**3GPP TSG-RAN WG2 Meeting #121bis-e draft R2-2304249**

**Online, Apr 17th-26th, 2023**

**Source: Samsung**

**Title: Report of [AT121bis-e][109][NR NTN Enh] RACH-less HO (Samsung)**

**Agenda item:** **7.7.4.2**

**Document for:** **Discussion and Decision**

# Introduction

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

* [AT121bis-e][109][NR NTN Enh] RACH-less HO (Samsung)

Initial scope: Continue the discussion on RACH-less HO, e.g. based on proposals in [R2-2303768](file:///C:\Data\3GPP\Extracts\R2-2303768.docx). Also discuss interactions between RACH-less HO and CHO

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 R2-2304249): Monday 2023-04-24 18:00 UTC

Proposals marked "for agreement" in R2-2304249 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).

Participating delegates are encouraged to provide contact information in this table.

|  |  |  |
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# Background

RAN2 has agreed to support RACH-less handover (HO) for NTN for Rel-18 HO enhancement. The following agreements have been made on RACH-less HO.

Agreements 121:

1. Support RACH-less Handover in Rel-18.
2. RACH-less Handover in NR NTN is a L3 mobility procedure (FFS if this is combined with the unchanged PCI approach, if supported) and uses the LTE’s RACH-less Handover procedure as a baseline. FFS on TA acquisition
3. In NTN RACH-less handover, network indicates (implicitly or explicitly) whether NTA in the target cell is identical to the source cell or explicitly provided by the NW.
4. Support dynamic grant from the target cell for RACH-less PUSCH transmission to reduce random access congestion in the target cell. FFS whether to limit the solution to same feeder link/gateway scenario

Agreements 121bis-e:

1. In Rel-18 we don’t aim at RACH-less HO for NTN-TN mobility
2. For initial UL transmission in RACH-less HO, support pre-allocated grant in RACH-less HO command

# Discussion

## Applicable scenarios

For RACH-less HO, UE has to perform UL synchronization without RA. As specified in TS 38.211 and TS 38.213, UE calculates TA, i.e., , for the first UL transmission, where

* is configured by parameter *n-TimingAdvanceOffset* or a default value is used if not configured,
* is configured by common TA parameter,
* is computed based on UE location and ephemeris.

The only uncertainty is . In LTE RACH-less, two cases are supported: N\_TA equals 0 and N\_TA equals a source serving cell. To check the feasibility for NTN, RAN2 have listed all 4 scenarios and asked RAN1 and RAN4.

1. Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB
2. Intra-satellite handover with different feeder links, i.e., with gateway/gNB switch
3. Inter-satellite handover with gateway/gNB switch
4. Inter-satellite handover with same gateway/gNB

RAN1 and RAN4 have replied respectively in R2-2300020 and R2-2301998 as follows.

|  |
| --- |
| **RAN1 response**  For scenario (1), from RAN1 perspective the RACH-less handover is possible, assuming the following notes can be satisfied, when UE UL transmission synchronization can be maintained by applying pre-compensation using the assistance information, e.g., epoch time, ephemeris, common TA, of the target cell.  For scenario (2)-(4), from RAN1 perspective the RACH-less handover may be possible, assuming the following notes can be satisfied, when UE UL transmission synchronization can be maintained by applying pre-compensation using the assistance information, e.g., epoch time, ephemeris, common TA, of the target cell.  Note 1: RAN1 assumes that the RAN4 UL synchronization requirement specified in Table 7.1C.2-1 of TS38.133 applies to the first UL transmission in the target cell.  Note 2: gNB is expected to provide valid assistance information of the target cell to UE.  Note 3: gNB is expected to ensure the UE can perform the UL transmission while respecting common TA and UE processing time.  **To RAN2:**  RAN1 respectfully asks RAN2 to take the above response into account in the future work.  **To RAN4:**  RAN1 respectfully asks RAN4 whether RAN1’s assumption in Note 1 is correct. |

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| RAN4 would like to thank RAN1 for the liaison in R1-2213001 regarding RACH-less handover in NTN.   * For NTN-NTN FR1-FR1 handover, RAN4 confirms that Note 1 in the LS (R1-2213001) is correct, i.e. the timing requirement specified in Table 7.1C.2-1 of TS 38.133 applies to the first UL transmission, including PUCCH, PUSCH, SRS, PRACH, and msgA, in the target cell, provided that * At least one SSB is available at the UE during the last 160 ms. * UE is provided with information such that the UE has valid and upon handover execution. * The network and UE have a common understanding of NTA component upon HO execution. * RAN4 assumes the determination of the value for NTA for the different scenarios is up to RAN1. * The timing requirement specified in Table 7.1C.2-1 of TS 38.133 are applicable to FR1 only and there are no requirements for other frequency ranges. * There are no existing RAN4 NR RRM requirements for RACH-less HO and additional RAN4 work will be required to introduce requirements and identify side conditions.   **To RAN1**  **ACTION:** RAN4 respectfully asks RAN1 to take the above information into consideration in their future work. |

RAN4 confirms UL synchronization requirements, which includes the requirement for N\_TA, i.e., the network and UE have a common understanding of N\_TA component upon HO execution. This can be satisfied by RAN2 agreement.

1. In NTN RACH-less handover, network indicates (implicitly or explicitly) whether NTA in the target cell is identical to the source cell or explicitly provided by the NW.

RAN4 also assumes the determination of the value for N\_TA for the different scenarios is up to RAN1.

RAN1 confirms given the RAN4 requirement is satisfied, scenario (1) is possible and scenario (2-4) may be possible.

Based on these, NTN RACH-less HO for scenario (1) is more possible than for scenario (2-4). From UE perspective, there is no difference to support RACH-less UL synchronization in different scenrios. From NW perspective, N\_TA has to be indicated to configure RACH-less HO. So it is proposed to confirm the applicable scenarios.

**Q1) Do you agree the following proposal?**

* **NTN RACH-less HO is supported for Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB;**
* **NTN RACH-less HO can be supported for intra-satellite handover with different feeder links, i.e., with gateway/gNB switch, inter-satellite handover with gateway/gNB switch, and inter-satellite handover with same gateway/gNB.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| CMCC | Yes |  |
| CATT | Yes | We share the same view as Rapporteur that NTN RACH-less HO for scenario (1) is more possible than for scenario (2-4) based on LSes from RAN1 and RAN4. |
| vivo | See comments | We agree the first bullet. For other scenarios except for intra-satellite handover with the same feeder link, the source cell can not determine the N\_TA for target cell and provide it to UE, so NTN RACH-less HO is not supported in these scenarios. |
| Thales | Yes |  |
| NEC | Yes |  |
| Xiaomi | See comments | According to the LS from RAN4, *the timing requirement specified in Table 7.1C.2-1 of TS 38.133 applies to the first UL transmission, including PUCCH, PUSCH, SRS, PRACH, and msgA*, we understand the requirements are the same for firsrt preamble and PUSCH transmission. So the NTA for the first PUSCH in the target cell is zero, which is the same as the first preamble transmission. In this way, the RACH-less handover is supported for the both 4 scenarios. |
| DOCOMO | Yes |  |
| MediaTek | Yes, but | Scenario 2-4 is also feasible as using the satellite assistance information, the UE can estimate the TA for target cell. |
| Apple | Yes |  |
| Lenovo | Yes | All scenarios can be supported, and RAN2 only need to focus on how to guarantee RAN1’s assumption for each scenario:  “assuming the following notes can be satisfied, when UE UL transmission synchronization can be maintained by applying pre-compensation using the assistance information, e.g., epoch time, ephemeris, common TA, of the target cell”. |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| TCL | Yes |  |
| ZTE | Yes | But no need to differentiate scenarios in RAN2 now, based on RAN4’s LS we can assume all scenarios are supported unless RAN1 consider the requirement proposed by RAN4 cannot be fulfilled for some cases. |
| InterDigital | Yes | Based on contents of the RAN1/RAN4 LSs, we see no need to exclude any scenario at this point. |
| Qualcomm | Yes |  |
| Transsion | Yes |  |
| ASUSTeK | Yes |  |
| Intel | Yes |  |
| Nokia | Yes, with comments | We agree that scenario 1 seems more reasonable, but we don’t think that whether scenario 2-4 is reasonable is up to RAN2. We propose to agree that RACH-less is supported for at least case 1, and let it be up to RAN1/4 whether/how the other cases should also be included |
| Continental | Yes |  |
| Sequans | Yes |  |
| Ericsson | See comments | It is clear to us from RAN1/RAN4 LSs that all scenarios are possible. Thus, we see no need to exclude any scenario at this point. If the proponents have some specific technical issue, we can ask RAN1/RAN4 to confirm. |
| LGE | Yes |  |

Summary:

For scenario 1: all 25 companies agree NTN RACH-less HO is supported for scenario 1.

For scenario 2,3,4: 23 companies think NTN RACH-less HO can be supported, among which 6 companies further commented RAN2 don’t need to exclude/distinguish scenarios. One company thinks scenario 2,3,4 cannot be supported. One company thinks whether scenario 2,3,4 can be supported is up to RAN1/4.

**(25/25) Proposal 1: NTN RACH-less HO is supported for Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB;**

**(23/25) Proposal 2: NTN RACH-less HO can be supported for intra-satellite handover with different feeder links, i.e., with gateway/gNB switch, inter-satellite handover with gateway/gNB switch, and inter-satellite handover with same gateway/gNB.**

## High-level procedure

As RAN2 has agreed LTE RACH-less HO is the baseline, and both pre-allocated and dynamic grant for initial UL transmission are supported. It would be good to first confirm the high-level procedure for NTN RACH-less HO and then further fill in detailed procedures, identify and resolve NTN-specific issues, etc.. The following high-level UE procedure is proposed. Note RACH-less HO failure is not included here, which can be further discussed.

**Q2) Do you agree the procedure for NTN RACH-less HO as follows?**

1. **receive a RACH-less HO command which can include N\_TA, preallocated grant.**
2. **start timer T304**
3. **perform DL and UL synchronization, and start timer T430**
4. **start time alignment timer**
5. **monitor PDCCH for dynamic grant if pre-allocated grant is not configured in RACH-less HO command**
6. **send initial UL transmission including RRCReconfigurationComplete message using the available UL grant**
7. **consider RACH-less HO is completed upon receiving NW confirmation**
8. **stop timer T304 and release UL grant for initial UL transmission**

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| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| CMCC | See comments | Step1 is not applicable to NTN UE, since NTN UE could derive the TA value based on ephemeris of target satellite and its own location. In addition, step 2-8 may not be mandatory considering PCI unchanged solution. |
| CATT | Yes with comments | In current procedure, it is unclear which layer, e.g. MAC or RRC, performs the corresponding behavior. So, we are wondering whether the behaviours can be categrated into layers. |
| vivo | See comments | We agree the general procedure above except for the description of N\_TA in step-1. Except for intra-satellite handover with the same feeder link, the source cell can not determine the N\_TA for target cell, so we think rach-less HO is only supported for intra-satellite handover with the same feeder link. For such a scenario, N\_TA in the target cell is identical to the source cell and does not need to be included in rach-less HO command. |
| Thales | Yes | Same comment as CATT concerning layers clarification |
| NEC | Yes | We agree the general procedure, details can be further clarified |
| Xiaomi | See comments | In the legacy, if the T304 is expired, the UE initiates the RRC re-establishment procedure, but for the RACH-less handover,considering the UE may not receive the UL grant in the target cell since too many UEs peferoms the handover at the same time, UE should perfrom the RACH based handover in the target cell. |
| DOCMO | Yes |  |
| MediaTek | Yes, but | Some more detailed discussion is needed, as UE can estimate the TA using satellite assistance information. |
| Apple | See commetns | We can understand the proposed high level procedure is to describe the procedure same as LTE RACH-less handover procedure. But we have some comments as below:  1) In step 3, it’s possible for UE to acquire the DL sync of the target cell in advance before receiving the RACH-less HO command, if the target cell is in the NTN neigbhor cell list.  2) In step 3, how UE can acquire the target cell’s UL sync is the key point for NTN HO. It's better to mark it as FFS.  3) In step 7, what's the network confirmation? Using MAC CE as LTE or considering other L1 signaling based confirmation? Maybe we should mark it as FFS.  4) In step 8, whether to release UL grant should be FFS. If network provide the type-1 configured grant in HO command, the CG can be used as the preallocated grant for the initial transmission, and also for the subsequent UL transmission.  5) General comments: we may need to indicate at which layer each step is performed.  6) General comments: is it possible that UE fallback to RACH based HO if the RACH-less HO condition can not be met? Maybe we need to keep the possibility for further discussion. |
| Lenovo | See comments | The LTE mechanism can be the baselines, with potential enhancement in procedural details for NTN, e.g.:  In Step 1, may provide information of target cell when it is not 0 or identical to that of the source cell; may provide additional information of target cell (e.g., 0, identical or specific value) to ensure UE calculates target cell TA pre-compensation.  In Step 3, UE may use information of target cell TA (e.g., , , ephemeris) provided in HO Command to calculate target cell TA pre-compensation.  In Step 5, when CHO is configured as well, UE montoring on PDCCH may not be triggered before fulfillment CHO execution condition. |
| OPPO | Agree with comments | Step 1:  **receive a RACH-less HO command which can include N\_TA, and optionally preallocated grant.**  Step 8:  **stop timer T304 and release UL grant for initial UL transmission, if it is pre-allocated.** |
| Huawei, HiSilicon | See comments | 1. The “UL synchronization” is step 3 is unclear. 2. An additional FFS is needed: FFS the modifications needed if RACH-less is combined with unchanged PCI or CHO. |
| ZTE | Yes with comments | We understand the intention is to take LTE as baseline, but the details can be further discussed. |
| InterDigital | Yes with comments | Like others, we agree that as a general baseline this is okay and details can be further clarified (e.g., as mentioned by CATT). |
| Qualcomm | Ok in general | But specific detail may need to further discussed. |
| Transsion | Yes with comments | These procedure can be a baseline, RAN2 need to further discuss on detail. |
| ASUSTeK |  | The procedures can be a baseline. The detail may need further discussion.  In step 1, the RACH-less HO command could include N\_TA, pre-allocated grant and associated beam(s), if provided by the network.  In step 5, the UE could monitor PDCCH for dynamic grant if the pre-allocated grant is not configured or not available. |
| Intel | OK in general | But according to RAN4 LS, the UE automonous TA can be applied to the first UL transmission, so it’s also feasible to not indicate N\_TA in step 1. |
| Nokia | Yes, with comments | We are fine to take as a baseline, and then discuss details on i.e. how to get ephemeris of a new cell along with the related timings.  Step 3 we propose to add “start timer T304 **for the target cell**”  Step 5 we propose to clarify that it is referring to target cell’s PDCCH |
| Continental | Agree with comments | OK to consider LTE mechanism as baseline. Some details need further discussions. |
| Sequans | Yes | As a baseline. More discussion is required for CHO/unchanged PCI and use of satellite assistance information. |
| Ericsson | Yes | Fine to take this as a baseline. FFS further enhancements and fallback mechanism. |
| LGE | Yes with comments | Step 3 is needed to be clarified: what is the “UL synchronization”? |

Summary:

Totally 24 companies have replied. The general procedure is agreeable to all.

Several companies have commented that N\_TA does not need to be indicated if it is 0. But in LTE RACH-less HO, N\_TA is always indicated, even if N\_TA is 0, it is indicated as NULL. So whether N\_TA is optional is formulated as FFS.

One company mentioned DL synchronization can be omitted if UE has acquired before receiving RACH-less HO command. But as specified in both LTE RACH-less HO procedure and in NR RACH-based HO procedure, UE starts synchronising to the DL of the target cell after starting T304, even if UE may already acquires the target cell DL timing if the target cell is a measured neighbour cell. From this viewpoint, the same procedure can be followed for RACH-less HO.

One more comment from multiple companies is that procedures per layer need to be clarified. Other comments are captured as FFS as follows.

FFS how to perform RACH-less UL synchronization to NTN target cell

FFS how to confirm RACH-less HO is successfully completed

FFS whether UL grant for initial UL transmission is released after RACH-less HO completion

FFS RACH-less HO failure handling, e.g. whether UE fallback to RACH-based HO to the target cell

FFS procedure for RACH-less HO combined with PCI unchanged or CHO if supported

**(24/24) Proposal 3: RAN2 confirms the general UE procedure for NTN RACH-less HO**

1. **receive a RACH-less HO command which can include preallocated grant optionally. FFS N\_TA is optional. (RRC)**
2. **start timer T304 for the target cell (RRC)**
3. **perform DL and UL synchronization, and start timer T430. FFS how to perform RACH-less UL synchronization to NTN target cell. (RRC, MAC)**
4. **start time alignment timer (MAC)**
5. **monitor target cell PDCCH for dynamic grant if pre-allocated grant is not configured in RACH-less HO command (MAC, PHY)**
6. **send initial UL transmission including RRCReconfigurationComplete message using the available UL grant (RRC, MAC, PHY)**
7. **consider RACH-less HO is completed upon receiving NW confirmation. FFS how to confirm RACH-less HO is successfully completed. (RRC, MAC)**
8. **stop timer T304 for the target cell. (RRC)**

**FFS whether to release UL grant if pre-alloated after RACH-less HO completion**

**FFS RACH-less HO failure handling, e.g. whether UE fallback to RACH-based HO to the target cell**

**FFS procedure for RACH-less HO combined with PCI unchanged or CHO if supported**

How to confirm RACH-less HO successful completion needs to be discussed. In LTE “UE Contention Resolution Identity MAC CE” is used to confirm RACH-less handover is successfully completed. When UE receives this MAC CE in target cell, it stops T304. Since there is no contention during RACH-less, the MAC CE body is ignored by UE, which means only the MAC CE subheader (i.e., the LCID) is actually used for this purpose. The intention is to confirm the RRCReconfigurationComplete message is received by target cell successfully. Compared to LTE RACH-less approach, other solutions can also be considered to be more efficient, e.g., the reception of PDCCH addressed to C-RNTI after the initial UL transmission.

**Q3) Which option(s) do you agree for the confirmation of RACH-less HO completion?**

**Option 1: reuse of LTE approach, i.e., UE Contention Resolution Identity MAC CE is used but UE ignores the content of this field.**

**Option 2: the reception of PDCCH addressed to the UE’s C-RNTI in target cell.**

**Option 3: the reception of UE’s C-RNTI MAC CE.**

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| **Company** | **Option(s)** | **Comments** |
| Samsung | 2 |  |
| CMCC | 1 | In LTE, option 1 has experienced a long discussion time, no need to repeat. |
| CATT | 1 | Actually, Option 1 follows the mechanism in LTE which is definitely agreeable.  Current Option 2 may not work. When the uplink grant is scheduled by PDCCH, there may be some issues. For example, the UE performs the initial transmission in the first UL grant scheduled by the PDCCH. It may happen that the network does not detect this transmission, due to poor channel condtion or uplink synchoronization issue. And the network may send the PDCCH again. From the UE’s perspective, the UE will consider this is the confirmation according to option 2. But from the network’s perspective, it still wait for the UE’s uplink transmission. This misunderstanding brings transmission failure eventually. Hence, we suggest one revision for option 2 as following:  **Option 2a: the reception of PDCCH addressed to the UE’s C-RNTI in target cell *indicating successful initial UL transmission, e.g. PDCCH inidicating one new transmission for UL and DL***.  For option 3, we think this brings new DL MAC CE, which is not necessary. |
| vivo | Option 1 |  |
| Thales | Option 1 |  |
| NEC | Option 1 | Reception of PDCCH addressed to the UE’s C-RNTI does not means a positive acknowledgement /completion, option 1 can be adopted for robustness. |
| Xiaomi | Option 1 |  |
| DOCOMO | Option1 |  |
| MediaTek | Option 1 |  |
| Apple | Option 1 and Option 2a | We think both Option 1 and Option 2a as CATT suggested can work.  Actually Option 2a is more efficient than Option 1. |
| Lenovo | Option 1 | Reuse LTE is OK. |
| OPPO | Option 1 |  |
| Huawei, HiSilicon | Option 1 |  |
| TCL | Option 1 | Reuse LTE is sufficient. |
| ZTE | Both option1.2 | Both option 1/2 is used in LTE. |
| InterDigital | Option 1 |  |
| Qualcomm | Option 2 | There is no contention to resolve here. There is no random access procedure here. |
| Transsion | Option 1 | Reuse the legacy mechanism, i.e. LTE RACH-less confirmation. |
| ASUSTeK | Option 1 or 2 |  |
| Intel | Option 1 |  |
| Nokia | Option 1 and 2 | But we can agree to reuse legacy (LTE) principle |
| Continental | Options 1 and 2a | Both options 1 and 2a are feasible.  Consider Option 2a (as suggested by CATT) instead of original Option 2. |
| Sequans | Option 1 |  |
| Ericsson | Option 1 |  |
| LGE | Option 2a | We have the same view as Apple. Option 2a is more efficient than Option 1. |

Summary:

25 companies have replied. Most companies support Option 1 to reuse LTE approach with UE contention resolution identity MAC CE. Several companies mentioned there is no contention and Option 2 PDCCH addressed to C-RNTI is more efficient. One company mentioned Option 2 may not work if NW blindly send another PDCCH for initial UL transmission. One company mentioned both Option 1 and 2 are used in LTE RACH-less HO.

**Proposal 4: for the confirmation of RACH-less HO completion**

**Option 1 (22/25): reuse of LTE approach, i.e., UE Contention Resolution Identity MAC CE is used but UE ignores the content of this field.**

**Option 2 (5/25): the reception of target cell PDCCH addressed to the UE’s C-RNTI.**

**Option 2a (3/25): the reception of target cell PDCCH addressed to the UE’s C-RNTI inidicating one new transmission for UL and DL**.

## Initial UL transmission

In LTE, the terminology “preallocated” grant is used specifically for RACH-less HO. If preallocated grant is provided in RRC RACH-less HO command, UE directly uses it and sends initial UL transmission to the target cell. In NR, configured grant (CG) is used for UL transmission without dynamic grant (DG) by PDCCH, which can be used as a baseline for the preallocated grant and to be further optimized/tailored.

The configured grant works in two schemes: for type-1 CG the actual grant for UL transmission is configured via RRC, for type-2 CG the actual grant for UL transmission is provided/activated via PDCCH. For NTN RACH-less HO, considering the long propagation delay and potential initial UL transmission storm, which scheme is used for the initial UL transmission can be discussed. For type-1, the preallocated grant can be directly used for initial UL transmission after RACH-less HO command is received, similar to type-1 CG, so there is no delay in waiting for UL grant but it may cause potential initial UL transmission storm. For type-2, the preallocated grant can be configured in RRC and activated by PDCCH, similar to type-2 CG, so delay in waiting for UL grant activation is expected but NW can more control to distribute initial UL transmissions from UEs and mitigate potential storm.

**Q4) Which option(s) do you agree for the preallocated grant?**

**Option 1: the preallocated grant is provided as type-1 CG**

**Option 2: the preallocated grant is provided as type-2 CG**

**Option 3: support both Option 1 and Option 2, but only one is configured**

**Option 4: Option 1 and Option 2 can be configured together**

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| --- | --- | --- |
| **Company** | **Option(s)** | **Comments** |
| Samsung | 1 or 3 | Option 1 is more aligned with LTE preallocated grant. Option 3 allows more flexibility. |
| CMCC | 1 | Reuse LTE mechanism. |
| CATT | 1 | Optino 2 requires PDCCH activation which brings extra latency to the whole procedure.  Option 3/4 include option 2. |
| vivo | Option 1 or option 3 |  |
| Thales | 1 | Reuse LTE solution. |
| NEC | 1 | No benefit to support Type-2 CG comparing with DG |
| Xiaomi | 1 | Prefer to use LTE mechanism. |
| DOCOMO | 1 |  |
| MediaTek | Option 1 |  |
| Apple | 1 | We donot think Option 2 can work well.  For Option 1, we think UE doesnot needs to release the type-1 CG resource after RACH-less HO completion. |
| Lenovo | 1 | Reuse LTE is OK. |
| OPPO | 1 |  |
| Huawei, HiSilicon | 1 |  |
| TCL | 1 |  |
| ZTE | Option 1 | And we can check the feasibility with RAN1. |
| InterDigital | Option 1 |  |
| Qualcomm | 1 |  |
| Transsion | Option 1 |  |
| ASUSTeK | Option 1 |  |
| Intel | 1 or 3 |  |
| Nokia | 1 |  |
| Continental | 1 or 3 |  |
| Sequans | 1 |  |
| Ericsson | Option 3 | Higher flexibility for the network to avoid signaling storm and maximize resource utilization. |
| LGE | 1 |  |

Summary:

Option 1 has 24 supporters, Option 3 has 5 supporters.

**(24/25) Proposal 5: The preallocated grant is provided as type-1 CG**

Since NTN is deployed in NR where multi-beam operation is supported, UE can select a suitable beam for UL transmission. In RACH based HO, a suitable beam (SSB/CSI-RS) is first selelcted based on a configured RSRP threshold and then the PRACH resource corresponding to the selected beam is determined. The initial UL transmission in CG-SDT can also be considered as a reference. For CG-SDT, type-1 CG is configured, a SSB is selected based on a configured RSRP threshold and the corresponding configured grant is used for initial UL transmission. Similarly, the preallocated grant can be provided with association to SSBs, and SSB selection based on a configured RSRP is performed for initial UL transmission.

**Q5) Do you agree that the preallocated grant is provided with association to SSBs?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| CMCC | FFS | In NR NTN, multiple beams operation has not been discussed in both RAN1 and RAN2, therefore we prefer to wait for RAN1 input. |
| CATT | Comments | We agree with CMCC that this is in RAN1 scope. But in CG-SDT, the solution mapping SSB and CG resources has been agreed. We think it can be considered as reference.  CG-SDT-Configuration-r17 ::= SEQUENCE {  cg-SDT-RetransmissionTimer INTEGER (1..64) OPTIONAL, -- Need R  sdt-SSB-Subset-r17 CHOICE {  shortBitmap-r17 BIT STRING (SIZE (4)),  mediumBitmap-r17 BIT STRING (SIZE (8)),  longBitmap-r17 BIT STRING (SIZE (64))  } OPTIONAL, -- Need S  sdt-SSB-PerCG-PUSCH-r17 ENUMERATED {oneEighth, oneFourth, half, one, two, four, eight, sixteen} OPTIONAL, -- Need M  sdt-P0-PUSCH-r17 INTEGER (-16..15) OPTIONAL, -- Need M  sdt-Alpha-r17 ENUMERATED {alpha0, alpha04, alpha05, alpha06, alpha07, alpha08, alpha09, alpha1} OPTIONAL, -- Need M  sdt-DMRS-Ports-r17 CHOICE {  dmrsType1-r17 BIT STRING (SIZE (8)),  dmrsType2-r17 BIT STRING (SIZE (12))  } OPTIONAL, -- Need M  sdt-NrofDMRS-Sequences-r17 INTEGER (1..2) OPTIONAL -- Need M  } |
| vivo | Yes with comments | The final decision requires RAN1 input. |
| Thales | Yes but | Wait for RAN1 input. |
| NEC | Yes |  |
| Xiaomi | See comments | It should be up to RAN1. |
| DOCOMO | Yes but | We need wait for RAN1 input. |
| MediaTek | Wait for RAN1 | It is more in the scope of RAN1 |
| Apple | Yes | We have same understanding as CATT. The CG-SDT has introduced the association between SSB and CG resource, and we can use it as baseline or reference.  We are also fine to send LS to RAN1 and ask their view. |
| Lenovo | See comments | It is up to RAN1. |
| OPPO | Yes |  |
| Huawei, HiSilicon | Up to RAN1 | Agree with CMCC that RAN1 has no clear agreement how beam management works in NTN scenario. |
| TCL | Wait for RAN1 |  |
| ZTE | Yes | Similar view as CATT, it is possible to reuse the association between SSB and CG resource rules as defined for CG-SDT. The feasibility can be further checked with RAN1. |
| InterDigital | Wait for RAN1 |  |
| Qualcomm | No | There is no enhancement for multi-beam operation in NTN and we are not sure it works in NTN. We are ok to check with RAN1. |
| Transsion | Yes with comment | RAN1 to confirm with this. |
| ASUSTeK | Yes | Can wait for RAN1. |
| Intel | Wait for RAN1 |  |
| Nokia | Yes with comments | We propose to let it be up to RAN1 |
| Continental | Up to RAN1 | As this is RAN1 scope, send LS to RAN1 and ask for RAN1’s view. |
| Sequans | Wait for RAN1 |  |
| Ericsson | FFS |  |
| LGE | UP to RAN1 |  |

Summary:

Among 25 companies, 11 tend to agree but need to confirm with RAN1, 14 companies think this is up to RAN1. All agree RAN2 asks RAN1 whether the preallocated grant is provided with association to SSBs.

**Q6) If yes to Q4, do you agree a RSRP threshold is configured for SSB selection for preallocated grant?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| CMCC | Pls. see our comment to Q5 |  |
| CATT | Comments | See Q5) |
| vivo | Yes with comments | The existing mechanism of SSB selection can be the baseline. But the final decision still requires RAN1 input. |
| NEC | Yes |  |
| Xiaomi | See comments | It should be up to RAN1. |
| DOCOMO | Yes |  |
| MediaTek | Wait for RAN1 | It is more in the scope of RAN1 |
| Apple | Yes | As our feedback in Q5, we can reuse the CG-SDT design and SSB based RSRP threshold is used to help UE select the SSB and CG resource. |
| Lenovo | See comments | It is up to RAN1. |
| OPPO | Yes |  |
| Huawei, HiSilicon | Up to RAN1 |  |
| TCL | Wait for RAN1 |  |
| ZTE | Yes | If confirmed that preallocated UL resource is associated with beam , than this is needed to guarantee a proper beam is selected for UL transmission, |
| Transsion | Yes with comment | RAN1 to confirm with this. |
| ASUSTeK | Yes |  |
| Nokia | Yes | But can be up to RAN1 |
| Continental | Up to RAN1 | As this is RAN1 scope, send LS to RAN1 and ask for RAN1’s view. |
| Sequans | Up to RAN1 |  |
| Ericsson | Postpone |  |
| LGE | Up to RAN1 |  |

Summary:

10 out of 21 companies support to introduce a RSRP threshold is configured for SSB selection for preallocated grant if preallocated grant is associated with SSBs. Almost all companies comfirms RAN1 should be asked on this.

Furthermore, several issues on initial UL transmission may involve RAN1. Considering RAN1 has no TU on NTN HO enhancement, relevant discussion can be first triggered in RAN2 to collect views and potential solutions.

One issue is about PDCCH monitoring for dynamic grant. To receive dynamic grant, UE monitors PDCCH in the target cell. Different from RACH-based handover where UE monitors PDCCH using the selected beam during the RACH procedure (i.e. the selected SSB beam for RO/preamble mapping and RAR reception), there is no RACH procedure for RACH-less handover. Hence, how to monitoring PDCCH to receive dynamic grant for the initial UL transmission needs to be considered. One possible solution is that network indicates suitable SSB beams (TCI states) in RACH-less HO command for UE to monitor PDCCH in the target cell. This can be done by the target cell as it can have beam measurement results forwarded by the source cell.

**Q7) Do you agree that from RAN2 perspective beam indication can be provided in RACH-less HO command for UE to monitor PDCCH?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| CMCC | Pls. see our comment to Q5 |  |
| CATT | Comments | See Q5) |
| vivo | No | Similar to RACH-based HO, it is more reasonable for the UE to select the beam itself than for the network to indicate the beam. |
| NEC | No | Blind scheduling and searching on all SSB beams would be the way. Not sure whether and how gNB can provide beam at target cell correctly. RAN1 would be better WG to confirm this |
| Xiaomi | No |  |
| DOCOMO | See comments | We need confirm with RAN1 for this. |
| MediaTek | No | This needs consultation with RAN1 | Wait for RAN1 | It is more in the scope of RAN1 |
| Apple | Yes |  |
| Lenovo | See comments | It is up to RAN1. |
| OPPO | Yes | To keep the principle of PDCCH monitoring in CONNECTED mode |
| Huawei, HiSilicon | Up to RAN1 |  |
| TCL | Up to RAN1 |  |
| ZTE | Yes with comments | This can be done by configuring proper TCI states |
| InterDigital | Wait for RAN1 |  |
| Qualcomm | Ok to check with RAN1 |  |
| Transsion | No |  |
| ASUSTeK | Up to RAN1 |  |
| Intel | Wait for RAN1 |  |
| Nokia | No |  |
| Continental | Up to RAN1 | As this is RAN1 scope, send LS to RAN1 and ask for RAN1’s view. |
| Sequans | Up to RAN1 |  |
| Ericsson | Postpone |  |
| LGE | Up to RAN1 |  |

Summary:

As this is more RAN1 scope, whether beam indication can be provided in RACH-less HO command for UE to monitor PDCCH is up to RAN1.

Another issue is about power control. For initial UL transmission by dynamic grant, assuming DCI can indicates power control parameters, UE follows the indicated parameters to adjust the transmission power. For initial UL transmission using preallocated grant, the first option to be consider is to follow LTE principle, where the power control follows the rules specified for PUSCH scheduled by Random access grant. Another option, considering the pre-allocated grant can be seen as a special type of configured-grant, is to consider the power control mechanism used for PUSCH scheduled by configured grant.

**Q8) Do you agree for power control of initial UL transmission using preallocated grant** **following options can be considered from RAN2 perspective? Which option is preferred?**

**Option 1: Follow the power control rule applied for PUSCH scheduled by RAR**

**Option 2: Follow the power control rule applied for PUSCH scheduled by configured grant**

**Option 3: others**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option(s)** | **Comments (e.g., other solution)** |
| CATT | Others | We think this can follow LTE but this is in RAN1 scope. |
| vivo | See comments | The discussion of power control is in RAN1 scope, we should ask RAN1 regarding this issue. |
| NEC |  | Leave this to RAN1 |
| Xiaomi | See comments | It should be up to RAN1. |
| DOCOMO | See comments | Up to RAN1. |
| MediaTek | See comments | RAN1 item, not in RAN2 scope. |
| Apple |  | Leave it to RAN1. |
| Lenovo | See comments | It is up to RAN1. |
| OPPO |  | Up to RAN1 |
| Huawei, HiSilicon | Up to RAN1 |  |
| TCL | Up to RAN1 |  |
| ZTE | Check with RAN1 | This is indeed RAN1 scope, we can list both options and check their views. |
| InterDigital | Up to RAN1 |  |
| Qualcomm | Option 2 |  |
| Transsion | See comments | It is up to RAN1. |
| ASUSTeK | Up to RAN1 |  |
| Intel | Wait for RAN1 |  |
| Nokia | Option 2, with comments | We think this is up to RAN1 |
| Continental | Up to RAN1 |  |
| Sequans | Up to RAN1 |  |
| Ericsson |  | Up to RAN1 |
| LGE | Up to RAN1 |  |

Summary:

As this is more RAN1 scope, power control for initial UL transmission in RACH-less HO is up to RAN1.

A LS needs be sent to RAN1 to inform RAN2 agreements on NTN RACH-less HO and check views on relevant issues/solutions (e.g., PDCCH monitoring for DG, power control, etc).

**Q9) Do you agree that RAN2 sends a LS to RAN1 on NTN RACH-less HO to inform RAN2 agreements and check RAN1 views on PDCCH monitoring and power control, e.g., the potential solutions discussed in Q7 and Q8, and other issues if any?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (e.g., any other aspects)** |
| CATT | Yes | We think the mapping betweem SSB and pre-allocated UL grant can also be included in the LS. |
| vivo | Yes | Potential solutions discussed in Q5 and Q6 need to be confirmed by RAN1. |
| Thales | Yes | Include Q5 and Q6 in the LS. |
| NEC | Yes |  |
| Xiaomi | Yes | Include Q5 and Q6 as well. |
| DOCOMO | Yes |  |
| MediaTek | Yes |  |
| Apple | Yes | Include all the questions we decides to ask RAN1. |
| Lenovo | Yes |  |
| OPPO | Yes | Checking with RAN1 is also ok with us. |
| Huawei, HiSilicon | Yes |  |
| TCL | Yes |  |
| ZTE | Yes |  |
| InterDigital | Yes | Agree that Q5/Q6 could also be included. |
| Transsion | Yes |  |
| ASUSTeK | Yes |  |
| Intel | Yes |  |
| Nokia | Yes |  |
| Continental | Yes | Include all RAN1-related questions. |
| Sequans | Yes |  |
| Ericsson | Yes |  |
| LGE | Yes |  |
| Samsung | Yes |  |

Summary:

All companies agree to send an LS to RAN1 informing RAN2 agreements on NTN RACH-less HO and check RAN1 views on the issues mentioned in this offline discussion.

**(23/23) Proposal 6: send an LS to RAN1 informing RAN2 agreements on NTN RACH-less HO and check RAN1 views on the following aspects,**

**1. whether the preallocated grant is provided with association to SSBs; if so, whether a RSRP threshold is configured for SSB selection.**

**2. to monitor target cell PDCCH for dynamic grant for initial UL transmission, whether beam indication can be provided in RACH-less HO command.**

**3. power control for initial UL transmission**

## Interaction between RACH-less and CHO

The combination of RACH-less HO and CHO is proposed to obtain the benefits of both. The feasibility needs to be checked first. Since the CHO execution timing is unknown, how long the preallocated grant is valid and when to send dynamic grant in PDCCH are questionable. Given the time information is available for when and how long the target cell has to reserve the RACH-less resources, time-based CHO with RACH-less handover can be possible. Another question is whether the configured N\_TA can be considered valid at CHO execution timing.

**Q10) For the combination of RACH-less HO and CHO, please comment how and in which conditions this would work, considering conditions on N\_TA, time-based event (condEventT1), preallocated grant, dynamic grant, etc.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | For NTN, since the trajectory of the satellite can be predicated, we think the time when the UL grant is valid in the target cell can also be predicated. This implies CHO combing RACH-less is feasible. |
| vivo | If rach-less HO and CHO combine, the configuration (e.g., preallocated grant) will not be suitable when the condition of CHO is fulfilled or the grant resources will be greatly wasted since the NW doesn't know when UE performs HO. To address such an issue, a lot of discussions may be needed. This topic can be de-prioritized considering there is not much time left for this release. |
| NEC | RAN2 should aim to support RACH-less CHO in all scenarios. Otherwise , we can only either avoid RACH via RACH-less handover or avoid signalling around handover time via RACH-based CHO, then handover issues in NTN scenario would be solved in half way.  At least time-based CHO can work with RACH-less without further enhancement  For other cases, necessary enhancement (it won’t be complex) can be discussed further, we are not yet running out of WI time. |
| MediaTek | Agree with CATT’s comments. |
| Apple | RACH-less HO is applicable in all NTN handover scenarios, there fore it’s feasible to support RACH-less CHO.  For TA acquisition, UE can get the TA info from the RACH-less CHO command, and use it to acquire the target cell’s TA.  For the first UL grant, if CHO is executed based on time based condition, network can predict when to provide the 1st dynamic grant and when the preallocated UL grant may be used by UE. Then there is also no problem for RACH-less CHO. |
| Lenovo | Agree with CATT and Apple. |
| OPPO | We share vivo’s views that at least preallocated grant is not suitable for CHO as it’ll cause a lot of resource waste. |
| Huawei, HiSilicon | “Combining RACH-less with CHO” bears much similarity with “combining RACH-less with unchanged PCI”, as no specific HO command will be sent, and the UE monitors target cell PDCCH for UL grant.  From our perspective, both are feasible. |
| ZTE | The joint usage of RACH-less and CHO needs further discussion, .e.g., for location-based CHO how to ensure the TA requirement is still valid and also how to reserve the resource may need to be further considered. |
| Qualcomm | Time-based CHO with RACH-less can be further considered. |
| Transsion | The CHO with RACH-less can be support for certain scenarios, RAN2 can further discuss on those scenario first. |
| Intel | Support the combination of time based CHO and RACH-less |
| Nokia | Time/location triggers are necessary to execute the HO at the right time. Otherwise, RACH-less HO could be triggered too late/early and lead to RLF  Most likely, a dynamic grant from target PDCCH is needed. |
| Continental | Agree with CATT’s and Apple’s comments. |
| Sequans | We don’t see strong issues with time based CHO and RACH-less, and think it should be supported. There are some obvious implications, e.g. the CG would need to be valid only during the CHO time window. |
| Ericsson | We don’t think NTA supposes a limitation. If the target cell has the same serving satellite and the same feeder link as the source cell, the current NTA used in the source ell can be used for access to the target cell too. In other cases, NTA = 0 should be used, i.e. relying entirely on the UE’s ability to autonomously calculate a sufficiently accurate TA. |
| LGE | We have the same view as CATT and Apple. Due to the predictability of satellite movement, the network can configure time-based CHO to be conducted at a specific time point. According to the execution time, the network can provide first dynamic grant and TA information at the execution time. |

Summary:

14 out of 17 companies are positive in supporting RACH-less HO with CHO for NTN. Other companies raised concern on the feasibility of preallocated grant, location-based CHO. Among the supporters, 10 companies think RACH-less HO can work with time-based CHO, where the timing of CHO execution is predictable. Potential issue for combining RACH-less HO and time-based CHO to be solved are 1) validity of preallocated grant and potential waste of reserved resource; 2) when/how to provide dynamic grant in PDCCH.

**(14/17) Proposal 7: RAN2 consider to support combining RACH-less HO with time-based CHO for NTN, taking into account the 1) validity of preallocated grant and potential waste of reserved resource; 2) when/how to provide dynamic grant in PDCCH.**

# Conclusions

**For agreement:**

**(25/25) Proposal 1: NTN RACH-less HO is supported for Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB;**

**(23/25) Proposal 2: NTN RACH-less HO can be supported for intra-satellite handover with different feeder links, i.e., with gateway/gNB switch, inter-satellite handover with gateway/gNB switch, and inter-satellite handover with same gateway/gNB.**

**(24/24) Proposal 3: RAN2 confirms the general UE procedure for NTN RACH-less HO**

1. **receive a RACH-less HO command which can include preallocated grant optionally. FFS N\_TA is optional. (RRC)**
2. **start timer T304 for the target cell (RRC)**
3. **perform DL and UL synchronization, and start timer T430. FFS how to perform RACH-less UL synchronization to NTN target cell. (RRC, MAC)**
4. **start time alignment timer (MAC)**
5. **monitor target cell PDCCH for dynamic grant if pre-allocated grant is not configured in RACH-less HO command (MAC, PHY)**
6. **send initial UL transmission including RRCReconfigurationComplete message using the available UL grant (RRC, MAC, PHY)**
7. **consider RACH-less HO is completed upon receiving NW confirmation. FFS how to confirm RACH-less HO is successfully completed. (RRC, MAC)**
8. **stop timer T304 for the target cell. (RRC)**

**FFS whether to release UL grant if pre-alloated after RACH-less HO completion**

**FFS RACH-less HO failure handling, e.g. whether UE fallback to RACH-based HO to the target cell**

**FFS procedure for RACH-less HO combined with PCI unchanged or CHO if supported**

**(24/25) Proposal 5: The preallocated grant is provided as type-1 CG**

**(23/23) Proposal 6: send an LS to RAN1 informing RAN2 agreements on NTN RACH-less HO and check RAN1 views on the following aspects,**

**1. whether the preallocated grant is provided with association to SSBs; if so, whether a RSRP threshold is configured for SSB selection.**

**2. to monitor target cell PDCCH for dynamic grant for initial UL transmission, whether beam indication can be provided in RACH-less HO command.**

**3. power control for initial UL transmission**

**For discussion:**

**Proposal 4: for the confirmation of RACH-less HO completion**

**Option 1 (22/25): reuse of LTE approach, i.e., UE Contention Resolution Identity MAC CE is used but UE ignores the content of this field.**

**Option 2 (5/25): the reception of target cell PDCCH addressed to the UE’s C-RNTI.**

**Option 2a (3/25): the reception of target cell PDCCH addressed to the UE’s C-RNTI inidicating one new transmission for UL and DL**.

**(14/17) Proposal 7: RAN2 consider to support combining RACH-less HO with time-based CHO for NTN, taking into account the 1) validity of preallocated grant and potential waste of reserved resource; 2) when/how to provide dynamic grant in PDCCH.**

# References

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2. [R2-2303768](file:///C:\Data\3GPP\Extracts\R2-2303768.docx) Discussion on NTN handover enhancements Samsung Research America discussion Rel-18 NR\_NTN\_enh-Core
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10. [R2-2303170](file:///C:\Data\3GPP\Extracts\R2-2303170%20Even%20Further%20Aspects%20on%20Connected-mode%20Mobility%20in%20Rel-18%20NTN.docx) Even Further Aspects on Connected-mode Mobility in Rel-18 NTN Nokia, Nokia Shanghai Bell discussion Rel-18 NR\_NTN\_enh-Core
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