**3GPP TSG RAN WG2 #118-e R2-220xxxx**

**Online, 9th – 20th May, 2022**

**Agenda Item: 7.2.4**

**Source: GateHouse**

**Title: [draft] Report of [AT118-e][057][IOT NTN] Discontinuous coverage (Gatehouse)**

**Document for: Discussion**

# Introduction

This document is the report from the following offline discussion:

* [AT118-e][057][IOT NTN] Discontinuous coverage (Gatehouse)

      Scope:

 1. Based on Agreements related to R2-2205933, progress further to identify agreeable parts.

 2. Treat R2-2206160, determine agreeable parts (and related TPs)

      Intended outcome: Report, agreeable parameters definitions (TP)

      Deadline: For Online CB W2 Tue

During the 1st round of discussion, the rapporteur invites companies to provide their comments before the deadline that is set to: **Monday, 16th of May – 1200 UTC.**

Hereafter the rapporteur will summarize, and the summary will be made available for the online session on Tuesday, 17th of May.

# Contact

Delegates are encouraged to provide their contact information in the following table:

|  |  |  |
| --- | --- | --- |
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# Agreements

This document is intended for discussion and agreement of parameters related to the discontinuous coverage case. The discussion will be based on the [post-RAN2#117-e discussion](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205933.zip) and the proposals of [R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip).

The following agreements, based on the [post-RAN2#117-e discussion](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205933.zip), were made during the [first NTN IoT online session](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Inbox/Chairs_Notes/R2_118-e%20Chair%20Notes%202022-05-10%200600%20UTC.docx) in RAN2#118-e:

* P2, P3, P4, P6 are agreed
* P1 is agreed (can explore during R2 118-e whether optimizations/removal of some info is possible, optionality etc).
* (based on P1) Go for a single format / type of mean parameters for prediction of coverage (overrides earlier agreement).
* Include Satellite footprint reference location (coordinates) and coverage radius (for earth-fixed cells).
* Discuss further during R2 118-e for earth moving beams, and also clarify details for earth fixed cells (if needed)

The post-RAN2#117-e proposals:

Proposal 1: RAN2 will use SGP4 mean elements (Type 4) for sharing mean ephemeris, to support discontinuous coverage in IoT-NTN.

Proposal 2: RAN2 will explicitly use the epoch for sharing the mean ephemeris elements (of serving satellite, as well as the neighbour satellites) in IoT-NTN. RAN2 will discuss the possible format of epoch time as part of the new SIB.

Proposal 3: RAN2 will not discuss use of dedicated RRC signalling to share neighbour satellites’ ephemeris information, required for discontinuous coverage of IoT-NTN, in Rel-17.

Proposal 4: RAN2 will not discuss any further details of AS-NAS interaction for Discontinuous Coverage in IoT-NTN.

Proposal 5: RAN2 will include Satellite footprint reference location (coordinates) and coverage radius for earth-fixed cells (besides already agreed coverage start and end-times). RAN2 will discuss if elevation angle needs to be included for earth-moving beams.

Proposal 6: Network is not needed to explicitly indicate support of Discontinuous Coverage per PLMN by SIB1.

Proposal 7: RAN2 will discuss and finalize the contents and format of the new SIB.

Color code: Agreed, to be discussed.

# SGP4 ephemeris and Satellite footprint parameters.

As agreed, the satellite assistance information (SAI) to be transmitted in SIB32 consists of coverage information. This may come in the form of ON-timestamps for the earth-fixed (EF) scenario or as an SGP4-ephemeris in the earth-moving (EM) scenario, satellite footprint parameters and possibly a satellite/beam number.

## SGP4 ephemeris

### SGP4 reference frame

The standard reference frame of SGP4-propagators is true equator, mean equinox (TEME) of the epoch.

Question 4.1: Do you agree to specify the reference frame of the SGP4 format as TEME at epoch?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes | trust the satellite companies |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| ZTE | - | Can trust the satellite companies, but there are still ambiguities that would affect our understanding on the whole scheme and consideration on signalling details. Honestly to say, we feel it’s difficult to discuss these things in RAN, especially in RAN2 scope. In [[R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip)], only one sentence mentions TEME as below:“*The reference frame of the SGP4/SDP4 orbital models are coordinates in the Earth-centred inertial (ECI) frame with regards to true equator, mean equinox (TEME) of epoch.*”Per our knowledge, we have the following clarifications:* The SGP4 model can only accurately propagate the orbit of objects near Earth (with an orbital period shorter than 225 minutes, corresponding approximately to an altitude lower than 5877.5 km). For propagation of objects in deep space (with an orbital period longer than 225 minutes), the SDP4 model should be used. Then here in 3GPP, do we only need to specify SGP4, not include SDP4, right? (the consideration may be that orbital period of LEO would not be longer than 225 minutes while GEO has no discontinuous coverage issue? Then how about MEO?)
* True equator, mean equinox (TEME) is a type of coordinate system. There are other types of coordinate system, e.g., Mean Equator Mean Equinox (MEME). In [[R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip)], there are some discussion on how to simplify the elements included in TLEs and finally some elements are proposed in Proposal#4 in [[R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip)]. But it’s not clear whether the selected elements are aligned with TEME coordinate system? Or if there is understanding that TLE and SGP4 can only be used in the TEME coordinate system, then TEME would be confirmed and it’s no need to discuss Q4.1.
 |
| Eutelsat | Yes |  |
| Lenovo | Yes |  |
| Nokia | Yes |  |
| CATT | Yes |  |
| Google | Yes |  |

### SGP4 parameters

In[R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip) it is proposed that the range and granularity of the orbital parameters needed for SGP4 propagation should be based on the ranges and granularity already defined for TLE since the TLE is a well-known and tried standard-format for SGP4 parameters in the satellite community.

However, the elements included in TLEs [2] go beyond the requirements for SGP4 so that some of them could be skipped. In particular, the derivatives of mean motion, both first and second order, are not needed for SGP4 propagation [7], but are part of the TLE for compatibility reasons. In addition, the international designation of the satellite is not necessary for orbit propagation.

The necessary SGP4-based ephemeris parameters are further detailed in Table 2. The parameters in Table 2 are specified based on a conversion of the range/state-space covered by the character-encoded parameters in the TLE format (see Figure 2 and [9]) to state encoded parameters in Table 2.

 **Table 2**. SGP4 parameters: Units, range, bit size and granularity.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Range | Min states | Nearest Bit | States | Granularity |
| *Example* | *SI* | *X to Y* | *Smin* | *B =* ⌈log2*(Smin)*⌉ | *S = 2B* | *(Y-X)/(S-1)* |
| Inclination | Deg | 0 to 180.0000 | 1800001 | 21 | 221 | 8.583073616e-5 |
| Arg of Perigee | Deg | 0 to 180.0000 | 1800001 | 21 | 221 | 8.583073616e-5 |
| Right Ascension of the Node | Deg | 0 to 360.0000 | 3600001 | 22 | 222 | 8.5830712318e-5 |
| Mean Anomaly | Deg | 0 to 360.0000 | 3600001 | 22 | 222 | 8.5830712318e-5 |
| Eccentricity | - | 0 to .9999999 | 1e+7 | 24 | 224 | 5.96046388e-8 |
| Mean Motion  | rev/day | 0 to 99.99999999 | 1e+10 | 34 | 234 | 5.82076609e-9 |
| Revolution Number at Epoch  | rev | 0 to 131071 | 131072 | 17 | 217 | 1 |
| B\* |  (earth radii)-1 | Nonlinear∓.99999∓9 | - | 23 | - | - |
| Epoch\* | sec | -1048575 to 1048575 | 221 - 1 | 21 | 221 | 1 |

Notes:

1. B\* is defined in TLE format as the string “∓CCCCC∓E” - where ∓ is a binary sign, C is a value 0 through 9 and E is an exponent valued 0 through 9. The nearest bit is very close to the required number of bits (21.93) hence we keep the industry standard intact and do not attempt to improve the nonlinear granularity. A decimal point is assumed after the initial sign. To clarify the bitmask for the B\* term we provide the following:
	1. Bit 0: Determines the sign of the decimal.
	2. Bit 1-17: Determine the value of the decimal, range: .00000 to .99999, nBits = 17, granularity: .00001.
	3. Bit 18: Determines the sign of the exponent.
	4. Bit 19-22: Determine the value of the exponent, range: 0 to 9, B = 4, granularity: 1.
	5. For bit 1-17 and bit-19-22 they can represent more cases than required by the granularity. However, the extra cases shall be disregarded, i.e.. the integers beyond the range of 99999 and 9, respectively, are discarded.
2. The granularity of the number of revolutions should be the integer 1 so the range has been extended from the TLE formats maximum of 99999 to 131071.
3. The variables, ”*Inclination, Arg of Perigee, Right Ascension of the Node, Mean Anomaly, Eccentricity and Mean Motion*“ all have slightly improved granularities compared to TLEs due to “extra” states being introduced when per-parameter encoding is introduced in contrast to TLEs character encoding.

This is a total of 205 bits, or 25.625 Bytes.

Question 4.2: Do you agree to specify the range and granularity of the orbital parameters needed for SGP4 propagation ..

1. .. based on the ranges and granularity already defined for TLE parameters
2. .. and adopt the parameters specified in table 2 for the SGP4 format? Any suggestions in comments.

 Epoch to be discussed in the next question

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes | trust the satellite companies |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| ZTE | Yes to specify the range and granularity | We understand satellite companies would prefer option b, right?Our further comments:It’s not clear why the value range of “the number of revolutions” is to be extended from 99999 to 131071. Is the intention here just to simply use up all the value range of 17bits? Is it really needed?Moreover, we understand the original counting of the number of revolutions is from the real epoch time, e.g., from the launch time of the satellite. Now, as satellite companies suggest a variable Epoch\* parameter, does the meaning and value range of the number of revolutions also need to be changed accordingly? |
| Eutelsat | Yes | Note: A further suggestion is - for avoiding confusion - to reflect the original TLE parameters names in the ASN.1 structure (in particular "Argument of perigee" - vs. "periapsis", and " Right ascension of node" vs. "longitude") |
| Lenovo | Yes |  |
| Nokia | Yes |   |
| CATT | Yes |  |
| Google | Yes |  |

The variable Epoch\* is a time offset between the beginning of the current week (Monday 00:00:00 UTC) of the SGP4 Epoch.

1. The Epoch time parameter within TLE is encoded as the last two digits of the Epoch year, and the Epoch day down to a granularity of ~1 microsecond and would need 44 bits. To reduce this size, Epoch\* defines the offset to the actual Epoch and is limited to a range of +/- 1048575 seconds (+/- ~12.1 days) referenced at the start of the current week. (This is considered a sufficient time to have a new TLE update).
2. It is reasonable that a new ephemeris is available before the old ephemeris (and any propagations) becomes too inaccurate. In the (unlikely) case that SGP4 ephemerides have Epochs that lay outside of this range, those can reasonably be propagated to the current week before being broadcast. Propagated ephemerides neither gain nor loose accuracy compared to the original ephemerides.
3. Since the SAI is for aiding UEs to predict coverage in the DC scenario a granularity of 1 sec is very reasonable as the added energy consumption for a UE to wake up approximately half a second in advance of predicted coverage (excluding prediction error over time) is negligible.

Question 4.3: Do you agree to specifying Epoch\* as a substitute for Epoch based on the above formulation?

* 1. Epoch\* as an offset to Epoch
	2. Epoch\* with reference to the beginning of the current week, Monday 00:00:00 UTC
	3. Epoch\* with granularity of 1 sec and a range of $\pm \frac{2^{21}-1}{2}$ seconds (~12.1 days) around the reference time.0
	4. It is up to the network to appropriately propagate the SGP4-parameters if they fall outside this range

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | yes in principle | a) we welcome reducing the size of the parameterb) does that mean that the UE needs to know the (current) UTC time, i.e. that SIB16 shall also be broadcast |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| ZTE | Yes in principle | Epoch\* defines the offset between the actual Epoch and the beginning of the current week (Monday 00:00:00 UTC), right?We have same question as Huawei, does it mean UTC time in SIB16 also need to be broadcasted? We hope not but still not sure whether Epoch\* can be workable without time info from SIB16. |
| Eutelsat | Yes | It is assumed that ephemeris should be updated frequently enough (e.g. once per day or more) so that a UE would get a fresh enough ephemeris set at any wakeup moment, and would be able to compute a prediction with an optimum accuracy even after a (reasonably) long sleep time period. |
| Lenovo | Yes with comments | For the concerns in b), in our understanding there is no need of current UTC time in SIB16, as the Epoch\* is with reference to the beginning of the current week (Monday 00:00:00 UTC) which is already known. |
| Nokia | Yes |  |
| CATT | Yes |  |
| Google | Yes |  |

## Quasi earth fixed parameters

From [R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip):

“The service start time, or “t-Service-r17” in [TS 36.311v17.0.0] is intended for quasi-earth-fixed cells. We have made the following observations:

1. TimeUTC-r17 is a 39 bits parameter than ranges over ~1700 years starting from Jan 1 1900 with a granularity of 10 ms. We believe this is excessive for scheduling MO-traffic opportunities between paging opportunities and the parameter range could be reduced to a range of one week with a granularity of one second to significantly reduce the ASN.1 parameter size.
2. We suggest transmitting a list of timestamps, instead of just one, that can be up to X long to match the bit size of the ephemeris parameters (X=10 for the proposed range/granularity). This will allow for several MO-traffic opportunities to be scheduled for UEs in quasi-earth-fixed cells between scheduled paging opportunities (MT-traffic).
3. The parameter name “t-Service-r17” causes some confusion with regards to the purpose of the parameter, e.g. it seems to indicate a service period, so we suggest renaming it in some way to include “Start” – for example “tServiceStart-r17”.
4. If the Quasi-Earth-fixed cell scenario is extended with additional parameters that are specific to the scenario in future Release, it would be advantageous to gather the related parameters, eg. tServiceStart-r17 in a SEQUENCE that can be extended in future releases.

**…**

ASN.1 coding example for 2, 3, 4 above:

|  |
| --- |
| -- ASN1STARTSatelliteInfo-r17 ::= SEQUENCE { satelliteSAI-r17 CHOICE { ephemerisOrbitalParameters-r17 EphemerisOrbitalParameters-r17 sgp4EphemerisParameters-r17 SGP4EphemerisParameters-r17  earthFixedCellParameters-r17 EarthFixedCellParameters-r17 nonCriticalExtension SEQUENCE {}  } satelliteID-r17 INTEGER (0..255) OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL, ...} EarthFixedCellParameters-r17 ::= SEQUENCE { t-ServiceStart-r17 SEQUENCE( SIZE (1..10)) OF INTEGER (0..1048575) nonCriticalExtension SEQUENCE {}}-- ASN1STOP |

“

**Question 4.4: Do you agree to specifying the above “EarthFixedParameters-r17” type - for the earth-fixed scenario?**

Rapporteur’s notes: This specification makes three changes:

1. It embeds “t-ServiceStart-r17” in a “EarthFixedParameters-r17” type along with a empty SEQUENCE “noncritical extensions”, which allows for extensibility to this type for earth-fixed cells in future releases.
2. It redefines “t-ServiceStart-r17” from the type “TimeUTC-r17” an “INTEGER (0..1048575)” This defines a time difference ranging from 0 to ~12.1 days from the beginning of the current week (Mon, 00:00:00 UTC with a granularity of 1 sec) to the time that coverage starts.
This proposed type is 20-bits instead of the 39-bit TimeUTC-r17.
3. It allows for the transmission of a list of several “t-ServiceStart-r17” instead of allowing only a single “t-ServiceStart-r17” to be informed. This allows for more opportunities to transmit mobile-originating traffic. To match the size of the proposed ASN.1 type for SGP4 ephemeris then up to 10 such timestamps can be allowed per “EarthFixedParameters-r17”.

Additional: This does NOT exclude footprint parameters or beamID from being included in SIB32. Specific questions on footprint parameters and satellite / beam ID follow.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes | same as for EpochTime in Q4.3, does that means that the current UTC time should be known, i.e. SIB16 be broadcastIf we agree on this, we think the same should apply to t-Service in SIB3 (i.e. time when the serving cell stops service) |
| Ericsson | No | No need for the optimization of signalling multiple t-Service. We think it is really too late for these type of optimizations and we think that the UE would have to wake up to read system information occasionally to receive paging etc, so we do not really see the need for multiple t-ServiceStart.  |
| MediaTek | es |  |
| ZTE | Yes in principle | We have the further comments as below:* Same comments as Huawei for SIB16 and for t-Service in SIB3.
* For earth-fixed scenario, we understand the intention of above #3 change is to provide at most 10 (seems too many?) service start times for each satellite. From signalling perspective, the scheme seems less optimized. We are wondering whether the format can be [the first service start time + [periodicity](https://dict.cn/periodicity)] or [the first service start time + a list of offset], here each offset means the time offset between the current entry of service start time and the first service start time.
 |
| Qualcomm | No | This signaling structure is presented so badly.There should be only critical extension inside CHOICE.There is no need of having non-critical extension and extension marker together.earthFixedCellParameters-r17 Can be outside CHOICE and can be Need OR which is present probably in the case of fixed cell.But we are ok with multiple service times. |
| Lenovo | Yes with comments | For t-ServiceStart-r17 we share Huawei’s concern as it may be based on current UTC time, which is different from the Epoch\*. |
| Nokia | Yes | OK to have multiple service times which may save UE’s power consumption for SIB reading. |
| CATT | No | Have the same view with Ericsson that, it is too late to define a new structure. For the coverage prediction of earth-fixed cell, one t-Service is enough for one cell, and the t-Service should be associated with a specific cell.  |
| Google | Comments | We are fine with the CHOICE structure and the renamed tServiceStart-r17, but not sure about the critical/non-critical extension part. We don’t think it is needed to have multiple tServiceStart-r17 for the same satellite. |
| Xiaomi | No | In our understanding, for the quasi earth fixed scenarios, network only need to provide timing information and footprint parameters for UE to predict the discontinuous coverage, there is no need to provide ephemeris data additionally. So there is no need to match the t-service with the size of the proposed ASN.1 type for SGP4 ephemeris and the multiple service times is also not needed. |

## Satellite footprint parameters

RAN2#118-e agreement:

* RAN2 will include Satellite footprint reference location (coordinates) and coverage radius for earth-fixed cells (besides already agreed coverage start and end-times). RAN2 will discuss if elevation angle needs to be included for earth-moving beams.

This is in line with proposals made in [R2-2205598](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205598.zip) and [R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip). The following will discuss the schemes and parameterisation for satellite footprint parameters for the cases of earth-fixed (EF) cells and earth-moving (EM) cells.

### Reference point and radius (EF+EM)

In this scheme a reference point as a set of coordinates and a radius will define the edge of a beam (EF) or a cell (EM)

**Rapporteur’s proposal:**

Reference frame: WGS 84

Reference coordinates: Longitude and Latitude
 Range: 180.000 to 180.000

 Granularity: 0.00068664681 Deg (< 100 meter on Earth’s surface)
 Bits: 19 x2

Radius:

 Range 10 to 2560 km

 Granularity: 10 km.
 Bits: 8

So 46 bits in total, or 5.75 Bytes.

Question 4.5: Do you agree to the rapporteur’s proposal for refencepoint+radius signalling? And do you agree to allowing this footprint parameter to be sent in both the Earth-moving and Earth-fixed scenarios?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes | These footprint parameters are also beneficial for UE to predict Earth-moving coverages. |
| Ericsson | Comments | First of all, our understanding is what is being signalled is not beam coverage, but satellite coverage. This means that there will only be a single coverage parameter per satellite, and not multiple for each beam within a satellite. We are really confused by “*coordinates and a radius will define the edge of a beam (EF) or a cell (EM)*”. We understand that reference location and radius is what has been agreed for earth-fixed, but we cannot understand how this is used for Earth moving. We agree to this being used for earth-fixed.  |
| MediaTek | Yes |  |
| ZTE | Yes |  |
| Qualcomm | Yes but | Due to signaling overhead, beam edge radius may not be important to broadcast. Simply what it matters is coverage of a beam. The UE just needs to detect a beam, but it can select any cell found suitable. We do not see more optimization than this.For moving cell, the reference coordinates should correspond to the epoch time of the ephemeris so that the UE can project the reference coordinates at time t.  |
| Eutelsat | Yes with comment | - As long as they remain optional parameters- We have the same understanding as Ericsson that these parameters are for the overall satellite coverage as they are used for predicting UE wakeup time |
| Lenovo | Yes with comments | We share Ericsson’s view that it should be a single coverage parameter per satellite. Besides we prefer to use EM for moving cell, while if we use refencepoint+radius in moving cell, it may also necessary to indicate the velocity of the referencepoint as well. |
| Nokia | Yes with comments | We think reference point and radius is useful for both EMC and EFC scenarios. But for EMC it may be challenging to define the reference point as a location on Earth, because it keeps moving i.e., it may need to be complemented with a time stamp. Alternatively, the reference point can be given as a point/angle relative to the satellite’s position (e.g. under the nadir). If this is the case, then the reference point can be omitted which means NW only needs to provide the satellite radius.We share the view that only 1 set of parameters is given per SAI. However, we think it is NW implementation to decide it is satellite coverage radius or cell coverage radius. E.g., for EFC, it is cell radius to support the spot beam to cover an island. But for EMC, it is satellite coverage radius since one satellite may support multiple cells which can serve the UEs. |
| CATT | Comments | We agree that reference point and radius can be used for earth-fixed. But also not sure how this can be applied to earth-moving cell, maybe time information associated with the reference point is needed. |
| Google | Yes, but only for the earth-fixed scenario | We share the same view as Ericsson that the reference location and radius are only for the quasi-earth-fixed cell (i.e., they should only present inside the ‘earthFixedCellParameters-r17’ IE). |
| Xiaomi | Yes with comments | Agree with Ericsson that only a single coverage parameter is for one satellite. For earth moving cell, we are not clear how the reference location is implemented, and we have a concern it may lead the UE to predict the reference location based on some additional information. We agree it is used only for earth fixed cell. |

### Elevation angles (EM only)

In this scheme two elevation angles, define the cross-track (axis orthogonal to the direction of the satellite) footprint coverage width. In this scheme the elevation angles are given with regards to the satellite position. In [R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip) the following description is made:

If a single value is given, the “Right-” and “Left minimum elevation angles” are assumed equivalent. That is, the footprint is even around the satellite track. To describe a footprint coverage that is offset from the satellite track, two minimum elevation angle thresholds can be specified. The right minimum elevation angle is the rightmost (with reference to the satellite direction) elevation angle. The left being the leftmost. Both angles can be given from -70 to 70 allowing a leftmost elevation angle to be placed on the right side of the reference satellite. A “left minimum elevation angle” that is located to the right of the reference satellite is indicated by a negative sign on the elevation angle and equivalently for a “right minimum elevation angle” to the left of the reference satellite. See Figure Y.



**Figure Y**. Satellites travelling “into the paper”. The left satellite depicts the case of a footprint cross-section that is even around the nadir and so a single elevation angle “a” is necessary to describe the case. In this case a UE will be within the footprint if the minimum elevation angle the UE will experience during a satellite pass is greater than “a”. The satellite to the right projects a footprint to the left of the satellite: the “right minimum elevation angle”, “b”, is on the left of the satellite - it is measured as any other elevation angle, but assigned a negative sign. In this case a UE will be within the footprint if the minimum elevation angle the UE will experience during a satellite pass is greater than “a”, less than “b” and the UE is located on the left of the satellite pass.

**Rapporteur’s proposal:**

Reference point: Associated SGP4 satellite

Elevation angles:

 Range -70 to 70 Deg

 Granularity: 10 Deg
 Bits: 4 x2

So 8 bits in total.

**Question 4.6:** Do you agree to the rapporteur’s proposal for elevation angle as a footprint parameter? – to be allowed strictly for the earth-moving case.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSlicon | yes |  |
| Intel | no strong view | If Reference point and radius approach can be agreed, it seems not necessary to adopt another approach. |
| Ericsson |  | It seems like there are a lot of details that are assumed that we have yet to agree upon. We have for instance not even agreed to have multiple elevation angles. We would like to ask satellite operators whether there really is a use case why the satellites coverage would not be not radiating directly downwards (remember that there is no possibility of changing how the beams point or risk messing with UEs estimation algorithms). If it is the case, then we are fine to have two elevation angles. Otherwise we would prefer not to optimize and only have a single elevation angle to represent the satellite’s coverage.  |
| MediaTek | yes |  |
| ZTE | Maybe No | It’s still not clear what ambiguity would occur without such elevation angle for earth-moving case. We should try to avoid providing redundant information via SIB. |
| Qualcomm | No | On the earth surface, what the UE needs is a reference point and coverage radius of the footprint for simplicity. |
| Eutelsat | Yes | (Optional) |
| Lenovo | Yes | We prefer to use EM for moving cells rather than refencepoint+radius. |
| Nokia |  | We do not see a need for the elevation angle information if the (reference point + radius) is provided. However, use of elevation angle may result in less SI updates for the network.- If the reference point is agreed as “under nadir”, then NW may only need to indicate the radius, in this case ,there is no need to define the min elevation angle to define two mechanisms for the same purpose.- Otherwise, we think min elevation angle is better than (ref point + radius) for earth moving cell. |
| CATT | Yes | If Reference point and radius approach cannot be agreed for earth-moving case. |
| Google | Yes |  |
| Xiaomi |  | Prefer to define unified solution for earth moving cell and earth fixed cell if we decide to introduce foot print parameters for earth moving cell. |

## Other

### Satellite/Beam ID

A Satellite / Beam ID is suggested in R2-2206160. A satellite ID is suggested in [R2-2205143](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205143.zip).

**Rapporteur’s proposal:**

Include an **optional** satellite / beam ID

ID:

 Range 0 to 255

 Granularity: 1
 Bits: 8

So, 8 bits or 1 byte in total.

UE behaviour on receiving a list of non-ID’d SAI:

1. Discard all prior SAI (both non-ID’d and ID’d) and only keep the new non-ID’d SAI.
2. Discard all prior non-ID’d SAI and keep the new non-ID’d SAI along with any ID’d SAI.
3. Add the new non-ID’d SAI to the set of known SAI. It is up to UE implementation to discard old SAI.

UE behaviour on receiving ID’d SAI:

1. Discard all prior SAI (both non-ID’d and ID’d) and only keep the new ID’d SAI.
2. Discard all prior non-ID’d SAI and keep the new non-ID’d SAI along with any ID’d SAI.
3. Add the new non-ID’d SAI to the set of known SAI. It is up to UE implementation to discard old SAI.

**Question 4.7: Do you support an optional ID for satellites / beams as specified above? Please list your prioritization of the associated UE behaviour.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Example | Yes | We support an optional ID for both satellites (earth-moving scenario) and beams (earth-fixed scenario).Priorities: (C, B, A) and (F, E, D) |
| Huawei, HiSilicon |  | is the satellite ID only applicable to early fixed scenario as in R2-2206160 ?Globally, it is not clear to us the usage of the satellite ID. The reason is that, normally, delta configuration does not apply to broadcast signalling. i.e. the new contents of the SIB replaces the old contents (options A, D). However, the proposals here B.C, E, F seem to suggest otherwise |
| Intel | F | not clear in which scenario there is a non-ID’d SAI. |
| Ericsson | No | **We do not prefer to have optimizations at this point.** We prefer to signal satellite ID to identify the ephemeris/coverage of a satellite and that it is up to UE implementation how to process this information so we do not quite agree to the behaviour above. Huawei has a good point about delta configuration in broadcast signalling and we need to think about how to deal with this.  |
| MediaTek | Yes | Support satellite operators. Options (C) and (F) seems the best. |
| ZTE | Maybe No | Even we have mentioned a global satellite ID with one byte length in our contribution [R2-2205143], we are also not clear about the usage of such satellite ID.We agree with Huawei’s comments that, in legacy IoT, we support neither delta configuration in SIB nor concatenation of multiple identical SIBXs. From this perspective, a global satellite ID seems not useful.Is there any intention to support SIB segmentation in RRC layer? (as in IoT, the SIB size is limited so that not much satellites’ assistant information can be provided.). However, we hope this would not be supported in R17 as this may need many changes and have impacts on SIB change notification/SIB update procedure. |
| Qualcomm | Yes but | It is easy to refer and associate with neighbor cell list.Can’t the satellite ID be unique for a given PLMN? The UE should be able to store the valid ID of the valid ephemeris.If same satellite ID is broadcast, then off course the UE will replace it. |
| Eutelsat | See comments | At least for moving beams in Rel-17, we prefer always having an explicit satellite ID associated to each ephemeris set as:- benefits of not indicating a Sat Id are not obvious- pros and cons of the different options that would be resulting from not indicating a sat Id would have to be further evaluated. |
| Lenovo | Yes with comments | We can accept satellite IDs to be added, but if IDs can be associated to cells/cell list, then it is not necessary. |
| Nokia | Yes | We prefer to leave the handling of SAI to UE implementation (options C and F).  |
| CATT | Yes with comments | Have the same view with Lenovo. |
| Google | No | Prefer to not optimize this aspect (delta signalling for the broadcast configuration?) at this point.  |
| Xiaomi | See comments | We are not clear why the Satellite ID is needed since the cell id can be used to identify the neighbour cells.  |

### Validity duration for satellite Epoch

[R2-2205143](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205143.zip) suggests to have a validity duration for the earth-moving case in the order of minutes.

“… Moreover, during email discussion, companies mentioned the observation that the epoch times of the ephemeris information sent for different satellites is unlikely to coincide. Each advertised satellite will come with its own epoch time, which only indicates the time at which the TLE was determined.”

The rapporteur points out that the EPOCH is not the time at which a TLE is determined – it is the time at which the TLE was determined for, i.e., the EPOCH can lie in the future. The TLE is most accurate around the EPOCH. Creating and assessing TLEs with EPOCHs in the future involves sampling the future orbit of the satellite using numerical integration methods, which are extremely accurate.

**Question 4.8: Do you support a validity duration parameter should be included as an optional parameter in SIB32?**

1. If so, please remark on the range and granularity of the validity duration?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | FFS | We assume that the ephemeris will be updated before they become too inaccurate and that these updates will not be frequent (i.e stay accurate for several hours)so either updates are notified by the system information update procedure (see 4.9), and there is no need for a validitity time.Or the system information procedure is not used and an information on how long the UE can consider the information accurate is needed |
| Ericsson | No | We think there should not be a reported validity duration for the mean ephemeris. It is up to UE implementation. |
| MediaTek | No strong view |  |
| ZTE | Maybe No | We have similar view as Huawei and slightly prefer that network can trigger the legacy update procedure of SIB32 in time and the network may not need to provide the validity duration for each satellite.If validity duration is absent for a satellite, UE can assume this satellite is always valid till it’s updated. |
| Qualcomm | Yes | But default value has to be assumed if not provided, for example, a week based on SGP-4 epoch time. |
| Eutelsat | No | - Network should update ephemeris frequently enough so that a fresh-enough set should be available to the UEs- A UE should be able to estimate a wakeup time accuracy based on the used propagator type (here SGP4) and on the horizon of the computed wakeup. The UE can move the wakeup forward to compensate for the inaccuracy |
| Lenovo | FFS | If the validity time of mean ephemeris can be very long (e.g. weeks), we think it may not be necessary to have a validity time as NW will update it in time. |
| Nokia | No | Given the expected long validity of TLE it does not seem useful to complement the SAI with a validity duration. It may be sufficient to have some pre-defined values on the duration in specification. |
| CATT | No strong view | If included, the validity duration can be defined with a coarse granularity, like minute, ten minutes or hour.  |
| Google | No | Updating SIB32 does not occur frequently and hence the optimization is not that critical (can be moved to Rel-18). |
| Xiaomi | No | The mean ephemeris data will not be changed frequently, if network update the ephemeris data, the system information modification procedure is used. So the validity duration is not needed. |

Furthermore, R2-2205143 suggests using legacy notification procedure to signal changes in SIB32.

**Question 4.9: Should we define a, b, c or d?**

1. **UEs to only read SIB32 if changes are signalled by legacy procedure ie. in MIB. to save power?**
2. **UEs read SIB32 upon wake-up, but otherwise only if changes are signalled by legacy procedure**
3. **Up to UE implementation. Changes to SIB32 can be signalled by legacy procedure.**
4. **Nothing.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | FFS | see answer to Q4.8 |
| Ericsson | Not clear on the options | There is no need to indicate changes in SIB32. Addition or removal of satellites from the list does not affect UEs which already acquired SI.We expect that a UE should wake up regularly to detect paging etc.  |
| MediaTek | No | Not needed at this point. |
| ZTE | b | See answer to Q4.8. We just assume this is same as some legacy SIBs, e.g., SIB3~SIB5. |
| Qualcomm |  | Isn’t there validity duration, Be it the signaled one or default one? |
| Eutelsat | See comment | IoT UEs would read SIB 32 at wakeup time and acquire ephemeris for predicting their next wakeup time before (e.g.) proceeding to data transmission then going back to deep sleep. As mentioned by Ericsson, MediaTek, there seems no need to indicate change to this SIB. |
| Lenovo | FFS | Not quite sure about the necessity. Could be UE implementation. |
| Nokia | See comments | Changes to SIB32 should be excluded from legacy “SI change” procedure. As a satellite passes over an area the content of SIB32 will change to reflect that different future satellites will cover the different parts of the area. In our understanding, it can be left to UE implementation to ensure they obtain the SIB32 during the time the satellite provides service to the UE. |
| CATT | b |  |
| Google | c | It can be left to UE implementation in Rel-17. |
| Xiaomi | C  | We are not clear why we need specify the UE behaviour for reading SIB32.  |

### Other

**Question 4.9: Feel free to raise any other points – any additional parameters or behaviour that is essential for discontinuous coverage in Rel-17 that has not been considered.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson |  | In 36.304 we have the following editor’s note: Editor's Note: FFS which parameters may be used for determining out of coverage and how network can configure that a UE may determine that it is out of coverage, i.e. through configuring SIB32 or not.We think that a UE may **only** use discontinuous coverage if SIB32 is signalled, otherwise the UE shall not be allowed to sleep.  |
| ZTE |  | Can agree with Ericsson for the mentioned issue. |
| Nokia |  | The proposed SAI is useful, but also leads to a large payload (EFC example): 205 (SGP4) + 20 (t-ServiceStart-r17) + 46 (reference point + radius) + 8 (satellite/beam ID) = 279 bits.NB-IoT has a maximum SIB size of 680 bits i.e. just 2 sets of SAI can fit. There may be a need for RAN2 to investigate segmentation of the SIB32 |
|  |  |  |
|  |  |  |
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# ASN1 proposals (TN)

 The following structure is based on an acceptance of all proposals of R2-2206160.

|  |
| --- |
| -- ASN1STARTSystemInformationBlockType32-r17 ::= SEQUENCE { satelliteInfoList-r17 SatelliteInfoList-r17 OPTIONAL, -- Need OR nonCriticalExtension SEQUENCE {} OPTIONAL, ...}SatelliteInfoList-r17 ::= SEQUENCE (SIZE (1..maxSat-r17)) OF SatelliteInfo-r17SatelliteInfo-r17 ::= SEQUENCE { satelliteSAI-r17 CHOICE { sgp4EphemerisParameters-r17 SGP4EphemerisParameters-r17  earthFixedCellParameters-r17 EarthFixedCellParameters-r17 nonCriticalExtension SEQUENCE {}  } satelliteID-r17 INTEGER (0..255) OPTIONAL, satelliteFootprintParameters-r17 SatelliteFootprintParameters-r17 OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL,} EarthFixedCellParameters-r17 ::= SEQUENCE { t-ServiceStart-r17 SEQUENCE( SIZE (1..10)) OF INTEGER (0..1048575) nonCriticalExtension SEQUENCE {}}SGP4EphemerisParameters-r17 ::= SEQUENCE { inclination-r17 INTEGER (0..2097151) periapsis-r17 INTEGER (0..2097151) longitude-r17 INTEGER (0..4194303) anomaly-r17 INTEGER (0..4194303) eccentricity-r17 INTEGER (0..16777215) meanMotion-r17 INTEGER (0..17179869183) revNoEpoch-r17 INTEGER (0..131071) bStar-r17 BIT STRING (23) epochStar-r17 INTEGER (-1048575..1048575)} SatelliteFootprintParameters-r17 ::= SEQUENCE { elevationAngleR-r17 INTEGER (-7..7) OPTIONAL, elevationAngleL-r17 INTEGER (-7..7) OPTIONAL, refPointX-r17 INTEGER (X1..X2) OPTIONAL, refPointY-r17 INTEGER (Y1..-Y2) OPTIONAL, refRadius-r17 INTEGER (1..200) OPTIONAL, nonCriticalExtension SEQUENCE {} OPTIONAL,}-- ASN1STOP |

**Question 5.1: Please provide views on the above ASN.1 specifications structure without regard to the parameters, which are to be discussed in section 4. Are you okay with:**

1. SAI type as a CHOICE per satellite/beam.
2. earthFixedParameters-r17 SEQUENCE to hold parameters for the EF scenario – to ensure extensibility.
3. EF parameters as a list of parameters (timestamps) instead of a single instance (single timestamp).

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon |  | it is possible to have mix deployment, earth fixed and earth moving ? if no, the CHOICE would be better moved out of the satelliteInfo element. i.e. provided at the list levelOn ASN.1 aspect, nonCriticalExtension cannot be used in sub-element, extension marker ‘…’ are used instead.However, extension markers are not recommended in element of a list due to the ‘multiplied’ signalling overhead. Instead when extension are needed, parallel are created. In summary, only the top level nonCriticalExtension and extension marker ‘…’ should be kept. Other pure ASN1 details, e.g. Need Code, can be sorted out by the CR rapporteur  |
| Ericsson |  |  36.331 rapporteur can implement it according to the agreements later. The above excerpt needs some re-working. a. We have so far only been talking about satellite coverage and not beam coverage. We do not want this optimization. c. Discussed above, but we prefer not to do this optimization at this point. |
| MediaTek | Yes, but | Agree in principle. The details could be implemented by 36.331 rapporteur |
| Qualcomm |  | Let the rapporteur handle this.  |
| Lenovo |  | Discuss in 36.331 implementation. |
| Nokia |  | The ASN.1 provided before question 4.4 included also ephemerisOrbitalParameters. It will be beneficial if that is excluded as also proposed in the above proposal for question 5.1. |
| CATT | No |  |
| Google |  | We are fine with the first bullet (a), but think the details/implementation can be handled by the rapporteur after the discussions above are concluded. |

# Conclusion

TBD, TP for CR to be written based on replies. TPs (ASN.1 code) in section 5 are currently based on all proposals being agreeable.

# References

1. [R2-2205933](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205933.zip) "Email Discussion Report [Post117-e][906][IoT-NTN] Non-Continuous Converge”, MediaTek Inc.

1. [R2-2206160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2206160.zip) “ASN.1 proposal for satellite assistance information for prediction of discontinuous coverage”, Sateliot, GateHouse, Mediatek, ESA, Eutelsat, Hispasat, Hughes/Echostar, Inmarsat, Ligado, Novamint, Omnispace,
2. [R2-2205598](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205598.zip) “Assistance Information for Predicting the Discontinuous Coverage”, Google Inc.
3. [R2-2205143](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205143.zip) “FFS and RILZ302, H000, O302 etc for SIB32”, ZTE Corporation, Sanechips

1. [R2#118-e](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Inbox/Chairs_Notes/R2_118-e%20Chair%20Notes%202022-05-10%200600%20UTC.docx) “Monday online seesion, chair’s notes”