**3GPP TSG RAN WG1 Meeting #113** **R1-230xxxx**

**Incheon, Korea, May 22nd – May 26th, 2023**

**Agenda item:** 9.9

**Source:** Samsung

**Title:** Discussion on how to reply to RAN2 LS on RACH-less handover

**Document for:** Discussion

# Introduction

RAN2 sent an LS (R1-2304322) to RAN1 about some issues related to RAN1 for NTN RACH-less handover.

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| RAN2 has also identified some issues which are more relevant to RAN1 and would like to check RAN1 views on the following aspects for NTN RACH-less HO. 1. Regarding the pre-allocated grant for initial UL transmission, considering the similarity to Msg1 in RACH and the similarity to the initial UL transmission in CG-SDT, where PRACH/PUSCH resource is mapped to SSBs, whether the pre-allocated grant is provided with association to SSB(s)? If yes, whether a RSRP threshold is needed for SSB selection for initial UL transmission? 2. To monitor target cell PDCCH for dynamic grant for initial UL transmission, whether beam selection is needed (e.g., performed by NW with selected beam(s) indicated, or performed by UE)? 3. Regarding the power control for initial UL transmission, whether it follows the rules specified for PUSCH scheduled by Random Access grant or by configured grant or others? |

The followings are contribution list that several companies have provided for this LS in RAN1#103.

R1-2305222 Draft Reply LS on RACH-less Handover Apple

R1-2305223 Discussion on RAN2 LS on RACH-less Handover Apple

R1-2305492 Draft reply LS on RACH-less Handover Samsung

R1-2305920 [Draft] Reply LS on RACH-less handover Ericsson

R1-2305921 Discussion on RAN2 LS on RACH-less handover Ericsson

R1-2305566 Discussion on LS on RACH-less ZTE

R1-2305925 Discussion on LS on RACH-less handover Huawei, HiSilicon

R1-2305946 Draft reply LS on RACH-less handover Huawei, HiSilicon

R1-2304450 Discussion on RAN2 LS on RACH-less Handover vivo

R1-2305442 Discussion RAN2 LS on RACH-less Handover OPPO

R1-2305443 Draft reply LS on RACH-less Handover OPPO

R1-2305313 Draft reply LS to RAN2 on RACH-less handover Qualcomm Incorporated

# Discussion

## 1st question

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| 1. Regarding the pre-allocated grant for initial UL transmission, considering the similarity to Msg1 in RACH and the similarity to the initial UL transmission in CG-SDT, where PRACH/PUSCH resource is mapped to SSBs, whether the pre-allocated grant is provided with association to SSB(s)? If yes, whether a RSRP threshold is needed for SSB selection for initial UL transmission? |

**Companies’ view:**

**Whether the pre-allocated grant is provided with association to SSB(s)?**

* Yes: Apple, Ericsson, Huawei, vivo, Samsung
* No: ZTE, OPPO, Qualcomm

**Whether a RSRP threshold is needed for SSB selection for initial UL transmission?**

* Yes: Apple, Huawei, Qualcomm, Samsung
* No: Ericsson, ZTE, OPPO

**Moderator’s observation:**

**Observation 1:** Some companies think that the association between the pre-allocated grant and SSB(s) is necessary because gNB may not know which beam direction is preferable to the UE. While some companies think that the association is not needed because there is no case where gNB doesn’t know the preferred beam direction for the UE.

**Observation 2:** One company think that RACH-based handover should be considered instead of RACH-less handover if gNB doesn’t know the preferred beam direction for the UE because the association mechanism would require more candidate PUSCH resources for beam sweeping in case of RACH-less handover.

**Observation 3:** Some companies think that RSRP threshold is necessary with different reasons: 1) to ensure reliable initial uplink transmission, 2) for determining whether to change RACH-based handover and 3) power control. On the other hand, some companies think that RSRP threshold is not necessary with different reasons: 1) the association itself is not needed and 2) *SRS-SpatialRelationInfo* for configured grant already includes SSB index that a UE would apply.

Table 1: Summary of Contributions inputs for 1st question

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| **Company** | **Contributions inputs** |
| Apple | We think the similar SSB-PRACH or SSB-PUSCH resource association mechanism could be applied to the pre-allocated grant for initial uplink transmission in NR NTN RACH-less handover. This allows target cell to learn the transmit beam to serve the UE, as well as facilitates target cell to receive the initial uplink transmission.In NR CG-SDT, a UE triggers SDT only if the measured downlink RSRP is larger than or equal to a RSRP threshold. If the measured downlink RSRP is smaller than the RSRP threshold, UE will trigger the legacy RRC resume procedure. This mechanism ensures the reliability of SDT transmissions. Similarly, to ensure the reliability of initial uplink transmission in RACH-less handover, UE needs to first compare its measured downlink RSRP with a RSRP threshold. UE is allowed to make the initial uplink transmission only if the measured downlink RSRP is larger than or equal to RSRP threshold. Otherwise, UE follows the legacy handover procedure. Hence, RSRP threshold is needed for SSB selection for initial uplink transmission.  |
| Samsung | RAN1 response: If the pre-allocated grant for initial UL transmission could be configured similarly as configured grant PUSCH for CG-SDT, RAN1 think that it is possible that the pre-allocated grant is provided with association to SSB. RAN1 think that RSRP threshold is necessary because similar mechanisms (RACH and SDT) have been already supported.  |
| Ericsson | The configured grant configuration consists of settings for the pre-allocated grant for initial UL transmission, PUSCH resource is associated via SRS resource, which in turn has a spatial relation with respect to SSB. Before the initial uplink transmission, SSB selection is already done. Therefore, RSRP threshold is not needed for SSB selection during initial UL transmission and the UE shall use the SSB it’s been provided through SSB-index in *SRS-SpatialRelationInfo*. The same can be inferred by inspecting the RRC information element *ConfiguredGrantConfig.*  |
| ZTE | In the TN system, normally, each SSB may be associated to the different beams (e.g., digital or analog) and the received signaling quality can be different due to complicated propagation channel condition, e.g., blockage of signal for certain direction. However, in NTN case, when one or multiple SSBs are associated with one beam, the UE is not expected to detect multiple SSBs with different signal quality during HO. For example, in case that single SSB is mapped to one beam, since the beam coverage is much larger than TN and different frequency reuse pattern is considered among beams, the detectable SSB at certain location will represent the proper beam for following communication. If multiple SSBs are mapped to one beam, since same satellite set-up and propagation is shared, the channel quality will be always same. Then, it’s clear that UE does not need to perform SSB selection in RACH-less HO.  |
| Huawei | For Question 1, the pre-allocated grant should be provided with association to SSB(s). For the subsequent transmission after the pre-allocated grant, the gNB needs to know the beam direction of the UE. If the SSBs are associated with pre-allocated grant, the gNB can know the downlink beam that is used to transmit PDCCH for the UE to schedule subsequent transmissions. This is similar as that used for RACH occasions. RSRP threshold is also needed for SSB selection for initial pre-configured UL transmission, otherwise UE may fail the handover due to the poor channel conditions. |
| vivo | Considering that there’s no UL transmission before the initial UL transmission in the target serving cell, the target gNB is not aware of which downlink beam is preferred by UE in time and is probably not aware of which uplink beam is better to receive the uplink transmission either except that there could be some RRM measurement reported in source cell which may be not up to data for PUSCH transmissions. Therefore, an association between SSB and the initial PUSCH transmission resource is needed.It can be seen that the initial UL transmission in RACH less handover can be either scheduled by dynamic grant or by type 1 configured grant. The association would be different for these 2 cases. For UL transmission scheduled by configured grant, a mapping between SSB and the CG PUSCH resources can be introduced similar to the SSB to CG PUSCH mapping applied in CG SDT introduced in Rel-17. For UL transmission scheduled by dynamic grant, the SSB associated to the DG PUSCH resource can be indicated in the DCI directly. For this DG PUSCH, the indicated SSB can be roughly determined based on RRM measurement of target cell reported in source cell. |
| OPPO | When the RACH-less PUSCH is performed in pre-allocated PUSCH resource, whether a similar PUSCH resource vs. SSB index mapping should be considered. We understand that the association between PUSCH resource and SSB index is only useful if the network does not have the knowledge of the best DL beam towards the UE. Thus, through the PUSCH-SSB mapping, the UE may perform a PUSCH resource selection to inform the network about the DL beam. This is also equivalent to beam-sweeping. However, this beam-sweeping would consume additional PUSCH resource. Thus there is a paradox, i.e. RACH-less allows to reduce the RO congestion, but to enable RACH-less, we need to use beam-sweeping PUSCH resources. Thus, why not directly increase the RO resources instead of using RACH-less. On the other hand, we think that before RACH-less HO, the UE would have performed RRM, where per-beam level RRM result can be available at network side, which allows the network to know the best DL beam already at target cell. Therefore, we think that if the network knows the suitable DL beam towards the UE at the target cell, there is no need to configure beam-sweeped PUSCH resources associated with different SSB index. But when the network cannot obtain the knowledge of the suitable DL beam towards the UE, the best way is to use legacy RACH based HO instead of RACH-less RO. |
| Qualcomm | In an NTN cell with more than one SSBs, UE needs to measure the RSRP of the desired SSB for the power control of the initial UL transmission. For this purpose, a RSRP threshold can be optionally configured for SSB selection. Since the ideal spatial direction for transmission and reception should always be pointing towards the satellite, regardless of which SSB the UE selects, explicit association of the pre-allocated grant to SSB(s) is not necessary given that the UE is provided the time and frequency resource for the grant. This does not prevent network from indicating the SSB index if the network knows in priori based on UE location such as source beam footprint. |

**Moderator’s suggestions for initial discussion:**

Considering the companies views, moderator think that RAN1 needs to discuss the possible scenario/feasibility for RACH-less handover together with draft reply LS.

It is moderator understanding that there is a case where gNB doesn’t know the preferred/suitable beam in some cases (e.g., overlapped two beam footprints which was shown in Figure 4.1-1 in TR 38.821 as shown in the appendix, or quasi earth-fixed beam). For the usefulness of RACH-less handover, moderator think that the signaling overhead reduction (i.e., skipping msgs 1&2) is one of motivations regardless of congestion control.

For RSRP threshold, moderator think that it may be necessary due to reliable transmission, HO failure determination, and power control. Regarding the comment about SSB-index in SRS-SpatialRelationInfo for pre-allocated grant, moderator think that it may be feasible only if gNB know the preferred/suitable beam. Otherwise, it is not clear how gNB can provide proper SSB-index which is associated SRS-SpatialRelationInfo.

### [Open] Questions:

Please provide your views in the table below regarding the following questions and initial draft reply LS

* **Q1:** Whether or not gNB is always able to know the preferred/suitable beam for a UE during RACH-less handover?
* **Q2:** If there is case where gNB doesn’t know the preferred/suitable beam for a UE, is RACH-based handover better than RACH-less handover?
* **Q3:** Is RSRP threshold necessary assuming that it considers the association between initial pre-allocated grant and SSB?
* **Draft reply LS (to be updated based on discussion on the above questions – version 1):** RAN1 think that the association between the pre-allocated grant for initial transmission and SSB index(s) may be necessary if gNB cannot determine the beam direction for a UE during RACH-less handover. Otherwise, the association may not be necessary. RAN1 think that RSRP threshold may be necessary due to improving reliability, identifying handover failure determination and power control for initial UL transmission.

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| **Company** | **Comment** |
| **Mediatek** | Q1: NoQ2: Network cannot determine this caseQ3: YesSupport draft reply LS |
| **OPPO** | For Q1: the gNB may not always certain about the preferred DL beam for a UE, which should be independent of handover mode, i.e. RACH-based or RACH-less. For Q2: In NTN handover, it can be triggered by satellite movement, leading to HO for a large number of UEs. Given that the pre-allocated grant is a per-UE based, thus we think introducing beam-sweeped pre-allocated grant may not be a good idea. Rather if gNB is uncertain about the preferred DL beam, the network may configure RACH-based HO for the UE. For Q3: see our comment in Q2 |
| **Ericsson** | Q1: Yes, gNB is always aware of the suitable beam based on the L3 measurement report that is received from the UE (before the RACH-less handover).Q2: We don’t see this case if the gNB has L3 measurement report. RACH-less handover will not work as good as RACH-based handover when there is no beam information. Q3: No. We don’t see the need for an explicit RSRP threshold if there is association between initial pre-allocated grant and SSB. There is no threshold in legacy of NR Uu and the UE transmits according to its configuration. If the UE is unable to access the target cell due to RSRP is very low and the UE chooses not to transmit in the UL,  it triggers handover failure. It can be left up to RAN2 in this case. 🡺 Moderator’s response: I would like to clarify threshold. Current specification has already supported threshold with the following RRC parameters from 38.331. RACH-ConfigCommon ::= SEQUENCE { rsrp-ThresholdSSB RSRP-Range OPTIONAL, -- Need R }rsrp-ThresholdSSB UE may select the SS block and corresponding PRACH resource for path-loss estimation and (re)transmission based on SS blocks that satisfy the threshold (see TS 38.213 [13]).  |
| **Moderator** | Thanks for inputs so far. To address concerns from OPPO/Ericsson, reply LS is updated as follows. Please share your further comments on the following updated LS. **Draft reply LS (version 2)**RAN1 think that gNB can always know the suitable beam based on the L3 measurement report. Thus, the association between the pre-allocated grant for initial transmission and SSB index(s) is not necessary for RACH-less handover.  |
| **LG** | We have similar view with Ericsson. This is because, gNB can have the cell-level and beam-level measurement results reported from the UE before RACH-less HO procedure. Therefore, Draft reply LS (version 2) seems fine for us. |
| **Apple** | Q1: No, gNB is not always able to know the suitable beam for a UE.Q2: We think RACH-less handover is beneficial and usable in this case.Q3: Yes, RSRP threshold is necessary for SSB selection for initial uplink transmission. Support draft reply LS (version 1) |
| **QC** | Q1: No, gNB may not always know the suitable beam for a UE.Q2: The answer to this question is not important. Q3. RSRP threshold can be helpful.Support version 1 with the following change: **RAN1 thinks that RSRP threshold can be helpful** …. |
| **Nokia, Nokia Shanghai Bell** | Q1: No, gNB may not always be able to know the most suitable beam for a given UE.Q2: RACH-based handover would be beneficial.Q3: Yes. |
| **Vivo**  | Q1: No. We do not think the preferred beam is known by gNB when a PUSCH resource is selected by UE. SRS has never been transmitted in target cell before UE handovers to target cell, RRM can not be used in the RACH less handover either, which is the same reason why we introduce SSB to PRACH occasion mapping for RACH based random access. Although we agree that SRS spatial relation with SSB configured in CG PUSCH configuration may be used for uplink beam association after RACH less handover, it would take quite long time for multiple SRS transmissions in future after RACH less handover. Instant SSB/CSI-RS measurement is preferred the first uplink transmission (PUSCH) in target cell given the intention of RACH less is to reduce both latency and signaling overhead..Q2: No. RACH less is preferred to reduce overhead signaling and latency.Q3: Yes. Instant SSB measurement and selection is preferred for PUSCH resource selection.Support reply LS version 1. Actually the wording “may be necessary if gNB cannot determine the beam direction for a UE during RACH-less handover” is not that clear in version 1, we’re talking about the preferred downlink beam when PUSCH is transmitted by UE, the RRM measurement may be too old for a UE to determine a corresponding uplink beam, which is also why we introduce SSB to RO mapping in RACH based random access. |
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## 2nd question

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| 2. To monitor target cell PDCCH for dynamic grant for initial UL transmission, whether beam selection is needed (e.g., performed by NW with selected beam(s) indicated, or performed by UE)? |

**Companies’ view:**

**Whether beam selection is needed?**

* Yes: Apple, Ericsson, Huawei, Qualcomm, Samsung
* No: ZTE, [OPPO]

**Moderator’s observation:**

**Observation 1:** Most companies think that beam selection is necessary for monitoring PDCCH to receive initial UL grant. Some companies think that the explicit beam indication is necessary in order to ensure QCL assumption while some companies think that implicit indication is enough.

**Observation 2:** One company thinks that beam selection is not necessary since a UE doesn’t expect to receive multiple beams in NTN. One company thinks that RACH-based handover should be considered instead of RACH-less handover if gNB doesn’t know suitable DL beam information.

**Observation 3:** One company discusses on how to select beam for PUSCH/PDSCH/PUCCH. However, since RAN2 asked only about the necessity of beam selection to monitor target cell PDCCH, moderator think that it is out of scope in this discussion.

Table 2: Summary of Contributions inputs for 2nd question

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| **Company** | **Contributions inputs** |
| Apple | In NR NTN RACH-less handover where the initial uplink transmission is scheduled by a dynamic grant, UE needs to monitor target cell PDCCH. The receive beam of this PDCCH can be selected by UE based on its measurement of SSB. Specifically, the receive beam of PDCCH for dynamic grant for initial uplink transmission is derived from the SSB receive beam which has good RSRP measurement results. Through this way, network’s explcit beam indication is not needed.  |
| Samsung | RAN1 response: RAN1 think that beam selection is necessary to monitor target cell PDCCH for dynamic grant in order that which DL RS or SS/PBCH block the UE can assume that a DM-RS antenna port for PDCCH in the CORESET is quasi co-located with. For RACH-based HO, UE use a SS/PBCH block identified during a most recent random access procedure for QCL. However, it may not be applicable to RACH-less HO since random access procedure is omitted for target cell. To resolve this issue, RAN1 think that it is necessary that gNB provides SS/PBCH block for target cell that can be used to the UE for QCL assumption for monitoring target cell PDCCH in advance. |
| Ericsson | To monitor target cell PDCCH for dynamic grant for initial UL transmission, beam selection is needed, which must be performed by NW. However, the specifications do not readily facilitate the indication of the selected beam to the UE and one potential solution is to indicate the selected beam through RRC Reconfiguration with sync, which may require specification changes.  |
| ZTE | As commented in the response for Question 1, UE is not expected to detect multiple beams in NTN due to large beam coverage. Therefore, there is no need of beam selection to monitor target cell PDCCH for dynamic grant for initial UL transmission. |
| Huawei | For Question 2, to monitor target cell PDCCH for dynamic grant for initial UL transmission, the beam selection is needed. After receiving the measurement configuration, UE measures and reports the measurements results of beam of the target cell to the network. Besides the measurement results, if the target cell is also provided with UE’s location, the gNB can figure out the beam that can serve the UE, and indicate the target beam on the target cell through the source cell to the UE for PDCCH monitoring in the target cell. However, in case the UE location is not reported, beam selection by UE is needed. The UE can choose the beam via beam selection and report the beam indication to the network.  |
| vivo | Proposal 3:* For the first PDCCH transmission in target cell to schedule initial DG PUSCH, the corresponding TCI state can be indicated in handover command in the RACH less procedure.

Proposal 4:* For PDCCH and PDSCH receptions to confirm that RACH-less HO is successfully completed, the UE may assume that the DM-RS antenna port associated with the PDCCH receptions, the DM-RS antenna port associated with the PDSCH receptions, and the SS/PBCH block associated with the initial PUSCH transmission are quasi co-located with respect to average gain and quasi co-location 'typeA' or 'typeD' properties.

Proposal 5:* The UE should transmit PUCCH with HARQ-ACK information associated with the PDSCH reception (to confirm the RACH less HO complete) using a same spatial domain transmission filter as for the last PUSCH transmission in RACH less handover.
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| OPPO | For RAN2’s second question: the second question is about the dynamic grant for initial UL transmission in RACH-less HO, where the CORESET for the PDCCH monitoring should be associated with a DL beam. This question is similar to the first question. The network may have the knowledge about the suitable DL beam towards the UE via for instance RRM procedure. Thus, the DL beam info can be directly configured for the CORESET via TCI state, i.e. in HO command the network can configure a suitable TCI state of the CORESET for the target cell. However, when network cannot obtain the information about the suitable DL beam, RACH-based HO should be used instead of RACH-less HO with beam-sweeped CORESET with the similar reasoning as we explained for the first question. |
| Qualcomm | Answer: Before monitoring target cell PDCCH, the UE needs to perform SSB detection/selection to achieve DL synchronization and read the ephemeris if needed. The network can identify the desired SSB if it knows in priori or let UE to select the SSB. |

**Moderator’s suggestions for initial discussion:**

In TS38.213, QCL assumption has been specified to monitor PDCCH as follows. In RACH-less handover, RAN1 needs to discuss on which SS/PBCH block of target cell is applied because of no random access procedure in RACH-less handover.

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| For a CORESET with index 0, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with - the one or more DL RS configured by a TCI state, where the TCI state is indicated by a MAC CE activation command for the CORESET, if any, or - a SS/PBCH block the UE identified during a most recent random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no MAC CE activation command indicating a TCI state for the CORESET is received after the most recent random access procedure. |

Considering companies views, it is moderator understanding that it is likely that gNB can know suitable DL beam information based on explicit way (e.g., RSRP measurement reports from a UE) or implicit way (e.g., satellite beam footprint) for the UE in target cell. In this case, beam selection is done by gNB, and then this information can be delivered to the UE before monitoring target cell PDCCH for dynamic grant for initial UL transmission for QCL assumption. On the other hand, if gNB cannot know exact target cell DL beam information, it is not clear for the UE about how to assume QCL because random access procedure is skipped in RACH-less handover. With this understanding, it may be reasonable to consider RACH-based random access procedure in this case.

Moderator guesses that some companies think a similar procedure like when a UE receives SIB in order to provide implicit beam selection for target cell PDCCH monitoring. However, moderator think that it may not be feasible because the UE doesn’t know which SS/PBCH block is QCL-ed with PDCCH. Also, in current specification, it seems that this operation is only applicable to PDCCH providing SIB1 in the following specification text.

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| The UE may assume that the DM-RS antenna port associated with PDCCH receptions in the CORESET configured by *pdcch-ConfigSIB1* in *MIB*, the DM-RS antenna port associated with corresponding PDSCH receptions, and the corresponding SS/PBCH block are quasi co-located with respect to average gain, QCL-TypeA, and QCL-TypeD properties, when applicable [6, TS 38.214], if the UE is not provided a TCI state indicating quasi co-location information of the DM-RS antenna port for PDCCH reception in the CORESET. |

### [Open] Questions:

Please provide your views in the table below regarding the following questions and initial draft reply LS

* **Q1:** Do you agree that SS/PBCH block information (or TCI state) should be indicated to the UE to monitor target cell PDCCH? If not, please share your reasons or alternatives.
* **Q2:** Do you agree that beam selection is not feasible for target cell PDCCH monitoring for initial dynamic UL grant in RACH-less handover if gNB cannot determine preferred/suitable DL beam? If not, please share your reasons or alternatives.
* **Draft reply LS (to be updated based on discussion on the above questions – version 1):** RAN1 think that gNB is possible to let UE know the beam information before monitoring target cell PDCCH if gNB can determine DL beam direction (spatial information) for the UE during RACH-less handover. Otherwise, it may not be feasible for RACH-less handover.

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| **Company** | **Comment** |
| **MediaTek** | Q1: YesQ2:YesSupport draft reply LS |
| **OPPO** | For Q1: CORESET TCI indication should be indicated to the UE for PDCCH monitoringFor Q2: if beam-sweeped PDCCH is introduced, the network would have to transmit the same PDCCH in multiple beams. Provided that a number of UE can perform HO due to satellite movement, the signaling overhead may become significant. 🡺 Moderator’s response: From gNB side, yes. gNB may be able to transmit same PDCCH in multiple beams. However, UE should know which RS (e.g., SS/PBCH block) is QCLed with PDCCH DMRS according to the current specification. In that sense, I’m not sure whether or not this implementation is feasible in current specification.  |
| **Ericsson** | Q1: YesQ2: Yes. But, in legacy, the gNB will be able to determine the suitable beam as long as the L3 report available. |
| **Moderator** | Thanks for inputs so far. Similar to previous question, I updated draft reply LS as follows by removing the case where gNB doesn’t know the suitable beam. Please share your further comments on the following updated LS. **Draft reply LS (version 2)**RAN1 think that gNB should indicate beam information (i.e., TCI state) for monitoring target cell PDCCH during RACH-less handover.  |
| **LG** | Similar with 1st question, gNB can have the cell-level and beam-level measurement results reported from the UE before RACH-less HO procedure. So, we think suitable beam information can be provided to the UE, for example, via HO commend.  |
| **Apple** | Q1: No, UE can measure SSB and determines by itself. Q2: We think beam selection is feasible for target cell PDCCH monitoring for initial dynamic UL grant.  |
| **QC** | Q1: No. Spatial QCL has no meaning to UE in NTN. Regardless which SSB the UE selects, it applies the same transmit/receive direction.Q2: It still feasible.We don’t think UE needs to know the spatial QCL information..  |
| **Nokia, Nokia Shanghai Bell** | Q1: YesQ2: Agree |
| **Vivo**  | Q1: Is the intention of this question about the PDCCH monitoring after initial PUSCH transmission of RACH less handover? If yes, we think UE should assume the SSB associated with the PUSCH transmission for determining such PDSCH and PDCCH monitoring for confirming RACH less handover complete message as pointed out by RAN2. Note that for DG case, we can also call the SSB beam assumed for the scheduling PDCCH monitoring as an SSB associated to the initial PUSCH transmission.Q2: Yes, gNB needs to indicate the associated SSB in handover command. |
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* **Q1:** Do you agree that SS/PBCH block information (or TCI state) should be indicated to the UE to monitor target cell PDCCH? If not, please share your reasons or alternatives.
* **Q2:** Do you agree that beam selection is not feasible for target cell PDCCH monitoring for initial dynamic UL grant in RACH-less handover if gNB cannot determine preferred/suitable DL beam? If not, please share your reasons or alternatives.

## 3rd question

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| 3. Regarding the power control for initial UL transmission, whether it follows the rules specified for PUSCH scheduled by Random Access grant or by configured grant or others? |

**Companies’ view:**

Whether it follows the rules specified for PUSCH scheduled by Random Access grant or by configured grant or others?

* RAR: [ZTE]
* Configured grant: [Apple], [Ericsson], [Qualcomm]
* Both: [OPPO], [Samsung], [vivo]

**Moderator’s observation:**

**Observation 1:** All companies think that legacy power control procedures (rule) can be used for RACH-less handover. However, it is not clear whether the same rule (e.g., either RAR grant or configured grant) is applied for both dynamic scheduled PUSCH and configured grant PUSCH or different rules are applied.

**Observation 2:** Some companies think that the power control rule specified for PUSCH scheduled by a RAR UL grant for initial UL transmission scheduled by dynamic grant.

**Observation 3:** Some companies think that the power control rule specified for PUSCH configured by a configured grant for pre-allocated grant for initial UL transmission.

Table 3: Summary of Contributions inputs for 3rd question

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| **Company** | **Contributions inputs** |
| Apple | The power control of PUSCH scheduled by random access grant (RAR) is a closed loop power control. The TPC command for PUSCH is indicated in RAR. The indicated value is an adjustment offset, which is based on the PRACH transmission power. In the initial uplink transmission, there is no baseline transmission power at UE side. Hence, the rule specified for PUSCH scheduled by RAR does not fit for initial transmission power control. In type 1 configured grant, the power control parameters (e.g., “*p0-PUSCH-Alpha*”, “*pathlossreferenceIndex*”) are configured. If the initial uplink transmission is based on pre-allocated grant, then the configuraton of pre-allocated grant could have these power control parameters. If the initial uplink transmission is based on dynamic grant, then the dynamic grant could indicate these power control parameters. With that, the power control rule specified by configured grant could be applied for initial uplink transmission.  |
| Samsung | RAN1 response: The UE can determine the power control for initial UL transmission as described in clause 7.1.1 in TS 38.213 regardless of whether the PUSCH is scheduled by dynamic grant or configured by type-1 configured grant except for path loss. If the initial UL transmission is configured grant which is designed similar to CG-SDT, path-loss is determined as described in clause 19 in TS 38.213. If the initial UL transmission is scheduled by dynamic grant, path-loss is determined by using a RS resource from SS/PBCH block that is used for QCL assumption to monitor target cell PDCCH.  |
| Ericsson | Regarding the power control for initial UL transmission, the UE follows the rules specified for PUSCH scheduled by configured grant. Specifically, pathlossReferenceIndex indicates the reference signal index used as PUSCH pathloss reference. |
| ZTE | In legacy HO with RACH, the power control for PUSCH scheduled by Random Access grant will be followed for initial UL transmission. In RACH-less HO, the main difference is that the RACH procedure is not needed to achieve UL synchronization due to UE pre-compensation. While for power control, similar rule as in legacy HO should be followed. Hence, in our view, the power control rules for PUSCH scheduled by Random Access grant should be followed for initial UL transmission in RACH-less handover. |
| Huawei | Per Question 3, regarding the power control for initial UL transmission, the rules specified for PUSCH scheduled grant can be applied with RACH-less handover.  |
| vivo | As discussed in section 2.1, SSBs can be associated to the initial PUSCH transmission for both CG PUSCH and DG PUSCH in RACH less handover. For pre-allocated initial PUSCH transmission, an SSB would be determined before the CG PUSCH resource is determined. And the pathloss reference signal for the PUSCH transmission can be determined as the selected SSB for CG PUSCH resource determination. For DG based initial PUSCH transmission, the SSB can be indicated by the PDCCH directly. Therefore, for power control of the initial PUSCH transmission, the pathloss reference can be the SSB associated to the initial PUSCH transmission.***Proposal 6:**** ***For power control of the initial PUSCH transmission, the pathloss reference is the SSB associated to the initial PUSCH transmission.***

Regarding the initial nominal power of PUSCH transmission, it can be configured in RRC in the same way as legacy. However, when it’s not configured, it can be determined as the initial target received power of PRACH in target cell since the initial target received power of PRACH can be read by UE in SIB1 of target cell although PRACH is not transmitted by this UE.***Proposal 7:******For power control of the initial PUSCH transmission, nominal power of PUSCH transmission is determined as initial target received power of PRACH in target cell when the nominal power is not configured*** |
| OPPO | For RAN2’s third question: RAN2 asks the power control rule whether it should follow PUSCH scheduled by RAR or configured grant or others. We think that for the pre-allocated configured grant based initial UL transmission, as there is no DCI scheduling, thus, the power control rule for RAR scheduled PUSCH is not suitable. It would rather follow the power control rule for MSGA transmission or CG-SDT transmission. However, for dynamic scheduling PUSCH for initial UL transmission, we can reuse the power control rule for MSG3 transmission.  |
| Qualcomm | Answer: For the initial UL transmission, the power control rules similar like that for Msg3 and MsgA may be applied. RAN1 is expected to discuss further on the subject after additional design details from RAN2. |

**Moderator’s suggestions for initial discussion:**

Considering companies view, RAN1 needs to check whether current specification can support power control for the initial UL transmission in RACH-less handover or not. The following table is power control rule for configured grant and dynamic grant (RAR UL), respectively, for determining $P\_{O\\_PUSCH,b,f,c}(j)$, $α\_{b,f,c}\left(j\right)$, $f\_{b,f,c}\left(i,l\right)$ and $f\_{b,f,c}(i,l)$ in TS 38.213.

|  |  |
| --- | --- |
| $$P\_{O\\_PUSCH,b,f,c}(j)$$ | - If a UE established dedicated RRC connection using a Type-1 random access procedure, as described in clause 8, and is not provided *P0-PUSCH-AlphaSet* or for a PUSCH (re)transmission corresponding to a RAR UL grant as described in clause 8.3,  $j=0$, $P\_{O\\_UE\\_PUSCH,b,f,c}\left(0\right)=0$, and $P\_{O\\_NOMINAL,PUSCH,f,c}\left(0\right)=P\_{O\\_PRE}+∆\_{PREAMBLE,Msg3}$, where $P\_{O\\_PRE}$ is provided by *preambleReceivedTargetPower* [11, TS 38.321] and $Δ\_{PREAMBLE\\_Msg3}$ is provided by *msg3-DeltaPreamble* or *deltaPreamble*, or $∆\_{PREAMBLE,Msg3}=0$ dB if *msg3-DeltaPreamble* and *deltaPreamble* are not provided, for carrier $f$ of serving cell $c$- For a PUSCH (re)transmission configured by *ConfiguredGrantConfig*, $j=1$, $P\_{O\\_NOMINAL,PUSCH,f,c}\left(1\right)$ is provided by *p0-NominalWithoutGrant*, or $P\_{O\\_NOMINAL,PUSCH,f,c}\left(1\right)=P\_{O\\_NOMINAL,PUSCH,f,c}\left(0\right)$ if *p0-NominalWithoutGrant* is not provided.  |
| $$α\_{b,f,c}\left(j\right)$$ | - For $j=0$, - if $P\_{O\\_NOMINAL\\_PUSCH,f,c}(0)=P\_{O\\_PRE}+Δ\_{MsgA\\_PUSCH}$ and *msgA-Alpha* is provided, $α\_{b,f,c}(0)$ is the value of *msgA-Alpha*- elseif $P\_{O\\_NOMINAL\\_PUSCH,f,c}(0)=P\_{O\\_PRE}+Δ\_{PREAMBLE\\_Msg3}$ or *msgA-Alpha* is not provided, and *msg3-Alpha* is provided, $α\_{b,f,c}(0)$ is the value of *msg3-Alpha*- else, $α\_{b,f,c}\left(0\right)=1$- For $j=1$, - else $α\_{b,f,c}(1)$ is provided by *alpha* obtained from *p0-PUSCH-Alpha* in *ConfiguredGrantConfig* providing an index *P0-PUSCH-AlphaSetId* to a set of *P0-PUSCH-AlphaSet*, or by *sdt*-*Alpha* for a PUSCH (re)transmission as described in clause 19.1, for active UL BWP $b$ of carrier $f$ of serving cell $c$ |
| $$PL\_{b,f,c}(q\_{d})$$ | - $PL\_{b,f,c}(q\_{d})$ is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index $q\_{d}$ for the active DL BWP, as described in clause 12, of carrier $f$ of serving cell $c$- If the PUSCH transmission is scheduled by a RAR UL grant as described in clause 8.3, or for a PUSCH transmission for Type-2 random access procedure as described in clause 8.1A, **the UE uses the same RS resource index** $q\_{d}$ **as for a corresponding PRACH transmission.** - For a PUSCH transmission configured by *ConfiguredGrantConfig,* if *rrc-ConfiguredUplinkGrant* is included in *ConfiguredGrantConfig*, a RS resource index $q\_{d}$ is provided by a value of *pathlossReferenceIndex* included in *rrc-ConfiguredUplinkGrant* where the RS resource is either on serving cell$c$ or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*. If the UE is provided two SRS resource sets in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with *usage* set to 'codebook' or 'nonCodebook' and for configured grant Type 1 PUSCH, first and second RS resource indexes $q\_{d}$ that are respectively associated with the first and second *srs-ResourceIndicator* in *rrc-ConfiguredUplinkGrant* are provided by respective values of *pathlossReferenceIndex* and *pathlossReferenceIndex2* in *rrc-ConfiguredUplinkGrant*. |
| $$f\_{b,f,c}(i,l)$$ | For the PUSCH power control adjustment state $f\_{b,f,c}(i,l)$ for active UL BWP $b$ of carrier $f$ of serving cell $c$ in PUSCH transmission occasion $i$- $δ\_{PUSCH,b,f,c}(i,l)$ is a TPC command value included in a DCI format that schedules the PUSCH transmission occasion $i$ on active UL BWP $b$ of carrier $f$ of serving cell $c$ or jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, as described in clause 11.3- If the UE receives a random access response message in response to a PRACH transmission or a MsgA transmission on active UL BWP $b$ of carrier $f$ of serving cell $c$ as described in clause 8- $f\_{b,f,c}\left(0,l\right)=∆P\_{rampup,b,f,c}+δ\_{msg2,b,f,c}$, where $l=0$ and |

It is moderator understanding that pre-allocated grant for RACH-less handover can follow existing power control rule for configured grant PUSCH according to the current specification. However, for dynamic grant (i.e., RAR UL grant) for RACH-less handover, the pathloss determination is unclear because the UE applies the same RS resource index $q\_{d}$ as for a corresponding PRACH transmission as stated in the current specification, and RACH-less handover doesn’t have PRACH transmission. Except for that, dynamic grant for RACH-less handover can follow existing power control rule for RAR UL grant PUSCH according to the current specification.

For PUSCH power control adjustment, moderator thinks that since current specification has the condition such as “If the UE receives a random access response message in response to a PRACH transmission”, the power control adjustment based on PRACH transmission power is not applicable in RACH-less handover. Thus, there is no issue, and it is understood that it can follow power control adjustment for normal PUSCH transmission.

### [Open] **Questions:**

Please provide your views in the table below regarding the following questions and initial draft reply LS

* **Q1:** Do you agree that the initial UL transmission (configured by type 1 configured grant) in RACH-less handover follows power control rule for type-1 configured grant PUSCH in the current specification? If not, please provide reason(s) and alternative(s).
* **Q2:** Do you agree that the initial UL transmission (scheduled by dynamic grant) in RACH-less handover follows power control rule for Msg3 (or MsgA) PUSCH except for path-loss determination in the current specification? If not, please provide reason(s) and alternative(s).
* **Q3:** To resolve the ambiguity on path-loss determination for initial UL transmission scheduled by dynamic grant, which option do you prefer in the following options if path-loss determination is not clear in the current specification for RACH-less handover?
	+ Option 1: the UE calculates $PL\_{b,f,c}(q\_{d})$ using a RS resource from an SS/PBCH block with same SS/PBCH block index as the one the UE uses to obtain *MIB*
	+ Option 2: the UE calculates $PL\_{b,f,c}(q\_{d})$ using a RS resource index $q\_{d}$ with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero
	+ Option 3: the UE calculates $PL\_{b,f,c}(q\_{d})$ using a RS resource from an SS/PBCH block with same SS/PBCH block index as the one the UE uses to monitor PDCCH scheduling dynamic UL grant for initial transmission
	+ Option 4: else…
* **Draft reply LS (to be updated based on discussion on the above questions – version 1):** For the initial UL transmission (configured by type 1 configured grant) in RACH-less handover, RAN1 think that it follows power control rule for type-1 configured grant PUSCH as described in clause 7.1.1 in TS 38.213. For the initial UL transmission (scheduled by dynamic grant) in RACH-less handover, RAN1 think that it follows power control rule for Msg3 (or MsgA) PUSCH as described in clause 7.1.1 in TS 38.213 except for pathloss determination. For pathloss determination, RAN1 is discussing on details for RACH-less handover.

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| **Company** | **Comment** |
| **MediaTek** | Q1: YesQ2: YesQ3: can be further discussedSupport draft reply LS |
| **OPPO** | Q1: agreeQ2: agreeQ3: option 3. In our understanding, the network should indicate CORESET QCL info for the target cell to the UE regardless the RACH-less is based on pre-allocated grant or dynamic grant.  |
| **Ericsson** | Q1: YesQ2: YesQ3: We think option 1 and option 3 can be feasible. For the dynamic grant case, further discussion is needed in RAN1 to get a common understanding related to all the available options.  |
| **Moderator** | Thanks for inputs so far. Regarding path-loss determination, if RAN1 can make common understanding for the certain option in this meeting, we can update reply LS. Otherwise, I think that we can still send reply LS to RAN2 with current version 1 because it doesn’t have any impact to RAN2. If necessary, I think that we will be able to send another LS for path-loss determination to RAN2 if we make common understanding in next meeting.  |
| **LG** | Agree with Moderator’s updated comment. Also, we slightly prefer Option 3.  |
| **Apple** | Q1: YesQ2: YesQ3: can be further discussed.We suggest that for both configured grant and dynamic grant initial UL transmission, it follows power control rule for type-1 configured grant PUSCH as described in clause 7.1.1 in TS 38.213 to avoid further discussions on Q3.  |
| **QC** | Q1: Not exactly. For instance, pathlossRS can be different.Q2: power adjustment state can also be different from the existing one.Q3: Option 1/3 with some modification.Suggested reply: RAN1 will further discuss the issue. |
| **Nokia, Nokia Shanghai Bell** | Q1: YesQ2: YesQ3: Option 1 or 3. |
| **Vivo**  | Q1: No if the CG Type 1 means the normal CG PUSCH transmissions in RRC connected state. Yes if the CG Type 1 means the CG PUSCH transmissions for SDT transmission as specified in section 19.1 of 38.213.The pathloss RS should be the SSB associated to the initial PUSCH transmission similar to initial PUSCH transmission for SDT introduced in Rel-17, as we discussed separately.Q2: Yes.Q3: Pathloss RS should be the SSB associated to the initial PUSCH transmission assuming that for DG case, we can also call the SSB beam assumed for the scheduling PDCCH monitoring as an SSB associated to the initial PUSCH transmission. |
|  |  |

# Appendix

## RAN2 agreement

Agreements RAN2#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 RAN2#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
3. NTN RACH-less HO is supported for Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB;
4. 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.
5. RAN2 confirms the general UE procedure for NTN RACH-less HO

 1. receive a RACH-less HO command which can include pre-allocated 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-allocated 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

4. The pre-allocated grant is provided as type-1 CG

5. At least for pre-allocated grant, for the confirmation of RACH-less HO completion we reuse of LTE approach, i.e., UE Contention Resolution Identity MAC CE is used but UE ignores the content of this field. FFS if anything else is needed for dynamic grant

6. Consider to support combining RACH-less HO with time-based CHO for NTN, taking into account the 1) validity of pre-allocated grant and potential waste of reserved resource; 2) when/how to provide dynamic grant in PDCCH.

## TR 38.821 (NTN overview)

A non-terrestrial network refers to a network, or segment of networks using RF resources on board a satellite (or UAS platform).

The typical scenario of a non-terrestrial network providing access to user equipment is depicted below:



Figure 4.1-1: Non-terrestrial network typical scenario based on transparent payload