**3GPP TSG-RAN WG2 Meeting #123 R2-23xxxxx**

**Toulouse, France, August 21 – 25, 2023**

**Source: Samsung**

**Title: Report of [Post122][852][MIMOevo] 2TAs for multi-DCI multi-TRP**

**Agenda item:** **xxxx**

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

# Introduction

This document records inputs and outcome for the following post-meeting discussion.

* [Post122][852][MIMOevo] RAN2 impacts of 2TAs for multi-DCI multi-TRP (Samsung)

 Scope: Long email discussions after the meeting, taking into account a) potential RAN1 reply to the previous R2 LS, and b) controversial/unclear aspects discussed during this RAN2 meeting.

 Intended outcome: Email discussion report with proposals, trying to align the understanding regarding the procedure of 2TAs and its impact from RAN2 point of view

 Intermediate Deadline for initial views: June 29th 1000 UTC

 Final Deadline for proposals: August 9th 1000 UTC

Contact information:

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| --- | --- |
| Company | Name (Email Address) |
| NTT Docomo | Riki Okawa (riki.ookawa.rp at nttdocomo.com) |
| CATT | Bufang Zhang (zhangbufang@catt.cn) |
| LGE | Hanul Lee (hanul.lee@lge.com) |
| Samsung | Shiyang Leng (shiyang.leng@samsung.com) |
| Qualcomm | Ruiming Zheng (rzheng@qti.qualcomm.com) |
| OPPO | Zonda(duzhongda@oppo.com) |
| Xiaomi | Yumin Wu (wuyumin@xiaomi.com) |
| Huawei, HiSilicon | Chong Lou (louchong@huawei.com) |
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# Discussion

On 2TA for multi-DCI multi-TRP, it has been agreed that 2 TAGs are configured for 2 TAs of a serving cell, with one TAT per TAG.

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| RAN2#122 Agreement [1]:* Configure one TAT per TAG to support two TAs for a serving cell, i.e., in this case 2 TAGs are configured for the serving cell.
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For discussion here, TAG1/TAT1 for TRP1 and TAG2/TAT2 for TRP2 are used to denote the two TAGs/TATs and two TRPs.

## TAG configuration

### Restriction on the association of cells/TRPs to TAGs

One issue is that whether there is any restriction on the association of serving cells/TRPs to TAGs. RAN2 has sent an LS R2-2304342 in RAN2#121bis-e and received the reply R1-2306249 in RAN2#122 [2] [3].

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| **Question 1 on TAG grouping**RAN2 discussed how the cells/TRPs configured for the UE, are to be grouped if UE is configured with two TA groups per serving cell. Currently, NR does not impose any requirements in configuring the association of serving cells and TAGs. **Q1a:** For the 2TA operation, are there any restrictions on the association of serving cells and/or TRPs to the TAGs?**Answer:**  *Apart from the agreements RAN1 has sent in LS R1-2302226 to RAN2 before, RAN1 has not agreed to any further restrictions on the association of serving cells and/or TRPs to the TAGs at this point. If RAN1 agrees to such restrictions, RAN1 will inform RAN2.* |

Based on RAN1 LS reply, the following RAN1 agreements are relevant.

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| RAN1#112 (2023-02) Agreement [4]:For associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, support the following:Associate TAG to TCI-state* Associate TAG ID with UL/joint TCI state
* For UL transmission, the TAG ID associated with the UL/joint TCI state is utilized
* A baseline is UE expects that the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESET Pool Index correspond to one TAG
* Working Assumption: A UE may report that it supports that the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESETPoolIndex correspond to both TAGs

RAN1#113 (2023-05) Agreement [5]:For associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, the baseline feature is revised as follows:* UE expects that the ~~[activated]~~ UL/joint TCI states ~~[~~of UL signals/channels~~]~~ associated to one CORESET Pool Index correspond to one TAG
* Association of TAG ID with UL/joint TCI state is via RRC configuration
	+ Above does not impact the association of the indicated TCI states and coresetPoolIndex values as agreed in previous meetings in 9.1.1.1.

Possible AgreementFor associating TAGs to target UL channels/signals for multi-DCI based multi-TRP operation, confirm or revert the following working assumption:A UE may report that it supports that the [activated] UL/joint TCI states [of UL signals/channels] associated to one CORESETPoolIndex correspond to both TAGs |

According to the above RAN1 agreements, on one aspect of TAG configuration, NW configures the association of TAG with UL/joint TCI state by RRC, that one TCI state is associated with either TAG-1 or TAG-2. This is also indicated in RAN1 RRC parameter list [6].



On another aspect, the unified TCI states indicated with a CORESET Pool Index (in TCI state activation/deactivation MAC CE for multi-DCI multi-TRP as agreed by RAN1/RAN2) correspond to one of the two TAGs for the baseline feature. This means PDCCH from one TRP schedules transmissions with beams only from/to the same TRP. For further enhancement, the RAN1 WA supports that the unified TCI states indicated with a CORESET Pool Index can correspond to both TAGs. This enhancement enables cross-TRP scheduling, i.e., PDCCH from one TRP can schedule transmissions with beams from/to TRP-1 and TRP-2.

Furthermore, from RAN1 point of view, there is no restrictions on grouping of serving cells/TRPs to TAGs. From RAN2 perspective, there is also no specification impacts identified on how to group serving cells/TRPs to TAGs. Based on the above analysis, the following question is asked.

**Q1) Do you agree that RAN2 confirms**

**a: each joint/UL TCI state is associated with either TAG1 or TAG2 via RRC configuration;**

**b: the joint/UL TCI states indicated with a CORESET Pool Index in MAC CE corresponds to one TAG for baseline feature, and if RAN1 agrees, can correspond to both TAGs;**

**c: RAN2 do not assume any restriction on grouping serving cells/TRPs to TAGs unless RAN1 indication comes.**

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| **Company** | **Yes to** | **Comments**  |
| Docomo | a | The first bullet (a) is exactly what RAN1 is requiring in RRC parameter list, i.e., to implement *tag-Id2* in *ServingCellConfig* and *tag-id-ptr* in both *TCI-State* and *TCI-UL-State* to indicate which TAG ID (*tag-Id* or *tag-Id2*) each TCI state is associated to.RAN1 discussion on the second bullet (b) has a potential impact on MAC CEs (i.e., a modified unified TCI state activation/deactivation MAC CE for mDCI based mTRP operation and a new MAC CE for sDCI based mTRP operation) which are being discussed in 7.20.3 in RAN2. But we should wait for RAN1 to make a clear conclusion on *Possible Agreement*.The intension behind third bullet (c) should be fine, in short, we do not assume specific grouping rules like “If one TA is common with two 2-TA-cells, the other TA shall be common as well.” But strictly saying we are going to make changes to group TAGs for each serving cell. (I mean “*no specification impacts* *on how to group*” could cause a misleading…) We wonder if we could agree like, **RAN2 do not assume any restriction on grouping serving cells/TRPs to TAGs unless RAN1 indication comes.** |
| CATT | a/b/c | For b, agree to wait for RAN1, but even RAN1 confirm the WA, I think there is not additional impacts on MAC CE.For c, fine to the wording proposed by Docomo. |
| LGE | a, c | We are OK with a and c. Regarding b, the first part highlighted in green is agreeable, but the second part highlighted in yellow is not agreeable.* the joint/UL TCI states indicated with a CORESET Pool Index in MAC CE corresponds to one TAG for baseline feature, and if RAN1 agrees, can correspond to both TAGs;

In our understanding, one TRP belongs to one TAG. This is similar to legacy behaviour that one servivng cell belongs to one TAG. Moreover, one CORESET Pool Index represents one TRP, i.e., one CORESET Pool Index is associated only one TAG.However, if joint/UL TCI states indicated with a CORESET Pool Index can correspond to both TAG, CORESET Pool Index can have assosications with two TAG. For example, if TCI state#1 is activated by MAC CE indicated with CORESETPoolIndex#1 and TCI state#1 corrensponds to STAG#1 and STAG#2, CORESETPoolIndex#1 is associated with both STAG#1 and STAG#2. In this case, RAN2 needs to discuss many things additionally, e.g.how to handle CORESETPoolIndex#1 depending on TAT expiry and how to perform UL transmission using which TA.Therefore, in RAN2 point of view, joint/UL TCI states indicated with a CORESET Pool Index should not correspond to both TAG.[Rapp] “correspoinding to both TAGs” referes to the case that in the MAC CE with CORESET Pool Index #1, some activated TCI states (e.g., TCI state#1) are associated with TAG1 and some other activated TCI states (e.g., TCI state#2) are associated with TAG2. |
| Samsung | a,b,c | B has no impacts on MAC CE format.For c, fine with the wording by Docomo |
| Qualcomm | a  | a is aligned with RAN1 agreement.b is under RAN1 discussion. We don’t think RAN2 can confirm anything, and we should wait for RAN1 conclusion. c needs more discussions in the next RAN2 meeting. We can not confirm it by email discussion. |
| OPPO | a,c | for b, technically it could be correct. But we don’t think it is helpful to reach any conclusion based on RAN1’s working assumption. So let’s wait for RAN1’s agreement furtherfor c, we think the mapping should be still restricted by the total number of TAG groups i.e. 4. In this sense it is not completely no spec impact.  |
| Rapp |  | Q1 is updated based on comments above. Please provide input for the updated Q1. |
| Xiaomi | c | We think the reworded Option c is more aligned with the current RAN1 discussion. |
| Huawei, HiSilicon | a, b with comment, c | For b, we prefer to be more align with RAN1 wording as below:**the joint/UL TCI states associated with ~~indicated with~~ the same CORESET Pool Index ~~in MAC CE~~ corresponds to the same one TAG for baseline feature, and if RAN1 agrees, can correspond to both TAGs;**For c, fine with Docomo’s wording. |
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### Maximum number of TAGs per cell group

Regarding the maximum number of TAGs per cell group, there is no consensus to increase the number in RAN1 as informed in the LS.

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| **Q1b:** NR currently supports up to 4 TAGs per cell group. Are the 4 TAGs enough or does RAN1 see a need to increase the number of TAGs per cell group?**Answer:**  *RAN1 has not reached consensus to increase the current number of TAGs per cell group.* |

Currently, each serving cell has one TA belonging to one TAG, and up to 4 TAGs can be configured per cell group. This implies in the worst scenario 4 serving cells can be supported if there are 4 different TAs per cell group. For intra-cell multi-DCI mulit-TRP, each serving cell can have 2 TAs. For inter-cell multi-DCI mulit-TRP, the additional cell with PCI other than the serving cell PCI can have a different TA than the serving cell TA. In the worst scenario, 4 TAGs can only support 2 serving cells with 4 different TAs for intra-/inter-cell operation. Thus, 4 TAGs seems not enough to support flexible NW implementation for multi-DCI multi-TRP. To maintain the application of 4 serving cells per cell group in the legacy case, the maximum number of TAGs may need to be doubled.

**Q2) Do you agree that the maximum number of TAGs per cell group should be increased?**

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| **Company** | **Yes/No** | **Comments**  |
| Docomo | No | RAN1 conclusion means that their understanding is no need to increase maximum number of TAGs. We don’t think RAN2 have enough rationale to challenge the RAN1 conclusion. |
| CATT | No |  |
| LGE | No strong view | We think whether to increase the maximum number of TAGs is the RAN1 scope. However, there is no conclusion in RAN1, so there is no strong motivation to increase the maximum number in RAN2. |
| Samsung | Yes | For flexible implementation and future proof, we see a benefit of increasing the max number. |
| Qualcomm | No | Same view with Docomo. RAN1 conclusion is that no need to increase max. number of TAGs. We don’t observe the motivation from RAN2 to challenge RAN1 conclusion.  |
| OPPO | No | We think the rapporteur’s statement i.e. “In the worst scenario, 4 TAGs can only support 2 serving cells with 4 different TAs for intra-/inter-cell operation.” is bit misleading. In the same TAG it is quite possible that there are more than one serving cells and hence “group” of timing advance makes sense. |
| Xiaomi | No strong view | Increasing the number of the TAGs per cell group would require new UE capabilities. We are open to discuss introducing a new UE capability for the increased TAGs per cell group. |
| Huawei, HiSilicon | No | Agree with Docomo.For multi-DCI multi-TRP operation, it is expected that the network deployments will not be modified so the same diversity of physical location and frequency range will exist and 4 TAGs should also be sufficient.  |
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**Q3) If Q2 is agreed, do you agree at least the following aspects need to be discussed?**

1. **To which value the maximum number of TAGs is increased;**
2. **Impacts on TAC MAC CE.**

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| **Company** | **Yes/No** | **Comments (e.g., other aspects)** |
| Docomo | Comment | Q2 should not be agreed. |
| Samsung | Yes |  |
| Xiaomi | No strong view |  |
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## UE behaviour when TAT expired

Regarding UE behaviour when TAT expired, RAN1 has replied as follows in the LS [3].

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| **Question 2 on operation****Q2:** When the time-alignment timer associated with one of the TRPs of a serving cell expires, are certain UL or DL operation only impacted towards that TRP while they are not impacted towards the another TRP? If so, which UL or DL operation?**Answer:** *RAN1 confirms that when the TA timer associated to one TRP expires for a TAG associated with a TCI state, UL or DL operation associated to the another TRP is not impacted. This further depends on PTAG/STAG definition, which is up to RAN2 to decide.**Which UL or DL operation is impacted have not been discussed in RAN1.* |

RAN1 confirms that when one TAT is expired, while the other TAT is running, UL and DL operation associated to the TRP whose TAT is running is not impacted.

Regarding the modeling of PTAG and STAG, the existing modeling may or may not be suitable for the new scenarios of multi-DCI multi-TRP with 2 TAs, which is up to RAN2 discussion. The discussion starting with TAG modeling would be difficult without a clear understanding of the operation. Instead, it would be beneficial to start with how UE behaves when TAT expired based on the functions of TRPs.

For multi-DCI multi-TRP operation with 2 TAs, UE behavior when TAT is expired can be discussed case by case based on the current list of actions. In TS 38.321 clause 5.2, the current procedure for TAT expiry is specified as follows.

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| 1> when a *timeAlignmentTimer* expires:2> if the *timeAlignmentTimer* is associated with the PTAG:3> flush all HARQ buffers for all Serving Cells;3> notify RRC to release PUCCH for all Serving Cells, if configured;3> notify RRC to release SRS for all Serving Cells, if configured;3> clear any configured downlink assignments and configured uplink grants;3> clear any PUSCH resource for semi-persistent CSI reporting;3> consider all running *timeAlignmentTimer*s as expired;3> maintain NTA (defined in TS 38.211 [8]) of all TAGs.2> else if the *timeAlignmentTimer* is associated with an STAG, then for all Serving Cells belonging to this TAG:3> flush all HARQ buffers;3> notify RRC to release PUCCH, if configured;3> notify RRC to release SRS, if configured;3> clear any configured downlink assignments and configured uplink grants;3> clear any PUSCH resource for semi-persistent CSI reporting;3> maintain NTA (defined in TS 38.211 [8]) of this TAG.When the MAC entity stops uplink transmissions for an SCell due to the fact that the maximum uplink transmission timing difference between TAGs of the MAC entity or the maximum uplink transmission timing difference between TAGs of any MAC entity of the UE is exceeded, the MAC entity considers the *timeAlignmentTimer* associated with the SCell as expired.The MAC entity shall not perform any uplink transmission on a Serving Cell except the Random Access Preamble and MSGA transmission when the *timeAlignmentTimer* associated with the TAG to which this Serving Cell belongs is not running, CG-SDT procedure is not ongoing and SRS transmission in RRC\_INACTIVE as in clause 5.26 is not on-going. Furthermore, when the *timeAlignmentTimer* associated with the PTAG is not running, CG-SDT procedure is not ongoing and SRS transmission in RRC\_INACTIVE as in clause 5.26 is not ongoing, the MAC entity shall not perform any uplink transmission on any Serving Cell except the Random Access Preamble and MSGA transmission on the SpCell. The MAC entity shall not perform any uplink transmission except the Random Access Preamble and MSGA transmission when the *cg-SDT-TimeAlignmentTimer* is not running during the ongoing CG-SDT procedure as triggered in clause 5.27 and the *inactivePosSRS-TimeAlignmentTimer* is not running. |

According to the above procedure, the list of actions are summarized as follows.

1. not perform any uplink transmission except the Random Access Preamble and MSGA transmission;
2. flush all HARQ buffers;
3. notify RRC to release PUCCH, if configured;
4. notify RRC to release SRS, if configured;
5. clear any configured downlink assignments and configured uplink grants;
6. clear any PUSCH resource for semi-persistent CSI reporting;
7. maintain NTA (defined in TS 38.211 [8]) of this TAG;
8. consider all running timeAlignmentTimers as expired.

The following cases for multi-DCI multi-TRP with 2 TAs need to be discussed.

1. For a SpCell/SCell, both TATs are expired.
2. For a SpCell/SCell, one TAT is expired and the other TAT is running.

**Q4) For the case both TATs for a SpCell/SCell are expired, please fill in table with the required actions (by numbers) and clarify the required actions are applied to which TRPs/serving cells.**

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| **Company** | **In case of SpCell** | **In case of SCell** | **Comment** |
| **actions** | **to which TRPs and/or serving cells** | **actions** | **to which TRPs and/or serving cells** |
| Docomo | All | All TRPs for all serving cells | All but 8 | Both TRPs for the SCell | If both TATs are expired, the legacy behavior upon PTAG expiry should be suitable for SpCell case while that of STAG expiry is for SCell case. |
| CATT | 1,2,3,4,5,6,7,8 | All serving cells including both SpCell and SCells | 1,2,3,4,5,6,7 | Only for the corresponding SCell | When both TATs expired, the legacy behaviour should be reused. And also for this case, there is no need to differ the TRP, cell level behaviour is enough. |
| LGE | 1/2/3/4/5/6/7/8 | All TRPs and all serving cells. | 1/2/3/4/5/6/7 | All TRPs belonging to STAG associated with the expired TAT | Question is ambiguous. We think that the question should be "***For the case TAT for PTAG/STAG is expired, please fill in table with the required actions (by numbers) and clarify the required actions are applied to which TRPs/serving cells.***"We provide our answers based on following assumption.* In case of SpCell 🡪 In case of PTAG
* In case of SCell 🡪 In case of STAG

With these assumption, there is no difference between Q4 and Q5.We think that even if two TRPs are associated with SpCell, there should be only one PTAG same as legacy.One of TRP in SpCell which is associated with Type 1 CSS should be defined as SpTRP, and PTAG is defined as a TAG containing the SpTRP of a MAC entity. STAG is defined as a TAG not containing the SpTRP.Each TRP of SCell belongs to either PTAG or STAG.[Rapp] Type-1 CSS is cell specific, wonder how type-1 CSS is associated with TRP/TAG, there seems no clear association between the two. |
| Samsung | 1-8 | All TRPs for all serving cells | 1-7 if TAT for PTAG(s) is running1-8 if no TAT for PTAG(s) is running | all TRPs in all serving cells for which TAT(s) is expiredall TRPs in all serving cells | If both TATs for both TRPs of a serving cell are expired, the actions are applied on the cell. |
| Qualcomm | all | All TRPs for all serving cells | Depends on whether TAT of PTAG is still running.1-7 if TAT of PTAG is running otherwise all | All TRPs in all serving cells for which TAT is expired | We also think the assumption should be based on the case of PTAG/STAG instead of SpCell/SCell, which is more aligned with the MAC spec. structure.  |
| OPPO | All | All TRP of all serving cells | All but 8 | Both TRPs of concerned scell | We also think the question is bit ambiguous for scell since it could be part of the PTAG or STAG which make the answer differently. Our answer is based on the assumption that scell in the context is not part of PTAG i.e. part of STAG.For PTAG, legacy UE’s behaviour i.e. 1~8 is applied only when both TAT timers expires. It will be strange that legacy UE’s behaviour applies when one TAG of pSCell is still working. If it does, so what’s the point to introduce two TAGs here? |
| Xiaomi | all | All TRPs for all serving cells | All but 8 | Both TRPs for the SCell |  |
| Huawei, HiSilicon | all | All TRPs for all serving cells | All but 8 if any TAT(s) of PTAG is running.All if no TAT for PTAG is running. | All TRPs associated with STAG with the expired TAT | If both TATs of a serving cell are expired, the existing actions are applied. |
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**Q5) For the case one TAT is expired and the other TAT is running, please fill in the table with the required actions (by numbers) and clarify the required actions are applied to which TRPs/serving cells.**

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| **Company** | **In case of SpCell** | **In case of SCell** | **Comment** |
| **actions** | **to which TRPs and/or serving cells** | **actions** | **to which TRPs and/or serving cells** |
| Docomo | All for PTAG expiry.1, 3, 4, 5, 6, 7 for STAG expiry. | All TRPs of all serving cells for PTAG expiry.Only one TRP with expired TAT for STAG expiry. | 1, 3, 4, 5, 6, 7 | Only one TRP with expired TAT. | For SpCell case, we assume that one TRP is associated to PTAG and the other is STAG. Basically we think the required actions depend on whether the expired TAT is in PTAG or STAG. |
| CATT | Please see comment |  | Please see comment |  | Agree with Docomo, what impacts the behaviour is whether the expired TAT is for PATG or STAG, but not it is SpCell or SCell.It also depend on the modelling of the TAG for SpCell, e.g., 2 PATGs or 1 PTAGs and 1 STAGs. Beside, the behaviour may also be different (per TRP level or per cell level UE behaviour) for cells configured with separate TRP with different TAGs or serving cells configured with only one TAGs.**If there is 2 PTAGs for SpCell, then:*** In case the TAT for only one PTAG of the SpCell expire (PTAG#1), then
* For the cells configured with 2 TAGs and one is the PTAG#1, some actions (at least 7) should be applied for the corresponding TRP(s) of the cells for which the associated TAT expire.

For other actions, this further depend on RAN1 progress on which part is impacted as indicated by RAN1 LS. Which UL or DL operation is impacted have not been discussed in RAN1.* For cells configured with 1 TAGs and the TAG is PTAG#1, actions 1,2,3,4,5,6,7 should be applied for the cells.
* In case the TAT of one STAG expire, e.g. STAG (STAG#2), then
* For the cells configured with 2 TAGs and one is the STAG#2, some actions (at least 7) should be applied for the corresponding TRP(s) of the cells for which the associated TAT expire.

For other actions, this further depend on RAN1 progress on which part is impacted as indicated by RAN1 LS. Which UL or DL operation is impacted have not been discussed in RAN1.* For cells configured with 1 TAGs and the TAG is STAG#2, actions 1,2,3,4,5,6,7 should be applied for the cells.

**If there is only 1 PTAGs for SpCell, then:*** In case the TAT for the PTAG of the SpCell expire (PTAG#1), then
* the actions 1,2,3,4,5,6,7,8 should be applied for all serving cells. And for this case, no need to differ the TRP for serving cell configured with 2 TRPs.
* In case the TAT of STAG expire (STAG#2), then
* For the cells configured with 2 TAGs and one is the STAG#2, some actions (at least 7) should be applied for the corresponding TRP(s) of the cells for which the associated TAT expire.

For other actions, this further depend on RAN1 progress on which part is impacted as indicated by RAN1 LS. Which UL or DL operation is impacted have not been discussed in RAN1.* For cells configured with 1 TAGs and the TAG is STAG#2, actions 1,2,3,4,5,6,7 should be applied for the cells.
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| LGE | 1/2/3/4/5/6/7/8 | All TRPs and all serving cells. | 1/2/3/4/5/6/7 | All TRPs belonging to STAG associated with the expired TAT | Question is ambiguous. We think that the question should be "***For the case TAT for PTAG/STAG is expired, please fill in table with the required actions (by numbers) and clarify the required actions are applied to which TRPs/serving cells.***"We provide our answers based on following assumption.* In case of SpCell 🡪 In case of PTAG
* In case of SCell 🡪 In case of STAG

With these assumption, there is no difference between Q4 and Q5.We think that even if two TRPs are associated with SpCell, there should be only one PTAG same as legacy.One of TRP in SpCell which is associated with Type 1 CSS should be defined as SpTRP, and PTAG is defined as a TAG containing the SpTRP of a MAC entity. STAG is defined as a TAG not containing the SpTRP.Each TRP of SCell belongs to either PTAG or STAG. |
| Samsung | 1, 7 if TAT for PTAG(s) is running; 1-8 if no TAT for PTAG(s) is running | to TRPs for which the TAT is expiredall TRPs in all serving cells | 1, 7 if TAT for PTAG(s) is running; 1-8 if no TAT for PTAG(s) is running | to TRPs for which the TAT is expiredall TRPs in all serving cells | For 2, HARQ retransmission can be sent via the TRP whose TAT is running, so no need to flush HARQ buffer.The issue of 3,4,5,6 is that the resource is not configured per TRP, but per BWP per cell. When only one TAT expired and the other TAT is still running in a serving cell, the configured resource can still be used for DL/UL transmissions via TCI states associated with the TAG for which TAT is running, so no need to release the configured resources. |
| Qualcomm | All for PTAG expiry1,3,4,5,6,7 for STAG expiry | For PTAG expiry, All TRPs of all serving cells.For STAG expiry, the TRP associated with the expired TAT. | All for PTAG expiry1,3,4,5,6,7 for STAG expiry | For PTAG expiry, All TRPs of all serving cells.For STAG expiry, the TRP associated with the expired TAT. | For SpCell, we assume that one TRP is associated to PTAG and the other is STAG. We think the required actions depend on whether the expired TAT is associated to PTAG or STAG. For PTAG, similar to legacy. For STAG, for the 2, there is no need to flush HARQ buffers. Because HARQ retransmission might be sent via the other workable TRP. However, there are some details that needs further discussion. Because UE may indicate an ‘incapability’ that UE does not support ReTx from the other TRP. |
| OPPO | All but 8 | To TRP, for which the TAT is expired | All but 8 | To TRP, for which the TAT is expired | When only one TAT timers of the same serving cell expires, as indicated in RAN1’s LS, one concerned TRP is impact. This general rule should be applied for SpCell and SCell. |
| Xiaomi | All for PTAG expiry1,3,4,5,6,7 for STAG expiry | For PTAG expiry, All TRPs of all serving cells.For STAG expiry, the TRP associated with the expired TAT. | All for PTAG expiry1,3,4,5,6,7 for STAG expiry | For PTAG expiry, All TRPs of all serving cells.For STAG expiry, the TRP associated with the expired TAT. | It seems this depends on how we model the TAGs for TRPs. |
| Huawei, HiSilicon | 1,3,4,5,6,7 | the TRP associated with the expired TAT. | 1,3,4,5,6,7 | the TRP associated with the expired TAT. | We assumed MAC should specifiy two independent PTAG for mTRP for good performace. |
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## Impacts on Random Access procedure

For multi-TRP operation with 2TAs, when 2 TAGs are configured, one issue is to determine which TAG is applied in Random Access procedure. RAN1 is mainly discussing PDCCH ordered RACH, for which the following agreement has been made.

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| RAN1#113 (2023-05) Agreement [5]:For intra-cell multi-DCI based Multi-TRP operation with two TA enhancement, down-select one of the following alternatives:* Alt 1: indicate TAG ID as part of TA command in RAR
* 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.
 |

For UE-initiated RACH, similar discussion is needed as UE has to decide which or RACH resouce is applied for PRACH. More specifically, in TS 38.211 Section 4.3, the following is specified regarding .

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| Uplink frame number  for transmission from the UE shall start before the start of the corresponding downlink frame at the UE where- and are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where shall be used;- given by clause 4.2 of [5, TS 38.213] is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ;- given by clause 4.2 of [5, TS 38.213] is computed by the UE based on UE position and serving-satellite-ephemeris-related higher-layers parameters if configured, otherwise .**Figure 4.3.1-1: Uplink-downlink timing relation.** |

For , a timing advance value shall be assumed for PRACH preamble [5.3.2 TS38.211], see appendix.

For , the second for the second TA/TAG is configured per cell, as indicated in RAN1 RRC parameter list [6].



And as indicated in RAN1 CR for TS 38.213 [7], the second is applied for the second TRP in intra-cell multi-TRP operation, and for the additional cell with different PCI than the serving cell in inter-cell scenario.

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| A UE can be provided a value of a timing advance offset for a serving cell by *n-TimingAdvanceOffset* for the serving cell. If for a serving cell the UE is provided two *coresetPoolIndex values 0 and 1 for first and second CORESETs, or is not provided coresetPoolIndex value for first CORESETs and is provided coresetPoolIndex value of 1 for second CORESETs, the UE can be provided first and second*  values by *n-TimingAdvanceOffset* and *n-TimingAdvanceOffset2* for transmissions with TCI states associated with the first and second CORESETs, respectively. A UE can be *provided a second*  value for transmissions with spatial domain filters corresponding to TCI states associated with *physCellId* different from *physCellId* for the serving cell in addition to a first value for transmissions with spatial domain filters corresponding to TCI states associated with *physCellId* for the serving cell. The *first and second*  values correspond to first and second TAGs [11, TS 38.321] having an association indicated by *tag-Id* with first and second joint TCI states provided by *dl-OrJointTCI-StateList* or first and second UL TCI states provided by *ul*-*TCI-State-List*.If the UE is not provided *n-TimingAdvanceOffset* for a serving cell, the UE determines a default value of the timing advance offset for the serving cell as described in [10, TS 38.133].  |

Upon initiation of random access (UE initiated or network initiated), UE has to know whether to apply TAG1 or TAG2 for the RA, in order to apply the corresponding NTA, offset for PRACH preamble transmission. This is for both intra-cell and inter-cell scenario. In the inter-cell scenario, RACH resource/configuration is different for the serving cell and the additional cell with different PCI. In order to apply appropriate RACH resource/configuration, UE also needs to know which TAG1/TAG2 (or TRP1/TRP2) is applied for PRACH preamble transmission.

**Q6) Do you agree that for both UE initiated RACH and PDCCH ordered RACH and for both intra-cell and inter-cell scenarios,** **UE has to know whether to apply TAG1 or TAG2 for PRACH transmission, in order to apply the appropriate** NTA, offset **and/or the RACH resource/configuration?**

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| **Company** | **Yes/No** | **Comments**  |
| Docomo | Partially | Yes for intra-cell case, but no for inter-cell case. Our understanding is following. We can address the FFS in Q7.1) Intra-cell multi-TRP case; 2) PDCCH order CFRA; 3) 4-step RACH; 4) RAN1 FFS: how to indicate TAG ID (RAN1#113 [1]). 3) 2-step RACH; 4) How to indicate TAG ID by Absolute TAC MAC CE is up to RAN2. 2) Else (i.e., if CBRA); 3) 4-step RACH; 4) Seems not clear (FFS). 3) 2-step RACH; 4) How to indicate TAG ID by Absolute TAC MAC CE is up to RAN2.1) Else (i.e., inter-cell multi-TRP case); 2) PDCCH order CFRA; 3) RAN1 agreed that gNB indicates which PRACH configuration shall be used via PDCCH order (in RAN1#112bis-e [2]). 2) Else (i.e., CBRA); 3) No enhancement is needed? Please correct me if I misunderstand.

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| [1] (RAN1#113)Agreement*For intra-cell multi-DCI based Multi-TRP operation with two TA enhancement, down-select one of the following alternatives:** *Alt 1: indicate TAG ID as part of TA command in RAR*
* *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.*
 |
| [2] (RAN1#112bis-e)Agreement*For intercell multi-DCI based Multi-TRP operation with two TA enhancement, support indication of which PRACH configuration to be used in the RACH procedure in the PDCCH order.** *FFS: Whether additionalPCI or a generic identifier is indicated in PDCCH order*
* *FFS: The detail of the indication in PDCCH order in terms of whether to support PRACH triggered for inactive additionalPCI.*
 |

 |
| CATT | Yes for intra-cell, no for inter cell | **For inter-cell case**: it is obvious that the second NTA, offsetconfigured within the dedicated signalling is for the cell with additional PCI. And additional RACH configuration shall be configured for the cell with additional PCI. So for UE initiated RACH, it is clear for UE which NTA, offsetand RACH resource should be taken when initiating the RACH toward NW. Besides, since the addition PCI index is included in the PDCCH order, so it is also clear for UE to decide which NTA, offsetand RACH resource should be taken for PDCCH order CFRA.[Rapp] Do you mean that for UE initiated RACH RACH in inter-cell case, UE apply RACH config and NTA, offset of TRP not associated with additional PCI?**For intra-cell case**: this is indeed a issue only for the case when both TATs associated with the two TRPs are expired. Since for intra-cell case, UE is unclear of the association of the TRP with RACH resource and the NTA, offset, so the UE cannot decide which NTA, offset should be used for both UE initiated RACH or PDCCH ordered RACH in case TATs associated with two TRPs are expired. [Rapp] Do you mean that for UE initiated RACH in intra cell case, if TAT of only one TRP is expired,  RA is towards TRP for which TAT has expired and TA received is for TAG of this TRP and UE applies NTA, offset of this TRP? |
| LGE | comment | Question is not clear. If the intention is whether the UE should know which TAG is applied for PRACH transmission, the answer is "yes".If the intention is whether the UE already knows which TAG is applied for PRACH transmission, the answer is "no" for PDCCH ordered RACH in intra-cell case. |
| Samsung | Yes  | For inter-cell PDCCH order RACH, an indication in PDCCH is agreed by RAN1 in 112b as Docomo mentioned, so that UE knows the RACH config for which additional PCI should be used for PRACH transmission. The additional PCI should be associated with one of the two TAGs, so that the corresponding TAG and N\_TAoffset should be applied for RACH.For intra-cell PDCCH order RACH, the issue is there and we can wait for RAN1.For inter-cell and intra-cell UE-initiated RACH, the issue exists, that is, when RACH is triggered towards a SpCell and the SpCell is configured with 2 TA, which TAG/RACH config/ N\_TA\_Offset to apply as the configuration has two TAGs, two N\_TA\_Offsets and additional RACH configs (inter cell case). We can define a rule to resolve the issue, e.g., UE always use the legacy RACH config, the legacy TAG and N\_TAoffset for the SpCell. |
| Qualcomm | ~~Yes~~ comment | The questin is not clear. If the question is to ask whether UE should know which TAG is applied to PRACH transmission, then answer is No. Actually whether/how to to use NTA, offset for RACH Tx for intra-cell is RAN1 issue. |
| OPPO | Comment | Agree with LGE the question itself is not clear. For PDCCH order triggered CFRA:A, for inter-cell case, UE can already know the intended TAG via PDCCH order signalling following RAN1 agreement[Rapp] Rapp understands the RAN1 agreements support each additional PCI has a PRACH configuration (there are up to 7 additional PCI), and PDCCH order includes an indication of the PRACH configuration to be used for the additional PCI. But 2 N\_TAoffset and 2 TAGs are configured for a serving cell, when PDCCH orders RACH for an additional PCI associated with this serving cell, which N\_TAoffset and TAG to be applied is not clear. B, for intra-cell case, under discussion of RAN1(FFS)For UE initiated CBRA:In general it doesn’t matter which TAG UE tries to recover. So to reduce spec impact it would be desirable that legacy UE’s behaviour/parameter is utilized i.e. by default existing TAG is recovered. For 4-step, legacy RACH resource in *RACH-ConfigCommon* can be used and hence existing TAG and legacy are applied.For 2-step RACH, because we are addressing RACH when UE in RRC\_CONNECTED state, technically absolute TA command can be used to indicate TAG id. But even in this case explicit TAG id is not necessary by following the general rule above.Actually by reusing legacy RACH resource and parameters, network can’t even differentiate whether the triggering UE is a Rel18 UE configured with multiple TAGs or legacy UE. But for UE initited CBRA, it doesn’t matter as long as uplink synchronization can be recovered. After that, new UE’s behaviour via PDCCH order CFRA can be applied. |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes | For the details on how UE can know the TAG for RA and Ran2 should wait for RAN1 since it is unclear whether RACH resource/configuration can be associated with TAG ID provided in RRC signalling. If it is yes, L1 can know it based on the RRC signaling. Then nothing more is needed from MAC layer. |
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As RAN1 is discussing the case for PDCCH ordered RACH. RAN2 can start discussing UE-initated RACH. Considering the options for PDCCH ordered RACH discussed in RAN1, the following options are listed for UE-initiated RACH.

**Option 1**: SSBs are partitioned, i.e., separate set of SSBs for each TRP

* UE selects SSB before preamble transmission as in legacy. So based on selected SSB index, UE can determine whether TAG1 or TAG2 is applied.

**Option 2**: Indication in RAR/absolute TAC MAC CE

* Note this approach does not work if Q6 is agreed.
* If this option is adopted, some rules are needed to determine whether TAG1 or TAG2 is applied for PRACH transmission

**Option 3**: follow legacy UE inititated RACH procedure, i.e., use the legacy RACH config, the legacy TAG and N\_TAoffset for the SpCell

**Q7) Which option(s) do you agree for UE-initiated RACH? Please indicate other options if any.**

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| **Company** | **Option(s)** | **Comments**  |
| Docomo | Option 2 | At first we would like to note our understanding that we only need to discuss 4-step CBRA in intra-cell case (please see our comment in Q6).Considering that 2-step CBRA is addressed by Absolute TAC MAC CE in MsgB, an indication in RAR looks more consistent, but this is not a strong preference. |
| CATT | Option 1 | Option 1 is simple, and is a unified solution for both UE initiated RACH and PDCCH order triggered RACH. Further, if we go option 1, then the issue in Q6 can be eliminated. Otherwise if go option 2, separate solution is still required to address the issue for Q6.  |
| LGE | None | If the number of PTAG is one same as legacy, UE initiated RACH is always initiated for PTAG. Thus, there is no need to determine TAG to transmit PRACH preamble. |
| Samsung | Option 1 or 3 | Option 1 allows a unified solution for PDCCH order RACH and UE initiated RACH. Otherwise, some rules are needed for UE initiated RACH.Option 3: always use the legacy RACH config, the legacy TAG and N\_TAoffset for the SpCell.Option 4: If TATs of both TRPs have expired, apply option 3. Otherwise, apply the TAG, N\_TAoffset and RACH config (in case of inter cell) of TRP whose TAT is expired. Note that purpose of UE to initiate RACH is to obtain UL grant and with option 4 both TA (for expired TAT) and UL grant can be obtained within same RA procedure.  |
| Qualcomm | Option 2 | Noted that RAN1 already has agreement to have indication for absolute TAC MAC CE. So, for 4-step RACH, we would to prefer to have a consistent solution. i.e., indication in RAR.[Rapp] Rapporteur understands that RAN1 made the agreement “have indication for absolute TAC MAC CE” for PDCCH order RACH, but not for UE intitiated RACH. And actually the absolute TAC MAC CE is not supported in PDCCH order RACH in the current spec.. So basically I don’t think that RAN1 agreement can be considered in RAN2 discussion.To Rapp: As you said, the absolute TAC MAC CE is not supported in PDCCH order RACH in current spec. So, the inention of this RAN1 agreement is for UE initiated RACH。 |
| OPPO | None | Please refer to answer to Q6 also.UE initiated RACH is to address the case when both TAT timers of SpCell expires. In this case UE’s behaviour can fall back to the case as if no additional TAG is configured. So by just following legacy RACH resource and parameter like NTA,offset it can already work. Note in this case from network point of view it even it doesn’t matter whether it is Rel18 UE or legacy UE.[Rapp] UE can initiate RACH if there is no valid UL grant for SR even when TAT is still running. Option 3 is updated: follow legacy UE initiated RACH procedure, i.e., use the legacy RACH config, the legacy TAG and N\_TAoffset for the SpCell. But one issue with this option is that when UE selects SSB for PRACH transmission, a SSB from the TRP associated with the new TAG (not the legacy TAG) can be selected, and NW sends TA for this TAG, in this case UE should apply the new TAG and new N\_TAoffset. |
| Xiaomi | Option 1 | If companies agree on Q6, it seems that Option 1 is the straightforward solution. |
| Huawei, HiSilicon | Option 1 | Agree with CATT and Xiaomi.Option 1 is unified solution for both inter-cell and intra-cell mTRP operation.On the other hand, UE should first know the RA is initiated for which TAG for applying the accurate parameter (e.g. NTA\_offset) for preamble transmission. RAR with TAG id seems not needed. |
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## Other issues

**Q8) Please indicate other issues to be discussed.**

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| **Company** | **Comment** |
| Docomo | We can continue discussing an enhancement on absolute TAC MAC CE to indicate which TAG to update.[Rapp] Rapp understands the absolute TAC MAC CE is only used in UE-initiated 2-step RACH. Q6-7 are intended to discuss this. Besides the issue identified in Q6, what’s the other motivation to included TAG indication in absolute TAC MAC CE? |
| LGE | RAN2 should confirm that the number of PTAG is one same as legacy. |
| Qualcomm | RAN2 should first discuss definition of PTAG/STAG. We think one PTAG is the simplest solution from RAN2 spec. perspective.  |
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# Conclusions and Proposals

**TBD**

# Appendix

TS 38.211

5.3.2 OFDM baseband signal generation for PRACH

The time-continuous signal  on antenna port for PRACH is defined by

where  and

-  is given by clause 6.3.3;

-  is the subcarrier spacing of the initial uplink bandwidth part during initial access. Otherwise,  is the subcarrier spacing of the active uplink bandwidth part;

- is the largest value among the subcarrier spacing configurations by the higher-layer parameter *scs-SpecificCarrierList*;

-  is the lowest numbered resource block of the initial uplink bandwidth part and is derived by the higher-layer parameter *initialUplinkBWP* during initial access. Otherwise,  is the lowest numbered resource block of the active uplink bandwidth part and is derived by the higher-layer parameter *BWP-Uplink*;

- is the frequency offset of the lowest PRACH transmission occasion in frequency domain with respect to physical resource block 0 of the active uplink bandwidth part. The quantity is given by the higher-layer parameter *msgA-RO-FrequencyStart* if configured and a type-2 random-access procedure is initiated as described in clause 8.1 of [5, TS 38.213], otherwise by *msg1-FrequencyStart* as described in clause 8.1 of [5 TS 38.213];

-  is the PRACH transmission occasion index in frequency domain for a given PRACH transmission occasion in one time instance as given by clause 6.3.3.2;

-  is the number of resource blocks occupied and is given by the parameter allocation expressed in number of RBs for PUSCH in Table 6.3.3.2-1.

- is the start CRB index of uplink RB set corresponding to the quantity . The UE assumes that the RB set is defined as when the UE is not provided *IntraCellGuardBandsPerSCS* for an UL carrier as described in Clause 7 of [6, TS 38.214]

- is the index of the RB set which contains the lowest PRACH transmission occasion in frequency domain indicated by . The UE may assume that is configured such that each PRACH transmission occasion is fully contained within an RB set.

-  and  are given by clause 6.3.3

- where

- for ,

- for kHz, is the number of times the interval overlaps with either time instance 0 or time instance  in a subframe

The starting position of the PRACH preamble in a subframe (for ) or in a 60 kHz slot (for kHz) is given by

 

where

- the subframe or 60 kHz slot is assumed to start at ;

- a timing advance value shall be assumed;

- and are given by clause 5.3.1;

-  shall be assumed for kHz, otherwise the value of corresponds to kHz and the symbol position  is given by

where

-  is given by the parameter "starting symbol" in Tables 6.3.3.2-2 to 6.3.3.2-4;

-  is the PRACH transmission occasion within the PRACH slot, numbered in increasing order from 0 to  within a RACH slot where  is given Tables 6.3.3.2-2 to 6.3.3.2-4 for and fixed to 1 for ;

-  is given by Tables 6.3.3.2-2 to 6.3.3.2-4;

-  is given by

- if kHz, then 

- if kHz and either of "Number of PRACH slots within a subframe" in Tables 6.3.3.2-2 to 6.3.3.2-3 or "Number of PRACH slots within a 60 kHz slot" in Table 6.3.3.2-4 is equal to 1, then , otherwise

- if kHz and

- the "Number of PRACH slots within a 60 kHz slot" in Table 6.3.3.2-4 is equal to 1, then for kHz and for kHz, or

- the "Number of PRACH slots within a 60 kHz slot" in Table 6.3.3.2-4 is equal to 2, then for kHz and for kHz.

If the preamble format given by Tables 6.3.3.2-2 to 6.3.3.2-4 is A1/B1, A2/B2 or A3/B3, then

- if , then the PRACH preamble with the corresponding PRACH preamble format from B1, B2 and B3 is transmitted in the PRACH transmission occasion;

- otherwise the PRACH preamble with the corresponding PRACH preamble format from A1, A2 and A3 is transmitted in the PRACH transmission occasion

# References

1. R2-2306552 Report from NR MIMO evolution session
2. R2-2304342 LS on 2TA for multi-DCI multi-TRP
3. R1-2306249 Reply on LS 2TA for multi-DCI multi-TRP
4. R2-2302455 LS to RAN2/4 on Agreements for Rel-18 MIMO
5. Draft Report of 3GPP TSG RAN WG1 #113 v0.1.0
6. R1-2306271 Consolidated higher layers parameter list for Rel-18
7. R1-2306292 Introduction of MIMO Evolution for Downlink and Uplink
8. R2-2304766 Discussion on multiple TAG OPPO discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
9. R2-2304938 Further issues for Multi-TRP with two TAs support SHARP Corporation discussion NR\_MIMO\_evo\_DL\_UL-Core
10. R2-2305318 Discussions on Two TAs for Multi-DCI Multi-TRP CATT discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
11. R2-2305588 Discussion on Two TAs for Multi-TRP NEC Corporation discussion NR\_MIMO\_evo\_DL\_UL-Core
12. R2-2305719 Discussion on the impacts of Two TAs for multi-DCI multi-TRP operation Lenovo discussion Rel-18
13. R2-2305720 Discussion on the UE-initiated RACH procedure in multi-TRP operation Lenovo discussion Rel-18
14. R2-2305752 RA procedure while SpCell is configured with 2 TAGs Nokia, Nokia Shanghai Bell discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
15. R2-2305799 Discussion on multi-DCI multi-TRP with two TAs Qualcomm Incorporated discussion NR\_MIMO\_evo\_DL\_UL-Core
16. R2-2305848 On 2TA operation Ericsson discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core Withdrawn
17. R2-2305921 Two TAs for multi-DCI multi-TRP Huawei, HiSilicon discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
18. R2-2306036 On 2TA operation Ericsson discussion Rel-18
19. R2-2306140 Discussion on TA maintenance in two TAs for multi-TRP LG Electronics Inc. discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
20. R2-2306161 Support of Two TAs for multi-DCI multi-TRP Apple discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
21. R2-2306327 Discussion on two TAs for multi-DCI multi-TRP Samsung Research America discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
22. R2-2306421 Further Considerations On UE initiated RACH for acquiring TA ZTE Corporation,Sanechips discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core
23. R2-2306433 Status of open issues on Two TAs for mDCI mTRP NTT DOCOMO INC. discussion Rel-19