3GPP TSG-RAN WG2 Meeting #118 Electronic DRAFTR2-2206196

Elbonia, 9th – 20th of May 2022

**Agenda item: 6.10.3.2.1**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Report from [AT118-e][106][NTN] CP issues (Nokia)**

**WID/SID: NR\_NTN\_solutions-Core - Rel-17**

**Document for: Discussion and Decision**

# 1 Introduction

The scope of this paper is as follows:

**[AT118-e][106][NTN] CP issues (Nokia)**

Initial scope: based on contributions in 6.10.3 discuss CHO @ T2 expiry; assistance information for SMTC and neighbour cell information/ephemeris
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): Tuesday 2022-05-10 0800 UTC
Deadline (for rapporteur's summary in R2-2206196): Tuesday 2022-05-10 1000 UTC

The CHO, SMTC and neighbour cell information are summarized and discussed in the following sections.

# 2 Conditional Handover for NTN

This subsection tries to summarize the remaining issues for CHO in NTN. The following has been agreed and discussed at RAN2#117:

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| 2. If the CHO is not executed at T2 (timer associated with this candidate CHO cell) the UE continues to operate in the source cell and evaluates other CHO execution conditions (if configured).Proposal 5-5: Discuss further what happens with the CHO configuration after T2 expiry (i.e. UE releases the configuration or maintains the configuration for potential failure recovery). Discuss if the UE can use also the CHO configuration for which T2 has expired. |

## 2.1 On CHO Recovery after T2

One of the unresolved issues for NTN CHO is what happens with CHO configurations at T2 if the UE was configured with CHO recovery. As usual, there are different views presented. The authors of [1] argue candidate cell may no longer be valid beyond T2 or the target cell is not detectable beyond T2. As a consequence, the failure may occur when the UE attempts to access such CHO candidate after T2. Also the authors of [5] claim the CHO configs “can” be released at T2. On the contrary, there are numerous papers (e.g. [6][9][13]), where it is emphasized that a legacy behavior would be to allow the UE to use any of those configurations if selected cell is a CHO candidate. That, in the simplest approach, may actually not require any specification changes (as suggested in [7]), while the CHO configurations may be reconfigured by the NW, while not released by the UE at time T2. It is worth noting that it was commonly agreeable at RAN2#117 that CHO Recovery should be supported in NTN, if CHO is already a functionality to be used by NTN-capable UEs. Please also consider that if NTN UEs are not allowed to access via CHO the selected cell in CHO Recovery process, the UEs will be forced to continue the reestablishment and this may be more costly in terms of the delay data interruption period. What some companies seem to be missing is that the cell, which may be potentially accessed using CHO configuration, beyond T2, is still a selected cell (i.e. highest ranked cell in cell selection which is a first part of actions the UE takes upon failure), so not a cell which was chosen randomly, but still the best cell in terms of DL quality/signal strength.

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| **Question 1: Can the NTN-capable UE use CHO configuration if during CHO recovery a selected cell is a CHO candidate, even though the timer T2 has expired?**  |
| **Company** | **Answer** | **Comments** |
| Nokia | Yes | As we have argued at the last meeting and in our TDoc (e.g. in [13]), it is pointless to delete the configurations at T2, as then the UE is forced to perform the legacy reestablishment (i.e. without any recovery actions). On the contrary, if we allow to use CHO configs the UE may access one of the prepared cells ONLY IF that cell was selected during cell selection process (so it is not the randomly chosen cell, but still the best ranked cell, even if beyond timer T2). That is how CHO recovery works. Timer T2 will be set by the network, so its expiry does not necessarily mean the cell disappears immediately. It is, however, important to ensure the network keeps the resources, considering potential recovery (as discussed below, in the next questions). |
| OPPO | Yes |  |
| Lenovo | No | For time-based CHO UE is allowed to evaluate measurement-based condition within the time duration, and it seems unnecessary for the UE to evaluate after it. In our understanding NW may consider the validity of a candidate cell when configuring T2. Therefore when T2 expires, a candidate cell is expected to be unavailable. UE can release the configuration when T2 expires. |
| MediaTek | Yes |  |
| Sony | Yes | This is a legacy behaviour and we have reached agreement that CHO recovery should be supported.  |
| Lockheed Martin | Yes |  |
| Qualcomm | No | Network can configure very large value of duration-r17 so this is not needed.Otherwise why T2 is configured by network? If this is allowed, network may release the reserved resources after T2 and UE’s attempt will fail.If this is to allow, we propose T2 be optional, meaning make duration-r17 optional. |
| Apple | No | Agree with the views expressed by Lenovo and QC |
| vivo | No | Just wonder if the CHO configuration can still be used after associated T2 expiry whether T2 is actually of any use, and why we introduced T2 at all.  |
| Xiaomi | Yes | Agree with Nokia. The cell used for recovery is selected by cell selection in RRC re-establishment procedure. In R16 CHO recovery, even though the leaving condition is fulfilled, UE can also trigger CHO for recovery when the associated candidate target cell is the selected cell. So, if the selected cell is the candidate cell and *attemptCondReconfig* is configured, CHO configuration after T2 can also be applied. |
| Transsion | No | After T2, the network reserved resource is released. That is, UE is not available to use CHO configurations. |
| ZTE | Yes | We understand T1-T2 is the valid time for a CHO candidate cell but does not necessarily equal to the valid time for this cell to be configured for CHO recovery. If the cell is not valid anymore for time based CHO or CHO recovery, NW should update the CHO recovery configuration or release the CHO configuration.Thus, it is preferred not to specify any automatic release at UE side or any limitation on the usage of CHO recovery configuration, should be configured and controlled by NW. |
| Samsung | No | The NW configures time-based CHO in a way that the UE can only hand over to the candidate cell and apply associated configuration before T2. For recovery, UE can select the candidate cell before T2 for the same reason. However, after T2, the UE cannot assume the candidate cell and associated configuration is valid for handover or recovery.  |
| Ericsson | No | CHO recovery can only work if the reserved cell resources (and UE configuration) are retained in the candidate target cell after expiry of T2, and since the network is not required to keep the resources after T2, there is no guarantee the CHO recovery will work in the candidate target cell. In fact, as described in [11], it may even result in an increased access delay time for the UE compared to a case where the UE would have sent an *RRCReestablishmentRequest* message in the first place.Referring to legacy behaviour is not correct since expiration of T2 is a new scenario without a matching legacy scenario. A scenario that will match the CHO legacy behaviour is rather if the UE fails to execute CHO, initiates the re-establishment procedure, and converts it into a CHO attempt, all before T2 expiry.  |
| Google | No | Not sure what T2 aims to achieve if this is allowed. If we want to allow UE to access a prepared cell using the CHO configuration during the recovery phase, T2 should be made optional for that cell.  |
| Huawei, HiSilicon | No | Same view as Lenovo that NW may consider the validity of a candidate cell when configuring T2 and when T2 expires the candidate cell is expected to be unavailable. In other words, the candidate cell will not become the selected cell as mentioned by Nokia. |
| ITRI | Yes | If during CHO recovery a selected cell is a CHO candidate only when the CHO candidate cell meets cell selection criteria. UE should be able to use CHO configuration for CHO recovery even after T2 expiry. |
| NEC | No | Different from other CHO trigger which does not have validity time, Time-based CHO is only valid during T1 to T2, after T2, we assume that the prepared gNB will release the corresponding configuration and consequently CHO recovery will fail. gNB should configure T2 enough long.If the time-based CHO configuration can be used for recovery after T2, then T2 should not be in time-based CHO trigger definition at first place.  |
| Panasonic | No | Question is, if T2 marks the end in time of the geographical overlap of serving cell and candidate/target cell(s) or if it marks the end of the availability of candidate/target cell(s). The first case makes more sense.Nonetheless assuming the latter, after T2 expiry the former candidate cell is not available anymore. Otherwise the related signalling would have been erroneous. |
| CATT | Yes with comment | We agree that UE can use CHO configuration for CHO recovery. If most companies choose to release CHO configurations at T2, we can accept it. |
| LGE | No | RAN2 does not allow the UE to conduct the CHO after T2 expiry as agreed in RAN2#117-e meeting. The network may release the reserved resources of the candidate cells after T2 expiry. In this case, the UE cannot conduct CHO recovery. The network can configure the T2 later than *t-Service* of serving cell to support CHO recovery of UE. |

If the dominant response to Question 1 would be “NO”, e.g. due to the reasons highlighted in [11], where it is argued the resources at the NW side may not be kept beyond T2, then RAN2 is asked to consider additional means to ensure the UE can still safely execute CHO as a part of recovery beyond T2 and the network will admit such a UE.

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| **Question 2: Is there a need for NW coordination to ensure the UE can attempt to access a CHO candidate selected during recovery even after timer T2 expires?**  |
| **Company** | **Answer** | **Comments** |
| Nokia | Maybe | Clearly this is not entirely a RAN2 topic, while RAN3 has completed their NTN work. But in principle, the source cell configuring the UE with CHO, including window [T1, T2], shall know how the T2 relates to the actual resource reservation at the NW side.  |
| OPPO | No | In Rel-16, We don’t have any NW coordination for failure handling via CHO. We don’t need any also for NTN. |
| Lenovo | See comments | We are not quite sure about what “UE can attempt to access a CHO candidate selected during recovery even after timer T2 expires” means. If it means that UE may still reselect to a candidate cell which was configured with time-based conditions after T2 expiring, we think it would be a rare case as NW may consider the validity of a candidate cell when configuring T2. Therefore when T2 expires, a candidate cell is expected to be unavailable e.g. due to satellite movement.For NW coordination, on the contrary we think source gNB may need to inform target gNB upon T2 expiring, so that gNB can release the sources reserved for the UE. |
| Sony | Yes | Network can choose to keep those configurations. |
| Qualcomm | Yes | Network should make sure to reserve the resources far beyond T2. |
| Apple | No | Seems like an optimization and can be pushed to R18 |
| vivo | No  | See our reply for Q1, if associated T2 is expired for a candidate cell, the cell can’t be the target cell for CHO recovery. Even if No is selected for Q1, there is no NW coordination that needs to be specified as in Rel-16.  |
| Xiaomi | No | Can be discussed in R18 |
| Transsion | No | Network can prepare for an new CHO configuration as legacy behavior, if needed. After T2 had expired, UE act as legacy. |
| Samsung  | No | As commented in Q1, UE should not select a candidate cell whose T2 is expired for recovery. No additional means is needed to help UE recovery from a candidate cell with T2 expired.  |
| Ericsson | Yes, but… | We think that a predictable network behaviour in which the UE knows if the reserved network resources are retained in the target cell after expiration of T2 benefits both UE and network performance and robustness.This could potentially be useful in a quasi-earth fixed cell scenario deployment; however, we are not sure whether it needs to be supported in Rel-17. |
| Google | No | Can be further discussed in R18. |
| Huawei, HiSilicon | No | We share the similar view with Lenovo and Vivo that the time-based CHO candidate cell is unlikely to become the target cell for recovery after T2, so answering No to Q1 does not mean another mechanism is needed. |
| ITRI | No | It could be an optimization and can be discussed in Rel-18. |
| NEC | Yes | At least the prepared gNB should agree to keep the configuration longer than T2 implicitly or explicitly. |
| Panasonic | See answer to Q1. | Widely agree with Lenovo. |
| CATT | No |  |
| LGE | No | The network can configure the T2 later than *t-Service* of serving cell to support CHO recovery of UE, as same with the Q1.  |
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Obviously, it needs to be considered that the WI is completed and no new functionalities should be pursued. Nevertheless, it should be acceptable to design a proper NTN CHO functionality, including the recovery aspects, even if it does require some extra work. If so, and if Question 2 is responded positively, then perhaps also the UE needs to know for how long the network guarantees the resources beyond time T2.

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| **Question 3: Shall the UE also know how far beyond T2 it can try to safely access the CHO candidate cell (considering how long the resources are kept at the NW side)?**  |
| **Company** | **Answer** | **Comments** |
| Nokia | Maybe | That could be one option – to tell the UE how long beyond T2 it can safely attempt to recover using CHO configurations. |
| OPPO | No | UE simply tries CHO and if it fails, UE tries RRC re-establishment. That’s it and let’s not over optimize.  |
| Lenovo | No | We think such optimization is not necessary in this release. |
| Sony | Maybe not | This can leave to network side. |
| Lockheed Martin | No |  |
| Qualcomm | Yes | Now its getting complicated. Simply stop using CHO after T2. |
| Apple | No | Can be considered for R18 |
| vivo | No | We don’t agree to allow UE to access to a CHO candidate cell after associated T2 expires. |
| Xiaomi | No | Can be discussed in R18 |
| Transsion | No | Can be considered in later release. UE’s behavior is just act as RAN#2 had agreed so far for time-based CHO. |
| ZTE | No | As we mentioned above, if NW does not update the configuration for CHO recovery, UE would consider the current configuration to be valid and would be allowed to perform Cho recovery accordingly. No more spec impact is needed. |
| Samsung | No | It should be clear to the UE that after T2 the candidate cell cannot be selected since T2 is defined in this meaning. |
| Ericsson | Yes | A potential solution in line with our comments to Q2, would require the network to somehow inform the UE that, (1) the reserved resources are kept in the candidate target cell after T2 expiry, and (2) the time when the reserved resources are released in the candidate target cell. |
| Huawei, HiSilicon | No |  |
| ITRI | No | It could be an optimization and can be discussed in Rel-18. |
| NEC | See comment | That is exact meaning of T2 in our understanding, so we should not define another time point. |
| Panasonic | Depends … | … on the precise definition of T2 (see our answer to Q1). If T2 marks the end of the availability of the candidate/target cell, it hardly makes sense to define a time period beyond the point of time the candidate/target cell became unavailable. |
| CATT | No |  |
| LGE | No |  |

As the Rel-17 is on the verge of finalization, a Stage-3 impact of these Proposals need to be pursued once we reach the consensus on the issues discussed above.

# 3 SMTC for IDLE/INACTIVE

In this subsection we try to summarize and resolve the pending issues for SMTC in NTN. There are several topics to consider. At RAN#117 the following agreements have been taken:

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| SMTC offset and change rate is needed to assist UE-based SMTC adjustment in idle and inactive mode (FFS on the signalling details, e.g. whether to broadcast feeder link delay difference or something different)RAN2 assumes that in addition to the ephemeris information, assistance information is needed for UE-based SMTC adjustment in idle and inactive mode. (FFS on the option to enable this) |

and the following Options have been considered:

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| * Option 1: feeder link delay of neighbor cells
* Option 2: Common TA parameters of neighbor cells
* Option 3: SMTC offset or change rate of neighbor cells
* Option 4: Reference time of the SMTC of neighbor cells
* Option 5: Delay difference between the serving and neighbor cell
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Let’s try to check first which Option is preferred for representing this assistance information.

## 3.1 On what SMTC assistance information is provided for IDLE/Inactive

In [4] it is proposed to broadcast SMTC offset, SMTC offset drift and SMTC offset drift variation, but it is not stated how the UE applies this information and what is the meaning of these fields. It is also stated that the component responsible for the feeder link delay does not have to be explicitly labelled and the UE does not need to know which delay component is related to which link. In [8] it is proposed to use common TA parameters and Kmac of the neighbour cells to support IDLE/Inactive UEs in adjusting SMTC. It is also suggested that epoch time and validity duration of the serving cell can be reused. In [12] it is proposed to use the SMTC offset, its drift and drift variation, which would be location-specific. The UE assesses its location and performs SMTC adjustment. The authors of [18] argue it is not realistic to rely on UE location assessment in IDLE mode for UE autonomous SMTC adjustments. Thus, it is suggested to use the timing threshold derived from the delay difference between the serving and neighbor cell. On this basis the UE determines if the SMTC window should be shifted (if the SSB is received out of the window, UE moves the SMTC window by configurable threshold value).

As can be seen above, the views are still largely different, so it is difficult to suggest one agreeable way forward. Thus, it is suggested to respond to the following questions:

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| **Question 4: Please select from the options listed below how the SMTC adjustment in IDLE/Inactive is done:**1. **NW broadcasts SMTC offset, offset drift and drift variation for a specific location within a cell**
2. **NW broadcasts timing threshold for determining if the SMTC window should be shifted by the UE**
3. **NW broadcasts Common TA and Kmac of the neighbour cell to aid the UE in SMTC adjustments**
4. **Other**
 |
| **Company** | **Answer** | **Comments** |
| Nokia | Option b | It should be enough to inform the UE on the threshold (describing how much the SSB of the neighbour is received outside the window). Then each UE individually offsets its SMTC window. It is not realistic to apply one common solution for all IDLE UEs in the cell. Similarly, relying on UE’s location in IDLE is not the right approach. |
| OPPO | Option a | This is like how UE determines common TA for pre-compensation. SMTC offset refers to the amount UE needs to adjust for the feeder link’s delay difference between serving cell and neighbour cell. The ultimate SMTC adjustment shall also include the amount needed for service link’s delay difference.  |
| Lenovo | Option c) or Option b) | For Option a) we may need to divide a cell into multiple locations and the overhead could be large. We think Option c) can be simpler as it can reuse the same format as for the serving cell (ephemeris, common TA & Kmac).Option b) is also acceptable but we have concerns in its accuracy e.g. how to determine the threshold and how long shall a UE offset if its timing fulfils the threshold. |
| MediaTek | Option a is preferred |  |
| Sony | b) | Timing threshold is enough for the UE to autonomously determine whether a shift is needed nor not. |
| Qualcomm | Option c | Simply broadcast common TA parameters would be helpful in SMTC adjustment. |
| Apple | Option c |  |
| vivo | Option c | Based on the common TA and Kmac of the neighbour cell, UE can calculate the delay of the neighbour cell, and thus can adjust the SMTC to measure the neighbour cell autonomously. |
| Xiaomi | Option c | UE can use the Common TA and Kmac of the neighbour cell to calculate the link’s delay. And it is more simple for UE.  |
| Transsion | Option c | The parameters of common TA and Kmac of neighbor cell are relative fixed and can be design while deployment. UE can use them to self adjust SMTC for neighbor cell measurement. |
| Samsung | Option a | For Option b, 1) it’s questionable how to determine the threshold according to propagation delay difference since the NW does not know how much the propagation delay difference a UE is suffering without UE location; 2) how does UE know whether to shift the window forward or backward. For Option c, the UE needs to know service link delay difference to calculate propagation delay difference, however we are not sure common TA is equal to service link delay, we think it depends on how the NW sets the reference point for the common TA. It may be feasible if the serving cell and neighbour cell are provided by the same satellite and same gNB, but this cannot be guaranteed.We think for Option a, the NW broadcast SMTC offset, offset drift and drift variation which reflect how the service link delay difference changes over time between the serving cell and a neighbour cell, and UE can determine how the feeder link delay difference changes over time between the serving cell and a neighbour cell using the UE location and ephemeris of the serving and a neighbour cell. With these two component (i.e. service link delay difference changes and feeder link delay difference changes) UE can determine how much to shift the SMTC window.  |
| Ericsson | C modified | R2-2205698 by Samsung presents a solution that can be the basis for working out the final solution to be adopted. With a variation, the solution in R2-2205698 can be made to match option C.R2-2205698 proposes that the network configures a fixed SMTC offset for SMTC valid at the neighbour gNB. This is complemented by broadcasting the difference between the feeder link delay of the neighbour satellite and the feeder link delay of the serving satellite, including drift information. The UE can determine the difference in service link delay itself, and hence the UE determine the complete gNB-UE propagation delay difference and can adjust the broadcast SMTC offset with that propagation delay difference.This, however, does not fully match any of the listed options. But a variation of the solution would match option c, if the combination of the SMTC at the neighbour gNB and the feeder link delay difference information is replaced by a broadcast SMTC offset, including offset drift information, that represents the difference in timing at the neighbour satellite vs. the serving satellite. This is equivalent to the SMTC offset and feeder link delay difference proposed in R2-2205698. What remains is the difference in service link delay between the neighbour and serving cell and the UE can determine that difference as in R2-2205698 and adjust the broadcast SMTC offset with the service link delay difference. This method matches option c and achieves the same result as the solution proposed in R2-2205698. |
| Google | Option a | For option c), common TA is not equivalent to the feeder link delay, it may contain certain part of service link delay depending on where is the reference point. If the UE adjusts the SMTC first and then applies the common TA on top of the adjusted SMTC, certain part of the service link delay will be counted twice. Therefore we think option c) is not feasible.  |
| Huawei, HiSilicon | Option c | Kmac and common TA parameters have already been designed by RAN1. If Option c is feasible, we see no need to pursue other methods.For option a), we are not sure whether RAN2 has time to determine the details of offset drift and drift variation. And option b) leaves the complexity to the network configuration, it is unclear whether the network can configure such thresholds accurately, especially for Idle mode UEs located at different locations in the cell coverage. |
| ITRI | Option a | Network has the knowledge of the ephemeris of neighbour cells and could assist UE with the SMTC offset, offset drift and drift variation of neighbour cells to assist UE in determining when to perform SMTC adjustment and the value should be adjusted for the searching and measurements of neighbour cells. |
| CATT | Option c | For service link delay, UE can calculate the delay by the satellite ephemeris, which has agreed to be broadcast. For feeder link delay, which is a cell-specific value, it can be broadcast by common TA parameters.  |
| LGE | a), but | RAN2 already confirms that the UE needs the SMTC offset and offset drift for UE-based SMCT adjustment. However, we are not sure about the necessity of the SMTC drift variation. |
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## 3.2 Where to broadcast assistance information

Another related issue is where such assistance information shall be broadcast. The answer obviously also depends on what kind of assistance information is used (e.g. the existing parameters or completely new content), but at least the following options can be found in the submitted papers:

* Additional NTN-specific SIB for neighbour satellite information [12][10]
* Use SIB19 [14][18][4]

Using the same SIB (i.e. SIB19) has a benefit of not introducing yet another system information block for NTN. However, if the NTN neighbour-related information becomes massive (for multiple neighbours and with multiple parameters, like SMTC offsets, ephemeris, etc., as discussed further in section 4) then it may be challenging to insert everything into SIB19. Thus, each option has its pros and cons. RAN2 needs to take another decision.

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| **Question 5: How is the SMTC assistance information for IDLE/Inactive mode provided?**1. **Via new NTN SIB for neighbour cells**
2. **Via SIB19**
3. **Other**
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| **Company** | **Answer** | **Comments** |
| Nokia | a) | Can be a new SIB, if it is decided to introduce such new block for other neighbour-related information as well. |
| OPPO | b) |  |
| Lenovo | b) or a) | We slightly prefer to include in SIB19, but we can also accept a new SIB if majority support this. |
| MediaTek | a) |  |
| Sony | b) |  |
| Lockheed Martin | a) |  |
| Qualcomm | b) or a) |  |
| Apple | b) or a) | Prefer b)  |
| vivo | b | We tent to put all neighbour cell related information in SIB19 with a bit-efficient signalling structure. |
| Xiaomi | b |  |
| Transsion | b) or a) | Prefer b)  |
| ZTE | Either is fine, SIB19 is preferred |  |
| Samsung | b |  |
| Ericsson | a) | Using a new NTN SIB for the broadcast of this information is preferable. One advantage is the one mentioned in the text preceding the question, i.e. that otherwise SIB19 may become overloaded with information. Another argument is that that as opposed to the content of SIB19, this information is not needed for accessing the cell and hence it can be broadcast less frequently. And since the information will not be used for calculation of the TA, it has much lower accuracy requirements than the ephemeris and common TA parameters in SIB19 and hence its validity time can be much longer and the UE therefore can re-acquire the new SIB much less frequently. In addition, as the information is only relevant for UEs in RRC\_IDLE and RRC\_INACTIVE state, putting it in a separate SIB in another SI message will ease the burden for RRC\_CONNECTED UEs to repeatedly re-acquire SIB19 when the validity timer requires it. Furthermore, an additional NTN SIB has already been agreed for IoT NTN. |
| Google | b) |  |
| Huawei, HiSilicon | b |  |
| ITRI | a | Prefer to include neighbour cell related information in a new SIB. |
| NEC | a) | we prefer to keep serving cell information and neighbouring cell information in different SIB as we did in legacy, and likely the payload size is not small. |
| Panasonic | a) | It is likely that multiple neighbours each consisting of multiple parameters need to be indicated. |
| CATT | a)  | Discuss together with Q7. |
| LGE | b) or a) | We do not have any strong views. But, we slightly prefer to b) due to the minimum impact to the spec. |

# 4 Neighbour cell information

## 4.1 On what neighbour information to provide

One more topic to address at RAN2#118 is where to provide the information concerning the NTN neighbour cells and what kind of information should be provided. This area has been covered e.g. in [2][20][21][22]. In addition, in making the final decisions in RAN2, we shall also consider RAN1 feedback sent in [23]. Based on RAN1 response, it seems we need to include the following neighbour-related information:

1. Ephemeris
2. DL and UL polarization
3. Epoch time of assistance information
4. Validity duration

Please share your opinion on the elements listed above:

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| **Question 6: Do you agree with the aforementioned list of parameters/IEs to provide regarding neighbour cells in NTN? If you find the list incomplete, please suggest what other information needs to be provided.**  |
| **Company** | **Answer** | **Comments** |
| Nokia | Yes | In line with what RAN1 requests us to do. |
| OPPO | Yes |  |
| Lenovo | Yes | We can follow RAN1’s reply. |
| MediaTek | Yes | We should follow RAN1’ suggestions |
| Sony | Yes  |  |
| Lockheed Martin | Yes |  |
| Qualcomm | Yes together with common TA parameters | Agree, we should simply follow RAN1’s reply.  |
| Apple | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes with comments  | Common TA parameters (TACommon, TACommonDrift and TACommonDriftVariation) are also included in the RAN1’s reply. So we should follow RAN1’s suggestions.  |
| Transsion | Yes | Agree with RAN#1’s suggestions. |
| ZTE | Yes | Follow RAN1’s request |
| Samsung | Yes | Reference location of neighbour cell is needed for ranking in cell reselection. |
| Ericsson | Yes, the list of parameters/IEs suggested by RAN1 is agreeable. | The carrier frequency should also be indicated. And obviously, the neighbour information should also include the SMTC information for UEs in RRC\_IDLE and RRC\_INACTIVE state, as discussed in question 4. |
| Google | Yes |  |
| Huawei, HiSilicon | Yes except c) | By c), does it mean introducing a separate epoch time for neighbour cell information? Why the epoch time for serving cell cannot be reused?RAN1 only says validity duration may be different without mentioning epoch time.***RAN1 answer:*** *Validity duration information should be provided based on neighbor cell since it may be different from the serving cell (e.g. satellite for neighbor cell is different). Further, from RAN1 perspective, the Epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) should be also provided to the UE.* |
| ITRI | Yes |  |
| NEC | Yes |  |
| Panasonic | Yes | Refer to RAN1 response. |
| CATT | Yes  | The PCI and frequency should also be included together with the above mentioned neighbour cell information. |
| LGE | Additionally, e) reference location | The UE needs the a) ephemeris information of neighbor cells to calculate the delay difference between the serving cell and neighbor cells. Accordingly, the UE also needs the c) epoch time and d) validity duration of ephemeris information. The reference location of the neighbor cell is essential as the RAN2 introduces the location-based cell reselection. The UE cannot calculate the reference location of neighbor cells only with the ephemeris information of the neighbor cell. |

## 4.2 On where to broadcast assistance information

The format needs to be decided as well. In [20] it is proposed to provide the neighbour cell assistance information in the same SIB (i.e. SIB19) as other NTN-related information. More specifically, a new sequence is proposed to be included into SIB19, which will comprise carrier frequency, PCI and the index to one of the pre-defined NTN configurations.

In [21] it is suggested to use ‘SIBXX’ (allegedly SIB19) and reduce the signalling load by using delta configuration for the ephemeris of the cells from the same satellite constellation. However, it is unclear whether the same satellite is meant (then ephemeris is the same) and whether it related to orbital or PVT part of the ephemeris (for orbital delta can be applied, for PVT not necessarily).

The authors of [22] argue a new SIB (e.g. SIB22) shall be introduced, e.g. as validity timer for serving cell (applicable to SIB19) can be different than the validity timer for neighbour cell information. Thus, a separate SIB is suggested.

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| **Question 7: Where to broadcast the neighbour cell assistance information for NTN:**1. **In SIB19**
2. **In new SIB (e.g. SIB22)**

**Please also suggest the signalling format, for example, by stating whether you agree with the proposal in [20]** |
| **Company** | **Answer** | **Comments** |
| Nokia | b) | Likely a new SIB may be needed to include all neighbour-related info. |
| OPPO | a) |  |
| Lenovo | a) or b) | We slightly prefer to include in SIB19, but we can also accept a new SIB if majority support this. |
| MediaTek | b) | A new SIB is a better choice. |
| Sony | a) |  |
| Lockheed Martin | b) |  |
| Qualcomm | b) or a) | Its better to provide SMTC assistance, neighbor satellite information together. |
| Apple | a) or b) | Prefer to use SIB19 |
| vivo | a | For the specific signalling format, we think the neighbour cell information should be at the cell level, so the carrier frequency info and PCI info need to be included in SIB19 to identify the specific inter-/intra- frequency neighbor cells. Also considering that there may be some neighbour cells that share the same assistance information, a common list of assistance information can be provided in SIB19, with each neighbor cell referring to an entry of the list as its associated information configured. We think this fashion proposed in [20] is more in line with the legacy way to avoid parameter duplication and improve bit efficiency.  |
| Xiaomi | a |  |
| Transsion | a) | For the common neighbor cell assistant information can be grouped into the same SIB, i.e. SIB19. |
| ZTE | a), SIB19 |  |
| Samsung | a |  |
| Ericsson | A new SIB. | This new SIB should be the same new SIB as the SMTC for RRC\_IDLE and RRC\_INACTIVE state will be included in (see question 5).The possible gain from providing the ephemeris as delta information is probably negligible and should not be supported.And note that the validity time for the neighbour assistance information may be much longer than for the ephemeris and common TA parameters for the serving cell in SIB19, since it will not be used for calculation of the TA, but only for adjustment of SMTC offset and to guide the direction of directional antennas or RX beamforming (for UEs that use this). |
| Google | b) | Information included in SIB19 is more essential and has to be broadcasted periodically by the network. We think the neighbour cell assistance information is not as essential as SIB19 and can be provided upon being requested (i.e., on-demand basis). |
| Huawei, HiSilicon | a |  |
| ITRI | b | We prefer to include neighbour cell related information in a new SIB. |
| NEC | b |  |
| Panasonic | b) | Similar situation as outlined in conjunction with Q5 above. |
| CATT | b) | It can avoid unnecessary signaling cost, and is a clearer way.  |
| LGE | a) or b) | We do not have any strong views. But, we slightly prefer to a) due to the minimum impact to the spec. |

As the assistance information (including the ephemeris) for neighbour cells can be largely the same (as argued in [21]), it may be desirable to use delta signalling approach, at least for the orbital part of the ephemeris. Do you support such scheme?

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| **Question 8: Do you support using delta signalling approach, at least for the orbital part of the neighbour cell ephemeris, if the cells belong to the same satellite, or satellite orbit?** |
| **Company** | **Answer** | **Comments** |
| Nokia | Yes | As we have argued in our paper, this makes sense, at least for the orbital part of the ephemeris, for the cells from the same satellite or orbit.  |
| OPPO | Maybe | But this should be consulted with RAN1 as the current ephemeris format was designed by RAN1. |
| Lenovo | Yes | As we have analysed in our contribution, at least there is no need to always indicate the same orbit in each ephemeris of multiple satellites. |
| Sony | No |  |
| Lockheed Martin | Yes |  |
| Qualcomm | Yes |  |
| Apple | Yes |  |
| vivo | Maybe No. | If the intention is to avoid duplication of the parameters with same values, we think the signalling format proposed in [20] is already sufficient and more follows the legacy way. It is more straightforward with better readability, compared with the delta signalling. Also, for the delta configuration, when a parameter is not present, it is confusing whether it means the neighbour shares the same value of the serving or the NW doesn’t configure it at all. So perhaps no delta signalling is needed. |
| Xiaomi | Yes |  |
| Transsion | Yes |  |
| ZTE | Yes |  |
| Samsung | No with comment | Delta signalling can reduce overhead, but we have same concern as OPPO and vivo. Maybe delta signalling can be discussed in Rel-18 for overhead reduction. |
| Ericsson | We support the intention, but not using delta-signalling. | For the neighbour cells that are served by the same satellite as the serving cell, the neighbour information can refer to ephemeris (and epoch time) of the serving cell ephemeris in SIB19. However, an explicit validity time should be provided, since it may be much longer than the validity time in SIB19. This is because it will not be used for calculation of the TA, but only for adjustment of SMTC offset and to guide the direction of directional antennas or RX beamforming (for UEs that use this). The validity time could be the same for the neighbour information of all neighbour cells in the same satellite constellation.Furthermore, for the neighbour cells that are served by the same neighbour satellite, the same ephemeris (including the epoch time) can be reused, i.e. indicated only once per group of neighbour cells served by the same neighbour satellite. |
| Google | Yes |  |
| Huawei, HiSilicon | Maybe | Agree with Oppo that this is more of RAN1 expertise. |
| ITRI | Yes |  |
| NEC | No strong opinion | Delta signalling could be considered if the gain is estimated big  |
| Panasonic | Yes | To be checked, in how far that approach minimises the amount of data. And to be harmonised with RAN1. |
| CATT | No | Considering that the epoch time and validity duration of serving cell can be different from the epoch time and valid duration of neighbour cells, delta signalling will bring problems to parameters update. |
| LGE | Yes, but | Suppose the neighbor cell belongs to the same satellite as the serving cell. In that case, the network removes the neighbor cell ephemeris information in SIB. |

# 5 Conclusion

The following proposals have been made in this document:

**Proposals for agreement:**

**Proposals for discussion:**

# References

1. R2-2204659 Time-based CHO after T2 Qualcomm Incorporated
2. R2-2204660 Assistance information for IDLE mode measurements in NTN Qualcomm Incorporated
3. R2-2204663 SMTC and MG configuration Qualcomm Incorporated
4. R2-2204715 Discussion on assistance information for IDLE mode and CONNECTED mode measurement
5. R2-2204964 Remaining details of UE assistance reporting and CHO Lenovo
6. R2-2205225 Remaining issues of NTN CHO Xiaomi Communications
7. R2-2205235 Further Discussion on CHO CATT
8. R2-2205304 Discussion on SMTC and gaps Huawei, HiSilicon
9. R2-2205341 CHO configuration after T2 expiry Sony
10. R2-2205372 Assistance information for neighbour cell measurement
11. R2-2205436 RIL: M404, V318, Z550 CHO configuration discarded or retained after T2
12. R2-2205438 SMTC for RRC\_IDLE and RRC\_INACTIVE state in NR NTN Ericsson
13. R2-2205529 Resolving open NTN issues for CONNECTED mode Nokia, Nokia Shanghai Bell
14. R2-2205589 SMTC Offset and Change Rate Google Inc.
15. R2-2205697 Discussion on CHO open issues Samsung Research America
16. R2-2205698 Discussion on SMTC open issues Samsung Research America
17. R2-2205957 Time-based CHO configuration after T2 InterDigital
18. R2-2205530 Assistance information for UE-based SMTC adjustment in idle and inactive mode Nokia
19. R2-2206029 UE based SMTC adjustment LG Electronics Inc.
20. R2-2204561 [V319][V305][V310] Remaining issues on signalling design and corresponding procedures for neighbour cell assistance information in NR NTN
21. R2-2204963 Remaining issues of provisioning neighbor cell satellite information Lenovo
22. R2-2205233 Discussion on Neighbor Cell Satellite Information CATT
23. R2-2204470 Reply LS to RAN2 on NR NTN Neighbour Cell and Satellite Information