**3GPP T****SG-RAN WG2 Meeting #121-bis R2-230xxxx**

**E-Meeting: April 17-26, 2023**

**Agenda item: 8.6.3.1**

**Source: Qualcomm Incorporated**

**Title: Report of [POST121][105][IoT NTN Enh] Neighbour cell assistance information**

**Document for: Discussion and Decision**

# Introduction

This document provides the report of the following email discussion.

* [POST121][105][IoT NTN Enh] Neighbour cell assistance information (Qualcomm)

Scope: Discuss the possible content of neighbour cell assistance information and whether this should be included in an existing or new SIB

Intended outcome: report of the email discussion

Deadline: Long

# Discussion

**Content of the neighbor cell assistance information**

RAN4 has sent LS in [1] indicating that following information is helpful for UE to perform neighbor cell measurements.

*Similar as NR NTN, the mobility and measurement requirements for IoT NTN apply provided that valid information for the neighbour/target cell is made available to the UE.*

Accordingly, the Rel-18 WID is updated to include the signaling details for neighbor satellite information.

In addition, the common TA parameters should also be provided as optional parameters as clarified by RAN4 in [1]. There are also discussions on time and location-based enhancements for neighbor cell measurements and cell reselection procedure, for which, additional information like beam information or reference location will need to be provided for the neighbor cell.

1. In addition to ephemeris and optional epoch time of the satellite associated with a neighbor cell, what other parameters can be optionally broadcast as neighbor cell assistance information?
2. Validity duration
3. Common TA parameters
4. For moving cell, footprint information
5. For fixed cell, satellite start time and stop time
6. Reference location and distance threshold/radius
7. Others
8. Note: List of frequen4cies/cells, satellite IDs are addressed in Q2 and Q3.

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| --- | --- | --- |
| Company | Options | Comments |
| MediaTek | 1,2,4,5 | Validity duration can be optional, as it can be absent when it is same as the serving cell.  For moving cell, (5) reference location and distance threshold/radius is similar to (3) footprint information. Hence, it seems that Option 5 cover for both earth moving cell and earth fixed cell and thus option 3 is not needed. |
| Qualcomm | 1,2, (3 or 5),4 | All these information are helpful and network can optionally provide to UEs. |
| Lenovo | 1,2,4 for all cells, and:  5 for fixed cells  3 or 5 for moving cells | We have not decided on what to be indicated for the moving neighbour cell and how it is represented. Both 3 and 5 are possible and we think it is better to have it open for now. |
| OPPO | 1 | For 2) common TA parameters, it is not needed for IoT NTN as there is no SMTC in IoT NTN and therefore no need for SMTC adjustment.  For 4), it is sufficient to have it for serving cell and no need for neighbour cells.  For 5), they are not needed for Idle mode UEs, but reference location may be needed for connected mode UEs, e.g. for conditional D1 event for CHO. |
| Apple | 1, 2, 4  5 for moving cells | Between 3 and 5 for moving cell, 5 seems simpler than 3. |
| Xiaomi | 1,2 | According to the LS from RAN4, only 1 and 2 are needed, the other parameters related to time and location-based enhancements for neighbor cell measurements can be discussed later when the corresponding agreements are made. |
| Intel | 1,2,4,5 | (5) is the detail of (3). |
| Samsung | 2 | (1): In order to decide this, there needs to be agreements on how such element would be used. We believe that sync validity duration cannot be present in the neighbouring cell info list – and this also includes the presence of the epoch time.  (2): To our understanding this would be required, but we can check in with RAN4 regarding this.  (3) – (6): For the enhancements on monitoring neighbouring cells related to what we are currently discussing, some other elements may need to be included. We think that those can be discussed separately to this discussion. |
| Nokia | 1,2  For fixed cells 4  For moving cell 5 | In our view for NB-IoT, additional information is to start the RACH access in target cell after RLF to minimise the time to start access. For this purpose 1 and 2 are sufficient. The connected mode measurements can be optimised if the UE knows the neighbour-cell start time. If the SIB contents to be optimised then this can be skipped as it is not essential for the base functionality. |
| ZTE | 1,2 (as required by RAN4)  4 (only start time, no stop time for neighbour satellites) | In last meeting, for connected mode measurement, RAN2 only agreed to introduce **serving cell** reference location and a distance threshold/radius for the new location-based trigger. There is no discussion and agreement about introducing information of neighbour satellites for the new trigger. From technical point of view, we think it may be too complicated for IoT NTN UE to consider both serving cell location and neighbour cell location. Therefore, we suggest not to introduce the location-based measurement information for neighbour satellites for IoT NTN.  However, for time-based trigger and also for earth-fixed cell case, even we also have no related agreement, technically it may be simple/beneficial to also consider the start time of neighbour satellites. Therefore, we are fine to discuss the start time in (4). But we don’t see any reason to consider the stop time of neighbour satellites.  Even we think the purpose of providing ephemeris information of neighbour satellites is different from that of providing time and location-based trigger information of neighbour satellites, we are fine to put all needed information in one place, e.g., in one set of assistant information of neighbour satellite. |
| Huawei, HiSilicon | 2, FFS on 1 (depends on whether a separate SIB is used) | For 2), we think it’s important for the UE to know the common TA parameters of neighbour cell, as required by RAN4.  For 1), we think the validity duration (and epochTime) of neighbour cell are necessary, but if they are eventually included in SIB31, it would be simpler to reuse that of the serving cell. If we introduce a separate validity duration field for neighbour cell, then it brings the discussion of whether the UE maintains a separate validity timer for each neighbour cell, and the UE behaviour when each of the validity timer expires. If the validity duration (and epochTime) are included in a new SIB, then a separate validity duration is needed.  For 3/4/5, there is so far no such agreement to introduce these information. Since the question is about the information in SIB, the time/location based CHO is not considered. For time based measurement initiation we think the stop time of serving cell is enough; for location-based measurement initiation, we think the reference location and distance threshold for serving cell is enough. No additional neighbour cell information is needed. |
| Nordic Semiconductor | 1, (3 or 5), 4 | If required by RAN4 then 2 need to be there as well. |
| Turkcell | 2 | For 1, it needs more clarification related how it’s used. For 3/4/5 we may need additional parameter. |
| CATT | 1,3,4(without stopping time) | For 2), have the same view with OPPO, more evaluation is needed.  5) may be the detail of 3). |
| Panasonic | 1, 2, 4, 5 | 3) differs from 5) in so far as the elevation angle information has been added to 3), but we don’t really see a need for that. If instead of 5) 3) would be adopted, that’s nonetheless okay for us.  Reference location and distance threshold of relevant neighbouring cells is required for a new (conditional) event D2 (but also for existing event D1) applicable to measurement initiation, cell reselection and (conditional) handover to a neighbouring cell with higher accuracy and well-spread reselections and handovers of high amounts of UEs.  We are proposing a new location-based event D2 (a modified version of event D1) as follows:  *Distance between UE and a reference location referenceLocation1 is smaller than configured threshold distanceThreshFromReference1 and distance between UE and a reference location referenceLocation2 of conditional reconfiguration candidate becomes shorter than configured threshold distanceThreshFromReference2.* |

In NR, the list of neighbor cells is provided which created long discussion on associating neighbor cell and corresponding satellite. In IoT NTN case, the other option is to provide list of satellite and include the frequency and list of cells under each satellite information. The absence of ephemeris can also be defined as it is possible that the neighbor cell is also associated with the serving satellite. An example is shown below.

SatelliteInfoList-r18 ::= SEQUENCE (SIZE (1..maxSat-r17)) OF SatelliteInfo-r18

SatelliteInfo-r18::= SEQUENCE {

satelliteId-r18 INTEGER (0..255),

ephemerisInfo-r18 CHOICE {

orbitalParameters-r18 EphemerisOrbitalParameters-r18,

epochTime-r18 SEQUENCE {

startSFN-r18 INTEGER (0..1023),

startSubFrame-r18 INTEGER (0..9)

} OPTIONAL -- Need OR

} OPTIONAL, -- Need OP

carrierFreqList-r18 CarrierFreqList-r18 OPTIONAL, -- Need OP

nta-CommonParameters-r18 SEQUENCE {

nta-Common-r18 INTEGER (0..8316827) OPTIONAL, -- Need OP

nta-CommonDrift-r18 INTEGER (-261935..261935) OPTIONAL, -- Need OP

nta-CommonDriftVariation-r18 INTEGER (0..29479) OPTIONAL -- Need OP

} OPTIONAL, -- Need OP

ul-SyncValidityDuration-r18 ENUMERATED {s5, s10, s15, s20, s25, s30, s35, s40,

s45, s50, s55, s60, s120, s180, s240, s900} OPTIONAL, -- Need OP

footprintInfo-r18 SEQUENCE {

referencePoint-r18 SEQUENCE {

longitude-r18 INTEGER (-131072..131071),

latitude-r18 INTEGER (-131072..131071)

} OPTIONAL, -- Need OR

radius-r18 INTEGER (1..256) OPTIONAL -- Need OR

} OPTIONAL, -- Need OP

serviceInfo-r18 SEQUENCE {

t-ServiceStart-r18 TimeOffsetUTC-r17 OPTIONAL, -- Need OR

t-ServiceStop-r18 TimeOffsetUTC-r17 OPTIONAL -- Need OR

} OPTIONAL -- Need OP

}

CarrierFreqList-r18 ::= SEQUENCE (SIZE (1..maxFreq)) OF CarrierFreqInfo-r18

CarrierFreqInfo-r18 ::= SEQUENCE {

FreqNeighCellList-r18 SEQUENCE (SIZE (1..maxCellInter)) OF PhysCellId OPTIONAL, -- Need OR

...

}

1. How should the list of frequencies and list of cells associated with a satellite be included?
2. Similar to NR, list of neighbor cells and associate each cell with the frequency and satellite information.
3. Similar to SIB32, list of satellites and include list of frequencies/cells for each satellite. Absence of ephemeris could mean serving satellite.

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| Company | Options | Comments |
| MediaTek | Option 2 | We think Option 2 is easier to maintain and understand. |
| Qualcomm | Option 2 | The corresponding cell list can be provided for each satellite. We agree it would be simpler. |
| Lenovo | Option 2 |  |
| OPPO | Option 2 |  |
| Apple | No strong views | We can go with the majority view. |
| Xiaomi | Option 2 | Prefer to align with SIB32. |
| Intel | Option 2 | ephemerisInfo-r18 is a CHOICE structure, and the second choice should be PVT instead of epoch time?  In IE CarrierFreqInfo-r18, there is no freq info.  We also wonder whether the case of “Absence of ephemeris” exists. Does it mean multiple satellite IDs share the same ephemeris data? |
| Samsung | Option 2 | Note that we do currently not have a list of frequencies/cells for each satellite for SIB32.  The structure above has some problems as there should be a choice between orbital and PVT parameters, not between epochtime and orbital parameters.  We think that there can be a choice structure of ephemeris to make it more explicit to reflect the same as serving cell, such as:  ephemerisInfo-r18 CHOICE {  stateVectors EphemerisStateVectors-r17,  orbitalParameters EphemerisOrbitalParameters-r17,  sameAsServingCell NULL  } |
| Nokia | See comments | It depends on the option selected for the additional information. |
| ZTE | None | We disagree Option 2 and strongly against to put carrier list (and also neighbour cell list) under the assistant information of each neighbour satellite. We cannot understand why there is saying “Similar to SIB32”? In SIB32, we have NO carrier/cell list.  With Option 2, it would cause much confusion on the relationship between the new SIB of neighbour satellites assistant information (let’s assume it’s SIBxx) and the legacy SIB3/SIB4/SIB5. Moreover, we assume there will be a lot of duplicate (carrier/cell) information in different messages, e.g., in SIBxx and SIB5. This is certainly undesired for IoT NTN.  We are also not so clear what exactly the Option 1 means? We think it’s different from the way in NR NTN.  We are open to discuss the way that:   * Firstly, to define a new SIB, e.g., SIBxx to include several sets of neighbour satellite assistant information. Each set of information can be tagged with a satellite ID. * Secondly, the neighbour cell info in SIB4/SIB5 can be extended to include satellite ID (As mentioned in Q3). By this way, we can correlate the existing neighbour carriers/cells information with the needed neighbour satellite assistant information. * We can further discuss how to handle the absence of neighbour satellite assistant information. As neighbour satellite assistant information for IoT NTN is not as critical as that for NR NTN, either way UE can perform legacy measurement even without satellite assistant information. Another way is that the serving satellite assistant information or another neighbour satellite assistant information can be applied. |
| Huawei, HiSilicon | list of satellites and include list of frequencies/cells for each satellite | We support to include list of satellites and include list of frequencies/cells for each satellite (Option 2), but that’s not “similar to SIB32”, rather, we think it’s “similar to NR”.  And if this option is chosen, satellite id is not necessary since the neighbour cells are already associated with satellite ephemeris. |
| Nordic Semiconductor | option 2 |  |
| Turkcell | Option 2 |  |
| CATT | list of satellites and include list of frequencies/cells for each satellite |  |
| Panasonic | See comment | We should decide in favour with a metadata-saving approach for indicating the relevant parameters of neighbouring cells first. Do we want to enable describing an entire satellite network or are we sticking to the current maximum number of 8 satellites?  A concrete proposal for saving overhead in conjunction with different numbers of neighbouring satellites to be covered we made with **R2-2300466**. Already in conjunction with neighbours in close proximity one would be dealing with different orbits and kind of phase shifts between the satellites in neighbouring orbits. |

It may not be possible to broadcast all ignallin satellites information due to TBS size limit. When configuring measurement in connected mode, it is possible that network may want the UE to perform measurement of the cell associated with the satellite whose information is not being broadcast. In this case network can provide all necessary satellite information via dedicated information. However, it is possible that the network wants UE to perform the measurement of the cell associated with the satellite whose information is already being broadcast, in this case ignalling overhead can be reduced by just providing satellite ID.

1. Do you agree to include satellite ID (as done in SIB32) such that this could be provided to UE via SIB3/4/5 or via RRC for connected mode measurements?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Mediatek | No strong view | Okay to go with the majority. |
| Qualcomm | Yes | This is nice to have. |
| Lenovo | Yes | OK to have |
| OPPO | No | We are not sure what neighbour cell’s information needs to be signalled to the UE for connected mode measurement since in LTE we don’t have PDD report and SMTC configuration. It would be good that proponents can provide detailed information and also the reason why this information is needed for connected mode measurement. |
| Apple | Yes | This indeed can give UE more information whether to check IoT NTN SIB to acquire the corresponding ephemeris data. |
| Xiaomi | Yes |  |
| Intel | No | Not sure if this case is real, i.e., “network may want the UE to perform measurement of the cell associated with the satellite whose information is not being broadcast”. If a neighbour cell is associated to a satellite, why not add the satellite info in SIB? |
| Samsung | Yes |  |
| Nokia | Yes | We think that some information can be provided via dedicated signalling for connected mode measurements. Moreover for NB-IoT UE, switching to SIB reading when the validity timer expires may interrupt the ongoing connection. RAN may decide to provide latest information based on current serving cell conditions known via CQI. |
| ZTE | Yes | We see this is the suitable way to finally introduce neighbour satellite assistant information for neighbour carriers/cells to facilitate the NTN cell measurement and reselection.  Moreover, with this way, we see no any reason to include carriers/cells list in the assistant information of neighbour satellites in the new SIBxx.  An example to extend SIB5 is as below:  SystemInformationBlockType5-NB-r13 ::= SEQUENCE {  //skip  [[ scptm-FreqOffset-r14 INTEGER (1..8) OPTIONAL -- Need OP  ]]  }  InterFreqCarrierFreqList-NB-r13 ::= SEQUENCE (SIZE (1..maxFreq)) OF InterFreqCarrierFreqInfo-NB-r13  InterFreqCarrierFreqInfo-NB-r13 ::= SEQUENCE {  //skip  [[ nsss-RRM-Config-r15 NSSS-RRM-Config-NB-r15 OPTIONAL, -- Need OR  interFreqNeighCellList-v1530 InterFreqNeighCellList-NB-v1530 OPTIONAL -- Need OR  ]],  [[ dl-CarrierFreq-v1550 CarrierFreq-NB-v1550 OPTIONAL -- Cond TDD  ]],  [[ interFreqNeighCellList-r18 InterFreqNeighCellList-NB-r18 OPTIONAL -- Need OR  ]]  }  //skip  InterFreqNeighCellList-NB-r18 ::= SEQUENCE (SIZE (1..maxCellInter)) OF InterFreqNeighCellInfo-NB-r18  InterFreqNeighCellInfo-NB-r18 ::= SEQUENCE {  satelliteId-r17 INTEGER (0..255) OPTIONAL, -- Need OR  }  // |
| Huawei, HiSilicon | Prefer no | We are open on this issue, but if Option 2 in the previous question is adopted, there is no need for additional satellite id. |
| Nordic Semiconductor | Yes |  |
| Turkcell | No strong view | We are ok with the majority’s opinion. |
| CATT | No strong view |  |
| Panasonic | Yes | Such a SatelliteID enables assigning distributed information to the satellite it belongs to. To be discussed if it makes sense going one step further and identify satellite beams (there might be multiple beams emitted from the same satellite in slightly different directions). |

**Existing SIB vs new SIB**

The other debate now is where to signal additional information such as ephemeris, epoch time and possibly many other parameters such as common TA, list of frequencies/cells, service time, reference location etc. that apply ONLY to the Rel-18 UEs as legacy UEs (i.e., Rel-17 UEs) won’t understand this information. One simple option is to extend the existing SIB, i.e., SIB31 to include addition neighbor cell information and the other option is to introduce new SIB to carry the neighbor cell information. There are also other options raised, such as repurposing the SIB32 for neighbor cell measurement or extending SIB3/4/5.

More information on each option is provided in the table.

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| --- | --- | --- | --- |
| **Option#1**: extend SIB31 | **Option#2**: New SIBxx (i.e., another SIB32 version for measurement purpose) | **Option#3**: extend existing SIB3/4/5 | **Option#4**: Repurpose SIB32 |
| 1. Additional burden for legacy UEs (Rel-17 UEs) to acquire the larger TBS SIB with contents that must be discarded.  2. SIB31 is essential, and UE needs to acquire it and maintain it, however the neighbor cell information is not.  3. Larger the TBS, larger the number of repetitions required. This can negatively impact initial access delay. | 1. Not essential for initial access. Up to UE when to acquire and how to maintain.  2. Not subject to SIB update notification procedure  3. Network will have flexibility in scheduling and new SIB can be scheduled with larger periodicity unlike SIB31  4. Legacy UE does not need to acquire  5. it is possible for network to schedule SI message including essential SIBs together for initial access as SIB31 TBS size remains unchanged.  - SIB2 + SIB31 | For each inter-frequency or intra-frequency cell, satellite information needs to be provided. This could lead to more signaling overhead and complexity. | 1. This does not work as legacy UEs will assume the discontinuous coverage is enabled, that will be wrong design.  2. The UEs not supporting discontinuous coverage, will not even try to acquire SIB32. |

1. Where (in which SIB) the neighbor cell/satellite information should be broadcast?
2. Extend SIB31.
3. New SIBxx.
4. Extend SIB3/4/5.
5. Repurpose SIB32

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| --- | --- | --- |
| Company | Options | Comments |
| Mediatek | Option 2 | A new SIB is preferred in order to obtain the maximum possible space for neighbor cell information. Option (4) will not work and Option (1) and Option (3) will incur additional overhead in signalling. |
| Qualcomm | Option 2 | It is better not to make SIB31 worse. Option 2 can accommodate more satellite information. |
| Lenovo | Option 2 |  |
| OPPO | Option 2 |  |
| Apple | Option 2 |  |
| Xiaomi | Option 2 |  |
| Intel | Ok with option 2 |  |
| Samsung | Option 2 | A new SIB is needed to have sufficient space for neighbour cell ephemeris and ensure that the coverage of SIB31 is not affected by legacy UEs. If we make SIB31 very large, then network has to compensate by introducing more repetitions, which is not preferred as it may cause scheduling issues with sync validity operations and also causes more energy consumption. |
| Nokia | Option 3 is preferred | If the required information to be added is minimum extension of SIB3/4 is sufficient instead of new SIB. New SIB will require definition of validity timer for each target satellite and other impacts. If extension of SIB 3 and 4 is not possible, we can consider new SIB (Option 2) |
| ZTE | Ok with option 2 | Initially, we prefer to directly put assistant information of a neighbour satellite under the information of each neighbour cell in SIB4/SIB5 (e.g., Option 3).  However, considering the original size of SIB5, as well as the possible size of a set of neighbour satellite assistant information (more than 300 bits), we realize it may not even be able to contain one complete set of neighbour satellite assistant information in SIB5, e.g., for NB-IoT.  Meanwhile, if a new SIB, e.g., SIBxx is introduced, it can contain at least two sets of neighbour satellite assistant information in one message. And by making use of satellite ID to mark each set of neighbour satellite assistant information, we can include different neighbour satellites information in different SIBxx messages. By this way, the information of more neighbour satellites can be provided. (We also need the step mentioned in Q3 to correlate the existing neighbour carriers/cells information with the needed neighbour satellite assistant information, e.g., via satellite ID).  ----------------------------------  Here are evaluations on the needed bits:   |  |  | | --- | --- | | **Possible IE for neighbour satellite assistant information** | **Needed bits** | | ephemerisInfo-r17 | 296 | | stateVectors | 132 | | orbitalParameters | 164 | | ul-SyncValidityDuration-r17 | 4 | | epochTime-r17 | 14 | | nta-CommonParameters-17 | 57 | | (possible)TimeOffsetUTC-r17 // start time of neighbor cell | 20 |   -- |
| Huawei, HiSilicon | Option 1, Option 2 is also acceptable. | We think extending SIB3/4/5 also has SIB capacity issues.  Option 2 means there needs to be (at least one) separate validity timer for the UE to maintain. RAN2 needs to further discuss whether to have one additional validity timer for the whole new SIB, or to have one validity timer for each neighbour cell in the new SIB, either way is more complicated than Option 1.  But we can also accept majority view (Option 2) on this, considering Option 2 allows more non-serving satellites to be broadcast which is beneficial for mobility. |
| Nordic Semiconductor | option 2 | Most clean approach and can accommodate most satellite information. |
| Turkcell | Option 2 | Option 2 is the simplest solution. |
| CATT | Option 2 |  |
| Panasonic | Option 2, see comment | Whatever a) enables backwards compatibility and b) prevents a SIB overflow. Option 2) seems to provide the safest solution. |

1. If answer to Question 4 is (1) i.e., extend SIB31, how to address the following issues?

**Issue#1**: SI TBS size limit is 936 bits for eMTC and 680 bits for NB-IoT and SIB31 is essential. Legacy Rel-17 UEs will have burden to maintain valid SIB31 with most of the content being discarded from SIB31.

**Issue#2**: As size of SIB31 grows larger, it may not be possible to schedule SIB31 in a SI message with essential SIBs such as SIB2. This can add network constraint in SIB31 scheduling with shorter periodicity to reduce initial access delay. Otherwise, UE will suffer with larger initial access delay to initiate random access.

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| Company | Comments on **issue#1** | Comments on **Issue#2** |
| Mediatek | The TBS size limit for NB-IoT is 680 bits. |  |
| Qualcomm | Thank you for correction. To be more accurate, it is 936 bits for eMTC. |  |
| Huawei, HiSilicon | We did some rough calculation (as in R2-2207150), SIB31 can still accommodate 1 neighbour satellite for NB-IoT and 2 neighbour satellites for eMTC.  Even if a new SIB is introduced, it can at most include 2 neighbour satellites for NB-IoT and 3 neighbour satellites for eMTC, i.e., one more satellite ephemeris compared with reusing SIB31. |  |

1. Any other issues to cover?

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| Company | Comments |
| ZTE | We can further discuss how to handle the absence of neighbour satellite assistant information for a neighbour cell.  As neighbour satellite assistant information for IoT NTN is not as critical as that for NR NTN, either way UE can perform legacy measurement even without satellite assistant information. Another way is that the serving satellite assistant information or another neighbour satellite assistant information can be applied.  In NR NTN, it agreed to apply the serving satellite assistant information when a neighbour satellite assistant information is absent. But we think it may be not so reasonable. The probability that two neighbour cells belong to a same neighbour satellite may be high. Therefore, If we assume the serving satellite assistant information would be applied in the absence case, the gain of the delta configuration may be very small. But if we assume the assistant information of another or a previous neighbour satellite can be applied, more gain of delta configuration can be expected. |
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# Conclusion

**No table of contents entries found.**

# Reference

[1] R2-2211171, “LS on information for neighbor/target cell in IoT NTN”, Toulouse, 14th - 18th November, 2022.