**3GPP TSG-RAN WG2 Meeting #121bis-edraft R2-2304248**

Electronic, 17th – 26th April, 2023

Agenda Item: 7.7.4.2

Source: Ericsson

Title: Report of [AT121bis-e][108][NR NTN Enh] Common (C)HO configuration (Ericsson)

Document for: Discussion, Decision

# Introduction

This document records the discussion and outcome for the following offline discussion.

* ****[AT121bis-e][108][NR NTN Enh] Common (C)HO configuration (Ericsson)****

Initial scope: Continue the discussion on potential pros and cons of a broadcast common (C)HO configuration

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 R2-2304248): Monday 2023-04-24 18:00 UTC

Proposals marked "for agreement" in R2-2304248 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).

Rapporteur encourages the participating delegates to provide their contact information in this table.

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# Discussion

## Background

In both MEO and LEO deployments, mobility connected mode is expected to be heavily impacted by rapid satellite movements. The total number of handovers per second will likely be very high and cause a significant signalling load in the network. A possible solution to the signalling overhead problem is to provide in advance the common target cell configuration via broadcast (e.g., system information) given the following conditions specific to NTN:

* Most information provided to each UE in the (C)HO command describing target cell configuration is identical for all UEs accessing the same target cell.
* Most handovers are predictable in NTN because these occur due to the movement of cells and at regular intervals. Most of UEs in the source cell will perform handover to the same target cell. Only UEs moving closer to the cell border may need to perform handover to a different target cell.
* Certain target cell configurations such as C-RNTI or security keys need to be sent in a dedicated manner to each UE.
* From a deployment perspective, during service link switch in a quasi-Earth fixed cell or a feeder link switch in an Earth-moving cell, it can be assumed that the source cell and the target cell will be configured almost identically.

During RAN2#121, the following was agreed:

* Continue in the next meeting, to show the possible signalling gain of the proposal to have some common (C)HO configuration. FFS the number of cells that could be signalled. FFS whether broadcast or groupcast signalling could be used.

The objective of this offline is to evaluate the possible signalling gains of common signalling. Note that group-based handover proposals are to be treated separately.

## Analysis *ServingCellConfigCommon*

As noted by several companies, the IE, which is part of the *RRCReconfiguration* message with *ReconfigurationWithSync*, is used to configure cell specific parameters of a UE's serving cell and could be broadcasted to all UEs to reduce handover signalling overhead. [1] propose other parameters such as t304.

The major benefit, as noted by several companies [2,3,4,5,6,7,8], is that the use of common signalling can reduce the overhead to repeat the same configurations upon frequent and predictable handover. In addition, [9] argues that this new mechanism gives flexibility to the network to finally decide whether using unicast or broadcast common (C)HO configuration depending on the situation. [2] mentions that the reduced handover command size also helps to improve the success rate of reception of *RRCReconfiguration* message.

As expressed by other companies [9,10,11,12], the principal drawbacks or issues with this solution are:

* **Support of delta signalling**. [12] clarifies that the existing handover mechanism already allows delta configuration. Given the conditions presented in the background, this existing mechanism would result in a very reduced handover message. Thus, the gains are very limited. [13] wonders if this is possible.
* **Increased overhead due to frequent transmission.** Broadcasting in system information consumes radio resources and power for both network and UEs. Sending handover configuration via broadcast may not really reduce the overall signalling if it is transmitted too frequently. [14] notes that the frequency of broadcast may negatively impact UEs in the serving cell.
* **Issues with maximum SIB size** [4,12].Depending on the information that needs to be broadcast and the number of neighbour cells that should be included, there might be limitations with SIB’s transport block maximum size.
* **Minimal reduction of overhead**. [1] shows a technical analysis with field data (taken from a fullConfig intra-frequency handover). The size of *ServingCellConfigCommon* is around 500 bits, the size of the whole *RRCReconfiguration* message is around 500 bytes. The potential signalling saving amounts to only 12,5% of the message, 500 bits per UE, the remaining 440 bytes need to be sent via a dedicated *RRCReconfiguration* message. The case of handover using *fullConfig* shows the maximum possible savings. If delta configuration is taken into consideration, any potential savings are sharply reduced.
* **Exception procedure handling**. [12] wonders how a UE behaves when it does not receive the common configuration successfully and how network can ensure that the UE has read the common configuration in SIB.

## Way forward

**Q1) Do you agree that potential gain of providing common target cell configuration in the source cell does not offset the increased complexity and signaling for network and UEs?**

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| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | From the overhead analysis, it is clear to us that gains are minimal. |
| CATT | No | **Support of delta signalling/ Minimal reduction of overhead:**  Actually, the signalling gain for common signalling is to consider the massive number of UEs which are served by NTN cells, not for single UE. Due to the predicable trajectory of the satellite, most of the UEs will be switched to the identified one or several cells. Considering the huge coverage area of NTN cells, the number of the connected UE could be very large. Hence, the same *servingConfigCommon* will be sent to a large number of UEs using dedicated signalling repeatedly via unicast mechanism. So, **common signalling reduces the signalling consumption from the network’s perspective not for single UE’s perspective.**  **Issues with maximum SIB size:**  Considering the deployment of the cell under the satellite, the number of coming cells will be small, e.g. 1 or 2. Take the following figure as one example, the number of the coming cells for Cell O may be 2. The NW doesn’t need to broadcast the common configuration to 8 neighbour cells. So **the cell size will not be so huge**.    **Increased overhead due to frequent transmission**  The network broadcasts the common configuration only when it is needed, e.g. before the stop serving time in quasi-earth fixed cell or when an amount of UE is going to lose coverage in earth moving cell. It doesn’t need to broadcast periodically as frequently as SIB1. From the UE’s perspective, only the UE facing HO needs to require the common signalling. Furthermore, whether to broadcast the common configuration is up to the NW, if massive connected UEs need to perform handover to the predicated target cell, the network can make the decision to broadcast the common configuration for HO/CHO. Otherwise, the network can choose to use the legacy HO/CHO procedure. Hence, **the broadcast will not so frequent and the overhead is small.**  **Exception procedure handling:**  We can consider introducing some indication to inform network whether the UE receive the information via SI successfully. Or just leave the UE to read the SIB1 from the target cell. Furthermore, we think it should be corner case of the UE couldn’t read the SIB successful. Since, when the UE does not receive the SIB, the whole radio environment is rather poor, the handover will probably fail either. **The exception procedure can be handled with simple solutions.** |
| Nokia | Yes | Good analysis from the Rapporteur. We agree with the observations. As also commented during online, maybe this could be adopted for a single neighbour cell in quasi EFC scenario. But even there, the signalling reduction gains compared to the use of legacy delta signalling are quite minor. |
| DOCOMO | Yes | Agree with the analysis from Rapporteur. The signalling overhead reduction gain is small compared with existing delta signalling. |
| Apple | No | We share CATT’s view.  The signalling gain for common signalling is to consider the massive number of UEs which are served by NTN cells, not for single UE.  In SAT switching scenario, there is only one upcoming cell to serve the same area, and only one target cell to be handovered by a large amount of UEs. In this scenario, the common HO configuration of up to 1 target cell can be provided in source cell. And the benefit is to save N times of common config of target cell from network perspective.  In addition, up to 1 candidate cell’s common config provided in current serving cell will not bring much burden. |
| NEC | Yes | Agree with the analysis from Rapporteur.  Moreover, this enhancement will only reduce the size of a dedicated RRC signalling but not the number of signalling for a handover. Hence it is less attractive in general than the features of RACH-less or CHO, which reduce the number of signalling. |
| Samsung | No | - Support of delta configuration  Delta signaling in HO command is used for UE dedicated configuration. UE dedicated configuration in the source cell can be different than cell common configuration in the target cell. Delta configuration is legacy operation which can always be applied, we pursue enhancements to further reduce HO overhead.  - Increased overhead due to frequent transmission  No issue. For the applicable scenario, e.g., quasi-fixed cell, there is no need to frequently broadcast/update since the upcoming target cell and the time for handover is predictable.  - Max SIB size  No issue. Normally the target cell to replace the source cell would be one or two (especially in quasi-earth fixed cell)  - Minimal reduction of overhead  Quite a lot of signaling reduction assuming 10000 UEs are handed over. We should consider number of UEs to be handed over in a limited time duration.  - Exception procedure handling  As other SIBs, typically UE can receive SIB with no issue. That can be discussed in stage 3 details. |
| MediaTek | No | Agree with Apple and CATT that common signalling needs to consider the entire set of UEs and not a single UE. |
| Lenovo | No | Agree with Apple and CATT. The benefits of common signalling, e.g. signalling overhead reduction, are for multiple UEs in the same cell. |
| vivo | No | Firstly, the potential gain of providing common target cell configuration through common signaling is huge. For the Non-GEO scenario, a large number of UEs are likely to be handed over to the same target cell, considering the large cell size of non-terrestrial networks, many UEs may be served within a single cell (the maximum number of UEs is 65519 considering the current maximum C-RNTI value) and the average HO Rate is up to 19824 UEs/sec based on the Rel-16 NR NTN SI outcome, if the HO is triggered due to the movement of the satellite. If the target cell common configuration of these UEs can be delivered via common signalling instead of respectively being signalled to the UEs via dedicated signalling, the overall HO signalling overhead in the source cell can be significantly reduced.  Secondly, the enhancement of signalling is not very complex for network and UEs. Compare to the legacy handover that UE can get all the HO configurations at once, UE obtains the handover configuration in two steps. The UE only needs to obtain the common configuration (e.g. target cell configuration) through the system information and get UE-specific configuration through dedicated signalling. |
| OPPO | No | Agree with Apple and CATT. The benefits of common signalling, e.g. signalling overhead reduction, are for multiple UEs in the same cell. |
| Huawei, HiSilicon | Yes | Agree with NEC that the mechanism reducing the number of RRC messages to be sent is more attractive. |
| ITRI | No | We share the view of CATT and Apple. The benefit of common signalling is to reduce the signalling load for multiple UE in the cell. Network can choose to use common signalling in case of massive connected UE. |
| Xiaomi | No | Even for the delta configuration, network should configure the common cell specific parameters of the target cell to all UEs by RRC signalling, which still leads to large signalling overhead.  When the common configuration of the target cell is broadcasted by the network, the network don’t need to update it frequently. For instance, the network could trigger UE to receive the common configuration in SIB before the cell stopping serving for the earth fixed cell.  Considering the satellite orbit is fixed, the target cell for UE can be predicted, thus network can only broadcast the common configuration of one target cel, and there is no issues with maximum SIB size.  For minimal reduction of overhead, if we consider there are a large number of UEs in the serving ell, the benefits for signalling overhead is obvious. |
| CMCC | No | There is value to provide common (C)HO configuration due to handover signaling overhead reduction(e.g. some message size reduction). And, considering the large coverage of a NTN cell, different coverage parts may require slightly different common signaling, and just with common signaling by broadcast may not be proper for all the UEs in the cell.Therefore, we could consider a compromise solution, for example, to combine the group HO and common (C)HO configuration, and provide common (C)HO configuration in a same group by groupcast signaling. |
| TCL | No | Agree with CATT that the common configuration can definitely bring benefits for the massive number of UEs. We can not consider it from a single UE perspective. |
| ZTE | No | Considering the number of UE supported in NTN the overall overhead can saved is still appearing. If only consider use system information to broadcast common configuration while the dedicated configuration can relies on existing RRC dedicated signalling procedure the specs impact can be acceptable considered with the gain. Regarding the system information size, I guess if only quasi-fixed scenario is considered, then the target cell for UE under current cell will be most likely the same, which can limit the target cell to only up to 1 or 2. As for the exceptional behavior, it is possible for UE to reacquire SIB, similar as SIB19. |
| Qualcomm | Yes | Unless group HO is considered, this does not bring much gain compared to overall complexity.  As we repeated mentioned, only reducing the TBS size does not help. Because massive number of UE specific signalings will anyway needed and for network it is of not much gain overall. For UE, it is additional burden of maintaining it for HO execution. |

**Q2) If the answer to Q1 is No, please explain how you would address the drawbacks presented in section 2.2 and why and which the benefits offset those drawbacks.**

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| **Company** | **Comments** |
| CATT | Please see Q1. |
| Apple | Please see Q1. |
| Samsung | Please see Q1. |
| MediaTek | As mentioned in response to Q1, the signalling gain for common signalling needs to consider the massive number of UEs which are served by NTN cells, not just a single or a few UEs. |
| Lenovo | Same as in Q1. The benefits of common signalling, e.g. signalling overhead reduction, are for multiple UEs in the same cell. |
| vivo | 1. The delta configuration is only applicable to the parameters which are optionally present upon SpCell change. For the parameters which are mandatorily present upon SpCell change, the related signalling overhead cannot be reduced. So using delta signaling is not as efficient as broadcasting common configuration to save signaling.  2. The SIB which carries the common configuration for HO will broadcast for a while before the stopping time of the serving cell. Even if the SIB needs to be broadcast many times before the stopping time of the serving cell, it will be more signaling efficient than providing configurations for each UE unicast considering large numbers of UEs are served by the cell.  3. The SIB can carry at least configuration information of one target cell. The majority of UEs in a cell need to switch to the same target cell such as the feeder link switch occurs. So the signaling overhead can be reduced for the majority of UEs by broadcasting the configuration of only one target cell.  4. See our reply to Q1, considering a large amount of UE may handover to same target cell, the overall HO signalling overhead in the source cell can be significantly reduced.  5. It is not a general case that UE cannot receive common configuration, the UEs that do not receive the configuration are at the edge of the cell, in such case, the legacy HO can be used. |
| OPPO | Agree with Lenovo and vivo. |
| ITRI | Common configuration benefits for mandatory parameters that are not used for delta configuration when a large number of connected UE need to be handover.  The common configuration would be broadcast in a short period before the triggering of handover, e.g. in a SI modification period considering LOS of NTN.  If a UE could not receive the common configuration successfully, it would be handled as failure of SI acquisition and relative procedure would be triggered. |
| Xiaomi | Please see Q1. |
| CMCC | Pls. See our comment to Q1. |
| TCL | Please see Q1. |
| ZTE | Please refer to Q1. |
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**Q3) If the answer to Q1 is No, should this enhancement be supported for:**

1. **Earth-moving cells,**
2. **quasi-Earth fixed cells,**
3. **or both?**

**Write in the comments how many neighbor cells should be included in SIB.**

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| **Company** | **A/B/C** | **Comments** |
| CATT | C | Both earth moving cell and quasi-earth fixed should be supported.  For quasi-earth fixed cell, if the upcoming cell can full cover the current serving cell, then the network just needs to broadcast the common configuration for 1 cell, and at most 2 or 3 is enough.  For earth moving cell, based on the regular deployment, the neighbour cells number included in SIB could be 1 or 2, e.g. Cell A and Cell B which replaces Cell O later.    We would like to state that, we don’t need to provide all the possible neighbour cells common configuration, but just 1 or 2 cells who can provide service for most UE in future. |
| Apple | C | We think up to 1 neigbhor cell’s common config is provided in SIB. |
| Samsung | B | One or two |
| MediaTek | C | Just one or 2 neighbour cells should be enough, as satellite trajectories are fairly deterministic and UE’s speed is negligible comparing to satellite’s speed. |
| Lenovo | C (B at least) |  |
| vivo | C | For quasi-earth fixed cell case, providing one neighbor cell is sufficient; for earth-moving cell, UEs with similar geographic locations may switch to the same target cell, multiple neighbor cells should be included in SIB. |
| OPPO | C | For quasi-earth fixed cell scenario, providing one neighbour cell is sufficient. Fo earth moving cell scenario, it could be up to network’s implementation to decide how many neighbour cells’ common configuration to be broadcasted in the source cell, i.e., it is still under network’s control. |
| ITRI | B | Support quasi-earth fixed case as the baseline. |
| Xiaomi | C | Considering the satellite orbit is fixed, the target cell for UE can be predicted, one target cell for earth fixed cell and up to 2 target cells for earth fixed cell is enough. |
| ZTE | B | It is sufficient to consider quasi-fixed scenario in this release where the target cell seen by UE served by the same satellite is the same, and limited (1 or 2) |
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# Conclusions

**For agreement:**

**For discussion:**

# References

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14. R2-2302697, Discussion on NTN 2-step handover, Intel, RAN2#121bis-e, April 2023.