**3GPP TSG-RAN WG2 Meeting #117-e R2-22xxxxx**

**Online, Feb 21st – March 03rd, 2022**

**Agenda item: 9.2.3**

**Source: MediaTek Inc.**

**Title: [AT117-e][015][IoT-NTN] Miscellaneous Issues (MediaTek)**

**Document for: Discussion and Decision**

# 1 Introduction

This document is aimed to make a report of the email discussion on IOT NTN miscellaneous issues:

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| * [AT117-e][015][IoT-NTN] Miscellaneous Issues (MediaTek)        Scope: Based on R2-2203721 (and related summarized input), Include OI 2.13 and OI 2.14 from AI 9.2.5, and progress the following:  - P3 on cell reselection priority  - Location Reporting in IoT-NTN, and kick this part off as soon as LS reply is received (e.g. for NB-IoT), and/or as soon as relevant progress is achieved for NR NTN (e.g. for eMTC).  - UE report of remaining GNSS validity duration (Chair comment: this is a R1 agreement and can thus be followed, however the R1 agreed range might not be sufficient for this reporting to be useful, suggest to discuss this).  - For Prediction of discontinuous coverage: Can attempt to address the earlier defined FFS: *FFS whether additional assumptions (like averaging time) need to be clarified, e.g. to have predictable performance*.  - For Prediction of discontinuous coverage: additional new parameters, like satellite footprint reference location on ground and coverage radius (condition that they shall be defined without RAN1 involvement).  - Determine agreeable parts, Aim to agree less controversial points offline (with no CB). Identify CB points.  Intended outcome: Report  Deadline: In time for first on-line CB W2 Tuesday, later CB TBD. |

# 2 Contact Information

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| --- | --- | --- |
| **Company** | **Name** | **Email** |
| MediaTek | Abhishek Roy | Abhishek.Roy@mediatek.com |
| Ericsson | Jonas Sedin | Jonas.sedin@ericsson.com |
| Intel | Tangxun | xun.tang@intel.com |
| Apple | Pavan Nuggehalli | pnuggehalli@apple.com |
| Transsion Holdings | Wen wu | wen.wu5@transsion.com |
| Lenovo | Min Xu | xumin13@lenovo.com |
| Huawei, HiSilicon | Odile Rollinger | odile.rollinger@huawei.com |
| Spreadtrum | Xu Liu | xu.liu1@unisoc.com |
| Xiaomi | Xiaolong Li | lixiaolong1@xiaomi.com |
| Nokia | Ping Yuan | Ping.1.yuan@nokia-sbell.com |
| ZTE | Ting Lu | lu.ting@zte.com.cn |
| GateHouse | René Brandborg Sørensen | rbs@gatehouse.com |
| Sateliot | Ramon Ferrús | ramon.ferrus@sateliot.space |
| InterDigital | Brian Martin | brian.martin@interdigital.com |
| Inmarsat | Luca Lodigiani | Luca.lodigiani@inmarsat.com |
| NEC | Yuhua chen | Yuhua.chen@emea.nec.com |
| Eutelsat | Rene Faurie | rfaurie-LS@sfr.fr |
| Sequans | Olivier Marco | omarco@sequans.com |
| CATT | Xiangdong Zhang | zhangxiangdong@catt.cn |

# 3 Discussion (Phase I)

3.1 Prioritize TN vs NTN Frequencies

**OI 2.3 Whether existing offset are sufficient to prioritize TN vs NTN frequencies**

Out of 5 contributions (R2-2202414, R2-2202729, R2-2202747, R2-2203002 and R2-2203453), 4 contributions (R2-2202414, R2-2202729, R2-2203002 and R2-2203453 suggested that the same existing offset are sufficient to prioritize TN over NTN frequencies. Only one contribution R2-2202747 suggested using new offset. Note that this is also discussed and recently agreed in NR-NTN [1] with the following agreement: **“2. No further enhancement on cell reselection priority in NTN. Remove the corresponding FFS from 38.304 CR.”** Hence, based on these, the rapporteur asks the following question:

**Question 1: Do companies agree that IoT-NTN can use NR-NTN agreements that “No further enhancement on cell reselection priority in NTN”?**

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| **Company** | **Agree/Disagree** | **Comments** |
| Ericsson | Agree | Yes, this is in line with NR NTN. And this would be sufficient to prioritize TN over NTN and NTN over TN (this was discussed in NR NTN, but we doubt it is needed). |
| Intel | Agree |  |
| Apple | Agree |  |
| Transsion Holdings | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| Huawei, Hisilicon | Agree |  |
| Spreadtrum | Agree |  |
| OPPO | Agree | The legacy reselection priorities can enable prioritization of TN over NTN frequencies by implementation. Hence, we think no need to consider any further enhancement in Rel-17 as same as NR NTN. |
| Xiaomi | Agree |  |
| Nokia | Agree | No further enhancements on cell reselection priority for IoT-NTN in Rel-17. |
| ZTE | Agree | We have mentioned several times that priority-based cell reselection is not supported for NB-IoT. This is difference from NR NTN.  But if there is common understanding that TN and NTN network would be deployed on different frequencies (even they may be on overlapped band), we can agree the existing mechanism can handle the issue, no need of further enhancement. |
| GateHouse | Agree |  |
| InterDigital | Agree |  |
| Inmarsat | Agree | It is very likely that NTN and TN may be deployed in different frequency bands, but may have partially overlapping frequency. We can agree that the current mechanism is probably sufficient. |
| NEC | Agree | We are fine with legacy mechanism in this release |
| Eutelsat | Agree |  |
| Sequans | Agree |  |
| CATT | Agree |  |
| MediaTek | Agree |  |
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**Rapporteur Summary**

All the 20 participating companies agree that IoT-NTN can use NR-NTN agreements that “No further enhancement on cell reselection priority in NTN”.

**Proposal 1: No further enhancement on cell reselection priority is needed in IoT-NTN.**

2.2 Reporting GNSS Validity

The joint (co-source) contribution in R2-2203530 has mentioned concerns about RAN2 116bis-e agreements on GNSS validity. According to this contribution it would make IoT NTN challenging for network operations if the network is not aware of GNSS validity duration. According to this contribution if the GNSS validity timer is set to a low value by the UE and the UE goes to idle mode without the network being aware and the network then attempts to reach the UE there could be problem. When UE is unreachable, it is difficult for the network to know what to do with the UE resources and there is a risk that significant resources are wasted on UEs that have gone to idle mode. Hence, it is suggested that UE reports the remaining GNSS validity duration to the network, following the RAN1 agreement:

**Agreement**

The UE autonomously determines its GNSS validity duration X and reports information associated with this valid duration to the network via RRC signalling.

* X = {10s, 20s, 30s, 40s, 50s, 60s, 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 60 min, 90 min, 120 min, infinity}

Based on these discussions the rapporteur would like to raise the following question:

**Question 2: Do companies agree** **that UE needs to report the remaining GNSS validity duration to the network?**

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| **Company** | **Agree/Disagree** | **Comments** |
| Ericsson | Agree | RAN1 made the agreement to report it and they would not have introduced the GNSS validity duration without the reporting. As stated in the contribution above, using this duration, the network knows when to release the UE so that there is no state mismatch and the network can prioritize UEs with a short duration. This is needed for the network and we do not think that it is an optimization.  Regarding chair comments:  *(Chair comment: this is a R1 agreement and can thus be followed, however the R1 agreed range might not be sufficient for this reporting to be useful, suggest to discuss this).*  As the point of the reporting is to give the network an idea whether UE might disappear soon or not, we believe the value range reported does not need to be super precise. To keep it simple, we can use the X values in the RAN1 agreement to be reported. However, we can further discuss the values needed. |
| Intel | Agree | This is in line with the RAN1 agreement in LS R2-2200084. |
| Apple | Agree |  |
| Transsion Holdings | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| Huawei, HiSilicon | - | We think this is an optimisation and not absolutely needed as RAN2 has agreed this would be a rare case.  We agree that the very low values, e.g. 10s and 20s, indicated in the RAN1 LS will be challenging for the NW but this is regardless of whether the timer is reported or not. We actually doubt it can work at all, at least in NB-IoT.  Considering the large support and the RAN1 agreement, we will follow the majority, but we expect the changes to be kept simple and no additional optimisations. |
| Spreadtrum | Agree |  |
| OPPO | Agree with comments | As PUSCH may suffer from HARQ retransmissions, reporting the remaining valid duration may be problematic as when eNB successfully decodes the PUSCH, the exact remaining invalid duration may be actually shortened and the reported one would be obsolete. We think it would be reasonable to report an absolute invalid time point and in this way it will not be impacted by any retransmissions. |
| Xiaomi | Disagree | In RAN2#116bis meeting, the agreements was made as follows:  *UE need to have a valid GNSS fix before going to connected. RAN2 assumes that the UE may need to re-aquire the GNSS fix right before establishing the connection (regardless if previously valid or not), if needed to avoid interruption during the connection.*  Based on the agreements, the GNSS should be valid during the RRC connection, so it is not necessary to report the remaining GNSS validity duration to network.  And there is no above RAN2 agreement when RAN1 made the agreements on GNSS validity duration reporting, so RAN2 can explain it in the reply LS to RAN1. |
| Nokia | Agree | NW should have the knowledge of GNSS status to enable its scheduling (including resource release) according to RAN1 LS (R1-2112848), otherwise, NW may have scheduling failure and resource waste since UE will stop its UL transmission if GNSS is invalid. |
| ZTE | Agree | Agree with Ericsson. |
| GateHouse | Agree | Agree with Ericsson’s proposal |
| InterDigital | Agree | As it is a RAN1 agreement we can follow this. |
| Inmarsat | Agree | This is important because a UE might go into idle mode whilst it’s moving, therefore the GNSS validity depends on the mobility speed. If the network doesn’t know that the UE may have moved, and thus its previously reported GNSS position is not valid anymore, this could indeed be a problem. Similarly if the UE is not expected to move much or at all, resources could be wasted if the GNSS validity timer is not increased.  The GNSS validity should be determined by the UE – how is left to the UE implementation (potentially even based on distance moved or velocity) – but should definitely be reported to the network. |
| NEC | Agree |  |
| Eutelsat | Agree |  |
| Sequans | Agree | As agreed by RAN1. |
| CATT | Disagree | Have the same view with Xiaomi, and we wonder why the UE will let the timer expire. |
| MediaTek | Neutral |  |

**Rapporteur Summary**

Out of the 20 participating companies, 16 companies have expressed their support UE needs to report the remaining GNSS validity duration to the network. 3 companies are against this and one company has taken a neutral stand. Hence, based on the majority of the companies, the rapporteur suggests the following agreement:

**Proposal 2: RAN2 will follow the RAN1 agreement that UE will report the remaining GNSS validity duration to the network. FFS: If the values of RAN1 agreement can be used.**

3.3 Discontinuous Coverage

Discontinuous coverage was discussed during RAN2 117-e online session on Feb-21 and the following agreement is made:

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| * RAN2 assumes that for Discontinuous Coverage, network can signal mean ephemeris parameters (for neighbors and potentially serving satellite for coverage prediction purpose), using the same (already introduced) ephemeris format. UE can always assume these are mean values and It is up to the network implementation to derive this mean value (and any trade-off between instantaneous and mean values if needed). FFS whether additional assumptions (like averaging time) need to be clarified, e.g. to have predictable performance. |

Hence, based on the above agreement, n order to make some progress on the FFS, the rapporteur would like to ask the following question:

**Question 3: Do companies agree that the additional assumption need to be clarified for a predictably better performance? If “agree” then companies are requested to mention any such additional assumptions (like averaging time etc.).**

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| **Company** | **Agree/Disagree** | **Comments** |
| Ericsson | - | We assume the additional information would be how long the ephemeris would be valid, similar to the validity duration, but with a much longer duration. If companies for instance want to introduce a parameter that indicates how many hours {1,2,3…, 24} that an ephemeris for discontinuous coverage would be considered valid, we are fine with this. Otherwise state the maximum time that a UE can use an ephemeris value could also be fine for us.  Satellite companies can also voice whether this would be useful. |
| Intel | Disagree | It’s up to NW implementation to generate this “mean” ephemeris. And this “averaging time” is similar to the validity duration, i.e. when it is longer than the averaging time the ephemeris is outdated. If this averaging time information is needed, we can reuse the validity duration in SIB for this purpose. |
| Apple | Agree | We would be fine to introduce a parameter as Ericsson suggests to indicates for how long the ephemeris is considered valid. We think reusing the currently defined validity duration is not practical (since it is likely tailored for the “instantaneous” ephemeris of the serving cell) |
| Transsion Holdings | Disagree | We are not sure how the additional “mean” value can be used. |
| Lenovo | Agree | Can be considered if nedded |
| Qualcomm | Agree | It is not clear at what accuracy these parameters will be derived. Some indication of validity is helpful.  For discontinuous coverage, it should be valid until the satellite coverage appears in the area. |
| Huawei, HiSilicon | Disagree | The benefit of signaling the average time is unclear and would need to be justified |
| Spreadtrum | - | It is up to network implementation to generate the mean ephemeris parameters and to determine the averaging time. |
| OPPO | Disagree | We don’t see the need of additional assumption such as averaging time. It could be up to NW implementation to update the parameters in time in order to ensure the predictable performance. |
| Xiaomi | Disagree | If the mean ephemeris data is invalid, it should update it and inform UE based on SI modification procedure. |
| Nokia | Disagree | Agree with Huawei. More information is needed to justify the benefit. |
| ZTE | Disagree | We agree with Huawei that the benefit and complexity of providing the mean ephemeris data is unclear and would need to be justified.  Our initial comments during online meeting is to clarify whether additional information is needed if network provides mean ephemeris data. For example, as mean ephemeris data is an average value over a period of evaluating time, we are not sure whether UE needs to know how long the evaluating time is, 10 minutes or 1 hour? Without this information, will it affect the prediction accuracy of discontinuous coverage in UE side? Things are not clear as no specification on how the UE make use of mean ephemeris data.  Proponents of mean ephemeris data indicate mean ephemeris data can be supported without any additional impacts. We worry about this. And if additional information is still needed, we think we’d better stick to use [instantaneous](https://dict.cn/instantaneous) ephemeris data. |
| GateHouse and Sateliot | - | We would like to clarify that the concept of “mean” in the name “mean orbital elements” does not refer to a numerical average (i.e. mean) of a sampling of the instantaneous orbital elements (see [Ref1](https://help.agi.com/stk/index.htm#stk/vehSat_meanElements.htm)). Therefore, there is no need on having assumptions related to the “averaging time”.  However, “mean orbital elements” are values calculated to fit a set of observations using a specific orbital model that accounts for specific perturbations effects. For example, the mean elements provided in a NORAD TLE are based specifically on the SGP4/SDP4 orbital model and, as such, those mean values can only be used with a SGP4 propagator and cannot be inserted into other propagators using e.g. osculating elements (see [Ref](https://agiweb.secure.force.com/faqs/articles/Keyword/Can-I-use-the-values-from-a-Two-Line-Element-set-TLE-with-STK-s-other-propagators-Two-Body-J2-HPOP?retURL=%2Ffaqs%2Fapex%2Ffaq&popup=true)2).  So, the prediction accuracy depends on: (1) the type of mean orbital elements and associated propagators being used and (2) how “old” are the mean orbital parameters being used. Illustrative prediction accuracies using (instantaneous orbital parameters + basic Keplerian propagation) and (SGP4 mean elements + SGP4 propagation) were collected in our previous contribution  <https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201017.zip>.  In contrast to the instantaneous orbital parameters used for UL pre-compensation, it worth stressing that the values of the “mean orbital elements” for long-term prediction are much more static over time so that they can be transmitted/updated at much lower frequency via the SIB signalling (i.e. no need to send the “mean orbital parameters” every 1-2 seconds as it is necessary for the case of instantaneous parameters). Indeed, mean element values can be valid for periods of tens of hours or even days so that, once a UE acquires the “mean orbital elements” for a given satellite, it may keep using it for several days for pass prediction.  Therefore, if mean orbital elements are going to be used in the new SIB, what could be necessary to specify along with the mean orbital elements is:   * The type of mean orbital elements being provided * The time when these mean orbital elements were computed (which indirectly determines its usability/validity) * The satellite to which the mean elements belong to. |
| InterDigital | Disagree | It’s up to UE implementation how to estimate the discontinuous coverage so there won’t be predictable performance anyway as there is no UE requirement. |
| Inmarsat |  | Whilst this is definitely an interesting approach to help the UE with discontinuous coverage in a LEO scenario, it is a bit too simplistic and not sufficient to cover more realistic cases where the availability of the next satellite beam/cell is not determined exclusively by the next satellite overpass, but rather by a beam illumination scheme (regardless if same or different satellite, regardless if LEO or GEO), in which case it would be based on dwell time (coverage time) of the current serving cell and time at which the next cell becomes available. |
| NEC | Agree | Satellite operator should have more expertise to make voice on this. our current understanding is that extra information (e.g., type of the ephemeris information) would be needed considering IoT UE needs to know how accurate the predication will be after hour/days sleeping and hence UE can plan to wake up with right time advance/margin |
| ESA | Agree | The validity time for ephemeris data is an important information. As mentioned by Sateliot/GateHouse, the update rate is less frequent than the agreed SIB for UL synch, and ephemeris data with validity time for several hours/days can be dissiminated. |
| Eutelsat | Agree - See comment | Agree with GateHouse / Sateliot with following comments:  - Averaging time is NOT relevant  - Type of provided ephemeris is needed for identifying the matching orbital model for right computation at the UE.  - Age, Epoch time or timestamp of ephemeris is useful for determining the uncertainty of a prediction, allowing the UE to wake up earlier enough for compensating the estimated uncertainty  - Satellite identification (was - presumably - implicitly assumed already) |
| Sequans | Maybe | What needs to be clarified is the validity duration of this information. |
| CATT | Agree |  |
| MediaTek | Agree | Agree with comments of Gatehouse/Sateliot that satellite-id, epoch time and type of mean orbital parameters are needed. |

**Rapporteur Summary**

Out of the 20 participating companies, 12 companies (8 companies explicitly mentioned and 4 companies mentioned in their comments) have agreed with the necessity of some additional information regarding the validity of the mean ephemeris. 8 companies have disagreed that some additional information regarding the validity of the mean ephemeris is needed. Hence, looking into the comments from the satellite operators, the rapporteur proposes the following proposal for discussion:

**Proposal 3 (for discussion): Additional assumption or information about satellite id, ephemeris type and epoch time will be provided with the ephemeris information.**

Another major open issue in Discontinuous Coverage is to decide on “**whether additional new parameters like satellite footprint reference point on ground, satellite coverage radius can be used**”. A set of 13 contributions (R2-2202352, R2-2202458, R2-2202559, R2-2202589, R2-2202621, R2-2202748, R2-2202931, R2-2203001, R2-2203081, R2-2203223, R2-2203258, R2-2203293 and R2-2203453) are submitted on this Discontinuous Coverage. All the contributions suggested use of additional new parameters, like cell coverage or reference point on the ground for supporting Discontinuous Coverage. The rapporteur agrees that there is a considerable support from many companies to include additional, new parameters for supporting Discontinuous Coverage. However, given the completion of IoT-NTN Work Item (WI) in RAN1, RAN2 needs to define and include any such additional new parameters without any RAN1 involvement. Hence, the rapporteur asks the following question:

**Question 4a: Do companies agree that RAN2 can include some additional, simple, new parameter(s) without any RAN1 involvement.**

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| **Company** | **Agree/Disagree** | **Comments** |
| Ericsson | Agree | We think RAN2 can introduce this without RAN1. We are not sure what RAN1 can help us with here, since the parameters suggested are anyways quite simple. |
| Intel | Agree | We think satellite coverage radius is a simple parameter as it is per satellite, but not per cell. And there is no RAN1 impact. |
| Apple | Agree | Parameters like footprint reference point and radius can be specified by RAN2 without RAN1 involvement. |
| Transsion Holdings | Agree | So far we don’t see anything need RAN1 involvement. |
| Lenovo | Agree | No need of RAN1 involvement. |
| Qualcomm | Agree | The average/mean ephemeris is agreed without any accuracy analysis from RAN1.  In NR NTN, RAN2 introduced distance threshold for UE to determine whether it is in cell edge without RAN1 involvement.  Approximate coverage radius can also be introduced. |
| Huawei, HiSilicon | Agree | We do not think this is related to RAN1 |
| Spreadtrum | Agree | We think the parameter footprint reference point and radius can be specified by RAN2 independently without any RAN1 involvement. |
| OPPO | Agree | No need to involve RAN1. |
| Xiaomi | Agree |  |
| Nokia | Agree |  |
| ZTE | Agree |  |
| GateHouse and Sateliot | Agree | No need to involve RAN1 |
| InterDigital | Agree |  |
| Inmarsat | Agree - comments | Cell/beam coverage radius is far more important than satellite coverage radius because we need to account for satellites both GEO and LEO that have a dynamic beam configuration.  Single beam satellites are not too realistic anymore.  Satellite coverage radius may not be pre-determined at all in a realistic constellation design. |
| NEC | Neutral |  |
| ESA | Agree | No need for RAN1 |
| Eutelsat | Agree |  |
| CATT | Agree |  |
| MediaTek | Neutral |  |

**Question 4b: If the answer to Question 4a is “yes” (i.e., no RAN1 involvement), then the companies are requested to mention any such simple, additional parameter(s) and explain how these parameters can be defined and included without any RAN1 involvement. (Possible additional parameters include satellite coverage radius, elevation angle, satellite footprint reference point on ground, etc.)**

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| **Company** | **Additional Parameters** | **Comments** |
| Ericsson | 1) Coverage radius below satellite nadir for moving beams  2) Coverage radius and satellite footprint reference for earth-fixed cells | We think that the below parameters are roughly a compromise of most contributions on this issue:  1) Using a radius to characterize the coverage of a satellite is quite a typical, especially for LEO.  In the below figure the coverage of a LEO satellite at 600 km altitude can be seen and the red line would represent the coverage radius.  Chart  Description automatically generated  We think that this coverage could easily be characterized by a radius from the satellite nadir point as we would believe that for these satellite solutions it is most likely that the satellite would point its beams roughly directly downwards.  2) The coverage radius and satellite footprint reference locations. This can be used by the UE to estimate when a reference location will be illuminated using the ephemeris. The network would thus include one or two reference locations on what central location that upcoming satellite will point its beams towards. We can skip any type of elevation angle or time when these reference locations are illuminated and let UE estimate. |
| Intel | satellite coverage radius | It is a per satellite parameter, and the value range can reuse the beam footprint range in TR 38.821. As for satellite footprint reference, we think it is the sub-satellite point and the position can be calculated based on ephemeris. |
| Transsion Holdings | 1. coordinate of cell reference point on ground 2. the cell footprint size of the satellite | We think this values also be introduced by NR-NTN, we think we can reuse them |
| Lenovo | * coverage area information * minimum elevation angle | * cell’s coverage area information (e.g. cell center, radius) for quasi-fixed. * the minimum elevation angle from the satellite to cell center, and cell center (when the start/end time of satellite’s coverage is unavailable) for earth-moving. |
| Qualcomm | 1. cell center 2. ellipse or just circular radius | Obviously more information can be provided for more accuracy, like minimum elevation angle on both sides of center or ellipse.  We prefer ellipse coordinate, for example  Beam center coordinates C (x0, y0, z0)  Semi-major axis = a  Semi minor axis = b  Orientation major axis = phi  So using ellipse property, distance checking is  if (UE to focus F1 distance + UE to focus F2 distance) > 2a, UE can assume outside the ellipse or outside of the coverage. |
| Huawei, HiSilicon | a) coordinates of footprint reference point  b) coverage radius | Also start-time of incoming satellite’s coverage for Quasi-Earth Fixed satellites (already agreed) |
| Spreadtrum | 1. satellite footprint reference point on ground 2. satellite coverage radius 3. elevation angle | For fixed scenario, parameters a), b) are needed. But for moving scenario, not only parameters a), b) but parameter c) are needed. |
| OPPO | (1) Satellite coverage radius,  (2) Satellite footprint reference point on ground,  (3) Beam direction information for earth-moving cell | For earth-fixed cell, the satellite coverage radius and the satellite footprint reference point on ground are also needed. For the definition of Satellite coverage radius, we can follow the beam footprint range in 38821, or some inputs from satellite companies would be expected. For reference point, we can refer to the similar parameters, such as the ellipsoid-Point IE specified in TS 36.331, TS 37.355 (and TS 23.032), which is used for definitions of reference locations in NR NTN.  For earth-moving cell, one issue needs to clarify is that whether we can assume the satellite always transmits the beam perpendicular to the earth ground. If it is true, the sub-satellite point derived by ephemeris info could be used as satellite footprint reference point on ground. Therefore, satellite ephemeris orbital parameters and the satellite coverage radius are enough for the prediction of discontinuous coverage. But if we cannot always assume that, RAN2 may need to further study on the **beam direction information**, in addition to the satellite ephemeris orbital parameters and the satellite coverage radius. |
| Xiaomi | Satellite footprint reference location and coverage radius | For earth moving case, the parameters are not needed. |
| Nokia | * For earth-moving cell: satellite coverage radius * For earth-fixed cell: reference point and cell coverage radius | We would assume the reference points for moving cell are at Nadir, so it can be deduced from ephemeris.  For earth-fixed cell, to enable coverage prediction, we assume the timing information when a serving cell is going to stop service and the timing when an incoming satellite will provide service are available in UE. |
| ZTE | 1. Satellite coverage radius 2. Satellite footprint reference | If we can assume that satellite transmits the perpendicular beam to the earth ground, only coverage radius is needed. |
| GateHouse and Sateliot | 1. Type of orbital parameters 2. Satellite\_ID (for mean parameters) 3. Epoch time (for mean parameters) 4. Minimum elevation angle (for optional satellite coverage characterization) | In line with our response to Q3, in case mean orbital parameters are to be used, we envision the need of the following parameters:   * **Type of orbital parameters:** 3-4 bits to indicate the type of mean orbital parameters being broadcasted. * **Satellite ID**: A way to keep track of the satellite ID (5-6 bits allowing for the UE to retain/discriminate mean orbital parameters for 32-64 satellites). Higher number may not be necessary because the problem of discontinuous coverage is less relevant. * **Epoch time:** Time when mean orbital parameters where determined.   Moreover, another parameter could be considered to characterize the size of the satellite coverage footprint for the case of Earth-moving cells:   * **Minimum Elevation angle:** This can allow an UE to be able to discard in advance satellite passes not reaching such elevation angle and for which it will be highly unlikely to detect the satellite (i.e. the UE may not try cell search for those passes). This could be a single value but, in order to consider the more general case where the coverage of the satellite should not be necessarily symmetrical around Nadir, two values for minimum elevation angles can be given: one applicable to the furthest point rightmost of the satellite cross-track line and another applicable to the leftmost point of the satellite cross-track. A few bits (3-4) could be enough to encode each of these angles, considering a discrete number of possible angles (e.g. 10, 20, 30, 40, 50, …90).   Wrapping up, we envision the following contents for the new NTN SIB with Satellite Assistance Information (SAI) for the purpose of discontinuous coverage:  SIB\_SAI contents:   * Orbital parameters type (e.g. instantaneous, SGP4 mean elements, …) * Satellite coverage information type (e.g., none, minimum elevation angle for moving cells, …) * Satellite#1   + Orbital parameters (which may include “Satellite\_ID” and “Epoch time” if mean elements such as SGP4 are used or it could be just the 18-byte long RAN1 agreed format if oscullating parameters are used)   + Satellite coverage information: e.g. Minimum elevation angle (rightmost, leftmost) * … * Satellite#N   + Orbital parameters (which may include “Satellite\_ID” and “Epoch time” if mean elements such as SGP4 are used or it could be just the 18-byte long RAN1 agreed format if instantaneous parameters are used)   + Satellite coverage information: e.g. Minimum elevation angle (rightmost, leftmost)   We point out that it is simple to encode these parameters as optional in ASN1 encoding. Furthermore, information can be given for a large set of satellites in the same constellation by defining a self-referencing ASN1 sequence for SAI, and defining inheritance of orbital parameters for SAIs that do not explicitly include them. |
| InterDigital | Cell centre and radius |  |
| Inmarsat | 1. Cell/spot beam center reference point 2. Cell/spot beam ellipse coordinates | We think the satellite coverage parameters are not useful for earth-fixed cells and of limited usefulness for earth-moving cells.  Beam/cell center coordinates (x0, y0, z0) and Ellipse coordinates (semi-major axis, semi-minor axis and angle phi) of the beam as proposed by Qualcomm is the best approach as it covers the very likely case of non-circular spot beams.  If additional information such as minimum elevation on both sides of ellipse can be provided, this will significantly improve accuracy.  We also are of the view as suggested by Nokia that timing information of when serving cell will stop service and new cell will come in service are required for intermittent/discontinuous coverage operation. |
| GateHouse and Sateliot  (Additional comment) |  | Complementing our previous comment, we have inserted a table at the end of this section with a list of different types of “mean orbital parameters” that can be considered, detailing for each of them the contents and format to be included in the SIB and the possible propagator to use in the UE side.  The numerical predictive accuracy is in the order of hours for instantaneous orbital elements, days for the simpler mean element propagators (J2) and weeks for SGP4.  Additionally, we note that different parameters can be defined for the moving-cell and fixed-cell cases, eg. one can use “timings” while another utilizes ephemeris. |
| Eutelsat | See answer to Q3 | (For additional parameters, we would agree with majority views) |
| MediaTek | Minimum Elevation Angle | Agree with Gatehouse |
|  |  |  |

[GateHouse and Sateliot comment] Table X – Types of “mean orbital elements”, delineating possible associated contents/formats for SIB encoding and propagators on the UE side.

|  |  |  |
| --- | --- | --- |
| Type | Contents and format of the “orbital elements” within the SIB\_SAI | Possible propagator |
| Instantaneous orbital elements  *(NOTE: This is not actually mean elements, but can be considered as a possible option)* | **Contents:** (1) semi-major axis, (2) eccentricity, (3) argument of periapsis, (4) longitude of the ascending node, (5) inclination, (6) mean anomaly at epoch time,  **Format:** 18-byte orbital parameters format already agreed in RAN1  \*Epoch time is not transmitted. It is assumed to be the time that the SIB is received. | Propagator: Simple Keplerian motion, Two-body propagator |
| Kozai-Izsak Mean Elements | **Contents:** (1) semi-major axis, (2) eccentricity, (3) argument of periapsis, (4) longitude of the ascending node, (5) inclination, (6) mean anomaly at epoch time, (7) epoch time  **Format:** 18-byte orbital parameters format already agreed in RAN1 + 32 bit EPOCH (4 byte)  Total: 22-bytes | J2 propagator |
| Brouwer-Lyddane Mean Elements Short |
| Brouwer-Lyddane Mean Elements Long | **Contents:** (1) semi-major axis, (2) eccentricity, (3) argument of periapsis, (4) longitude of the ascending node, (5) inclination, (6) mean anomaly at epoch time, (7) epoch time  **Format:** 18-byte orbital parameters format already agreed in RAN1 + 32 bit EPOCH (4 byte)  Total: 22-bytes | J4 propagator   (Includes J2,J3) |
| SGP4 mean elements (extracted from e.g. NORAD TLE) | **Contents:** (1) Inclination, (2) RAAN, (3) eccentricity, (4) argument of perigee, (5) mean anomaly, (6) mean motion, (7) revolution number at epoch, (8) epoch time,  (9) First time derivative of the mean motion, (10) Second time derivative of the mean motion, (11) BSTAR drag term  **Format:** 18-byte orbital parameters format already agreed in RAN1 + 32 bit EPOCH + 4-bit revolution number + 33 bit ballistic coefficient + 24 bits second derivative of mean motion + 24-bit drag term = 18-byte orbital parameters + 11 byte SGP4 parameters + 4 byte EPOCH.  Total: 33-bytes | SGP4 propagator |

**Rapporteur Summary**

Out of the 19 participating companies, 17 companies agreed that RAN2 can include some additional, simple, new parameter(s) without any RAN1 involvement. 2 companies are neutral.

However, regarding the details of additional information, the companies’ opinions and suggestions are widely varied. While 11 companies have mentioned satellite coverage radius for earthmoving beams, many of the satellite operators have indicated that coverage radius is of limited use. 8 companies have also mentioned about the satellite footprint or reference location, especially for earth-fixed cells. On the other hand, satellite vendors and operators have explicitly mentioned about minimum elevation angle as additional information (besides satellite id, ephemeris type and epoch time).

Hence, based on these discussions, the rapporteur would like to make this proposal for discussion

**Proposal 4(a): RAN2 can include some additional, simple, new parameter(s) without any RAN1 involvement.**

**Proposal 4(b): RAN2 to select from one of the options mentioned below as additional new parameter:**

* + **Coverage radius and satellite footprint reference location (both for earth fixed beams and only cell radius for earth moving beams)**
  + **Cell center, along with major and minor axis of ellipse**
  + **Elevation angle (besides the information needed for mean ephemeris)**

3.4 UE’s Location Reporting

The major open issues in Location Reporting are the following:

**OI 2.13 [Other] UE location reporting in eMTC**

**OI 2.14 [Other] UE location reporting in NB-IoT**

A total 8 contributions (R2-2202414, R2-2202549, R2-2202729, R2-2203002, R2-2203052, R2-2203080, R2-2203193 and R2-2203453) are submitted in RAN2 117-e on this aspect. 3 contributions (R2-2202414, R2-2202729 and R2-2203453) suggested sending coarse location reporting before security establishment and location reporting by NAS. On the other hand, 2 contributions in R2-2202549 and R2-2203193, have suggested not to use location information in Rel-17 as UE reported location could be debatable and may require network verification. 3 other contributions in R2-2203002, R2-2203052 and R2-2203080 has suggested to wait for LS response from SA2/SA3 before further progress in IoT-NTN.

The rapporteur would like to note and mention that RAN2 had already spend a lot of time in discussion and making agreements on this issue in NR-NTN session. SA3 has mentioned not to use location report before security establishment. Two LSs are sent from RAN2: R2-2201881 and R2-2209158 for confirming about this location information report. Hence, the rapporteur suggests waiting for the LS response and check any progress and outcome in NR-NTN before discussing this in IoT-NTN – possibly in the Phase 2.

# 5 Conclusion

Based on the summary, the rapporteur categorizes the proposals into two categories: (A) Proposals for Agreement (B) Proposals for Discussion.

**(A) Proposals for Agreement**

**Proposal 1 (consensus): No further enhancement on cell reselection priority is needed in IoT-NTN.**

**Proposal 2 (17/20): RAN2 will follow the RAN1 agreement that UE will report the remaining GNSS validity duration to the network. FFS: If the values of RAN1 agreement can be used.**

**(B) Proposals for Discussion**

**Proposal 3: Additional assumption or information about satellite id, ephemeris type and epoch time will be provided with the ephemeris information.**

**Proposal 4(a): RAN2 can include some additional, simple, new parameter(s) without any RAN1 involvement.**

**Proposal 4(b): RAN2 to select from one of the options mentioned below as additional new parameter:**

* + **Coverage radius and satellite footprint reference location (both for earth fixed beams and only cell radius for earth moving beams)**
  + **Cell center, along with major and minor axis**
  + **Elevation angle (besides satellite id, ephemeris type and epoch time)**

# 6 References

1. R2-117-e Agenda v5.0
2. R2-2202352 Discussion on the additional new parameters for supporting discontinuous coverage for IoT over NTN Transsion Holdings
3. R2-2202414 Discussion on the remaining issue of IoT over NTN Spreadtrum Communications
4. R2-2202458 Discussion on additional parameters for Non continuous coverage Intel Corporation
5. R2-2202549 Location reporting in NAS Apple
6. R2-2202550 Support of discontinuous coverage Apple
7. R2-2202559 Additional issues on the support of the discontinuous coverage Qualcomm Incorporated
8. R2-2202562 Signalling of multiple TACs per PLMN in eMTC and NB-IoT Qualcomm Incorporated
9. R2-2202589 Satellite assistance information and exchange for discontinuity Prediction in IoT NTN Lenovo, Motorola Mobility
10. R2-2202615 UP leftover issues for IoT-NTN CMCC
11. R2-2202621 Discussion on open issues for support of Non continuous coverage CMCC
12. R2-2202729 Remaining Issues of CP Impact of IoT over NTN CMCC
13. R2-2202746 Remaining issues of user plane in IoT NTN ZTE Corporation, Sanechips
14. R2-2202747 Remaining issues of control plane in IoT NTN ZTE Corporation, Sanechips
15. R2-2202748 Remaining issues of discontinuous coverage in IoT NTN ZTE Corporation, Sanechips
16. R2-2202749 Remaining issues of UE capabilities in IoT NTN ZTE Corporation, Sanechips
17. R2-2202931 Discussion on discontinuous coverage Xiaomi
18. R2-2203000 Discussion on UP open issues in IoT NTN OPPO
19. R2-2203001 Discussion on the open issues of discontinuous coverage for IoT over NTN OPPO
20. R2-2203002 Discussion on Control Plane open issues for IoT NTN OPPO
21. R2-2203052 On remaining control plane issues for IoT-NTN Nokia Solutions & Networks (I)
22. R2-2203080 Further Discussion on the Open Issues of IoT-NTN Control Plane CATT
23. R2-2203081 Open Issue on UP and Discontinous Coverage CATT
24. R2-2203192 Issues related to IOT NTN RRC running CR Xiaomi
25. R2-2203193 Remaining issues of IOT NTN RRC Xiaomi
26. R2-2203222 OI 2.9: Signalling of multiple TACs per PLMN in eMTC and NB-IoT Huawei, HiSilicon
27. R2-2203223 OI 3.5: Discussion on non continuous coverage Huawei, HiSilicon
28. R2-2203258 On IoT NTN open issues for Discontinuous Coverage and User plane Nokia, Nokia Shanghai Bell
29. R2-2203293 (O1 3.5) Parameters for coverage gap prediction and Idle mode behaviour Interdigital, Inc.
30. R2-2203453 Control plane and discontinuous coverage aspects of IoT NTN Ericsson
31. R2-2203483 User plane aspects of NB-IoT and LTE-M in NTNs Ericsson
32. R2-2203530 On GNSS validity duration reporting Ericsson, Nokia, Nokia Shanghai Bell, Turkcell, NEC, Qualcomm, ZTE.
33. R2-2201881 LS on UE location during initial access in NTN
34. R2-2203386 Pre117-e][102][NTN] Idle mode open issues (ZTE)
35. R2-2203154 Pre117-e][NTN][101] RRC open issues (Ericsson)