3GPP TSG-RAN WG2 Meeting #121bis-e draftR2-2304246

Elbonia, 17th – 26th of April 2023

**Agenda item: 7.7.4.1.1**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Report from [AT121bis-e][106][NR NTN Enh] Signalling of TN coverage (Nokia)**

**WID/SID: NR\_NTN\_enh – Rel-18**

**Document for: Discussion and Decision**

# 1 Introduction

This is to discuss the following:

* [AT121bis-e][106][NR NTN Enh] Signaling of TN coverage (Nokia)

Initial scope: Continue the discussion on the signaling of TN coverage: signaling details for area center+radius (e.g. reuse of *Ellipsoid-PointWithUncertaintyCircle*?), which SIB to usse, whether additional information in dedicated signalling is needed, validity of the TN coverage area information, how to associate TN coverage info and frequency

Initial intended outcome: Summary of the offline discussion with e.g.:

* List of proposals for agreement (if any)
* List of proposals that require online discussions
* List of proposals that should not be pursued (if any)

Deadline for companies' feedback: Monday 2023-04-24 12:00 UTC  
Deadline for rapporteur's summary (in R2-2304246): Monday 2023-04-24 18:00 UTC

Proposals marked "for agreement" in R2-2304246 not challenged until Tuesday 2023-04-25 08:00 UTC will be declared as agreed via email by the session chair (for the rest the discussion might continue online in the Tuesday CB session).

In the next section we elaborate on TN coverage signaling and related matters.

# 2 Contact Information

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# 3 Discussion

During the RAN2#121bis online discussion on 18th of April, the following agreements related to TN coverage were made [4]:

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| Agreements:  1. For signaling the TN coverage, the corresponding geographical area information is provided by broadcast signalling by the network via a list of (possibly overlapping) areas where each area is defined using center location coordinates + radius (where the area is meant to describe a group of cells, not just a single one). FFS on the SIB. FFS on whether additional information in dedicated signalling is needed/useful |

In this e-mail discussion we want to collect companies’ views regarding the aforementioned FFS points and other TN coverage related aspects listed in the e-mail discussion scope.

## 3.1 Signalling details – area center and radius

As stated in the agreement box above, the TN coverage information will be signalled in the form of a list of areas. Each area should be defined using center location and the radius. There were various proposals submitted to this meeting regarding which IE to apply for signaling the coordinates and the range of the radius. In [1] it is suggested to use *Ellipsoid-Point* which would consume 48 bits to provide the latitude and longitude. During the online discussion it was pointed out that *Ellipsoid-PointWithUncertaintyCircle* could be applied alternatively. A related topic is how to signal the radius and how accurate it shall be. Thus, companies are asked to share their view on how to signal area’s center location and its radius.

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| **Question 1: For TN coverage information, how to signal area center and its radius?**   1. **Ellipsoid-Point and radius separately** 2. **Ellipsoid-PointWithUncertaintyCircle** 3. **Other**   **In your response, please indicate how accurate that shall be and how many bits are jointly needed per single TN coverage area.** | | |
| **Company** | **Answer** | **Comments** |
| CATT | a) | In Rel-17, the reference location information introduced for serving cell and neighbour cells are defined by *Ellipsoid-Point*. The same format can be reused for providing TN coverage information. And the range of the radius can be defined directly by RRC.  If b) is used, how to define the range of the radius is complexity, due to the derivation of the radius is based on the following equation:  *r* = C\*(((1+x)K)-1)  it may not only involve the spec of TS38.331, it may also need to involve TS37.355 TS23.032, which make the work complexity. |
| Samsung | a) | Seems even for b) radius needs to be separately indicated. The uncertainty circle is used to describe the uncertainty of the area center location, which is not needed and the complexity should be avoided.  a) can be used as in R17. |
| vivo | a) | The same mechanism of *referencelocation* and *distanceThresh* provided in Rel-17 can be used. |
| Transsion | a) | The legacy Rel-17 means can be reused. Even the *Ellipsoid-PointWithUncertaintyCircl*e can provide less signaling overhead comare to *Ellipsoid-Point.* The major differnence between these two formats is the range to represent coveraged area, the former one provide shorter than later one, but from imlpelmentation perspective, the later one can provide more flexible. |
| OPPO | a) | Option b) has been previously discussed but not agreed for idle mode location-based measurement initiation. The value range of radius is not linear, and many radius values less than the radius of typical TN cells are useless for TN coverage information (49 out of 128 values are mapped between 0m and 1km).  For Option a), we think referenceLocation-r17 (48 bits) and distanceThresh-r17 (16 bits) in the current SIB19 could be considered as the baseline. Thus, the size of signalling would be 64 bits per coverage area at most. The step of current distanceThresh-r17 IE is 50m, whether coarser step is enough or not could be further considered. |
| Lenovo | a) | Similar format to *referencelocation* and *distanceThresh* in Rel-17 can be used. |
| Xiaomi | a | Prefer to reuse the R17 mechanism. |
| Thales | a) | Option a) is straightforward as it reuse similar format already existing in Rel-17 even if Option b) seems to reduce overhead of few bits. |
| ZTE | b) | The uncertainty served the same purpose as radius, and the granularity can be from 0m to 1800km, which shall be sufficient for TN coverage. We can reuse what we have in LPP specs, as the coverage information designed in LPP specs is an already mature method to describe a TN coverage since legacy. For Ellipsoid-Point we also referred to LPP specs, there is no extra complexity to refer to other specs in our view. If option b is used, then it would be beneficial to give the NW the freedom to use other existing IEs in LPP spec for this, like EllipsoidPointwithUncertaintyEllipse, which might be useful (i.e. less signalling heavy) to better describe the TN coverage than mutiple area centers + radius in some cases. |
| NEC | a | Uncertainty circle is exponentially inaccurate, i.e. many values in low radii, e.g. R<1km, and very few in inaccurate high values. This is not adapted to describing TN areas with multiple cells.  We prefer to have the radius signalled separately and with an accuracy that is more adapted to this scenario. |
| Apple | a) | We prefer to reuse R17 method.  If we use the R17 format, the size of 1 TN coverage area is about 8 bytes.  Graphical user interface, text, application, email  Description automatically generated |
| Ericsson | a | As noted by previous comments, it is straightforward to re-use Rel-17 mechanism. No need of further complexity. |
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Summary for Q1:

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## 3.2 Signaling details – frequency information

In [2] and [3] there are different approaches presented on how to signal the frequency information which has been agreed to be provided per TN coverage area. [2] suggests to use a list of frequencies under each TN area information (Option 1). [3] proposes to introduce TN coverage area identity and then use this identifier in SIB4 and SIB5 for all TN frequencies listed there (Option 2). It seems both approaches have some benefits, so it would be good to check what companies prefer.

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| **Question 2: How the frequency information for TN coverage area should be signalled? Please choose from the options below.**   1. **Option 1: use a list of frequencies under each TN area information** 2. **Option 2: introduce TN coverage area identity and the use this identifier in SIB4 and SIB5 for all TN frequencies listed there** 3. **Other** | | |
| **Company** | **Answer** | **Comments** |
| CATT | a) | Option 1 is direct and clear.  For option 2, when the TN coverage data is changed, the network should also update SIB4/5, and the behaviour of UE acquiring updated system information is complete. And an area may relate to serval frequency points, and a frequency may presence in many areas, option 2 will be very cumbersome. |
| Samsung | a) |  |
| vivo | Option 1 | There may be multiple TN cells of multiple frequencies in an area, only one area is needed to be provided in order to save signaling overhead, option 1 is simpler to let UE know which frequencies are associated with the area. |
| Transsion | a) | The TN coverage is relative fixed compare to NTN. Option 1 can dirtectly indicate carrier frequency(ies) in a certain area, when UE is closeing to one of area, it can measures for those frequencies. |
| OPPO | a) | Option 1 is straightforward and similar to what we do for the NTN neighbour cell assistance information in SIB19. |
| Lenovo | a) | Option 1 is simple and easily associates frequencies with specific areas. |
| Xiaomi | a | We prefer not to couple different SIBs for a feature. |
| Thales | a) |  |
| ZTE | c) | First we prefer to provide the associated frequencies information directly in TN area so that update of TN coverage will not impact update of SIB3/4. To save the signalling overhead, a bitmap of frequencies may be introduced in SIB that carries TN coverage information (e.g., SIB19) , where each bit can refer to the frequency entries included in SIB3/4 in order, to indicate whether the frequency is used for this TN coverage or not. |
| NEC | a) Option 1 | Since frequency usage may change over the vast NTN area (that can span countries with different frequency usage), we prefer to associate frequencies per TN area. |
| Apple | a) | Option 1 is clear, simple and easy for UE implementation. |
| Ericsson | a | Option 1 is simpler and similar to NTN’s satellite neighbour assistance information. |
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Summary for Q2:

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## 3.3 Signaling details – the size of TN coverage list

A somewhat related question to the issues discussed already above would be: how many TN coverage areas do we actually need? Please provide the justification on your preferred size of TN coverage list.

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| **Question 3: What shall be the size of TN coverage list?** | | |
| **Company** | **Answer** | **Comments** |
| CATT | See the comment | The amount of TN coverage areas is up to the actually geographic location and network deployment.  From our perspective, the amount of TN coverage areas may in level of tens. Hence, the signalling overhead is up to thousands of bits. |
| vivo | 16 | NTN cells can broadcast up to eight NR neighboring frequencies and eight E-UTRA neighboring frequencies, considering each frequency may be associated with one TN coverage, up to sixteen TN coverage needs to be provided. |
| Transsion |  | Same view with CATT |
| OPPO | See comments | It is difficult to say how many TN coverage areas could be provided in the TN coverage list, since it depends on whether a new SIB is introduced or not and the bit size of one TN coverage area and its associated frequency band list.  If separate SIB is used, then we can start with 16 TN coverage areas. |
| Lenovo | Depends | We share OPPO’s view that it can be 16 in the new SIB. |
| Xiaomi | See comments | The actual TN numbers which are broadcasted by network is according to the TN network deployment and TN coverage accuracy, but we can decide the max number of TN coverage based on the signalling overhead that a SIB can carry. |
| ZTE | See comments | In our understanding, only the TN coverage associated to current NTN cell is needed to be broadcast. For example, when reselect to another NTN cell, the TN coverage and the associated frequency could be different due to different satellite deployment. Or UE might reselects to TN, in this case this information is also useless. Upon change of cell (to either TN or NTN), UE will based on the new assisting information broadcast to do measurement. Also, considering NW can based on its implementation to aggregate the TN cells in one TN coverage, there is no need to broadcast too many TN coverage entries. RAN2 can decide a maximum number after deciding the SIB carrying this information and overhead for each TN coverage. Our preference would be reuse SIB19 since this information is only used in NTN. |
| NEC | Large | The size will depend on the coverage scenario and up to NW implementation. Given the size of an NTN cell, it is easy to imagine multiple land/sea borders and mountainous or deserted areas.  Thus, a typical scenario may require tens of areas, so 64 values may be appropriate. |
| Apple | See comments | What we can say is that accurate and complete TN coverage data is more helpful for the optimization of NTN-TN cell reselection.  The more the number, the better. |
| Ericsson | Postpone | Discuss a maximum number once the format is agreed. Then, we may decide based on SIB’s maximum TB size and typical NTN and TN cell sizes. |
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Summary for Q3:

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## 3.4 Signaling details – which SIB to use

It remains to be decided where TN coverage area information list is sent. Obviously, the final answer may depend on the ultimate design of this list (e.g. how many bits are consumed to signal a single TN coverage area information). However, companies are already encouraged to express their opinions.

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| **Question 4: Where TN coverage area list should be broadcast? Please select from the options below:**   1. **SIB19** 2. **Other SIB** | | |
| **Company** | **Answer** | **Comments** |
| CATT | b)  Introduce a new SIB | 1) no enough space to contain TN coverage info in SIB19  Based on our answer in Q3, the signalling overhead to provide TN coverage may up to thousands of bits. In Rel-17, the SIB19 was designed to contain at most 8 neighbour cells (with ephemeris), based on the maximum capacity of SIB. Hence, SIB19 has not enough space to contain the TN coverage information.  2) different periodicity and update requirement between TN coverage information and SIB19  The character of the TN coverage area information is different with the SIB19, e.g. the update mechanism, periodicity. Once UE acquire the TN coverage information, the UE may not acquire the TN coverage information repetitively if it doesn’t move far away (under this situation the TN coverage around the UE is unchanged). However, UE need to acquire SIB19 very frequently. And from the NW side, the NW doesn’t need to broadcast the TN coverage with short periodicity, due to it is not necessary for UE access, but SIB19 is essential for UE access, so the periodicity requirement is different between SIB19 and TN coverage area information. If TN coverage information is broadcast in SIB19, UE has to acquire the TN coverage again and again, which bring unnecessary data reception and corresponding energy consumption.  Since TN coverage data has different valid characteristics. Introduce TN coverage data in the other existing SIBs make update mechanism complex. We prefer to introduce a new SIB to broadcast the TN coverage information. |
| Samsung | b)  Use SIB4/3 | SIB4/3 includes inter-frequency and/or intra-frequency information cell reselection information. |
| vivo | a) | Since information on the TN coverage area is NTN-specific cell reselection information, same as location-based and time-based cell reselection related information, the information on the TN coverage area can be included in SIB19. Considering the capacity of SIB19, in addition to the information currently in SIB19, there are still more than one thousand bits left that can be used to provide TN coverage information. |
| Transsion | b) | Introduce new SIB to indicate neighbor TN cells, which less spec impact. |
| OPPO | b) | The current SIB19 cannot contain much TN coverage information. It is better to introduce a new SIB to capture TN coverage information and the associated frequency band list. |
| Lenovo | b) | Prefer to introduce a new SIB for neighbour TN/NTN cells. |
| Xiaomi | b | A new SIB could is more flexible can could carry more TN areas. |
| Thales | See comment | Depending on the size of TN coverage area information, it should be included in SIB19 since it is NTN-specific cell reselection information.  However, if no space left in SIB19 or if it poses an overhead issue e.g. if the UE does not update TN coverage information at the same periodicity as SIB19 transmission periodicity, a new SIB for neighbour TN/NTN cells is a good solution. |
| ZTE | a) | We think the TN coverage is only applicable for NTN, and it is associated to a certain satellite, for different NTN cells from neighboring satellite even for the same coverage the assocaited Tn frequencies may be different, to allow linkage between satellite and THN coverage, reuse SIB19 is the straightforward way. |
| NEC | b | We prefer to have the flexibility in terms of size of TN coverage information. |
| Apple | b) | We can consider introducing a new SIB. |
| Ericsson | Postpone | Once the format is decided, it will become easier to discuss whether a new SIB is required or not based on the necessary signalling to describe an area. |
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Summary for Q4:

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## 3.5 Signaling details – need for dedicated signaling

Another aspect that still needs to be concluded is whether there is a necessity for dedicated signaling to provide the UE with TN coverage area information. In some of the papers submitted to RAN2#121bis it was pointed out that SIB may provide just a coarse information, while more details shall be given using dedicated signaling. On the other hand, during the online discussion it was rather clear to RAN2 that TN coverage area information does not need to be very accurate/detailed, and it needs to work for the UEs in IDLE mode.

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| **Question 5: Is there a need to support dedicated signaling for providing the TN coverage information?** | | |
| **Company** | **Answer** | **Comments** |
| CATT | Yes | Considering the signalling overhead, the network may not configure enough precise TN coverage data to UE via SI. Based on the TN coverage information broadcast in SI, UE couldn’t get the accurate TN location information. However, NW could get the UE position information in connected state, so NW could give accurate TN coverage information. With the more accurate TN coverage information, UE could make more smart decision on whether and on which TN frequency to perform TN measurement, it bring benefit on UE power saving. |
| Samsung | No | How can dedicated signalling work for idle UE?  Even if UE receives more accurate TN information in connected mode and enters idle mode to use it, UE can move to a new area in idle mode and the stored information will become inaccurate without NW nor UE awareness. Then how to update this information for the UE in idle mode? If this idle UE acquires new TN area information in SIB from a new serving cell, how does UE deal with the two sets of different TN information? If the new TN area information in SIB overrides the TN area information from the dedicated signalling, then we doubt the benefit to support dedicated signalling with large specs impact. |
| vivo | No | The TN coverage information is used for UE power-saving, coarse area information is sufficient and is useful for all IDLE/INACTIVE mode UEs in the cell. Furthermore, for the purpose of reducing signaling overhead, providing this information through dedicated signaling is not expected. |
| Transsion | No | UE is in Idle mode and peroforms NTN-NT cell reselection, no need to go beck to CONNECT mode to get dedicate information. |
| OPPO | No | In our understanding, it is not necessary to introduce a dedicated signalling manner for providing/updating the TN coverage area. The TN coverage information is relatively static and common for all UEs, therefore the broadcast signalling manner is straightforward and sufficient. We do not see the motivation for the additional enhancement in a dedicated signalling manner. Meanwhile, if the dedicated signalling manner is introduced, it would need much effort in further discussion, e.g., the update mechanism, the validity time, or the behaviour when the TN coverage information is different between dedicated signalling and broadcast signalling. |
| Lenovo | Maybe | We tend to leave it open (e.g., in RRCRelease) to have further flexibility. |
| Xiaomi | No | The TN coverages are fixed and the same for all UEs, no need to introduce the RRC signalling, Moreover, the feature is for UE power saving and the coarse TN coverage information is enough. |
| Thales | No strong view | The use case and benefits of a precise TN coverage area information compared to the proposed coarse one are unclear, then we would prefer to prevent signalling overhead and much effort in further discussion on this topic. |
| ZTE | No | This is only for measurement relaxation coarse information is sufficient. |
| NEC | No | This information is also aimed at inactive and camping UEs when they get closer to TN areas. To help them save energy when in NTN-only zones and let them know when to wake up when they get *roughly* close to TN zones.  Hence, the information should be broadcasted and does not need to be very precise. |
| Apple | Yes | We see 3 reasons to support the UE dedicated signaling as the supplementary method to deliver the TN coverage data info.  1) Accurate and complete TN coverage data is more helpful for the optimization of NTN-TN cell reselection. But the accurate TN coverage area info costs heavy signaling overhead which may be over the max size of SIB. But UE dedicated signaling can help deliver the accurate TN coverage data info with huge size.  2) UE dedicated signaling can provide the security protection of the TN coverage info and avoid exposing the TN deployment, which can avoid some security risk.  3) Since TN deployment is relative static, the validity period of the TN coverage data will be very long, and network doesnot need to update the TN coverage data frequently. Based on this characteristic, network can provide the accurate and complete TN coverage area info to CONNECTED UE, and UE stores the info in IDLE/INACTIVE state. |
| Ericsson | No | In addition to the increased overhead problem, UE does not need high accurate information to assist cell measurements. |
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Summary for Q5:

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## 3.6 Signaling details – validity of TN coverage information

Eventually, we need to discuss how long such TN coverage information shall remain valid and how to realize that. As this information is expected to be rather static, it would be good to allow the UE to store it, once acquired. On the other hand, we need to think of the triggers which should make the UE acquire new TN coverage information.

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| **Question 6: How long the UE should consider the acquired TN coverage information remains valid?** | | |
| **Company** | **Answer** | **Comments** |
| CATT | See the comment | We think we can follow the legacy mechanism for SI, i.e. 3 hours. |
| Samsung | Follow legacy SI update mechanism | UE can reacquires the SIB if it becomes invalide. |
| vivo | Until the SIB carrying TN coverage information is reacquired. | If the NW wants to provide TN coverage information for a given frequency, this information should be provided together with the frequency information in SIB4. If the NW wants to update the frequency information in SIB4, the SIB4 and the SIB which carrying TN coverage information should be updated together. The existing SI modification procedure can be used and no additional spec work is needed. |
| Transsion | See the comment | TN coverage information is relative static, RAN2 can further discuss on UE based solutions. |
| OPPO | Follow the legacy system information update mechanism | The legacy system information update mechanism is sufficient since TN coverage information is relatively static. |
| Lenovo | Follow legacy SI update | Follow legacy SI update is OK. |
| Xiaomi |  | The legacy SI update procedure can be reused to trigger UE to acquire new TN coverage information. |
| ZTE | Upon cell reselection or SI update | Per our understanding described in Q3, we think the broadcast TN coverage is only valid and used up until NTN cell boundary, which simplifies NW’s implementation to broadcast the TN coverage. For example, the same circle can be used to descried two different TN coverage at the NTN boundary as given below.    Therefore, UE shall not assume the TN coverage information received and used in current NTN cell as valid upon cell reselection. Also, considering NW may update the associated frequencies in the TN coverage, UE needs also to reacquire SIB if the SIB is updated. |
| NEC | Legacy is fine | The legacy 3 hours should not require too much power consumption from UE point of view, although we understand that such mapping may not change in such a small period. |
| Ericsson | SI update mechanism |  |
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Summary for Q6:

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And a related question:

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| **Question 7: Do we need to define any triggers making the UE reacquire the TN coverage information? Please share the details on those triggers or explain why there is no such need.** | | |
| **Company** | **Answer** | **Comments** |
| CATT | Yes | Due to TN coverage information of the surrounding of the UE is varied with the UE location. So a distance-based solution can be introduced. E.g. when UE movement exceeds a distance threshold, UE needs to reacquire new TN coverage information.  Additionally, we would like to propose that, the update of TN coverage info will neither result in SI change notifications nor in a modification of valueTag in SIB1. Especially for earth-moving cell, the TN cell under coverage of NTN cell keeps changing. NW has to frequently update the TN coverage info to ensure fresh TN coverage info for the newly covered UE. However, for UE who already acquire the surrounding TN coverage info should not be triggered to re-acquire the updated TN coverage data. |
| Samsung | No | An NTN serving cell should provide enough TN area information relevant to a certain area in an area-specific SIB, or enough TN area information relevant to the cell in a cell-specific SIB. Since TN coverage information is static, legacy SI update mechanism is sufficient. When moving to a new area/cell, UE checks the validity of SIB and reacquires the SIB if the stored SIB is not valid. |
| vivo | No | The existing SI modification procedure can be used, no other trigger condition is needed. |
| Transsion | Yes | UE based tirggers. |
| OPPO | No | It is sufficient to rely on the legacy system information modification notification. |
| Lenovo | No | For now we see no essential need, and following legacy SI update is OK. |
| Xiaomi | No | The legacy SI update procedure can be reused to trigger UE to acquire new TN coverage information. |
| ZTE | See comments | UE can reacquire this information when reselects to NTN or upon SI change as specified in legacy. No additional trigger is needed. |
| NEC | No | The legacy SI update procedure is sufficient, the broadcast TN signalling does not depend on the location of a UE within the NTN cell. |
| Apple | See comments | For broadcast signalling, legacy SI change mechanism can be used.  For UE dedicated signalling, since TN coverage information is relative static, UE dedicated TN coverage data change can be triggered by network. |
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Summary for Q7:

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# 4 Conclusion

This paper discussed TN coverage information details. The following proposals are made:

For agreement:

**Proposal x:**

For discussion:

**Proposal y:**

# References

1. R2-2303168 On TN Coverage Area Information - signaling, validity and definition aspects 3GPP TSG-RAN WG2 Meeting #121bis-e Elbonia, 17th – 26th of April 2023
2. R2-2303100 Discussion on the NTN-TN cell reselection enhancements 3GPP TSG-RAN WG2 Meeting #121bis-e Elbonia, 17th – 26th of April 2023
3. R2-2303037 TN cell coverage info and measurement relaxation 3GPP TSG-RAN WG2 Meeting #121bis-e Elbonia, 17th – 26th of April 2023
4. Report from Break-out session on NR-NTN and IoT-NTN