3GPP TSG-RAN WG1 Meeting #110bis-e R1-22nnnnn

e-Meeting, October 10th – 19th, 2022

Agenda Item: 9.1.1.2

Source: Moderator (Ericsson)

Title: Moderator Summary #2 on Two TAs for multi-DCI

Document for: Discussion & Decision

1 Introduction

During RAN#94e, a new WID for Rel-18 MIMO evolution for DL and UL was agreed [26]. The highlighted Part of objective 7 is relevant for this AI:

1. Study, and if justified, specify the following
	* Two TAs for UL multi-DCI for multi-TRP operation
	* *Power control for UL single DCI for multi-TRP operation where unified TCI framework extension in objective 2 is assumed.*

For the case of simultaneous UL transmission from multiple panels, the operation will only be limited to the objective 6 scenarios.

In this summary, proposals and views expressed on the proposals are summarized.

# 2 Association between TAs and UL channels/signals

The following feedback was received related to association between TAs and UL channels/signals in the first round by companies:

FL’s reply to each comment by company is provided with below:

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | For Alt-1, the design is simple and flexible to be extended to other cases like L1/L2 mobility. The only drawback is that it cannot be used for FR1 under legacy TCI framework.For Alt-2, we have strong concern.* Firstly, as listed by the FL, it requires huge spec impact as there are many types of UL channel/RS and the principle for the association between each type of channel/RS and CORESETPoolIndex can be different. We need spend plenty of time to discuss them case by case, and it will introduce a lot of spec change.
* In addition, it can be only used in mDCI MTRP case and cannot be extended for other cases like sDCI MTRP and L1/L2 mobility. As L1/L2 mobility is being discussed in parallel in Rel-18, it is better to unified the design as much as possible to minimize the standardization effort.

For Alt-3, to make it more clear, we suggest the following update. * *Alt 3: Associate TAG to SSB group. For a UL transmission, UE adopts the TAG associated with the SSB group that*
	+ *PL RS of the UL transmission belongs to, if the PL RS is an SSB*
	+ *QCL source SSB of the PL RS belongs to, if the PL RS is a CSI-RS*

[Moderator] Revised Alt 3 according to suggestion with slight rewording. Note that this modified Alt-3 assumes that we introduce SSB groups and associate each group with a TAG. This is just one of the options in Proposal 8. So I added “if such an association is agreed in agenda 9.1.1.2” in the modified Alt 3.The advantage of Alt-3 over other alternatives at least includes the following:* Firstly, the spec impact is small, which only includes:

1) SSB of each TRP are configured in an SSB group/list and each SSB group/list is associated with a TAG; 2) UE determines TA of a UL transmission based on the PL RS of the UL transmission as given above.* In addition, as PL RS is adopted for any UL transmission, such principle can be applied for any cases, including mDCI MTRP, sDCI MTRP and L1/L2 mobility under either FR1 or FR2.

**Hence, we support Alt-3. We are also ok with combination of Alt-1 + Alt-3 with Alt-1 for FR2 and Alt-3 for FR1.**[Moderator] Added Alt-1 (for FR2) + Alt-3 (for FR1) as a new alternative (Alt 4)  |
| Google | Support Alt 1. Also OK with Alt 3 revised by HW. Regarding Alt 2, we share similar concerns as HW and other companies that Alt 2 may not be extended to use cases other than M-DCI M-TRP.  |
| QC | Support Alt2 in principle, but the formulation is not accurate / proper. For example, for CG, it depends on whether it is Type 1 or Type 2 (for Type2, the legacy association based on activation DCI can be used). Also, for SRS, a configuration is needed only for P/SP (legacy rule can be used for AP). Hence, we suggest the following formulation for Alt2:* *Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled/activated channels/signals ~~PUSCH/PUCCH~~, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for P/SP channels / signals (not scheduled or activated by DCI), coresetPoolIndex is RRC-configured.*
	+ *~~for CG PUSCH, configure CORESET pool index in CG configuration, and the TAG associated with the configured CORESET pool index is utilized for UL transmission~~*
	+ *~~for periodic/semi-persistent PUCCH, configure CORESET pool index per PUCCH resource, and the TAG associated with the CORESET pool index is utilized for UL transmission~~*
	+ *~~for SRS, configure CORESET pool index per SRS resource, and the TAG associated with the configured CORESET pool index is utilized~~*

[Moderator] Ok. Alt 2 is now revised.Please also see some additional comments:* The spec impact of Alt2 is limited to RRC configuration of coresetPoolIndex for P/SP channels / signals. It is not reasonable to say it requires “huge spec impact”, especially considering the procedural spec impact required for Alt1 or Alt3.
* We already agreed that the focus in this AI is multi-DCI and we are not aiming to specify enhancements for other scenarios, and that discussion does not belong to AI 9.1.1.2“Note: Whether two TA enhancement is applicable to other schemes is a separate discussion, which is not in the scope of AI 9.1.1.2.”
* Alt1 does not works for FR1 w/o unified TCI. It basically requires three different frameworks: unified TCI, Spatial relation, FR1 w/o unified TCI
* Alt3 requires either to specify association for each possible DL-RS or to specify multi-chain relationship (if SSBs are divided into two groups) since PL-RS may be CSI-RS and the QCL of the CSI-RS may be TRS, etc. These complications are completely unnecessary for multi-DCI. For other use cases, whether such mechanisms for association are needed or not can be discussed in other AIs such as mobility for the corresponding use cases, but we do not need to spend time on those in this AI as explicitly agreed before.
 |
| NEC | Support Alt 1 as the baseline solution. If TCI state/spatial relation is not explicitly configured/indicated for UL transmission, additional rules (e.g., default rules from previous releases, or Alt 3) apply. |
| Lenovo | Support updated Alt 2 from QC. And the association between CORESETPoolIndex value and UL channels/signals are discussed on AI9.1.1.1 where we can just reuse the design on that AI. The spec work is always needed on AI9.1.1.1 but not increase the spec work on this AI. |
| MediaTek | We still have concern on Alt2, which can be used only for M-DCI based MTRP. Alt1 is our first preference, however, we are also fine with Alt3 with HW’s modification. |
| OPPO | Support Alt.2 of the FL proposal in principle. One feeling on Alt.2 is that we don’t need to split UL channels/signals in this level of details. The classification in QC’s update seems more compact and accurate. Specifically, the SRS can be classified into two sets, i.e. P/SP SRS via RRC/MAC CE and AP SRS triggered by DCI. [Moderator] Alt 2 revised according to Qualcomm commentIn our reading, how to associate the Type 1 CG PUSCH, SRS resource or resource set /PUCCH resource or resource group with TAG ID can be up to RAN2. In RAN1, what should be done is to determine such basic principle at first.  |
| ZTE | Support Alt 2.*CORESETPoolIndex* is broadly used in the current specification to identify TRP ID in both intra-cell MDCI MTRP and inter-cell MDCI MTRP scenarios so far, it provides very clear association between scheduling DCI and DL/UL signals. Regarding the case of Type 1 CG PUSCH, P/SP PUCCH and SRS, it should be noted that ongoing discussion in AI 9.1.4.1 is involved in, it can be referred to this part later to avoid duplicate discussion.* *Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled PUSCH/PUCCH, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *FFS: Associate TAG to CORESETPoolIndex for CG PUSCH, P/SP PUCCH, SRS*

[Moderator] I think the current Alt 2 (with revision suggested by QC) is more complete without FFSs.  |
| vivo | We share similar views with QC. Support alt2.Alt 1 requires two different frameworks for Rel-15/16 spatial relation info and TCI state in Rel-17. In addition, it is not feasible for FR1 for spatial relation info is not configured. DL RS group shall be configured for each TRP in Alt 3, which overturns the mTRP framework designed in Rel-16. There could be potential spec impact on Rel-16 mTRP design which is not foreseen now with the newly introduced DL-RS group. Spec impact with alt2 is only about RRC configurations. |
| InterDigital | OK for further down-selection among the three revised alternatives |
| Huawei, Hisilicon(2nd) | For Alt 2, here are some further concerns from our side.* We don’t think it is reasonable to explicitly bundle every UL channel/RS to a TRP by CORESETPoolIndex. For example, regarding PUCCH for SR/CSI, it can be transmitted to either TRP with relatively better quality. However, if it is configured to be associated with a CORESETPoolIndex, the only way to switch its target TRP is by RRC reconfiguration which is quite low in efficiency.
* For some channel/RS, like SP SRS/PUCCH, under legacy TCI framework, when gNB wants to switch their target TRP, gNB can update their spatial relation and PL RS by MAC-CE with latency of 3 ms. However, to update the TA to the other TRP, gNB need to send RRC reconfiguration signal to update the associated CORESETPoolIndex which cause larger latency. So there exists a period of time during which the spatial relation /PL RS are switched to the other TRP but TA is not, and hence the transmission of the channel/RS is problematic. While, Alt-1 and Alt-3 don’t have such issue as TA is determined by spatial relation/PL RS and hence update of spatial relation/PL RS and TA are always aligned.
* The spec impact of Alt 2 doesn’t only lie in RRC configuration. For example, regarding SRS for ‘antenna switch’ and ‘beam management’, how to associate them to CORESETPoolIndex is unclear. Unlike CB/NCB SRS which support per-TRP configuration, per-TRP configuration is not supported for SRS for ‘antenna switch’ and ‘beam management’. Do we need to firstly study per-TRP configuration of these two types of SRS? In addition, in MTRP BFR, two PUCCH SR can be configured with each PUCCH SR associated with a CORESETPoolIndex/TRP. when a TRP fail, the PUCCH SR associated with the failed TRP/CORESETPoolIndex is transmitted. According to Alt-2, the PUCCH SR will adopt TA of the failed TRP/CORESETPoolIndex. However, the PUCCH SR should be transmitted to the other TRP as the TRP associated with the PUCCH SR is already failed. In addition to the above two cases, there are also other issues that need to be considered if Alt-2 is adopted. That why we say the spec impact of Alt-2 is huge.
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| NTT DOCOMO | Support Alt.2 in principle. However, in our understanding,* + - for dynamic scheduled PUCCH, it is also beneficial that CORESETPoolIndex is per PUCCH resource. A reason is considering joint ACK/NACK feedback mode, a DCI can indicate a PUCCH transmission to either of the TRPs for joint ACK/NACK feedback. Another reason is we can have a unified design for semi-static and dynamic PUCCH which has lower spec impact.
		- for dynamic SRS, we think the CORESETPoolIndex should be per SRS resource. The reason is a DCI may trigger multiple SRS resources which can be transmitted to different TRPs.

Thus, we prefer following modification based on FL proposal.* *Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled PUSCH~~/PUCCH~~, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for CG PUSCH, configure CORESET pool index in CG configuration, and the TAG associated with the configured CORESET pool index is utilized for UL transmission*
	+ *for ~~periodic/semi-persistent~~ PUCCH, configure CORESET pool index per PUCCH resource, and the TAG associated with the CORESET pool index is utilized for UL transmission*
	+ *for SRS, configure CORESET pool index per SRS resource, and the TAG associated with the configured CORESET pool index is utilized*

[Moderator] Isn’t association rule for dynamic PUCCH is already clear in Rel-16? Then, do we need to configure CORESETPoolIndex for dynamic PUCCH? Alt 2 now revised as per Qualcomm comment. |
| Apple  | Prefer modified Alt.2 by Qualcomm.  In our opinion, it is quite straightforward to associate TAG with a corresponding TRP for UL transmission. Even Alt.1, it essentially first divides the TCI states into two groups and then associate them with TAG(s) based on the TRP they associated with. Why not directly to associate TAG with TRP i.e., CORESETpoolindex? [Moderator] Alt 2 now revised as per Qualcomm comment.Regarding the spec impact, Alt.2 just needs to add ‘CORESETpoolindex’ value into TAG configuration ASN.1 IE, where the ‘huge’ complexity comes from? In our view, Alt.1 and Alt.2 are comparable from spec impact perspective and fairly a simple change.  |
| Sharp | Support Alt 2. In our view, Alt 2 has good compatibility with legacy TRP indication for mDCI based MTRP by using CORESET pool index. Furthermore, we are fine with the QC’s proposal.[Moderator] Alt2 revised according to Qualcomm comment. |
| LGE | In general, we are ok to merge option 2 and 4 into alt2. However, we have concern on configuring CORESETPoolIndex to UL channels since CORESET pool is mainly for DL operation, and more importantly, it is not forward-compatible (e.g., extending two TA for S-DCI mTRP in later releases). We would be ok to modify QC’s version as below:* *Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled/activated channels/signals ~~PUSCH/PUCCH~~, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for P/SP UL channels / signals (not scheduled or activated by DCI), ~~coresetPoolIndex~~TAG ID is RRC-configured.*

[Moderator] This is a new alternative. I’ve added this as Alt 5 in the proposal. |
| QC (2) | We have the following response to Huawei:* Regarding “the only way to switch its target TRP is by RRC reconfiguration” for SR / CSI: That is not the case. Network can configure multiple PUCCH resources for SR / CSI, and just like Rel-16, transmission toward any TRP can be done using the corresponding resource.
* Regarding updating spatial relation and PL-RS by MAC-CE for SP channels / signals, we do not think TRP switching is the intended mode of operation for multi-DCI (instead of TRP switching, we have “multi-TRP” operation). This is not DPS (dynamic point selection). Network can still change PL-RS due to a change of beam within one coresetPoolIndex value, but this does not mean that TA also needs to change. This would have been a good argument for Rel-15 DPS or single-DCI mTRP, but unfortunately, those are not in scope.
* Regarding SRS for ‘antenna switch’ and ‘beam management’, there is no need to study any per-TRP configuration for the purpose of two TAs other than the RRC configuration discussed before. Remember that even for CB/NCB PUSCH, we only have one SRS resource set in Rel-16 for TDM multi-DCI. Hence, additional spec impact you listed are not related to TA enhancement. For the purpose of TA enhancement, all that is needed is RRC configuration. This does not change existing restrictions (whether Rel-16, Rel-17, or Rel-18) wrt other enhancements.

Also, for Alt1 and Alt3, here are additional concerns from our side (in addition to spec impact mentioned before):In Rel-16, we have multiple rules that rely on “coresetPoolIndex” to differentiate TRP. For UL, some examples are DCI-PUSCH out-of-order, PDSCH-PUCCH out-of-order, separate HARQ-Ack codebook generation, TDM restrictions for PUCCH/PUSCH associated with different coresetPoolIndex values, etc. Now, if we have Alt1 or Alt3, it means that a PUSCH/PUCCH associated with the same coresetPoolIndex value may be now associated with different TAGs (are transmitted toward different TRPs). Does it mean that all these rules need to be revisited? If not, what defines multi-DCI based mTRP is no longer operational, because for those rules we follow one notion of “TRP differentiation” but at the same time, from TA perspective, the actual TRP is different. For example, we allow out-of-order operation even though both transmissions are toward the same TRP, or we do not allow separate feedback even though they are toward different TRPs.  |
| Intel | Alt-1, in Alt-2 we are not sure how DCI from CORESETPoolIndex-1 can schedule uplink transmission for the other TRP (CORESETPoolIndex-2) ? this seems a quite fundamental feature that provides gNB scheduling flexibility |
| Xiaomi | Support Alt.2. Alt.1 cannot be used in FR1 since spatial relation does not exist for FR1. We are also OK with updated Alt.2 from QC.[Moderator] Alt 2 revised a per QC comment. |
| Samsung | Prefer Alt1. Associating a beam with a TCI state or spatial relation seems to a nature design option as beams can have different propagation delays and hence require different TAs. |
| CATT | We prefer both Alt1 & Alt2. For the concerns that Alt1 can’t be applied to FR1 where spatial relation info for uplink transmission is not configured. A possible solution is to associate TAG to the TCI-state of the PDCCH that dynamically schedules uplink transmission.  |
| Ericsson | We prefer Alt1. Just like LG, we feel that the configuration of CORESETPoolIdx in multiple UL channels is not logical, since CORESETs are not related to UL channels/signals. To make Alt1 clearer, we propose the following modification:* *Alt 1: Associate TAG to TCI-state/spatial relation*
	+ *Configure TAG ID as part of UL/ TCI state or spatial relation*
	+ *for UL transmission, the TAG ID associated with the UL/ TCI state or spatial relation is utilized*

[Moderator] Modified Alt 1.Note that this works for all cases:* With the R15 TCI framework in FR1: in the TCI state
* With the R15 TCI framework in FR2: in the spatial relation
* With the R17 TCI framework in FR1: in the TCI state
* With the R17 TCI framework in FR2 with joint TCI: in the TCI state
* With the R17 TCI framework in FR2 with separate TCI: in the UL TCI state

So it is clear that Alt1 works for all cases.We could also be OK to explore an option to directly associate UL channels/signals with TAGs, just as in LGs subbullet 2: so each SRS and PUCCH resource could contain a TAG. |
| Nokia/NSB | We are fine with both Alt.2 and Alt.1, and we are also fine with the suggested updates by QC regarding Alt.2. In addition, as explained below, “configure TAG ID as part of UL/joint TCI state or spatial relation” is not the only way to achieve the association between TCI state or spatial relation info and a TAG.In the following, we provide some observations regarding Atl.1 and Alt.2 (which could also be found in our Tdoc R1-2210062):* Alt.1 would require defining and specifying association to a TAG considering the Rel-18/Rel-17 unified TCI framework as well as the existing spatial relation framework. This could be achieved by (i) either defining a direct association of a TAG to a TCI state or spatial relation, or (ii) by associating a TAG to a set of DL RSs, i.e., SSBs/CSI-RSs, where this association is used to determine the association of TAG to TCI state or spatial relation.
* Alt.2 would already work for the PUSCH/PUCCH/SRS with a corresponding PDCCH, as in this case the association to a CORESETPoolIndex can be obtained through the PDCCH scheduling the PUSCH/PUCCH/SRS. For configured UL transmissions, an association of periodic and maybe some semi-persistent UL resources to CORESETPoolIndex would be needed. On the other hand, Alt.2 may result is some scheduling flexibility limitation since, in addition to the fact that CORESETPoolIndex has been so far defined for DL only, using CORESETPoolIndex for UL would not really allow scheduling from one TRP an UL transmission towards another TRP. However, this should not be a problem especially given that the focus is on the multi-DCI mode, since this mode is typically more suitable for non-ideal backhaul between the TRPs which suggests a more independent operation of the TRPs.
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*FL Comment:* I’ve revised the alternatives as per comments received above. There were a few other suggested alternatives which I have added as Alts 4-6.

## *Proposal 3 – Rev2*

*For associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, downselect one of the Alts in RAN1#110bis-e:*

* *Alt 1: Associate TAG to TCI-state/spatial relation*
	+ *Configure TAG ID as part of UL TCI state or spatial relation*
	+ *for UL transmission, the TAG ID associated with the UL TCI state or spatial relation is utilized*
* *Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled/activated channels/signals, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for P/SP channels / signals (not scheduled or activated by DCI), coresetPoolIndex is RRC-configured.*
* *Alt 3: Associate TAG to SSB group (if such an association is agreed in agenda 9.1.1.2). For a UL transmission, UE adopts the TAG associated with the SSB group such that*
	+ *if the PL RS is an SSB, then the UE adopts the TAG associated with the SSB group which the PL RS of the UL transmission belongs to*
	+ *if the PL RS is a CSI-RS, then the UE adopts the TAG associated with the SSB group which the QCL source SSB of the PL RS belongs to*
* *Alt 4: Alt 1 for FR2 and Alt 3 for FR1*
* Alt 5: *TAG association performed as follows:*
	+ *for dynamically scheduled/activated channels/signals, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for P/SP UL channels / signals (not scheduled or activated by DCI), TAG ID is RRC-configured.*
* Alt 6: *TAG association performed as follows:*
	+ *for P/SP UL channels / signals, TAG ID is RRC-configured.*

*Please provide your input on Proposal 3 – Rev2 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Moderator | The current Situation is summarized below:Alt 1 Support **(7)**: Google, NEC, Intel, Nokia/NSB, Samsung, CATT, EricssonAlt 1 Concern **(3)**: Qualcomm, vivo, Xiaomi, Docomo, OPPO, LenovoAlt 2 Support **(9)**: Qualcomm, OPPO, ZTE, vivo, ~~NTT Docomo,~~ Apple, Nokia/NSB, Xiaomi, CATT, LenovoAlt 2 Concern **(3)**: Huawei/HiSilicon, Google, Intel, DocomoAlt 3 Support **(2)**: Huawei/HiSilicon, Google, Alt 3 Concern **(2)**: Qualcomm, vivo, Docomo, OPPO, LenovoAlt 4 Support **(1)**: Huawei/HiSiliconAlt 4 Concern: Docomo, OPPO, LenovoAlt 5 Support **(1)**: LGE, OPPOAlt 5 Concern: DocomoAlt 6 Support **(1)**: EricssonAlt 6 Concern: Lenovo**Important: Please update your support/concerns with one or more alternatives in the list above. In case of concern with an alternative, please provide your reasoning so that the proponent of that alternative can try to address your concern. Note that we cannot leave too many alternatives on the table. I plan to remove those alternatives that lack support eventually.** |
| NTT Docomo | Concern on Alt.1: it is not applicable when unified TCI or spatial relation is not provided for an UL transmission Concern on Alt.2: we support to associate TAG with CORESETPoolIndex. However, we have different view for AP SRS and dynamic PUCCH. For AP SRS, a DCI may trigger multiple SRS resources which are transmitted to different TRPs (e.g., when two SRS resources in a CB SRS resource set are transmitted to different TRP, or when a DCI triggers multiple SRS resource sets and different SRS resource sets are transmitted to different TRP). Thus, we think for AP SRS, the CORESETPoolIndex should be configured per SRS resource. For dynamic scheduled PUCCH, a DCI can indicate a PUCCH transmission to either of the TRPs especially considering joint ACK/NACK feedback mode. Thus, we think for dynamic PUCCH, the CORESETPoolIndex should be configured per PUCCH resource.Concern on Alt.3: it is not applicable in some cases where default PL RS is used for UL transmission. Concern on Alt.4: no need to have different Alt for FR1/2Concern on Alt.5: similar as Alt.2. we think TAG should be per SRS/PUCCH resource for AP SRS and dynamic PUCCH.Thus, we prefer a revised Alt.2* *revised Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled PUSCH, TAG associated with the CORESET pool index of the CORESET carrying the scheduling PDCCH is utilized for UL transmission*
	+ *for CG PUSCH, configure CORESET pool index in CG configuration, and the TAG associated with the configured CORESET pool index is utilized for UL transmission*
	+ *for PUCCH, configure CORESET pool index per PUCCH resource, and the TAG associated with the CORESET pool index is utilized for UL transmission*
	+ *for SRS, configure CORESET pool index per SRS resource, and the TAG associated with the configured CORESET pool index is utilized*
 |
| Huawei, Hisilicon | Thanks QC and other companies for clarification on Alt 2. However, we still have concerns as below.* We still don’t think it is reasonable to tightly bundle every channel/RS to CORESETPoolIndex, which is too inflexible. For some channels/RS, it can be transmitted to either TRP according the quality of the two TRPs. Here are two examples:
* **PUCCH for CSI**: one PUCCH can be used for CSI feedback for either TRP. It is not reasonable that the gNB has to configure two PUCCH for CSI with each for one TRP.
* **PUCCH for A/N**: when joint HARQ codebook is configured, A/N of both TRPs are reported by one PUCCH. Such PUCCH can be transmitted to either TRP with better quality.
* We still think the spec impact of Alt 2 is larger than Alt 1 and 3. The biggest problem of Alt 2 in spec impact is that we need to specify the principle between each type of cahnnel/RS and CORESETPoolIndex case by case, because there are many cases in which the principle can be different. In addition to the ones listed in current Alt 2, there are still some other corner cases that have to be considered separated. Here are some examples:
* **PUCCH for A/N**: as given above, one PUCCH is used to feedback A/N of the two TRP when joint HARQ codebook is configured. How to determine the TA of such PUCCH should be a special case of Alt 2.
* **PUCCH for BFR**: When a TRP fails, the PUCCH associated with the TRP should be transmitted according to current spec. According to Alt 2, TA of the failed TA should be used. However, the PUCCH should be transmitted to the non-failed TRP using the TA of the non-failed TRP. This is another special case of Alt 2.
* Above are two typical corner cases that we need to consider separately. We believe there are still other cases that I didn’t find out. Companies are encouraged to think more about these cases that current Alt 2 cannot work for, as anyway we need fix all of these issues if Alt 2 is finally support.

For Alt 3, regarding the comments from companies, here are some clarifications.* To QC’s comments: “if we have Alt1 or Alt3, it means that a PUSCH/PUCCH associated with the same coresetPoolIndex value may be now associated with different TAGs”: I think this would never happen. The PUSCH/PUCCH associated with the same coresetPoolIndex is associated with the same TRP, and hence associated with the same SSB group, and hence associated to the same TAG, as TRP-SSB group-TAG are one-to-one mapped.
* To vivo’s comments: “There could be potential spec impact on Rel-16 mTRP design which is not foreseen now with the newly introduced DL-RS group”: In Alt 3, only SSB grouping is needed. We don’t need to grouping every DL-RS. For SSB grouping, please note that, even in Rel-16, SSB of the cell are allocated to two TRPs. In other words, SSB grouping has already been realized based on implementation. The only step forward in R18 is configuring this information to the UE for the UE to differiate TRP based on SSB. So, I don’t think this will introduce impact to current MTRP framework.
* To DCM’s comments: “it is not applicable in some cases where default PL RS is used for UL transmission”: no matter the PL RS is explicit indicated or derived by default, anyway the UE can get a PL RS for the UL transmission, and then use the PL RS to determine the TAG according to Alt 3. So, it is applicable in cases where default PL RS is used.

*For the updated Alt 3, the last sentence of the main bullet seems redundant. So, suggest to remove it.** *Alt 3: Associate TAG to SSB group (if such an association is agreed in agenda 9.1.1.2). For a UL transmission,*
	+ *if the PL RS is an SSB, then the UE adopts the TAG associated with the SSB group which the PL RS of the UL transmission belongs to*
	+ *if the PL RS is a CSI-RS, then the UE adopts the TAG associated with the SSB group which the QCL source SSB of the PL RS belongs to*

**I’d like to emphasize that Alt 3 is a clean principle that can be used for all use cases including SDCI MTRP, MDCI MTRP, L1/L2 mobility under both FR1 and FR2.**  |
| QC | Alt6 is not complete and it should be removed (it does not even mention DG).On Alt1 / 3 / 4, we still have multiple concerns as explained the details before, summarizing them here again (given that we did not see a reply for some of the concerns, and some of the replies did not ready address the issue):* Alt1 does not works for FR1 w/o unified TCI. It basically requires three different frameworks: unified TCI, Spatial relation, FR1 w/o unified TCI
* Alt3 requires either to specify association for each possible DL-RS or to specify multi-chain relationship (if SSBs are divided into two groups) since PL-RS may be CSI-RS and the QCL of the CSI-RS may be TRS, etc. These complications are completely unnecessary for multi-DCI. For other use cases, whether such mechanisms for association are needed or not can be discussed in other AIs such as mobility for the corresponding use cases, but we do not need to spend time on those in this AI as explicitly agreed before.
* In Rel-16, we have multiple rules that rely on “coresetPoolIndex” to differentiate TRP. For UL, some examples are DCI-PUSCH out-of-order, PDSCH-PUCCH out-of-order, separate HARQ-Ack codebook generation, TDM restrictions for PUCCH/PUSCH associated with different coresetPoolIndex values, etc. Now, if we have Alt1 / Alt3 / Alt4, it means that a PUSCH/PUCCH associated with the same coresetPoolIndex value may be now associated with different TAGs (are transmitted toward different TRPs). Does it mean that all these rules need to be revisited? If not, what defines multi-DCI based mTRP is no longer operational, because for those rules we follow one notion of “TRP differentiation” but at the same time, from TA perspective, the actual TRP is different. For example, we allow out-of-order operation even though both transmissions are toward the same TRP, or we do not allow separate feedback even though they are toward different TRPs.

On Alt5, it is equivalent to Alt2 from the point of this AI (no difference in functionality). However, configuration of coresetPoolIndex value can be potentially beneficial for other sub-agenda’s as well such as unified TCI extension to multi-DCI based mTRP or for STxMP for multi-DCI. But if we configure TAG-ID, such potential unification is lost for no good reason. Just to clarify, we are not saying Option 2 automatically results in reusing this for other sub-agenda, but it allows the possibility to reuse the RRC configuration if they choose to do so (especially because it should not make a difference for this sub-agenda). @Huawei: Thank you for the follow-up. Please see some further comments below: * Based on your comment “To QC’s comments: “if we have Alt1 or Alt3, it means that a PUSCH/PUCCH associated with the same coresetPoolIndex value may be now associated with different TAGs”: I think this would never happen.”, do I understand it correctly that you are ok with Alt2 for dynamic signals / channels? If this never happens, then it is equivalent to associating it with CORESETPoolIndex value, no? Also, I assume “never happens” requires exact specification language on the conditions that this is not expected. W/o such conditions, Alt1/3/4 may result in all these issues, unfortunately.
* Regarding “one PUCCH can be used for CSI feedback for either TRP. It is not reasonable that the gNB has to configure two PUCCH for CSI with each for one TRP.”, I assume you are referring to P/SP-CSI based on the previous round of discussions (for AP-CSI, DCI can dynamically trigger AP-CSI on PUSCH). Then, w/o CSI for each TRP, how PDSCH scheduling from both TRPs can be enabled?

To address the DCM and HW concerns, we suggest the following (even though we prefer the original Alt2 in Rev2, it is ok to further discuss AP-SRS and dynamic A/N)* *revised Alt 2: Associate TAG to CORESETPoolIndex*
	+ *for dynamically scheduled/activated PUSCH, TAG associated with the CORESET pool index of the CORESET carrying the scheduling/activating PDCCH is utilized for UL transmission*
	+ *for Type 1 CG, P/SP-SRS, and P/SP-PUCCH, coresetPoolIndex is RRC-configured.*
	+ *FFS: Other signals / channels: AP- SRS, and dynamic HARQ-Ack*
 |
| LGE | We are not talking about a new option of Alt 5, it was agreed Option 4 which was merged into Option 2. The only difference is to use TAG ID instead of CORESETPoolIndex, which is more future-proof solution to cover both mDCI case and non-mDCI case. In the first bullet of Alt 2, TAG ID would be associated with each CORESET pool index. Similarly, in the second bullet of Alt 2, TAG ID would be associated(RRC-configured) with P/SP UL channels/signals. Then, it is technically same as the current Alt 2 and more forward compatible solution. |
| OPPO | Update our support and concern in moderator’s column. On Alt.5, in our reading, the difference from Alt.2 is how to handle the P/SP UL channels/signals. Alt.2 applies *CORESETPoolIndex* via RRC configuration, whereas Alt.5 uses TAG ID for the same purpose from RAN1 perspective. Hence, we support both Alt.2 and Alt.5 and fine to leave the RRC signaling to RAN2.On Alt.1, the cons are very clear that for legacy UL channels/signals, there is absence of support of spatial relation at FR1. The association between TAG ID and spatial relation cannot be done. Moreover, if TAG were associated with TCI state, we have to put further restriction to make sure all the TCI states for the same TRP are configured with the same TAG ID, otherwise, UE may send UL channels/signals to the same TRP with different TAs. On Alt. 3 and Alt.4, first SSB grouping itself would put restrictions on NW DL coverage. Second, if PL RS is a CSI-RS, then UE has to trace back its QCL source for determining the corresponding TAG. For associating TAG and UL channel/signals, it seems the design goes too far, while simple solutions are at hand.  |
| Lenovo | Concern on Alt1: it is not applicable when unified TCI or spatial relation is not provided for an UL transmission.Concern on Alt3: Similar view with QC that Alt3 requires either to specify association for each possible DL-RS or to specify multi-chain relationship.Concern on Alt4: no need to have different Alt for FR1/2。Concern on Alt5: Similar view with QC. Although it is equivalent to Alt2 from the point of this AI (no difference in functionality), however, the association between coresetPoolIndex value and UL channels/signals on M-DCI based M-TRP is discussed on other AI which can be just reused on this AI. But if we configure TAG-ID, such potential unification is lost for no good reason.Concern on Alt6: Not a complete solution.We support the revised Alt2 from Docomo. |

# 3 Need for separate PRACH configurations

In the first FL summary R1-2210304, the following questions were discussed:

Question 3 (from Previous Round)

*Whether there is a need to configure separate CFRA configurations to the UE for each additional PCI in case of inter-cell MTRP scenario?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | Yes. Each additional PCI can have independent RACH configuration. |
| Google | We are OK to it |
| QC | Yes. |
| Lenovo | Open to discuss it. |
| MediaTek | We are fine to have separate resource configuration for Msg1 |
| OPPO | Yes. |
| ZTE | Yes |
| vivo | Yes, CFRA configuration for each non-serving cell is required.  |
| NTT DOCOMO | Yes |
| Apple  | Yes |
| Sharp | No, we think it is enough that a part of CFRA resources in a CFRA configuration is used. |
| LGE | Yes but we prefer to discuss intra-cell and inter-cell together for unifying solution. |
| Spreadtrum | Yes. |
| Xiaomi | Yes. |
| CMCC | Yes |
| CATT | Yes |
| Ericsson | No, CBRA should be enough. Also, configuring separate preambles for each TRP does not scale. |
| Nokia/NSB | In principle yes, but we are open to further discuss this point. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | CFRA configurations for inter-cell MTRP should be further discussed. |

*FL Comment:* The following is the summary of company views related to supporting separate CFRA config for each additional PCI

* Support separate CFRA config for each additional PCI **(17)**: Huawei/HiSi, Google, Qualcomm, MediaTek, OPPO, ZTE, vivo, NTT DOCOMO, Apple, LGE (unifying solution for intra-cell and inter-cell cases), Spreadtrum, Xiaomi, CMCC, CATT, Lenovo, Nokia/NSB, Samsung
* Not Support separate CFRA config for each additional PCI **(2)**: Sharp, Ericsson

Question 4 (from Previous Round)

*Whether there is a need to configure separate CBRA configurations to the UE for each addition PCI in case of inter-cell MTRP scenario?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | It is still unclear how CBRA can work for TA acquisition under MTRP case. Detail of CBRA including use case, procedure and triggering condition should be clarified first. |
| Google | We are OK to it |
| QC | It depends on whether per-TRP CBRA is introduced or not.  |
| Lenovo | Open to discuss it. |
| MediaTek | We are fine to have separate resource configuration for Msg1 |
| OPPO | For TA acquisition, it seems CFRA configuration of inter-cell would work. So, we see no strong motivation to introduce CBRA configuration of inter-cell for the same purpose as well. |
| ZTE | Yes.According to the current specification, when non-synchronized UL caused by TAT expiry, the MAC entity will maintain timing advance values of this TAG or all TAGs, and CBRA can be triggered to acquire the initial TA. If TAT associated with the TRP without initial access expires, CBRA should still be triggered to align with the legacy procedures, otherwise some new procedures should be specified additionally in such case. For example, UE cannot maintain timing advance values until receiving a PDCCH order in case of TAT expiry of the TAG associated with additional PCI. |
| vivo | No, since RACH towards non-serving cell targets for acquiring initial synchronization, CFRA triggered by PDCCH order is sufficient. |
| NTT DOCOMO | Same view with QC |
| Apple  | Yes. In general, CBRA procedure is always a fallback operation for CFRA procedure. In addition, CFRA causes increased RACH overhead, which is mitigated by CBRA. In our view, the CBRA function should be supported and leave network to decide which one to go e.g., tradeoff between latency and overhead.  |
| Sharp | CFRA enhancement should be discussed first |
| LGE | Open to discuss. |
| Spreadtrum | If CBRA for inter-cell is supported, we are fine to have separated RACH configuration. |
| Xiaomi | Similar view with OPPO. |
| CMCC | Open to discuss. |
| CATT | Open to discuss. |
| Ericsson | There is probably a need. Note that a CBRA configuration is a subset of a CFRA configuration. |
| Nokia/NSB | We are open to support CBRA also for inter-cell M-TRP cases.  |
| Moderator | Let’s continue discussion in next round. |
| Samsung | CBRA configurations for inter-cell MTRP should be further discussed. |

*FL Comment*: The following is the summary of company views related to supporting separate CBRA config for each additional PCI

* Support separate CFRA config for each additional PCI **(11)**: Google, MediaTek, ZTE, Apple, Ericsson, Nokia, CMCC, CATT, LGE, Lenovo, Spreadtrum
* Need further discussion **(3)**: Qualcomm, NTT Docomo, Samsung
* Not Support separate CBRA config for each additional PCI **(5)**: Huawei/HiSilicon, OPPO, vivo, Sharp, Xiaomi

Based on Questions 3 and 4 from previous rounds, the following is proposed:

## Proposal 4

*For multi-DCI based inter-cell Multi-TRP operation with two TA enhancement, support to configure additional PRACH configurations.*

* *one additional PRACH configuration is supported for each additional configured PCI*
* *the additional PRACH configurations are for CFRA*
* *FFS: whether the additional PRACH configurations are for CBRA*

*Please provide your input on Proposal 4 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support  |
| Huawei, Hisilicon | Support the proposal. |
| QC | Support |
| LGE | We suggest to consider intra-cell and inter-cell together for unifying solution.*For multi-DCI based ~~inter-cell~~ Multi-TRP operation with two TA enhancement, support to configure additional PRACH configurations.** *one additional PRACH configuration is supported for each additional ~~configured PCI~~TRP and/or UE panel*
* *the additional PRACH configurations are for CFRA*

*FFS: whether the additional PRACH configurations are for CBRA* |
| OPPO | Support  |
| Lenovo | We only support the proposal for inter-cell but not intra-cell. |

# 4 Information on PRACH configuration in PDCCH order

In the first FL summary R1-2210304, the following question was discussed:

Question 1 (from Previous Round)

*Whether enhancements are needed to introduce information about which RACH configuration (i.e., RACH configuration corresponding to serving cell PCI or an additional PCI) to use in the PDCCH order in case of inter-cell MTRP scenario?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | Yes, support introducing AdditionalPCIIndex in PDCCH order. |
| Google | Yes |
| QC | Yes, but shouldn’t the need for multiple PRACH configurations (Question 3) be discussed first? |
| NEC | Yes. RACH configuration corresponding to non-serving cell is needed. |
| Lenovo | Yes. |
| MediaTek | Yes, RACH procedure has to be associated with SSB with PCI different from the serving cell |
| OPPO | Yes. For inter-cell MTRP scenario, multiple RACH configuration seems necessary. |
| ZTE | Yes, both intra-cell MDCI MTRP and inter-cell MDCI MTRP should be taken into account. |
| vivo | Yes |
| InterDigital | Yes. |
| NTT DOCOMO | Yes. |
| Apple  | Yes |
| Sharp | Q3 should be discussed first |
| LGE | Yes but we prefer to use unified solution for both inter-cell and intra-cell, e.g. indicating TAG ID in PDCCH order. |
| Spreadtrum | Yes.  |
| Xiaomi | Yes. |
| CMCC | Yes |
| CATT | Yes |
| Ericsson | Yes |
| Nokia/NSB | Yes. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | Yes |

*FL Comment:* All companies seem to be supportive. Hence, the following proposal is proposed:

## Proposal 5

*For multi-DCI based inter-cell Multi-TRP operation with two TA enhancement, support introducing information about which PRACH configuration (i.e., RACH configuration corresponding to serving cell PCI or an additional PCI) to use in the PDCCH order*

* *FFS: Signaling Details*

*Please provide your input on Proposal 5 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support A clarification question: does this proposal intend to have an explicit indication of this information in PDCCH order? |
| Huawei, Hisilicon | Support the proposal. |
| QC | Support. We think both methods of explicit indication in DCI payload as well as implicit indication (e.g., based on coresetPoolIndex of the PDCCH order DCI) have pros / cons, but we lean toward explicit indication method. |
| LGE | We don’t even have agreed on introducing of PDCCH-order for TRP-specific RACH transmission. From the procedure perspective, firstly we should agree that PDCCH-order is supported for TRP-specific RACH triggering. So we suggest as below:Proposal 5*For multi-DCI based Multi-TRP operation with two TA enhancement, support PDCCH order for TRP-specific RACH triggering.* |
| OPPO | Similar clarification as Docomo. On the introduced information, is it to be added into PDCCH order, like a short indicator for PRACH configuration selection? Though the signaling details are under FFS, hopefully the intention can be further clarified. Thanks.  |
| Lenovo | Support. |

# 5 Per TRP vs cross TRP PDCCH order

In the first FL summary R1-2210304, the following question was discussed:

Question 2 (from Previous Round)

*Whether a PDCCH order that triggers RACH procedure towards another TRP/Cell needs to be supported?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | It should be supported. This is beneficial for PDCCH load balance. For example, when gNB intends to trigger RACH for TRP1 but PDCCH resources of TRP1 are all used for other purposes, gNB can transmit the PDCCH order via TRP2. |
| Google | Yes, it should be supported. It provides network flexibility.  |
| QC | Not necessarily. We do not think “load balancing” is a justification here as PDCCH order DCI is not transmitted very frequently. Also, we do not understand the flexibility argument. Flexibility for which purpose?  |
| NEC | We are open to it but per TRP RACH might be enough to obtain/maintain two TAs. |
| Lenovo | Yes. |
| MediaTek | Yes, but intra-cell MTRP may not need enhancement |
| OPPO | Consider the commonly assumed non-ideal backhaul for M-DCI MTRP, we tend to think the cross-TRP RACH triggering can be deprioritized at least for intra-cell MTRP. It seems reasonable to focus on the case that the TRP/cell sends PDCCH order for itself first.  |
| ZTE | Yes |
| vivo | Yes, TRP specific absolute TAC is required for 2 TAGs. |
| InterDigital | Yes.  |
| NTT DOCOMO | We think it is not necessary  |
| Apple  | Yes |
| Sharp | Yes, the UE needs to transmit preamble to another TRP based on the PDCCH order |
| LGE | Yes, this can be supported optionally for ideal backhaul scenario.  |
| QC (2) | Just an observation from the responses above: Some companies (including us) understood the question as cross-TRP PDCCH order (TRP1 triggers PDCCH order for TRP2), while other companies may have understood the question as per-TRP PDCCH order. If the intention of the question was the latter, we also think the answer is yes at least for some cases (CFRA PDCCH order). |
| Spreadtrum | We are open for this issue. |
| Xiaomi | Yes. |
| CMCC | It depends on which kind of mechanism for acquiring the initial TA is supported. For the acquiring of initial TA based on PDCCH ordered RACN mechanism, the answer is yes.  |
| CATT | Yes |
| Ericsson | We think this would be an attractive option. There are also big synergies with the mobility item. |
| Nokia/NSB | In principle, yes, it’s needed in order for the network to acquire an (additional) TA at least for inter-cell M-TRP cases.  |
| Moderator | Let’s continue discussion in next round. |
| Samsung | Yes |

*FL Comment*: There are two cases being discussed above. The case with PDCCH order sent by one TRP triggering RACH procedure towards the same TRP seems obviously needed. The question is then whether a PDCCH order sent by one TRP can trigger RACH procedure towards a different TRP? The two possibilities need further discussion. Hence, the following is proposed:

## Proposal 6

*For multi-DCI based Multi-TRP operation with two TA enhancement, support one of the following alternatives in RAN1#111:*

*Alt 1: PDCCH order sent by one TRP triggers RACH procedure towards the same TRP*

* *note: with Alt 1, PDCCH order sent by one TRP triggering RACH procedure towards another TRP is not allowed*

*Alt 2: PDCCH order sent by one TRP triggers RACH procedure towards either the same TRP or a different TRP*

*Please provide your input on Proposal 6 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support  |
| Huawei, Hisilicon | Support Alt 2. Here are some reasons:* This is beneficial for PDCCH load balance. For example, when gNB intends to trigger RACH for TRP1 but PDCCH resources of TRP1 are all used for other purposes, gNB can transmit the PDCCH order via TRP2, instead of waiting for PDCCH resource.
* PDCCH order can be transmitted via the TRP with better quality to ensure the reliability of PDCCH order transmission.
 |
| QC | Support the proposal. |
| LGE | Fine in principle. In our view, Alt 2 can be supported for ideal backhaul scenario and Alt1 can be supported for non-ideal backhaul case, i.e. both Alts can be supported and which one to use is up to NW configuration. Thus, we propose:*For multi-DCI based Multi-TRP operation with two TA enhancement, support at least one of the following alternatives in RAN1#111:* |
| OPPO | Support the FL proposal |
| Lenovo | Support and prefer Alt2. |

# 6 Need for configure type1 CSS for receiving RAR from a TRP corresponding to an additional PCI

In the first FL summary R1-2210304, the following question was discussed:

Question 5 (from Previous Round)

*Whether there is a need for configure type1 CSS for receiving RAR from a TRP corresponding to an additional PCI in inter-cell MTRP scenario?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | We think this is not needed. PDCCH order for triggering RACH of TRP corresponding to an additional PCI can be transmitted by the serving cell. Hence, there is no need to configure type 1 CSS dedicatedly for additional PCI. |
| Google | Q5 seems to be related to Q3 and Q4.  |
| QC | This is one possibility, but not the only one.  |
| Lenovo | Same view with Huawei. |
| MediaTek | No, we don’t see the need to configure a Type1 CSS particular for additional cell |
| OPPO | In Rel.17, we understanding is that some of the DL common channels can only be transmitted by serving cell, rather than non-serving cell with different PCI. If PDCCH order comes with such restriction, then our answer to Q5 is a No. |
| ZTE | Not needed. For inter-cell MDCI MTRP in Rel-17, the following agreement was reached.

|  |
| --- |
| **Agreement**UE is not required to monitor a Type0/0A/1/2 CSS in a CORESET when the active TCI state is associated with a PCI different from serving cell PCI. |

 |
| vivo | OK to discuss. |
| NTT DOCOMO | Similar view with QC that this is one solution. |
| Apple  | The preamble is received at the target TRP. If the RAR is transmitted by the serving TRP, it requires ‘RAR forwarding’ from target TRP to the serving TRP. Considering the target mDCI mTRP use case or even inter-cell mobility, it causes significantly increased latency, which can be avoided by directly monitoring Type1 CSS from the target TRP. If a unified two TA framework is targeted to share inter-cell mobility, latency reduction is the key for UL sync procedure, and it makes sense to transmit RAR from target TRP based on its Type1-CSS.  |
| Sharp | It is unnecessary because Q5 is related to Q3 |
| LGE | Regarding Q3/4/5, prefer to discuss for intra-cell mDCI case and inter-cell mDCI together. |
| Spreadtrum | Agree with Huawei. |
| Xiaomi | OK to discuss. |
| CATT | We share similar view as QC.  |
| Ericsson | Huawei and Apple describe the two main options. Both have pros and cons. In general, having multiple type1-CSS seems awkward – and places burden on the UE. On the other hand, if “RAR” should be sent from the same TRP that send the PDCCH order, it would lead to longer delay between the PRACH reception and the “RAR” transmission. But we lean towards that we should avoid configuring multiple type1-CSSs.  |
| Nokia/NSB | We have similar view as Huawei that this may not be needed, but this approach could be one possibility as mentioned by QC. Anyways, we are open to further discuss this aspect. Also, as pointed out by other companies, this question is related to at least one other question above. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | This can be discussed after we progress on questions Q3 and Q4. |

Based on the above responses, there are two possibilities:

* Alt 1: RAR will always be received from serving cell: in this case, there is no need for additional type 1 CSS configuration per additional PCI
* Alt 2: RAR can be received from a TRP corresponding to an additional PCI: in this case, there is a need support additional type 1 CSS configuration per additional PCI

The two possibilities need further discussion. Hence, the following is proposed:

## Proposal 7

*For inter-cell multi-DCI based Multi-TRP operation with two TA enhancement, support one of the alternatives (down selection to be done in RAN1#111):*

*Alt 1: RAR will always be received from serving cell => there is no need for additional type 1 CSS configuration per additional PCI*

*Alt 2: RAR can be received from a TRP corresponding to an additional PCI for a RACH procedure associated to the additional PCI => additional type 1 CSS configuration per additional PCI needs to be supported*

*Please provide your input on Proposal 7 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support  |
| Huawei, Hisilicon | Support Alt 1. If I remember correctly, in Rel-17, it was agreed that non-UE dedicated PDCCH/PDSCH should only be transmitted by the serving cell. |
| QC | Support  |
| LGE | Support. |
| OPPO | Support with preference on Alt.1. We agree with the assessment from HW. Recall the inter-cell beam management in Rel.17, the cell common channel can only be received from serving cell. Note that there is ongoing parallel session to treat TA issue for mobility, it is not desire to make overlapped design on TA acquisition in this AI.  |
| Support  | Support and prefer Alt1. |

# 7 Details of TA/TAG identification for Intra-cell Multi-DCI

In the first FL summary R1-2210304, the following questions were discussed:

Question 6 (from Previous Round)

*for CFRA triggered by PDCCH order, whether enhancements are needed for determination of whether TA command in RAR PDSCH corresponds to first TAG or second TAG?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | Yes. UE can determine the TRP according to the SSB indicated in the PDCCH order. This can be easily realized by configuring SSB of each TRP in an SSB list/group and associate SSB list/group with TAG.Note that, with SSB list/group configuration, the issue of TA association in section 4 can also be easily solved. In other words, SSB list/group configuration can minimize the spec impact of the whole TA enhancement framework. |
| Google | Yes. In our views, if Q2 is true/supported, then UE can understand which TRP is targeted for in a received PDCCH order, and UE should also understand whether TA command in RAR PDSCH corresponds to first TAG or second TAG.  |
| QC | Is this for intra-cell or inter-cell? The answer depends on this assumption. Of course, in both cases, the UE should know that TA corresponds to which TAG. However, for intra-cell, this info can come later (e.g., in the RAR itself) as PDCCH order and PRACH are transparent (wrt first or second TRP) in intra-cell case. On the other hand, for inter-cell, the UE should know which PRACH configuration should be used (so, this info cannot be in RAR PDSCH itself) |
| NEC | Not needed if the MAC entity can only have one valid RACH procedure for two TAGs of one serving cell. MAC entity may not start RACH for TAG 2 before the completion of RACH for TAG 1, in this case, there is no need to have TAG ID in RAR. It might be better to consult with RAN2 on the RACH capability of one MAC entity. |
| Lenovo | It may be different for intra-cell and inter-cell cases. In intra-cell case, enhancement is needed in the TA command in RAR PDSCH to inform the TA command is associated which TAG if there is no other enhancement for RACH resource/configuration for PDCCH order targeting for different TRPs. For inter-cell case, since the RACH configuration of serving cell and non-serving cell need be different, UE can know which TAG of the RACH resource indicated by the PDCCH order, therefore, no further enhancement is needed in the TA command in RAR PDSCH. |
| MediaTek | Yes, at least for intra-cell MTRP case, it could be ambiguous that the triggered RACH procedure is specific to which TRP/TAG. |
| OPPO | In our understanding, it depends. If PDCCH order indicates to which associated TAG (1st or 2nd) the RACH procedure is triggered, it seems not necessary to enhance the RAR PDSCH. Otherwise, the UE should know which TAG should be updated with new TAC in RAR. |
| ZTE | Yes, share the similar view with Huawei. |
| vivo | Yes |
| InterDigital | Yes, at least for intra-cell MTRP case. |
| NTT DOCOMO | Yes. |
| Apple  | Yes, for intra-cell mTRP case at least. For inter-cell mTRP, TAG ID maybe implicitly associated with the non-serving cell. If the CFRA is triggered for non-serving cell TRP based on PDCCH order, the TA in the subsequent RAR is used to update the TAG associated with the non-serving cell TRP and there is no need to implicit indicate in RAR payload.  |
| Sharp | Yes, we have the same view as Google. |
| LGE | Yes. In our understanding, introducing TRP-specific type1-CSS for RAR can easily solve the problem, i.e., CORESET pool specific type1-CSS. If specific RACH transmission is related with a CORESET pool index, then gNB/UE transmit/receive RAR in type1-CSS of the CORESET pool index. |
| Spreadtrum | Yes. Agree with the majority that it may depend on use case. But at least for inter-cell M-TRP case, it is needed. Given this, we prefer one unified solution. |
| Xiaomi | Yes. |
| CMCC | Yes, at least for intra-cell MTRP. |
| CATT | It depends. If PDCCH order indicates to which TRP the RACH procedure is triggered, UE can use the CORESEPoolIndex of the PDCCH order to decide the TA included in the RAR MAC PDU belong to a specific TRP. Otherwise, the UE needs to be indicated to which TRP the TA should be updated with the new TAC in RAR MAC PDU. |
| Ericsson | This depends on the overall design of the PDCCH order solution. We should aim for one solution for intra-cell and inter-cell. Again, we should align with mobility.  |
| Nokia/NSB | This aspect could be discussed separately for inter-cell case and intra-cell case. Also, it may depend on the outcome/response of other questions and proposals. So, we think it would be better to discuss this aspect at a later stage. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | Yes |

*FL Comment:* In the above discussion, two different solutions were discussed:

* Solution 1: include TAG ID as part of TA command RAR
* Solution 2: indicate TAG ID as part of PDCCH order

While some companies expressed preference for unified solution for inter-cell and intra-cell cases, some other companies preferred to intra-cell and intra-cell cases separately. It was pointed out by some that only Solution 1 will not work for the inter-cell multi-DCI multi-TRP scenario as the UE already needs to know which PRACH configuration to use in order to transmit RACH. Solution 2 can work for inter-cell multi-DCI or intra-cell multi-DCI. Given companies still prefer to study different solutions, we’ll focus on the intra-cell case in this section. Note that the inter-cell case will be discussed as part of Proposal 5.

Question 7 (from Previous Round)

*For intra-cell M-TRP scenario, whether there is a need to divide SSBs/RACH resources/Preambles into two groups, where for a RACH procedure*

* *if the corresponding SSB/RACH resource/preamble belongs to 1st group, then the TA obtained via RACH procedure corresponds to first TRP, and*
* *if the corresponding SSB/RACH resource/preamble belongs to 2nd group, then the TA obtained via RACH procedure corresponds to second TRP.*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | Yes. SSB grouping based solution is better than other solutions, like introducing new field in PDCCH order or introducing TAG ID in the RAR format, which consume the reserved bit of PDCCH/RAR. For future enhancement, every reserved bit is precious. We’d better avoid consuming the reserved bits if there are other options. |
| Google | We are open to it |
| QC | No, this is not necessarily required for intra-cell, but is it is one design option.  |
| NEC | It seems just one of NW implementations and can be transparent to UE. |
| Lenovo | Yes. |
| MediaTek | We don’t see the need |
| OPPO | No, for intra-cell MTRP, the grouping of SSBs/RACH resources/preambles can be up to NW’s implementation on MTRP and transparent to UE. PDCCH order can deliver SSB index, preamble, etc toward to a specific TRP. |
| ZTE | Yes.SSB index indicated in the PDCCH order or determined based on RSRP measurement is used to determine the RACH occasion(s) to transmit a preamble. When two SSB groups are configured for two TRPs, the mapping of SSB index to RACH occasion can be per TRP as well. As the number of SSB indexes mapped in a RACH occasion can be indicated by ssb-perRACH-OccasionAndCB-PreamblesPerSSB in RACH-Config, SSB grouping should ensure the SSB indexes mapped in the same RACH occasion are associated with the same TRP. |
| vivo | No, the intention of grouping SSB/RACH resources is to acquire the association between TAG and the absolute TAC received in RACH procedure, which can also be achieved by indication TAG ID in RAR, or, by the associating RACH procedure with coresetPoolIndex. |
| NTT DOCOMO | Similar view with QC. We think it is one of the options for determination of whether TA command in RAR PDSCH corresponds to first TAG or second TAG, but not the only one. |
| Apple  | This is just one candidate solution.  |
| Sharp | Yes, RACH resources for secondary TA acquisition should be configured. |
| LGE | Yes. To associate RACH with a specific TRP/TAG, RACH resource grouping can be useful. |
| Spreadtrum | Seems not necessary. It can be up to gNB’s implementation and configuration. |
| Xiaomi | Yes. |
| CMCC | This is kind of related to the association mechanism discussed in proposal 3. But if the UE has to acquire the timing difference between two TRPs, it should have the knowledge that the SSB #A is from TRP#1 and SSB#B is from another. And the RACH resources and preambles are all related to the SSB indices.  |
| CATT | We think the grouping of SSBs/preambles depend on NW’s implementation and transparent to UE. The preamble index and the beam to send preamble (SSB index) to a specific TRP can be included in PDCCH order. Upon the reception of the RAR MAC PDU in the RAR window after sending the preamble, UE can use the CORESETPoolIndex of the PDCCH order to decide the TA included in the RAR MAC PDU belong to a specific TRP.  |
| Ericsson | This is not necessary and should be avoided. |
| Nokia/NSB | This is one possibility. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | Yes, we can discuss further |

*FL Comment:* AS commented by some companies, the solution(s) discussed in Question 7 from previous round contains three solution variants for intra-cell multi-DCI case. Hence, the following can be considered as potential solutions for the intra-cell multi-DCI case.

* Solution 3: divide SSBs into two groups, where for a RACH procedure, if the corresponding SSB belongs to the *nth* group (*n=1,2)*, then the TA obtained via the RACH procedure corresponds to the *nth* TRP.
* Solution 4: divide RACH resources into two groups, where for a RACH procedure, if the corresponding RACH resource belongs to the *nth* group (*n=1,2)*, then the TA obtained via the RACH procedure corresponds to the *nth* TRP.
* Solution 5: divide preambles into two groups, where for a RACH procedure, if the corresponding preamble belongs to the *nth* group (*n=1,2)*, then the TA obtained via the RACH procedure corresponds to the *nth* TRP.

Combining the solutions from Questions 6-7, the following is proposed:

## Proposal 8

*For intra-cell multi-DCI based Multi-TRP operation with two TA enhancement, support one of the following alternatives (down selection to be done in RAN1#111):*

*Alt 1: include TAG ID as part of TA command in RAR*

*Alt 2: indicate TAG ID as part of PDCCH order*

*Alt 3: divide SSBs into two groups, one for each TRP. If a SSB associated to a RACH procedure belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP.*

*Alt 4: divide RACH resources into two groups, where for a RACH procedure, if the corresponding RACH resource belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP.*

*Alt 5: divide preambles into two groups, where for a RACH procedure, if the corresponding preamble belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP*

*Please provide your input on Proposal 8 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | One clarification question is does Alt.1/2 intend to explicitly indicate TAG ID in RAR or PDCCH order? If so, instead of explicitly indicating TAG ID in PDCCH order or RAR, we think another alternative is to associate TAG ID with CORESETPoolIndex and implicitly determine TAG ID based on the CORESETPoolIndex of PDCCH order/RAR. Thus, we suggest adding an Alt.6.* + - Alt.6. TAG ID is associated with CORESETPoolIndex and TAG ID is determined based on the CORESETPoolIndex of PDCCH order or RAR
 |
| Huawei, Hisilicon | Support Alt 3. For Alt 1 and 2, it will consume reserved bit of RAR/PDCCH, which is not good for future enhancement. While, Alt 3, Alt 4 and Alt 5 don’t consume any reserved bit of RAR/PDCCH. For Alt 4 and Alt 5, they will degrade the flexibility of RACH. For example, preamble/RO allocated to TRP1 cannot be used for TRP2. While, there is no such issue for Alt 3, since the allocation of SSB between two TPRs is usually static.  |
| QC | Support, and suggest Alt6 mentioned by DCM to be captured as Alt2B (while Alt2A can be based on the PDCCH order DCI payload) |
| LGE | OK to list and down-select in the next meeting, but not sure whether one solution works for all cases. Suggest to revise ‘support at least one of….’ for safety. |
| OPPO | Support the proposal in principle. There could be one more implicit solution. That is from which CORESET the PDCCH order come, if TAG ID is associated with *CORESETPoolIndex*. The advantages over other Alts could be no additional new filed in PDCCH order and no need for grouping rules.  |
| Lenovo | Support Alt1, 3 and 4. And similar view with LGE that it may support more than one alternative. Propose to revise the proposal as follows.Proposal 8*For intra-cell multi-DCI based Multi-TRP operation with two TA enhancement, support at least one of the following alternatives (down selection to be done in RAN1#111):**Alt 1: include TAG ID as part of TA command in RAR**Alt 2: indicate TAG ID as part of PDCCH order**Alt 3: divide SSBs into two groups, one for each TRP. If a SSB associated to a RACH procedure belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP.**Alt 4: divide RACH resources into two groups, where for a RACH procedure, if the corresponding RACH resource belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP.**Alt 5: divide preambles into two groups, where for a RACH procedure, if the corresponding preamble belongs to the nth group (n=1,2), then the TA obtained via the RACH procedure corresponds to the nth TRP* |

# 8 Potential enhancements to absolute TA command

In the first FL summary R1-2210304, the following question was discussed:

Question 9 (from previous round)

*Are there other issues RACH related issues that are not captured by Questions 1-8?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| QC | Yes: * Absolute TA MAC-CE is also related to random access procedures (part of 2-step RACH procedures).
* Allowing for two parallel random access procedures is also relevant for multi-DCI based mTRP with 2 TAs. RAN1 should study the use case and benefit further, and if needed, ask about RAN2’s opinion.
 |
| Lenovo | Agree with QC about the need to study Absolute TA MAC-CE since it is also related to RACH. |
| Ericsson | Agree with QC that absolute TA MAC CE should be enhanced. An enhanced absolute MAC CE can be used in more situations than in 2-step RACH.  |
| Nokia/NSB | It should be discussed whether a PRACH transmission is always needed when a new TCI state(s), associated with a different/new or even same TRP/PCI, is indicated or activated. And whether to let the UE determine the need for such a transmission at least in some cases. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | For PDCCH order, whether a PDCCH order can trigger one preamble only or two preambles (one from each TRP). In case two preamble are triggered, whether the RAR includes one or two TAs. |

*FL Comment:* Three companies point out potential enhancements to absolute TA command. We can try to collect comments on this in Proposal 9. The other issues mentioned in the above table are only discussed by one company each. We can discuss these proposals in the future.

## Proposal 9

*For multi-DCI based Multi-TRP operation with two TA enhancement, support potential enhancements related to indicating TAG ID via absolute TA command:*

* *FFS: whether the indication is implicit or explicit*
* *Detailed indication schemes are FFS*

*Please provide your input on Proposal 9 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support  |
| Huawei, Hisilicon | We are open to discuss this. |
| QC | Support |
| LGE | This could be merged with Proposal 8? |
| OPPO | Open for further discussion.  |
| Lenovo | Ok to discuss and it seems it can be merged with Proposal 8 since it’s RACH related. |

# 9 Overlapped region handling

In TDocs submitted, some companies propose to support overlapped transmission when the UE is capable of simultaneous uplink transmission. In RAN1#110bis-e, simultaneous transmission of PUSCH+PUSCH has been agreed for multi-DCI via the following agreement in agenda 9.1.4.1:

**FL Proposal 2-1**

**Support STxMP PUSCH+PUSCH transmission in multi-DCI based system in Rel-18.**

* **Two independent PUSCHs associated with different TRPs can be transmitted by a UE simultaneously in same active BWP.**
* **The total number of layers of these two PUSCHs is up to 4.**
* **FFS: whether the number of layers of each of these two PUSCHs is up to 2.**

Hence, we can see if the following proposal is agreeable:

## Proposal 10

*For multi-DCI based Multi-TRP operation with two TA enhancement, support overlapping transmission between two PUSCHs transmitted with different TAs for UEs that are capable of multi-DCI based PUSCH+PUSCH STxMP*

* *Further details are FFS*

*Please provide your input on Proposal 10 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| NTT Docomo | Support  |
| Huawei, Hisilicon | More details should be clarified. In our view, whether overlapping of two UL slots is allowed or not should depends on whether the two beams use for the two UL slots can be used for STxMP or not. A UE that supports STxMP may not support overlapped UL slots if the beams used for these two UL slots cannot be used for STxMP. |
| QC | One issue we see is that UE may need to follow one rule for PUSCH+PUSCH and another rule for SRS+PUSCH, PUSCH+PUCCH, SRS+PUCCH. This type of overlap should not be based on whether the spec supports a specific combinations of STxMP UL signals / channels. Rather, this type of overlap can happen even for signals / channels logically TDMed (due to different TAs). Hence, whether the UE needs to drop something (or scheduling restriction is needed) depends on RF capability of UE (two Tx RF chains), and not based on which STxMP combinations are supported by the spec in Rel-18.We see two solutions:1. Leave this up to UE implementation, i.e., UE may drop or not drop
2. UE indicates a separate capability whether a dropping / scheduling restriction is needed or not. This capability is not necessarily tied to STxMP cases supported by the spec.

At the end, we think there is really no good solution for this issue in general. Hence, we might as well leave this to UE implementation.  |
| LGE | OK in principle. |
| OPPO | Support. For M-DCI PUSCH + PUSCH STxMP, it seems two separate UL transmission chains can be deployed at UE side, if supporting STxMP. From UL beam aspects, no matter these UL beams are within the same slot or cross slots, UE should be able to transmit independently two PUSCHs.  |
| Lenovo | Support. |
|  |  |

Next, on the issue of overlap handling for UEs that are not capable of simultaneous uplink transmission, whether scheduling restriction can be adopted may depend on if the two TRPs both have knowledge of the overlapping region. Hence, companies are asked to provide their views on the assumption of the knowledge of overlapping region at both TRPs in the questions below:

## Question 10

*For multi-DCI based Multi-TRP operation with two TA enhancement, can it be assumed that both TRPs have knowledge of the overlapping region between transmissions corresponding to the two TAs?*

## Question 11

*If the answer to Question 10 is yes, can the overlapped handling issue be addressed via scheduling restriction?*

*Please provide your input on Questions 10 and 11 below:*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | For Q10, we don’t think this assumption is reasonable. It is unclear how the two TRPs can get the knowledge of the overlapped region. |
| QC | Question 10: Not always (e.g., not in non-ideal BH) or not accurately (exact absolute TA value at the UE is not known even in ideal backhaul).Question 11: Yes, leaving a symbol gap can address the issue (MTTD is half a symbol for inter-band CA, and it is very unlikely that RAN4 increases MTTD for mTRP), but this approach results in overhead.  |
| LGE | For Question 10, it depends on whether it is ideal backhaul case or non-ideal backhaul case. For non-ideal backhaul case, dynamically scheduling channels/signals could not be shared across different TRPs so both TRPs may not have knowledge of the overlapping region.For Question 11, since the answer to Question 10 is no, overlapping handling issue with scheduling restriction is not proper solution. Rather, dropping of overlapped part from UE side could be the solution as gNB can detect partial dropping. |
| OPPO | Q10: for M-DCI MTRP, we cannot easily assume the TRPs could coordinate in slot level. Consider the legacy approach in Spec, the overlapped part of later transmission can be dropped by UE.  |
|  |  |
|  |  |
|  |  |

# 10 Potential Issue related to RAN2

In the first FL summary R1-2210304, the following question was discussed:

Question 8 (from previous round)

*Whether there is a need to enhance CBRA procedures to support UE-based PRACH triggering per TRP when the corresponding Time alignment timer expires?*

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei, Hisilicon | We are open to discuss this. |
| Google | We are OK to it.  |
| QC | This may be a RAN2 issue. We suggest to first focus on CFRA from RAN1 signaling perspective, and also send an LS to RAN2 regarding timer and PTAG definition. |
| Lenovo | Open to discuss it. |
| MediaTek | TA timer related issue can be left to RAN2 |
| OPPO | Support to study in RAN1.  |
| ZTE | Yes.In addition to our elaboration in Q4, it should be noted that the following events related to TA (as specified in TS38.300) can be based on CBRA:* DL or UL data arrival during RRC\_CONNECTED when UL synchronisation status is "non-synchronised"
* Request by RRC upon synchronous reconfiguration (e.g. handover)
* To establish time alignment for a secondary TAG
 |
| vivo | Yes, it could be discussed in RAN2, in our view, only relevant enhancement on RAR is to simply include TAG ID. |
| InterDigital | Support to study, and also agree with QC to send an LS to RAN2 regarding the timer and PTAG related issues. |
| NTT DOCOMO | We think a necessary enhancement for UE triggered RACH is determination of whether TA command in RAR PDSCH corresponds to first TAG or second TAG. |
| Apple | If the intended use case is ‘TAT timer expires’, it can be handled by RAN2.  |
| Sharp | Support to study |
| LGE | Open to discuss. However it seems more like gNB’s choise to trigger RACH for the corresponding TAG. If both of timers are expired in SpCell, it is clear that UE-based PRACH triggering should be supported. |
| Spreadtrum | Fine to leave it to RAN2. |
| Xiaomi | Support to discuss in RAN1. |
| CMCC | Open to discuss.  |
| CATT | We are open to discuss it.  |
| Ericsson | The use case should be clarified first, and RAN2 should be involved. |
| Nokia/NSB | This aspect needs to be discussed and addressed, be it in RAN1 and/or RAN2. |
| Moderator | Let’s continue discussion in next round. |
| Samsung | Existing procedures seem to be sufficient. When the timer expires (for first TA or second TA), the UE can trigger a corresponding preamble. This can be further considered in RAN2 |

*FL Comment:* Several companies pointed out that the issue discussed should be considered by RAN2. Some companies also proposed to send an draft LS to RAN2. Some companies also pointed out that there may be other issues that are RAN2 related also (e.g., whether one or two PTAGs need to be supported when the SpCell contains two TAGs). Note that we haven’t discussed these other issues yet. From FL’s perspective, this is the first meeting where we are discussing RACH related issues in RAN1. May be we can wait 1-2 more meetings to make some more progress on RAN1 related issues before sending the LS to RAN2.

# 11 Proposals for Online Discussion

TBD