3GPP TSG RAN WG1 #106-e R1-2108xxx

e-Meeting, August 16th – 27th, 2021

**Agenda item: 8.1.2.1**

**Source:** **Moderator (Nokia, Nokia Shanghai Bell)**

**Title: Summary #4 of Multi-TRP PUCCH and PUSCH Enhancements**

**Document for: Discussion and Decision**

# Introduction

This document is for the phase 1 discussion of M-TRP PUSCH and PUCCH enhancement for Rel-17. Previous FL summary versions can be found in R1-2108298 and R1-2108299.

R1-2108298 Summary#1 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

R1-2108299 Summary#2 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

R1-2108300 Summary#3 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

Latest proposals are in yellow.

FL Instructions are in red text.

FL updates are in blue.

#  Multi-TRP PUCCH transmission

## Per-TRP closed loop power control

The following proposal had multiple rounds of discussion. Two issues from ZTE and vivo,

* **Issue #1**: ZTE keep on arguing that we shall discuss a scenario “two same “*closedLoopIndex*” values for multi-TRP repetitions”. Based on the FL reading, the suggestion from ZTE is not in line with the earlier agreements (we had mentioning that per-TRP closed-loop power control valid when closed-loop indexes are different).
* **Issue #2**: vivo is arguing that text in the TS38.213 (see below under their comment), should be valid for the case with two TPC commands are configured in the DCI. In summary, if sTRP mode is active for a given PUCCH transmission, vivo mention that the other TPC command can still be used to determine sum of TPC commands. Based on FL reading, as this two TPC fields are introduced in Rel-17, the text in 38.213 cannot be fully refer to the behavior corresponding to the second TPC field. If RAN1 conclude that the second field is unused, that means the indicated TPC in that field is not considered to determine sum of the TC commands.

**Proposed conclusion 2.1-1:** For per-TRP closed-loop power control,

* When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission [or with two same “closedLoopIndex” values for multi-TRP repetitions], the other TPC field associated with the other “*closedLoopIndex*” value is unused.
* Note: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).

Concerns: vivo and ZTE.

@ZTE, vivo >> please reconsider your opinion.

@Others >> please provide your views on Issue #1 and #2 to convince ZTE and vivo.

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| **Company** | **Comments** |
| **vivo** | First of all, when we reading the current spec in TS38.213-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUCCH transmission occasion  and  symbols before PUCCH transmission occasion  on active UL BWP  of carrier  of primary cell  for PUCCH power control adjustment state, where  is the smallest integer for which  symbols before PUCCH transmission occasion  is earlier than  symbols before PUCCH transmission occasion If there is no spec change on above power control text and two TPC fields have been configured with previous agreements that each TPC field is for each closed-loop index value respectively, do we go to this proposed conclusion 2.1-1? Our interpretation is NO. Because the TPC commands forming the cardinality between  symbols before PUCCH transmission occasion  and  symbols before PUCCH transmission occasion  includes all possible TPC commands.So in our view, if no agreement is made the possible conclusion should be **Proposed conclusion 2.1-1:** For per-TRP closed-loop power control, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission,  ~~the other~~ both TPC fields are used ~~associated with the other “~~*~~closedLoopIndex~~*~~” value is unused~~.
* Note: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).

In **Fl Update #3**, FL thought removing the first bullet will not result vivo’s interpretation when there are two TPC fields, which is different from Apple’s interpretation on that. However, our reading on Apple’s point is same as ours.So we’d like ask for the companies’ interpretations and proofs on closed-loop power control when no spec change is adopted. If companies still have the same interpretation as the proposed conclusion given by FL, we think the Proposed conclusion 2.1-1 should be an agreement. |
| **Apple** | **If this is still controversial, we are ok not to agree anyting, since the agreement in last meeting is already completed as follows.****Agreement*** To support per TRP closed-loop power control for PUCCH with DCI formats 1\_1 / 1\_2, a second TPC field can be configured via RRC.
* When the second field is configured by RRC, a second TPC field (similar to the existing TPC field) is added in DCI formats 1\_1 / 1\_2 (option 3).
	+ Each TPC field is for each closed-loop index value respectively
		- FFS: Whether or not the mapping between the TPC field and the PUCCH transmissions is needed
* When the second field is not configured by RRC, a single TPC field (the existing TPC field) is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for the closed loop index(es) for the scheduled PUCCH
* To support per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2, adopt the same solution as with M-TRP PUCCH schemes.
	+ FFS: any additional considerations
* Support UE to report the capability on whether it supports the second TPC field
* Note1: Per TRP closed-loop power control is only applicable when the “closedLoopIndex” values are not the same for TRPs.
 |
| **Lenovo/MotM** | **Thanks for the good discussion. I think the key point is whether the note in proposed conclusion 2.1-1, “**1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively**”, is a common understanding. We prefer to take it as an agreement.** **Based on this common understanding, a single TPC command indicated by the corresponding TPC field shall be applied to PUCCH/PUSCH transmitted to different TRPs regarding ZTE’s scenario, i.e.,** *a same closedLoopIndex*” values for multi-TRP repetitions**.****Regarding issue#2, we share the same view with vivo that if one of the TPC field is unused, it should has spec impact as vivo highlighted, otherwise, the other “unused” TPC field should be included in the** **.****How about the following update on conclusion:** **Proposed conclusion 2.1-1:** For per-TRP closed-loop power control, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission, only one TPC command carried by the corresponding TPC filed is applied to the PUCCH transmission ~~the other TPC field associated with the other “closedLoopIndex” value is unused~~.
* Note: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).
 |
| **ZTE** | **On issue #1:**Regarding the scenario “two same “*closedLoopIndex*” values for multi-TRP repetitions”, as we mentioned many times, we think this case can be possible at least for gNB scheduling flexibility, and its indication is the same as the scenario “one single “*closedLoopIndex*” value for single TRP transmission”.Basically, we respect the previous agreement specifies that “To support per TRP closed-loop power control... second TPC field can be configured via RRC... Note 1: Per TRP closed-loop power control is only applicable when the “*closedLoopIndex*” values are not the same for TRPs.”. However, it should be noted that the above two cases (highlighted as this) can be true and the corresponding indication rules should be clarified.In order to avoid any confusion and to make progress, we suggest using the following revision to try to reach a consensus here:**Proposed conclusion 2.1-1:** For closed-loop power control in Rel-17 MTRP PUCCH repetitions scheme, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission or with two same “closedLoopIndex” values for multi-TRP repetitions, the other TPC field associated with the other “*closedLoopIndex*” value is unused.
* Note: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).

@Apple: the part you highlighted in the previous agreement is only valid when two CLI are different, please pay attention to the Note 1 below. Hope that clarifies.@Lenovo: thanks for sharing your view technically, I appreciate we are on the same page now.**On issue #2:**In general, if following the current specification shown by vivo, it can be a valid way to jointly use two TPC fields to indicate one TPC value for a single CLI or two same CLIs, we have also proposed and supported this way before. However, we can compromise to another way ,as FL explained above, to restrict the use of the second TPC field, which at least can ensure that the indications of the above two cases to be clear. |
| **MediaTek** | Our preference is that the other TPC field associated with the other “*closedLoopIndex*” value is unused.We can be fine with ZTE’s update as we fail to find agreements strongly suggesting per-TRP power control is mandatory for M-TRP PUCCH/PUSCH repetition schemes. However, if it is common understanding among companies, then an explicit agreement may be good.On the other hand, if making the proposed conclusion 2.1-1 as agreement can resolve vivo’s concern, we are fine with making it an agreement. |
| **Samsung** | For issue 1, if gNB configures the same closed loop index for both TRPs, gNB doesn’t need to configure ‘twoPUCCH-PC-AdjustmentStates’ for mTRP PUCCH repetition and RRC parameter for two TPC command field in DCI. For issue 2, we cannot see the strong reason why TPC field for the other TRS should be used. This is Rel-17 mTRP enhancement and we are making specification to support mTRP PUCCH repetition. So, FL’s proposed conclusion doesn’t make any problem because the operation is clear. And if gNB wants to update value of closed loop index for the other TRP, gNB can transmit other DCI (e.g. DCI format 2\_2) to update that value.  |
| **NTT Docomo** | Similar view with MediaTek. |
| **CMCC** | We can be fine with ZTE’s version.We have the same view with MTK. If there is a case that the PUCCH resource for Multi-TRP transmission is configured with a same close loop index, meanwhile the second TPC is configured, we could make an agreement to clarify the behavior.  |
| **CATT** | Support ZTE’s version. |
| **OPPO** | Issue 1: If the same “closedLoopIndex” values are used for multi-TRP repetitions, why does gNB configure the 2nd TPC field?Issue 2: The current spec still needs some modification even for vivo’s interpretation because there are two TPC fields in this case and the current spec only supports on TCI field  |
| **ZTE** | @Samsung, OPPO: Please note that CLI is configured by RRC per PUCCH spatial relation, and it can be possible that MAC CE activates one PUCCH resource with two spatial relations and with the same RRC-configure CLIs. Similarly, for PUSCH, due to CLI is configured per sri-PUSCH, two SRI fields in DCI may indicate two SRIs for MTRP PUSCH repetitions with the same RRC-configure CLIs. Therefore, “two same “*closedLoopIndex*” values for multi-TRP repetitions” is the valid case for MTRP PUCCH as well as MTRP PUSCH. |
| **Intel** | the update from ZTE seems reasonable to us. |
| **FL Update #1** | **Comments on Issue #1**@**ZTE**>> Few comments. On “Regarding the scenario “two same “*closedLoopIndex*” values for multi-TRP repetitions”, as we mentioned many times, we think this case can be possible at least for gNB scheduling flexibility, and its indication is the same as the scenario “one single “*closedLoopIndex*” value for single TRP transmission”.” : In the use case you suggest, the same closed-loop index is applied for both TRPs. In that case, there is no per-TRP closed loop power control and also different to assumption we had in earlier agreements. To my reading, your suggestion cannot be under “per-TRP” closed-loop power control, it is more about gNB flexibility, if yes, lets discuss that separately. Furthermore, you seem to be agreeing that use of same *closedloopindex* is not fully inline with the earlier agreements on per-TRP close-loop power control. It should be ok to mix things in that sense.Please check my update. @**others**>> some companies are ok with ZTE suggestion and some are not. Please see FL update to address ZTE suggestion. **Comments on Issue #2**As several companies provided inputs that making an agreement (instead of conclusion) is better, I added a note to clarify the behavior suggested by majority. **Proposal 2.1-1:** For per-TRP closed-loop power control, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission ~~[or with two same “closedLoopIndex” values for multi-TRP repetitions]~~, the other TPC field associated with the other “*closedLoopIndex*” value is unused.
* Note1: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).
* Note2: When the other TPC field associated with the other “*closedLoopIndex*” value is unused, the unused TPC field is not applied for any legacy procedures of calculating sum of TPC command values.

**Proposal 2.1-2:** For mTRP PUCCH (or PUSCH) repetitions schemes, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with the same “*closedLoopIndex*” value for mutli-TRP tranmission, the other TPC field associated with the other “*closedLoopIndex*” value is unused.
 |
| **QC** | Support both proposals. We think both are needed to avoid ambiguity in the future. Also, we think ZTE’s suggestion makes sense, and ok with separate proposals, but both should be discussed at the same time. |
| **Futurewei** | We can support both. Does Note2 also apply to Proposal 2.1-2? Please clarify. |
| **Lenovo/MotM** | We support both proposals since it clarify the specific impact for the TPC filed issue. |
| **ZTE** | According to FL’s assessment, we can live with both proposal 2.1-1 and 2.1-2 as separated, and we have the similar view with QC the two proposals should be agreed at the same time.In addition, we also think it is better to add Note2 to proposal 2.1-2 for the same clarification. |
| **NTT Docomo** | Support both proposals. |
| **Samsung** | We can live with both proposals to make the spec clear.  |
| **Xiaomi** | We think the use case ZTE provided exists and ambiguity should be avoided. we can support both proposals. |
| **vivo** | We are fine with both proposals. |
| **OPPO** | Support Proposal 2.1-1Regarding Proposal 2.1-2, we still failed to see the use case. If gNB configures per-TRP power control for PUCCH repetition, why does gNB configure some PUCCH with two different CLIs and configure other PUCCH resources with two dame values of CLI? What’s the benefit?  |
| **FL Update #2** | Only Oppo has concerns. ZTE suggests adding Note2 in the second proposal. Clean version of the proposals are, **Proposal 2.1-1:** For per-TRP closed-loop power control, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with one “*closedLoopIndex*” value for single TRP transmission, the other TPC field associated with the other “*closedLoopIndex*” value is unused.
* Note1: Each TPC field is for each closed-loop index value respectively (i.e., 1st /2nd TPC fields correspond to “*closedLoopIndex*” value = 0 and 1, respectively).
* Note2: When the other TPC field associated with the other “*closedLoopIndex*” value is unused, the unused TPC field is not applied for any legacy procedures of calculating sum of TPC command values.

**Proposal 2.1-2:** For mTRP PUCCH (or PUSCH) repetitions schemes, * When the second TPC field is configured and the indicated PUCCH transmission in DCI formats 1\_1/1\_2 (or PUSCH transmission in DCI formats 0\_1/0\_2) is associated with the same “*closedLoopIndex*” value for mutli-TRP tranmission, the other TPC field associated with the other “*closedLoopIndex*” value is unused.
* Note: When the other TPC field associated with the other “*closedLoopIndex*” value is unused, the unused TPC field is not applied for any legacy procedures of calculating sum of TPC command values.
 |
| **ZTE** | @OPPO: let me use the following procedures to explicate why the use case ( “two same “*closedLoopIndex*” values for multi-TRP repetitions”) of proposal 2.1-2 is true. For MTRP PUCCH operation:* First, RRC can configure up to two CLIs and up to sixty-four spatial relations for all PUCCH resources in one PUCCH resource set, plus a second TPC field can also be configured.
* Second, two out of sixty-four spatial relations will be activated via MAC CE for one PUCCH resource for MTRP operation.
* Third, if the two MAC CE-activated spatial relations of the PUCCH resource are linked with two different RRC-configured CLIs, it corresponds to the case of previous agreement. If the two MAC CE-activated spatial relations of the PUCCH resource are configured with one same RRC-configured CLI, it corresponds to the case of proposal 2.1-2.

If without proposal 2.1-2, it means MAC CE can only activate two spatial relations for one PUCCH resource with two different CLIs. It is too restrictive and will definitely impact the flexible of beam management from gNB scheduling point of view. That’s the benefit why the case of “two same “*closedLoopIndex*” values for multi-TRP repetitions” should be allowed and possible. |

## Default beam for PUSCH

LG and intel concerns are not fully technical according to the FL reading. Mainly suggesting that this is not an important issue.

**Proposal 2.2:** If the PUCCH resource with the lowest ID is activated with two spatial relation info, the spatial relation info with lower ID, is used as the default beam for PUSCH scheduled by DCI format 0\_0.

Concerns: LG and Intel

@Intel, LG >> please reconsider your opinion.

@Others >> please provide further justifications than just indicating “support”.

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| **Company** | **Comments** |
| LG | We don’t support. It can be addressed by scheduling restriction without additional issue. The following is our proposal:UE does not expect the PUCCH resource with the lowest ID is activated with two spatial relation info if PUSCH is scheduled by DCI format 0\_0. |
| **Apple** | **OK with either proposal 2.2 or LG’s proposal** |
| **QC** | **We also prefer to close this issue and have a clear behavior or restriction. We are Ok with LG’s Proposal.** |
| **ZTE** | Support proposal 2.2, which can ensure the flexibility on PUCCH resource configuration especially when considering STRP/MTRP dynamic switching. It is unreasonable to restrict the above flexibility from the side of gNB scheduling. |
| **MediaTek** | Same view as Apple. |
| **Samsung** | Support Proposal 2.2. If the clear specification is not defined, other parts of specification for activating spatial relation info. (Single MAC CE based activation, PUCCH resource group activation etc.) can be ambiguous. On the other hand, if the restriction is introduced, we should make some spec impacts according to the restriction (e.g. restriction for PUCCH resource group activation). So, if we make Proposal 2.2 as agreement, we don’t need to make additional spec change except this and make the spec clear and no need to do more discussion for this issue.  |
| **Vivo** | We think any PUCCH resource can be activated with two spatial relations without exception. The scheduling restriction is not needed. With this proposal, the network will be safe to activate the spatial relations for PUCCH resources and schedule the PUSCH with DCI format 0\_0. |
| **NTT Docomo** | Similar view with vivo. |
| **CMCC** | Support Proposal 2.2 for the sake of scheduling flexibility and less spec impact. |
| **CATT** | Support Proposal 2.2. |
| **OPPO** | Support Proposal 2.2 as it can provide more flexibility for gNB’s configuration |
| **Huawei, HiSilicon** | We are fine with LG’s version. |
| **Intel** | If this is agreed then we also have to reflect this change such that when the PUCCH group including this PUCCH resource is activated with 2 spatial relation info, this resource would be an exception – right ?what is “lower ID” ?  |
| **FL update #1** | Do not support FL proposal: **LG**Ok with LG’s version: **Apple, QC, MTek, HW**Not Ok with LG’s version: **ZTE, SS, vivo, DCM, CMCC, CATT, OPPO** **@LG >>** situation should be clear. Lot of companies do not support your suggestion. **@Intel >>** Assume a case of PUCCH resource with the lowest ID is included in a PUCCH group and activated with 2 spatial relation info, still the above agreement does not have to be different as the spatial relation with lower ID (among activated spatial relation info’s) shall be used as the default beam. There should not be any issue there. If the above is not agreed, other restrictions may be needed when grouping of PUCCH resources. Lower ID shall be the lower ID among the activated spatial relation info’s. if that is not clear, we can clarify as “the spatial relation info with lower ID among the activated spatial relation info’s” |
| **Futurewei** | Support LG’s version. We can accept the FL proposal if it is the majority view. |
| **Lenovo/MotM** | We support proposal 2.2 since it provide more flexibility. |
| **Xiaomi** | We prefer LG’s version.  |
| **FL update #2** | Discussion is via email. LG is ok with the FL version.  |

## Frequency hopping

This discussion is extending also without any convergence. Some companies suggest more results to justify the case. FL view is that it is bit late for simulating these further, but there are certain benefits that proponents justified multiple time.

**Proposal 2.3:** When inter-slot frequency hopping is configured with Scheme 1, support the following,

* If sequential mapping pattern is configured, frequency hopping is performed on slot level (as in Rel-15).
* If cyclical mapping pattern is configured, frequency hopping is performed among the repetitions with the same beam.

Concerns: ZTE, vivo, OPPO, HW

@ZTE, vivo, Oppo, HW >> as there is good support on this. RAN1 can support it. Suggest you to reconsider.

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| **Company** | **Comments** |
| **ZTE** | If all other companies can live with proposal 2.3, we can compromise it for progress. |
| **MediaTek** | We do not support Proposal 2.3. The mentioned benefits by proponents are not convincing.To have frequency diversity and spatial diversity, sequential mapping with FH can achieve the same full diversity without additional specification impact.  |
| **vivo** | Firstly, we are not convinced to support the proposal. Secondly, there could be other specification impact which needs us to fix, such as the configuration restrictions, etc.Thus, our suggestion to go forward is to encourage companies to show the performance comparison between the two bullets to see how much benefit of the second bullet can provide before we make decision. |
| **CATT** | Support the proposal in principle. As we have mentioned for many times, according to current proposal, different frequency hopping schemes would be used for case 1) repetition=2, sequential mapping pattern is configured and case 2) repetition=2, cyclical mapping pattern is configured. In our opinion, a uniform solution should be used for repetition = 2, regardless of the configured beam mapping pattern. We prefer to change the proposal with the following FFS added:FFS: the frequency hopping scheme when repetition number = 2 is configured. |
| **OPPO** | As we commented several times, the claimed benefits are not convincing. With this new feature, the existing solution can work well. Since we have only two remaining meeting, we prefer to focus on the completion of essential features.  |
| **Huawei, HiSilicon** | We are still not convinced that the cyclical mapping plus frequency hopping is needed. The benefits of cyclic mapping plus frequency hopping can already be achieved by sequential mapping and frequency hopping. |
| **Intel** | we think that intra-slot freq. hopping can be used to achieve freq. diversity  |
| **Fl update #1** | Thanks, ZTE for compromise. CATT>> I do not understand your concern on repetition = 2. We agreed to the below. **Agreement**For multi-TRP PUCCH (scheme 1 and 3) and PUSCH (Type A and B) repetition, when the number of repetitions is equal to two, the first and second transmission occasion shall be associated with two TRPs, respectively (two UL beams or Power control parameter sets), regardless of the configured mapping pattern. * Note: For M-TRP PUSCH type B, the number of repetitions refers to ‘nominal’ repetition.

 **MTek, vivo, OPPO, HW, Intel** have concerns.  |
| **Futurewei** | We do not support it but we won’t object it if it has majority support. |
| **FL update #2** | **MTek, vivo, OPPO, HW, Intel, FW** have concerns |

#  Multi-TRP PUSCH transmission

## PTRS-DMRS association

**Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is not enhanced (legacy framework, i.e., the same PTRS-DMRS association field is applied to both TRPs (to both sets of repetitions)).

@ ZTE, Apple, E///, LG, vivo, Intel >> Let’s conclude this formally. Not agreeing means also the legacy framework.

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| **Company** | **Comments** |
| **Ericsson** | Our preference is Alt2 in the previous proposal.But if this is the approach everyone wants to take, we can give it a try as long as our following comments are addressed.The first sentence of the proposal says ‘the indication of PTRS-DMRS association for maxRank > 2 is **not enhanced**’. Not enhanced essentially means no spec change. But the part inside the brackets will need specification enhancements. For instance, we’ll have to capture in the spec that the same PTRS-DMRS association field is applied to both TRPs. So, the first sentence of the current proposal contradicts the part inside the brackets.In legacy framework, there is only one TRP, and the PTRS-DMRS association field is applied to the one TRP. To make the proposal more closer to the legacy framework, we suggest to apply the indicated PTRS-DMRS association field to the first TRP. As to what to do with the 2nd TRP, may be a simple solution is to specify a fixed PTRS-DMRS mapping in the spec for the 2nd TRP.Could the following be an acceptable compromise?**Revised Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indicated PTRS-DMRS association field is applied to the first TRP (i.e., the first set of repetitions) when maxRank>2. The PTRS-DMRS association for the 2nd TRP is fixed in specifications.~~The indication of PTRS-DMRS association for maxRank > 2 is not enhanced (legacy framework, i.e., the same PTRS-DMRS association field is applied to both TRPs (to both sets of repetitions)).~~  |
| **Apple** | This proposal seems to be the worst solution compared with all the 3 options we have agreed for further down-selection. It seems what we can do is as follows, if we cannot down-select one option among the 3 agreed options.**UE shall not expect to be scheduled M-TRP PUSCH with Rank>2 when PT-RS is transmitted** |
| **ZTE** | As we elaborated in previous rounds, if no agreement here or using the legacy framework, it means the case of rank > 2 is not enhanced. Note that there is no agreement/conclusion saying the number of rank should be limited, it makes no sense to preclude the case of rank > 2. We can compromise and live with Alt. 2 to complete this enhancement.**Alt.2:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2, 1-bit MSB is used to indicate PTRS-DMRS association for the first TRP, and 1 bit LSB is used to indicate PTRS-DMRS association for the second TRP* + if *maxNrofPorts* = 1, the 1 bit indicates one of the first two DMRS ports.
	+ if *maxNrofPorts* = 2, the 1 bit indicates one of two DMRS ports sharing the same PTRS port.
 |
| **Vivo** | Don’t support. We don’t understand why per-TRP PTRS-DMRS indication is supported for maxRank=2, while per-TRP PTRS-DMRS indication is not supported for maxRank>2?Support Option 3 since it supports per-TRP PTRS indication with least bit size.* Option 3 (2 bits): 1 bit MSB is used to indicate PTRS-DMRS association for the first TRP, and 1 bit LSB is used to indicate PTRS-DMRS association for the second TRP
	+ if *maxNrofPorts* = 1, the 1 bit indicates one of the first two DMRS ports.
	+ if *maxNrofPorts* = 2, the 1 bit *indicates* one of two DMRS ports sharing the same PTRS port.
 |
| **Intel** | We think its good to have a per-TRP PTRS-DMRS association for rank > 2 (we are flexible in a solution). If no agreement, then fall-back is of course legacy. |
| **FL update #1** | Objecting companies provided valid reasons. @**E**/// >> I see how you interpret the proposal But I assume intention of this was clear. In summary, there is no common view among companies to agree on one specific method/enhancement on PTRS-DMRS association for maxRank > 2 for m-TRP operation. That does not mean legacy framework is not applied for maxRank > 2. I change the FL proposal to avoid any misinterpretation. Revised proposal sent by E/// >> @others please provide your feedback on that as well. @**Apple, ZTE, vivo** >> Understand the concerns. But this is how the group stands at this point. **Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is not enhanced (legacy framework, i.e., the same PTRS-DMRS association field is applied to ~~both TRPs (to both sets of~~ all repetitions). |
| **Futurewei** | We can accept the FL proposal though our preference is Alt2. |
| **ZTE** | We have strong concern of the wording in this proposal “the indication of PTRS-DMRS association for maxRank > 2 is not enhanced”, why rank > 2 should be precluded for this enhancement only? We suggest to discuss it in GTW session if possible. |
| **Apple** | I suggest we defer the decision and companies can try some evaluation to come back. Since this has no RRC impact, it is not so urgent. |
| **FL update #2** | @**ZTE, Apple** >> this issue was discussed over last two RAN1 meetings. Companies have different preferences. FL perspective, yes it may be good to get more evaluation results to justify a decision. If this does not get agreed, FL proposal will only be added if there are company results for justifying a supported option.  |

## Number of SRS resources

**Proposal 3.6-2:** On the number of SRS resource configured in the two SRS resource sets, select one of the following alternatives,

* Alt.1: Support the same number of SRS resources for both CB and NCB based m-TRP PUSCH repetition.
* Alt.2: Support different number of SRS resources for both CB and NCB based m-TRP PUSCH repetition. The first SRS resource set always have the same or larger number of SRS resources than the second SRS resources set.
	+ The bit width of the 1st SRI field is determined based on maximum number of SRS resources among two resource sets
	+ FFS: How to interpret “SRI field is present or not present”
* Alt.3: Support different number of SRS resources for both CB and NCB based m-TRP PUSCH repetition. The first SRS resource set always have the smaller, same or larger number of SRS resources than the second SRS resources set.
	+ The bit width of the 1st SRI field is determined based on maximum number of SRS resources among two resource sets
	+ FFS: How to interpret “SRI field is present or not present”

**Alt.1** – TCL, ZTE, LG, Xiaomi, E///, OPPO

**Alt.2** – CATT, NEC, Mtek, vivo, SS, HW (?), CMCC, Apple, DCM, FW

**Alt.3** – Lenovo, Fujitsu, ~~DCM~~, HW (?), Apple, CATT, FW

Ok with majority – QC, Nokia

@ All>> Need to conclude this as not agreeing does not mean Alt.3 is supported. If option 3 supported, there are still some work to be finalized. Given that, my suggestion is to take Alt.1.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Apple** | Open to Alt2 or Alt3 |
| **Lenovo/MotM** | Support Alt.3 since it has no limitation of the number of SRS resources of different SRS resource sets which gives a most flexible solution compared with Alt 1 and Alt 2. |
| **ZTE** | We have discussed this issue through two meetings, it is unnecessary to waste more budget to finish the derivative works of Alt.2 and Alt. 3. We support to take Alt. 1 as way forward. |
| **MediaTek** | We are fine with FL’s suggestion, i.e., Alt. 1. |
| **Samsung** | We can think Alt. 2 is more flexible than Alt.1 and doesn’t require additional spec impact for the definition of two SRI fields (Alt.2 can work with agreed table for dynamic switching). For alt3, total bit width of two SRI fields can be increased because the 1st SRI field is determined based on maximum number of SRS resources among two resource sets (for Alt2, always first SRS resource set has more or same number of SRS resources so there is no issue). |
| **vivo** | Since majority think different number of SRS resources is useful, can we first agree the following in this meeting?**Proposal 3.6-x**Support different number of SRS resources for both CB and NCB based m-TRP PUSCH repetition. |
| **NTT Docomo** | After reviewing companies’ comments in previous round, we can understand some benefit of alt.2.We can support Alt.2.  |
| **CMCC** | Support Alt 2.Alt 1 is unnecessary limitation on SRS configuration for the two TRPs. Alt 3 will make the first SRI/TPMI field always be determined by the maximum number of the two SRS resources in the two sets, which will increase the bit of SRI/TPMI fields. |
| **CATT** | Either Alt 2 or Alt 3 is fine. |
| **OPPO** | Support FL’s suggestion. The motivation to allow different number of SRS resource are not justified* It is not likely for a UE equipped with panels each of which supporting different capability (e.g., layers of data transmission)
* If gNB configures different number of SRS resources based on the current status of channel state, there will be frequent RRC reconfiguration when UE is moving or rotating.
 |
| **Fl update #1** | I updated company views just below the original proposal. No change in the suggestion as that helps to close this issue.  |
| **Futurewei** | Support vivo’s version, or Alt2/3 in the FL proposal. |
| **Lenovo/MotM** | We support Alt 3 considering its flexibility of SRS resource number configuration. However, considering the situation, we can accept VIVO’s version for further progress. |
| **ZTE** | Support FL’s suggestion to take Alt.1 as way forward. |
| **FL update #2** | I updated company views just below the original proposal.  |

# Agreements in RAN1 #106-e

**Agreement**

When DCI schedules a retransmission of CG-PUSCH for type 1 CG or type 2 CG (DCI with CRC scrambled with CS-RNTI and NDI=1) while the CG configuration is RRC-configured with two fields of power control parameters, apply the same procedure as DCI activation for CG type 2 agreed before, i.e.,

* The first (legacy) RRC-configured fields ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’ are associated with the first SRS resource set.
* The second (new) RRC-configured fields ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’ are associated with the second SRS resource set.
* Applying the first, second, or both first and second RRC-configured fields ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’ is determined from the new DCI field (for dynamic switching) of the activating DCI similar to the case of DG-PUSCH.

**Agreement**

When fallback DCI (DCI format 0\_0) activates a type 2 CG or schedules a retransmission of a type 1 or type 2 CG, and the CG configuration is RRC-configured with 2 sets of power control parameters (two ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’):

* The UE uses the first set of values for power control (first RRC-configured ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’).

**Agreement**

When a DCI that includes the new 2-bits DCI field for dynamic switching activates a type 2 CG or schedules a retransmission of a type 1 or type 2 CG, and the CG configuration is RRC-configured with only one set of power control parameters (one ‘*p0-PUSCH-Alpha*’ and ‘*powerControlLoopToUse*’):

* The UE expects the new DCI field for dynamic switching is set to “00”, and all PUSCH repetitions are associated with the first SRS resource set.

**Agreement**

For the new field in DCI for dynamic switching,

* For Codepoint “11”, the 1st SRI/TPMI field associate with the 1st SRS resource set while the 2nd SRI/TPMI field associate with the 2nd SRS resource set. i.e.,

|  |  |  |
| --- | --- | --- |
| **Codepoint** | **SRS resource set(s)** | **SRI (for both CB and NCB)/TPMI (CB only) field(s)** |
| 11 | m-TRP mode with (TRP2,TRP1 order)1st SRI/TPMI field: 1st  SRS resource set2nd SRI/TPMI field: 2nd SRS resource set | Both 1st and 2nd SRI/TPMI fields |

* For Codepoint “11”, the first repetition in time is associated with the second SRS resource set, and the remaining repetitions follow the configured mapping pattern (cyclic or sequential).
* For Codepoint “10”, the first repetition in time is associated with the first SRS resource set, and the remaining repetitions follow the configured mapping pattern (cyclic or sequential).

**Agreement**

For PHR reporting related to M-TRP PUSCH repetition, support Option 4 as UE optional capability for a UE that supports mTRP PUSCH,

* Option 4: Calculate two PHRs (at least corresponding to the CC that applies m-TRP PUSCH repetitions), each associated with a first PUSCH occasion to each TRP, and report two PHRs.

**Agreement**

For SP-CSI report on mTRP PUSCH repetition Type A and B activated by a DCI, support the use of a similar mechanism to A-CSI multiplexing on M-TRP PUSCH without a TB, which includes the following,

* When SP-CSI multiplexed on m-TRP PUSCH, SP-CSI multiplexed on the two repetitions associated with the two TRPs, and the number of repetitions is always assumed to be 2, regardless of the value indicated.
* For mTRP PUSCH repetition Type A, or for the first PUSCH after activation for PUSCH repetition Type B**,** reuse similar conditions to support SP-CSI multiplexing on m-TRP PUSCH as defined in A-CSI multiplexing on M-TRP PUSCH, i.e.,
	+ The UE is expected to follow the above operation for transmitting SP-CSI on two PUSCH repetitions only if
		- For the first PUSCH after activation for PUSCH repetition Type B, the first and second nominal repetitions are expected to be the same as the first and second actual repetitions, respectively (no segmentation).
		- For PUSCH repetition Type A and B, UCIs other than the SP-CSI are not multiplexed on any of the two PUSCH repetitions.
	+ When the UE does not follow the above operation, UE transmits SP-CSI only on the first PUSCH repetition similar to Rel. 15/16.
* For subsequent PUSCHs after activation (without corresponding PDCCH) for PUSCH repetition Type B, use the following criteria,
	+ If the first / second nominal repetition is not the same as the first / second actual repetition, the first / second nominal repetition is dropped
		- If one of the first or second nominal repetitions is not dropped, SP-CSI is multiplexed on that repetition
	+ Else (the first and second nominal repetitions are the same as the first and second actual repetitions)
		- If UCIs other than the SP-CSI are not multiplexed on any of the two PUSCH repetitions, SP-CSI is multiplexed on both repetitions.
		- Otherwise, UE transmits SP-CSI only on the first PUSCH repetition similar to Rel. 15/16 (and the second repetition is dropped)

**Agreement**

For indicating per-TRP OLPC set in DCI format 0\_1/0\_2, if no SRI field presents in the DCI,

* Use the existing field (1 or 2 bits) for OLPC set indication and the second p0-PUSCH-SetList-r16.
	+ if value of the field equals to ‘0’ or ‘00’, the UE determine two values of P0 for two TRPs (one P0 value for each TRP) from the first and the second default P0 values.
		- Note: per TRP default P0 values to be decided in separate discussion (alt.1, alt.2, alt.3 in default power control parameter sets).
	+ if value of the field equals to ‘1’ or ‘01’, the UE determine two values of P0 for two TRPs (one P0 value for each TRP) from the **first value** in the first *P0-PUSCH-Set-r16\_list* and the **first value** in the **second** *P0-PUSCH-Set-r16\_list*.
	+ if value of the field equals to ‘10’ or ‘11’, the UE determine two values of P0 for two TRPs (one P0 value for each TRP) from the **second value** in the first *P0-PUSCH-Set-r16\_list* and the **second value** in the **second** *P0-PUSCH-Set-r16\_list.*

**Agreement**

For RV mapping of type 1 or type 2 CG based multi-TRP PUSCH repetition, support,

* the configured RV sequence (via “repK-RV”) is applied separately for PUSCH repetitions corresponding to the first TRP and the second TRP with a an RV offset for the starting RV corresponding to the second TRP (similar to the case of dynamic multi-TRP PUSCH repetition).
* if startingFromRV0 set to ‘on’, support that the initial transmission of a transport block may start at:
	+ the first RV0 transmission occasion of any TRP if the configured RV sequence is {0 2 3 1},
	+ any of the transmission occasions of the K repetitions that are associated with RV = 0 if the configured RV sequence is {0 3 0 3}, (same as Rel-15/16).
	+ any of the transmission occasions of the K repetitions if the configured RV sequence is {0,0,0,0}, except the last transmission occasion when K≥8. (same as Rel-15/16).
* if startingFromRV0 set to ‘off’, the initial transmission of a transport block may only start at the first transmission occasion of the K repetitions (same as Rel-15/16).

**Agreement 2.1-2:**

For per-TRP closed-loop power control, when the indicated PUCCH transmission in DCI format 1\_0 (fallback DCI) is associated with two “*closedLoopIndex*” values for multi-TRP PUCCH transmission schemes, the single TPC field (the existing TPC field) is applied to both closed loop indices for the scheduled PUCCH.

**Working assumption 3.7:**

For non-codebook based multi-TRP PUSCH repetition, select Alt.2.

* Alt. 2: the actual number of PT-RS ports corresponding to the 1st SRS resource set can be different from the actual number of PT-RS ports corresponding to the 2nd SRS resource set.
* FFS: Whether specification change is needed due to this working assumption

**Agreement**

For option 4, support the following:

When PHR MAC-CE is reported in slot n, for a CC that is configured with mTRP PUSCH repetition, PHR value(s) are determined as,

* The first PHR value is reported same as Rel. 15/16.
* If the first PHR value is actual PHR (based on Rel. 15/16) corresponding to a repetition among mTRP PUSCH repetitions associated with a given TRP, the second PHR value, select Alt. 1A or Alt. 2A
	+ Alt.1A: Is always actual. When there are more than one repetitions associated with the other TRP, the second PHR is calculated considering on the following repetition,
		- If there are repetition(s) towards the other TRP which transmit after the repetition used to calculate first PHR, the UE select the earliest repetition among them.
		- Otherwise, the UE select the latest repetition which transmitted before the repetition used to calculate first PHR.
	+ Alt.2A: Is actual only when a repetition associated with the other TRP is transmitted in slot n. Otherwise, it is virtual.
		- If there are multiple repetitions associated with the other TRP in slot n, the earliest one in slot n is selected.
* If the first PHR value is actual PHR (based on Rel. 15/16) but not corresponding to a repetition among mTRP PUSCH repetitions (corresponds to sTRP PUSCH), select Alt. 1B or Alt. 2B
	+ Alt1B: a second PHR value is reported as virtual PHR.
	+ Alt2B: a second PHR is not reported
* If the first PHR value is virtual, select Alt. 1C or Alt. 2C
	+ Alt1C: a second PHR value is reported as virtual PHR.
	+ Alt2C: a second PHR is not reported
* When second PHR is virtual, it is calculated based on a set of default power control parameters defined for the other TRP (that is not associated with the first PHR)
* Note: the above is applicable to both single entry and multi-entry PHR reports

**Agreement**

For the grouping of PUCCH resources in Rel-17 multi-TRP PUCCH repetition schemes,

* Support MAC-CE activating two spatial relation info’s (for FR2) for a group of PUCCH resources in a CC.
* Support MAC-CE activating two sets of power control parameters (for FR1) for a group of PUCCH resources in a CC.
* When the PUCCH resource is indicated with two spatial relation info’s or two sets of power control parameters (via a MAC-CE that activating two spatial relation info’s or a MAC-CE that activating two sets of power control parameters for a group of PUCCH resources, respectively), the other PUCCH resources in the group also get updated to have the same two spatial relation info’s or two sets of power control parameters.
* When the PUCCH resource is indicated with one spatial relation info or one set of power control parameters (via a MAC-CE that activating single spatial relation info or a MAC-CE that activating single set of power control parameters for a group of PUCCH resources, respectively), then the other PUCCH resources in the group also get updated to have the same spatial relation info or the same set of power control parameters.
* The signalling details are up to RAN2 to decide.
* Note: Impacts coming from coverage enhancement work item on associating PUCCH resource with repetition factor can be discussed separately

**Agreement**

For single-DCI based M-TRP PUSCH repetition schemes, when one SRS resource per SRS resource set is configured (i.e., when two SRI fields are absent in DCI formats 0\_1 / 0\_2), per TRP default P0, alpha, PL-RS, and closed loop index is defined by,

* + If the UE is provided*enablePL-RS-UpdateForPUSCH-SRS*, the first set of values {the first value in *P0-AlphaSet*, the PL-RS corresponding to the first *sri-PUSCH-PowerControl* associated with the first SRS resource set and closed-loop index *l* = 0} is used for TRP1, and the second set of values {the second value in *P0-AlphaSet*, the PL-RS corresponding to the first *sri-PUSCH-PowerControl* associated with the second SRS resource set and closed-loop index *l* = 1 if  *twoPUSCH-PC-AdjustmentStates* is configured, *l*=0 otherwise} is used for TRP2.
	+ Otherwise, the first set of values {the first value in *P0-AlphaSet*, the PL-RS with *PUSCH-PathlossReferenceRS-Id=0* and closed-loop index *l* = 0} can be used for TRP1, and the second set of values {the second value in P0-AlphaSet, the PL-RS with *PUSCH-PathlossReferenceRS-Id*= 1 and closed-loop index *l* = 1 if *twoPUSCH-PC-AdjustmentStates* is configured, *l*=0 otherwise } can be used for TRP2.
	+ Note: How to design the signaling link sri-PUSCH-PowerControl with two SRS resource sets is up to RAN2.

**Agreement**

For option 4, support the following:

* When PHR MAC-CE is reported in slot n, for a CC that is configured with mTRP PUSCH repetition, second PHR value is determined as,
	+ If the first PHR value is actual PHR (based on Rel. 15/16) corresponding to a repetition among mTRP PUSCH repetitions associated with a given TRP, the second PHR value, select Alt. 2A
		- Alt.2A: Is actual only when a repetition associated with the other TRP is transmitted in slot n. Otherwise, it is virtual.
			* If there are multiple repetitions associated with the other TRP in slot n, the earliest one in slot n is selected.
	+ If the first PHR value is actual PHR (based on Rel. 15/16) but not corresponding to a repetition among mTRP PUSCH repetitions (corresponds to sTRP PUSCH), select Alt. 1B
		- Alt1B: a second PHR value is reported as virtual PHR.
	+ If the first PHR value is virtual, select Alt. 1C
		- Alt1C: a second PHR value is reported as virtual PHR.
* Note: It was agreed that when second PHR is virtual, it is calculated based on a set of default power control parameters defined for the other TRP (that is not associated with the first PHR)
* Note: It was agreed that the above is applicable to both single entry and multi-entry PHR reports

# Reference

|  |  |  |
| --- | --- | --- |
| [R1-2106464](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106464.zip) | Enhancements on multi-TRP for reliability and robustness in Rel-17 | Huawei, HiSilicon |
| [R1-2106542](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106542.zip) | Multi-TRP enhancements for PDCCH, PUCCH and PUSCH | ZTE |
| [R1-2106572](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106572.zip) | Further discussion on Multi-TRP for PDCCH, PUCCH and PUSCH enhancements | vivo |
| [R1-2106641](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106641.zip) | Discussion on Enhancements for PDCCH, PUCCH, and PUSCH | InterDigital, Inc. |
| [R1-2106667](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106667.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Lenovo, Motorola Mobility |
| [R1-2106686](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106686.zip) | Discussion on enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Spreadtrum Communications |
| [R1-2106790](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106790.zip) | Considerations on Multi-TRP for PDCCH, PUCCH, PUSCH | Sony |
| [R1-2106866](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106866.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Samsung |
| [R1-2106936](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106936.zip) | Enhancements on multi-TRP/panel transmission for PDCCH, PUCCH and PUSCH | CATT |
| [R1-2107030](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107030.zip) | Enhancements on Multi-TRP for PDCCH PUCCH and PUSCH | Fujitsu |
| [R1-2107079](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107079.zip) | Multi-TRP/panel for non-PDSCH | FUTUREWEI |
| [R1-2107144](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107144.zip) | Discussion on multi-TRP for PDCCH, PUCCH and PUSCH | NEC |
| [R1-2107204](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107204.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | OPPO |
| [R1-2107293](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107293.zip) | Discussion on enhancements on multi-TRP for uplink channels | FGI, Asia Pacific Telecom |
| [R1-2107324](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107324.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Qualcomm Incorporated |
| [R1-2107391](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107391.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | CMCC |
| [R1-2107465](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107465.zip) | On multi-TRP enhancements for PDCCH and PUSCH | Fraunhofer IIS, Fraunhofer HHI |
| [R1-2107486](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107486.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | MediaTek Inc. |
| [R1-2107571](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107571.zip) | Multi-TRP enhancements for PDCCH, PUCCH and PUSCH | Intel Corporation |
| [R1-2107719](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107719.zip) | Views on Rel-17 multi-TRP reliability enhancement | Apple |
| [R1-2107815](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107815.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | LG Electronics |
| [R1-2107839](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107839.zip) | Discussion on MTRP for reliability | NTT DOCOMO, INC. |
| [R1-2107894](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107894.zip) | Enhancements on Multi-TRP for PDCCH, PUSCH and PUCCH | Xiaomi |
| [R1-2108020](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108020.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Convida Wireless |
| [R1-2108053](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108053.zip) | Enhancements for Multi-TRP URLLC schemes | Nokia, Nokia Shanghai Bell |
| [R1-2108072](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108072.zip) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | TCL Communication Ltd. |
| [R1-2108074](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108074.zip) | On PDCCH, PUCCH and PUSCH enhancements for multi-TRP | Ericsson |
| [R1-2108106](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108106.zip) | Discussion on mTRP PXXCH | ASUSTeK |