**3GPP TSG RAN WG1 Meeting #114** **R1-230xxxx**

**Toulouse, France, August 21st – August 25th, 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 the issues related to RAN1 for NTN RACH-less handover in RAN1#113.

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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? |

At that time, it was discussed on how to reply the above RAN2 questions, and the following RAN1 responses were agreed for reply LS, but some of issues have not been resolved yet.

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| For Q1 (pre-allocated grant)  **Agreement**  One company thinks that when the network knows the suitable DL beam for RACH-less handover, the pre-allocated grant can be associated with a SSB index of the target cell, and when the network does not know the suitable DL beam, RACH-based HO can be used instead of introducing beam-sweeped pre-allocated grants associated with multiple SSB indexes. Other companies think that the association between the pre-allocated grant for initial transmission and SSB index should be supported without any condition(s), and think that RSRP threshold may be helpful.  For Q2 (target cell PDCCH monitoring)  **Agreement**  If single beam is indicated, UE will monitor the target cell PDCCH scheduling the first PUSCH based on the indicated beam. RAN1 will further discuss the case where multiple beams are indicated. |

To resolve remaining issues, the followings are submitted by interested companies in RAN1#104.

R1-2306489 Further discussion on the reply of question 3 in the LS for RACH-less handover Huawei, HiSilicon

R1-2306706 Discussions on RAN2 LS on RACH-less Handover vivo

R1-2307257 Draft Reply LS on RACH-less Handover Apple

R1-2307256 Discussion on RAN2 LS on RACH-less Handover Apple

R1-2307548 Discussion RAN2 LS on RACH-less Handover OPPO

R1-2307637 Discussion on reply LS on RACH-less handover Samsung

R1-2307775 Discussion on RAN2 LS on RACH-less handover Ericsson

# 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?  For Q1 (pre-allocated grant)  **Agreement**  One company thinks that when the network knows the suitable DL beam for RACH-less handover, the pre-allocated grant can be associated with a SSB index of the target cell, and when the network does not know the suitable DL beam, RACH-based HO can be used instead of introducing beam-sweeped pre-allocated grants associated with multiple SSB indexes. Other companies think that the association between the pre-allocated grant for initial transmission and SSB index should be supported without any condition(s), and think that RSRP threshold may be helpful. |

Vivo suggested two proposals related 1st question as follows.

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| **Proposal 1:**   * **For RACH less handover, introduce SSB to CG PUSCH resource mapping for CG PUSCH and indicate the SSB associated to the DG PUSCH in the DCI scheduling the PUSCH.**   **Proposal 2:**   * **For RACH less handover, reuse SSB to CG PUSCH resource mapping in SDT as much as possible and indicate a subset of SSBs in handover command for SSB to CG PUSCH resource mapping.** |

It is moderator’s understanding that RAN1 doesn’t need to discuss further in details on top of the reply LS agreed in RAN1#113. It would be good to hear other companies’ view for vivo’s proposals.

### **Questions:**

Do you think that vivo’s two proposals should be discussed further, if so, why?

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| **Company** | **Comment** |
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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)?  For Q2 (target cell PDCCH monitoring)  **Agreement**  If single beam is indicated, UE will monitor the target cell PDCCH scheduling the first PUSCH based on the indicated beam. RAN1 will further discuss the case where multiple beams are indicated. |

**Companies’ view:**

**Whether to support the case where multiple beams are indicated?**

* Support (beam selection based on SSB measurement): Apple
* Support (beam selection based on TCI state): vivo
* Not support: Samsung, OPPO

**Moderator’s observation:**

**Observation 1:** Two companies think that multiple beams can be indicated. This is because a UE is likely to be located in coverage edges of two beams. Regarding beam selection, one company think that a UE would select a beam based on SSB measurement to monitor PDCCH scheduling dynamic grant PUSCH, and the other one company think that source cell can provide PDCCH monitoring beam information to target cell.

**Observation 2:** Two companies think that multiple beams cannot be indicated. Reason is that there is no motivation from gNB side to indicate multiple beams (e.g., gNB should provide same PDCCH content using different PDCCH resources with different beam directions if gNB doesn’t know preferred beam information), and then RACH-based handover is better than RACH-less handover.

Table 2: Summary of Contributions inputs for 2nd question

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| **Company** | **Contributions inputs** |
| Apple | In RACH-less handover, it is possible that a UE is located at the coverage edges of two beams. Subsequently, in NR NTN RACH-less handover where the initial uplink transmission is scheduled by a dynamic grant, network may indicate multiple (candidate) beams for PDCCH reception at UE side. The TCI states of these multiple beams could be indicated to UE. 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 the best RSRP measurement results. Through this way, UE is able to select the receive beam of PDCCH.  ***Proposal 1:*** *If multiple beams are indicated during RACH-less handover, the receive beam of PDCCH for dynamic grant for initial uplink transmission is selected by UE based on its measurement of SSB.* |
| vivo | According to current spec., uplink measurements or uplink transmissions are always needed for determining the relevant DL RS beam unless the uplink resources are mapped to SSBs. For the first PDCCH reception in target cell to schedule DG PUSCH, although there’s no uplink transmission in target cell, source cell may report the downlink RRM measurements of target cell to the target cell so that downlink beam preferred by UE for this PDCCH transmission can be known by target cell before triggering RACH less handover. Therefore, the PDCCH beam can be indicated in the handover command.  ***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.*** |
| Samsung | if multiple beams are indicated from NW, UE behavior is unclear because the UE doesn’t know which beam the UE should assume for QCL assumption. Following options are to be considered in order to resolve the problem.   * Option 1: UE doesn’t expect to have multiple beam indications from NW. * Option 2: UE assumes lowest (or largest) beam index if multiple beams are indicated from NW. * Option 3: UE reports the best beam to NW to monitor target cell PDCCH   We think that all options would work since it provides clear UE behavior and NW can schedule PDCCH for scheduling PUSCH for RACH-less handover by considering this aspect. However, it should discuss the motivation of indicating multiple beams first before discussing details. If gNB doesn’t know preferable beam for the UE, then it might be possible to indicate multiple beams so that the UE can choose one of them for monitoring target cell PDCCH scheduling PUSCH. However, it requires additional UE reporting to let NW know the best beam. Accordingly, considering RACH-based handover might be reasonable instead of RACH-less handover in that case.  **Proposal 1: For RACH-less handover, UE doesn’t expect that multiple beams are indicated from NW.** |
| OPPO | However, when network cannot obtain the information about the suitable DL beam, one proposal discussed in RAN1/2 is to let the network to indicate multiple beams and leave UE to select the best beam. It is to note that with this it implies that the network has to transmit the same PDCCH content as well as to reserve the PUSCH resources in multiple beams, which drastically reduces the spectrum efficiency, in particular for the case where a number of UEs are performing RACH-less HO.  It is clear that the main motivation to support RACH-less PUSCH transmission is to reduce the RACH congestion in the target cell. But we should also bear in mind that if the network is afford to increase the RO resource, it can naturally reduce the RACH congestion as well. This is an important observation to be considered later when it comes to the RAN2’s questions in LS.  Proposal : Response to RAN2’s second question: If the network does not know the suitable DL beam, it would be more reasonable to use RACH-based HO instead of RACH-less HO with beam-sweeped CORESET. |

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

Since only 4 companies provided their views on the necessity of the case where multiple beams are indicated and views are diverged, moderator think that getting more views is necessary before drafting reply LS for the case.

### Questions:

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

* **Q1:** Do you think that the case where multiple beams are indicated is necessary? If necessary, what additional benefit do you think on top of considering RACH-based handover?
* **Q2:** If multiple beams are indicated, what method(s) do you have in mind in order to select the beam to monitor PDCCH, and why?

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| **Company** | **Comment** |
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## 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:**

For the power control for initial UL TX, reuse rules for Type-1 configured grant in section 7.1.1 in TS 38.213. For the power control for initial UL TX, reuse rules for dynamic grant in section 7.1.1 in TS 38.213 except for the path-loss determination.

* Huawei, Apple, vivo, Samsung, [Ericsson]

For path-loss determination for initial UL transmission scheduled by dynamic grant, which one is considered among the following options?

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| * Option 1: the UE calculates 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 using a RS resource index with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero * Option 3: the UE calculates 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 3: Huawei, Apple, vivo, Samsung

**Moderator’s observation:**

**Observation 1:** All companies think that existing power control rule can be applicable to initial UL transmission. For path-loss determination for initial UL transmission scheduled by dynamic grant, most companies think that the UE calculates 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.

Table 3: Summary of Contributions inputs for 3rd question

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| **Company** | **Contributions inputs** |
| Huawei | Since the PDCCH scheduling dynamic UL grant for initial transmission is from the target cell, it is more beneficial and accurate for UE to calculate the path-loss directly using a RS resource from an SSB/PBCH block with the same index as the one UE uses to monitor PDCCH.  Option 1 does not particularly specify relationship between the SSB/PBCH block and the target cell, thus there is a possibility that UE calculates the path-loss using a RS resource from adjacent beams. Per Option 2, using a RS resource index with a *PUSCH-PathlossReferenceRS-Id* equal to 0 only does not specifically indicate a reference signal, which may not be accurate. |
| Ericsson | Alternatively, if pre-allocated grant is not configured in RACH-less HO command, then the UE monitors target cell PDCCH for dynamic grant. In such case, the UE can utilize the existing procedure of power control for PUSCH scheduled by DCI, including the pathloss reference. Specifically, Section 7.1.1 in TS38.213 covers also the computation of the pathloss estimate when the PUSCH is scheduled by DCI with different formats, including format 0\_0, format 0\_1, etc.   1. If the UE monitors target cell PDCCH for dynamic grant during RACH-less HO, then the UE utilizes the existing procedure of power control for PUSCH scheduled by DCI in section 7.1.1 of TS38.213, including the pathloss reference while estimating the downlink pathloss.   In Section 7.1.1, there exist different power control rules for PUSCH scheduled by DCI format 0\_0 and DCI format 0\_1. Depending on the DCI format used in the target cell PDCCH, the UE applies the corresponding power control rule. To make it clear, RAN1 needs to discuss this further and agree on the DCI format to be used in the target cell PDCCH for dynamic grant during RACH-less HO.   1. There exist different power control rules for PUSCH scheduled by DCI format 0\_0 and DCI format 0\_1 in Section 7.1.1 of TS38.213. 2. RAN1 needs to discuss this further and agree on the DCI format to be used in the target cell PDCCH for dynamic grant during RACH-less HO. |
| 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 derived by the PDCCH beam discussed in previous section.  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.*** |
| Apple | In type 1 configured grant, the power control parameters (e.g., “*p0-PUSCH-Alpha*”, “*pathlossreferenceIndex*”) are configured. If the initial uplink transmission in RACH-less handover is based on pre-allocated grant, then the configuraton of pre-allocated grant could have these power control parameters. Subsequently, the power control for initial uplink transmission follows the power control rule for type 1 configured grant.  If the initial uplink transmission is scheduled by a dynamic grant, then the power control for initial uplink transmission could follow the power control rule for Msg3 PUSCH. In the current power control rule for Msg3 PUSCH, a UE uses the same RS resource index as for a corresponding PRACH transmission. In RACH-less handover, there is no PRACH transmission. Hence, we think the pathless determination is based on an SSB which the UE uses to monitor PDCCH scheduling dynamic uplink grant for initial transmission.  ***Proposal 2:*** *The power control for initial uplink transmission follows*   * *the power control rule for type 1 configured grant, if the initial uplink transmission is scheduled by a pre-allocated grant.* * *the power control rule for Msg3 PUSCH, if the intial uplink transmission is scheduled by a dynamic grant, where*    + *the pathloss determination is based on an SSB which the UE uses to monitor PDCCH scheduling dynamic uplink grant for initial transmission.* |
| Samsung | In last RAN1 meeting, there was a discussion on whether existing power control can be applicable to initial PUSCH transmission during RACH-less handover. Actually, most companies have thought that existing power control rule can be reused except that path-loss determination in case of dynamic scheduled PUSCH. This is because the UE applies the same RS resource index as for a corresponding PRACH transmission as stated in the current specification, and RACH-less handover doesn’t have PRACH transmission. With that reason, following alternatives were discussed.   * + Option 1: the UE calculates 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 using a RS resource index with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero   + Option 3: the UE calculates 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   We think that option 3 should be straightforward since single (SSB) beam is indicated to the UE for monitoring target cell PDCCH, and then this information can be used for path-loss measurement.  **Proposal 2: Support option 3 for pathloss measurement in case of dynamic scheduled initial PUSCH for RACH-less handover.**   * **Option 3: the UE calculates 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** |

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

Considering companies view, it is moderator’s understanding that existing power control rule can be reused for initial transmissions 1) provided by configured grant and 2) scheduled dynamic grant, respectively. For path-loss determination, most companies think that option 3 is straightforward. Accordingly, we can conclude reply LS based on the views. Also, since power control is RAN1 issue, it is expected that RAN spec would be updated when RACH-less handover is finalized in RAN2. That’s why moderator think that the corresponding RAN1 agreement is necessary other than reply LS to RAN2.

### **Questions:**

Please provide your views in the table below regarding a proposal and an initial draft reply LS.

* **Proposal:** For pathloss measurement in case of dynamic scheduled initial PUSCH for RACH-less handover, the UE calculates 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.
* **Draft reply LS:** 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, the UE use 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.

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| **Company** | **Comment** |
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# 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.

## Power control rule specified in TS38.213

The following table is power control rule for configured grant and dynamic grant (RAR UL), respectively, for determining , , and in TS 38.213.

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|  | - 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,  , , and ,  where is provided by *preambleReceivedTargetPower* [11, TS 38.321] and is provided by *msg3-DeltaPreamble* or *deltaPreamble*, or dB if *msg3-DeltaPreamble* and *deltaPreamble* are not provided, for carrier of serving cell  - For a PUSCH (re)transmission configured by *ConfiguredGrantConfig*, , is provided by *p0-NominalWithoutGrant*, or if *p0-NominalWithoutGrant* is not provided. |
|  | - For ,  - if and *msgA-Alpha* is provided, is the value of *msgA-Alpha*  - elseif or *msgA-Alpha* is not provided, and *msg3-Alpha* is provided, is the value of *msg3-Alpha*  - else,  - For ,  - else 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 of carrier of serving cell |
|  | - is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index for the active DL BWP, as described in clause 12, of carrier of serving cell  - 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 as for a corresponding PRACH transmission.**  - For a PUSCH transmission configured by *ConfiguredGrantConfig,* if *rrc-ConfiguredUplinkGrant* is included in *ConfiguredGrantConfig*, a RS resource index is provided by a value of *pathlossReferenceIndex* included in *rrc-ConfiguredUplinkGrant* where the RS resource is either on serving cell 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 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*. |
|  | For the PUSCH power control adjustment state for active UL BWP of carrier of serving cell in PUSCH transmission occasion  - is a TPC command value included in a DCI format that schedules the PUSCH transmission occasion on active UL BWP of carrier of serving cell 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 of carrier of serving cell as described in clause 8  - , where and |