3GPP TSG-RAN WG1 Meeting #110bis-e R1-2210304

e-Meeting, October 10th – 19th, 2022

Agenda Item: 9.1.1.2

Source: Moderator (Ericsson)

Title: Moderator Summary #1 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 Two vs One reference timing

The proposals related to the number of timings references from contributions is listed below:

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| R1-2208627 (vivo) | Proposal 2 Two reference timing are considered for two TA. |
| Proposal 3 UE shall assume the timing difference between signals from two TRPs arriving at the UE is within a CP. |
| R1-2209713 (Samsung) | Proposal 5 For multi-DCI multi-TRP operation with two TAs, there is one DL reference time. |
| Proposal 4 Using the measured difference in propagation delay between the first TRP and the second TRP the UE can determine the uplink transmission time to the second TRP. |
| R1-2208677 (Ericsson) | Proposal 3 Two reference timings are used with two TAs. |
| R1-2209968 (Qualcomm) | Proposal 2 For multi-DCI multi-TRP operation with two TAs, support Alt 1: Two reference timings of DL reception are considered.* UE can indicate whether the Rx timing difference at the UE can be larger than CP length as an additional capability. Otherwise, Rx timing difference at the UE is assumed to be no larger than CP length.
	+ Even for a UE that indicates such capability, Rx timing difference is limited by MRTD requirements for inter-band CA.
* For a TAG associated with a coresetPoolIndex value, “the first detected path (in time) in the reference CC” is based on the DL-RS of the active TCI states associated with the same coresetPoolIndex value.
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| R1-2208440 (Huawei, HiSilicon) | Proposal 9 Support two independent reference timings with each corresponding to one TA.* Note: Gap of the two reference timings is assumed to be no larger than CP length.
 |
| R1-2210062 (Nokia, NSB) | Proposal 1 For multi-DCI multi-TRP operation with two TAs, two reference timings are considered. |
| Proposal 2 Discuss the association of DL RSs to TAGs/TRPs if Alt.1 is adopted, i.e., if two reference timings are considered. |
| R1-2209493 (MediaTek) | Proposal 2 When two TAGs are configured within a serving cell, support two reference timings for the two TAGs, respectively. Note: This doesn’t imply the change of maximum Rx timing difference between the DL transmissions from two TRPs that UE may assume for M-DCI based MTRP |
| R1-2208503 (ZTE) | Proposal 5 Regarding the reference timing of downlink reception to adjust uplink transmission timing in case of two TAs for multi-DCI multi-TRP scenario,* One reference timing (Alt 2) should be supported at least.
* Whether to support two reference timings (Alt 1) can be subject to UE capability.
	+ Whether/how to specify mapping between DL reference timing and UL TA is up to RAN4.
	+ Note: If additionally supporting two reference timings, the time gap between the two reference timings should not be larger than one CP length.
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| R1-2209889 (NTT Docomo) | Proposal 2.1:  Two reference timings are considered for two TRPs of a serving cell. |
| R1-2209569 (Apple) | Proposal 6: * Support two DL reference timings for two TAs in mDCI-based mTRP operation.
* Keep Rel-17 restriction for DL receptions from two TRPs within a CP in FR1 and FR2. FFS on need of UE capability.
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| R1-2208374 (FUTUREWEI) | Proposal 1: For multi-DCI multi-TRP operation with two TAs, support two reference timings where reference timing is the timing of the DL reception. |
| R1-2209040 (Intel) | Proposal-5: Conclude to relax the assumption of DL MTRP reception within a CP, otherwise there is no practical use-case for 2-TA enhancement |
| R1-2208793 (OPPO) | Proposal 1: For M-DCI MTRP, support one DL reference timing for two TAGs. |
| R1-2209321 (CMCC) | Proposal 6: Two reference timings should be considered in the mTRP scenario, considering that the two TAs are induced by different propagation delays.  |
| Proposal 7:It should discuss the impact of the two reference timings to the uplink transmission. |
| R1-2209380 (Sharp) | Proposal 5: Two DL reference timing should be considered. |
| Proposal 6: The gap between two DL reference timings can be no larger than CP length. |
| R1-2209257 (xiaomi) | Proposal 1: Adopting two reference timings for multi-DCI multi-TRP operation. |
| R1-2208741 (Lenovo) | Proposal 1: Support only one reference timing for TA enhancement in M-DCI based M-TRP in R18. |
| R1-2208946 (CATT) | Proposal 8: Support Alt.2, i.e. one reference timings is considered. |
| R1-2208494 (InterDigital) | Proposal 1: For both intra-cell and inter-cell deployment cases, support beyond a CP receive timing difference. |
| R1-2209139 (NEC) | Proposal 2: Support that two reference timings of the two TAGs for a serving cell are within a CP. |
| R1-2208540 (Spreadtrum) | Proposal 3: For multi-DCI based M-TRP with two TAs, it is enough to only consider one reference timing. |
| R1-2209166 (Transsion) | Proposal 3: For the reference timings of DL reception, support Alt 1, i.e. two reference timings are considered. |

Based on the Tdocs submitted to RAN1#110bis-e, the following are the company positions for one vs two DL reference timings:

* two DL reference timings ***(supported by 13 companies)***: vivo, Ericsson, Qualcomm, Huawei/HiSilicon, Nokia/NSB, MediaTek, NTT Docomo, Apple, FUTUREWEI, CMCC, Sharp, xiaomi, Transsion
* one DL reference timing ***(supported by 6 companies)***: Samsung, ZTE, OPPO, Lenovo, CATT, Spreadtrum

Furthermore, regarding receive timing difference between TRPs, the following are proposed:

* Rx timing difference between signals from two TRPs within CP length ***(supported by 7 companies)***: vivo, Qualcomm, Huawei/HiSilicon, MediaTek, Apple, Sharp, NEC,
* Rx timing difference between signals from two TRPs can be beyond CP length ***(supported by 3 companies)***: Qualcomm (as additional UE capability), Intel, InterDigital,

A large majority of companies support two DL reference timings, while some companies also expressed preference for a single DL reference timing. In RAN1#110, we almost reached consensus on two DL reference timings if the Rx timing difference between signals from two TRPs is restricted to within a CP length.

However, some companies did not agree that the Rx timing difference between signals from two TRPs should be limited to within a CP length. These companies argue that such limitation will limit the use case for two TAs.

As a compromise, let’s try if we can agree two DL reference timings with baseline assumption being Rx timing difference between signals from two TRPs restricted to within a CP length. To address the concern from the companies that didn’t want to restrict the Rx timing difference within a CP length, we can introduce an optional capability where the UE can indicate support for Rx timing difference between signals from two TRP is beyond CP length.

Note that one company suggested that the Rx timing difference should be limited by MRTD requirements for inter-band CA. In the Reply LS, RAN4 stated the following:

*“Whether exiting MTTD requirements are applicable for multi-DCI multi-TA scenario or new requirements needs to be developed is currently under discussion in RAN4. We shall inform RAN1 once RAN4 has consensus on the MTTD value for multi-DCI multi-TA scenario.”*

Hence, decisions related to applicable requirements can be left to RAN4.

## *Proposal 1*

*For multi-DCI multi-TRP operation with two TAs, two DL reference timings are supported where each DL reference timing is associated with one TAG*

* *baseline assumption is that the Rx timing difference between the two DL reference timings is no larger than CP length*
* *as an optional UE capability, Rx timing difference between the two DL reference timings can be assumed to be larger than CP length*

Please provide your comments/suggestions on Proposal 1 below.

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| **Company Name** | **Comments** |
| Huawei, Hisilicon | Support the proposal with the following update. The UE feature can be reported only in mDCI MTRP case. *Proposal 1* *For multi-DCI multi-TRP operation with two TAs, two DL reference timings are supported where each DL reference timing is associated with one TAG** *baseline assumption is that the Rx timing difference between the two DL reference timings is no larger than CP length*
* *as an optional UE capability, Rx timing difference between the two DL reference timings for mDCI based UL MTRP transmission can be assumed to be larger than CP length*
 |
| Google | We support this proposal.  |
| QC | Support.  |
| NEC | OK for progress. However, this assumption (Rx timing difference of two TAGs be larger than CP) should only be considered for UL m-DCI MTRP case as in WID. |
| MediaTek | For progress, we are fine with the proposal.  |
| OPPO | Support the proposal in principle. We also think the revision from Huawei looks good, i.e. confining the UE capability on Rx timing difference larger than a CP length to M-DCI UL MTRP.  |
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# 3 Applicability of two TA enhancement

The proposals related to the frameworks for which the two TA enhancement is applicable is discussed in the following contributions:

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| R1-2208677 (Ericsson) | Proposal 1 Two TAs for UL multi-DCI for multi-TRP operation is only supported for the extension of the Rel-17 unified TCI framework. |
| Proposal 2 Do not design the two-TA handling on properties that are only available for multi-DCI multi-TRP transmission. |
| R1-2209541 (Google) | Proposal 2: 2TA operation is designed in a way applicable for both R17 unified TCI framework and R15/16 UL beam indication via spatial relation. |

Whether the two TA enhancement only applies to (1) only multi-DCI multi-TRP schemes based on unified TCI framework or (2) to multi-DCI multi-TRP schemes based on both unified TCI framework and spatial relation based framework needs to be decided. This may be needed before we can make a decision on how to associate TAs with UL channels/signals.

## *Proposal 2*

*Multi-DCI multi-TRP operation with two TAs is supported for one of the following:*

* *Alt 1: Only unified TCI framework*
* *Alt 2: both unified TCI framework and UL beam indication via spatial relation*

Please indicate your preference between Alt1 and Alt2. Since the outcome of this proposal may impact how TAs are associated with UL channels/signals, we’ll aim to make a decision on this in the first GTW session.

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| **Company Name** | **Comments** |
| Huawei, Hisilicon | Support Alt 2. |
| Google | Support Alt 2.  |
| QC | Alt2 should be the default assumption. Anything other than Alt2 requires explicit agreement and consensus. |
| NEC | Support Alt 2. |
| Lenovo | Support Alt 2. |
| MediaTek | Prefer Alt1 |
| OPPO | Prefer Alt.2. For M-DCI MTRP, since UL TA and UL beam indication are separate features (at least by now), we fail to see strong motivation to restrict two TAs only for unified TCI state(s). For legacy beam indication based on spatial relation, we suppose the same reason for applying two TAs also hold.  |
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# 4 Association between TAs and UL channels/signals

The following proposals related to association between TAs and UL channels/signals were made in TDocs contributed by companies:

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| R1-2208627 (vivo) | Proposal 4 Support associate TAG to CORESETPoolIndex. |
| Proposal 5 The relation between channels/signals and the applied TAs is acquired by the assumption that TCI states activated by one MAC CE associated with one CoresetPoolIndex share one TA. |
| R1-2209713 (Samsung) | Proposal 7 For multi-DCI multi-TRP operation with two TAs, each TA value is associated with an UL or Joint TCI state or UL spatial relation. |
| R1-2208677 (Ericsson) | Proposal 7 Include a TAG in each joint or UL TCI state. |
| Proposal 8 The timing reference for any UL transmission is the reference signal providing the UL TX spatial filter. If the RS providing the UL spatial TX spatial filter is an SRS, the PL RS for the UL TCI state provides the timing reference. |
| R1-2209968 (Qualcomm) | Proposal 3 For multi-DCI based multi-TRP operation with two TAs, support Option 2: The two TAG IDs are associated with the two coresetPoolIndex values, and association between UL channels/signals and the two TAG IDs is determined based on coresetPoolIndex value.* For dynamic UL channels/signals: Reuse Rel-16 rule for associated coresetPoolIndex value.
* For periodic/semi-persistent UL channels/signals: RRC configures the associated coresetPoolIndex value.
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| R1-2208440 (Huawei, HiSilicon) | Proposal 5 Support associating TAG to an SSB group (Option 3). For an 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
* that QCL source SSB of the PL RS belongs to, if the PL RS is a CSI-RS
 |
| R1-2210062 (Nokia, NSB) | Proposal 3 For associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, select one of the following options: * Option 1: Associate TAG to TCI-state/spatial relation.
	+ This could be achieved by (i) either defining direct association of a TAG to a TCI state or spatial relation, or (ii) by associating a TAG to a set of DL RSs where this association is used to determine the association of TAG to TCI state or spatial relation.
* Option 2 (with or without aspects from Option 4): Associate TAG to CORESETPoolIndex.
	+ configured UL resources/transmissions can be associated to a CORESETPoolIndex (based on Option 2) or to a TAG (based on Option 4).
 |
| Proposal 10 In case of update/switch of (indicated) TCI state, discuss efficient ways, based at least partially on UE decision/evaluation, to allow the network determining the TA (or TA adjustment) corresponding to this TCI state.* FFS whether to use PRACH and/or UL transmission(s) in longer CP occasion(s), etc.
 |
| Proposal 11 Discuss whether there is a need to clarify the impact of TCI state update/switch on some UL transmissions at least before a corresponding TA update is obtained. |
| R1-2209493 (MediaTek) | Proposal 1 When two TAGs are configured within a serving cell, support the association between TCI state/spatial relation and TAG |
| R1-2208503 (ZTE) | Proposal 4 For associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, support to associate TAG to CORESETPoolIndex (Option 2).* Study to configure CORESETPoolIndex in the transmission configuration of UL channels/signals without dynamical scheduling.
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| R1-2209889 (NTT Docomo) | Proposal 2.5: For association between TAG and UL channel/RS, support option2/4. For dynamic grant PUSCH, TAG associated with the CORESETPoolIndex of scheduling DCI can be applied.  For CG PUSCH, CORESETPoolIndex/TAG can be configured in CG configuration. For SRS, CORESETPoolIndex/TAG can be configured per SRS resource.  For PUCCH, CORESETPoolIndex/TAG can be configured per PUCCH resource. |
| R1-2209569 (Apple) | Proposal 5: * Adopt Opt.2 for TAG association with uplink transmissions, i.e., each TAG is associated with one of the CORESETPoolIndex values.
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| R1-2208374 (FUTUREWEI) | Proposal 2: For multi-DCI multi-TRP operation with two TAs, associate TAG to DL RS group comprising SSB/TRS resource(s). For a UL transmission, the UL channels/signals which are QCLed to a SSB/TRS resource, directly or indirectly, or whose PL RS(s) are QCLed to the SSB/TRS resource, are associated with the TAG associated with the DL RS group to which the SSB/TRS resource belongs.  |
| R1-2208892 (LG) | Proposal #4: Associate TAG ID to target UL channels/RSs directly for semi-static UL channels/RSs (e.g. P CSI PUCCH, P SRS, CG PUSCH)- For dynamic UL channels/RSs, support association of TAG ID to CORESETPoolIndex. |
| R1-2209040 (Intel) | Proposal-2: Consider associating unified TCI States and UL-TCI States or spatial relation with a TAG |
| R1-2208793 (OPPO) | Proposal 2: For M-DCI MTRP, support to associate TAG to CORESETPoolIndex (Option 2) for dynamic UL channels/RSs and study associations for semi-static UL channels/RSs (Option 4). |
| R1-2209541 (Google) | Proposal 3: For association of TA values with UL channels/RSs, support Option 2, i.e., a TA value is associated or included in a Rel-17 joint/UL TCI or a Rel-15/16 spatial relation. |
| R1-2209321 (CMCC) | Proposal 5:For the dynamic scheduled UL transmission, the TAG should be associated with the CORESETPoolIndex. And for the semi-static configured UL transmissions, the TAG should be associated with the targeted channels and signals. But more details should be discussed. |
| R1-2209380 (Sharp) | Proposal 7: TAG should be associated with CORESET pool index. |
| R-2208741 (Lenovo) | Proposal 3: Support Option 2 (Associate TAG to CORESETPoolIndex) for associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation. |
| Proposal 4: Apply the TA value of a TAG associated with one CORESETPoolIndex value for all UL transmissions associated with the CORESTPoolIndex value. |
| R1-2208946 (CATT) | Proposal 5: TA can be associated with uplink transmission by CORESETPoolIndex or with TCI state/spatial relation info. Both option 1 and option 2 are supported. For periodic/semi-persistent PUCCH, SRS and type-1 configured grant PUSCH, the association between CORESETPoolIndex and the uplink channel can be defined by RRC configuration. |
| R1-2208494 (InterDigital) | Proposal 4: Consider Option 2 (associating TAG to CORESETPoolIndex) as a baseline. Further study on Option 4 (target channel-wise TAG association especially for semi-static UL channels/RSs). |
| R1-2209139 (NEC) | Proposal 4: Support Option 1 to associate TAG to TCI-state/spatial relation. |
| R1-2208540 (Spreadtrum) | Proposal 1: Support one TAG associated with one coresetPoolIndex. |
| Proposal 2: Support periodic PUCCH and CG type1 PUSCH to be associated with one TAG or coresetPoolIndex. |
| R1-2208460 (TCL) | Proposal 1: Support option 2: Associate TAG to CORESETPoolIndex. |
| R1-2209166 (Transsion) | Proposal 4: For associating TAGs to target UL channels/signals, we support Option 2, i.e., associate TAG to CORESETPoolIndex. |

In the last meeting, 4 options were listed for further study. In the following proposal, options 2 and 4 from the previous agreement in RAN1#110 have been merged into Alt 2. Further details are also included for the other two options.

## *Proposal 3*

*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/joint TCI state or spatial relation*
	+ *for UL transmission, the TAG ID associated with the UL/joint TCI state or spatial relation is utilized*
* *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*
* *Alt 3: Associate TAG to DL RS group.*
	+ *For a UL transmission, UE adopts the TAG associated with the DL RS group to which the PL RS of the UL transmission belongs.*

Current company positions are as follows:

* Alt 1 ***(Supported by 8)***: Samsung, Ericsson, Nokia/NSB, MediaTek, Intel, Google, CATT, NEC,
* Alt 2 ***(Supported by 16)***: vivo, Qualcomm, Nokia/NSB, ZTE, NTT Docomo, Apple, LG, OPPO, CMCC, Sharp, Lenovo, CATT, InterDigital, Spreadtrum, TCL, Transsion
* Alt 3 ***(Supported by 2)***: Huawei/HiSilicon, FUTUREWEI,

Please check Proposal 3 and check if each alternative is a complete solution. We’ll likely discuss down-selection later this meeting. Companies are welcome to indicate a second preference among the alternatives above.

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| **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*

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.** |
| 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~~*

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. In 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.  |
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# 5 RACH procedure

The following proposals related to RACH procedure were made in TDocs contributed by companies:

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| R1-2208627 (vivo) | Proposal 7 The association between the RACH procedure and TRP can be implicitly obtained through *CoresetpoolIndex* in both intra-cell and inter-cell mTRP operations. * + - * Per TRP RACH resource configuration also needs to be enhanced for inter-cell MTRP cases.
 |
| Proposal 8 Further study configuration of type1 CSS for the TRP-specific RACH. |
| R1-2209713 (Samsung) | Proposal 1 The UE is informed of the association between SSBs and TRPs.* At least for RRC connected mode.
* FFS: acquisition of 2 TAs for 2 TRPs during initial access
 |
| Proposal 2 If the difference in time of arrival from the two TRPs exceeds a threshold, the UE can trigger a random access procedure towards the second TRP. |
| Proposal 3 A TRP can trigger a PDCCH order to determine the TA for uplink transmissions to the TRP. A TRP can trigger a PDCCH order for itself or for another TRP. |
| R1-2208677 (Ericsson) | Proposal 9 Introduce information in the PDCCH order about which RACH configuration to use. |
| Proposal 10 Introduce a PDCCH order that triggers a RACH procedure towards another TRP/cell. |
| Proposal 11 At the reception of the absolute timing advance MAC CE, the UE stops transmitting PRACH. |
| Proposal 12 Further clarify what aspects of the UE-triggered RACH procedure should be studied. |
| R1-2209968 (Qualcomm) | Proposal 6 At least for CFRA triggered by PDCCH order for intra-cell multi-DCI based mTRP with two TAGs, support one of the following alternatives for determination of whether TA command in RAR PDSCH corresponds to the first TAG or second TAG:* Alt 1: One (reserved) bit of the PDCCH order DCI is used.
* Alt 2: The coresetPoolIndex value associated with the PDCCH order DCI is used.
* Alt 3: The reserved bit of the PDSCH RAR is used.
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| Proposal 7 For CFRA triggered by PDCCH order for inter-cell multi-DCI based mTRP with two TAGs:* Support separate PRACH configurations corresponding to each additional PCI(s).
* Support one of the following alternatives to determine whether PDCCH order triggers PRACH for a serving cell PCI or an additional PCI:
	+ Alt 1: One or more reserved bits of the PDCCH order DCI is used.
	+ Alt 2: The coresetPoolIndex value associated with the PDCCH order DCI is used.
* FFS 1: Reception of Type1 CSS for the PDCCH that schedules RAR PDSCH.
	+ Whether Type1 CSS can be transmitted from an additional PCI or not.
* FFS 2: Whether PRACH for a configured additional PCI that is not active yet can be triggered by PDCCH order or not.
 |
| Proposal 8 For a CC that is configured with two TAGs, support using a reserved bit of the “Absolute Timing Advance Command MAC CE” to indicate whether the TA command corresponds to the first TAG or the second TAG. |
| Proposal 9 For multi-DCI based mTRP with two TAs, support two parallel random-access procedures in a MAC entity. |
| R1-2208440 (Huawei, HiSilicon) | Proposal 2 In intra-cell M-TRP scenario, SSBs of the serving cell can be divided into two groups, with each SSB group corresponding to one TRP. Information of SSB groups can be configured to UE. |
| Proposal 3 For a RACH procedure, if the corresponding SSB belongs to the 1st/2nd SSB group, then the TA obtained via the RACH procedure is corresponding to the 1st/2nd TRP. |
| Proposal 4 Introduce an *AdditionalPCIIndex* field in PDCCH order for UE to differentiate that the triggered RACH procedure is corresponding to which cell. |
| R1-2210062 (Nokia, NSB) | Proposal 5 To enable the determination of two TAs for inter-cell multi-TRP scenarios, for CFRA procedures: support providing the UE with CFRA configuration corresponding to a non-serving cell PCI. |
| Proposal 6 To enable the determination of two TAs for intra-cell and inter-cell multi-TRP scenarios, for CBRA procedures: support at least triggering PRACH per TRP.* FFS provide the UE with CBRA configuration per each PCI and define a way to indicate the PCI through the PDCCH order for inter-cell cases.
* FFS splitting RACH resources into two groups each corresponding to a TRP/CORESETPoolIndex and define a way to indicate corresponding TRP/CORESETPoolIndex for intra-cell cases.
 |
| Proposal 7 To enable the determination of two TAs for multi-TRP scenarios, for CBRA and CFRA procedures, RAN1 should discuss for both intra-cell and inter-cell cases:* if the PDCCH order operation should be enhanced so that a PDCCH order from a first TRP can trigger PRACHs towards the two TRPs at a time or towards any TRP, or
* if the PDCCH order operation should be made TRP specific, i.e., each TRP can send a corresponding PDCCH order triggering PRACH transmission towards that TRP.
 |
| Proposal 8 To enable the determination of two TAs for multi-TRP scenarios, for CBRA procedures: support UE-based PRACH triggering per TRP when the corresponding time alignment timer expires.* FFS provide CBRA configuration per PCI for inter-cell cases.
* FFS splitting RACH resources into two groups each corresponding to a TRP/CORESETPoolIndex for intra-cell cases.
 |
| R1-2209493 (MediaTek) | Proposal 3 If two TAGs are configured within the serving cell, study how to indicate/determine which TAG should apply the initial TA value indicated by RAR in response to PRACH transmission triggered by PDCCH order on the serving cell, the following options can be considered:* + Option 1: If a TAG is associated with a coresetPoolIndex value, the initial TA value indicated by an RAR in response to a PRACH transmission triggered by DCI format 1\_0 on a CORESET associated with a coresetPoolIndex is applied to the TAG corresponding to the coresetPoolIndex
	+ Option 2: If each TCI state can be associated with a TAG, the initial TA value indicated by an RAR in response to a PRACH transmission triggered by DCI format 1\_0 on a CORESET is applied to the TAG corresponding to the TCI state used as the QCL assumption for the CORESET
	+ Option 3: Use some of the reserve bits in PDCCH order to carry a TAG-ID. The initial TA value indicated by an RAR in response to a PRACH transmission initiated by PDCCH order applies to the TAG corresponding to the TAG-ID carried by the PDCCH order
	+ Option 4: Introduce new signaling to trigger RACH
 |
| Proposal 4 If two TAGs are configured within the serving cell, which TAG should apply the initial TA value indicated by RAR in response to PRACH transmission triggered by UE can be determined based a pre-defined rule, e.g., the initial TA value shall be applied to the TAG with lowest TAG-ID. |
| R1-2208503 (ZTE) | Proposal 6 Regarding obtaining initial timing advance values for multi-DCI based multi-TRP operation with two TAs through random access procedures, both UE triggered RACH and PDCCH order based RACH should be supported. |
| Proposal 7 Regarding RACH enhancements for multi-DCI based multi-TRP operation with two TAs, the following options should be considered.* Option 1: Two Preamble groups for two TAs.
* Option 2: Two SSB groups for two TAs.
* Option 3: Two RACH occasion sets for two TAs.
 |
| R1-2209889 (NTT Docomo) | Proposal 2.3: For PDCCH ordered RACH, TAC in MAC RAR can be applied to the TRP associated with the PDCCH/PDSCH of the RAR or the TRP associated with the PDCCH order. The association between PDCCH/PDSCH of RAR or PDCCH order and TRP can be determined based on CORESETPoolIndex.  For UE triggered RACH, TAC in MAC RAR can be applied to the TRP associated with PDCCH/PDSCH of the RAR. The association between PDCCH/PDSCH of RAR and TRP can be determined based on CORESETPoolIndex. |
| Proposal 2.4: For inter-cell M-TRP, RACH configuration of non-serving cell needs to be provided to UE.  If PDCCH order is associated with non-serving cell TRP, UE applies the RACH configuration of the non-serving cell. |
| R1-2209569 (Apple) | Proposal 1* *For CFRA, support to provide the following non-serving cell CFRA configurations for two TAs in MTRP operation:*
	+ *CFRA configuration*
	+ *Type-1 CSS configuration.*
	+ *The associated PCI*
 |
| Proposal 2* *In a CFRA procedure, a UE determines the coresetPoolIndex of Type 1 CSS based on the PCI associated with the transmitted PRACH resource.*
 |
| Proposal 3: * *Study the CFRA triggering mechanism to obtain the initial TA value for non-serving cell after dedicated RACH resources are provided by serving cell.*
 |
| R1-2208374 (FUTUREWEI) | Proposal 3: For multi-DCI multi-TRP operation with two TAs, support PDCCH order triggering PRACH transmission to obtain a second TA. |
| R1-2208892 (LG) | Proposal #5: Support enhancement on both PDCCH ordered RACH and UE triggered RACH for measuring timing offset per TRP/panel and for indicating TA value per TRP/panel.- In order to introduce TRP/panel-specific RACH transmission, RACH-related resources for CBRA/CFRA can be associated with CORESETPoolIndex/TAG ID. |
| R1-2209040 (Intel) | Proposal-3: For PDCCH ordered RACH for intra-cell MTRP, include a TAG-id to the RAR |
| Proposal-4: For PDCCH ordered RACH for inter-cell MTRP, configure RACH configurations for one or more “additional” PCIs. Indicate one “additional” PCI with the PDCCH ordered RACH |
| R1-2208793 (OPPO) | Proposal 5: For intra-cell MTRP case, study the PDCCH ordered RACH procedure toward the TRP from which the PDCCH order is transmitted. |
| Proposal 6: On RACH triggered by PDCCH order, suggest to focus on the intra-cell MTRP case to avoid potential design collision with agenda item 9.12.2. |
| Proposal 7: For UE triggered RACH, study how to associate TAG with RACH procedure, i.e. for UE to differentiate different TRPs. |
| R1-2209541 (Google) | Proposal 4: Support introducing a per-TRP RA procedure for acquiring TA value, where the per-TRP RA procedure supports both CBRA and CFRA procedure. |
| R1-2209321 (CMCC) | Proposal 2: For inter-cell and intra-cell MTRP PDCCH ordered RACH, it should be clarified when will the TRP trigger the PDCCH ordered RACH. For the inter-cell MTRP PDCCH ordered RACH, it should be clarified how could UEs get the RACH related information of the non-serving cell. |
| Proposal 3:It should be clarified that in which kind of situation or in any event the UE can trigger a RACH procedure when the UE is synchronized with one of the TRPs. |
| R1-2209380 (Sharp) | Proposal 3: For inter-cell MTRP CFRA for the second TA acquisition,- Step 0: TRP#1 should provide the UE with preamble assignment for second TA acquisition via PDCCH order.- Step 1: The UE should transmit the preamble to TRP#2.- Step 2: The UE should receive the RAR including the second TA from TRP#1. |
| Proposal 4: For intra-cell MTRP CFRA for the second TA acquisition,- Step 0: Either TRP#1 or TRP#2 should provide the UE with preamble assignment for second TA acquisition via PDCCH order.- Step 1: The UE should transmit the preamble to TRP#2.- Step 2: The UE should receive the RAR including the second TA from either TRP#1 or TRP#2. |
| R1-2209257 (xiaomi) | Proposal 4: Adopting per-TRP random access process to acquire two TAs for inter/intra-cell multi-TRP operation. |
| Proposal 5: For intra-cell multi-TRP, the UE initiates random access and transmits preamble to TRP#1 in the first RO. The gNB triggers PDCCH order to indicate the random access process for TRP#2 in the second RO to acquire two TAs. |
| Proposal 6: Associate TRP/TAG to CORESETPoolIndex for multi-DCI based multi-TRP operation. |
| R1-2208946 (CATT) | Proposal 1: For CFRA based RACH in intra-cell MTRP, SS/PBCH index in the PDCCH order determines the beam used by UE to transmit preamble with Random access preamble index to the second or first TRP. CORESETPoolIndex of the PDCCH order is used by UE to decide the TA applied to second or first TRP. |
| Proposal 2: For CBRA based RACH in intra-cell MTRP, UE can work in single TRP mode and wait until the CFRA based preamble is available. No enhancement is needed. |
| Proposal 3: For inter-cell MTRP, to obtain the initial TA of the non-serving cell TRP, the SSBs with non-serving cell index and the association between SSB with non-serving cell index and PRACH occasion are pre-configured. |
| R1-2208494 (InterDigital) | Proposal 5: Study and decide on how the UE can identify a clear association of the received PDCCH order with a specific TRP(TAG) for the two-TA scenario. |
| R1-2208540 (Spreadtrum) | Proposal 4: Suggest to take PDCCH order triggered CFRA as high priority. |
| Proposal 5: Enhancement on RAR is needed to indicate TAC per TAG/TRP. |
| Proposal 6: For inter-cell case, enhancement on PDCCH order is needed to indicate SSB/RACH configuration for either serving cell or neighbor cell. |
| R1-2209166 (Transsion) | Proposal 1: Association between SSBs and TRPs can be designed to differentiate RACH procedures for different TRPs. |
| Proposal 2: To trigger RACH by PDCCH order in inter-cell MTRP case, the RACH configuration of the non-serving cell should be provided to UE. |

Several different enhancements were proposed by different companies. In order to collect more views from companies, companies are asked to provide their views on the following questions. Proposals will be formulated later based on answers provided by companies.

## Question 1

*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?*

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| **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. |
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## Question 2

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

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| **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.  |
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## Question 3

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

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| **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. |
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## Question 4

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

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| **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. |
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## Question 5

*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?*

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| **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. |
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## Question 6

*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?*

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| **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. |
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## Question 7

*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.*

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| **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. |
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## Question 8

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

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| **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.  |
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## Question 9

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

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| **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.
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| Lenovo | Agree with QC about the need to study Absolute TA MAC-CE since it is also related to RACH. |
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# 6 Proposals for Online Discussion

TBD