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. |
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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. |
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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. |
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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**
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| **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. |
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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)  |
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# 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. |
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## 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. |
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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 |  |
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# 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