordinate System (LCS), the azimuth angle is measured measured counter-clockwise from the x-axis of the LCS.  Scale factor 0.1 degrees; range 0 to 359.9 degrees. |
| ***dl-PRS-Elevation***  This field specifies the elevation angle of the boresight direction in which the DL-PRS Resources associated with this DL-PRS Resource ID in the DL-PRS Resource Set are transmitted.  For a Global Coordinate System (GCS), the elevation angle is measured relative to zenith and positive to the horizontal direction (elevation 0 deg. points to zenith, 90 deg to the horizon).  For a Local Coordinate System (LCS), the elevation angle is measured relative to the z-axis of the LCS (elevation 0 deg. points to the z-axis, 90 deg to the x-y plane).  Scale factor 0.1 degrees; range 0 to 180 degrees. |
| ***alpha***  This field specifies the bearing angle α for the translation of the LCS to a GCS as defined in TR 38.901 [x].  Scale factor 0.1 degrees; range 0 to 359.9 degrees. |
| ***beta***  This field specifies the downtilts angle β for the translation of the LCS to a GCS as defined in TR 38.901 [x].  Scale factor 0.1 degrees; range 0 to 359.9 degrees. |
| ***gamma***  This field specifies the slant angle γ for the translation of the LCS to a GCS as defined in TR 38.901 [x].  Scale factor 0.1 degrees; range 0 to 359.9 degrees. |

– *NR-RTD-Info*

The IE *NR-RTD-Info* is used by the location server to provide time synchronization information between a reference TRP and a list of neighbour TRPs. The list index is the reference used from the DL-PRS assistance data to associate a TRP of the DL-PRS to an element in this list.

-- ASN1START

NR-RTD-Info-r16 ::= SEQUENCE {

referenceTRP-RTD-Info-r16 ReferenceTRP-RTD-Info-r16,

rtd-InfoList-r16 RTD-InfoList-r16,

...

}

ReferenceTRP-RTD-Info-r16 ::= SEQUENCE {

ref-trp-id-r16 TRP-ID-r16,

refTime-r16 CHOICE {

systemFrameNumber-r16 BIT STRING (SIZE (10)),

utc-r16 UTCTime,

...

},

rtd-RefQuality-r16 NR-TimingMeasQuality-r16 OPTIONAL, -- Need ON

...

}

RTD-InfoList-r16 ::= SEQUENCE (SIZE (0..254)) OF RTD-InfoElement-r16

RTD-InfoElement-r16 ::= SEQUENCE {

subframeOffset-r16 INTEGER (0..1966079),

rtd-Quality-r16 NR-TimingMeasQuality-r16,

...

}

-- ASN1STOP

| ***NR-RTD-Info* field descriptions** |
| --- |
| ***referenceTRP-RTD-Info***  This field defines the reference TRP for the RTD and comprises the following sub-fields:  - ***ref-trp-id***: This field specifies the identity of the reference TRP.  - ***refTime***: This field specifies the reference time at which the *rtd-InfoList* is valid. The *systemFrameNumber* choice refers to the SFN of the reference TRP.  - ***rtd-RefQuality***: This field specifies the quality of the timing of reference TRP, used to determine the RTD values provided in *rtd-InfoList*. |
| ***subframeOffset***  This field specifies the subframe boundary offset at the TRP antenna location between the reference TRP and this neighbour TRP in time units where Hz and (TS 38.211 [x]).  The offset is counted from the beginning of a subframe #0 of the reference TRP to the beginning of the closest subsequent subframe of this neighbour TRP.  Scale factor 1 Tc. |
| ***rtd-Quality***  This field specifies the quality of the RTD. |

– *NR-DL-PRS-AssistanceData*

The IE *NR-DL-PRS-AssistanceData* is used by the location server to provide DL-PRS assistance data.

-- ASN1START

NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {

nr-DL-PRS-ReferenceInfo-r16 DL-PRS-IdInfo-r16 OPTIONAL, -- Need ON

nr-DL-PRS-AssistanceDataList-r16 SEQUENCE (SIZE (1..nrMaxFreqLayers)) OF NR-DL-PRS-AssistanceDataPerFreq-r16,

nr-SSB-Config-r16 SEQUENCE (SIZE (0..255)) OF NR-SSB-Config-r16, ...

}

NR-DL-PRS-AssistanceDataPerFreq-r16 ::= SEQUENCE {

nr-DL-PRS-AssistanceDataPerFreq SEQUENCE (SIZE (1..nrMaxTRPsPerFreq)) OF NR-DL-PRS-AssistanceDataPerTRP-r16,

nr-DL–PRS-PositioningFrequencyLayer-r16 NR-DL–PRS-PositioningFrequencyLayer-r16 OPTIONAL, --Need ON

...

}

NR-DL-PRS-AssistanceDataPerTRP-r16 ::= SEQUENCE {

nr-DL-PRS-expectedRSTD-r16 INTEGER (-3841..3841),

nr-DL-PRS-expectedRSTD-uncerainty-r16 INTEGER (-246..246),

trp-ID-r16 TRP-ID-r16 OPTIONAL,

nr-TRP-UEB-refIndices-r16 NR-TRP-UEB-refIndices-r16 OPTIONAL, -- Cond UEB

nr-DL-PRS-Config-r16 NR-DL-PRS-Config-r16,

...

}

NR-TRP-UEB-refIndices-r16 ::= SEQUENCE {

trp-locInfo-index-r16 INTEGER (0..255),

trp-beamInfo-index-r16 INTEGER (0..255) OPTIONAL, -- Cond BeamInfo

trp-rtdInfo-index-r16 INTEGER (0..254) OPTIONAL, -- Cond RTDInfo

}

NR-DL–PRS-PositioningFrequencyLayer-r16 ::= SEQUENCE {

dl-PRS-SubcarrierSpacing-r16 ENUMERATED {kHz15, kHz30, kHz60, kHz120, ...},

dl-PRS-ResourceBandwidth-r16 INTEGER (1..63),

dl-PRS-StartPRB-r16 INTEGER (0..2176),

dl-PRS-PointA-r16 ARFCN-ValueNR-r15,

dl-PRS-CombSizeN-r16 ENUMERATED {n2, n4, n6, n12, ...},

dl-PRS-CyclicPrefix-r16 ENUMERATED {normal, extended, ...},

...

}

nrMaxFreqLayers INTEGER ::= 4 -- Max freq layers

nrMaxTRPsPerFreq INTEGER ::= 64 -- Max TRPs per freq layers

nrMaxResourceIDs INTEGER ::= 64 -- Max ResourceIDs

-- ASN1STOP

| ***NR-DL-PRS-AssistanceData* field descriptions** |
| --- |
| ***nr-DL-PRS-Config***  This field specifies the PRS configuration of the TRP. |
| ***nr-DL-PRS-ReferenceInfo***  This field indicates the IDs of the reference TRP. |
| ***nr-DL-PRS-ResourceID-List***  The list of nr DL PRS resource ID. Only a single NR-DL-PRS-ResourceId is included if the field is used in measurement reporting. |
| ***nr-TRP-UEB-refIndices***  The set of reference indices refers to TRPs in the corresponding lists defined by IEs NR-TRP-LocationInfo, NR-DL-PRS-BeamInfo, and RTD-InfoList. |

### Annex 2: Text Proposal for 37.355 Subsection 6.4.16.4.1 Common Lower-Level IEs

*[…]*

– *NR-DL-PRS-BeamInfo*

*[…]*

NR-PRS-Beam-Info-ResourceSet-r16 ::= SEQUENCE {

nr-PRS-BeamInfoList-r16 SEQUENCE (SIZE(0..63)) OF NR-PRS-BeamInfoElement-r16

    lcs-To-GCS-Translation           SEQUENCE {

       alpha                            INTEGER (0..359),

alpha-fine INTEGER (0..9), OPTIONAL, -- Need OP

       beta                             INTEGER (0..359)     OPTIONAL,  -- Need OP

beta-fine INTEGER (0..9) OPTIONAL, -- Need OP

       gamma                            INTEGER (0..359)     OPTIONAL   -- Need OP

gamma-fine INTEGER (0..9) OPTIONAL -- Need OP    },                                                       OPTIONAL,  -- Need OP

    ...

}

NR-PRS-BeamInfoElement-r16 ::= SEQUENCE {

nr-PRS-Azimuth-r16 INTEGER (0..359),

nr-PRS-Azimuth-fine-r16 INTEGER (0..9), OPTIONAL, -- Cond FineAngles

nr-PRS-Elevation-r16 INTEGER (0..180) OPTIONAL, -- Need ON

nr-PRS-Elevation-fine-r16 INTEGER (0..9) OPTIONAL, -- Cond FineAngles

...

}

-- ASN1STOP

Annex 3: Text Proposal for 37.355 Subsection 6.4.3 (which should be considered for relocation to 6.4.1)6.4.1 Common Lower-Level IEs

*[…]*

- *NR-TRP-LocationInfo*

The IE *NR-TRP-LocationInfo* is used by the location server to provide the coordinates of the antenna reference points for a set of TRPs. For each TRP, the ARP location can be provided for each associated PRS Resource ID per PRS Resource Set.

-- ASN1START

NR-TRP-LocationInfo-r16 ::= SEQUENCE (SIZE (1..4)) OF NR-TRP-LocationInfoPerFreqLayer-r16

NR-TRP-LocationInfoPerFreqLayer-r16 ::= SEQUENCE {

referencePoint-r16 ReferencePoint-r16 OPTIONAL, -- Cond NotSameAsPrev

trp-LocationInfoList-r16 SEQUENCE (SIZE (1..64)) OF TRP-LocationInfoElement-r16,

...

}

TRP-LocationInfoElement-r16 ::= SEQUENCE {

trp-id-r16 TRP-ID-r16,

trp-Location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

trp-DL-PRS-ResourceSets-r16 SEQUENCE (SIZE(1..2)) OF

DL-PRS-ResourceSets-TRP-Element-r16 OPTIONAL, -- Need OP

...

}

DL-PRS-ResourceSets-TRP-Element-r16 ::= SEQUENCE {

dl-PRS-ResourceSetARP-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

dl-PRS-Resource-ARP-List-r16 SEQUENCE (SIZE(1..64)) OF

DL-PRS-Resource-ARP-Element-r16 OPTIONAL, -- Need OP

...

}

DL-PRS-Resource-ARP-Element-r16 ::= SEQUENCE {

dl-PRS-Resource-ARP-location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP

...

}

-- ASN1STOP

| **Conditional presence** | **Explanation** |
| --- | --- |
| *NotSameAsPrev* | The field is mandatory present in the first entry of the *NR-TRP-LocationInfoPerFreqLayer* list; otherwise it is optionally present, need OP. |

| ***NR-TRP-LocationInfo* field descriptions** |
| --- |
| ***referencePoint***  This field specifies the reference point used to define the TRP location in the *trp-LocationInfoList*. If this field is absent, the reference point is the same as in the previous entry of the *NR-TRP-LocationInfoPerFreqLayer* list. |
| ***trp-LocationInfoList***  This field provides the antenna reference point locations of the DL-PRS Resources for the TRPs and comprises the following sub-fields:  - ***trp-id***: This field provides an identity of the TRP.  - ***trp-Location***: This field provides the location of the TRP relative to the *referencePoint* location. If this field is absent the TRP location coincides with the *referencePoint* location.  - ***trp-DL-PRS-ResourceSets***: This field provides the antenna reference point location(s) of the DL-PRS Resource Set(s) associated with this TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resource Set(s) coincides with the *trp-Location* location. This field comprises the following sub-fields:  - ***dl-PRS-ResourceSetARP***: This field provides the antenna reference point location of the DL-PRS Resource Set relative to the *trp-Location* location. If this field is absent, the antenna reference point location of this DL-PRS Resource Set coincides with the *trp-Location* location.  - ***dl-PRS-Resource-ARP-List***: This field provides the antenna reference point location(s) of the DL-PRS Resource(s) associated with this resource set of the TRP. If this field is absent, the antenna reference point location(s) of the DL-PRS Resources coincides with the *dl-PRS-ResourceSetARP* location. This field comprises the following sub-fields:  - ***dl-PRS-Resource-ARP-location***: This field provides the antenna reference point location of the DL-PRS Resource associated with the DL-PRS Resource Set of the TRP relative to the *dl-PRS-ResourceSetARP* location. If this field is absent, the antenna reference point location of this DL-PRS Resource coincides with the *dl-PRS-ResourceSetARP* location. |

– *ReferencePoint*

The IE *ReferencePoint* provides a well defined location relative to which other locations may be defined.

-- ASN1START

ReferencePoint-r16 ::= SEQUENCE {

referencePointGeographicLocation-r16 CHOICE {

location3D-r16 EllipsoidPointWithAltitudeAndUncertaintyEllipsoid,

ha-location3D-r16 HighAccuracyEllipsoidPointWithAltitudeAndUncertaintyEllipsoid-r15,

...

},

...

}

-- ASN1STOP

| ***ReferencePoint* field descriptions** |
| --- |
| ***referencePointGeographicLocation***  This field provides the geodetic location of the reference point. |

– *RelativeLocation*

The IE *RelativeLocation* provides a location relative to some known reference location.

-- ASN1START

RelativeLocationLoLaAlt-r16 ::= SEQUENCE {

milli-arc-second-units-r16 ENUMERATED { mas0-03, mas0-3, mas3, mas30, ...},

height-units-r16 ENUMERATED {mm, cm, m, ...},

delta-latitude-r16 Delta-Latitude-r16,

delta-longitude-r16 Delta-Longitude-r16,

delta-height-r16 Delta-Height-r16,

locationUNC-r16 LocationUncertainty-r16 OPTIONAL, -- Need OP

...

}

Delta-Latitude-r16 ::= SEQUENCE {

delta-Latitude-r16 INTEGER (-1024..1023),

coarse-delta-Latitude-r16 INTEGER (0..4095) OPTIONAL, -- Need OP

...

}

Delta-Longitude-r16 ::= SEQUENCE {

delta-Longitude-r16 INTEGER (-1024..1023),

coarse-delta-Longitude-r16 INTEGER (0..4095) OPTIONAL, -- Need OP

...

}

Delta-Height-r16 ::= SEQUENCE {

delta-Height-r16 INTEGER (-1024..1023),

coarse-delta-Height-r16 INTEGER (0..4095) OPTIONAL, -- Need OP

...

}

LocationUncertainty-r16 ::= SEQUENCE {

horizontalUncertainty-r15 INTEGER (0..255),

horizontalConfidence-r15 INTEGER (0..100),

verticalUncertainty-r15 INTEGER (0..255),

verticalConfidence-r15 INTEGER (0..100)

}

RelativeLocationXYZ-r16 ::= SEQUENCE {

xyz-units-r16 ENUMERATED {cm, dm, ...},

delta-x-r16 INTEGER (0..4095),

delta-y-r16 INTEGER (0..4095),

delta-z-r16 INTEGER (0..4095),

locationUNC-r16 LocationUncertainty-r16 OPTIONAL, -- Need OP

...

}

RelativeLocation-r16 ::= CHOICE {

relativeLocationLoLaAlt-r16 RelativeLocation-r16,

relativeLocationxyz-r16 RelativeLocationXYZ-r16

}

-- ASN1STOP

| ***RelativeLocation* field descriptions** |
| --- |
| ***milli-arc-second-units***  This field provides the units and scale factor for the *delta-latitude* and *delta-longitude* fields. Enumerated values *mas0-03*, *mas0-3*, *mas3*, and *mas30*, correspond to 0.03, 0.3, 3, and 30 milliarcseconds, respectively. |
| ***height-units***  This field provides the units and scale factor for the *delta-height* field. Enumerated values *mm*, *cm*, and *m* correspond to 10-3 metre, 10-2 metre, and 1 metre, respectively. |
| ***delta-latitude***  This field specifies the delta value in latitude of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:  - ***delta-Latitude*** specifies the delta value in latitude in the unit provided in *milli-arc-second-units* field.  - ***coarse-delta-Latitude*** specifies the delta value in latitude in 1024 times the size of the unit provided in *milli-arc‑second‑units* field and with the same sign as in the *delta-Latitude* field. If this field is absent, the value for *coarse-delta-Latitude*is zero.  I.e., the full *delta-latitude* is given by:  (*delta-Latitude* × *milli-arc-second-units*)±(*coarse-delta-Latitude* × 1024 × *milli-arc-second-units*) [milli-arc-seconds] |
| ***delta-longitude***  This field specifies the delta value in longitude of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:  - ***delta-Longitude*** specifies the delta value in longitude in the unit provided in *milli-arc-second-units* field.  - ***coarse-delta-Longitude*** specifies the delta value in longitude in 1024 times the size of the unit provided in *milli-arc‑second‑units* field and with the same sign as in the *delta-Longitude* field. If this field is absent, the value for *coarse-delta-Longitude*is zero.  I.e., the full *delta-longitude* is given by:  (*delta-Longitude* × *milli-arc-second-units*)±(*coarse-delta-Latitude* × 1024 × *milli-arc-second-units*) [milli-arc-seconds] |
| ***delta-height***  This field specifies the delta value in ellipsoidal height of the desired location, defined as "desired location" minus "reference point location" and comprises the following sub-fields:  - ***delta-Height*** specifies the delta value in ellipsoidal height in the unit provided in *height-units* field.  - ***coarse-delta-Height*** specifies the delta value in ellipsoidal height in 1024 times the size of the unit provided in *height-units* field and with the same sign as in the *delta-Height* field. If this field is absent, the value for *coarse-delta-Height*is zero.  I.e., the full *delta-height* is given by:  (*delta-Height* × *height-units*) *±* (*coarse-delta-Height* × 1024 × *height-units*) [metres] |
| ***xyz-units***  This field provides the units and scale factor for the *delta-x, delta-y* and *delta-z* fields. Enumerated values *cm* and *dm* corresponds to centimeter and decimeter, respectively. |
| ***delta-x, delta-y***  This field specifies the delta value in horizontal cartesian coordinates of the desired location, defined as "desired location" minus "reference point location" |
| ***delta-x, delta-y***  This field specifies the delta value in horizontal cartesian coordinates of the desired location, defined as "desired location" minus "reference point location" |
| ***delta-z***  This field specifies the delta value in vertical cartesian coordinates of the desired location, defined as "desired location" minus "reference point location" |
| ***locationUNC***  This field specifies the uncertainty of the location coordinates and comprises the following sub-fields:  - ***horizontalUncertainty*** indicates the horizontal uncertainty of the ARP latitude/longitude. The ′*horizontalUncertainty*′ corresponds to the encoded high accuracy uncertainty as defined in TS 23.032 [15] and ′*horizontalConfidence*′ corresponds to confidence as defined in TS 23.032 [15].  - ***verticalUncertainty*** indicates the vertical uncertainty of the ARP altitude. The '*verticalUncertainty*' corresponds to the encoded high accuracy uncertainty as defined in TS 23.032 [15] and '*verticalConfidence*' corresponds to confidence as defined in TS 23.032 [15].  If this field is absent, the uncertainty is the same as for the associated reference point location. |