**3GPP TSG-RAN WG2 Meeting #121-bis-e *R2-23xxxxx***

**Online, 17 – 26 April, 2023**

**Agenda item:** 5.3.1

**Source:** Swift Navigation (Rapporteur)

**Title:** [AT121bis-e][408][POS] Yaw and APC (Swift)

**Document for:**  Discussion, Agreement

# 1. Introduction

\*  **[AT121bis-e][408][POS] Yaw and APC (Swift)**

Scope: Check the proposals in R2-2303030 and R2-2303658, merge if necessary, and conclude on the needed changes.  Also progress the related discussion from the TEI18 proposal in R2-2303033 and attempt to converge to agreeable CRs

     Intended outcome: Report, agreed Rel-16/17 CRs (without CB if possible), agreeable Rel-18 CRs

     Deadline: Monday 2023-04-24 2359 UTC

This email discussion covers the following submissions:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tdoc | Company | Title | Agenda | Impacted releases |
| [1] [R2-2303030](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303030.zip) | Swift Navigation, Ericsson | Yaw and APC clarifications for SSR positioning | 5.3.1 | Yaw: R16/17  APC: R15/16/17 |
| [2] [R2-2303658](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303658.zip) | u-blox | GNSS PCO and PCV error analysis | 5.3.1 |
| [3] [R2-2303033](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303033.zip" \t "_blank) | Swift Navigation | Updated proposal on Yaw and APC extensions | 7.24.2 | TEI18 |

The discussion is divided into four parts:

1. Clarifications on Yaw (16/17)
2. Clarifications on APC (R15/16/17)
3. TEI18 proposal on Yaw (R18)
4. TEI18 proposal on APC (R18)

The deadline for first round comments is **Thursday 20-Mar-23 10:00 UTC** to allow sufficient time for CR drafting and any additional discussion before the comebacks.

# 2. Discussion

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| Nokia | mani.thyagarajan@nokia.com |
| Intel | Yi.guo@intel.com |
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## 2.1 Clarifications on Yaw (R16/17)

In R2-2303030 **Swift Navigation** and **Ericsson** make the following observations and proposals on the handling of satellite Yaw information in the current LPP specifications (further background on Yaw is provided in [4][5]):

**Observation 1:** LPP inherited a zero-yaw assumption from CLAS but this condition is not explicitely described in LPP or the Stage 2 specifications.

**Observation 2:** The zero-yaw condition is not valid for all corrections vendors and therefore without clarification could be a source of interoperability issues.

* **Proposal 1: In TS36/38.305 agree to add NOTE 3 to explicitly describe the zero-yaw condition for the existing SSR Phase Bias element.**
  + Proposed change is shown below and in the [draft CR](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Inbox/Drafts/%5BAT121bis-e%5D%5B408%5D%5BPOS%5D%20Yaw%20and%20APC%20(Swift)/Draft%20CRs/DraftCR_Yaw_R16_NR.docx).

Note that the SSR Phase Bias was introduced in R16 so the clarifying text should be first introduced from R16.

START OF CHANGE

##### 8.1.2.1.24 SSR Phase Bias

SSR Phase Bias provides the GNSS receiver with the GNSS signal phase bias that are added to the carrier phase measurements of the corresponding signal to get corrected phase ranges. An indicator used to count events when phase bias is discontinuous is provided. An optional indicator is also provided to indicate whether fixed, widelane fixed or float PPP-RTK positioning modes are supported on a per signal basis.

NOTE 1: On the UE side, phase bias corrections of appropriate type are needed to restore the integer nature of the phase ambiguities in PPP-RTK. Their absence will affect the quality of the positioning solution and prevent a fast convergence time.

NOTE 2: PPP-RTK Fixed position mode corresponds to the UE fixing the carrier phase ambiguity to an integer value. The PPP-RTK Widelane Fixed positioning mode corresponds to forming the widelane combination of carrier phase measurements and fixing the resulting ambiguity as an integer value. In PPP-RTK Float positioning mode the carrier phase ambiguity is not treated as an integer value.

NOTE 3: The SSR Phase Bias values must be consistent with a satellite yaw angle of zero as per [43].

For integrity purposes, SSR Phase Bias also provides the mean and standard deviation that bounds the residual Phase Bias Error and its associated error rate.

*END OF CHANGE*

**Question 1: Do you agree with Proposal 1? If not, please provide your reasoning and any proposed text edits as part of your comments.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | Yes, with comments | Proposal 1 is confusing since it refer to Appendix A, which is from another TDoc and which has two changes to different sections in 38.305. We are fine with only the changes to Section 8.1.2.1.24 from the referenced Appendix A and do not agree to add the changes to Section 8.1.2.1.21 from the referenced Appendix A. We need to see separate CRs for this for LTE and NR stage-2 for the addition of the NOTE to SSR Phase Bias section. |
| Intel | Yes | Ok with the updated change from Swift. |
| Qualcomm | Yes | This seems in agreement with CLAS ICD, but this is not Ref [43] (should be Ref. [36]). |
| ESA | Yes | It helps clarify the interpretation of the yaw angle currently assumed in LPP. |
| Swift | Yes | We updated the numbering for the appendices and the reference [36], thanks. |

**Q1 Summary:** All companies agree to adopt Proposal 1, draft CRs to be circulated next round.

## 2.2 Clarifications on APC

In R2-2303030 **Swift Navigation** and **Ericsson** derive the following observations on satellite APC and ARP from the analysis and illustrations provided in Figure 1 [1].

* As in the case of Yaw, it can be inferred that LPP inherited the same behaviour from CLAS and that the NW should attempt to minimise the UE error given the UE does not apply any PCO/PCV correction, i.e. the UE must not apply any PCO/PCV correction from an external source.
* Unfortunately the CLAS specification itself is not explicit about this behaviour, and therefore it should be clarified in LPP so as to avoid the possibility of interoperability issues.
* The satellite ARP is some reference point along the satellite antenna which is set by the service provider … This choice is not explicitly communicated to the UE; it is implicit to the SSR orbit correction, i.e. the orbit correction defines the ARP by providing the offset between the broadcast ephemeris and the ARP.
* The UE therefore makes no assumptions on the ARP and simply accepts that all corrections used together should yield a consistent solution.

Similarly, in R2-2303658 **u-blox** makes the following observations for interpreting the PCO/PCV in the current specifications and also analyses the extent to which this interpretation will impact the UE positioning error:

**Observation**: The impact of PCO for most satellites can be kept within approximately 1cm using 3GPP messages defined in Release 16. Errors can be mitigated further if one considers the correction stream to cover only the area of the cell within which all UEs receiving it are located – a much smaller area than the global assumption used in the error modelling above.

**Observation**: The impact of ignoring satellite PCV’s is within approximately 3cm when using 3GPP messages defined in Release 16. Again, such errors can be minimised if all UEs are located within a smaller than global region such as the network cell over which it is broadcast.

Swift Navigation makes the following proposal:

* **Proposal 2: In TS36/38.305 agree to add the clarifying text on satellite ARP and APC.**
  + Proposed change is shown below and in the [draft CR](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Inbox/Drafts/%5BAT121bis-e%5D%5B408%5D%5BPOS%5D%20Yaw%20and%20APC%20(Swift)/Draft%20CRs/DraftCR_APC_R15_NR.docx).

Note that SSR Orbit Corrections was introduced in R15 so the clarifying text should be introduced from R15.

START OF CHANGE

##### 8.1.2.1.21 SSR Orbit Corrections

SSR Orbit Corrections provides the GNSS receiver with parameters for orbit corrections in radial, along-track and cross-track components. These orbit corrections are used to compute a satellite position correction, to be combined with satellite position ­calculated from broadcast ephemeris (see clause 8.1.2.1.7).

The orbit corrections define an offset between the broadcast ephemeris orbit and a satellite antenna reference point (ARP) to which the other corrections refer. The exact definition of the reference point along the satellite antenna is implementation-defined by the service provider and use of all corrections together shall yield a consistent solution.

The UE should not apply any additional corrections for the Satellite Antenna Phase Center (APC) such as Phase Center Offset (PCO) or Phase Center Variation (PCV) corrections. The service provider may form the SSR corrections to minimise the impact of Satellite APC effects on the UE.

For integrity purposes, SSR Orbit Corrections also provides the correlation time for orbit error and orbit error rate, and the mean and standard deviation that bounds the residual Orbit Error and its associated error rate. The SSR Orbit Corrections also includes the satellite and constellation residual risks. These residual risks are the aggregate residual risk for the satellite or constellation Signal in Space including Orbit, Clock, Bias and all other satellite or constellation feared events, but excluding atmospheric effects.

When applying the integrity bounds as per 8.1.1a, the mean and stdDev must be calculated by projecting the Orbit error mean and variance along the line-of-sight vector between the satellite and the user, according to the following formula:

*stdDevorbit =* (Equation 8.1.2.1.21-1)

*meanorbit =*

where: *I*: 3-D line of sight vector from the user to the satellite in the WGS-84 ECEF coordinate frame.

R: the rotation matrix from satellite along-track (AT), cross-track (CT) and radial (RA) coordinates into the WGS-84 ECEF coordinate frame. RT denotes the transposed matrix.

*v*: the 3-D Orbit error variance vector expressed in satellite along-track, cross-track and radial coordinates.

*μ*: the Mean Orbit Error vector expressed in satellite along-track, cross-track and radial coordinates.

The vector v is expressed in the SSR Orbit Corrections as the three elements in the Variance Orbit Residual Error Vector.

*END OF CHANGE*

**Question 2: Do you agree to add the clarifying text from Proposal 2 to TS36/38.305 (R15/16/17). If not, please provide your reasoning and any proposed text edits as part of your comments.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | No | For pre-Rel-18 specification, we only need to document the assumption on Yaw angle as we only agreed to adopt the CLAS based messages. The changes proposed by Proposal 2 can be left to implementation. |
| Intel | Yes | We see the benefit to clarify the behavior/expectation from CLAS. |
| Qualcomm | Yes, with modifications | The two new paragraphs should be captured in two informative NOTEs (like in Proposal 1).  "service provider" should be replaced by "network" or "LMF". |
| ESA | Yes | It will help UE and LMF nodes align in terms of APC assumptions. Agree with QCOM recommendations to use 3GPP terms and use notes. |
| Swift | Yes | Fine with the proposals from QC.  In response to Nokia, this is to correct an ambiguity in the specification which could lead to different incompatible implementations, i.e. if we do not clarify the intended behavior/expectation from CLAS the UE and NW may have different interpretations of how the APC has been handled by the NW. |

**Q2 Summary:** With the clarifications and modifications above we interpret a sufficient level of support to adopt proposal 2 but we need to check all CRs for the Yaw and APC clarifications first.

**Question 2a: Any further comments on the** [**draft CRs**](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Inbox/Drafts/%5BAT121bis-e%5D%5B408%5D%5BPOS%5D%20Yaw%20and%20APC%20(Swift)/Revised%20CRs) **for the Stage 2 Yaw and APC clarifications?**

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| **Company** | **Comments** |
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## 2.3 TEI18 proposal on Yaw (R18)

Regarding the zero-yaw condition discussed in Section 2.1, **Swift Navigation** and **Ericsson** provide the following comments in R2-2303030:

* Although CLAS is one type of implementation, it is not the default approach supported by all corrections providers. Others send yaw explicitly, allowing the UE to correct for phase wind-up locally and to compensate for additional variations in the PCO. For example, the IGS SSR standard [7] and draft RTCM standards also specify a yaw message.

In R2-2303033, **Swift Navigation** provides the latest version of the text proposal to address these limitations by adding an additional SSR Phase Bias with Yaw assistance data element, as show in Appendix A.

**Question 3: Do you agree that LPP should not be confined to a zero-yaw condition and should instead enable the yaw information to be provided explicitly? If not, please provide detailed reasoning.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | See comments | We are in-principle open to adding new corrections assistance data as shown in the Appendix 1, Appendix 2 and Appendix 3 in R2-2303033 as a new GNSS enhancement but the changes are substantial to go into a TEI type small enhancement, especially when it is for both LTE and NR. We view this as increasing the scope of Rel-18 integrity related enhancements, on top of the Rel-18 RAT-dependent integrity enhancement. Our preference is to handle this in a new release as part of a work item. |
| Intel | Yes | We are open to add new corrections. Regarding TEI18 or R18 positioning WI, we would prefer TEI18. |
| Qualcomm | See comments | For an existing implementation/deployment, what would be the motivation to change implementation? I.e., what would be the improvement when changing to non-zero yaw?  Assuming this Proposal is agreed, there will always be UEs supporting "zero-yaw assumption" and UEs supporting "non-zero yaw assumption", so NWs may have to support both versions, and the question is what would be the benefit for this overhead?  The reason for the proposal above seems only that not all correction providers follow the non-zero yaw version. However, usually implementations should follow the standard and not the other way around. So is there another reason for introducing a 2nd version of phase corrections with non-zero yaw? |
| ESA | No | As already stated at previous RAN2 meeting we still don’t have a quantification of the achievable gain if non-zero yaw is added combined with the fact that it needs an extra IEs, which is very similar to an existing one. The benefits for going to this length is not obvious at all.  With the notes and clarifications proposed above we think from a standard point of view there is no more room for different interpretations at the UE and LMF; therefore, corrections providers need to adapt to standard and account for non-zero yaw when generating corrections. |
| Swift | Yes | To Nokia’s comment this topic is related to the SSR positioning aspects rather than integrity (R17 integrity can already be reused as part of the proposed APC messages). We felt TEI was appropriate with the objective of improving the interoperability of LPP with different provider implementations and other standards.  To QC’s points, we agree there is some additional overhead for the NW needing to support both options and again our main goal was to enable greater interoperability not only with existing correction provider implementations but also with other SSR standards that also include the option to send yaw (IGS SSR, draft RTCM etc). Otherwise providers need to change their implementation to align with LPP.  To ESA and QC’s points on benefits, as stated previously this is primarily about correcting for phase wind-up (based on yaw) which impacts fixing rates. Some providers correct for yaw at the NW (CLAS), others require yaw to be corrected at the UE (and by sending yaw in the assistance data it removes the need to hardcode yaw locally).  Given the net effect of whether we correct for yaw at the NW or UE is close to zero (although there are some additional marginal benefits from using yaw to also correct for x,y variations in the APC and by sending yaw it may no longer need to be hard-coded locally), it may be acceptable to simply stick with the current LPP constraints if the wider group does not see the benefits of adding the new Phase Bias with Yaw AD. For the APC however, the net effect of correcting at the NW versus the UE is not zero, as has been detailed by Swift and u-blox. A NW-only approach to addressing APC leads to residual errors that are user-location-dependent and we further address this point below. |

**Question 4: Do you agree with the latest text proposal in Appendices 1, 2, 3 for adding the SSR Phase Bias with Yaw assistance data element? If not, please detail your reasoning and include any suggested text edits in the comments section below:**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel |  | In general ok. But further polish is needed, e.g. comma is missing for some fields. |
| ESA | NO | See above. We oppose increasing the number of IEs and posSIBs for unnecessary reasons or when simpler solutions exist outside 3GPP realm (generation of corrections). |
| Swift | Yes | Given the discussion and feedback above we would like to consider if there are simpler and more efficient ways to support the option of sending yaw. For now, the clarifications we agreed to in Question 1 for how to interpret the current spec are the most important first step. |
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**Q3/Q4 Summary:** No consensus on supporting the Phase Bias with Yaw proposal. ESA and QC wonder if the benefits of the proposal warrant the changes and additional overhead, Swift think this is necessary for interoperability with other standards and implementations, Intel notes that further polishing is needed on the TP. Swift suggests that additional refinements to the proposal can be contribution-led.

## 2.4 TEI18 proposal on APC (R18)

Rapporteur derives the following summary points from R2-2303030 and Section 2.2 above:

* In LPP there is currently no explicit ability for the UE to handle the PCO/PCV meaning these offsets must be handled at the NW, which may save bandwidth but will introduce residual errors at the UE.
* This works well for services like CLAS which only cover a small geographic region, whereas for global services like LPP the resulting UE errors will be user-location-dependent.
* In Section 2.2 we already see that the current interpretation in LPP needs clarifying as it can otherwise lead to ambiguity on whether the UE should or should not attempt to compensate for APC locally.
* Furthermore, the corrections in Section 2.2 do not resolve the fact that the UE is still subject to residual errors resulting from the uncorrected portion of the PCO/PCV which is user-location-dependent (Figure 1). There is no agreement yet on whether these errors can be ignored for all applications.
* In practice there are already multiple methods to address these residual errors by ensuring the PCO/PCV offsets associated with a given implementation can be provided to the UE.
* If we restrict users to the current implementation in LPP (i.e. by only handling PCO/PCV at the NW) we are limiting options on interoperability and achievable performance relative to what is implemented already in existing commercial services and other standards.

Further to Section 2.3, **u-blox** derives the following on why they believe the current handling of PCO/PCV in LPP is sufficient and manageable for 3GPP use cases:

* **Observation:** The impact of PCO for most satellites can be kept within approximately 1cm using 3GPP messages defined in Release 16. Errors can be mitigated further if one considers the correction stream to cover only the area of the cell within which all UEs receiving it are located – a much smaller area than the global assumption used in the error modelling above.
* **Observation:** The impact of ignoring satellite PCV’s is within approximately 3cm when using 3GPP messages defined in Release 16. Again, such errors can be minimised if all UEs are located within a smaller than global region such as the network cell over which it is broadcast.
* **Conclusion:** With correct design and implementation of the correction service, recognizing that correction broadcasts may be per network cell, errors introduced by PCO and PCV variations can be kept extremely small saving the extra bandwidth required to broadcast such corrections and additional cost and complexity at the GNSS receiver in the UE required to handle large tables of correction values.

**Question 5: Do you agree that LPP should provide the ability for implementations to optionally provide PCO/PCV values to the UE?**

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| **Company** | **Yes/No** | **Comments** |
| Nokia | See comments | We are in-principle open to adding new GNSS enhancements, but the changes are substantial to go into a TEI type small enhancement, especially when it is for both LTE and NR. We view this as increasing the scope of Rel-18 integrity related enhancements, on top of the Rel-18 RAT-dependent integrity enhancement. Our preference is to handle this in a new release as part of a work item. |
| Intel | Yes | We are open to add new corrections. Regarding TEI18 or R18 positioning WI, we would prefer TEI18. |
| ESA | See comments | Is it not enough the fact that the notes discussed above remove the chance of different interpretation at UE and LMF regarding APC? |
| Swift | Yes | The NOTES in Question 2 are important for clarifying the handling of PCO/PCV in the current spec but they do not address the remaining limitations of this approach, specifically:   * Providers must set PCO=0 but cannot send the residual PCO and PCV values to the UE, leaving residual errors at the UE which are user-location-dependent. |

**Question 6: Do you agree with the proposed SSR-Satellite-APC message in Appendices 1, 2, 3? Please detail your reasoning if not and provide any alternative text suggestions in the comments below.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel |  | In general ok. But further polish is needed, e.g. comma is missing for some fields. |
| Qualcomm | See comment | When a legacy UE receives the SSR Orbit Corrections, the UE does not apply any APC/PCO/PCV corrections, per compact SSR and CLAS convention (Proposal 2 above). In the Rel-18 TP this is now reversed to  "The UE should apply the Satellite Antenna Phase Center (APC) Corrections (see 8.1.2.1.3y) if provided by the network, otherwise no other Phase Center Offset (PCO) or Phase Center Variation (PCV) corrections should be applied."  However, a legacy UE will not comprehend any APC data and will always not apply any APC/PCO/PCV corrections, even if provided. This seems now breaking legacy UEs in a NW.  On the LPP TP, given that APC is very static information, we do not see the need for providing these data periodically (*GNSS-PeriodicAssistData*), since we would just repeat the same data (e.g., we also do not provide almanac, ephemeris or SSR Correction Points etc. periodically).  We also can't see a reason for increasing the SSR update interval to 44236800 seconds. E.g., what should be the UE behavior once 512 days elapsed? This seems like a validity time, but not an update interval. |
| Swift | Yes | To QC’s comments, the default setting for the orbit corrections must be consistent with the current interpretation of CLAS/LPP (i.e. PCO/PCV must be handled by the NW-only) in order to maintain backward compatibility with legacy UEs. This means that Examples 1 and 2 outlined in [R2-2303030](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303030.zip) cannot be supported and the legacy UEs must accept that they may be impacted by the residual errors which are user-location-dependent.  For newer UEs which may support the proposal, the default setting would still be limited to Example 3 (setting PCO=0) however the proposed message would permit sending the residual PCO and adjusted PCVs in order to remove the additional user-location-dependent errors (while maintaining the same behaviour on legacy UEs which cannot decode these additional values anyway).  Actually, in light of this discussion we would benefit from more time to see if we can refine the proposal in a way that supports all three Examples outlined in [R2-2303030](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303030.zip) while maintaining compatibility, and regardless we would advocate the benefits of having the option to fully address the PCO/PCV errors even just for Example 3 rather than limiting newer UEs to the same constraints that have been placed on the legacy UEs (and hence the reason for submitting this proposal as TEI). |
|  |  |  |

**Q5/Q6 Summary:** No consensus on the APC proposal. Nokia wonders about the TEI status, Intel and Swift prefer TEI, ESA wonders if the clarifications in Q2 are enough already (i.e. we settle for the CLAS constraints) and QC wonders about the backward compatibliity. Swift thinks the proposal is backward compatible but wants more time to consider how to make the proposal more flexible for the different types of implementations supported by newer UEs (and associated standards) without breaking backward compatibility – this can be contribution-led.

# 3. Conclusions and Proposals

**Proposal 1: In TS36/38.305 agree to add NOTE 3 to explicitly describe the zero-yaw condition for the**

**existing SSR Phase Bias element.**

* **CRs: R2-2304314, R2-2304315, R2-2304316, R2-2304317**

**Proposal 2: In TS36/38.305 agree to add the clarifying NOTES on satellite ARP and APC.**

* **CRs: R2-2304308, R2-2304309,** **R2-2304310, R2-2304311, R2-2304312, R2-2304313**

# 4. References

1. R2-2303030, “Yaw and APC clarifications for SSR positioning “, Swift Navigation, Ericsson, RAN2#121-bis-e.
2. R2-2303658, “GNSS PCO and PCV error analysis”, u-blox, RAN2#121-bis-e.
3. R2-2303033, “Updated proposal on Yaw and APC extensions”, Swift Navigation, RAN2#121-bis-e..
4. R2-2212544, “Discussion and TP on Yaw Angle and Antenna Phase Center corrections for SSR assistance data”, Swift Navigation, Mitsubishi Electric Corporation, Ericsson, RAN2#120.
5. R2-2301667, “Support for SSR Phase Bias with Yaw”, Swift Navigation, Intel Corporation, InterDigital RAN2#121.

# Appendix 1 – Yaw and APC extensions to TS 36/38.305

START OF CHANGE

**/\*\*Skip unmodified parts\*\*/**

### 8.1.2 Information to be transferred between NG-RAN/5GC Elements

This clause defines the information that may be transferred between LMF and UE.

#### 8.1.2.1 Information that may be transferred from the LMF to UE

Table 8.1.2.1-1 lists assistance data for both UE-assisted and UE-based modes that may be sent from the LMF to the UE.

NOTE: The provision of these assistance data elements and the usage of these elements by the UE depend on the NG-RAN/5GC and UE capabilities, respectively.

Table 8.1.2.1-1: Information that may be transferred from the LMF to UE

|  |
| --- |
| Assistance Data |
| Reference Time |
| Reference Location |
| Ionospheric Models |
| Earth Orientation Parameters |
| GNSS-GNSS Time Offsets |
| Differential GNSS Corrections |
| Ephemeris and Clock Models |
| Real-Time Integrity |
| Data Bit Assistance |
| Acquisition Assistance |
| Almanac |
| UTC Models |
| RTK Reference Station Information |
| RTK Auxiliary Station Data |
| RTK Observations |
| RTK Common Observation Information |
| GLONASS RTK Bias Information |
| RTK MAC Correction Differences |
| RTK Residuals |
| RTK FKP Gradients |
| SSR Orbit Corrections |
| SSR Clock Corrections |
| SSR Code Bias |
| SSR Phase Bias |
| SSR STEC Corrections |
| SSR Gridded Correction |
| SSR URA |
| SSR Correction Points |
| Integrity Service Parameters |
| Integrity Alerts |
| SSR Phase Bias with Yaw |
| SSR Satellite APC Corrections |

**/\*\*Skip unmodified parts\*\*/**

##### 8.1.2.1.21 SSR Orbit Corrections

SSR Orbit Corrections provides the GNSS receiver with parameters for orbit corrections in radial, along-track and cross-track components. These orbit corrections are used to compute a satellite position correction, to be combined with satellite position ­calculated from broadcast ephemeris (see clause 8.1.2.1.7).

The orbit corrections define an offset between the broadcast ephemeris orbit and a satellite antenna reference point (ARP) to which the other corrections refer. The exact definition of the reference point along the satellite antenna is implementation-defined by the service provider and use of all corrections together shall yield a consistent solution.

The UE should apply the Satellite Antenna Phase Center (APC) Corrections (see 8.1.2.1.3y) if provided by the network, otherwise no other Phase Center Offset (PCO) or Phase Center Variation (PCV) corrections should be applied. The service provider may form the SSR corrections to minimise the impact of Satellite APC effects on the UE.

For integrity purposes, SSR Orbit Corrections also provides the correlation time for orbit error and orbit error rate, and the mean and standard deviation that bounds the residual Orbit Error and its associated error rate. The SSR Orbit Corrections also includes the satellite and constellation residual risks. These residual risks are the aggregate residual risk for the satellite or constellation Signal in Space including Orbit, Clock, Bias and all other satellite or constellation feared events, but excluding atmospheric effects.

When applying the integrity bounds as per 8.1.1a, the mean and stdDev must be calculated by projecting the Orbit error mean and variance along the line-of-sight vector between the satellite and the user, according to the following formula:

*stdDevorbit =* (Equation 8.1.2.1.21-1)

*meanorbit =*

where: *I*: 3-D line of sight vector from the user to the satellite in the WGS-84 ECEF coordinate frame.

R: the rotation matrix from satellite along-track, cross-track and radial coordinates into the WGS-84 ECEF coordinate frame.

*v*: the 3-D Orbit error variance vector expressed in satellite along-track, cross-track and radial coordinates.

*μ*: the Mean Orbit Error vector expressed in satellite along-track, cross-track and radial coordinates.

The vector v is expressed in the SSR Orbit Corrections as the three elements in the Variance Orbit Residual Error Vector.

**/\*\*Skip unmodified parts\*\*/**

##### 8.1.2.1.3x SSR Phase Bias with Yaw

SSR Phase Bias with Yaw provides the GNSS receiver with the GNSS signal phase bias and yaw information that are used to adjust the carrier phase measurements of the corresponding signal to get corrected phase ranges. An indicator used to count events when phase bias is discontinuous is provided. An optional indicator is also provided to indicate whether fixed, widelane fixed or float PPP-RTK positioning modes are supported on a per signal basis.

NOTE 1: On the UE side, phase bias corrections of appropriate type are needed to restore the integer nature of the phase ambiguities in PPP-RTK. Their absence will affect the quality of the positioning solution and prevent a fast convergence time.

NOTE 2: PPP-RTK Fixed position mode corresponds to the UE fixing the carrier phase ambiguity to an integer value. The PPP-RTK Widelane Fixed positioning mode corresponds to forming the widelane combination of carrier phase measurements and fixing the resulting ambiguity as an integer value. In PPP-RTK Float positioning mode the carrier phase ambiguity is not treated as an integer value.

For integrity purposes, SSR Phase Bias with Yaw also provides the mean and standard deviation that bounds the residual Phase Bias Error and its associated error rate.

##### 8.1.2.1.3y SSR Satellite APC Corrections

SSR Satellite Antenna Phase Center (APC) Corrections provide the GNSS receiver with the satellite antenna Phase Center Offsets (PCO) and Phase Center Variations (PCV) that are used to correct the carrier phase measurements of the corresponding signal to determine the location of the effective center of the satellite antenna for a particular signal frequency and direction. The PCO and PCV are provided relative to the satellite Antenna Reference Point (ARP) for consistency with the other corrections.

#### 8.1.2.1a Recommendations for grouping of assistance data to support different RTK service levels

This clause provides recommendations for the different high-accuracy GNSS service levels: RTK, N-RTK, PPP and PPP-RTK.

The high-accuracy GNSS methods can be classified as:

- *Single base RTK service*: RTK is a technique that uses carrier-based ranging measurements i.e., phase-range to improve the positioning accuracy in a differential approach. The basic concept is to reduce and remove errors common to a Reference Station, with known position, and UE pair. When only pseudo ranges (code-based measurements) are used to compute the UE location, this method is known as DGNSS (Differential GNSS).

Table 8.1.2.1a-1: Single base RTK service: Specific information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| RTK Reference Station Information |
| RTK Observations |
| RTK Common Observation Information |
| GLONASS RTK Bias Information (if GLONASS data is transmitted) |
| Ephemeris and Clock (if UE did not acquire the navigation message) |

- *Non-Physical Reference Station Network RTK service*: In this approach the target UE receives synthetic observations from a fictitious Reference Station. The Network RTK software at the location server is performing the error estimation and creates a virtual Reference Station close to the initial location of the target device (provided a priori to the location server). The target UE interprets and uses the data just as if it had come from a single, real Reference Station. Additionally, the target UE can also receive network information such as RTK Network Residuals (see clause 8.1.2.1.19) or even FKP gradients (see clause 8.1.2.1.20).

Table 8.1.2.1a-2: Non-Physical Reference Station Network RTK service: Specific information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| RTK Reference Station Information |
| RTK Observations |
| RTK Common Observation Information |
| GLONASS RTK Bias Information (if GLONASS data is transmitted) |
| RTK Residuals |
| RTK FKP Gradients |
| Ephemeris and Clock (if UE did not acquire the navigation message) |

- *MAC Network RTK service*: In MAC network RTK, a group of Reference Stations are used and one of them is chosen as a Master station. The other stations are then called Auxiliary stations. In this service, the location server sends full raw observations and coordinate information for a single Reference Station, the Master Station. For all auxiliary stations in the network (or a suitable subset of stations) the information is provided to the UE in a highly compact form: their reduced ambiguity-levelled observations, coordinate differences (to the Master Station observations and coordinates), and network residuals. Two Reference Stations are said to be on a common ambiguity level if the integer ambiguities for each phase range (satellite-receiver pair) have been removed (or adjusted) so that the integer ambiguities cancel when double-differences (involving two receivers and two satellites) are formed during processing. The maintenance of a common ambiguity level at a specific set of stations rather than across the whole GNSS network will lead to a grouping in network clusters or subnetworks of all ambiguity-levelled Reference Stations. If one network has only one subnetwork, this indicates that an ambiguity level throughout the whole network is established. When subnetworks are predefined, the assistance data can be broadcast to all UEs located in the assigned sub-network. More details on the usage of subnetworks can be found in [31].

Table 8.1.2.1a-3: MAC Network RTK service: Specific Information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| RTK Reference Station Information |
| RTK Auxiliary Station Data |
| RTK Observations |
| RTK Common Observation Information |
| GLONASS RTK Bias Information (if GLONASS data is transmitted) |
| RTK MAC Correction Differences |
| RTK Residuals |
| Ephemeris and Clock (if UE did not acquire the navigation message) |

- *FKP Network RTK service*: With the concept of FKP, horizontal gradients of distance-dependent errors like ionosphere, troposphere and orbits are derived from a network of GNSS Reference Stations and transmitted to a target device together with raw or correction data of a corresponding Reference Station (physical or non physical). The target UE may use the gradients to compute the effect of the distance-dependent errors for its own position.

Table 8.1.2.1a-4: FKP Network RTK service: Information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| RTK Reference Station Information |
| RTK Observations |
| RTK Common Observation Information |
| GLONASS RTK Bias Information (if GLONASS data is transmitted) |
| RTK Residuals |
| RTK FKP Gradients |
| Ephemeris and Clock (if UE did not acquire the navigation message) |

- *PPP service*: This concept uses precise satellite orbit and clock parameters derived from global networks of Reference Stations as well as atmospheric models to perform single station positioning [31]. Compared to RTK and Network RTK, PPP is not a differential technique as there is no baseline limitation. When the orbits and clocks assistance data elements are provided in real-time, with no latency, the method is called Real-Time PPP.

Table 8.1.2.1a-5: SSR PPP service: Information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| SSR Orbit Corrections |
| SSR Clock corrections |
| SSR Code Bias |
| Ephemeris and Clock (if UE did not acquire the navigation message) |
| SSR Satellite APC Corrections |

- *PPP-RTK service*: This concept uses precise satellite orbits and clock parameters, the satellite signal biases derived from global networks of Reference Stations as well as ionosphere and troposphere corrections to perform single station positioning IS-QZSS-L6-001 [36]. Therefore, PPP-RTK services compensate the global and local corrections for a more accurate location information. Compared to PPP, PPP-RTK requires the UE to be located within the region covered by the ionosphere and troposphere corrections.

Table 8.1.2.1a-6: SSR PPP-RTK service: Information that may be transferred from the LMF to the UE

|  |
| --- |
| Assistance Data |
| SSR Orbit Corrections |
| SSR Clock corrections |
| SSR Code Bias |
| Ephemeris and Clock (if UE did not acquire the navigation message) |
| SSR Phase Bias |
| SSR STEC Corrections |
| SSR Gridded Correction |
| SSR URA |
| SSR Correction Points |
| SSR Phase Bias with Yaw |
| SSR Satellite APC Corrections |

#### 8.1.2.1b Mapping of integrity parameters

Table 8.1.2.1b-1 shows the mapping between the integrity fields and the SSR assistance data according to the Integrity Principle of Operation (Clause 8.1.1a). The corresponding field descriptions for each of the field names listed in Table 8.1.2.1b-1 are specified under Clause 6.5.2.2 of TS 37.355 [42].

Table 8.1.2.1b-1: Mapping of Integrity Parameters

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Error | GNSS Assistance Data | Integrity Fields | | | | |
| Integrity Alerts | Integrity Bounds (Mean) | Integrity Bounds (StdDev) | Residual Risks | Integrity Correlation Times |
| Orbit | SSR Orbit Corrections | Real-Time Integrity  (see Clause 8.1.2.1.8) | Mean Orbit Error  Mean Orbit Rate Error  (Calculated according to Equation 8.1.2.1.21-1) | Variance Orbit Error  Variance Orbit Rate Error  (Calculated according to Equation 8.1.2.1.21-1) | Probability of Onset of Constellation Fault  Probability of Onset of Satellite Fault  Mean Constellation Fault Duration  Mean Satellite Fault Duration | Orbit Range Error Correlation Time  Orbit Range Rate Error Correlation Time |
| Clock | SSR Clock Corrections | Mean Clock Error  Mean Clock Rate Error | Standard Deviation Clock Error  Standard Deviation Clock Rate Error | Clock Range Error Correlation Time  Clock Range Rate Error Correlation Time |
| Code Bias | SSR Code Bias | Mean Code Bias Error  Mean Code Bias Rate Error | Standard Deviation Code Bias Error  Standard Deviation Code Bias Rate Error |  |
| Phase Bias | SSR Phase Bias  SSR Phase Bias with Yaw | Mean Phase Bias Error  Mean Phase Bias Rate Error | Standard Deviation Phase Bias Error  Standard Deviation Phase Bias Rate Error |
| Ionosphere | SSR STEC Correction | Ionosphere DNU | Mean Ionospherre Error  Mean Ionospherre Rate Error | Standard Deviation Ionosphere Error  Standard Deviation Ionosphere Rate Error | Probability of Onset of Ionosphere Fault  Mean Ionosphere Fault Duration | Ionosphere Range Error Correlation Time  Ionosphere Range Rate Error Correlation Time |
| Troposphere Vertical Hydro Static Delay | SSR Gridded Corrections | Troposphere DNU | Mean Troposphere Vertical Hydro Static Delay Error  Mean Troposphere Vertical Hydro Static Delay Rate Error | Standard Deviation Troposphere Vertical Hydro Static Delay Error  Standard Deviation Troposphere Vertical Hydro Static Delay Rate Error | Probability of Onset of Troposphere Fault  Mean Troposphere Fault Duration | Troposphere Range Error Correlation Time  Troposphere Range Rate Error Correlation Time |
| TroposphereVertical WetDelay | Mean Troposphere Vertical Wet Delay Error  Mean Troposphere Vertical Wet Delay Rate Error | Standard Deviation Troposphere Vertical Wet Delay Error  Standard Deviation Troposphere Vertical Wet Delay Rate Error |

END OF CHANGE

# Appendix 2 – Yaw and APC extensions to LPP TS 37.355

START OF CHANGE

**/\*\*Skip unmodified parts\*\*/**

### 6.5.2 A-GNSS Positioning

#### 6.5.2.1 GNSS Assistance Data

#### – *A-GNSS-ProvideAssistanceData*

The IE *A-GNSS-ProvideAssistanceData* is used by the location server to provide assistance data to enable UE‑based and UE‑assisted A‑GNSS. It may also be used to provide GNSS positioning specific error reasons.

-- ASN1START

A-GNSS-ProvideAssistanceData ::= SEQUENCE {

gnss-CommonAssistData GNSS-CommonAssistData OPTIONAL, -- Need ON

gnss-GenericAssistData GNSS-GenericAssistData OPTIONAL, -- Need ON

gnss-Error A-GNSS-Error OPTIONAL, -- Need ON

...,

[[

gnss-PeriodicAssistData-r15 GNSS-PeriodicAssistData-r15 OPTIONAL -- Cond CtrTrans

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *CtrTrans* | The field is mandatory present in the control transaction of a periodic assistance data delivery session as described in clauses 5.2.1a and 5.2.2a. Otherwise it is not present. |

#### – *GNSS-CommonAssistData*

The IE *GNSS-CommonAssistData* is used by the location server to provide assistance data which can be used for any GNSS.

-- ASN1START

GNSS-CommonAssistData ::= SEQUENCE {

gnss-ReferenceTime GNSS-ReferenceTime OPTIONAL, -- Need ON

gnss-ReferenceLocation GNSS-ReferenceLocation OPTIONAL, -- Need ON

gnss-IonosphericModel GNSS-IonosphericModel OPTIONAL, -- Need ON

gnss-EarthOrientationParameters GNSS-EarthOrientationParameters OPTIONAL, -- Need ON

...,

[[

gnss-RTK-ReferenceStationInfo-r15

GNSS-RTK-ReferenceStationInfo-r15 OPTIONAL, -- Need ON

gnss-RTK-CommonObservationInfo-r15

GNSS-RTK-CommonObservationInfo-r15 OPTIONAL, -- Cond RTK

gnss-RTK-AuxiliaryStationData-r15

GNSS-RTK-AuxiliaryStationData-r15 OPTIONAL -- Need ON

]],

[[

gnss-SSR-CorrectionPoints-r16

GNSS-SSR-CorrectionPoints-r16 OPTIONAL -- Need ON

]],

[[

gnss-Integrity-ServiceParameters-r17

GNSS-Integrity-ServiceParameters-r17 OPTIONAL, -- Need ON

gnss-Integrity-ServiceAlert-r17

GNSS-Integrity-ServiceAlert-r17 OPTIONAL -- Need OR

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *RTK* | The field is mandatory present if the IE *GNSS-RTK-Observations* is included in IE *GNSS‑GenericAssistData*; otherwise it is not present. |

#### – *GNSS-GenericAssistData*

The IE *GNSS-GenericAssistData* is used by the location server to provide assistance data for a specific GNSS. The specific GNSS for which the provided assistance data are applicable is indicated by the IE *GNSS‑ID* and (if applicable) by the IE *SBAS‑ID*. Assistance for up to 16 GNSSs can be provided.

-- ASN1START

GNSS-GenericAssistData ::= SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataElement

GNSS-GenericAssistDataElement ::= SEQUENCE {

gnss-ID GNSS-ID,

sbas-ID SBAS-ID OPTIONAL, -- Cond GNSS-ID-SBAS

gnss-TimeModels GNSS-TimeModelList OPTIONAL, -- Need ON

gnss-DifferentialCorrections GNSS-DifferentialCorrections OPTIONAL, -- Need ON

gnss-NavigationModel GNSS-NavigationModel OPTIONAL, -- Need ON

gnss-RealTimeIntegrity GNSS-RealTimeIntegrity OPTIONAL, -- Need ON

gnss-DataBitAssistance GNSS-DataBitAssistance OPTIONAL, -- Need ON

gnss-AcquisitionAssistance GNSS-AcquisitionAssistance OPTIONAL, -- Need ON

gnss-Almanac GNSS-Almanac OPTIONAL, -- Need ON

gnss-UTC-Model GNSS-UTC-Model OPTIONAL, -- Need ON

gnss-AuxiliaryInformation GNSS-AuxiliaryInformation OPTIONAL, -- Need ON

...,

[[

bds-DifferentialCorrections-r12

BDS-DifferentialCorrections-r12 OPTIONAL, -- Cond GNSS-ID-BDS

bds-GridModel-r12 BDS-GridModelParameter-r12 OPTIONAL -- Cond GNSS-ID-BDS

]],

[[

gnss-RTK-Observations-r15 GNSS-RTK-Observations-r15 OPTIONAL, -- Need ON

glo-RTK-BiasInformation-r15 GLO-RTK-BiasInformation-r15 OPTIONAL, -- Cond GNSS-ID-GLO

gnss-RTK-MAC-CorrectionDifferences-r15

GNSS-RTK-MAC-CorrectionDifferences-r15

OPTIONAL, -- Need ON

gnss-RTK-Residuals-r15 GNSS-RTK-Residuals-r15 OPTIONAL, -- Need ON

gnss-RTK-FKP-Gradients-r15 GNSS-RTK-FKP-Gradients-r15 OPTIONAL, -- Need ON

gnss-SSR-OrbitCorrections-r15

GNSS-SSR-OrbitCorrections-r15 OPTIONAL, -- Need ON

gnss-SSR-ClockCorrections-r15

GNSS-SSR-ClockCorrections-r15 OPTIONAL, -- Need ON

gnss-SSR-CodeBias-r15 GNSS-SSR-CodeBias-r15 OPTIONAL -- Need ON

]],

[[

gnss-SSR-URA-r16 GNSS-SSR-URA-r16 OPTIONAL, -- Need ON

gnss-SSR-PhaseBias-r16 GNSS-SSR-PhaseBias-r16 OPTIONAL, -- Need ON

gnss-SSR-STEC-Correction-r16 GNSS-SSR-STEC-Correction-r16

OPTIONAL, -- Need ON

gnss-SSR-GriddedCorrection-r16 GNSS-SSR-GriddedCorrection-r16

OPTIONAL, -- Need ON

navic-DifferentialCorrections-r16 NavIC-DifferentialCorrections-r16

OPTIONAL, -- Cond GNSS-ID-NavIC

navic-GridModel-r16 NavIC-GridModelParameter-r16

OPTIONAL -- Cond GNSS-ID-NavIC

]],

[[

gnss-SSR-PhaseBiasYaw-r18 GNSS-SSR-PhaseBiasYaw-r18 OPTIONAL -- Need ON

gnss-SSR-SatelliteAPC-r18 GNSS-SSR-SatelliteAPC-r18 OPTIONAL -- Need ON

]]}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *GNSS‑ID‑SBAS* | The field is mandatory present if the *GNSS‑ID* = *sbas*; otherwise it is not present. |
| *GNSS‑ID‑BDS* | The field may be present if the *GNSS‑ID* = *bds*; otherwise it is not present. |
| *GNSS-ID-GLO* | The field is optionally present, need ON, if the *GNSS ID* = *glonass*; otherwise it is not present. |
| *GNSS-ID-NAVIC* | The field is optionally present, need ON, if the *GNSS‑ID* = *navic*; otherwise it is not present |

#### *– GNSS-PeriodicAssistData*

The IE *GNSS-PeriodicAssistData* is used by the location server to provide control parameters for a periodic assistance data delivery session (e.g., interval and duration) to the target device.

NOTE: Omission of a particular assistance data type field in IE *GNSS-PeriodicAssistData* means that the location server does not provide this assistance data type in a data transaction of a periodic assistance data delivery session, as described in clauses 5.2.1a and 5.2.2a. Inclusion of no assistance data type fields in IE *GNSS-PeriodicAssistData* means that a periodic assistance data delivery session is terminated.

-- ASN1START

GNSS-PeriodicAssistData-r15 ::= SEQUENCE {

gnss-RTK-PeriodicObservations-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

glo-RTK-PeriodicBiasInformation-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-RTK-MAC-PeriodicCorrectionDifferences-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-RTK-PeriodicResiduals-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-RTK-FKP-PeriodicGradients-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicOrbitCorrections-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicClockCorrections-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicCodeBias-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

...,

[[

gnss-SSR-PeriodicURA-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicPhaseBias-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicSTEC-Correction-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Need ON

gnss-SSR-PeriodicGriddedCorrection-r16 GNSS-PeriodicControlParam-r15 OPTIONAL -- Need ON

]],

[[

gnss-Integrity-PeriodicServiceAlert-r17 GNSS-PeriodicControlParam-r15 OPTIONAL -- Need ON

]],

[[

gnss-SSR-PeriodicPhaseBiasYaw-r18 GNSS-PeriodicControlParam-r15 OPTIONAL -- Need ON

gnss-SSR-SatelliteAPC-r18 GNSS-PeriodicControlParam-r15 OPTIONAL -- Need ON

]]

}

-- ASN1STOP

#### 6.5.2.2 GNSS Assistance Data Elements

*NEXT CHANGE*

**/\*\*Skip unmodified parts\*\*/**

#### *– GNSS-SSR-OrbitCorrections*

The IE *GNSS-SSR-OrbitCorrections* is used by the location server to provide radial, along-track and cross-track orbit corrections together with integrity information. The target device may use the *SSR-OrbitCorrectionList* to compute a satellite position correction to be combined with the satellite position calculated from broadcast ephemeris.

The parameters provided in IE *GNSS-SSR-OrbitCorrections –* except for *ORBIT-IntegrityParameters* and *SSR-IntegrityOrbitBounds –* are used as specified for SSR Clock Messages (e.g., message type 1057 and 1063) in [30] and apply to all GNSSs.

-- ASN1START

GNSS-SSR-OrbitCorrections-r15 ::= SEQUENCE {

epochTime-r15 GNSS-SystemTime,

ssrUpdateInterval-r15 INTEGER (0..15),

satelliteReferenceDatum-r15 ENUMERATED { itrf, regional, ... },

iod-ssr-r15 INTEGER (0..15),

ssr-OrbitCorrectionList-r15 SSR-OrbitCorrectionList-r15,

...,

[[

orbit-IntegrityParameters-r17 ORBIT-IntegrityParameters-r17 OPTIONAL -- Need OR

]]

}

SSR-OrbitCorrectionList-r15 ::= SEQUENCE (SIZE(1..64)) OF SSR-OrbitCorrectionSatelliteElement-r15

SSR-OrbitCorrectionSatelliteElement-r15 ::= SEQUENCE {

svID-r15 SV-ID,

iod-r15 BIT STRING (SIZE(11)),

delta-radial-r15 INTEGER (-2097152..2097151),

delta-AlongTrack-r15 INTEGER (-524288..524287),

delta-CrossTrack-r15 INTEGER (-524288..524287),

dot-delta-radial-r15 INTEGER (-1048576..1048575) OPTIONAL, -- Need ON

dot-delta-AlongTrack-r15 INTEGER (-262144..262143) OPTIONAL, -- Need ON

dot-delta-CrossTrack-r15 INTEGER (-262144..262143) OPTIONAL, -- Need ON

...,

[[

ssr-IntegrityOrbitBounds-r17 SSR-IntegrityOrbitBounds-r17 OPTIONAL -- Cond Integrity1

]]

}

ORBIT-IntegrityParameters-r17 ::= SEQUENCE {

probOnsetConstFault-r17 INTEGER (0..255),

meanConstFaultDuration-r17 INTEGER (1..3600),

probOnsetSatFault-r17 INTEGER (0..255),

meanSatFaultDuration-r17 INTEGER (1..3600),

orbitRangeErrorCorrelationTime-r17 INTEGER (0..255) OPTIONAL, -- Need OR

orbitRangeRateErrorCorrelationTime-r17 INTEGER (0..255) OPTIONAL, -- Cond Integrity2

...

}

SSR-IntegrityOrbitBounds-r17 ::= SEQUENCE {

meanOrbitError-r17 RAC-OrbitalErrorComponents-r17,

stdDevOrbitError-r17 RAC-OrbitalErrorComponents-r17,

meanOrbitRateError-r17 RAC-OrbitalErrorComponents-r17,

stdDevOrbitRateError-r17 RAC-OrbitalErrorComponents-r17,

...

}

RAC-OrbitalErrorComponents-r17 ::= SEQUENCE {

radial-r17 INTEGER (0..255),

alongTrack-r17 INTEGER (0..255),

crossTrack-r17 INTEGER (0..255)

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *Integrity1* | The field is mandatory present if *ORBIT-IntegrityParameters* is present*;* otherwise it is not present. |
| *Integrity2* | The field is mandatory present if *orbitRangeErrorCorrelationTime* is present*;* otherwise it is not present. |

| *GNSS-SSR-OrbitCorrections* field descriptions |
| --- |
| ***epochTime***  This field specifies the epoch time of the orbit corrections. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*. |
| ***ssrUpdateInterval***  This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value of *ssrUpdateInterval* to SSR Update Interval relation below. NOTE 1. |
| ***satelliteReferenceDatum***  This field specifies the satellite refence datum for the orbit corrections. |
| ***iod-ssr***  This field specifies the Issue of Data number for the SSR data. A change of *iod-ssr* is used to indicate a change in the SSR generating configuration. |
| ***svID***  This field specifies the satellite for which the orbit corrections are provided. |
| ***iod***  This field specifies the IOD value of the broadcast ephemeris for which the orbit corrections are valid (see IE *GNSS‑NavigationModel*). NOTE 2. |
| ***delta-radial***  This field specifies the radial orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.1 mm; range ±209.7151 m. |
| ***delta-AlongTrack***  This field specifies the along-track orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.4 mm; range ±209.7148 m. |
| ***delta-CrossTrack***  This field specifies the cross-track orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.4 mm; range ±209.7148 m. |
| ***dot-delta-radial***  This field specifies the velocity of radial orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.001 mm/s; range ±1.048575 m/s. |
| ***dot-delta-AlongTrack***  This field specifies the velocity of along-track orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.004 mm/s; range ±1.048572 m/s. |
| ***dot-delta-CrossTrack***  This field specifies the velocity of cross-track orbit correction for broadcast ephemeris. NOTE 3.  Scale factor 0.004 mm/s; range ±1.048572 m/s. |
| ***probOnsetConstFault***  This field specifies the Probability of Onset of Constellation Fault per Time Unit where a constellation fault is at least two satellites being faulty simultaneously due to the same event.  This field specifies the onset probability that the residual range or range rate error exceeds a bound created using the minimum allowed inflation factor *Kmin*, and bounding parameters as *mean* + *Kmin* \* *stdDev* where *Kmin* = *normInv*(*irMaximum* / 2), with *irMaximum* as provided in IE *GNSS-Integrity-ServiceParameters*.  The probability is calculated by *P*=10-0.04*n* [hour-1] where *n* is the value of *probOnsetConstFault* and the range is 10-10.2 to 1 per hour. |
| ***meanConstFaultDuration***  This field specifies the Mean Constellation Fault Duration which is the mean duration between when a constellation fault occurs, and the user is alerted by IE *GNSS-RealTimeIntegrity* (or the integrity violation is over).  Scale factor 1 s; range 1-3600 s. |
| ***probOnsetSatFault***  This field specifies the Probability of Onset of Satellite Fault per Time Unit which is the probability of occurrence of satellite error to exceed the residual error bound for more than the Time to Alert (TTA).  This field specifies the onset probability that the residual range or range rate error exceeds a bound created using the minimum allowed inflation factor *Kmin*, and bounding parameters as *mean* + *Kmin* \* *stdDev* where *Kmin* = *normInv*(*irMaximum* / 2), with *irMaximum* as provided in IE *GNSS-Integrity-ServiceParameters*.  The probability is calculated by *P*=10-0.04*n* [hour-1] where *n* is the value of *probOnsetSatFault* and the range is 10-10.2 to 1 per hour. |
| ***meanSatFaultDuration***  This field specifies the Mean Satellite Fault Duration which is the mean duration between when a satellite fault occurs, and the user is alerted by IE *GNSS-RealTimeIntegrity* (or the integrity violation is over).  Scale factor 1 s; range 1-3,600 s. |
| ***orbitRangeErrorCorrelationTime***  This field specifies the Orbit Range Error Correlation Time which is the upper bound of the correlation time of the satellite residual range error due to orbit.  The time is calculated using:  Range is 1-28,200 s. |
| ***orbitRangeRateErrorCorrelationTime***  This field specifies the Orbit Range Rate Error Correlation Time which is the upper bound of the correlation time of the satellite residual range rate error due to orbit.  The time is calculated using:  Range is 1-28,200 s. |
| ***meanOrbitError***  This field specifies the Mean Orbit Error bound in satellite radial, along-track and cross-track coordinates, which are the mean values for a set of three overbounding models that bound the residual orbit error in satellite radial, along-track and cross-track directions.  Each mean is calculated using:  Range is 0-17.5 m. |
| ***stdDevOrbitError***  This field specifies the Standard Deviation Orbit Error bound in satellite radial, along-track and cross-track coordinates, which are the standard deviation values for a set of three overbounding models that bound the residual orbit error in satellite radial, along-track and cross-track directions.  Each standard deviation is calculated using:  Range is 0-17.5 m. |
| ***meanOrbitRateError***  This field specifies the Mean Orbit Rate Error in satellite radial, along-track and cross-track coordinates, which are the mean values for a set of three overbounding models that bound the residual satellite orbit rate error in satellite radial, along-track and cross-track directions.  Scale factor 0.001 m/s; range 0-0.255 m/s. |
| ***stdDevOrbitRateError***  This field specifies the Standard Deviation Orbit Rate Error in satellite radial, along-track and cross-track coordinates, which are the standard deviation values for a set of three overbounding models that bound the residual satellite orbit rate error in satellite radial, along-track and cross-track directions.  Scale factor 0.001 m/s; range 0-0.255 m/s. |

NOTE 1: The update intervals are aligned to the GPS time scale for all GNSSs in order to allow synchronous operation for multiple GNSS services. This means that the update intervals may not be aligned to the beginning of the day for another GNSS. Due to the leap seconds, this is generally the case for GLONASS.

NOTE 2: In the cases that *gnss-ID* indicates 'gps' or 'qzss', the *iod* refers to the NAV broadcast ephemeris (GPS L1 C/A or QZSS QZS-L1, respectively, in table GNSS to iod Bit String(11) relation in IE *GNSS‑NavigationModel).*

NOTE 3: The reference time *t0* is *epochTime* + ½ × *ssrUpdateInterval*. The reference time *t0* for *ssrUpdateInterval* '0' is *epochTime*.

Value of *ssrUpdateInterval* to SSR Update Interval relation

|  |  |
| --- | --- |
| Value of *ssrUpdateInterval* | SSR Update Interval |
| 0 | 1 second |
| 1 | 2 seconds |
| 2 | 5 seconds |
| 3 | 10 seconds |
| 4 | 15 seconds |
| 5 | 30 seconds |
| 6 | 60 seconds |
| 7 | 120 seconds |
| 8 | 240 seconds |
| 9 | 300 seconds |
| 10 | 600 seconds |
| 11 | 900 seconds |
| 12 | 1800 seconds |
| 13 | 3600 seconds |
| 14 | 7200 seconds |
| 15 | 10800 seconds |
| 16 | 21600 seconds |
| 17 | 43200 seconds |
| 18 | 86400 seconds |
| 19 | 172800 seconds |
| 20 | 345600 seconds |
| 21 | 691200 seconds |
| 22 | 1382400 seconds |
| 23 | 2764800 seconds |
| 24 | 5529600 seconds |
| 25 | 11059200 seconds |
| 26 | 22118400 seconds |
| 27 | 44236800 seconds |

NOTE 4: Some IEs only support a Value of *ssrUpdateInterval* up to 15 to maintain backward compatibility.*NEXT CHANGE*

**/\*\*Skip unmodified parts\*\*/**

#### *– GNSS-SSR-PhaseBiasYaw*

The IE *GNSS-SSR-PhaseBiasYaw* is used by the location server to provide GNSS signal phase bias together with yaw and integrity information. The target device may use the phase bias and yaw values to adjust the phase-range measurement of the corresponding phase signal to get corrected phase-ranges.

The parameters provided in IE *GNSS-SSR-PhaseBiasYaw –* except for *SSR-IntegrityPhaseBiasBounds –* apply to all GNSSs and are used as specified for Compact SSR GNSS Satellite Phase Bias Messages (e.g., message type 4073,5) in [43] except that *GNSS-SSR-PhaseBiasYaw* also provides yaw angle and rate parameters rather than setting the yaw angle and rate to zero as in message type 4073,5 in [43].

-- ASN1START

GNSS-SSR-PhaseBiasYaw-r18 ::= SEQUENCE {

epochTime-r18 GNSS-SystemTime,

ssrUpdateInterval-r18 INTEGER (0..15),

iod-ssr-r18 INTEGER (0..15),

ssr-PhaseBiasYawSatList-r18 SSR-PhaseBiasSatList-r16,

...

}

SSR-PhaseBiasYawSignalList-r18 ::= SEQUENCE (SIZE(1..16)) OF SSR-PhaseBiasYawSignalElement-r18

SSR-PhaseBiasYawSignalElement-r18 ::= SEQUENCE {

signal-and-tracking-mode-ID-r18 GNSS-SignalID,

phaseBias-r18 INTEGER (-16384..16383),

phaseDiscontinuityIndicator-r18 INTEGER (0..3),

phaseBiasIntegerIndicator-r18 INTEGER (0..3) OPTIONAL, -- Need OP

yawAngle-r18 INTEGER (0..511)

yawRate-r18 INTEGER (-128..127) OPTIONAL, -- Need OR

ssr-IntegrityPhaseBiasBounds-r18 SSR-IntegrityPhaseBiasBounds-r17 OPTIONAL -- Need OR

...

}

-- ASN1STOP

|  |
| --- |
| ***GNSS-SSR-PhaseBiasYaw* field descriptions** |
| ***epochTime***  This field specifies the epoch time of the phase bias data. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*. |
| ***ssrUpdateInterval***  This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value of *ssrUpdateInterval* to SSR Update Interval relation in IE *GNSS‑SSR‑OrbitCorrections*. |
| ***iod-ssr***  This field specifies the Issue of Data number for the SSR data. A change of *iod-ssr* is used to indicate a change in the SSR generating configuration. |
| ***svID***  This field specifies the GNSS satellite for which the phase biases are provided. |
| ***signal-and-tracking-mode-ID***  This field specifies the GNSS signal for which the phase biases are provided. |
| ***phaseBias***  This field provides the phase bias for the GNSS signal indicated by *signal-and-tracking-mode-ID*.  Scale factor 0.001 m; range ±16.383 m. |
| ***phaseDiscontinuityIndicator***  This field provides the phase discontinuity counter for the GNSS signal indicated by *signal-and-tracking-mode-ID*. This counter is increased for every discontinuity in phase (roll-over from 3 to 0). |
| ***phaseBiasIntegerIndicator***  This field informs whether the phase bias is Undifferenced Integer (Value 0), Widelane Integer (Value 1) or Non-Integer (Value 2):  Value 0: The Undifferenced Integer Phase Bias supports PPP-RTK fixed, widelane or float mode.  Value 1: The Widelane Integer Phase Bias indicates that after application of the Phase Bias value, this signal can be differenced with any other signal from the same satellite that also has Widelane Integer Phase Bias indicated to form a new combined carrier phase measurement of integer quality, supporting PPP-RTK widelane fixed mode.  Value 2: The Non-Integer Phase Bias supports PPP-RTK float mode.  Value 3: Reserved.  If the *phaseBiasIntegerIndicator* field is not present then it is interpreted as having Value 0 (Undifferenced Integer). |
| ***yawAngle***  Yaw angle used for computation of phase wind-up correction and partial orientation for use with satellite antenna phase center data. The yaw angle is defined as the rotation angle around the satellites z-axis which is pointing towards the center of the earth. The reference direction is the yaw origin, a unit vector to form an orthogonal basis for the orbit plane and is in the general direction of the satellite velocity vector.  Units of 1/256 semi-circles. |
| ***yawRate***  Rate of change of the yaw angle.  Units of 1/8192 semi-circles/second. |

#### *– GNSS-SSR-SatelliteAPC*

The IE GNSS-SSR-SatelliteAPC is used by the location server to provide the phase center offsets from the satellite center of mass along the x-, y- and z-axis as well as the nadir-angle-dependent phase center variations

-- ASN1START

GNSS-SSR-SatelliteAPC-r18 ::= SEQUENCE {

epochTime-r18 GNSS-SystemTime,

ssrUpdateInterval-r18 INTEGER (0..27),

iod-ssr-r18 INTEGER (0..15),

ssr-SatelliteAPC-List-r18 SSR-SatelliteAPC-List-r18,

...

}

SSR-SatelliteAPC-List-r18 ::= SEQUENCE (SIZE(1..64)) OF SSR-SatelliteAPC-Element-r18

SSR-SatelliteAPC-Element-r18 ::= SEQUENCE {

svID-r18 SV-ID,

ssr-SatelliteAPC-FrequencyList-r18 SSR-SatelliteAPC-FrequencyList-r18,

...

}

SSR-SatelliteAPC-FrequencyList-r18 ::= SEQUENCE (SIZE(1..8)) OF SSR-SatelliteAPC-FrequencyElement-r18

SSR-SatelliteAPC-FrequencyElement-r18 ::= SEQUENCE {

frequencyID-r18 GNSS-FrequencyID-r15,

phaseCenterOffsetX-r18 INTEGER (-16384..16383),

phaseCenterOffsetY-r18 INTEGER (-16384..16383),

phaseCenterOffsetZ-r18 INTEGER (-16384..16383),

nadirStepSize-r18 INTEGER (1..20) OPTIONAL, -- Cond PCV

phaseCenterVariations-r18 SSR-PhaseCenterVariationList-r18 OPTIONAL -- Need OP

...

}

SSR-PhaseCenterVariationList-r18 ::= SEQUENCE (SIZE(1..180)) OF INTEGER(-128..127)

-- ASN1STOP

| *GNSS-SSR-SatelliteAPC* field descriptions |
| --- |
| ***epochTime***  This field specifies the epoch time of the satellite APC corrections. The *gnss-TimeID* in *GNSS-SystemTime* shall be the same as the *GNSS-ID* in IE *GNSS-GenericAssistDataElement*. |
| ***ssrUpdateInterval***  This field specifies the SSR Update Interval. The SSR Update Intervals for all SSR parameters start at time 00:00:00 of the GPS time scale. A change of the SSR Update Interval during the transmission of SSR data should ensure consistent data for a target device. See table Value of *ssrUpdateInterval* to SSR Update Interval relation in IE *GNSS‑SSR‑OrbitCorrections*. |
| ***iod-ssr***  This field specifies the Issue of Data number for the SSR data. A change of *iod-ssr* is used to indicate a change in the SSR generating configuration. |
| ***svID***  This field specifies the satellite for which the satellite APC corrections are provided. |
| ***frequencyID***  This field specifies the satellite carrier frequency to which this correction applies. |
| ***phaseCenterOffsetX***  This field specifies the mean offset from the satellite antenna reference point as defined by the *GNSS-SSR-OrbitCorrection*, along the x-axis. The coordinate system follows the convention in the IGS ANTEX file format [31], the x-axis completes the right-handed system (cross product of x and y = z) (see definitions of the z and y axis in phaseCenterOffsetZ and phaseCenterOffsetY)  In units of 1 mm. |
| ***phaseCenterOffsetY***  This field specifies the mean offset from the satellite antenna reference point as defined by the *GNSS-SSR-OrbitCorrection*, along the y-axis. The coordinate system follows the convention in the IGS ANTEX file format [31], the y-axis (rotation axis of the solar panels) corresponds to the cross product of the z-axis with the vector from the satellite to the Sun.  In units of 1 mm. |
| ***phaseCenterOffsetZ***  This field specifies the mean offset from the satellite antenna reference point as defined by the *GNSS-SSR-OrbitCorrection*, along the z-axis. The coordinate system follows the convention in the IGS ANTEX [31] file format, the z-axis points toward the geocenter.  In units of 1 mm. |
| ***nadirStepSize***  Step size between nadir buckets. In units of 0.5 degrees. |
| ***phaseCenterVariations***  This field specified the nadir only variations of the phase center. The nadir angle is defined to be the angle away from the z-axis. The first element is the variation at nadirStepSize degrees.  For nadir angles > element count \* *nadirStepSize,* the value will be interpreted as 0.  The number of elements must not exceed 90 degrees / *nadirStepSize*.  In units of 1 mm. |

|  |  |
| --- | --- |
| Conditional presence | Explanation |
| *PCV* | The field is mandatory present if phaseCentreVariations is present; otherwise, it is not present. |

#### 6.5.2.3 GNSS Assistance Data Request

#### – *A-GNSS-RequestAssistanceData*

The IE *A-GNSS-RequestAssistanceData* is used by the target device to request GNSS assistance data from a location server.

-- ASN1START

A-GNSS-RequestAssistanceData ::= SEQUENCE {

gnss-CommonAssistDataReq GNSS-CommonAssistDataReq OPTIONAL, -- Cond CommonADReq

gnss-GenericAssistDataReq GNSS-GenericAssistDataReq OPTIONAL, -- Cond GenADReq

...,

[[

gnss-PeriodicAssistDataReq-r15

GNSS-PeriodicAssistDataReq-r15 OPTIONAL -- Cond PerADReq

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *CommonADReq* | The field is mandatory present if the target device requests *GNSS-CommonAssistData*; otherwise it is not present. |
| *GenADReq* | This field is mandatory present if the target device requests *GNSS-GenericAssistData* for one or more specific GNSS; otherwise it is not present. |
| *PerADReq* | This field is mandatory present if the target device requests periodic GNSS assistance data delivery. This field may only be included if any of the fields are included in IE *GNSS‑GenericAssistDataReq:*  - *GNSS-RTK-ObservationsReq*,  - *GLO-RTK-BiasInformationReq*,  - *GNSS-RTK-MAC-CorrectionDifferencesReq*,  - *GNSS-RTK-ResidualsReq,*  - *GNSS-RTK-FKP-GradientsReq*,  - *GNSS-SSR-OrbitCorrectionsReq*,  - *GNSS-SSR-ClockCorrectionsReq*,  - *GNSS-SSR-CodeBiasReq.*  *- GNSS-SSR-URA-Req,*  *- GNSS-SSR-PhaseBiasReq,*  *- GNSS-SSR-STEC-CorrectionReq,*  *- GNSS-SSR-GriddedCorrectionReq,*  *- GNSS-Integrity-ServiceAlerReq,*  *- GNSS-SSR-PhaseBiasYawReq*  *- GNSS-SSR-SatelliteAPCReq.* |

#### – *GNSS-CommonAssistDataReq*

The IE *GNSS-CommonAssistDataReq* is used by the target device to request assistance data that are applicable to any GNSS from a location server.

-- ASN1START

GNSS-CommonAssistDataReq ::= SEQUENCE {

gnss-ReferenceTimeReq GNSS-ReferenceTimeReq

OPTIONAL, -- Cond RefTimeReq

gnss-ReferenceLocationReq GNSS-ReferenceLocationReq

OPTIONAL, -- Cond RefLocReq

gnss-IonosphericModelReq GNSS-IonosphericModelReq

OPTIONAL, -- Cond IonoModReq

gnss-EarthOrientationParametersReq GNSS-EarthOrientationParametersReq

OPTIONAL, -- Cond EOPReq

...,

[[

gnss-RTK-ReferenceStationInfoReq-r15

GNSS-RTK-ReferenceStationInfoReq-r15

OPTIONAL, -- Cond ARPReq

gnss-RTK-AuxiliaryStationDataReq-r15

GNSS-RTK-AuxiliaryStationDataReq-r15

OPTIONAL -- Cond AuxARPReq

]],

[[

gnss-SSR-CorrectionPointsReq-r16

GNSS-SSR-CorrectionPointsReq-r16

OPTIONAL -- Cond PointsReq

]],

[[

gnss-Integrity-ServiceParametersReq-r17

GNSS-Integrity-ServiceParametersReq-r17

OPTIONAL, -- Cond IntServiceReq

gnss-Integrity-ServiceAlertReq-r17

GNSS-Integrity-ServiceAlertReq-r17

OPTIONAL -- Cond IntAlertReq

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *RefTimeReq* | The field is mandatory present if the target device requests *GNSS-ReferenceTime*; otherwise it is not present. |
| *RefLocReq* | This field is mandatory present if the target device requests *GNSS-ReferenceLocation*; otherwise it is not present. |
| *IonoModReq* | This field is mandatory present if the target device requests *GNSS-IonosphericModel*; otherwise it is not present. |
| *EOPReq* | This field is mandatory present if the target device requests *GNSS-EarthOrientationParameters*; otherwise it is not present. |
| *ARPReq* | This field is mandatory present if the target device requests *GNSS‑RTK‑ReferenceStationInfo*; otherwise it is not present. |
| *AuxARPReq* | This field is mandatory present if the target device requests *GNSS‑RTK‑AuxiliaryStationData*; otherwise it is not present. |
| *PointsReq* | This field is mandatory present if the target device requests *GNSS-SSR-CorrectionPoints*; otherwise it is not present. |
| *IntServiceReq* | This field is mandatory present if the target device requests *GNSS-Integrity-ServiceParameters*; otherwise it is not present. |
| *IntAlertReq* | This field is mandatory present if the target device requests *GNSS-Integrity-ServiceAlert*; otherwise it is not present. |

#### – *GNSS-GenericAssistDataReq*

The IE *GNSS-GenericAssistDataReq* is used by the target device to request assistance data from a location server for one or more specific GNSSs. The specific GNSS for which the assistance data are requested is indicated by the IE *GNSS‑ID* and (if applicable) by the IE *SBAS‑ID*. Assistance for up to 16 GNSSs can be requested.

-- ASN1START

GNSS-GenericAssistDataReq ::= SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataReqElement

GNSS-GenericAssistDataReqElement ::= SEQUENCE {

gnss-ID GNSS-ID,

sbas-ID SBAS-ID OPTIONAL, -- Cond GNSS-ID-SBAS

gnss-TimeModelsReq GNSS-TimeModelListReq OPTIONAL, -- Cond TimeModReq

gnss-DifferentialCorrectionsReq GNSS-DifferentialCorrectionsReq OPTIONAL, -- Cond DGNSS-Req

gnss-NavigationModelReq GNSS-NavigationModelReq OPTIONAL, -- Cond NavModReq

gnss-RealTimeIntegrityReq GNSS-RealTimeIntegrityReq OPTIONAL, -- Cond RTIReq

gnss-DataBitAssistanceReq GNSS-DataBitAssistanceReq OPTIONAL, -- Cond DataBitsReq

gnss-AcquisitionAssistanceReq GNSS-AcquisitionAssistanceReq OPTIONAL, -- Cond AcquAssistReq

gnss-AlmanacReq GNSS-AlmanacReq OPTIONAL, -- Cond AlmanacReq

gnss-UTCModelReq GNSS-UTC-ModelReq OPTIONAL, -- Cond UTCModReq

gnss-AuxiliaryInformationReq GNSS-AuxiliaryInformationReq OPTIONAL, -- Cond AuxInfoReq

...,

[[

bds-DifferentialCorrectionsReq-r12

BDS-DifferentialCorrectionsReq-r12

OPTIONAL, -- Cond DBDS-Req

bds-GridModelReq-r12 BDS-GridModelReq-r12 OPTIONAL -- Cond BDS-GridModReq

]],

[[

gnss-RTK-ObservationsReq-r15

GNSS-RTK-ObservationsReq-r15 OPTIONAL, -- Cond RTK-OSR-Req

glo-RTK-BiasInformationReq-r15

GLO-RTK-BiasInformationReq-r15 OPTIONAL, -- Cond GLO-CPB-Req

gnss-RTK-MAC-CorrectionDifferencesReq-r15

GNSS-RTK-MAC-CorrectionDifferencesReq-r15

OPTIONAL, -- Cond MAC-Req

gnss-RTK-ResidualsReq-r15 GNSS-RTK-ResidualsReq-r15 OPTIONAL, -- Cond Res-Req

gnss-RTK-FKP-GradientsReq-r15

GNSS-RTK-FKP-GradientsReq-r15 OPTIONAL, -- Cond FKP-Req

gnss-SSR-OrbitCorrectionsReq-r15

GNSS-SSR-OrbitCorrectionsReq-r15

OPTIONAL, -- Cond OC-Req

gnss-SSR-ClockCorrectionsReq-r15

GNSS-SSR-ClockCorrectionsReq-r15

OPTIONAL, -- Cond CC-Req

gnss-SSR-CodeBiasReq-r15 GNSS-SSR-CodeBiasReq-r15 OPTIONAL -- Cond CB-Req

]],

[[

gnss-SSR-URA-Req-r16 GNSS-SSR-URA-Req-r16 OPTIONAL, -- Cond URA-Req

gnss-SSR-PhaseBiasReq-r16 GNSS-SSR-PhaseBiasReq-r16 OPTIONAL, -- Cond PB-Req

gnss-SSR-STEC-CorrectionReq-r16

GNSS-SSR-STEC-CorrectionReq-r16 OPTIONAL, -- Cond STEC-Req

gnss-SSR-GriddedCorrectionReq-r16 GNSS-SSR-GriddedCorrectionReq-r16

OPTIONAL, -- Cond Grid-Req

navic-DifferentialCorrectionsReq-r16

NavIC-DifferentialCorrectionsReq-r16

OPTIONAL, -- Cond DNavIC-Req

navic-GridModelReq-r16 NavIC-GridModelReq-r16 OPTIONAL -- Cond NavIC-GridModReq

]],

[[

gnss-SSR-PhaseBiasYawReq-r18 GNSS-SSR-PhaseBiasYawReq-r18 OPTIONAL -- Cond PBY-Req

gnss-SSR-SatelliteAPC-r18 GNSS-SSR-SatelliteAPC-r18 OPTIONAL -- Cond SatAPC-Req

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *GNSS‑ID‑SBAS* | The field is mandatory present if the *GNSS‑ID* = *sbas*; otherwise it is not present. |
| *TimeModReq* | The field is mandatory present if the target device requests *GNSS-TimeModelList*; otherwise it is not present. |
| *DGNSS-Req* | The field is mandatory present if the target device requests *GNSS-DifferentialCorrections*; otherwise it is not present. |
| *NavModReq* | The field is mandatory present if the target device requests *GNSS-NavigationModel*; otherwise it is not present. |
| *RTIReq* | The field is mandatory present if the target device requests *GNSS-RealTimeIntegrity*; otherwise it is not present. |
| *DataBitsReq* | The field is mandatory present if the target device requests *GNSS-DataBitAssistance*; otherwise it is not present. |
| *AcquAssistReq* | The field is mandatory present if the target device requests *GNSS-AcquisitionAssistance*; otherwise it is not present. |
| *AlmanacReq* | The field is mandatory present if the target device requests *GNSS-Almanac*; otherwise it is not present. |
| *UTCModReq* | The field is mandatory present if the target device requests *GNSS-UTCModel*; otherwise it is not present. |
| *AuxInfoReq* | The field is mandatory present if the target device requests *GNSS-AuxiliaryInformation*; otherwise it is not present. |
| *DBDS-Req* | The field is mandatory present if the target device requests *BDS-DifferentialCorrections*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'. |
| *BDS-GridModReq* | The field is mandatory present if the target device requests *BDS-GridModel*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'. |
| *RTK-OSR-Req* | The field is mandatory present if the target device requests *GNSS-RTK-Observations*; otherwise it is not present. |
| *GLO-CPB-Req* | The field is mandatory present if the target device requests *GLO-RTK-BiasInformation*; otherwise it is not present. |
| *MAC-Req* | The field is mandatory present if the target device requests *GNSS‑RTK‑MAC‑CorrectionDifferences*; otherwise it is not present. |
| *Res-Req* | The field is mandatory present if the target device requests *GNSS-RTK-Residuals*; otherwise it is not present. |
| *FKP-Req* | The field is mandatory present if the target device requests *GNSS-RTK-FKP-Gradients*; otherwise it is not present. |
| *OC-Req* | The field is mandatory present if the target device requests *GNSS-SSR-OrbitCorrections*; otherwise it is not present. |
| *CC-Req* | The field is mandatory present if the target device requests *GNSS-SSR-ClockCorrections*; otherwise it is not present. |
| *CB-Req* | The field is mandatory present if the target device requests *GNSS-SSR-CodeBias*; otherwise it is not present. |
| *URA-Req* | The field is mandatory present if the target device requests *GNSS-SSR-URA*; otherwise it is not present. |
| *PB-Req* | The field is mandatory present if the target device requests *GNSS-SSR-PhaseBias*; otherwise it is not present. |
| *STEC-Req* | The field is mandatory present if the target device requests *GNSS-SSR-STEC-Correction*; otherwise it is not present. |
| *Grid-Req* | The field is mandatory present if the target device requests *GNSS‑SSR‑GriddedCorrection*; otherwise it is not present. |
| *DNavIC-Req* | The field is mandatory present if the target device requests *NavIC-DifferentialCorrections*; otherwise it is not present. This field may only be present if the *gnss-ID* indicates 'navic'. |
| *NavIC-GridModReq* | The field is mandatory present if the target device requests *NavIC-GridModel*; otherwise it is not present. This field may only be present if the *gnss-ID* indicates 'navic'. |
| *PBY-Req* | The field is mandatory present if the target device requests *GNSS-SSR-PhaseBiasYaw*; otherwise it is not present. |
| *SatAPC-Req* | The field is mandatory present if the target device requests *GNSS-SSR-SatelliteAPC*; otherwise it is not present. |

#### *– GNSS-PeriodicAssistDataReq*

The IE *GNSS-PeriodicAssistDataReq* is used by the target device to request periodic assistance data delivery from a location server.

-- ASN1START

GNSS-PeriodicAssistDataReq-r15 ::= SEQUENCE {

gnss-RTK-PeriodicObservationsReq-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pOSR

glo-RTK-PeriodicBiasInformationReq-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pCPB

gnss-RTK-MAC-PeriodicCorrectionDifferencesReq-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pMAC

gnss-RTK-PeriodicResidualsReq-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pRes

gnss-RTK-FKP-PeriodicGradientsReq-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pFKP

gnss-SSR-PeriodicOrbitCorrectionsReq-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pOC

gnss-SSR-PeriodicClockCorrectionsReq-r15

GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pCC

gnss-SSR-PeriodicCodeBiasReq-r15 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pCB

...,

[[

gnss-SSR-PeriodicURA-Req-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pURA

gnss-SSR-PeriodicPhaseBiasReq-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pPB

gnss-SSR-PeriodicSTEC-CorrectionReq-r16 GNSS-PeriodicControlParam-r15 OPTIONAL, -- Cond pSTEC

gnss-SSR-PeriodicGriddedCorrectionReq-r16

GNSS-PeriodicControlParam-r15 OPTIONAL -- Cond pGrid

]],

[[

gnss-Integrity-PeriodicServiceAlertReq-r17

GNSS-PeriodicControlParam-r15 OPTIONAL -- Cond pDNU

]],

[[

gnss-SSR-PeriodicPhaseBiasYawReq-r18 GNSS-PeriodicControlParam-r15 OPTIONAL -- Cond pPBY

gnss-SSR-SatelliteAPC-r18 GNSS-PeriodicControlParam-r15 OPTIONAL -- Cond pSAPC

]]

}

-- ASN1STOP

| *Conditional presence* | Explanation |
| --- | --- |
| *pOSR* | The field is mandatory present if the target device requests periodic *GNSS‑RTK‑Observations*; otherwise it is not present. |
| *pCPB* | The field is mandatory present if the target device requests periodic *GLO‑RTK‑BiasInformation*; otherwise it is not present. |
| *pMAC* | The field is mandatory present if the target device requests periodic *GNSS‑RTK‑MAC‑CorrectionDifferences*; otherwise it is not present. |
| *pRes* | The field is mandatory present if the target device requests periodic *GNSS‑RTK‑Residuals*; otherwise it is not present. |
| *pFKP* | The field is mandatory present if the target device requests periodic *GNSS‑RTK‑FKP‑Gradients*; otherwise it is not present. |
| *pOC* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑OrbitCorrections*; otherwise it is not present. |
| *pCC* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑ClockCorrections*; otherwise it is not present. |
| *pCB* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑CodeBias*; otherwise it is not present. |
| *pURA* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑URA*; otherwise it is not present. |
| *pPB* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑PhaseBias*; otherwise it is not present. |
| *pSTEC* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑STEC‑Correction*; otherwise it is not present. |
| *pGrid* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑GriddedCorrection*; otherwise it is not present. |
| *pDNU* | The field is mandatory present if the target device requests periodic *GNSS-Integrity-ServiceAlert*; otherwise it is not present. |
| *pPBY* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑PhaseBiasYaw*; otherwise it is not present. |
| *pSAPC* | The field is mandatory present if the target device requests periodic *GNSS‑SSR‑SatelliteAPC*; otherwise it is not present. |

#### 6.5.2.4 GNSS Assistance Data Request Elements

**/\*\*Skip unmodified parts\*\*/**

*NEXT CHANGE*

#### *– GNSS-SSR-PhaseBiasYawReq*

The IE *GNSS-SSR-PhaseBiasYawReq* is used by the target device to request the *GNSS-SSR-PhaseBiasYaw* assistancefrom the location server.

-- ASN1START

GNSS-SSR-PhaseBiasYawReq-r18 ::= SEQUENCE {

signal-and-tracking-mode-ID-Map-r18 GNSS-SignalIDs,

storedNavList-r18 GNSS-NavListInfo-r15 OPTIONAL,

ssr-IntegrityPhaseBiasBoundsReq-r18 ENUMERATED { requested } OPTIONAL

...

}

-- ASN1STOP

| ***GNSS-SSR-PhaseBiasYawReq* field descriptions** |
| --- |
| ***signal-and-tracking-mode-ID-Map***  This field specifies the GNSS signal(s) for which the *GNSS-SSR-PhaseBiasYaw* is requested. |
| ***storedNavList***  This list provides information to the location server about which NAV data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*. |
| ***ssr-IntegrityPhaseBiasBoundsReq***  This field, if present, indicates that the *SSR-IntegrityPhaseBiasBounds* are requested. |

#### *–* *GNSS-SSR-SatelliteAPCReq*

The IE *GNSS-SSR-SatelliteAPCReq* is used by the target device to request the *GNSS-SSR- SatelliteAPC* assistancefrom the location server.

-- ASN1START

GNSS-SSR-SatelliteAPCReq-r18 ::= SEQUENCE {

signal-and-tracking-mode-ID-Map-r18 GNSS-SignalIDs,

storedNavList-r18 GNSS-NavListInfo-r15 OPTIONAL,

...

}

-- ASN1STOP

| ***GNSS-SSR-SatelliteAPCReq* field descriptions** |
| --- |
| ***signal-and-tracking-mode-ID-Map***  This field specifies the GNSS signal(s) for which the *GNSS-SSR-SatelliteAPC* is requested. |
| ***storedNavList***  This list provides information to the location server about which NAV data the target device has currently stored for the particular GNSS indicated by *GNSS-ID*. |

#### 6.5.2.5 GNSS Location Information

**/\*\*Skip unmodified parts\*\*/**

*NEXT CHANGE*

#### 6.5.2.10 GNSS Capability Information Elements

**/\*\*Skip unmodified parts\*\*/**

#### – *GNSS-GenericAssistanceDataSupport*

The IE *GNSS-GenericAssistanceDataSupport* is used by the target device to provide information on supported GNSS generic assistance data types to the location server for each supported GNSS.

-- ASN1START

GNSS-GenericAssistanceDataSupport ::=

SEQUENCE (SIZE (1..16)) OF GNSS-GenericAssistDataSupportElement

GNSS-GenericAssistDataSupportElement ::= SEQUENCE {

gnss-ID GNSS-ID,

sbas-ID SBAS-ID OPTIONAL, -- Cond GNSS‑ID‑SBAS

gnss-TimeModelsSupport GNSS-TimeModelListSupport

OPTIONAL, -- Cond TimeModSup

gnss-DifferentialCorrectionsSupport GNSS-DifferentialCorrectionsSupport

OPTIONAL, -- Cond DGNSS-Sup

gnss-NavigationModelSupport GNSS-NavigationModelSupport

OPTIONAL, -- Cond NavModSup

gnss-RealTimeIntegritySupport GNSS-RealTimeIntegritySupport

OPTIONAL, -- Cond RTISup

gnss-DataBitAssistanceSupport GNSS-DataBitAssistanceSupport

OPTIONAL, -- Cond DataBitsSup

gnss-AcquisitionAssistanceSupport GNSS-AcquisitionAssistanceSupport

OPTIONAL, -- Cond AcquAssistSup

gnss-AlmanacSupport GNSS-AlmanacSupport

OPTIONAL, -- Cond AlmanacSup

gnss-UTC-ModelSupport GNSS-UTC-ModelSupport

OPTIONAL, -- Cond UTCModSup

gnss-AuxiliaryInformationSupport GNSS-AuxiliaryInformationSupport

OPTIONAL, -- Cond AuxInfoSup

...,

[[

bds-DifferentialCorrectionsSupport-r12

BDS-DifferentialCorrectionsSupport-r12

OPTIONAL, -- Cond DBDS-Sup

bds-GridModelSupport-r12 BDS-GridModelSupport-r12

OPTIONAL -- Cond BDS-GridModSup

]],

[[

gnss-RTK-ObservationsSupport-r15

GNSS-RTK-ObservationsSupport-r15

OPTIONAL, -- Cond RTK-OSR-Sup

glo-RTK-BiasInformationSupport-r15

GLO-RTK-BiasInformationSupport-r15

OPTIONAL, -- Cond GLO-CPB-Sup

gnss-RTK-MAC-CorrectionDifferencesSupport-r15

GNSS-RTK-MAC-CorrectionDifferencesSupport-r15

OPTIONAL, -- Cond MAC-Sup

gnss-RTK-ResidualsSupport-r15 GNSS-RTK-ResidualsSupport-r15

OPTIONAL, -- Cond Res-Sup

gnss-RTK-FKP-GradientsSupport-r15

GNSS-RTK-FKP-GradientsSupport-r15

OPTIONAL, -- Cond FKP-Sup

gnss-SSR-OrbitCorrectionsSupport-r15

GNSS-SSR-OrbitCorrectionsSupport-r15

OPTIONAL, -- Cond OC-Sup

gnss-SSR-ClockCorrectionsSupport-r15

GNSS-SSR-ClockCorrectionsSupport-r15

OPTIONAL, -- Cond CC-Sup

gnss-SSR-CodeBiasSupport-r15 GNSS-SSR-CodeBiasSupport-r15

OPTIONAL -- Cond CB-Sup

]],

[[

gnss-SSR-URA-Support-r16 GNSS-SSR-URA-Support-r16 OPTIONAL, -- Cond URA-Sup

gnss-SSR-PhaseBiasSupport-r16 GNSS-SSR-PhaseBiasSupport-r16

OPTIONAL, -- Cond PB-Sup

gnss-SSR-STEC-CorrectionSupport-r16

GNSS-SSR-STEC-CorrectionSupport-r16

OPTIONAL, -- Cond STEC-Sup

gnss-SSR-GriddedCorrectionSupport-r16

GNSS-SSR-GriddedCorrectionSupport-r16

OPTIONAL, -- Cond Grid-Sup

navic-DifferentialCorrectionsSupport-r16

NavIC-DifferentialCorrectionsSupport-r16

OPTIONAL, -- Cond DNavIC-Sup

navic-GridModelSupport-r16 NavIC-GridModelSupport-r16

OPTIONAL -- Cond NavIC-GridModSup

]] ,

[[

gnss-SSR-PhaseBiasYawSupport-r18 GNSS-SSR-PhaseBiasYawSupport-r18

OPTIONAL -- Cond PBY-Sup

gnss-SSR-PhaseBiasYawSupport-r18 GNSS-SSR-PhaseBiasYawSupport-r18

OPTIONAL -- Cond SatAPC-Sup

]]

}

-- ASN1STOP

| Conditional presence | Explanation |
| --- | --- |
| *GNSS‑ID‑SBAS* | The field is mandatory present if the *GNSS‑ID* = *sbas*; otherwise it is not present. |
| *TimeModSup* | The field is mandatory present if the target device supports *GNSS-TimeModelList*; otherwise it is not present. |
| *DGNSS-Sup* | The field is mandatory present if the target device supports *GNSS-DifferentialCorrections*; otherwise it is not present. |
| *NavModSup* | The field is mandatory present if the target device supports *GNSS-NavigationModel*; otherwise it is not present. |
| *RTISup* | The field is mandatory present if the target device supports *GNSS-RealTimeIntegrity*; otherwise it is not present. |
| *DataBitsSup* | The field is mandatory present if the target device supports *GNSS-DataBitAssistance*; otherwise it is not present. |
| *AcquAssistSup* | The field is mandatory present if the target device supports *GNSS-AcquisitionAssistance*; otherwise it is not present. |
| *AlmanacSup* | The field is mandatory present if the target device supports *GNSS-Almanac*; otherwise it is not present. |
| *UTCModSup* | The field is mandatory present if the target device supports *GNSS-UTC-Model*; otherwise it is not present. |
| *AuxInfoSup* | The field is mandatory present if the target device supports *GNSS-AuxiliaryInformation*; otherwise it is not present. |
| *DBDS-Sup* | The field is mandatory present if the target device supports *BDS-DifferentialCorrections*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'. |
| *BDS-GridModSup* | The field is mandatory present if the target device supports *BDS-GridModel*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'bds'. |
| *RTK-OSR-Sup* | The field is mandatory present if the target device supports *GNSS-RTK-Observations*; otherwise it is not present. Note, support for *GNSS-RTK-Observations* implies support for *GNSS-RTK-CommonObservationInfo* as well. |
| *GLO-CPB-Sup* | The field is mandatory present if the target device supports *GLO‑RTK‑BiasInformation*; otherwise it is not present. This field may only be present if *gnss-ID* indicates 'glonass'. |
| *MAC-Sup* | The field is mandatory present if the target device supports *GNSS‑RTK‑MAC‑CorrectionDifferences*; otherwise it is not present. |
| *Res-Sup* | The field is mandatory present if the target device supports *GNSS‑RTK‑Residuals*; otherwise it is not present. |
| *FKP-Sup* | The field is mandatory present if the target device supports *GNSS‑RTK‑FKP‑Gradients*; otherwise it is not present. |
| *OC-Sup* | The field is mandatory present if the target device supports *GNSS‑SSR‑OrbitCorrections*; otherwise it is not present. |
| *CC-Sup* | The field is mandatory present if the target device supports *GNSS‑SSR‑ClockCorrections*; otherwise it is not present. |
| *CB-Sup* | The field is mandatory present if the target device supports *GNSS‑SSR‑CodeBias*; otherwise it is not present. |
| *URA-Sup* | The field is mandatory present if the target device supports *GNSS-SSR-URA*; otherwise it is not present. |
| *PB-Sup* | The field is mandatory present if the target device supports *GNSS-SSR-PhaseBias*; otherwise it is not present. |
| *STEC-Sup* | The field is mandatory present if the target device supports *GNSS-SSR-STEC-Correction*; otherwise it is not present. |
| *Grid-Sup* | The field is mandatory present if the target device supports *GNSS‑SSR‑GriddedCorrection*; otherwise it is not present. Note, support for *GNSS‑SSR‑GriddedCorrection* implies support for *GNSS-SSR-CorrectionPoints* as well. |
| *DNavIC-Sup* | The field is mandatory present if the target device supports *NavIC-DifferentialCorrections*; otherwise it is not present. This field may only be present if the *gnss-ID* indicates 'navic'. |
| *NavIC-GridModSup* | The field is mandatory present if the target device supports *NavIC-GridModel*; otherwise it is not present. This field may only be present if the *gnss-ID* indicates 'navic'. |
| *PBY-Sup* | The field is mandatory present if the target device supports *GNSS-SSR-PhaseBiasYaw*; otherwise it is not present. |
| *SatAPC-Sup* | The field is mandatory present if the target device supports *GNSS-SSR-SatelliteAPC*; otherwise it is not present. |

**/\*\*Skip unmodified parts\*\*/**

*NEXT CHANGE*

– *GNSS-SSR-PhaseBiasYawSupport*

-- ASN1START

GNSS-SSR-PhaseBiasYawSupport-r18 ::= SEQUENCE {

signal-and-tracking-mode-ID-Sup-r18 GNSS-SignalIDs,

ssr-IntegrityPhaseBiasBoundsSup-r18 ENUMERATED { supported } OPTIONAL

...

}

-- ASN1STOP

| ***GNSS-SSR-PhaseBiasYawSupport* field descriptions** |
| --- |
| ***signal-and-tracking-mode-ID-Sup***  This field specifies the GNSS signal(s) for which the *GNSS-SSR-PhaseBiasYaw* is supported by the target device. |
| ***ssr-IntegrityPhaseBiasBoundsSup***  This field, if present, indicates that the target device supports the IE *SSR-IntegrityPhaseBiasBounds*. |

– *GNSS-SSR-SatelliteAPC-Support*

-- ASN1START

GNSS-SSR-SatelliteAPC-Support-r18 ::= SEQUENCE {

signal-and-tracking-mode-ID-Sup-r18 GNSS-SignalIDs,

...

}

-- ASN1STOP

| ***GNSS-SSR-SatelliteAPC-Support* field descriptions** |
| --- |
| ***signal-and-tracking-mode-ID-Sup***  This field specifies the GNSS signal(s) for which the *GNSS-SSR-SatelliteAPC* is supported by the target device. |

#### 6.5.2.11 GNSS Capability Information Request

**/\*\*Skip unmodified parts\*\*/**

*NEXT CHANGE*

**/\*\*Skip unmodified parts\*\*/**

## 7.2 Mapping of *posSibType* to assistance data element

The supported *posSibType*'s are specified in Table 7.2-1. The GNSS Common and Generic Assistance Data IEs are defined in clause 6.5.2.2. The OTDOA Assistance Data IEs and NR DL-TDOA/DL-AoD Assistance Data IEs are defined in clause 7.4.2. The Barometric Assistance Data IEs are defined in clause 6.5.5.8. The TBS (based on MBS signals) Assistance Data IEs are defined in clause 6.5.4.8.

Table 7.2-1: Mapping of posSibType to assistanceDataElement

|  |  |  |
| --- | --- | --- |
|  | *posSibType* | *assistanceDataElement* |
| GNSS Common Assistance Data (clause 6.5.2.2) | *posSibType1-1* | *GNSS-ReferenceTime* |
| *posSibType1-2* | *GNSS-ReferenceLocation* |
| *posSibType1-3* | *GNSS-IonosphericModel* |
| *posSibType1-4* | *GNSS-EarthOrientationParameters* |
| *posSibType1-5* | *GNSS-RTK-ReferenceStationInfo* |
| *posSibType1-6* | *GNSS-RTK-CommonObservationInfo* |
| *posSibType1-7* | *GNSS-RTK-AuxiliaryStationData* |
| *posSibType1-8* | *GNSS-SSR-CorrectionPoints* |
| *posSibType1-9* | *GNSS-Integrity-ServiceParameters* |
| *posSibType1-10* | *GNSS-Integrity-ServiceAlert* |
| GNSS Generic Assistance Data (clause 6.5.2.2) | *posSibType2-1* | *GNSS-TimeModelList* |
| *posSibType2-2* | *GNSS-DifferentialCorrections* |
| *posSibType2-3* | *GNSS-NavigationModel* |
| *posSibType2-4* | *GNSS-RealTimeIntegrity* |
| *posSibType2-5* | *GNSS-DataBitAssistance* |
| *posSibType2-6* | *GNSS-AcquisitionAssistance* |
| *posSibType2-7* | *GNSS-Almanac* |
| *posSibType2-8* | *GNSS-UTC-Model* |
| *posSibType2-9* | *GNSS-AuxiliaryInformation* |
| *posSibType2-10* | *BDS-DifferentialCorrections* |
| *posSibType2-11* | *BDS-GridModelParameter* |
| *posSibType2-12* | *GNSS-RTK-Observations* |
| *posSibType2-13* | *GLO-RTK-BiasInformation* |
| *posSibType2-14* | *GNSS-RTK-MAC-CorrectionDifferences* |
| *posSibType2-15* | *GNSS-RTK-Residuals* |
| *posSibType2-16* | *GNSS-RTK-FKP-Gradients* |
| *posSibType2-17* | *GNSS-SSR-OrbitCorrections* |
| *posSibType2-18* | *GNSS-SSR-ClockCorrections* |
| *posSibType2-19* | *GNSS-SSR-CodeBias* |
| *posSibType2-20* | *GNSS-SSR-URA* |
| *posSibType2-21* | *GNSS-SSR-PhaseBias* |
| *posSibType2-22* | *GNSS-SSR-STEC-Correction* |
| *posSibType2-23* | *GNSS-SSR-GriddedCorrection* |
| *posSibType2-24* | *NavIC-DifferentialCorrections* |
| *posSibType2-25* | *NavIC-GridModelParameter* |
| *posSibType2-xy* | *GNSS-SSR-PhaseBiasYaw* |
| *posSibType2-wz* | *GNSS-SSR-SatelliteAPC* |
| OTDOA Assistance Data (clause 7.4.2) | *posSibType3-1* | *OTDOA-UE-Assisted* |
| Barometric Assistance Data  (clause 6.5.5.8) | *posSibType4-1* | *Sensor-AssistanceDataList* |
| TBS Assistance Data  (clause 6.5.4.8) | *posSibType5-1* | *TBS-AssistanceDataList* |
| NR DL-TDOA/DL-AoD Assistance Data (clauses 6.4.3, 7.4.2) | *posSibType6-1* | *NR-DL-PRS-AssistanceData* |
| *posSibType6-2* | *NR-UEB-TRP-LocationData* |
| *posSibType6-3* | *NR-UEB-TRP-RTD-Info* |
| *posSibType6-4* | *NR-TRP-BeamAntennaInfo* |
| *posSibType6-5* | *NR-DL-PRS-TRP-TEG-Info* |
| On-demand DL-PRS Configurations (clause 6.4.3) | *posSibType6-6* | *NR-On-Demand-DL-PRS-Configurations* |

END OF CHANGE

# Appendix 3 - Corrections to LPP TS 36.331 / 38.331

*START OF CHANGE*

– *DedicatedSIBRequest*

The *DedicatedSIBRequest* message is used to request SIB(s) required by the UE in RRC\_CONNECTED as specified in clause 5.2.2.3.5.

Signalling radio bearer: SRB1

RLC-SAP: AM

Logical channel: DCCH

Direction: UE to Network

***DedicatedSIBRequest message***

-- ASN1START

-- TAG-DEDICATEDSIBREQUEST-START

DedicatedSIBRequest-r16 ::= SEQUENCE {

criticalExtensions CHOICE {

dedicatedSIBRequest-r16 DedicatedSIBRequest-r16-IEs,

criticalExtensionsFuture SEQUENCE {}

}

}

DedicatedSIBRequest-r16-IEs ::= SEQUENCE {

onDemandSIB-RequestList-r16 SEQUENCE {

requestedSIB-List-r16 SEQUENCE (SIZE (1..maxOnDemandSIB-r16)) OF SIB-ReqInfo-r16 OPTIONAL,

requestedPosSIB-List-r16 SEQUENCE (SIZE (1..maxOnDemandPosSIB-r16)) OF PosSIB-ReqInfo-r16 OPTIONAL

} OPTIONAL,

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension SEQUENCE {} OPTIONAL

}

SIB-ReqInfo-r16 ::= ENUMERATED { sib12, sib13, sib14, sib20-v1700, sib21-v1700, spare3, spare2, spare1 }

PosSIB-ReqInfo-r16 ::= SEQUENCE {

gnss-id-r16 GNSS-ID-r16 OPTIONAL,

sbas-id-r16 SBAS-ID-r16 OPTIONAL,

posSibType-r16 ENUMERATED { posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,

posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,

posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,

posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,

posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20,

posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1,

posSibType5-1, posSibType6-1, posSibType6-2, posSibType6-3,..., posSibType1-9-v1710,

posSibType1-10-v1710, posSibType2-24-v1710, posSibType2-25-v1710,

posSibType6-4-v1710, posSibType6-5-v1710, posSibType6-6-v1710,..., posSibType2-xy-v1800,

posSibType2-wz-v1800 }

}

-- TAG-DEDICATEDSIBREQUEST-STOP

-- ASN1STOP

|  |
| --- |
| ***DedicatedSIBRequest field descriptions*** |
| ***requestedSIB-List***  Contains a list of SIB(s) the UE requests while in RRC\_CONNECTED. |
| ***requestedPosSIB-List***  Contains a list of posSIB(s) the UE requests while in RRC\_CONNECTED. |

|  |
| --- |
| ***PosSIB-ReqInfo* field descriptions** |
| ***gnss-id***  The presence of this field indicates that the request positioning SIB type is for a specific GNSS. Indicates a specific GNSS (see also TS 37.355 [49]) |
| ***sbas-id***  The presence of this field indicates that the request positioning SIB type is for a specific SBAS. Indicates a specific SBAS (see also TS 37.355 [49]). |

*NEXT CHANGE*

6.3.1a Positioning System information blocks

– *PosSystemInformation-r16-IEs*

-- ASN1START

-- TAG-POSSYSTEMINFORMATION-R16-IES-START

PosSystemInformation-r16-IEs ::= SEQUENCE {

posSIB-TypeAndInfo-r16 SEQUENCE (SIZE (1..maxSIB)) OF CHOICE {

posSib1-1-r16 SIBpos-r16,

posSib1-2-r16 SIBpos-r16,

posSib1-3-r16 SIBpos-r16,

posSib1-4-r16 SIBpos-r16,

posSib1-5-r16 SIBpos-r16,

posSib1-6-r16 SIBpos-r16,

posSib1-7-r16 SIBpos-r16,

posSib1-8-r16 SIBpos-r16,

posSib2-1-r16 SIBpos-r16,

posSib2-2-r16 SIBpos-r16,

posSib2-3-r16 SIBpos-r16,

posSib2-4-r16 SIBpos-r16,

posSib2-5-r16 SIBpos-r16,

posSib2-6-r16 SIBpos-r16,

posSib2-7-r16 SIBpos-r16,

posSib2-8-r16 SIBpos-r16,

posSib2-9-r16 SIBpos-r16,

posSib2-10-r16 SIBpos-r16,

posSib2-11-r16 SIBpos-r16,

posSib2-12-r16 SIBpos-r16,

posSib2-13-r16 SIBpos-r16,

posSib2-14-r16 SIBpos-r16,

posSib2-15-r16 SIBpos-r16,

posSib2-16-r16 SIBpos-r16,

posSib2-17-r16 SIBpos-r16,

posSib2-18-r16 SIBpos-r16,

posSib2-19-r16 SIBpos-r16,

posSib2-20-r16 SIBpos-r16,

posSib2-21-r16 SIBpos-r16,

posSib2-22-r16 SIBpos-r16,

posSib2-23-r16 SIBpos-r16,

posSib3-1-r16 SIBpos-r16,

posSib4-1-r16 SIBpos-r16,

posSib5-1-r16 SIBpos-r16,

posSib6-1-r16 SIBpos-r16,

posSib6-2-r16 SIBpos-r16,

posSib6-3-r16 SIBpos-r16,

... ,

posSib1-9-v1700 SIBpos-r16,

posSib1-10-v1700 SIBpos-r16,

posSib2-24-v1700 SIBpos-r16,

posSib2-25-v1700 SIBpos-r16,

posSib6-4-v1700 SIBpos-r16,

posSib6-5-v1700 SIBpos-r16,

posSib6-6-v1700 SIBpos-r16

... ,

posSib2-xy-v1800 SIBpos-r16

posSib2-wz-v1800 SIBpos-r16

},

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension SEQUENCE {} OPTIONAL

}

-- TAG-POSSYSTEMINFORMATION-R16-IES-STOP

-- ASN1STOP

– *PosSI-SchedulingInfo*

-- ASN1START

-- TAG-POSSI-SCHEDULINGINFO-START

PosSI-SchedulingInfo-r16 ::= SEQUENCE {

posSchedulingInfoList-r16 SEQUENCE (SIZE (1..maxSI-Message)) OF PosSchedulingInfo-r16,

posSI-RequestConfig-r16 SI-RequestConfig OPTIONAL, -- Cond MSG-1

posSI-RequestConfigSUL-r16 SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1

...,

[[

posSI-RequestConfigRedCap-r17 SI-RequestConfig OPTIONAL -- Cond REDCAP-MSG-1

]]

}

PosSchedulingInfo-r16 ::= SEQUENCE {

offsetToSI-Used-r16 ENUMERATED {true} OPTIONAL, -- Need R

posSI-Periodicity-r16 ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},

posSI-BroadcastStatus-r16 ENUMERATED {broadcasting, notBroadcasting},

posSIB-MappingInfo-r16 PosSIB-MappingInfo-r16,

...

}

PosSIB-MappingInfo-r16 ::= SEQUENCE (SIZE (1..maxSIB)) OF PosSIB-Type-r16

PosSIB-Type-r16 ::= SEQUENCE {

encrypted-r16 ENUMERATED { true } OPTIONAL, -- Need R

gnss-id-r16 GNSS-ID-r16 OPTIONAL, -- Need R

sbas-id-r16 SBAS-ID-r16 OPTIONAL, -- Need R

posSibType-r16 ENUMERATED { posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,

posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,

posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,

posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,

posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20,

posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1,

posSibType5-1,posSibType6-1, posSibType6-2, posSibType6-3, posSibType2-xy, posSibType2-wz,... },

areaScope-r16 ENUMERATED {true} OPTIONAL -- Need S

}

GNSS-ID-r16 ::= SEQUENCE {

gnss-id-r16 ENUMERATED{gps, sbas, qzss, galileo, glonass, bds, ...},

...

}

SBAS-ID-r16 ::= SEQUENCE {

sbas-id-r16 ENUMERATED { waas, egnos, msas, gagan, ...},

...

}

-- TAG-POSSI-SCHEDULINGINFO-STOP

-- ASN1STOP

|  |
| --- |
| ***PosSI-SchedulingInfo* field descriptions** |
| ***areaScope***  Indicates that a posSIB is area specific. If the field is absent, the posSIB is cell specific. |
| ***encrypted***  The presence of this field indicates that the *pos-sib-type* is encrypted as specified in TS 37.355 [49]. |
| ***gnss-id***  The presence of this field indicates that the positioning SIB type is for a specific GNSS. Indicates a specific GNSS (see also TS 37.355 [49]) |
| ***posSI-BroadcastStatus***  Indicates if the SI message is being broadcasted or not. Change of *posSI-BroadcastStat*us should not result in system information change notifications in Short Message transmitted with P-RNTI over DCI (see clause 6.5). The value of the indication is valid until the end of the BCCH modification period when set to *broadcasting*.  If *si-SchedulingInfo-v1700* is present, the network ensures that the total number of SI messages with *posSI-BroadcastStatus*and *si-BroadcastStatus*set to *notBroadcasting* in the concatenated list of SI messages configured by *schedulingInfoList* in *si-SchedulingInfo* and SI messages containing type2 SIB configured by *schedulingInfoList2* in *si-SchedulingInfo-v1700* does not exceed the limit of *maxSI-Message* when *posSI-RequestConfig* or *posSI-RequestConfigRedCap* or *posSI-RequestConfigSUL* is configured. |
| ***posSI-RequestConfig***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***posSI-RequestConfigRedCap***  Configuration of Msg1 resources for *initialUplinkBWP-RedCap*that the RedCap UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to *notBroadcasting*. |
| ***posSI-RequestConfigSUL***  Configuration of Msg1 resources that the UE uses for requesting SI-messages for which *posSI-BroadcastStatus* is set to notBroadcasting. |
| ***posSIB-MappingInfo***  List of the posSIBs mapped to this *SystemInformation* message. |
| ***posSibType***  The positioning SIB type is defined in TS 37.355 [49]. |
| ***posSI-Periodicity***  Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on. If the *offsetToSI-Used* is configured, the *posSI-Periodicity* of rf8 cannot be used. |
| ***offsetToSI-Used***  This field, if present indicates that all the SI messages in *posSchedulingInfoList* are scheduled with an offset of 8 radio frames compared to SI messages in *schedulingInfoList*. *offsetToSI-Used* may be present only if the shortest configured SI message periodicity for SI messages in *schedulingInfoList* is 80ms. If SI offset is used, this field is present in each of the SI messages in the *posSchedulingInfoList*. |
| ***sbas-id***  The presence of this field indicates that the positioning SIB type is for a specific SBAS. Indicates a specific SBAS (see also TS 37.355 [49]). |

| **Conditional presence** | **Explanation** |
| --- | --- |
| *MSG-1* | The field is optionally present, Need R, if *posSI-BroadcastStatus* is set to *notBroadcasting* for any SI-message included in *PosSchedulingInfo*. It is absent otherwise. |
| *SUL-MSG-1* | The field is optionally present, Need R, if *supplementaryUplink* is configured in *ServingCellConfigCommonSIB* and if *posSI-BroadcastStatus* is set to *notBroadcasting* for any SI-message included in *PosSchedulingInfo*. It is absent otherwise. |
| *REDCAP-MSG-1* | The field is optionally present, Need R, if *initialUplinkBWP-RedCap* is configured in *UplinkConfigCommonSIB* and if *posSI-BroadcastStatus* is set to *notBroadcasting* for any SI-message included in *PosSchedulingInfo*. It is absent otherwise. |

– *SIBpos*

The IE *SIBpos* contains positioning assistance data as defined in TS 37.355 [49].

***SIBpos* information element**

-- ASN1START

-- TAG-SIPOS-START

SIBpos-r16 ::= SEQUENCE {

assistanceDataSIB-Element-r16 OCTET STRING,

lateNonCriticalExtension OCTET STRING OPTIONAL,

...

}

-- TAG-SIPOS-STOP

-- ASN1STOP

| ***SIBpos* field descriptions** |
| --- |
| ***assistanceDataSIB-Element***  Parameter *AssistanceDataSIBelement* defined in TS 37.355 [49]. The first/leftmost bit of the first octet contains the most significant bit. |

END OF CHANGE