3GPP TSG RAN WG1 #104-bis-e R1-200xxxx

e-Meeting, April 12th – April 20th, 2021

**Agenda item: 8.1.2.1**

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

**Title: Summary #2 of Multi-TRP PUCCH and PUSCH Enhancements**

**Document for: Discussion and Decision**

# Introduction

The document is based on the earlier version

R1-2103843 Summary #1 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

Updates are only in **section 2.2 and 3.2.**

* Closed discussion treads are ash highlighted.
* Latest versions of proposals are in yellow highlight.
* Feature lead comments are in blue highlight.

Open proposals on PUCCH

Proposal 2.2

Proposal 2.3-1

Proposal 2.3-2

Proposal 2.3-3

Proposal 2.4

Proposal 2.7

Proposal 2.9

Open proposals on PUSCH

Proposal 3.1

Proposal 3.2-1

Proposal 3.2-2

Proposal 3.2-4

Proposal 3.2-6

Proposal 3.3-2

Proposal 3.4

Proposal 3.5

Proposal 3.6

Proposal 3.7

Proposal 3.8

Proposal 3.9

# Multi-TRP PUCCH transmission

The remaining open issues and company views are summarized below. The issues discussed by one or two companies are not listed for now.

## 2.1 Summary

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| **Issue** | **Summary from Tdocs** | **Moderator comments** |
| #1: PUCCH power control: *Linking of power control parameters to PUCCH resource* | Option 1: MAC-CE is used to link PUCCH resource with power control parameters: **QC, Intel, vivo, HW, CATT, E///, Nokia, Apple**   1. Use spatial relation info (without beam information) in FR1 - **QC, Intel, vivo, HW, CATT** 2. MAC-CE activating two power control parameters sets per PUCCH resource – **E///, Apple, Nokia**   Option 2: Only RRC is used to link PUCCH resource with power control parameters: **ZTE, LG, Lenovo** | * There seems to be good support on option 1. * It was agreed to introduce MAC-CE activating two spatial relation info for FR2 (and the same MAC-CE could be used with option 1). * Within option 1, there are two flavors but option 1 a) seems to be the preferred approach. The second approach 1b) appears to be needing a similar RRC IE as spatial relation info but only with power control parameters. * Also, companies discussed configuring single p0-Set/pathlossReferenceRSs or two p0-Set/pathlossReferenceRSs, but from the FL point of view *p0-Set/pathlossReferenceRSs* can still work with MAC-CE indication.   Proposal 2.1 |
| #2: PUCCH Power Control: *TPC command* | Supported TPC options   * Option 1: (5) **Oppo, Lenovo, QC, Nokia, Intel** * Option 2: (4) **CATT, APT, ZTE, Intel** * Option 3: (16) **Lenovo, CATT, Nokia, Fujitsu, MTek, LG, NEC, CMCC, Xiaomi, Covinda, DCM, E///, FW, IDC, SS, vivo** * Option 4: (8) **Oppo, Lenovo, QC, CATT, LG, Apple, E///, Intel** | * This was discussed for the last two meetings and still diverged views. However, option 3 has more support compared to the last time. * As one camp highlights the overhead issue and another highlights the required flexibility, FL thinks middle ground makes sense. When a second field is needed, the network has to configure that anyways via RRC. If RRC is not configured for the second field, option 1 could be applied.   Proposal 2.2 |
| #3: Beam switching gap | The time gap between PUCCH repetitions   * Required – **LG, E///, SS, Apple, MTek, Nokia, Xiaomi** * No – **vivo**   Time gap should be a configurable gap – **E///, MTek**  At least one symbol gap is needed **- Nokia**  Gap is handled by the PUCCH symbols per sub-slot – **SS**  There should be a common understanding of the gap between network and the UE – **Nokia, Apple**   * Define a transmission process – **Apple**   Cases indicated to RAN4 on transmitting the beam are unknown, and different UL timing cases are not required to be addressed. Send an updated LS - **Nokia**  Mapping patterns  Confirm the working assumptions on beam mapping patterns – **Nokia, Intel, MTek, DCM CMCC, Xiaomi** | * Based on the RAN4 LS, several companies see that a gap may be needed even when the same panel is used towards two TRPs. * RAN4 next reply might introduce the requirement of having more than one value for the switching gap. * If more than one value is required, few companies discussed the aspects of the configuration/common understanding between the network and UE sides on the applicable gap. * Also, based on the RAN4 reply, some companies view that the working assumptions can be confirmed.     Proposal 2.3-1/2.3-2/2.3-3. |
| #4: M-TRP inter slot repetition (Scheme 1): repetition numbers | Other values of the number of repetitions  For PUCCH formats 1/3/4:   * 16 **(CATT, Xiaomi, FW, E///, Oppo**)   For PUCCH format 0/2:   * larger than 2 (**E///, Spreadtrum, Oppo, Xiaomi**) * 4, 8, and 16 (**E///)** * No new values (**FW,** ~~Xiaomi~~ **)** | Discussion on the number of repetitions is not a critical issue, but several companies provided inputs.  Proposal 2.4 |
| #5: M-TRP intra slot beam hopping (Scheme 2) | Support Scheme 2:   * Yes: **LG, vivo, Fujitsu, Xiaomi, Qualcomm, Huawei** * No: **Nokia, Covinda** | There is good support for Scheme 2. RAN1 needs to decide on this in this meeting.  Proposal 2.5 |
| #6: M-TRP intra-slot repetition (scheme 3) | Confirm the working assumption supporting Scheme 3 – **~~QC,~~ Vivo, Spreadtrum, CMCC, FW, Lenovo, TCL, Intel** | It should be possible to confirm the following working assumption.  **Working Assumption**  For PUCCH reliability enhancement, support multi-TRP intra-slot repetition (Scheme 3) for all PUCCH formats.   * The same PUCCH resource carrying UCI is repeated for X = 2 [consecutive] sub-slots within a slot. * Refer the design details related to sub-slot configurations (e.g. other values of X) to Rel-17 eIIoT   Note1: The decision of supporting scheme 3 is only applicable for multi-TRP operation.  On the “[consecutive]”, it should be ok to remove that based on the reply received for RAN4 LS where at least one symbol may be needed between PUCCH repetitions. For the 2 symbol sub-slot case, it makes sense to support the switching by skipping one sub-slot.  Proposal 2.6 |
| #7: Default beam for PUSCH when scheduled by DCI format 0\_0 and two spatial relation info’s are configured for a PUCCH resource | Use spatial relation info with the lower ID among the two active spatial relation info’s of PUCCH resource: **QC, Apple, Oppo, DCM, Lenovo** | Good alignment between companies on the exact method to be used here.  Proposal 2.7 |
| #8: Enhancements needed on beam mapping in case of PUCCH/PUSCH dropping due to invalid UL symbols | Beam mapping shall be clarified when PUCCH is dropped due to DL symbols – **LG**  No discussion is needed on beam mapping when PUCCH is dropped due to DL symbols – **QC, Spreadtrum**  Discuss details on PUCCH deferral mechanism with M-TRP PUCCH repetition – **Nokia** | Not enough inputs on this topic.  Proposal 2.8 |
| #9: Frequency hopping (whether frequency hopping is performed among the repetitions with the same beam) | FH applied per beam: **Lenovo, CATT, QC, Xiaomi** | This was discussed even last time.  Proposal 2.9 |

## 2.2 Feature lead Proposals

### Proposal 2.1: Linking of power control sets in FR1

**[Draft for offline] Proposal 2.1:** To support per-TRP power control in FR1, the linking of PUCCH resource with two power control parameter sets can be indicated by the same MAC-CE that activating two spatial relation info in FR2.

* FFS1: Decide one from the following options,
  + Alt 1: MAC-CE indicating *PUCCH-SpatialRelationInfoIds* also in FR1, where *PUCCH-SpatialRelationInfo* is not providing a choice for *referenceSignal* (‘NULL’).
  + Alt.2: MAC-CE indicating new RRC IE that configures power control parameter set (p0, pathloss RS ID, and a closed-loop index).
* For Alt.1 and Alt.2, a single set of *P0-PUCCH* and *PUCCH-PathlossReferenceRS* in *PUCCH-PowerControl* can be used to indicate p0 ID and pathloss RS ID.

Please comment on preferred changes to the proposal. Select your preference for FFS.

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| **Company** | **Comments** |
| **QC** | **Support the proposal and prefer Alt1.**  **For Alt2, the motivation is not clear. Also, if we use new RRC, it is not clear how the same MAC-CE (that activates two spatial relation info in FR2) can be directly reused.** |
| **Lenovo&MotM** | **Support the proposal and prefer Alt 2.** |
| **vivo** | **Support the proposal and prefer Alt1. With Alt1, a single PC framework for PUCCH for both FR1 and FR2 relieves specification efforts.** |
| **Fujitsu** | **Support the proposal.** |
| **LG** | **Even though our first preference is semi-static PC set indication, we are fine with MAC-CE based approach if majority supports it. If MAC-CE indication is used, Alt 2 is preferred since the** *PUCCH-SpatialRelationInfo* **does not contain beam information anymore.** |
| **Samsung** | **We think that enhancing the default PUCCH power control is enough (i.e., P0-PUCCH with minimum and second minimum p0-PUCCH-Id, PUCCH-PathlossReferenceRS with index 0 and index 1 for each beam) to support per-TRP power control in FR1. However, we can live with Alt 1 as second preference.** |
| **NTT Docomo** | **In our understanding, PUCCH-SptialRelationInfo in FR1 or new RRC IE that configures power control parameter set is not needed. Instead, two power control parameter sets can be determined by default rules as in R15/16.**  **Furthermore, MAC CE can indicate whether one or two power control parameter sets is used.**  **Thus, we think another alternative as below can be considered:**  **Alt.3: two power control parameter sets are determined from p0-Set/pathlossReferenceRSs and default rules. MAC CE indicates whether one or two power control parameter sets is used for each PUCCH resource.** |
| **ZTE** | **Do NOT support this proposal.**  **Firstly, the intention of this issue should be how to link one or two PC parameter sets to the PUCCH resource. However, it’s quite weird to reuse PUCCH spatial relation activation/deactivation MAC CE in FR2 for the sake of indicating PC parameter sets in FR1. As shown in the following MAC CE is used to indicate one beam/ spatial relation of PUCCH resource at a time. Thus, it can NOT be seen the logical to use spatial relation update related MAC CE for PC parameter sets configuration, and which will cause misunderstanding and unnecessary spec changes/efforts.**    **In Rel-15/16, the linkage of PC parameter set of PUCCH in FR1 (w/o spatial relation info) is configured by RRC by default, instead of MAC CE. Thus, for Rel-17 MTRP PUCCH, the linkages between two PC parameter sets and two TRP should still be configured by RRC. For example, one indicator can be used to in *PUCCH-Resource* to indicate the PUCCH resource is linked to one or two PC parameter sets.**  **In the light of above analyses, we are NOT supportive of using MAC CE to link PC parameter sets to different TRPs in FR1. However, we can be acceptable to update this proposal for more discussion and further down-selection between RRC and MAC CE as following:**  **[Draft for offline] Proposal 2.1:** To support per-TRP power control in FR1, the linking of PUCCH resource with two power control parameter sets can be down selected from the below options:   * Option 1: configured by an indicator in RRC, i.e., 'PUCCH-Resource' that indicating the PUCCH resource is configured with one or two power control sets corresponding to STRP and MTRP operations, respectively. * Option 2: indicated by the same MAC-CE that activating two spatial relation info in FR2.   + FFS1: Decide one from the following options,     - Alt 1: MAC-CE indicating *PUCCH-SpatialRelationInfoIds* also in FR1, where *PUCCH-SpatialRelationInfo* is not providing a choice for *referenceSignal* (‘NULL’).     - Alt.2: MAC-CE indicating new RRC IE that configures power control parameter set (p0, pathloss RS ID, and a closed-loop index).   + For Alt.1 and Alt.2, a single set of *P0-PUCCH* and *PUCCH-PathlossReferenceRS* in *PUCCH-PowerControl* can be used to indicate p0 ID and pathloss RS ID. |
| **OPPO** | **We prefer Alt.2** |
| **MediaTek** | **Support ZTE’s revision and we prefer Option 1.** |
| **Xiaomi** | **Support the proposal, a simple and unified solution for both FR1&FR2 is preferred as Alt.1.** |
| **Apple** | **Alt2 should provide a clean solution, and it was defiend in R15 that PUCCH-spatialRelationInfo is not applicable for FR1. This would have backword compatable issue.** |
| **Spreadtrum** | **Not support the proposal and we are fine with ZTE’s revision. We prefer Option1 in ZTE’s version.** |
| **NEC** | **Alt 2 preferred.** |
| **Nokia** | **Support the proposal in principle.**  **Alt.2 is preferable as it seems a cleaner way forward.**  **We also be fine with the updates from ZTE.** |
| **Huawei, HiSilicon** | **Support Alt 1 as unified design that can be achieved for both FR1 and FR2.**  **The second sub-bullet is not very clear for us, does “*a single set of P0-PUCCH and PUCCH-PathlossReferenceRS*” mean joint open loop power control for both beams? It seems to be contradicting with previous agreements of separate power control.** |
| **CATT** | **Support the proposal, and Alt 2 is preferred.** |
| **Ericsson** | **Our preference is Alt 2. Agree with Apple that there may be backward compatibility issues with Alt 1.** |
| **InterDigital** | **Support the proposal.** |
| **CMCC** | **Support the proposal and prefer Alt 2.** |
| **Intel** | **We support Alt-1 in principle (reusing FR2 mechanism) and not introducing anything new for FR1. We are not sure if mentioning the NULL issue is necessary as it is up to RAN2 to figure out the details – for e.g. they can simply add a note in RRC specification where UE ignores the *referenceSignal* field.** |
| **FL update#1** | @QC >> The same MAC-CE could differently interpret when spatial relation info configured in FR2 or any other RRC IE (power control parameter set) configured in FR1. MAC-CE seems to be indicating just the IDs of these RRC parameters. Anyways, we do not have to mention “same” as it is up to RAN2.  @SS>> Thanks for the compromise towards the majority view.  @DCM, ZTE, MTek >> The idea is to down select and not to introduce all variants. I agree that the method you suggest is one possible solution. But the majority view is using MAC-CE and indicating power control parameter sets per PUCCH resource. Also, with Alt.2 the issue ZTE mentioned will not happen. For Alt.1, the idea is to not to provide beam information, but I would agree with you that spec update will be there.  @HW>> Even with a single set of P0-PUCCH and PUCCH-PathlossReferenceRS, two set of parameters can be indicated. So, it is in line with the earlier agreement.  @Intel > your concern on NULL is addressed by making it just an example.  @All> I mentioned RRC approach as option 2 and the above proposal (MAC-CE) as option 1 to list the company support as below. We can discuss in an online session as a decision is needed this time.  **[Draft for offline] Proposal 2.1:** To support per-TRP power control in FR1, the linking of PUCCH resource with two power control parameter sets, down select one option/alt from the below.  Option 1: indicated by MAC-CE   * Alt 1: MAC-CE indicating *PUCCH-SpatialRelationInfoIds* also in FR1, where *PUCCH-SpatialRelationInfo* is not providing a choice for *referenceSignal* (e.g.:‘NULL’, or other). * Alt.2: MAC-CE indicating new RRC IE that configures power control parameter set (p0, pathloss RS ID, and a closed-loop index). * For Alt.1 and Alt.2, a single set of *P0-PUCCH* and *PUCCH-PathlossReferenceRS* in *PUCCH-PowerControl* can be used to indicate p0 ID and pathloss RS ID.   Option 2: configured by an indicator in RRC, i.e., 'PUCCH-Resource' that indicating the PUCCH resource is configured with one or two power control sets corresponding to STRP and MTRP operations, respectively.  Company positions during phase 0  **Option 1 (MAC-CE): (18) QC, vivo, SS, Xiaomi, Lenovo, LG, Oppo, Apple, NEC, Nokia, HW, CATT, E///, IDC, Fujitsu, IDC, CMCC, Intel**   * Alt. 1: (6) QC, vivo, SS, Xiaomi, HW, Intel * **Alt.2: (9) Lenovo, LG, Oppo, Apple, NEC, Nokia, CATT, E///, CMCC**   Option 2 (RRC option that ZTE mentioned): (4) ZTE, DCM, MTek, Spreadtrum |
| **Futurewei** | **Support Alt 1 in principle. We also think NULL is not necessary. For example, RAN2 can add “**OPTIONAL -- Cond FR2-Only**” to** *referenceSignal*. It is up to RAN2 how to handle it. |
| **TCL** | **Support the proposal and prefer Alt1.** |
| FL Update #2 | **The discussion is closed**.  Agreement  For the case of multi-TRP, to support per-TRP power control in FR1, the linking of PUCCH resource with [one or] two power control parameter sets, the following is supported   * MAC-CE indicates RRC IE that configures power control parameter sets (p0, pathloss RS ID, and a closed-loop index).   + The exact design of RRC IE is up to RAN2 but from RAN1 point of view, one possible example is to reuse *PUCCH-SpatialRelationInfo* except for the *referenceSignal*   Note: It is common understanding in RAN1 that one PUCCH resource can be linked to one power control parameter set. |

### Proposal 2.3: Beam switching

**[Draft for offline] Proposal 2.3-1:** For multi-TRP PUCCH schemes, at least one symbol gap is required for switching UL beams /power control parameter sets associated with PUCCH repetitions/transmission in FR1/FR2.

* For FR2, the one symbol switching gap is applied when the UL beams are switched within the same panel.
* RAN1 may further introduce other values for switching gaps based on RAN4 reply on the transient period for cases with cross panel beam switch and/or if the spatial filter to transmit the beam is unknown and/or UL timing is different between different UL beams.
  + FFS1: If multiple values are introduced for switching gaps considering different assumptions, how the gNB determine the correct switching gap that two UL beams associated with a PUCCH resource.
  + FFS2: Whether the “beam is unknown’ case is useful to M-TRP discussions. If not, update the LS to reduce RAN4 work.

Please comment on preferred changes to the proposal. Select your preference for FFS.

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| **Company** | **Comments** |
| **QC** | **Do not support the proposal. RAN4 transient time has been transparent to RAN1 spec so far. For example, for frequency hopping, the same transient period as the case of power/beam change is defined in RAN4, but RAN1 never defined a gap between frequency hops. If RAN1 is to define gap for any type of transient time, this requires many redesigns including but not limited to: gap between frequency hops (Rel. 15/16), gap between PUSCH repetition Type B (Rel. 17), even conditions may be needed between different channels: UE is not expected to transmit same/different channels (PUCCH/PUSCH/SRS) back-to-back when there is power/beam change. Note that even RAN4 spec does not define gap in those cases except than one corner case, i.e., two channels each with one symbol and transient time need on both sides of one of them (Figure 6.3.3.9-3 of 38.101-2). In all other cases, transient time is taken from transmitted symbols (Section 6.3.3 of 38.101-2).**  **There is ongoing discussions for the case of 960 KHz (for higher bands), but for FR1/FR2 we do not see the need to define gap in all cases that there is a power/beam change, unless if the context is to extend the design to 960KHz SCS.** |
| **Lenovo&MotM** | **Support the proposal. However, we think the case that beams are switched between different panels are more general in multi-TRP PUCCH schemes, therefore, this case should be considered as higher priority and beam switching time should be studied and determined as fast as possible.** |
| **vivo** | **We have similar view as QC. Transient period is defined when at least one of the events including RB hopping, power change and UL beam switch occurs, which may degrade the performance of PUCCH/PUSCH transmission. If the spatial filter to transmit the beam is known, beams are switched within same panel and UL timing is the same for different UL beams, UL beam switching will add no addition period on that of intra-slot frequency hopping. As commented by QC, there is not any gap for intra-slot frequency hopping in Rel-15/16, so no additional gap is needed at least for current SCS configurations. Actually, a natural gap between the repetitions with different beams can be achieved by gNB scheduling in most cases.** |
| **LG** | **Support the proposal. In legacy system, symbol gap has already been supported for SRS port switching. Therefore, the need of symbol gap is obvious for panel switching case.** |
| **Samsung** | **Support FL’s proposal in principle. In Rel-15/16, transient time is taken from the transmitted symbols and we cannot guarantee to transmit these symbols due to power ramping and beam switching. In Rel-17, we can introduce the new framework to support mTRP PUCCH repetition and more reliable transmission can be considered to ensure all PUCCH symbols to be transmitted successfully. Therefore, we can design mTRP intra-slot PUCCH repetition with consideration of switching gaps and can guarantee the reliable transmission of entire PUCCH symbols even though beam is switched during repetitions.** |
| **NTT Docomo** | **Share similar view with QC that symbol gap is not necessary.**  **Transient period defined in RAN4 applies between continuous ON-power transmissions when power change or RB hopping is applied, and symbol gap was not defined in these cases.** |
| **ZTE** | **Similar with QC’s assessment that this proposal is NOT related to RAN1’s work. However, the rules of beam switching meets the invalid symbol(s) can be discussed in RAN1.** |
| **OPPO** | **UL beam is only used in FR2. Thus, the “FR1” should be removed from the main bullet.**  **For antenna switching, there is some guard period defined for each SCS based on similar RAN4 LS. Thus, it is beneficial to introduce guard period for UL beam switching. One symbol is not enough for some SCS(s).** |
| **MediaTek** | **Support the proposal. To our understanding, by gNB’s scheduling there can be a gap among different channels. The only exception is frequency hopping on the same channel, which can be discussed separately if needed. Since the target application is URLLC, any performance degradation is undesirable and thus it is preferable that any such issue can be avoided by design.** |
| **Xiaomi** | **From RAN4 reply to the LS, gap is needed at least in cases within same panel in FR1 and probably across panels in FR2, but for cases within the same panel in FR2, no gap is needed according to the current transient time. A mechanism or a new framework is needed when gaps exists.** |
| **Apple** | **OK with the proposal** |
| **NEC** | **Fine with the proposal.** |
| **Nokia** | **Support the proposal.**  **It’s clear from RAN4’s reply that a gap of (at least) one symbol would be required. In RAN1, the impact of such a gap would need to be considered/discussed essentially for Scheme 3 (intra-slot repetition) and Scheme 2 (intra-slot beam hopping, if supported).** |
| **Huawei, HiSilicon** | **We share the similar view as QC. The switching gap has been considered within the transient time defined in RAN4, which is transparent to RAN1 spec. Therefore, explicitly configuring one symbol gap is not needed.** |
| **CATT** | **Similar view as QC. It seems that switching gap is not needed for the case that the UL beams are switched within the same panel. Suggest postponing the discussion until further confirmation on beam switching among multiple panels is made from RAN4.** |
| **InterDigital** | **Needs further discussion** |
| **CMCC** | **Same view with QC and CATT. We could postpone the discussion until the reply from RAN4 about beam switching gap.** |
| **Intel** | **Do not support. Similar view as QC, CATT, HW, ZTE, DOCOMO, Vivo that transient period can be transparent to RAN1 specifications and handled by gNB allocation/configuration unless an explicit use-case is shown that requires specifying a gap** |
| **FL update#1** | This clearly has different opinions. A general comment is summarized using Ran4 LS response.  FL comments are in red.  ***Question 1****: What are the ranges of the transient period(s) between two PUCCH/PUSCH TDMed repetitions (with different UL beams)?*  **Answer 1**: For FR2, RAN4 observes that the ranges of transient period(s) between two PUCCH/PUSCH TDMed repetitions with different UL beams depends on different scenarios.   * If the spatial filter to transmit the beam is known, beams are switched within same panel and UL timing is the same for different UL beams, the transient period is 5us as defined in the RAN4 spec. % CP length is not enough to meet 5 us if the UL repetitions are in adjacent symbols. When considering SCS in FR2, one symbol duration could meet this transient time. * RAN4 needs more discussion to conclude the transient period for cases with cross panel beam switch and/or if the spatial filter to transmit the beam is unknown and/or UL timing is different between different UL beams. % RAN1 can wait for this discussion. But the unknown case is unnecessary from FL view.   For FR1, the transient period(s) between two PUCCH/PUSCH TDMed repetitions ranges from 10us to 15us depending on whether the switch from one transmission to the next is from the same antenna port or different antenna ports. % CP length is not enough to meet 10 to 15 us if the UL repetitions are in adjacent symbols. Similar to FR2 case, one symbol duration could meet this transient time.  ***Question 2****: In RAN4 perspective, are there additional considerations that RAN1 shall account for a switching gap (blanked symbol(s)) between two PUCCH/PUSCH TDMed repetitions (with different UL beams)?* % RAN1 asked the question from RAN4 about switching gap (blanked symbols)  **Answer 2**: There is no other additional considerations than the required transient period. In RAN4 general understanding, the performance degradation can be seen when the transient period is larger than CP. However, whether a switching gap (blanked symbol(s)) should be defined from performance or PHY design perspective, RAN4 thinks that it should be determined by RAN1. % RAN4 suggests that the **switching gap should be determined by RAN1 from Phy**. design perspective. There is no reason to debate it is not RAN1’s task. Even when there is a single panel, there is a gap needed for m-TRP URLLC if we meet URLLC performance requirements (as RAN4 mentioned that there could be a performance loss otherwise). The question is how we support this gap between transmissions.   * For PUCCH, is it necessary to have a switching gap? It may not be a critical issue as PUCCH format config can handle smaller delays but setting the number of symbols per PUCCH repetition (gNB task). * For PUSCH type B, it seems required to have the additional consideration of the switching gap.   As at least one case needing this, there should not be any issue defining it in general for M-TRP UL.  **Question 3**: *For different beam mapping principles (i.e. cyclical and sequential mapping patterns), is there any additional complexity that RAN4 foresees when applying cyclical beam mapping vs sequential beam mapping?*  **Answer 3**: RAN4 foresees more power consumption due to more frequent beam switching events when applying cyclical beam mapping vs sequential beam mapping, however, RAN4 does not see any additional complexity from RAN4 UE RF requirement perspective. % RAN4 replied that cyclical mapping has more power consumption. So, from Fl perspective, having UE capability is ok  ***Question 4****: In particular to multi-TRP intra-slot beam hopping (Scheme 2), can RAN1 assume the same requirement as RB hopping with respect to transient period in current RAN4 requirements, if the two hops have different UL beams in addition to different RBs?*  **Answer 4**: The current RAN4 requirements for transient period are applicable when RB hopping, or power change is applied. For RB hopping, transient period is defined as 5us for FR2 UE. In case of RB hopping with different UL beams, the transient period depends on different scenarios and it is the same as the answer to Question 1 for FR2 UE. % same discussion as above.  Now to summarize the company views  Support FL proposal: Lenovo, LG, SS, Oppo, MTek, Xiaomi, Nokia, Apple, NEC,  Do not support: QC, vivo, DCM, ZTE, HW, CATT, CMCC, Intel  Updating the proposal with PUCCH and PUSCH: Companies who did not like my initial version, please check option 2 is matching your views.  **[Draft for offline] Proposal 2.3-1: Related to switching gap (blanked symbol(s)) between UL transmissions towards two TRPs, select one from the below options,**  **Option 1:** For multi-TRP UL schemes, at least one symbol gap is required for switching UL beams /power control parameter sets associated with PUCCH/PUSCH repetitions/transmission in FR1/FR2.   * For FR2, the one symbol switching gap is applied when the UL beams are switched within the same panel. * RAN1 may further introduce other values for switching gaps based on RAN4 reply on the transient period for cases with cross panel beam switch and/or if the spatial filter to transmit the beam is unknown and/or UL timing is different between different UL beams.   + FFS1: If multiple values are introduced for switching gaps considering different assumptions, how the gNB determine the correct switching gap between two UL beams.   + FFS2: Whether the “beam is unknown’ case is useful to M-TRP discussions. If not, update the LS to reduce RAN4 work.   Option 2: For multi-TRP UL schemes, symbol gap(s) is not defined for switching UL beams /power control parameter sets associated with PUCCH/PUSCH repetitions/transmission in FR1/FR2.   * It is expected that the gNB to handle required transient periods by scheduling if the performance degradations are to be minimized. |
| **Futurewei** | **Agree with QC’s understanding.** |
| **TCL** | **Support the proposal. By introducing a gab when** **beams are switched between different panels, the** **more reliable transmission can be guaranteed. In addition, the switching gab determines the starting symbol of the second PUCCH repetition. Hence, it is related to RAN1’s work.** |
| **FL update#2** | **All >>** please check my previous comments. We can decide one of the following options in the next GTW. So, if you have any comments on the text, please indicate to save time.  **[Draft for offline] Proposal 2.3-1:** Related to switching gap (blanked symbol(s)) between UL transmissions towards two TRPs, select one from the below options,  **Option 1:** For multi-TRP UL schemes, at least one symbol gap is required for switching UL beams /power control parameter sets associated with PUCCH/PUSCH repetitions/transmission in FR1/FR2.   * For FR2, the one symbol switching gap is applied when the UL beams are switched within the same panel. * RAN1 may further introduce other values for switching gaps based on RAN4 reply on the transient period for cases with cross panel beam switch and/or if the spatial filter to transmit the beam is unknown and/or UL timing is different between different UL beams.   + FFS1: If multiple values are introduced for switching gaps considering different assumptions, how the gNB determine the correct switching gap between two UL beams.   + FFS2: Whether the “beam is unknown’ case is useful to M-TRP discussions. If not, update the LS to reduce RAN4 work.   Option 2: For multi-TRP UL schemes, symbol gap(s) is not defined for switching UL beams /power control parameter sets associated with PUCCH/PUSCH repetitions/transmission in FR1/FR2.   * It is expected that the gNB to handle required transient periods by scheduling if the performance degradations are to be minimized. |
| **ZTE** | **On introducing gap for the case of crossing panel, it is somehow related to BM for MTRP in Item 8.1.2.3. Maybe further clarification/assessment from FL is needed here.** |

**[Draft for offline] Proposal 2.3-2:** Confirm the following Working Assumption (with removing UE capability):

For PUCCH multi-TRP enhancements in Scheme 1, it is possible to configure either cyclic mapping or sequential mapping of spatial relation info’s over PUCCH repetitions.

* FFS: Applicability of mapping patterns for different beam switching gaps
* ~~The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.~~
* Note: For Scheme 1, cyclical mapping pattern and sequential mapping pattern are as follows,
  + Cyclical mapping pattern: the first and second beam are applied to the first and second PUCCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUCCH repetitions.
  + Sequential mapping pattern: the first beam is applied to the first and second PUCCH repetitions, and the second beam is applied to the third and fourth PUCCH repetitions, and the same beam mapping pattern continues to the remaining PUCCH repetitions.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **RAN4 reply LS does mention the aspect related to more power consumption. Considering this aspect, we prefer to confirm the working assumption w/o removing the UE feature bullet.** |
| **Lenovo&MotM** | **Support.** |
| **Fujitsu** | **Support the proposal.** |
| **LG** | **Support the proposal** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Support FL’s proposal in principle.**  **If too many/large gaps are needed for cyclical mapping scheme, it will be a too complex implementation and its gain will also be unclear. Therefore, this proposal can be discussed only after the agreements/conclusions of Proposal 2.3-1 have been reached.** |
| **OPPO** | **We can only accept to confirm the working assumption without removing UE capability. Thus, we cannot support the current version.** |
| **MediaTek** | **We share the same view as QC and OPPO. Confirm the working assumption w/o removing the UE feature bullet.** |
| **Xiaomi** | **Support the proposal** |
| **Apple** | **We should not remove the UE capability. We also need to discuss how to configure the cyclic mapping and sequenstial mapping, by RRC or dynamic signaling?** |
| **Spreadtrum** | **Support the FL’s proposal w/o removing the UE feature bullet.** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal.** |
| **Huawei, HiSilicon** | **Fine with the proposal.** |
| **CATT** | **Support the proposal.** |
| **Ericsson** | **Support the proposal.** |
| **InterDigital** | **We support in general the proposal. We share a similar view as Apple with respect to the configuration of the mappings.** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Support** |
| **FL update#1** | Few companies did not like removing of UE capability. It seems reasonable given that more power consumption on the cyclical pattern.  **[Draft for offline] Proposal 2.3-2:** Confirm the following Working Assumption:  For PUCCH multi-TRP enhancements in Scheme 1, it is possible to configure either cyclic mapping or sequential mapping of spatial relation info’s over PUCCH repetitions.   * FFS: Applicability of mapping patterns for different beam switching gaps * The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. * Note: For Scheme 1, cyclical mapping pattern and sequential mapping pattern are as follows,   + Cyclical mapping pattern: the first and second beam are applied to the first and second PUCCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUCCH repetitions.   + Sequential mapping pattern: the first beam is applied to the first and second PUCCH repetitions, and the second beam is applied to the third and fourth PUCCH repetitions, and the same beam mapping pattern continues to the remaining PUCCH repetitions. |
| **Futurewei** | **Support** |
| **TCL** | **Support FL’s proposal.** |
| **FL update #2** | **Looks stable to confirm.**  **Offline agreement 2.3-2:** Confirm the following Working Assumption:  For PUCCH multi-TRP enhancements in Scheme 1, it is possible to configure either cyclic mapping or sequential mapping of spatial relation info’s over PUCCH repetitions.   * FFS: Applicability of mapping patterns for different beam switching gaps * The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. * Note: For Scheme 1, cyclical mapping pattern and sequential mapping pattern are as follows,   + Cyclical mapping pattern: the first and second beam are applied to the first and second PUCCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUCCH repetitions.   Sequential mapping pattern: the first beam is applied to the first and second PUCCH repetitions, and the second beam is applied to the third and fourth PUCCH repetitions, and the same beam mapping pattern continues to the remaining PUCCH repetitions. |
| **ZTE** | **Support FL’s proposal in principle.**  **We have strong consideration on cyclical mapping, because beam switching gap of any two adjacent repetitions may always be needed, it will lead to huge performance loss. Therefore, we suggest whether support cyclical mapping for MTRP PUCCH scheme 1 should be based on the outcome on Proposal 2.3-1.** |

**[Draft for offline] Proposal 2.3-3:** Confirm the following Working Assumption (with small correction of typo):

* For beam mapping /power control parameter set mapping for PUCCH repetitions,
  + For M-TRP PUCCH Scheme 1 in FR1, it is possible to configure either cyclic mapping or sequential mapping of power control parameter sets over PUCCH repetitions (similar to spatial relation info’s over PUCCH repetitions).
  + For M-TRP PUCCH Scheme 3, reuse the same methods as Scheme 1 (by replacing slots with sub-slots) for beam mapping or power control resource set mapping ~~to sub-slots~~.

Please comment on preferred changes to the proposal.

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| **Company** | **Comments** |
| **QC** | **Ok for Scheme 1. For scheme 3, it is subject to confirming the other working assumption.** |
| **Lenovo&MotM** | **Support.** |
| **Fujitsu** | **Support the proposal.** |
| **LG** | **Same view with QC.** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Support this confirmation in principle.**  **This proposal can be discussed only after the agreements/conclusions of Proposal 2.3-1 have been reached.** |
| **OPPO** | **Support** |
| **MediaTek** | **Support the proposal.** |
| **Xiaomi** | **Agree with QC** |
| **Apple** | **I am not sure whether the UE capability is general in proposal 2.3-2. If not, UE capability should be added as well.** |
| **Spreadtrum** | **We share the same view as QC** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal** |
| **Huawei, HiSilicon** | **We are with the proposal.** |
| **CATT** | **Support the proposal.** |
| **Ericsson** | **Support FL proposal.** |
| **InterDigital** | **Support the proposal in principle. Similar view as ZTE that this proposal should be discussed after 2.3-2** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Support** |
| FL update#1 | Almost all companies support it. As mentioned by QC, this will be confirmed together with 2.3-2.  Apple>> UE capability is general for patterns. We could clarify that.  **[Draft for offline] Proposal 2.3-3:** Confirm the following Working Assumption (with small correction of typo and clarification on UE capability):   * For beam mapping /power control parameter set mapping for PUCCH repetitions,   + For M-TRP PUCCH Scheme 1 in FR1, it is possible to configure either cyclic mapping or sequential mapping of power control parameter sets over PUCCH repetitions (similar to spatial relation info’s over PUCCH repetitions).   + For M-TRP PUCCH Scheme 3, reuse the same methods as Scheme 1 (by replacing slots with sub-slots) for beam mapping or power control resource set mapping ~~to sub-slots~~.   The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. |
| **Futurewei** | **Support** |
| **APT** | **We support this proposal in general. However, we would like to confirm whether to support half-half mapping pattern. We don’t support half-half mapping pattern since the half-half mapping paten leads to ambiguity when it applies to intra-slot repetition. For example, the definition of ‘half’ should be clarified in the number of repetitions cannot always be split equally.** |
| **TCL** | **Support the proposal.** |
| FL update#2 | APT >> we can discuss half-half if others are supporting it. FL did not find good support on that.  **Offline agreement 2.3-3:** Confirm the following Working Assumption (with small correction of typo and clarification on UE capability):   * For beam mapping /power control parameter set mapping for PUCCH repetitions,   + For M-TRP PUCCH Scheme 1 in FR1, it is possible to configure either cyclic mapping or sequential mapping of power control parameter sets over PUCCH repetitions (similar to spatial relation info’s over PUCCH repetitions).   + For M-TRP PUCCH Scheme 3, reuse the same methods as Scheme 1 (by replacing slots with sub-slots) for beam mapping or power control resource set mapping ~~to sub-slots~~.   The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. |
| **ZTE** | **Support FL’s proposal in principle.**  **Hold the same concern of Proposal 2.3-2, we suggest whether support cyclical mapping for MTRP PUCCH scheme 3 should be based on the outcome on Proposal 2.3-1.** |

### Proposal 2.2: Power control TPC

**[Draft for offline] Proposal 2.2:** To support per TRP closed-loop power control for PUCCH, 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).
* 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 both PUCCH beams (option 1).

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support the proposal even though this is not our first preference. There have been enough discussions on this, and the FL proposal seems to be a good balance between different options.** |
| **Lenovo&MotM** | **Support the proposal.** |
| **vivo** | **Support.** |
| **LG** | **Support the proposal** |
| **Samsung** | **Support FL’s summary. For option 3, each TPC field can be associated with each SRI field.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Do NOT supportive this proposal.**  **Our views of each option are shown as follows:**  **- Option 1 is the worst solution which can NOT support TPR specific CLPC and always enforce the same TPC command towards two different TRPs.**  **- Option 2 can be used to indicate TDMed TPC command towards different TRPs but without any DCI overhead increasing.**  **- Option 3 will cause the most DCI overhead even though it provides the most flexibility.**  **- Option 4 is similar with Option 2 which can support TRP specific CLPC but will lead to additional DCI overhead.**  **In light of the above analyses, we think Option 2 is the best solution and should be adopted.** |
| **OPPO** | **We prefer Option 4. For the sake of progress, we can support FL proposal.** |
| **MediaTek** | **Fine with the proposal.** |
| **Xiaomi** | **Support the proposal.** |
| **Apple** | **Do not support the proposal. We do not think it is worth to add 2-bit in DCI for this, and if two SRIs are associated with the same closed-loop index, the 2-bit would be useless.** |
| **Spreadtrum** | **We can support to the FL proposal for the sake of progress.** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal, as it’s a good approach to conclude the discussion on this open aspect.** |
| **Huawei, HiSilicon** | **We prefer option 2 as it has less DCI overhead and still has flexibility of separate closed loop power control of beams.**  **For the sake of progress, we can accept the main bullet if option 2 is used for single TPC field, so that there’s one usable option if gNB wants to have less DCI payload size. MAC CE can be used to indicate which spatial filter the TPC field is used to adjust.** |
| **CATT** | **Support the proposal.** |
| **Ericsson** | **Support FL’s proposal.** |
| **InterDigital** | **We prefer option 3 but we are ok with FL’s proposal.** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Not our first preference as we think adding 2 bits is an optimization that is not critical** |
| **FL update#1** | ZTE, Apple, HW, Intel (?) have some issues with taking this as an agreement.  ZTE, Apple >> This was discussed in last two meetings. Your technical arguments are presented before, but option 3 only got more support than last time. Suggest compromising here and take the majority view. FL proposal is already a compromise between overhead vs flexibility. To be honest, we do not have much time to waste on this discussion to finalize details.  HW>> option 2 had the least support among all 4. It does not reflect the majority.  **@Apple, ZTE, HW >>** please re-consider your views. FL proposal kept without any change for now. |
| **Futurewei** | **We prefer option 3 but we are ok with FL’s proposal.** |
| **APT** | **We are fine with configuring the second TPC field via RRC. However, when the second field is not configured by RRC, we don’t think option 1 is a good solution since the channel conditions between each TRP and the UE are not the same. Option 2 or Option 4 are more applicable when the second field is not configured by RRC.** |
| **TCL** | **Support the proposal** |
| **FL update#2** | **[Draft for offline] Proposal 2.2:** To support per TRP closed-loop power control for PUCCH, 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). * 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 both PUCCH beams (option 1).   **@Apple, ZTE, HW** >> Reconsider your views again. |
| **ZTE** | **Although we sympathize with of the current deadlock, we believe add the second TPC field will be a bad solution from technical perspective. For the sake of progress, we can live with option 4 as one candidate for down-selection (even if we only support option 2 before), instead of option 1 (which is the worst solution from technical perspective).** |

### Proposal 2.4: Number of Repetitions

**[Draft for offline] Proposal 2.4:** For M-TRP PUCCH scheme 1,

* For PUCCH formats 1/3/4, the total number of repetitions can contain value 16 (in addition to values 2, 4, and 8)
* For PUCCH formats 0/2, the total number of repetitions can contain values 2, 4, and 8.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Only support the second bullet.** |
| **Lenovo&MotM** | **Support** |
| **vivo** | **For the 2nd bullet, we support 2 at this stage, and FFS other values depending on eIIoT’s outcome.**  **For PUCCH format 0 and 2, whether to support slot-level repetition is still under discussion in Rel-17 eIIoT. From our perspective, in Rel-17 M-TRP PUCCH scheme 1, the total 2 repetitions are enough for format 0 and 2 to ensure one opportunity per beam. As for other values, it depends on the conclusion in Rel-17 eIIoT if discussed.** |
| **LG** | **Same view with vivo.** |
| **Samsung** | **Support FL’s proposal. For the second bullet, as eIIoT session’s agreement, sub-slot based repetition can be supported in the similar way to the slot based repetition, i.e., slot is replaced with sub-slot and the repetition numbers of inter-slot repetition can be used for sub-slot based intra-slot repetition. Therefore, the repetition number 4 and 8 can be supported also for PUCCH formats 0/2.** |
| **ZTE** | **Only support the first bullet until now.**  **In Rel-15/16, the total repetition number {2, 4, or 8} can be used for PUCCH F1/F3/F4 rather than PUCCH F0/F2. When it comes to MTRP operation, it is natural to support the maximum repetition number can be 16 for PUCCH F1/F3/F4.**  **In comparison, the maximum repetition number of PUCCH F0/F2 should depends on the outcome from IIOT.** |
| **OPPO** | **We support the 2nd bullet with 2/4. We are open to 8 as the max # of repetition.**  **Don’t see the strong motivation for the 1st bullet** |
| **MediaTek** | **We do not see the need for any new values.** |
| **Xiaomi** | **Support the first bullet, we think all the repetition numbers can apply to all PUCCH types.** |
| **Apple** | **For PUCCH format 0/2, we failed to see the necessity to support 4 and 8.** |
| **Spreadtrum** | **Support the second bullet. For the first bullet, we haven’t see the strong motivation.** |
| **NEC** | **Support the proposal.** |
| **Nokia** | **We don’t see a strong need to support a total number of PUCCH repetitions of 16.**  **On the second bullet-point, similar to vivo and LG and others, we are also fine to wait for the Rel-17 eURLLC discussions.** |
| **Huawei, HiSilicon** | **For PUCCH format 1/3/4 in the first sub-bullet, we don’t think there’s any necessity to increase the number of repetitions to 16, while it is being discussed in other topics.**  **For PUCCH format 0/2 in the second sub-bullet, we think that value 2 is enough since short PUCCH format is for low latency requirements, which means repetition number of 8 is unnecessary.** |
| **CATT** | **Support the first bullet. For the 2nd bullet, support only 2 at this stage.** |
| **Ericsson** | **Support the proposal.** |
| **CMCC** | **Support the proposal.** |
| FL update#1 | This is not a big issue for companies to object to the majority view. FL suggests taking at least the second bullet.  **[Draft for offline] Proposal 2.4:** For M-TRP PUCCH scheme 1,   * For PUCCH formats 0/2, the total number of repetitions can contain values 2, 4, and 8. |
| **Futurewei** | **We still support the first bullet. For the 2nd bullet, support only 2 (i.e., no new values)** |
| **TCL** | **Support the updated proposal. We support the 2nd bullet with 2/4.** |
| FL update#2 | The latest version. Please indicate if you can not live with this extension.  **[Draft for offline] Proposal 2.4:** For M-TRP PUCCH scheme 1,   * For PUCCH formats 0/2, the total number of repetitions can contain values 2, 4, and 8. |
| **ZTE** | **Do Not support this proposal.**  **On the one hand, RAN1 didn’t support repetition scheme for PUCCH short formats 0/2 in Rel-15/16, it is natural to support repetition 2 except other values. On the other hand, whether other values (e.g., 4 and 8) can be supported for FeMIMO should be based on the outcome from eIIOT.** |
|  |  |

### Proposal 2.5: Intra-slot beam hopping

**[Draft for offline] Proposal 2.5:** Support intra-PUCCH resource beam-hopping (Scheme 2):

* UCI is transmitted in one PUCCH resource in which different sets of symbols within the PUCCH resource have different beams/power control parameter sets.
* FFS1: Determining different sets of symbols when a switching gap is applied between different UL beams or power control parameters sets.
* FFS2: Reuse frequency hopping mechanisms for the number of symbols in the first /second beam-hops, and the number of DMRS symbols and locations.

Please comment on preferred changes to the proposal. Select your preference for FFS.

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| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support the main proposal.**  **For FFS1, we think switching gap is not needed as explained above. RAN4 reply LS mentions that “The current RAN4 requirements for transient period are applicable when RB hopping, or power change is applied”. In current RAN4 spec, blank symbol is not defined for freq. hopping: “In case of RB hopping, transition period is shared symmetrically”.**  **The whole point of Scheme 2 is that it is simple as all freq. hopping mechanisms can be reused. If we were to define gap, then Scheme 2 has much more spec impact. Then, why not also define gap for Rel. 15/16 freq. hopping.** |
| **Lenovo&MotM** | **Not support it.** |
| **vivo** | **Support the main proposal. To differentiate the usage cases among three schemes, we propose to add another FFS as:**  **[Draft for offline] Proposal 2.5:** Support intra-PUCCH resource beam-hopping (Scheme 2):   * UCI is transmitted in one PUCCH resource in which different sets of symbols within the PUCCH resource have different beams/power control parameter sets. * FFS1: Determining different sets of symbols when a switching gap is applied between different UL beams or power control parameters sets. * FFS2: Reuse frequency hopping mechanisms for the number of symbols in the first /second beam-hops, and the number of DMRS symbols and locations. * FFS3: Details on Scheme 2 configuration |
| **Fujitsu** | **Agree with QC.** |
| **LG** | **Support the proposal** |
| **Samsung** | **Do not support the proposal. Unlike repetition schemes (scheme 1 and scheme 3), first half of PUCCH and second half of PUCCH should be transmitted toward each TRP. If any half of PUCCH cannot be received successfully due to the blockage, the entire PUCCH cannot be decodable. And we can expect that scheme 2 has similar performance gain to scheme 3. Therefore, supporting scheme 1 and scheme 3 is enough.** |
| **NTT Docomo** | **Do not support. Given that scheme 3 is supported, we do not see strong motivation to support scheme2 additionally.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **Not support. Share the similar view as DCM** |
| **MediaTek** | **We support the idea of Scheme 2 in general, but reusing frequency hopping mechanisms is questionable. Due to blockage, each beam hop should be self-decodable. Our preference is that the same codeword for UCI is repeated twice. Scheme 2 can be useful for UEs not implementing subslot operations.** |
| **Xiaomi** | **Support the proposal, and we can still leave the beam switching gap issue FFS.** |
| **Apple** | **Do not support the proposal. We already have intra-slot repetition.** |
| **Spreadtrum** | **Not support. Share the same view as DCM and OPPO** |
| **NEC** | **Not support.** |
| **Convida Wireless** | **Not support.** |
| **Nokia** | **Do not support the proposal.**  **As discussed in our Tdoc (R1-2103366), we don’t see any strong need to support Scheme 2 on top of Scheme 3, particularly since they achieve similar performance in terms of reliability and latency. In addition, we agree with Samsung’s comment.** |
| **Huawei, HiSilicon** | **Support Scheme 2 for low latency. We propose to add a note that TD-OCC is only applied within a beam to maintain orthogonal of the signal received by each TRP:**  **Draft for offline] Proposal 2.5:** Support intra-PUCCH resource beam-hopping (Scheme 2):   * UCI is transmitted in one PUCCH resource in which different sets of symbols within the PUCCH resource have different beams/power control parameter sets. * Note: TD-OCC is only applied within a beam. * FFS1: Determining different sets of symbols when a switching gap is applied between different UL beams or power control parameters sets. * FFS2: Reuse frequency hopping mechanisms for the number of symbols in the first /second beam-hops, and the number of DMRS symbols and locations.   **For FFS1, we don’t support switching gap as commented in proposal 2.3.**  **We support FFS2 for simplicity.** |
| **CATT** | **Not support the proposal. Since scheme 3 is already supported, the performance gain of scheme 2 compared to scheme 3 is not clear.** |
| **Ericsson** | **Not support. Given scheme 1 and 3 are supported already, there is no need to introduce yet another scheme. Plus, scheme 2 is not a repetition scheme. If one of the TRPs is blocked, then Scheme 2 may suffer performance losses.** |
| **InterDigital** | **Not support, same view as DCM.** |
| **CMCC** | **Not support.**  **Since we have already supported scheme 3, we don’t see the special use case of scheme 2. Besides, there might be performance loss in scheme 3 when blockage happens, considering it’s not a repetition scheme.** |
| **Intel** | **Do not support. Since we already support schemes 1, 3 there is no strong motivation to add another scheme.** |
| FL update#1 | **Not Support: Lenovo, SS, DCM, Oppo, Apple, Spreadtrum, NEC, Covinda, Nokia, CATT, E///, IDC, CMCC, Intel**  The number of objecting companies is larger than the supporting companies. The proposal is dropped for now. Any discussions to convince each other is welcome. |
| **Futurewei** | **Support** |
| **TCL** | **Support** |
| FL update#2 | **The discussion is closed due to larger number of companies not supporting scheme 2**. |

### Proposal 2.6: Intra-slot repetition

**[Draft for offline] Proposal 2.6:** Confirm the following working assumption (with removing ‘consecutive’),

For PUCCH reliability enhancement, support multi-TRP intra-slot repetition (Scheme 3) for all PUCCH formats.

* The same PUCCH resource carrying UCI is repeated for X = 2 ~~[consecutive]~~ sub-slots within a slot.
* Refer the design details related to sub-slot configurations (e.g. other values of X) to Rel-17 eIIoT

Note1: The decision of supporting scheme 3 is only applicable for multi-TRP operation

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **We think there should be no rush to confirm the working assumption. We believe Scheme 3 is useful and should be eventually specified. However, given that eIIoT WI already agreed to specify the scheme for single TRP in the previous meeting, we can at least wait for some initial designs from them. mTRP related aspects can mostly reuse agreed mechanisms from Scheme 1. So, waiting until August seems to be more logical.**  **If we are going to confirm this WA, then we prefer to add a bullet (or modify the second bullet) that “further discussions of PUCCH Scheme 3 should be postponed until after further details of sub-slot configuration for PUCCH repetition is agreed in Rel. 17 eIIoT.”** |
| **Lenovo&MotM** | **Support.** |
| **vivo** | **We have concerns on deleting “[consecutive]” because we haven’t agreed to introduce the gap yet.** |
| **LG** | **We have same view with QC.** |
| **Samsung** | **We support FL’s proposal. In previous meeting, the followings were agreed in Rel-17 eIIoT:**  Agreements: Support sub-slot based PUCCH repetition for HARQ-ACK based on the Rel-16 PUCCH procedure for slot-based PUCCH applied to sub-slot based PUCCH   * Note: the intention is to take the Rel-16 slot-based PUCCH by replacing with “sub-slot” appropriately, without further optimization unless necessary * FFS whether or not there is any restriction for the applicability of sub-slot based PUCCH repetition for HARQ-ACK * Dynamic repetition indication is supported also for sub-slot based PUCCH in Rel-17   + FFS: if the method to be specified in Cov. Enh WI for slot-based PUCCH repetition can be directly applied to sub-slot PUCCH or if changes are needed   Agreements: Support PUCCH repetition for PUCCH formats 0 and 2 at least for sub-slot based PUCCH repetition.   * FFS: Support for slot-based PUCCH repetition   **As above agreements, sub-slot based repetition can be supported by reusing Rel-16 slot-based PUCCH repetition. In that manner, X sub-slots cannot be consecutive (according to slot configuration) because Rel-16 slot-based PUCCH repetition can be transmitted into nonconsecutive slots depending on the slot configuration. And also, X can be 2 or other values (e.g. 4 and 8). Therefore, as baseline of scheme 3, we can confirm the previous working assumption as FL’s proposal without [consecutive] and X = 2, 4, 8 as follow:**  **[Draft for offline] Proposal 2.6:** Confirm the following working assumption (with removing ‘consecutive’),  For PUCCH reliability enhancement, support multi-TRP intra-slot repetition (Scheme 3) for all PUCCH formats.   * The same PUCCH resource carrying UCI is repeated for X = 2, 4, 8 ~~[consecutive]~~ sub-slots within a slot. * Refer the design details related to sub-slot configurations (e.g. other values of X) to Rel-17 eIIoT   Note1: The decision of supporting scheme 3 is only applicable for multi-TRP operation |
| **NTT Docomo** | **Share similar view with QC.** |
| **ZTE** | **Support this confirmation.** |
| **OPPO** | **Support** |
| **MediaTek** | **Support the proposal and fine with QC’s additional bullet.** |
| **Xiaomi** | **Agree with QC, we can discuss scheme 2 first and try to decide this later.** |
| **Apple** | **We think we can come back after we make a decision on gap.** |
| **Spreadtrum** | **We share the same view as QC.** |
| **Convida Wireless** | **Support** |
| **Nokia** | **Support the proposal.**  **In our view, we should discuss/specify at least the multi-TRP aspects of Scheme 3. We don’t see any strong reason to further wait for the Rel-17 eURLLC discussions.** |
| **Huawei, HiSilicon** | **Before confirming the working assumption, we would like to understand more details of Scheme 3, e.g., the sub-slot configuration.** |
| **CATT** | **Support the proposal.** |
| **Ericsson** | **Support** |
| **InterDigital** | **Agree with QC.** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **we can postpone this especially considering the RAN4 feedback on transition period** |
| FL update#1 | Companies suggesting to wait until IIoT progress on the topic. Dropped for now. |
| **Futurewei** | **Support in principle, and share the same view as QC** |
| **TCL** | **Support. We support to delete “[consecutive]” and introduce a switching gap between two different beams are preferable.** |
| FL update#2 | **The discussion is closed due to larger number of companies suggesting to wait for IIoT**. |

### Proposal 2.7: Default beam for PUSCH when PUCCH resource linked with two UL beams

**[Draft for offline] Proposal 2.7:** 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.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **Lenovo&MotM** | **Support.** |
| **vivo** | **We don’t support the proposal. Our preference is to use the first spatial relation info as the default beam for PUSCH scheduled by DCI format 0\_0, if the PUCCH resource with the lowest ID is activated with two spatial relation info.**  **We can list the two options for further agreement:**  **[Draft for offline] Proposal 2.7:** 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 is determined by:   * Option 1: the spatial relation info with lower ID * Option 2: the first spatial relation info |
| **Fujitsu** | **Support.** |
| **LG** | **Support the proposal.** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **Support** |
| **MediaTek** | **Fine with the proposal, although our preference is to disallow this case in the spec.**  **“If the UE needs to monitor DCI format 0\_0, the UE is not expected to be scheduled with two spatial relation info’s for the dedicated PUCCH resource with the lowest ID.”** |
| **Xiaomi** | **Support the proposal** |
| **Apple** | **Support FL’s proposal** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal** |
| **Huawei, HiSilicon** | **We don’t support, as we think gNB can make sure that PUCCH resource with lowest ID is with one spatial relation info.** |
| **CATT** | **We don’t support the proposal. In our opinion, similar solution as M-TRP PDSCH can be supported. UE can report whether two default beams for PUSCHs scheduled by DCI format 0\_0 is supported, and whether one or two default beams are applied to PUSCH should be configured by RRC.** |
| **Ericsson** | **We think this is not needed. This issue can be solved by gNB implementation where the PUCCH resource with the lowest ID is not activated with two spatial relations.** |
| **InterDigital** | **Support the proposal.** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Not support, same view as Ericsson.** |
| FL update#1 | Not Support: E///, HW, CATT, vivo, Intel  Two options are listed, and we can take this online if opinions do not change.  **[Draft for offline] Proposal 2.7:** Select one of the following options,   * Option 1: 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. * Option 2: The PUCCH resource with the lowest ID is not activated with two spatial relation info. |
| **Futurewei** | **Seems not necessary based on above inputs** |
| **TCL** | **Support FL’s proposal.** |
| FL update#2 | Latest version  **[Draft for offline] Proposal 2.7:** Select one of the following options,   * Option 1: 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. * Option 2: The PUCCH resource with the lowest ID is not activated with two spatial relation info. |
| **ZTE** | **Support FL’s proposal and prefer Option 1.** |

### Proposal 2.8: Invalid UL symbols

**Question 2.8:** What are the enhancements needed on beam mapping in the case of PUCCH/PUSCH dropping due to invalid UL symbols (proponents to provide more info)? If nothing is needed to discuss at this stage, please indicate that.

Please provide your inputs.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **No enhancements are needed.**  **For PUCCH, determination of number of repetitions already takes semi-static TDD config into account. For PUSCH, this is being specified in another agenda item (coverage enhancements) and parallel discussions should be avoided.** |
| **Lenovo&MotM** | **Enhancements are needed. For PUSCH repetition Type B, if there are some symbols of a PUSCH repetition which are dropped due to beam switching time, whether the dropped symbols are considered as invalid symbols should be determined.** |
| **vivo** | **We don’t think any enhancement is required either.**  **When the UE misses the DCI indicating the invalid symbol, there will be a misalignment on the UL beam between NW and UE if the beam mapping pattern changes for dropping PUCCH repetition.** |
| **Fujitsu** | **No need to enhance.**  **In Rel-15/16, the pattern for UL frequency hopping is not relevant to invalid UL symbols. We think the same logic can be applied here unless a strong motivation is provided.** |
| **LG** | **If dynamic invalid UL symbols are configured (e.g. due to dynamic PDSCH scheduling, triggering AP CSI-RS, SFI indication by DCI 2-0, invalid symbol pattern indication and so on) PUCCH/PUSCH TO can be dropped. If beams are mapped to PUSCH TO without considering dropping, PUSCH TO for one TRP can be dropped much more than PUSCH TO for another TRP. As a result, diversity gain from MTRP transmission can decrease or disappear. In order to balance TO for each TRP, beams should be mapped to PUSCH TO except for dropped TO due to invalid symbol.**  **@QC: during email discussion in the last meeting, we have already clarified this issue will not discussed in CE agenda. The issue here is about MTRP beam mapping on transmission occasion, which would not be discussed in CE WI. Their focus is how to count repetition number in case of dropping. Also, if counting repetition number for PUSCH is enhanced in the same way as legacy PUCCH in CE WI, then same beam mapping issue is there for both PUSCH and PUCCH.** |
| **Samsung** | **We also have similar view of QC for PUCCH. For PUCCH, PUCCH repetition can be transmitted into UL or flexible symbols depending on the slot configuration. Therefore, PUCCH will not be dropped due to invalid UL symbols.**  **For PUSCH, we don’t think the beam mapping issue can be discussed in another session but handling dropped PUSCH due to invalid symbols can be discussed. We should avoid parallel discussion but beam mapping rule can be discussed in the FeMIMO session.** |
| **NTT Docomo** | **No enhancement is needed.** |
| **ZTE** | **Whether this enhancement is needed may depends on the rule/agreement of frequency hopping in Proposal 2.9. We suggest to postpone this discussion until the agreements of Proposal 2.9 have been reached.** |
| **OPPO** | **Share the similar view as QC** |
| **MediaTek** | **No enhancement is needed.** |
| **Xiaomi** | **Agree with LGE that this issue is about the beam mapping to repetitions w and w/o considering the invalid symbols which can be enhanced further either in this discussion or together with beam mapping issue.** |
| **Apple** | **Nothing is needed** |
| **Spreadtrum** | **We share the same view as QC.** |
| **NEC** | **No need of enhancement.** |
| **Nokia** | **We think this question/aspect can be revisited later, as it would be good to at least clarify the point raised by LG.** |
| **Huawei, HiSilicon** | **We don’t see the necessity of enhancements.** |
| **CATT** | **At least for PUCCH scheme 1, the repetition can be postponed to the next slot or dropped due to invalid UL symbol. This issue is related to beam mapping. We prefer to support beam mapping based on repetition index.** |
| **Ericsson** | **No enhancements needed.** |
| **CMCC** | **No enhancement is needed.** |
| FL update#1 | Thanks for the inputs. Majority view is no enhancement is needed. |
| **Futurewei** | **Seems not necessary** |
| **APT** | **We don’t see the need of enhancements on PUCCH due to invalid UL symbol, but some enhancements on PUSCH due to invalid symbol pattern, which would be listed in section 3.3, may be needed.** |
| **TCL** | **No enhancement is needed.** |
| FL update#2 | **The discussion is closed** |

### Proposal 2.9: Frequency hopping

**[Draft for offline] Proposal 2.9:** 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.
  + Note: It is also feasible to configure sequential mapping pattern with inter-slot frequency hopping to achieve the same outcome.

Please comment on preferred changes to the proposal.

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| **Company** | **Comments** |
| **QC** | **Support the proposal except than the note, which is not accurate.**  **Sequential mapping + inter-slot freq. hopping is not the same as cyclic mapping with freq. hopping among the repetitions with the same beam. The latter case results in realizing the beam (spatial) diversity first followed by freq. diversity. The former case is the opposite. Realizing beam diversity first is important for early termination, followed by freq. diversity when early termination is not possible.** |
| **Lenovo&MotM** | **Support** |
| **vivo** | **Only support the first bullet.**  **From our perspective, frequency diversity and beam diversity both can be naturally achieved by the configuration of the first bullet with no addition space impact. For FR2, we are not clear the benefits of the second bullet compared with the case of enabling cyclic beam pattern without frequency hopping. In addition, changing frequency hopping pattern to adapt to one TRP requires additional spec impact.** |
| **Fujitsu** | **Same view as QC.** |
| **LG** | **We have same view with QC.** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **Support** |
| **MediaTek** | **We support frequency hopping in general. We share a similar view as vivo. We prefer not to impose any restriction on frequency hopping schemes. We suppose that gNB can configure a suitable frequency hopping scheme for each beam pattern.** |
| **Xiaomi** | **Support FL’s proposal.** |
| **Apple** | **We do no think we need to complicate this issue, we prefer to simply say “Support frequency hopping among the repetitions with the same beam”** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **We only support the first bullet-point, and agree with vivo’s comment.** |
| **Huawei, HiSilicon** | **Only support the first sub-bullet. We have similar view with Vivo that there’s little benefits to support cyclic mapping + frequency hopping, if sequential mapping + frequency hopping had been supported.** |
| **CATT** | **We don’t understand why there is two bullets. In our opinion, sequential mapping + slot level FH is equivalent to sequential mapping + FH inner each beam.**  **Besides, when the repetition number is 2, no matter which beam mapping patten is configured, the actual beam mapping is cyclical mapping. In order to have FH gain, we propose to use slot level hopping when the repetition number is 2.** |
| **InterDigital** | **Support the proposal without the note.** |
| **CMCC** | **Support in principle.**  **Same view as QC.** |
| **Intel** | **We believe frequency hopping with multi-TRP repetition is naturally supported (with the same principle as with single-TRP repetition) – what is the additional specification impact of this proposal is not clear to us.** |
| FL update#1 | The issue companies highlight on the note is not clear to me as the mapping of beams at the end looks the same. May be the problem that QC highlight is the cancelation of PUSCH? Anyways, at least it is not clear to FL what is the exact issue with the note.  Based on various inputs, FL sees that listing two options is more suitable.  **[Draft for offline] Proposal 2.9:** When inter-slot frequency hopping is configured with Scheme 1, support the one from the following,   * Option 1:   + 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. * Option 2:   gNB always configures sequential mapping pattern and frequency hopping is performed on slot level. |
| **Futurewei** | **Support and share the same view as vivo** |
| **TCL** | **Support FL’s proposal.** |
| FL update#2 | The latest version    **[Draft for offline] Proposal 2.9:** When inter-slot frequency hopping is configured with Scheme 1, support the one from the following,   * Option 1:   + 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. * Option 2:   gNB always configures sequential mapping pattern and frequency hopping is performed on slot level. |
| **ZTE** | **Support FL’s proposal in principle.**  **Based on the glance over companies’ views, we can be on the same page with QC and companies now that early termination of BH may should be guaranteed first, then we can live with Option 1 and its first bullet only. In the case of cyclical mapping pattern, maybe FH is performed on slot level can be treated as the compromise for progress. Otherwise, this part might can be FFS as follows:**  **[Draft for offline] Proposal 2.9:** When inter-slot frequency hopping is configured with Scheme 1, support the one from the following,   * Option 1:   + If sequential mapping pattern is configured, frequency hopping is performed on slot level (as in Rel-15).   + FFS: the case of cyclical mapping pattern. * Option 2:   gNB always configures sequential mapping pattern and frequency hopping is performed on slot level. |

## 2.3 Additional high priority proposals

In this FL summary, we have not included any FL proposals based on certain other directions suggested by one or two companies. Such proposals are not considered if that is not critical for the basic design framework or can be discussed in a later stage once the basic framework is agreed. If companies wish to bring any additional aspects related to PUCCH during RAN1 #104-bis-e, please comment below.

|  |  |
| --- | --- |
| Company | Comments |
| ZTE | Enhancement of PUCCH group for Rel-17 MTRP operation should be studied.  In RAN1 #104-e meeting, one FFS was raised about whether PUCCH group can be linked to PC parameter sets. Based on that, RAN1 should determine whether PUCCH group should be further enhance for Rel-17 MTRP firstly in this meeting. |
| FL Update #1 | PUCCH grouping can be discussed in a later stage when the details are finalized on critical items. |
| ZTE | Support FL’s assessment. |

# Multi-TRP PUSCH transmission

The remaining open issues and company views are summarized below. The topics discussed by one/two companies or proposals not aligned with earlier RAN1 agreements are not listed to simplify the summary.

## 3.1 Summary

|  |  |  |
| --- | --- | --- |
| **Issue** | **Summary from Tdocs** | **Moderator comments** |
| #1. Power Control: *TPC command* | Supported TPC options   * Option 1: (5) **Oppo, Lenovo, QC, Nokia, Intel** * Option 2: (4) **CATT, APT, ZTE, Intel** * Option 3: (16) **Lenovo, CATT, Nokia, Fujitsu, MTek, LG, NEC, CMCC, Xiaomi, Covinda, DCM, E///, FW, IDC, SS, vivo** * Option 4: (7) **Oppo, Lenovo, QC, CATT, LG, Apple, Intel** | This should be the easiest discussion compared to multiple issues pending on PUSCH. FL views that the same solution as PUCCH can be agreed here.  Proposal 3.1 |
| #2. Power control: remaining details | FFS1: Details on linking SRI fields to two power control parameters,   * Alt. 1*: (Add second sri-PUSCH-MappingToAddModList, and select two SRI-PUSCH-PowerControl from two sri-PUSCH-MappingToAddModList):* **HW, IDC, vivo, CATT, ZTE, Lenovo, LG, DCM, TCL** * Alt. 2*: (Add SRS resource set ID in SRI-PUSCH-PowerControl, and select SRI-PUSCH-PowerControl from sri-PUSCH-MappingToAddModList considering the SRS resource set ID):* **Xiaomi, QC, DCM, Nokia** * Alt. 3*: (Let RAN2 handle this):* **OPPO, Spreadtrum, FW, QC, Convida, E///, Intel** * Alt.4: (*Add second sri-PUSCH-PathlossReferenceRS-Id/sri-P0-PUSCH-AlphaSetId/sri-PUSCH-ClosedLoopIndex in SRI-PUSCH-PowerControl)*   FFS2: Enhancements on open-loop power control parameter set indication   * Support enhanced indication for OLPC parameters **– Intel, vivo, QC, Lenovo, FW, Xiaomi** * No additional indication enhancement needed – **Oppo, SS, Nokia**   FFS3: Consideration on *srs-PowerControlAdjustmentStates*   * Two *srs-PowerControlAdjustmentStates* included in both *SRS-ResourceSets* have same value as sameAsFci2. – **SS, FW** * Support two different closed-loop indexes for two SRS resource sets respectively – **Oppo** * The power control of the two SRS resource sets should follow the corresponding PUSCH repetitions – **HW, SS**   FFS4: Impact of multi-TRP PUSCH repetition on PHR reporting   * Option 1: Calculate one PHR, associated with the first PUSCH occasion (*first (earliest) repetition that overlaps with the first slot in which the PUSCH that carries the PHR MAC-CE)* – **QC, E///** * Option 2: Calculate two PHRs, each associated with first PUSCH occasion to each TRP, but report one of them (how to select the report has different opinions) – **E///, Nokia, Spreadtrum** * Option 3: Calculate two PHRs, each associated with first PUSCH occasion to each TRP, and report the average of the two PHRs – **E///** * Option 4: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report two PHRs – **E///, ZTE, Apple, Oppo, Xiaomi,** * Option 5: No change to legacy reporting - **FW**   Configure TRP-specific {'phr-PeriodicTimer', 'phr-ProhibitTimer', 'phr-Tx-PowerFactorChange'} for PHR trigger events – **ZTE**  FFS5: Enhancement on power control parameters per TRP when SRI(s) indication of two SRS resource sets is absent.   * At least two PL-RS shall be predefined – **vivo** * Define default values of each set of power control parameter (i.e, P0-Alpha, PL-RS, and closed-loop index) *–* **ZTE, Oppo, FW** * Not require any enhancement: **Intel** * Study further - **Lenovo**   Other Issues  When MAC-CE indicates a PL-RS ID for one or more SRI IDs, it also indicates whether the SRI IDs are associated with the first or the second SRS resource set – **ZTE, QC, vivo, E///** | **On FFS1**: Different opinions and alt.1 has slight majority support. Discussing this in RAN1 may not useful as the RRC details are up to RAN2. However, as few companies mentioned, it should be ok to list the options we RAN1 identified. Proposal 3.2-1  **On FFS2**: Multiple companies support enhancements to the OLPC parameters. FL suggests going with the majority view. Proposal 3.2-2  **On FFS3**: Couple of companies provided details, but not many companies addressing any issue with this. Some further discussion may be needed. Proposal 3.2-3  **On FFS4**: Several companies identified that extension for PHR reporting is needed. However, details provided by different companies are not yet allowing a solution. We can further discuss different options and clarify those. Proposal 3.2-4  **On FFS5**: Few companies suggested enhancement is needed when SRI(s) indication of two SRS resource sets is absent. However, inputs are limited to decide the necessity. Proposal 3.2-5  Other issues: Multiple companies discuss an issue when MAC-CE indicates a PL-RS ID for one or more SRI IDs. The proposed solution is aligned among proponents, and FL suggests a proposal based on that. Proposal 3.2-6 |
| #3: Beam switching gap | A time gap between PUCCH repetitions   * Required – **LG, E///, SS, Apple, MTek, Nokia, Xiaomi, Intel** * No – **vivo**   At least 1 or 2 symbol gap is needed **- Xiaomi, Nokia**  PUSCH symbol dropping (for Type B) is performed on the gap symbols required – **Xiaomi,** **Lenovo**  A configurable gap is needed – **E///**  There should be a common understanding of the gap between network and the UE – **Nokia, Apple**   * Define a transmission process – **Apple**   Mapping patterns  Confirm the working assumptions on beam mapping patterns – **Nokia, Intel, DCM** | Similar to the discussion under PUCCH, based on the RAN4 LS, several companies see that a gap may be needed even when the same panel is used towards two TRPs.  Few companies indicated that a gap is needed mainly for the M-TRP PUSCH type B repetition scenario.  Multiple companies are suggesting confirming the working assumptions on beam mapping patterns.  Proposal 3.3-1 and 3.3-2 |
| #4. PTRS-DMRS association | For maxRank >2: PTRS-DMRS association has the following options,   * A second field is needed: **vivo, QC,** **Xiaomi** * The existing field and entries/bits of DM-RS port indication are used: **ZTE, SS** * Only the existing field is used, with reduced resolution /interpretation: **Intel, SS, LG, E///** * Four bits used jointly for both TRPs (New table. 1 PT-RS port only) – **Apple**   Other   * For maxRank=2, PTRS-DMRS association field should be interpreted differently according to the total number of PTRS ports and the actual number of PTRS ports that is indicated by SRI or TPMI – **SS** | For “FFS: the indication of PTRS-DMRS association for maxRank > 2”, there are different opinions.  As URLLC is mainly focused on lower ranks, this discussion is not critical and does not need sophisticated handling. Also, max rank > 2 generally has an impact on DCI size in many other DCI fields and should be OK to have a larger overhead as the link between the network, and the UE should also be good to support higher ranks. FL suggests using a second field.  Proposal 3.4 |
| #5. A-CSI on M-TRP PUSCH repetition | Discussion on X   * X=1 also for the second beam/TRP: **HW, Spreadtrum, QC, E///, Nokia** * X= first actual repetition with same number of symbols as the first actual repetition with the first beam/TRP: **Intel, SS**   Other relevant details   * Consider A-CSI on two PUSCH repetitions with no TB in the case of multi-TRP PUSCH repetition – **Intel, QC**   + UE assumes that the number of repetitions is 2 regardless of indicated number **– QC**   + For PUSCH repetition Type B, first two nominal repetitions are expected to have no segmentation – **Intel, QC** * Support RRC configuration to enable new behavior for A-CSI on PUSCH, and UE follows the new behavior when the agreed conditions are met - **QC** * UCIs other than the A-CSI are not multiplexed on any of the two PUSCH repetitions: **QC** | Related to the “FFS: X = 1 or X = the first actual repetition corresponding to the second beam that contains the same number of symbols as the first actual repetition with the first beam”, most companies support X = 1. FL suggests taking the majority view.  Also, two companies discussed the support of A-CSI on M-TRP PUSCH when there is no TB. RAN1 can have some discussion on that.  Proposal 3.5 |
| #6. M-TRP CG PUSCH repetition. | Introduce the second fields (type 1 and/or type 2)   * 'srs-ResourceIndicator' – **ZTE, vivo, Intel, Apple, E///, Oppo** * 'precodingAndNumberOfLayers' – **ZTE, vivo, Intel, Apple. E///, Oppo** * 'dmrs-SeqInitialization' - **ZTE** * 'pathlossReferenceIndex' **– ZTE** * 'p0-PUSCH-Alpha' **– ZTE, Intel** * 'powerControlLoopToUse' **– ZTE, Intel**   For CG type1, clarification of UL PT-RS port(s) and DM-RS port(s) for CG type 1 towards M-TRP is required. – **vivo, Apple**  DCI activated switching between single-TRP and multi-TRP PUSCH transmissions for CG Type 2 transmissions   * Support– **Intel** * No – **Oppo**   For type 2 CG PUSCH transmission towards multiple TRPs, two SRIs/PMIs are indicated via the activating DCI – **E///**  For type 1 CG PUSCH transmission towards multiple TRPs, support configuring two frequency domain allocations in ConfiguredGrantConfig – **E///**  RV mapping for CG PUSCH should consider low latency transmission towards each TRP - **Nokia** | For M-TRP CG grant type 1, multiple companies suggest including the second field for 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers'. For CG grant type 2, two SRIs/TPMIs can be indicated via activating DCI.  ZTE and Intel suggest multiple other parameters such as the power control parameter for two TRPs by having additional fields for 'pathlossReferenceIndex', 'p0-PUSCH-Alpha', 'powerControlLoopToUse'.  A few companies mention few other points, but not enough inputs on those.  Proposal 3.6. |
| #7. CB based PUSCH: 2nd TPMI design | The field size of the second TPMI field is determined by the maximum number of TPMIs corresponding to different ranks – **HW, vivo, QC, E///, Oppo, FW, APT, Sharp**  No need to redesign of TPMI field **– Intel**  The presence of the second TPMI field can be separately configured for DCI format 0\_1 and DCI format 0\_2 **- QC** | There are different details in the discussion.  To some extent, the second TPMI field is related to dynamic switching of S-TRP/M-TRP and ordering of TRPs.  It was identified by multiple companies that using reserved entries of SRI or TPMI is not always available, and designing TPMI targeting such indications is not a very good design.  From FL perspective, there is majority support on determining the second TPMI field size by the maximum number of TPMIs corresponding to different ranks, and the FL proposal is based on the formulation provided in E/// contribution.  Proposal 3.7. |
| #8. NCB based PUSCH: 2nd SRI design | For non-codebook based PUSCH multi-TRP operation, the field size of the second SRI field is determined by the maximum number of SRIs corresponding to different ranks ***–* HW, vivo, E///, FW**  There are many other variant but not listed due to no common view. | For SRI, there is not much alignment between proposals. Similar to the reasons highlighted before (under TPMI), it will be difficult to have an unified solution for the second SRI field if the switching of S-TRP/M-TRP is supported with the SRI field.  Please also note some schemes that companies proposed are not aligned with the agreement last time where the first SRI design cannot be modified.  FL sees that E/// contribution summarize a good text that we can use to agree on SRI design.  Proposal 3.8 |
| #9. Support dynamic switching of M-TRP and ordering of TRPs. | Dynamic switching of the TRP order   * Support: **IDC, vivo, Xiaomi, APT, NEC, Nokia** * Do not support**: Spreadtrum, OPPO, E///**   Dynamic switching of s-TRP/m-TRP   * Alt.1: Introduce a new field – **vivo, E///, Oppo, CAICT, Xiaomi** * Alt.2: Design 2nd SRI (non-CB) and 2nd TPMI (CB) (with reusing reserved entries in SRI/TPMI field(s)) – **ZTE, Intel (CB ?), SS, DCM, CATT, Nokia, Xiaomi, APT, Covinda, NEC** * Alt.3: Utilize the TDRA field – **vivo, Apple** | On the dynamic switching of the TRP order, there is a slight majority to introduce the support. However, the details of the exact method have diverged views. From the FL point of view, this can be discussed later. Also, as PUSCH is repeated multiple instances (more than 1 repetitions), it does not matter which TRP starts the repetitions from the FL perspective.  On the dynamic switching of S-TRP and M-TRP modes, the majority support Alt.2 which is using 2nd SRI field or 2nd TPMI field. There are some other companies supporting Alt.1, which is requiring a separate field. In any case, Alt.2 does not work all the time, and the introduction of a new bit for handling this switching may be needed in most cases.  Proposal 3.9 |
| #10. Frequency hopping and beam mapping | Frequency hopping is performed among the repetitions with the same beam: **CATT, Fujistu, Lenovo, Xiaomi, QC, LG, Apple, LG, Ericsson**  R15/R16 frequency hopping schemes can be used with M-TRP schemes without specification impact – **MTek** | The majority support FH performed among the repetition with the same beam. Given that there is a similar proposal in PUCCH, and the beam gap is not agreed upon yet, an FL proposal will be discussed later. |
| #11. SP-CSI on M-TRP PUSCH repetition | SP-CSI on multi-TRP PUSCH repetition**:**   * Support: **OPPO, Intel, Convida, TCL, E///** * Not support: **Spreadtrum, Nokia, ~~QC~~**   Other details   * For PUSCH type B with no scheduled data, support SP-CSI transmission in the first actual repetition for first beam and the first actual repetition for the second beam and such PUSCH length is expected to be equal to a nominal repetition: **Intel** | There is not enough support to discuss SP-CSI on multi-TRP PUSCH. Given that basic framework is not ready for M-TRP PUSCH repetition, the FL is not including any proposal on this. |

## 3.2 Feature lead Proposals

### Proposal 3.1: Power control TPC

**[Draft for offline] Proposal 3.1:** 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.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **vivo** | **Support.** |
| **LG** | **Support.** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Do NOT support this proposal based on the analyses/concerns in Proposal 2.2.**  **Briefly speaking, we support Option 2 which can indicate TDMed TPC command towards different TRPs but without any DCI overhead increasing.** |
| **OPPO** | **We prefer Option 4. For sake of progress, we can accept the proposal** |
| **MediaTek** | **Support.** |
| **Xiaomi** | **Support FL’s proposal** |
| **Apple** | **We can come back after a decision is made there** |
| **Spreadtrum** | **We can support to the FL proposal for the sake of progress.** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal** |
| **Huawei, HiSilicon** | **We are fine with the proposal, we are also fine to discuss the power control for PUCCH/PUSCH separately.** |
| **CATT** | **Support.** |
| **Fraunhofer IIS/HHI** | **Support** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Not our first preference as we think adding 2 bits for TPC optimization is not necessary** |
| FL Update #1 | This can be agreed even without agreeing to PUCCH proposal on TPC.  ZTE, Apple, Intel have concerns. Proposal is not changed. |
| **Futurewei** | **Support** |
| **APT** | **Support** |
| **TCL** | **Support FL’s proposal.** |
| FL Update #2 | **[Draft for offline] Proposal 3.1:** 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.  ZTE, Apple, Intel >> please check your views again on proposal 2.2 and this. |
| **ZTE** | **Hold the same views on our comments in Proposal 2.2.** |

### Proposal 3.2: Other open issues of power control

**[Draft for offline] Proposal 3.2-1:** When SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2, for linking SRI fields to two power control parameters, it is up to RAN2 to finalize the RRC details related to linking. RAN1 identified that the following options could be used.

* + Alt. 1: Add second *sri-PUSCH-MappingToAddModList*, and select two *SRI-PUSCH-PowerControl* from two *sri-PUSCH-MappingToAddModList*
  + Alt. 2: Add SRS resource set ID in *SRI-PUSCH-PowerControl*, and select *SRI-PUSCH-PowerControl* from *sri-PUSCH-MappingToAddModList* considering the SRS resource set ID

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **Lenovo&MotM** | **Support.** |
| **Vivo** | **We are fine with the proposal even though our preference is Alt.1.** |
| **Fujitsu** | **Support** |
| **LG** | **Support Alt 1.** |
| **Samsung** | **We can support Alt. 1 because the linking between SRI and sri-PUSCH-PowerControl by Alt.1 is more direct than Alt 2.** |
| **NTT Docomo** | **Prefer alt.1.** |
| **ZTE** | **Support FL’s proposal with Alt. 1.**  **In Rel-15/16 single TRP operation, RRC configure the parameter ‘*sri-PUSCH-MappingToAddModList*’ to link SRIs and PC parameter sets. When it comes to Rel-17 MTRP operation, Alt. 1 is the better solution which is natural and clear enough to use two parameters of ‘*sri-PUSCH-MappingToAddModList*’ towards two TRPs. Besides, there is no SRS resource ID configured for PUSCH power control in Rel-15/16, which means Alt. 2 will lead to unnecessary spec changes/efforts.** |
| **OPPO** | **Support** |
| **MediaTek** | **Support.** |
| **Xiaomi** | **Support the proposal** |
| **Apple** | **Support** |
| **Spreadtrum** | **Support.** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **Support the proposal** |
| **Huawei, HiSilicon** | **Support the proposal.** |
| **CATT** | **Support.** |
| **Fraunhofer IIS/HHI** | **Support the proposal. Prefer Alt. 1** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **We are confused about the alternatives – how should they be interpreted, that RAN1 will not accept other solutions ?** |
| FL Update #1 | Almost all companies are ok with the proposal.  Intel>> Alternatives were listed in the last RAN1 meeting agreement (copied below). With the above FL proposal 3.2-1, RAN1 is not going to agree to alt.1 or alt.2 as details of RRC is up to RAN2. However, alt.1 and alt.2 are supported by majority of companies and listed as reference.  **Agreement**  For single-DCI based M-TRP PUSCH repetition schemes, up to two power control parameter sets (using *SRI-PUSCH-PowerControl*) can be applied when SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2.   * FFS1: Details on linking SRI fields to two power control parameters,   + Alt. 1: Add second *sri-PUSCH-MappingToAddModList*, and select two *SRI-PUSCH-PowerControl* from two *sri-PUSCH-MappingToAddModList*   + Alt. 2: Add SRS resource set ID in *SRI-PUSCH-PowerControl*, and select *SRI-PUSCH-PowerControl* from *sri-PUSCH-MappingToAddModList* considering the SRS resource set ID   + Alt. 3: Let RAN2 handle this   + Alt.4: Add second *sri-PUSCH-PathlossReferenceRS-Id*/*sri-P0-PUSCH-AlphaSetId*/*sri-PUSCH-ClosedLoopIndex* in *SRI-PUSCH-PowerControl*. * FFS2: Enhancements on open-loop power control parameter set indication * FFS3: Consideration on *srs-PowerControlAdjustmentStates* * FFS4: Impact of multi-TRP PUSCH repetition on PHR reporting * FFS5: Enhancement on power control parameters per TRP when SRI(s) indication of two SRS resource sets is absent. |
| **Futurewei** | **Fine the proposal, and support Alt. 1.** |
| **APT** | **Support** |
| **TCL** | **Support Alt. 1. Alt.1 is a natural solution because the two SRI-PUSCH-PowerControl can be selected from two sri-PUSCH-MappingToAddModList by the corresponding SRI of the two fields.** |
| FL Update #2 | **Offline agreement 3.2-1:** When SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2, for linking SRI fields to two power control parameters, it is up to RAN2 to finalize the RRC details related to linking. RAN1 identified that the following options could be used.   * + Alt. 1: Add second *sri-PUSCH-MappingToAddModList*, and select two *SRI-PUSCH-PowerControl* from two *sri-PUSCH-MappingToAddModList*   + Alt. 2: Add SRS resource set ID in *SRI-PUSCH-PowerControl*, and select *SRI-PUSCH-PowerControl* from *sri-PUSCH-MappingToAddModList* considering the SRS resource set ID |
| **ZTE** | **Support FL’s proposal with Alt. 1.** |

**[Draft for offline] Proposal 3.2-2:** When SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2, support enhanced open-loop power control parameter (OLPC) set indication by indicating per-TRP OLPC set.

* + FFS: Details of indication.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **Lenovo&MotM** | **Support** |
| **vivo** | **Support.** |
| **Samsung** | **Do not support the proposal. We agree that per-TRP OLPC RRC parameter set is required for mTRP PUSCH for URLLC traffic. But, we don’t need to introduce additional OLPC parameter set indication field in DCI because that DCI field only indicates whether p0 value is for eMBB or URLLC. If PUSCH is for URLLC traffic, only one OLPC parameter set indication field is set to ‘1’ and per-TRP p0 value for URLLC can be chosen from each OLPC RRC parameter set (i.e., p0-PUSCH-set in each p0-PUSCH-SetList). Therefore, additional OLPC parameter set indication field is not needed.**  **And, even though the SRI field doesn’t exist in DCI (when CB-based PUSCH with one SRS resource in each SRS resource set), OLPC parameter set indication field can be required for URLLC traffic. Therefore, the first condition ‘**When SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2,’ **should be removed.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **Ok** |
| **MediaTek** | **Do not support the proposal. We share a similar view as Samsung.** |
| **Xiaomi** | **Support the proposal** |
| **NEC** | **Support the proposal.** |
| **Nokia** | **In our view it’s not really critical to support such an enhancement where basically two open-loop power control parameter sets are indicated, each of which corresponding to a different beam/TRP. In fact, the dynamic indication (via DCI) of such a set was agreed in Rel-16 NR, under IIoT/eURLLC, for the inter-UE multiplexing topic where the main intention is e.g. to dynamically boost (by changing P0) the power for a UE with URLLC PUSCH transmission that overlaps with eMBB transmissions/resources. However, with the multi-TRP PUSCH repetition operation, the diversity created by having multiple PUSCH repetitions in time and towards different TRPs seems to be enough to guarantee the URLLC satisfaction ratio (i.e. latency and reliability), without the need to have a dynamic indication of different P0s each of which for a different TRP.** |
| **Huawei, HiSilicon** | **Don’t support the proposal. The benefit is unclear to us, while the DCI size would be increased.** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **We support to discuss this issue and formulate a proposal with specific alternatives for specification changes. We don’t prefer to increase DCI size.** |
| FL Update #1 | Nokia, HW, SS, MTek is not supporting the proposal.  Intel is seeking more specific alternatives, and that can be listed if the enhancement is agreed to support. Also, not all companies provided inputs on that.  **[Draft for offline] Proposal 3.2-2:** For the indication of open-loop power control parameter (OLPC) in DCI format 0\_1/0\_2, down-select one from below options,   * **Option 1:** Support enhanced open-loop power control parameter (OLPC) set indication by indicating per-TRP OLPC set.   + FFS: Details of indication. * **Option 2: No change to legacy o**pen-loop power control parameter (OLPC) set indication |
| **Futurewei** | **Support, as it is a direct extension of the legacy design** |
| **APT** | **Support** |
| **TCL** | **Support FL’s proposal.** |
| FL Update #2 | **Latest version for further inputs.**  **[Draft for offline] Proposal 3.2-2:** For the indication of open-loop power control parameter (OLPC) in DCI format 0\_1/0\_2, down-select one from below options,   * **Option 1:** Support enhanced open-loop power control parameter (OLPC) set indication by indicating per-TRP OLPC set.   + FFS: Details of indication. * **Option 2: No change to legacy o**pen-loop power control parameter (OLPC) set indication |
| **ZTE** | **Support FL’s proposal with Option 1.** |

**[Draft for offline] Proposal 3.2-3:** When SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2, further discuss the consideration required on *srs-PowerControlAdjustmentStates,* including

* + Whether srs-PowerControlAdjustmentStates indicates the same or separate power control adjustment state for SRS transmissions and PUSCH transmissions
    - Any parameter setting restrictions (sameAsFci2, separateClosedLoop) within srs-PowerControlAdjustmentStates IE
  + How power control of the two SRS resource sets follows the corresponding PUSCH repetitions

Please comment on preferred changes to the proposal and provide your inputs.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **We do not see the need for enhancements. The existing power control mechanisms for SRS allow to have same or different closed loop adjustment state as PUSCH. In the case of using the same, it allows to use either the first closed loop index or the second closed loop index of PUSCH.** |
| **vivo** | **Agree with QC.** |
| **Samsung** | **Support FL’s proposal and ‘srs-PowerControlAdjustmentStates’ for both SRS resource sets (usage is ‘codebook’ or ‘nonCodebook’) for mTRP PUSCH transmission is set as ‘sameAsFci2’ because of the alignment between the closed-loop index of SRS resource set and the closed-loop index of PUSCH. If we align the closed-loop index between the PUSCH and SRS resource set, we can manage the closed-loop index per TRP simply.** |
| **NTT Docomo** | **Support the proposal.** |
| **ZTE** | **Do NOT support this proposal which may not be needed.** |
| **OPPO** | **Support** |
| **MediaTek** | **Agree with QC that no enhancement is needed. However, association between an SRS resource set and a power control parameter set should be specified. The association is implicit in the current spec and thus there might be ambiguity when two power control parameter sets are configured.** |
| **Spreadtrum** | **We do not see the strong motivation for the enhancement.** |
| **Nokia** | **We don’t really see why there would be a need for such enhancements, and we agree with QC.** |
| **Huawei, HiSilicon** | **We support the proposal.** |
| **CMCC** | **Same view as QC.** |
| **Intel** | **We don’t see the need for this** |
| FL Update #1 | The majority think that nothing is needed on this. |
| **Futurewei** | **Support** |
| **TCL** | **Support the proposal.** |
| FL update#2 | **The discussion is closed** |

**[Draft for offline] Proposal 3.2-4:** For PHR reporting related to M-TRP PUSCH repetition, select one from the following options.

* + Option 1: Calculate one PHR associated with the first PUSCH occasion (earliest repetition that overlaps with the first slot in which the PUSCH that carries the PHR MAC-CE)
  + Option 2: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, but report one of them
    - FFS: How to select the PHR for reporting.
  + Option 3: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report the average of the two PHRs
  + Option 4: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report two PHRs
  + Option 5: No changes to legacy PHR reporting

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support Option 1. Reporting two PHRs (or the average of them) not only requires a new MAC-CE structure, but also may not be feasible, especially in the case of UL CA, e.g., MAC-CE is carried on PUSCH in CC1, and CC2 has a mTPRP PUSCH. At the time of transmission and determination of PHR MAC-CE, the actual PHR value for later repetition (including back-off / MPR values) are not known yet.**  **Minor edit to Option 1 for better readability is suggested:**  Option 1: Calculate one PHR associated with the first PUSCH occasion (earliest repetition that overlaps with the first slot in which the PUSCH that carries the PHR MAC-CE is transmitted). |
| **Lenovo&MotM** | **Support Option 4.** |
| **vivo** | **We think it’s too early to make a resolution because it is somewhat related to TPC definition. We propose to further study this issue.** |
| **Samsung** | **We can support Option 4. To manage power for mTRP PUSCH more efficiently, remaining power per TRP can be reported. Or as the second preference, Option 2 can be considerable if the minimum value of the two PHRs with TRP indication is reported. Based on the reported minimum value of PH, gNB can allocate mTRP PUSCH transmission power.** |
| **NTT Docomo** | **Support the proposal.** |
| **ZTE** | **Support FL’s proposal with Option 2.**  **Our views of each option are shown as follows:**  **- Option 1 is the worst solution which can NOT support TPR specific PHR reporting even though two PC parameter sets towards two TRPs were supported.**  **- Option 2 can be used to indicate TDMed PHR reporting towards different TRPs and can guarantee the great flexibility for TRP specific PHR event triggering.**  **- Option 3 is somehow similar with Option 1, besides its use case is unclear.**  **- Option 4 is similar with Option 2, but it is mandatory to report two TRPs’ PHR values no matter whether one out of them is needed to be reported.**  **In light of the above analyses, we think Option 2 is the best solution and should be adopted.** |
| **OPPO** | **Support the proposal with a preference on Option 4** |
| **Xiaomi** | **We prefer option.4, more discussions on the feasibility are needed.** |
| **Spreadtrum** | **Support Option2** |
| **Convida Wireless** | **Support Option 4.** |
| **Nokia** | **Support down-selecting between Option 2 or Option 4.**  **Option 1 seems to be too restrictive.** |
| **Huawei, HiSilicon** | **Support option 5, as we didn’t see the benefits of enhancements. Following the legacy behavior, the PHR for both TRPs can also be reported.** |
| **Intel** | **We think Option 5 is ok but we will further check** |
| FL Update #1 | No one is supporting option 3, removed. Also, added text change suggested by QC.  Up to now, option 4 has a slight majority.  **Draft for offline] Proposal 3.2-4:** For PHR reporting related to M-TRP PUSCH repetition, select one from the following options.   * + Option 1: Calculate one PHR associated with the first PUSCH occasion (earliest repetition that overlaps with the first slot in which the PUSCH that carries the PHR MAC-CE is transmitted)   + Option 2: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, but report one of them     - FFS: How to select the PHR for reporting.   + ~~Option 3: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report the average of the two PHRs~~   + Option 4: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report two PHRs   + Option 5: No changes to legacy PHR reporting |
| **Futurewei** | **Fine with the proposal and will further study** |
| **TCL** | **Support the proposal and Option 4 is preferable.** |
| FL Update #2 | The latest version is copied below. FL is not suggesting any down selection in this meeting. Companies can further study the below.  **Offline agreement 3.2-4:** For PHR reporting related to M-TRP PUSCH repetition, select one from the following options in RAN1 #105-e meeting.   * + Option 1: Calculate one PHR associated with the first PUSCH occasion (earliest repetition that overlaps with the first slot in which the PUSCH that carries the PHR MAC-CE is transmitted)   + Option 2: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, but report one of them     - FFS: How to select the PHR for reporting.   + ~~Option 3: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report the average of the two PHRs~~   + Option 4: Calculate two PHRs, each associated with a first PUSCH occasion to each TRP, and report two PHRs   + Option 5: No changes to legacy PHR reporting |
| **ZTE** | **Support FL’s proposal and can be fine to down-select one option in the next meeting.** |

**[Draft for offline] Proposal 3.2-5:** When SRI(s) indication of two SRS resource sets is absent, further discuss to select one from the options

* Alt.1: Define default values of each set of power control parameter (P0-Alpha, PL-RS, and closed-loop index)
* Alt.2: No additional enhancements is considered.

Please comment on preferred changes to the proposal.

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| --- | --- |
| **Company** | **Comments** |
| **QC** | **This depends on the discussions related to dynamic switching. If reserved SRI codepoints are added for that option, then there is always SRI field in the case of mTRP and no enhancements are needed for this proposal.** |
| **Lenovo&MotM** | **We prefer Alt 1.** |
| **vivo** | **Support Alt.1.** |
| **Samsung** | **We are fine with Alt. 1. If CB mTRP PUSCH repetition is scheduled with two SRS resource sets that include only one SRS resource, the SRI field does not exist in DCI. In this case, power control parameters per-TRP should be also clarified.** |
| **NTT Docomo** | **Support the proposal. And share similar view with QC that this is related to dynamic switching if SRI fields are used.** |
| **ZTE** | **Support FL’s proposal with Alt. 1. We can also be okay to discuss it after agreements are reached about STRP/MTRP dynamic switching indication.** |
| **OPPO** | **Support Alt.1.** |
| **MediaTek** | **Support Alt. 1.** |
| **Xiaomi** | **Agree with QC, this relies on the design for dynamic switching.** |
| **Spreadtrum** | **Support Alt.1.** |
| **NEC** | **Share similar view as QC.** |
| **Nokia** | **We prefer Alt.1** |
| **Huawei, HiSilicon** | **Support Alt 2. We can come back on this after decision of SRI fields.** |
| **CATT** | **Similar view as QC. We suggest to postpone the discussion until there is a conclusion on dynamic switching of S-TRP and M-TRP.** |
| **Fraunhofer IIS/HHI** | **Support Alt. 1** |
| **CMCC** | **Support Alt 1.** |
| **Intel** | **Same view as QC** |
| **Futurewei** | **Same view as QC** |
| **APT** | **Similar view as QC. If the reserved SRI state is applied for performing dynamic switching between multi-TRP and single-TRP, we don’t expect that the SRI field will be absent. We suggest that we can discuss this issue after we have progress on the dynamic switching issue.** |
| **TCL** | **Support FL’s proposal with Alt. 1. This depends on the discussions of dynamic switching and the number of sri-PUSCH-MappingToAddModList.** |
| FL Update #1/#2 | **Companies suggest discussing this after the decision on dynamic switching.** |

**[Draft for offline] Proposal 3.2-6:** When MAC-CE indicates a PL-RS ID for one or more SRI IDs, it also indicates whether the SRI IDs are associated with the first or the second SRS resource set.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **vivo** | **Support.** |
| **Fujitsu** | **Support.** |
| **NTT Docomo** | **Support the proposal.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **Support** |
| **MediaTek** | **Support.** |
| **Nokia** | **Support** |
| **Huawei, HiSilicon** | **We are fine with the proposal.** |
| **CATT** | **Support** |
| **CMCC** | **Support the proposal.** |
| FL Update #1 | Good support on this. |
| **Futurewei** | **Support** |
| **TCL** | **Support the proposal.** |
| FL Update #2 | **Offline agreement 3.2-6:** When MAC-CE indicates a PL-RS ID for one or more SRI IDs, it also indicates whether the SRI IDs are associated with the first or the second SRS resource set. |

### Proposal 3.3: Beam switching

**[Draft for offline] Proposal 3.3-1:** At least one symbol gap (for the case of same panel/port is used) is required for switching UL beams /power control parameter sets in multi-TRP PUSCH repetition.

* For PUSCH repetition type B, further discuss how to handle the switching gap between two actual transmissions (when different beams are applied).

Note: Similar to M-TRP PUCCH scenario, RAN1 may further introduce other values for switching gaps based on RAN4 reply.

Please comment on preferred changes to the proposal. Select your preference for FFS.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **As mentioned in the response to the question in PUCCH section, we do not think one symbol gap should be always added whenever there is power/beam/RB change for FR1/FR2. Having the higher bands (960 KHz SCS) in mind, we can have a framework of a configurable gap, but the context should be clear.** |
| **Lenovo&MotM** | **Support.** |
| **vivo** | **We think there is no need to introduce a gap, and the reason is same as what we describe for PUCCH.** |
| **LG** | **Support** |
| **Samsung** | **Support FL’s proposal.** |
| **NTT Docomo** | **Share similar view with QC that symbol gap is not necessary.**  **Transient period defined in RAN4 applies between continuous ON-power transmissions when power change or RB hopping is applied, and symbol gap was not defined in these cases.** |
| **ZTE** | **Hold the same views in Proposal 2.3 that RAN1 may only need to determine the rule of beam switching meets the invalid symbol(s), instead of introducing gap value configuration.** |
| **OPPO** | **UL beam is only used in FR2. Thus, the “FR1” should be removed from the main bullet.**  **For antenna switching, there is some guard period defined for each SCS based on similar RAN4 LS. Thus, it is beneficial to introduce guard period for UL beam switching. One symbol is not enough for some SCS(s).** |
| **MediaTek** | **Support the proposal. To our understanding, by gNB’s scheduling there can be a gap among different channels. The only exception is frequency hopping on the same channel, which can be discussed separately if needed. Since the target application is URLLC, any performance degradation is undesirable and thus it is preferable that any such issue can be avoided by design.** |
| **Xiaomi** | **Support a switching gap specified, but can be set to zero.** |
| **Apple** | **OK with the proposal** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **OK with the proposal** |
| **Nokia** | **Support the proposal for the same reasons mentioned for PUCCH.** |
| **Huawei, HiSilicon** | **We don’t support the gap as commented in proposal 2.3.** |
| **CATT** | **Similar view as that for PUCCH. It seems that switching gap is not needed for the case that the UL beams are switched within the same panel. Postpone the decision until RAN4’s reply on beam switching among multiple panels is available.** |
| **CMCC** | **Similar view with QC, the symbol gap might be unnecessary in RAN1.** |
| **Intel** | **We support the principle but the main bullet is not needed because a gap is not needed to be defined for cases where it is reasonable for the gNB to account for transition time via configuration/allocation (e.g. Type A repetition). The sub-bullet is okay.** |
| FL Update #1 | The discussion will be continued in proposal 2.3 |
| **Futurewei** | **Same view as QC** |
| **TCL** | **Support the proposal. By introducing a gab when** **beams are switched between different panels, the** **more reliable transmission can be guaranteed.** |
| FL Update #2 | Closing this discussion. |

**[Draft for offline] Proposal 3.3-2:** Confirm the following working assumption (with removing UE capability and the last bullet):

For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.

* ~~The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.~~
* FFS: Support of half-half mapping.
* FFS: Additional considerations on mapping patterns (including required beam switching gaps)
* ~~Companies are encouraged to provide further simulation results to decide details~~.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **RAN4 reply LS does mention the aspect related to more power consumption. Considering this aspect, we prefer to confirm the working assumption w/o removing the UE feature bullet.** |
| **Lenovo&MotM** | **Support.** |
| **vivo** | **For PUSCH repetition type B, beam mapping is based on nominal repetition, which may not be suitable for all cases. Regarding PUSCH repetition type B when inter-slot frequency hopping is enabled, slot-level based beam mapping may be more reasonable. So, we propose to add an FFS:**  **[Draft for offline] Proposal 3.3-2:** Confirm the following working assumption (with removing UE capability and the last bullet):  For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.   * ~~The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.~~ * FFS: Support of half-half mapping. * FFS: Additional considerations on mapping patterns (including required beam switching gaps) * FFS: beam mapping pattern of PUSCH repetition type B when inter-slot frequency hopping is enabled.   ~~Companies are encouraged to provide further simulation results to decide details~~. |
| **Fujitsu** | **Support.** |
| **LG** | **Support.** |
| **Samsung** | **We can support FL’s proposal.** |
| **NTT Docomo** | **Support.** |
| **ZTE** | **Support FL’s proposal.** |
| **OPPO** | **We can only accept to confirm the working assumption without removing UE capability. Thus, we cannot support the current version.** |
| **MediaTek** | **We share the same view as QC and OPPO. Confirm the working assumption w/o removing the UE feature bullet.** |
| **Xiaomi** | **Support the proposal, with the following suggestion.**  **[Draft for offline] Proposal 3.3-2:** Confirm the following working assumption (with removing UE capability and the last bullet):  For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.   * ~~The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.~~ * FFS: Support of half-half mapping. * FFS: flexible configuration of beam mapping patterns * FFS: Additional considerations on mapping patterns (including required beam switching gaps) * ~~Companies are encouraged to provide further simulation results to decide details~~. |
| **Apple** | **We think the UE capability should be kept** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support** |
| **Nokia** | **Support the proposal** |
| **Huawei, HiSilicon** | **Support the proposal.** |
| **CATT** | **Support the proposal.** |
| **Fraunhofer IIS/HHI** | **Support the proposal** |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Support** |
| FL Update #1 | The majority is ok with confirming working assumption. Similar to the PUCCH proposal, it should be ok to list UE capability.  Vivo, Xiaomi >> No new FFS are added. We can discuss them later.  **Draft for offline] Proposal 3.3-2:** Confirm the following working assumption (with removing UE capability and the last bullet):  For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.   * The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. * FFS: Support of half-half mapping. * FFS: Additional considerations on mapping patterns (including required beam switching gaps) * ~~Companies are encouraged to provide further simulation results to decide details~~ |
| **Futurewei** | **Support** |
| **APT** | **We support this proposal in general. In addition, we don’t support half-half mapping pattern since the half-half mapping paten leads to ambiguity when it applies to intra-slot repetition. For example, the definition of ‘half’ should be clarified in the number of repetitions cannot always be split equally.** |
| **TCL** | **Support FL’s proposal.** |
| FL Update #2 | **Offline Agreement 3.3-2:** Confirm the following working assumption (with removing UE capability and the last bullet):  For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.   * The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2. * FFS: Support of half-half mapping. * FFS: Additional considerations on mapping patterns (including required beam switching gaps)   ~~Companies are encouraged to provide further simulation results to decide details~~ |
| **ZTE** | **Hold the same concern of Proposal 2.3-2, we suggest whether support cyclical mapping for MTRP PUSCH scheme should be based on the outcome on Proposal 2.3-1.** |

### Proposal 3.4: PT-RS DMRS association

**[Draft for offline] Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is supported with a second PTRS-DMRS association field (similar to the existing field), and each field separately indicating the association between PTRS port and DMRS port for two TRPs.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support.** |
| **vivo** | **Support.** |
| **Fujitsu** | **Support.** |
| **LG** | **It is not desirable to increase DCI overhead to optimize PTRS indication for high rank. High rank is not beneficial for reliability enhancement. So, we propose to reuse the same approach which was agreed for rank 2. Specifically, 1 bit MSB indicates PTRS association among the subset of DMRS ports for TRP 1 and 1 bit LSB indicates PTRS association among the subset of DMRS ports for TRP 2.** |
| **Samsung** | **Do not support this proposal. For maxRank>2, we need to clarify the PTRS-DMRS association because rank limitation was not endorsed in previous meeting. However, it should be conducted without increase of DCI overhead since the PTRS-DMRS association is just optimization. Without increase of DCI overhead, per-TRP PTRS-DMRS association can be supported with other method (e.g., the limitation of DMRS candidates that can be associated with PTRS port(s))** |
| **ZTE** | **Do NOT support this proposal.**  **For single DCI based MTRP PUSCH scheme, the most sensitive issue is about DCI overhead increasing. In order to avoid this issue, one solution can be to use the existing 2 bits of PTRS-DMRS association field in DCI for TRP#1, then exploit some reserved entries or bits in the field of DMRS port indication for TRP#2. The following table shows one case of DMRS port indication field that 2 bits have been reserved in the current TS38.212.**  Table 7.3.1.1.2-10: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=1, rank = 3   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-2 | | 1-7 | Reserved | Reserved |   **Besides, after checking all fields/tables of DMRS port indications for rank > 2 in the current TS38.212, there are always at least 2 bits which can be used for the purpose of PTRS-DMRS association without any impact on the functionality for DMRS port allocation. Thus, we suggest to use the update proposal as below for further discussion.**  **[Draft for offline] Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is supported, and select from the below options:   * Option 1: using the existing PTRS-DMRS association field in DCI for the first TRP, and using reserved entries/bits in DM-RS port indication field for the second TRP. * Option 2: with a second PTRS-DMRS association field (similar to the existing field), and each field separately indicating the association between PTRS port and DMRS port for two TRPs. |
| **OPPO** | **Do not support. We think max Rank should not be larger than 2 in PUSCH repetition with M-TRP.** |
| **MediaTek** | **Support.** |
| **Xiaomi** | **Support the proposal** |
| **Apple** | **We have agreed to use a single field for joint indication for maxRank<=2. We suggest a unified solution.** |
| **Nokia** | **We are fine with the proposal in general. However, it would be better if we can find / conclude on a simple solution that doesn’t require increasing the DCI overhead.** |
| **CATT** | **Support the proposal.** |
| **Intel** | **Do not support. It doesn’t make sense to add 2 bits to DCI at the same time significant specification changes are proposed to save 1 bit in TPMI/SRI. We have the same view as LG, Samsung that we should have 2 options on the table, Alt-1 using 2 bits (MSB, LSB) for 2 TRPs and Alt-2 doubling the bit-field size to 4 bits.** |
| **Futurewei** | **Support** |
| **TCL** | **Share the same view with OPPO.** |
| FL Update #1/#2 | Support FL proposal: QC, vivo, Fujitsu, MTek, Xiaomi, Nokia, CATT, FW  Do not support: TCL, Intel, Apple, Oppo, ZTE, SS, LG  Oppo, LG >> there is no agreement to limit max rank (I tried that as you proposed last time. Majority did not agree). In that sense, this is an open issue. So, this should not be an argument against any solution.  Apple, ZTE, LG, SS, Intel >> You all seems to be suggesting a unified framework as maxrank = 2 case. FL tried to use ZTE suggestion as an option so we can further discuss this. I am not fully sure this was Apple’s suggestion. Anyways, suggest text to capture your suggestion accurately.  **[Draft for offline] Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is supported, down select one of the following options in RAN1 #104bis-e meeting,   * Option 1 (4 bits): with a second PTRS-DMRS association field (similar to the existing field), and each field separately indicating the association between PTRS port and DMRS port for two TRPs. * Option 2 (2 bits): using the existing PTRS-DMRS association field in DCI for the first TRP, and using reserved entries/bits in DM-RS port indication field for the second TRP. |
| **ZTE** | **Support FL’s proposal and further support Option 2.**  **Generally, it can be the common that DCI overhead is the most sensitive issue for single DCI based MTRP PUSCH. The intention of our solution is to indicate TRP specific PTRS-DMRS association without any DCI overhead increasing, because there are always 2 reserved bits can be used for the purpose of PTRS-DMRS association without any impact on the functionality for DMRS port allocation in the current spec. Besides, it can be noted that there is no restrictions of our solution, such as maxRank <= 2, PTRS port is mandatory to be 1, etc.** |

### Proposal 3.5: A-CSI on PUSCH

**[Draft for offline] Proposal 3.5:** For multiplexing A-CSI on two PUSCH repetitions in the case of multi-TRP PUSCH repetition,

* For S-DCI based multi-TRP PUSCH repetition Type B, support multiplexing A-CSI on the first PUSCH repetition corresponding to the first beam and the first (X = 1) PUSCH repetition corresponding to the second beam.
  + The UE does not expect the above operation for multiplexing A-CSI on two PUSCH repetitions if the first actual repetition corresponding to the first beam and the first actual repetition corresponding to the second beam does not have the same number of symbols.
* For s-DCI based multi-TRP PUSCH repetition Type A and B, support multiplexing of A-CSI on the first PUSCH repetition corresponding to the first beam and the first PUSCH repetition corresponding to the second beam when there is no TB carried in the PUSCH.
  + The UE assumes that the number of repetitions is 2 regardless of the indicated number of repetitions.
  + 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).

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Support in principle. For the first bullet, we think whether UE can multiplex A-CSI on two repetitions is not only a function of the two repetitions have the same number of symbols, but also whether there are other UCIs to be multiplexed. This is because the number of REs (and hence the polar mother code length) depends on the size of other UCIs. for example, for the case of CSI Part1 rate matching, it is a function of the number of HARQ-Ack bits multiplexed on PUSCH:**    **Hence, ensuring that these conditions (same length, no other UCIs) should be always satisfied is not easy. Instead, we think there should be a fallback behavior that if the necessary conditions are not satisfied, UE can multiplex A-CSI only on one of the repetitions (e.g. fallback to Rel. 15/16 behavior and multiplex the A-CSI on the first actual repetition).** |
| **vivo** | **From our perspective, it’s too early to make an agreement on enhancement of CSI reporting on PUSCH. The following issues shall be thoroughly discussed when enhancing CSI report on PUSCH:**  **Issue 1: Whether to enhance CSI report without data on PUSCH repetition type A or B scheduled by enhanced DCI format which can schedule CSI report on PUSCH towards M-TRP to withstand the blockage.**  **Issue 2: Whether to multiplex HARQ-ACK also on the X-th actual repetition corresponding to the second beam when it is to be multiplexed on the first actual repetition because of time domain resource overlapping as shown in the following figure.**    **Issue 3: Whether to multiplex CSI report on the X-th actual repetition corresponding to the second beam with same number of symbols as the first actual repetition corresponding to the first beam, when the X-th actual repetition corresponding to the second beam is to be used to multiplex HARQ-ACK because of time domain resource overlapping as shown in the following figure；**    **Issue 4: Whether to multiplex CSI report on the first actual repetition corresponding to the first beam and the X-th actual repetition corresponding to the second beam, when both repetition occasions are going to be used to multiplex different HARQ-ACK because of time domain resource overlapping as shown in the following figure；**    **Issue 5: Whether to enhance periodic CSI report and/or HARQ-ACK which are to be multiplexed on PUSCH repetition occasion, when they are carried on PUCCH overlapped with PUSCH repetition type B, and the number of overlapped repetitions corresponding to each TRP is at least one.**    **Before we make a resolution on the above cases, some principles can be discussed at first. For instance, the number of REs for multiplexing CSI report should be same for both repetitions to ensure a unified rate matching so that combination of repetitions can be easily implemented.** |
| **LG** | **We fail to find clear motivation to introduce ACSI repetition without TB, which was not supported in Rel-16.** |
| **Samsung** | **We do not support the first bullet. First of all, the main purpose of this proposal is enhancing reliability of A-CSI reporting by macro-diversity. We just want to increase the chance to multiplex A-CSI report on the repetition corresponding to the second beam. For PUSCH repetition type B, UE can calculate the number of symbols for each actual repetition because slot configuration (TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated,…) and invalid symbol pattern(InvalidSymbolPattern) are configured via RRC configuration. Based on these RRC configuration, UE can find the first actual repetition corresponding to the second beam that contains the same number of symbols as the first actual repetition corresponding to the first beam. By the way, if there is no candidate to multiplex A-CSI report on repetition corresponding to the second beam, UE does not expect to the above operation for multiplexing A-CSI on two PUSCH repetitions.**  **Therefore, we still support X can be 1 or another value.** |
| **OPPO** | **Not support. The proposal is too restricted and it is difficult to ensure the same number of symbols for the two PUSCH repetition. The X-th repetition corresponding to the 2nd beam can be the first one that has sufficient symbols to meet UCI requirement.** |
| **Xiaomi** | **Agree with QC that a fallback operation is preferred when the candidate for the second beam does not exist.** |
| **Apple** | **Support in principle and we suggest we modify the “first actual transmission” into “firat actual transmission that meets the timeline requriement”** |
| **Spreadtrum** | **Support the proposal in principle.** |
| **Nokia** | **We are fine with the proposal** |
| **Huawei, HiSilicon** | **Support the proposal in principle.**  **Agree with QC that a fallback behavior may need to be discussed at least when same length is not satisfied. For the other issues as mentioned by Vivo, we can further discuss after main bullet is agreed.** |
| **CATT** | **We don’t support this proposal. It’s too restrictive to implementation.** |
| **CMCC** | **Not support the proposal.**  **A fallback operation shall be discussed, considering too much restrictions on the A-CSI multiplexing implementation.** |
| **Intel** | **1st bullet- not support. As QC, OPPO has noted above, its quite restrictive for gNB to maintain such equal length condition and this should be further discussed. More importantly, we believe agreeing on a fall back behavior is important (same as QC+HW) so that PUSCH is not lost. Our proposal is for 1st bullet is:**  **For A-CSI multiplexing if X is not found then multiplexing of A-CSI on the second beam is not performed but PUSCH transmission is not affected.**  **2nd bullet – support in principle but we think SP-CSI case restricted to the reception of activating DCI should be included as well.** |
| **Futurewei** | **Support in principle, and can further study the details** |
| **APT** | **In general, we support the first bullet, however, the second bullet may need some further discussion since it seems that two repetitions should be always required when multiplexing A-CSI on PUSCH repetition Type B with no TB. Also, we share the same view with vivo that some other multiplexing issues (e.g., in case of PUCCH overlaps with PUSCH) should be discussed as well.** |
| **TCL** | **For the second bullet, when the sequential mapping pattern is applied, the first and second nominal repetitions have the same beam. However, multiplexing the A-CSI on two PUSCH nominal repetitions with the same beam is not appropriate. Hence, the second bullet can be updated as:**  **For PUSCH repetition Type B, the first nominal corresponding to the first beam and the first nominal repetition corresponding to the second beam are expected to be the same as the first actual repetition of these two nominal repetitions, respectively (no segmentation).** |
| FL Update #1/#2 | Different views and hard to respond to each company.  In summary, Fl agree with the following,   * Optimization on CSI multiplexing on PUSCH should not be the main discussion in this agenda. However, RAN1 agreed to something last time, and at least we should complete the remaining aspects on that. * Defining UE behaviors for the default case can be discussed later if the network is unable to fulfill the scheduling restrictions that are mentioned in the agreement. I have added FFS on that. * X = other values than 1 is not having the majority view. * Cases mentioned by vivo are not the primary discussion here. As mentioned, need to finalize critical aspects, we are already off the track a bit. * A-CSI on PUSCH without TB is not critical as companies object on that. mentioned only as FFS.   Updated proposal is as below.  **[Draft for offline] Proposal 3.5:** For multiplexing A-CSI on two PUSCH repetitions in the case of multi-TRP PUSCH repetition,   * For S-DCI based multi-TRP PUSCH repetition Type B, support multiplexing A-CSI on the first PUSCH repetition corresponding to the first beam and the first (X = 1) PUSCH repetition corresponding to the second beam.   + The UE is expected to follow the above operation for multiplexing A-CSI on two PUSCH repetitions only if     - the first actual repetition corresponding to the first beam and the first actual repetition corresponding to the second beam does not have the same number of symbols, and     - UCIs other than the A-CSI are multiplexed on any of the two PUSCH repetitions.   + When the UE does not follow the above operation, UE multiplexes A-CSI only on the first PUSCH repetition similar to Rel. 15/16. * Note: RAN1 has the assumption on CSI timelines are followed as rel-15/16. * FFS: For s-DCI based multi-TRP PUSCH repetition Type A and B, support multiplexing of A-CSI on the first PUSCH repetition corresponding to the first beam and the first PUSCH repetition corresponding to the second beam when there is no TB carried in the PUSCH.   + The UE assumes that the number of repetitions is 2 regardless of the indicated number of repetitions.   + 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). |

### Proposal 3.6: CG PUSCH

**[Draft for offline] Proposal 3.6:** For type 1 or type 2 CG based multi-TRP PUSCH repetition,

* Introduce the second fields of 'p0-PUSCH-Alpha' and 'powerControlLoopToUse' in 'ConfiguredGrantConfig’, and 'pathlossReferenceIndex' in 'rrc-ConfiguredUplinkGrant'.
* For type 1 CG based m-TRP PUSCH repetition, introduce the second fields of 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers' in 'rrc-ConfiguredUplinkGrant'.
* For type 2 CG based M-TRP PUSCH, two SRIs/TPMIs are indicated via the activating DCI.
* FFS1: UL PT-RS port(s) and DM-RS port(s) for CG type 1
* FFS2: Switching of M-TRP and S-TRP
* FFS3: Details on RV mapping.

Please comment on preferred changes to the proposal.

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| **Company** | **Comments** |
| **QC** | **We have some comments on the proposal:**   1. **'pathlossReferenceIndex' in 'rrc-ConfiguredUplinkGrant' is only needed for Type1 (for Type2, it should be based on SRI in the activating DCI)** 2. **FFS2 is not clear to us. What is the meaning of dynamic switching for CG?** 3. **We feel it is better to discuss the CG details after signaling details of dynamic PUSCH are stable.** |
| **Lenovo&MotM** | **Support.** |
| **vivo** | **We are supportive of the proposal in principle. But there are other issues to be considered. When initial transmission of a TB is occurred in one CG towards a TRP while retransmission is occurred in a PUSCH towards another TRP, power control parameters at least PL-RS of CG configuration is not suitable for retransmission PUSCH anymore, for power control parameters applied for CG retransmission are from CG configuration. Further study on power control of CG retransmission is required for CG enhancement in MTRP scenario. So, we propose to add an FFS:**    **[Draft for offline] Proposal 3.6:** For type 1 or type 2 CG based multi-TRP PUSCH repetition,   * Introduce the second fields of 'p0-PUSCH-Alpha' and 'powerControlLoopToUse' in 'ConfiguredGrantConfig’, and 'pathlossReferenceIndex' in 'rrc-ConfiguredUplinkGrant'. * For type 1 CG based m-TRP PUSCH repetition, introduce the second fields of 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers' in 'rrc-ConfiguredUplinkGrant'. * For type 2 CG based M-TRP PUSCH, two SRIs/TPMIs are indicated via the activating DCI. * FFS1: UL PT-RS port(s) and DM-RS port(s) for CG type 1 * FFS2: Switching of M-TRP and S-TRP * FFS3: Details on RV mapping. * FFS4: power control of CG retransmission. |
| **Fujitsu** | **Support in principle. For FFS2, does it mean the s/m-TRP switch between initial transmission and retransmission, or the TRP switch triggered by activation DCI for Type 2 CG?**  **Also, we share similar view as vivo that power control of CG retransmission should be for further study.** |
| **LG** | **One addition FFS point is TO (transmission occasion) for initial transmission. According to current specification, if RV=0231, initial transmission is possible only in the first TO which may causes high latency. The latency can be reduced if UE can transmit initial TB in one of two first TOs corresponding two Tx beams. So, we propose to capture “FFS: transmission occasion for initial transmission”** |
| **ZTE** | **Support FL’s proposal in principle.**  **On the one hand, sharing the same view with QC that 'rrc-ConfiguredUplinkGrant' can only be valid when fully Type1 CG.**  **On the other hand, other parameter may also should be configured as TRP specific when Type1 CG, e.g., 'dmrs-SeqInitialization' in 'rrc-ConfiguredUplinkGrant'. Such parameters at least can be further studied.**  **In the light of above discussion, we suggest to:**  **[Draft for offline] Proposal 3.6:** For type 1 or type 2 CG based multi-TRP PUSCH repetition,   * Introduce the second fields of 'p0-PUSCH-Alpha' and 'powerControlLoopToUse' in 'ConfiguredGrantConfig’. * For type 1 CG based m-TRP PUSCH repetition, introduce the second fields of 'pathlossReferenceIndex', 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers' in 'rrc-ConfiguredUplinkGrant'. * For type 2 CG based M-TRP PUSCH, two SRIs/TPMIs are indicated via the activating DCI. * FFS1: UL PT-RS port(s) and DM-RS port(s) for CG type 1 * FFS2: Switching of M-TRP and S-TRP * FFS3: Details on RV mapping. * FFS4: Other TRP specific parameters in 'rrc-ConfiguredUplinkGrant', e.g., 'dmrs-SeqInitialization'. |
| **OPPO** | **Support except FFS2. Regarding FFS2, we have similar comment as QC** |
| **Xiaomi** | **Support the proposal in principle.** |
| **Apple** | **Support in principle** |
| **Spreadtrum** | **Support FL’s proposal except the FFS2 in principle. For FFS2, we share the similar view as QC and OPPO.** |
| **Nokia** | **We are fine with the proposal.** |
| **Huawei, HiSilicon** | **We would prefer to finish the DG based PUSCH transmission firstly, and reuse them for CG PUSCH as much as possible.** |
| **CATT** | **Support in principle. We have similar concern on FF2 as QC and OPPO.** |
| **Intel** | **for the first bullet, we think its better to wait until DG agreements on usage of SRI field is agreed. for example, if SRI2 can indicate open-loop parameters, pathloss-RS and closed-loop index we may not need this bullet.** |
| **Futurewei** | **Fine in principle** |
| **APT** | **Support FL’s proposal in principle. We have the similar view as QC, i.e., 'pathlossReferenceIndex' in 'rrc-ConfiguredUplinkGrant' is only needed for Type1.** |
| **TCL** | **Support FL’s proposal in principle.** |
| **FL update #1/#2** | Good discussion and suggestions from companies. Overall. We can wait for DG PUSCH, but there is nothing wrong with progressing on things that are easier to progress.  FFS2 can be removed as proponents discussing that in their contributions did not raise the voice on that. FL is not aware of any need of switching.  ZTE suggestion also seems correct the mismatch had in the initial FL proposal.  In addition, LG Suggestion is added to FFS on RV. Vivo suggestion is not related to single CG PUSCH repetition from FL’s view.  **[Draft for offline] Proposal 3.6:** For type 1 or type 2 CG based multi-TRP PUSCH repetition,   * Introduce the second fields of 'p0-PUSCH-Alpha' and 'powerControlLoopToUse' in 'ConfiguredGrantConfig’ * For type 1 CG based m-TRP PUSCH repetition, introduce the second fields of ‘pathlossReferenceIndex’, 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers' in 'rrc-ConfiguredUplinkGrant'. * For type 2 CG based M-TRP PUSCH, two SRIs/TPMIs are indicated via the activating DCI. * FFS1: UL PT-RS port(s) and DM-RS port(s) for CG type 1 * FFS2: Switching of M-TRP and S-TRP * FFS3: Details on RV mapping including starting RV for each TRP. * FFS4: Other TRP specific parameters in 'rrc-ConfiguredUplinkGrant', e.g., 'dmrs-SeqInitialization'. |
| **ZTE** | **Support FL’s proposal, and agree to remove FFS 2 based on majorities’ view and FL’s assessment.** |

### Proposal 3.7: Second TPMI for CB-PUSCH

**[Draft for offline] Proposal 3.7:** For CB based M-TRP PUSCH repetition, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, , is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first codepoints of the second TPMI field are mapped to TPMIs of rank y associated with the first TPMI field in increasing order codepoint index, the remaining codepoints are reserved.

* FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI and the above method results , increase the bit width to The last reserved entry of the 2nd TPMI may be used for indicating S-TRP operation.

Please comment on preferred changes to the proposal.

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| **Company** | **Comments** |
| **FL** | Example change for the TPMI Table 7.3.1.1.2-2 is as follows,   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | *1st TPMI field* | | 2nd TPMI field | | | | | |  | 1st TPMI indicates  1 layer | 1st TPMI indicates  2 layers | 1st TPMI indicates  3 layers | 1st TPMI indicates  4 layers | | Bit field mapped to index | *codebookSubset* = *fullyAndPartialAndNonCoherent* | Bit field mapped to index | *codebookSubset* = *fullyAndPartialAndNonCoherent* | | | | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 2 layers: TPMI=0 | 3 layers: TPMI=0 | 4 layers: TPMI=0 | | 1 | 1 layer: TPMI=1 | 1 | 1 layer: TPMI=1 | 2 layers: TPMI=1 | 3 layers: TPMI=1 | 4 layers: TPMI=1 | | … | … | .. | … | .. | .. | .. | | 3 | 1 layer: TPMI=3 | 3 | 1 layer: TPMI=3 | 2 layers: TPMI=3 | 3 layers: TPMI=3 | 4 layers: TPMI=3 | | 4 | 2 layers: TPMI=0 | 4 | 1 layer: TPMI=4 | 2 layers: TPMI=4 | 3 layers: TPMI=4 | 4 layers: TPMI=4 | | 5 | 2 layers: TPMI=1 | 5 | 1 layer: TPMI=5 | 2 layers: TPMI=5 | 3 layers: TPMI=5 | reserved | | 6 | 2 layers: TPMI=2 | 6 | 1 layer: TPMI=6 | 2 layers: TPMI=6 | 3 layers: TPMI=6 | reserved | | … | … | .. | … | … | reserved | reserved | | 9 | 2 layers: TPMI=5 | 9 | 1 layer: TPMI=9 | 2 layers: TPMI=9 | reserved | reserved | | 10 | 3 layers: TPMI=0 | 10 | 1 layer: TPMI=10 | 2 layers: TPMI=10 | reserved | reserved | | 11 | 4 layers: TPMI=0 | 11 | 1 layer: TPMI=11 | 2 layers: TPMI=11 | reserved | reserved | | 12 | 1 layer: TPMI=4 | 12 | 1 layer: TPMI=12 | 2 layers: TPMI=12 | reserved | reserved | | … | … | .. | .. | … | reserved | reserved | | 19 | 1 layer: TPMI=11 | 19 | 1 layer: TPMI=19 | 2 layers: TPMI=19 | reserved | reserved | | 20 | 2 layers: TPMI=6 | 20 | 1 layer: TPMI=20 | 2 layers: TPMI=20 | reserved | reserved | | 21 | 2 layers: TPMI=7 | 21 | 1 layer: TPMI=21 | 2 layers: TPMI=21 | reserved | reserved | | … | … | .. | … | reserved | reserved | reserved | | 27 | 2 layers: TPMI=13 | 27 | 1 layer: TPMI=27 | reserved | reserved | reserved | | 28 | 3 layers: TPMI=1 | 28 | reserved | reserved | reserved | reserved | | 29 | 3 layers: TPMI=2 | 29 | reserved | reserved | reserved | reserved | | 30 | 4 layers: TPMI=1 | 30 | reserved | reserved | reserved | reserved | | 31 | 4 layers: TPMI=2 | 31 | reserved | reserved | reserved | reserved | | 32 | 1 layers: TPMI=12 |  |  |  |  |  | | … | … |  |  |  |  |  | | 47 | 1 layers: TPMI=27 |  |  |  |  |  | | 48 | 2 layers: TPMI=14 |  |  |  |  |  | | … | … |  |  |  |  |  | | 55 | 2 layers: TPMI=21 |  |  |  |  |  | | 56 | 3 layers: TPMI=3 |  |  |  |  |  | | … | … |  |  |  |  |  | | 59 | 3 layers: TPMI=6 |  |  |  |  |  | | 60 | 4 layers: TPMI=3 |  |  |  |  |  | | 61 | 4 layers: TPMI=4 |  |  |  |  |  | | 62-63 | reserved |  |  |  |  |  | |
| **QC** | **We think a simpler approach (instead of having a formula as well as 9x3 new tables) is to have only two tables: One for 2 PUSCH ports and another table for 4 PUSCH ports that covers all cases:**  **Second TPMI field for 2 antenna ports.**   |  |  |  |  | | --- | --- | --- | --- | |  | **1 layer** | **2 layers** | **# of bits** | | Coherent | Codepoints 0-5 mapped to TPMI indices 0-5 | Codepoints 0-2 mapped to TPMI indices 0-2 | 3 | | Non-coherent, not configured with fullpowerMode1 | Codepoints 0-1 mapped to TPMI indices 0-1 | Codepoint 0 mapped to TPMI index 0 | 1 | | Non-coherent, configured with fullpowerMode1 | Codepoints 0-2 mapped to TPMI indices 0-2 | Codepoint 0 mapped to TPMI index 0 | 2 |   **Second TPMI field for 4 antenna ports.**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | **1 layer** | **2 layers** | **3 layers** | **4 layers** | **# of bits** | | Coherent | Codepoints 0-27 mapped to TPMI indices 0-27 | Codepoints 0-21 mapped to TPMI indices 0-21 | Codepoints 0-6 mapped to TPMI indices 0-6 | Codepoints 0-4 mapped to TPMI indices 0-4 | 5 | | Partial-coherent, not configured with fullpowerMode1 | Codepoints 0-11 mapped to TPMI indices 0-11 | Codepoints 0-13 mapped to TPMI indices 0-13 | Codepoints 0-2 mapped to TPMI indices 0-2 | Codepoints 0-2 mapped to TPMI indices 0-2 | 4 | | Partial-coherent, configured with fullpowerMode1 | Codepoints 0-15 mapped to TPMI indices 0-15 | Codepoints 0-13 mapped to TPMI indices 0-13 | Codepoints 0-2 mapped to TPMI indices 0-2 | Codepoints 0-2 mapped to TPMI indices 0-2 | 4 | | Non-coherent, not configured with fullpowerMode1 | Codepoints 0-3 mapped to TPMI indices 0-3 | Codepoints 0-5 mapped to TPMI indices 0-5 | Codepoint 0 mapped to TPMI index 0 | Codepoint 0 mapped to TPMI index 0 | 2 (maxRank=1)  3 (maxRank>1) | | Non-coherent, configured with fullpowerMode1 | Codepoints 0-4 mapped to TPMI indices 0-3 and 13 | Codepoints 0-6 mapped to TPMI indices 0-6 | Codepoints 0-1 mapped to TPMI indices 0-1 | Codepoint 0 mapped to TPMI index 0 | 3 | |
| **vivo** | **We see the use case of a single shared TPMI field. So this proposal is only applied to the case of two TPMI fields. Our updates on this proposal is as follows:**  **[Draft for offline] Proposal 3.7:** For CB based M-TRP PUSCH repetition, when two TPMI fields are used, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, , is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first codepoints of the second TPMI field are mapped to TPMIs of rank y associated with the first TPMI field in increasing order codepoint index, the remaining codepoints are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI and the above method results , increase the bit width to The last reserved entry of the 2nd TPMI may be used for indicating S-TRP operation. * FFS: whether the second TPMI field can be absent. |
| **LG** | **We support the approach to determine but we have different view on dynamic switching. We prefer to introduce common signaling for dynamic switching for both CB and nonCB PUSCH, by using SRI field.** |
| **Samsung** | **We can support FL’s proposal. We should make an agreement for this proposal first. And then, we can move on the discussion for the dynamic switching of CB based PUSCH repetition, based on the design for the second TPMI field.** |
| **ZTE** | **Support FL’s proposal in principle, and one update of FFS should be revised as follows.**  **[Draft for offline] Proposal 3.7:** For CB based M-TRP PUSCH repetition, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, , is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first codepoints of the second TPMI field are mapped to TPMIs of rank y associated with the first TPMI field in increasing order codepoint index, the remaining codepoints are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI and the above method results , increase the bit width to The last one or two reserved entries of the 2nd TPMI may be used for indicating S-TRP operation.   **Besides, FL’s example changes for TPMI table looks better and clearer from our perspective.** |
| **OPPO** | **Support FL’s proposal in principle** |
| **MediaTek** | **Support.** |
| **Xiaomi** | **More preferred with QC ’s tables with less spec redundancy.** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **We are fine with the proposal in principle.**  **However, it would be good to first conclude whether to support dynamic switching of TRPs order, as this may impact the SRI/TPMI fields. Overall, such switching provides dynamic control for the network on whether the multi-TRP PUSCH repetitions should start with a repetition(s) towards the first TRP or the second TRP.**  **On the dynamic switching between single TRP and multi-TRP, we have a slight preference towards designing a unified solution for both codebook-based and non-codebook-based modes.** |
| **Huawei, HiSilicon** | **We support FL’s proposal.** |
| **CATT** | Support FL’s proposal in principle. In our opinion, “If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI and the above method results , increase the bit width to ” is unnecessary since the accurate value of is not provided (“, is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field”). The proposal can be updated as follows:  **[Draft for offline] Proposal 3.7:** For CB based M-TRP PUSCH repetition, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, , is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first codepoints of the second TPMI field are mapped to TPMIs of rank y associated with the first TPMI field in increasing order codepoint index, the remaining codepoints are reserved.   * FFS: ~~If dynamic switching of S-TRP/M-TRP supported with 2~~~~nd~~ ~~TPMI and the above method results , increase the bit width to~~ The last reserved entry of the 2nd TPMI may be used for indicating S-TRP operation. |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Do not support. Achieving dynamic switching is the key requirement, further bit savings is an optimization. With this proposal we are introducing 5 additional tables to the specification + new UE behavior while the bit savings is 1 bit for some cases. If the FFS sub-bullet is agreed (for dynamic switching), then we need to re-check whether any bit savings is achieved by this optimization.** |
| **Futurewei** | **Support the proposal in principle.**  **If a rank y has only one TPMI value, i.e., Ky = 1, then no codepoint is needed, and the reserved codepoints can be increased by 1. This should be captured in the proposal.**  **We also think describing how the 2nd field is design is sufficient in the spec, and there is no need to use any table --- there are already so many tables. This also addresses Intel’s concern.** |
| **APT** | **Support FL’s proposal in principle. However, we need to decide whether to use the second TPMI field for dynamic switching between multi-TRP and single-TRP operation first so that we can decide whether to enhance the TPMI table or not.** |
| **TCL** | **Support the proposal.** |
| **FL update #1** | QC >> suggested tables by you indeed one way to capture this in specs. Anyways, I see that your suggestion is inline with the proposal. I was still using wording instead of table as some companies want to extent 2nd TPMI (FFS in the FL proposal)  Vivo >> using same TPMI for multi-TRP UL can be discussed separately. But the open point here is design of 2nd TPMI.  ZTE >> your suggestion is captured in the updated version.  Nokia >> switching is also included in the proposal as FFS. Should be fine.  CATT >> I do not think your correction is accurate than the version I had. The idea is to have TPMI agreed without binding with switching. Switching part captured in FFS and some times it require one bit more.  Intel >> Bit confused with your comment. M2 determined based on TPMI entries (in the main text of the proposal). Switching part is FFS. Not sure the exact concern you have as this is the minimum we do even without switching supported. Please clarify further.  FW>> ky = 1 is already within the description we had. Anyways added ‘s’ in brackets.  All >> there is good support for the proposal. No big changes.  **[Draft for offline] Proposal 3.7:** For CB based M-TRP PUSCH repetition, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, , is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first codepoint(s) of the second TPMI field are mapped to TPMI(s) of rank y associated with the first TPMI field in increasing order codepoint index, the remaining codepoint(s) are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI and the above method results , increase the bit width to The last one or two reserved entries of the 2nd TPMI may be used for indicating S-TRP operation. * How to describe this in 38.212 is up to the editor.   QC, DCM, Intel >> please recheck and accept the majority supported direction. |
| **ZTE** | **Support FL’s proposal.** |

### Proposal 3.8: Second SRI field for NCB-PUSCH

**[Draft for offline] Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, , for the second SRI field is determined by the maximum number of codepoints per rank among all ranks associated with the first SRI field. For each rank x, the first codepoints are mapped to SRIs of rank x associated with the first SRS field, the remaining codepoints are reserved.

* FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd SRI and above method results , increase the bit width to The last reserved entry of the 2nd SRI may be used for indicating S-TRP operation.

Please comment on preferred changes to the proposal.

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| **Company** | **Comments** |
| **FL** | Example change for Table 7.3.1.1.2-31 is as follows,   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1st SRI field | | 2nd SRI field | | | | | | | | | 1st SRI field indicates 1 port or SRI | | 1st SRI field indicates 2 ports or SRIs | | 1st SRI field indicates 3 ports or SRIs | | 1st SRI field indicates 4 ports or SRIs | | | Bit field mapped to index | SRI(s), | Bit field mapped to index | SRI(s), | Bit field mapped to index | SRI(s), | Bit field mapped to index | SRI(s), | Bit field mapped to index | SRI(s), | | 0 | 0 | 0 | 0 | 0 | 0,1 | 0 | 0,1,2 | 0 | 0,1,2,3 | | 1 | 1 | 1 | 1 | 1 | 0,2 | 1 | 0,1,3 | 1 | reserved | | 2 | 2 | 2 | 2 | 2 | 0,3 | 2 | 0,2,3 | 2 | reserved | | 3 | 3 | 3 | 3 | 3 | 1,2 | 3 | 1,2,3 | 3 | reserved | | 4 | 0,1 | 4 | reserved | 4 | 1,3 | 4 | reserved | 4 | reserved | | 5 | 0,2 | 5 | reserved | 5 | 2,3 | 5 | reserved | 5 | reserved | | 6 | 0,3 | 6 | reserved | 6 | reserved | 6 | reserved | 6 | reserved | | 7 | 1,2 | 7 | reserved | 7 | reserved | 7 | reserved | 7 | reserved | | 8 | 1,3 |  |  |  |  |  |  |  |  | | 9 | 2,3 |  |  |  |  |  |  |  |  | | 10 | 0,1,2 |  |  |  |  |  |  |  |  | | 11 | 0,1,3 |  |  |  |  |  |  |  |  | | 12 | 0,2,3 |  |  |  |  |  |  |  |  | | 13 | 1,2,3 |  |  |  |  |  |  |  |  | | 14 | 0,1,2,3 |  |  |  |  |  |  |  |  | | 15 | reserved |  |  |  |  |  |  |  |  | |
| **QC** | **Do not support the proposal. This depends on if SRI fields indicate dynamic switching between sTRP and mTRP (next proposal).** |
| **vivo** | **Support in principle except the FFS.** |
| **LG** | **Support in principle. For non-CB PUSCH, codepoint in 2nd SRI field can be used to indicate MTRP/STRP switching but codepoint in 1st SRI field cannot be used since rank is indicated only from 1st SRI field. Therefore, two codepoints in 2nd SRI field should be used to indicate STRP 1 and STRP 2 transmission, respectively. If STRP 2 transmission is indicated 1st SRI field should be used to indicate SRS resource in SRS set 1 instead of set 0. We suggest to revise the proposal as follows:**  **[Draft for offline] Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, , for the second SRI field is determined by the maximum number of codepoints per rank among all ranks associated with the first SRI field. For each rank x, the first codepoints are mapped to SRIs of rank x associated with the first SRS field, the remaining codepoints are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd SRI and above method results , increase the bit width to The last two reserved entry of the 2nd SRI may be used for indicating S-TRP operation. |
| **Samsung** | **We can also support FL’s proposal. We should make an agreement for this proposal first. And then, we can move on the discussion for the dynamic switching of NCB based PUSCH repetition, based on the design for the second SRI field.** |
| **NTT Docomo** | **Do not support. Share similar view as QC that this depends on whether the 1st SRI field is used to indicate dynamic switching.** |
| **ZTE** | **Support FL’s proposal in principle, and one update of FFS should be revised as follows.**  **[Draft for offline] Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, , for the second SRI field is determined by the maximum number of codepoints per rank among all ranks associated with the first SRI field. For each rank x, the first codepoints are mapped to SRIs of rank x associated with the first SRS field, the remaining codepoints are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd SRI and above method results , increase the bit width to The last one or two reserved entries of the 2nd SRI may be used for indicating S-TRP operation.   **Likewise, FL’s example changes for SRI table looks better and clearer from our perspective.** |
| **OPPO** | **Support the main bullet.**  **Do not support the indication of S-TRP with 2nd SRI field.** |
| **MediaTek** | **Support.** |
| **Xiaomi** | **in our view, this discussion still relates to the dynamic switching, and the following summary is not accurate enough:**  **Alt.2: Design 2nd SRI (non-CB) and 2nd TPMI (CB) (with reusing reserved entries in SRI/TPMI field(s)) –** ZTE, Intel (CB ?), SS, DCM, CATT, Nokia, Xiaomi, APT, Covinda, NEC  **We support the following design as our second preference( a dedicated DCI field is our first priority),**  **Alt.3: Design 2nd SRI (CB and non-CB) (with reusing reserved entries in SRI fields)-**  **Xiaomi,…** |
| **NEC** | **Support the proposal.** |
| **Convida Wireless** | **Support the proposal.** |
| **Nokia** | **We are fine with the proposal in principle.**  **However, it would be good to first conclude whether to support dynamic switching TRPs order, as this may impact the SRI field(s). Overall, such switching provides dynamic control for the network on whether the multi-TRP PUSCH repetitions should start with a repetition(s) towards the first TRP or the second TRP.**  **On the dynamic switching between single TRP and multi-TRP, we have a slight preference towards designing a unified solution for both codebook-based and non-codebook-based modes.** |
| **Huawei, HiSilicon** | **Support the FL proposal in principle. We think that the same principle should be applied for CB and NCB. Dynamic switching issue can be separately discussed in proposal 3.9.** |
| **CATT** | **Support FL’s proposal in principle. In our opinion, “If dynamic switching of S-TRP/M-TRP supported with 2nd SRI and above method results , increase the bit width to ” is unnecessary since the accurate value of is not provided (“The number of bits, , for the second SRI field is determined by the maximum number of codepoints per rank among all ranks associated with the first SRI field.”). The proposal can be updated as follows:**  **[Draft for offline] Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, , for the second SRI field is determined by the maximum number of codepoints per rank among all ranks associated with the first SRI field. For each rank x, the first codepoints are mapped to SRIs of rank x associated with the first SRS field, the remaining codepoints are reserved.   * FFS: ~~If dynamic switching of S-TRP/M-TRP supported with 2~~~~nd~~ ~~SRI and above method results , increase the bit width to~~ The last reserved entry of the 2nd SRI may be used for indicating S-TRP operation. |
| **CMCC** | **Support the proposal.** |
| **Intel** | **Same view as QC and DOCOMO that this proposal depends on how dynamic switching between sTRP and mTRP is done. We also believe that enabling dynamic switching is the key feature and further optimization beyond that should be introduced based on savings of bits vs specification impact.** |
| **Futurewei** | **Support the proposal in principle.**  **If a rank x has only one SRI value, i.e., Kx = 1, then no codepoint is needed, and the reserved codepoints can be increased by 1. This should be captured in the proposal.**  **We also think describing how the 2nd field is design is sufficient in the spec, and there is no need to use any table.** |
| **APT** | **Support in principle. However, we have the similar view as we comment in proposal 3.7. We need to determine using which field (e.g., the second SRI field, the second TPMI field or both the second SRI and TPMI field) for dynamic switching between multi-TRP and single-TRP operation first.** |
| **TCL** | **Support the proposal.** |
| **FL update #1/2** | QC, DCM >> SRI field (2nd field reserved entries + 1st field reserved entries (if needed)) can be still used for dynamic switching with the proposal above. But that part is FFS.  Vivo, Oppo >> FFS is coming from majority of companies. You could object if we agree to support it.  LG, ZTE >> added the suggested text.  Xiaomi >> Sorry if I missed your views from the contribution check.  CATT >> I do not think your comment is accurate. Same with TPMI comment.  Intel >> This proposal’s FFS is the only thing that relate to dynamic switching. That is FFS and nothing wrong with the main bullet.  FW >> correcting ‘s’in the update below.  **[Draft for offline] Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, , for the second SRI field is determined by the maximum number of codepoint(s) per rank among all ranks associated with the first SRI field. For each rank x, the first codepoint(s) are mapped to SRIs of rank x associated with the first SRS field, the remaining codepoint(s) are reserved.   * FFS: If dynamic switching of S-TRP/M-TRP supported with 2nd SRI and above method results , increase the bit width to The last one or two reserved entries of the 2nd SRI may be used for indicating S-TRP operation.   QC, DCM, Intel >> please recheck and accept the majority supported direction. |
| **ZTE** | **Support FL’s proposal.** |

### Proposal 3.9: Dynamic switching of S-TRP and M-TRP

**[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,

* Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation
* Alt.2: Use 2nd SRI (for non-CB) and 2nd TPMI (for CB) design by using a reserved entry of the 2nd SRI or 2nd TPMI to indicate S-TRP operation.
* Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation.

Please comment on preferred changes to the proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **QC** | **Do not support. We think the option of always having a codepoint in each SRI field is more attractive not only in terms of less spec impact, but also it addresses the issue of Proposal 3.2-5 (power control when a SRS resource set has only one SRS resource).**  **Also, there may have been a misunderstanding on the following agreement:**  **Agreement**  For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRI field(s) corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework,   **The highlighted part does not mean that the option of adding a reserved codepoint to SRI is excluded. The above only means that the first SRI indicates both number of SRS resources (# of layers) as well as the SRS resources similar to Rel. 15 (as opposed to the second SRI, which could be optimized, i.e., not indicating number of layers). We even remember that this question was asked online last time and was clarified that the highlighted part does not exclude using the first/second SRI fields for dynamic switching.**  **Hence, this option should be also listed as an alternative. Based on contributions, it seems that this option still has a good amount of support.** |
| **vivo** | **Our preference is Alt.1.**  **Regarding Alt.2, at least two reserved entries are required in the second SRI or TPMI table to indicate two STRP cases: TRP1, or TRP2 for STRP transmission. However, there is no reserved entry in SRI fields for most of cases in CB-based PUSCH transmission. Considering TPMI field(s), the following table lists the cases without enough reserved entries in the second TPMI table to indicate dynamic switching between STRP and MTRP. For these cases, 1 additional bit have to be applied to the second TPMI field to extend the entries of the second TPMI table. Moreover, TPMI field may be absent in single antenna port scenarios at all.**   |  |  | | --- | --- | | 1 | maxRank=2; 4 ports; codebookSubset = partialAndNonCoherent; ul-FullPowerTransmission-r16 = fullpowerMode1  (Table 7.3.1.1.2-2A in TS38.212) | | 2 | maxRank=2; 4 ports; codebookSubset = nonCoherent; ul-FullPowerTransmission-r16 = fullpowerMode1  (Table 7.3.1.1.2-2A) | | 3 | maxRank = 3 or 4; 4 ports; codebookSubset = partialAndNonCoherent; ul-FullPowerTransmission-r16 = fullpowerMode1 (Table 7.3.1.1.2-2B) | | 4 | maxRank = 3 or 4; 4 ports; codebookSubset = nonCoherent; ul-FullPowerTransmission-r16 = fullpowerMode1 (Table 7.3.1.1.2-2B) | | 5 | maxRank=1; 4 ports; codebookSubset= noncoherent (Table 7.3.1.1.2-3) | | 6 | maxRank=1; 4 ports; codebookSubset=partialAndnoncoherent; ul-FullPowerTransmission-r16 = fullpowerMode1 (Table 7.3.1.1.2-3A) | | 7 | maxRank = 2; 2 ports; codebookSubset = noncoherent (Table 7.3.1.1.2-4) | | 8 | maxRank = 2; 2 ports; codebookSubset = noncoherent; ul-FullPowerTransmission-r16 = fullpowerMode1 (Table 7.3.1.1.2-4A) | | 9 | maxRank = 1; 2 ports; codebookSubset = noncoherent (Table 7.3.1.1.2-5) | | 10 | maxRank = 1; 2 ports; codebookSubset = noncoherent; ul-FullPowerTransmission-r16 = fullpowerMode1 (Table 7.3.1.1.2-5A) |   **Almost all cases don’t have enough reserved entries if the reserved entries in the second SRI field are intended to indicate dynamic switching between MTRP and STRP, as shown in Table 3 highlighted in yellow. One additional bit may also be required in the second SRI field for such cases. Moreover, the second SRI field may be absent if there is only one SRS resource in the corresponding SRS resource set. In this case, two bits are required to indicate the cases: TRP1, TRP2, TRP1 and TRP2.**    **Therefore, Alt.2 seems not a clean design for following reasons:**   * **For NCB-based PUSCH transmission, dynamic switching sometimes uses the second SRI table only containing the layer-specific SRI entries, sometimes uses another second SRI table with additional reserved entries.** * **For CB-based PUSCH transmission, dynamic switching sometimes uses the second TPMI table only containing the layer-specific TPMI entries, while in other occasions uses another second TPMI table with additional reserved entries.**   **A good signaling design should avoid mixing different cases to support dynamic switching indication, otherwise it will be complicated to specify the TPMI tables for all cases.**  **Based on above analysis, our preference is Alt.1 and Alt.3 which are unified and clear design to support dynamic switching between STRP and MTRP.**  **In addition, we see the need to support dynamic switch the order of targeting TRPs.**  **[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,   * Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation * Alt.2: Use 2nd SRI (for non-CB) and 2nd TPMI (for CB) design by using a reserved entry of the 2nd SRI or 2nd TPMI to indicate S-TRP operation. * Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation. * FFS: how to indicate the applying order of TRPs to PUSCH repetitions if dynamic switching the order of targeting TRPs is supported. |
| **LG** | **For nonCB PUSCH case, two codepoints in 2nd SRI field is needed as we explained in Proposal 3.8.**  **For CB PUSCH case, we prefer to introduce common signaling as nonCB PUSCH, instead of using TPMI field. One codepoint in each SRI field can be used for dynamic switching.**  **We propose to revise Alt 2 as follows:**  **[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,   * Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation * Alt.2: ~~Use 2~~~~nd~~ ~~SRI (for non-CB) and 2~~~~nd~~ ~~TPMI (for CB) design by using a reserved entry of the 2~~~~nd~~ ~~SRI or 2~~~~nd~~ ~~TPMI to indicate S-TRP operation.~~ Use two codepoints in 2nd SRI field to indicate S-TRP operation for non-CB PUSCH and a codepoint in each SRI field to indicate S-TRP operation for CB PUSCH. * Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation. |
| **Samsung** | **After making agreements on the proposal 3.7 (the second TPMI field design) and 3.8 (the second SRI field design), the detail method for dynamic switching can be discussed. Based on the FL’s proposal 3.7 and proposal 3.8, we can support Alt. 2 for dynamic switching.** |
| **NTT Docomo** | **Do not support.**  **Agree with QC that “first SRI field based on Rel-15/16 framework” does not mean adding new entry in 1st SRI field is excluded. We also remember that there is clarification on this point in last meeting.**  **Using two SRI fields provides a clear and unified signaling design and has less overhead compared to alt.1 in some cases where there is reserved codepoint.**  **We suggest adding the option of using two SRI fields.**   * **Alt.4. Use two SRI field (for CB and NCB) by using a codepoint of the 1st SRI field and the 2nd SRI field to indicate S-TRP operation.** |
| **ZTE** | **Support FL’s proposal in principle and Alt. 2.**  **Considering that the FFS in both of Proposal 3.7 and Proposal 3.8 described as that “**If dynamic switching of S-TRP/M-TRP supported with 2nd TPMI (SRI)..., increase the bit width to *M2* (*N2*) + 1...**”, we suggest to update Alt. 2 as following:**  **[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,   * Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation * Alt.2: Use 2nd SRI (for non-CB) and 2nd TPMI (for CB) design by using one or two reserved entries of the 2nd SRI or 2nd TPMI to indicate S-TRP operation. * Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation. |
| **OPPO** | **We prefer Alt.1** |
| **MediaTek** | **Support Alt. 2.** |
| **Xiaomi** | **Support alt.1 as a simple and unified solution, hence, SRI field do not need to extend for multiple cases and this indication field can also be used for when SRI field does not exist, and for TPC also. Furthermore, TRP reordering is also easily supported.** |
| **Apple** | **Support Alt3** |
| **Spreadtrum** | **We prefer Alt.1 for a unified design.** |
| **NEC** | **Support Alt 2.** |
| **Convida Wireless** | **Support the FL proposal and prefer Alt 2.** |
| **Nokia** | **We have a slight preference towards designing a unified solution for both codebook-based and non-codebook-based modes.**  **We are fine to downselect among Alt.1, Alt.2, and the alternative added by LG.**  **If for the majority of cases additional entries/bits(s) would be required to enable the switching operation(s) using the SRI and/or TMPI based approaches, then probably Alt.1 would be the simplest approach.** |
| **Huawei, HiSilicon** | **We prefer Alt 2.**  **For CB, we prefer to use one reserved state of 2nd TPMI to indicate single-TRP operation and reuse one of the SRI field to indicate the selected TRP (SRS resource set). Compared to the solution by using two reserved states, the cases with only one reserved state (such as Table 7.3.1.1.2-2A, Table 7.3.1.1.2-2B, Table 7.3.1.1.2-4A, Table 7.3.1.1.2-5A with *codebookSubset= nonCoherent*) can also be supported.**  **For NCB, we prefer to use one reserved state of 2nd SRI to indicate single-TRP operation and reuse one of the TPC field to indicate the selected TRP (SRS resource set). Compared to the solution by using two reserved states, the cases with only one reserved state (such as when Nsrs = 3) can also be supported. For the case without reserved state, one bit is added.** |
| **CATT** | **Support the proposal in principle. For Alt 2, if there is only one SRS resource in a SRS resource set (for NCB) or the number of antenna port for the PUSCH indicated by SRI is one (for CB), a 2bits 2nd SRI field (for NCB) or a 2bits 2nd TPMI field (for CB) would be present, and the states of the fields can’t be seen as reserved entries. We suggest to update the proposal as follows:**  **[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,   * Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation * Alt.2: Use 2nd SRI (for non-CB) and 2nd TPMI (for CB) design by using ~~a reserved entry~~ one or multiple entries of the 2nd SRI or 2nd TPMI to indicate S-TRP operation. * Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation. |
| **Fraunhofer IIS/HHI** | **Prefer Alt. 1** |
| **CMCC** | **Prefer Alt 2.** |
| **Intel** | **Do not support, same view as QC and DOCOMO that “first SRI field based on Rel-15/16 framework” does not mean adding new entry in 1st SRI field is excluded.**  **If we only use 1 code-point in the 2nd SRI field for dynamic switching, then we cannot indicate all 3 options (TRP1, TRP2, TRP1+TRP2). For both CB/NCB case, we prefer to use a reserved codepoint in each SRI field for s-TRP/m-TRP switching. In some cases, a reserved codepoint can be added in case it does not exist in the current specifications.**  **We support DOCOMO proposal to add**  **Alt.4. Use two SRI field (for CB and NCB) by using a codepoint of the 1st SRI field and the 2nd SRI field to indicate S-TRP operation.** |
| **Futurewei** | **Open for further discussion** |
| **APT** | **Support in principle. Besides, Alt. 2 is our preference.** |
| **TCL** | **Support FL’s proposal and Alt.1 is preferable.** |
| **FL Update #1/#2** | QC, DCM, Intel >> please see the following agreements. Details of SRIs are FFS only in the second SRI field of NCB SRI tables. Changes to the tables are only expected on those to indicate SRI. That was the long discussion had in last meeting. If the switching is done based on reserved entries of both SRIs (in CB) or first SRI reserved entries and second SRI design (in NCB), that should be ok.  As analyzed by many companies, SRI reserved entries in CB case is not always available and change of tables is needed. The idea is not to change the table entries or tables. That was the intension of “based on Rel-15/16” if you check back the two weeklong discussion in last meeting.  **Agreement**  For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRI fields corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework * Support dynamic switching between multi-TRP and single-TRP operation * FFS: Support dynamic switching the order of two TRPs   **Agreement**  For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRI field(s) corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework,   + Support the same number of layers applied over repetitions   + FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + FFS: whether/how to use SRI field(s) and additional details of SRI field(s) interpretations   **..**  DCM >> I added Alt.4 you listed but only for NCB case as it is not always feasible for CB.  Vivo >> Ordering of TRPs are not supported by majority. We can discuss such a need later.  **[Draft for offline] Proposal 3.9:** Support one of the following to indicate STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,   * Alt.1: Introduce a new field in DCI to indicate the S-TRP or M-TRP operation * Alt.2: Use 2nd SRI (for non-CB) and 2nd TPMI (for CB) design by using one or more reserved entries of the 2nd SRI or 2nd TPMI to indicate S-TRP operation. * Alt.3: Utilize the TDRA field to indicate the S-TRP or M-TRP operation. * Alt.4: Use two SRI fields (for CB and non-CB) by using a codepoint of the 1st SRI field and the 2nd SRI field indicate S-TRP operation when there are reserved entries of SRI fields.   **Company support is as below**   * Alt.1 – vivo, Oppo, Xiaomi, Spreadtrum, Nokia, HHI, TCL * Alt.2 – LG, SS, ZTE, Mtek, NEC, Covinda, Nokia, HW, CATT, CMCC, APT * Alt.3 – Apple, * Alt. 4- QC, DCM, Intel   Based on company positions, FL suggest taking Alt.2 as way forward. |
| **ZTE** | **Support FL’s assessment that take Alt. 2 as way forward.** |

## 3.3 Additional high priority proposals

In this FL summary, we have not included any FL proposals based on certain other directions suggested by one or two companies. Such proposals are not considered if that is not critical for the basic design framework or can be discussed in a later stage once the basic framework is agreed. If companies wish to bring any additional aspects related to PUSCH during RAN1 #104-bis-e, please comment below.

|  |  |
| --- | --- |
| Company | Comments |
| ZTE | Regarding PHR report related enhancements for MTRP PUSCH scheme, whether the higher layer parameters of PHR trigger events (e.g., 'phr-PeriodicTimer', 'phr-ProhibitTimer', 'phr-Tx-PowerFactorChange') can be configured as TRP specific should be studied. |
| Futurewei | All UL aspects, including separate PC, separate BM, two precoding, etc., have been covered, but no discussion of UL TA, a critical aspect for UL. We have shown in our tdoc that without proper TA, UL transmissions will fail. This has to be studied and discussed. |
| APT | In last meeting, there was an agreement regarding the need of enhancements on beam mapping in case of PUCCH/PUSCH dropping due to invalid UL symbols, and hance the definition of invalid UL symbols should be specified at first. For PUSCH repetition Type B, the symbols indicated by invalid symbol pattern should be considered as invalid UL symbol, and invalid symbol pattern configured per BWP leads to unnecessary dropping of PUSCH transmission. Therefore, whether to configure invalid symbol pattern per TRP should be further studied. |
| FL update #1/2 | Will come back to this once the details listed in FL summary are finalized |

# Reference

|  |  |  |
| --- | --- | --- |
| [R1-2102334](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102334.zip" \t "_parent) | Enhancements on multi-TRP for reliability and robustness in Rel-17 | Huawei, HiSilicon |
| [R1-2102379](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102379.zip" \t "_parent) | Enhancements on Multi-TRP based enhancement for PDCCH, PUCCH and PUSCH | OPPO |
| [R1-2102433](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102433.zip" \t "_parent) | Views on PDCCH, PUCCH, and PUSCH Enhancements for M-TRP | InterDigital, Inc. |
| [R1-2102442](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102442.zip" \t "_parent) | Discussion on enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Spreadtrum Communications |
| [R1-2102507](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102507.zip" \t "_parent) | Further discussion on Multi-TRP for PDCCH, PUCCH and PUSCH enhancements | vivo |
| [R1-2102568](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102568.zip" \t "_parent) | Enhancements on Multi-TRP for PUSCH | CAICT |
| [R1-2102599](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102599.zip" \t "_parent) | Discussion on multi-TRP/panel for PDCCH, PUCCH and PUSCH | CATT |
| [R1-2102661](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102661.zip" \t "_parent) | Multi-TRP enhancements for PDCCH, PUCCH and PUSCH | ZTE |
| [R1-2102676](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102676.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUSCH and PUCCH | MediaTek Inc. |
| [R1-2102713](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102713.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH PUCCH and PUSCH | Fujitsu |
| [R1-2102726](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102726.zip" \t "_parent) | Discussion on enhancements on multi-TRP for uplink channels | Asia Pacific Telecom, FGI |
| [R1-2102761](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102761.zip" \t "_parent) | Multi-TRP/panel for non-PDSCH | FUTUREWEI |
| [R1-2102807](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102807.zip" \t "_parent) | On multi-TRP enhancements for PDCCH and PUSCH | Fraunhofer IIS, Fraunhofer HHI |
| [R1-2102839](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102839.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Lenovo, Motorola Mobility |
| [R1-2102878](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102878.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | CMCC |
| [R1-2102960](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2102960.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Xiaomi |
| [R1-2103015](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103015.zip" \t "_parent) | Multi-TRP enhancements for PDCCH, PUCCH and PUSCH | Intel Corporation |
| [R1-2103089](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103089.zip" \t "_parent) | Views on Rel-17 multi-TRP reliability enhancement | Apple |
| [R1-2103151](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103151.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Qualcomm Incorporated |
| [R1-2103222](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103222.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Samsung |
| [R1-2103288](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103288.zip" \t "_parent) | Considerations on Multi-TRP for PDCCH, PUCCH, PUSCH | Sony |
| [R1-2103366](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103366.zip" \t "_parent) | Enhancements for Multi-TRP URLLC schemes | Nokia, Nokia Shanghai Bell |
| [R1-2103409](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103409.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | Convida Wireless |
| [R1-2103470](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103470.zip" \t "_parent) | Enhancements on Multi-TRP for PUSCH | Sharp |
| [R1-2103505](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103505.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | LG Electronics |
| [R1-2103522](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103522.zip" \t "_parent) | Discussion on multi-TRP for PDCCH, PUCCH and PUSCH | NEC |
| [R1-2103550](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103550.zip" \t "_parent) | On PDCCH, PUCCH and PUSCH enhancements for multi-TRP | Ericsson |
| [R1-2103560](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103560.zip" \t "_parent) | Discussion on MTRP for reliability | NTT DOCOMO, INC. |
| [R1-2103660](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103660.zip" \t "_parent) | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | TCL Communication Ltd. |
| [R1-2103674](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2103674.zip" \t "_parent) | Discussion on enhancements for Multi-TRP PDCCH | ASUSTeK |

# Previous Agreements

## 5.1 PUCCH

### 102-e (August 2020)

**Agreement**

* Detailed assumptions for PUCCH evaluation:

|  |  |
| --- | --- |
| Parameters | Potential values |
| Baseline scheme | Rel-15 PUCCH repetition |
| PUCCH format | Format 1 and 3.  Other PUCCH Formats can be optionally considered. |
| # of RBs/symbols | PUCCH Format 1: 4 symbols, 1 RB  PUCCH Format 3: 4 and 8 symbols, 1 RB  Other combinations are not precluded. |
| UCI payload | 2 bits for PUCCH Format 1 (and Format 0, if considered).  Companies to report assumptions on other PUCCH Formats |
| Frequency hopping | Reported by companies |
| Number of repetitions (when applicable) | 2, 4, 8 |
| Schemes | TDM  Details to be reported by companies |
| Receiver assumption | Reported by companies |

* Detailed assumptions for PUSCH evaluation:

|  |  |
| --- | --- |
| Parameters | Potential values |
| Baseline scheme | Rel-15/-16 PUSCH repetition |
| # of RBs/symbols | Companies to Report. |
| DMRS pattern | DM-RS configuration type 1  DM-RS Configuration type 2 (optional) |
| # of layers | 1, 2 (optional) |
| Code rates | Low (<0.2) and moderate (<0.4) |
| Frequency hopping | Reported by companies |
| UL transmission scheme | Codebook based UL transmission is baseline. Non-codebook based can be optional. |
| Redundancy Version | Reported by companies |
| Number of repetitions (when applicable) | 2, 4, 8  Other numbers are not precluded |
| Schemes | TDM  Details to be reported by companies |
| Receiver assumption | Reported by companies |

**Agreement**

To improve reliability and robustness for PUCCH using multi-TRP and/or multi-panel, consider all PUCCH formats.

**Agreement**

To enable TDMed PUCCH transmission with different beams, support configuring/activating of multiple PUCCH Spatial Relation Info. RAN1 shall further study the exact schemes considering the following aspects,

* Method of configuration/activation of multiple spatial relation info
* Use of the same PUCCH resource or different PUCCH resource for PUCCH transmission
* Mapping between PUCCH repetition/symbol and spatial relation info among multiple PUCCH repetitions / multiple PUCCH symbols.

**Agreement**

For configuration/indication of the number of PUCCH repetitions, RAN1 shall further study the following,

* Alt.1: Use Rel-15 like framework
* Alt.2: Dynamic indication of the number of PUCCH repetitions

**Agreement**

For multi-TRP PUCCH transmission, further investigate required power control enhancement.

**Agreement**

Support TDMed PUCCH scheme(s) to improve reliability and robustness for PUCCH using multi-TRP and/or multi-panel. Study the following alternatives,

* Alt.1: supporting both inter-slot repetition and intra-slot repetition / intra-slot beam hopping.
* Alt.2: supporting only inter-slot repetition
* Note1: It is not precluded to study the use of multiple PUCCH resources to repeat the same UCI in both inter-slot repetition and intra-slot repetition.
* Note2: The alternatives are clarified as below,
  + inter-slot repetition: One PUCCH resource carries UCI , another one or more PUCCH resources or the same PUCCH resource in another one or more slots carries a repetition of the UCI .
  + intra-slot repetition: One PUCCH resource carries UCI , another one or more PUCCH resources or the same PUCCH resource in another one or more sub-slots carries a repetition of the UCI
  + intra-slot beam hopping: UCI is transmitted in one PUCCH resource in which different sets of symbols have different beams

### 103-e (November 2020)

**Agreement**

For multi-TRP PUCCH transmission schemes.

* Support multi-TRP inter-slot repetition (Scheme 1)
  + One PUCCH resource carries UCI, another PUCCH resource or the same PUCCH resource in another one or more slots carries a repetition of the UCI.
  + FFS: Number of repetitions
* Further study the support (one or both) of the following schemes
  + Multi-TRP intra-slot beam hopping (Scheme 2)
    - UCI is transmitted in one PUCCH resource in which different sets of symbols within the PUCCH resource have different beams.
    - FFS: More than 2 beam hopping instances per PUCCH resource.
  + Multi-TRP intra-slot repetition (Scheme 3)
    - One PUCCH resource carries UCI, another PUCCH resource or the same PUCCH resource in another one or more sub-slots within a slot carries a repetition of the UCI.
* Note1: whether to support two PUCCH resources or the same PUCCH resource with different beams for Scheme 1 and 3 to be discussed separately.

**Agreement**

For multi-TRP PUCCH transmission schemes,

* For Scheme 1, at least PUCCH format 1/3/4 can be used.
* FFS: Support of PUCCH format 0/2 for Scheme 1
* FFS: Support of PUCCH formats for Scheme 2 and/or Scheme 3 (if schemes are agreed).

**Agreement**

For multi-TRP TDM-ed PUCCH transmission schemes,

* Support the use of a single PUCCH resource
* Up to two spatial relation info’s can be activated per PUCCH resource via MAC CE
* FFS: Required enhancements for FR1
* FFS: Use of multiple PUCCH resources.

**Agreement**

For PUCCH multi-TRP enhancements in FR2,

* Support separate power control parameters for different TRP via associating power control parameters via PUCCH spatial relation info.
  + Note: No spec impact.
* For per TRP closed-loop power control for PUCCH, further study the following alternatives considering TPC command when the “closedLoopIndex” values associated with the two PUCCH spatial relation info’s are not the same.
  + Option.1: A single TPC field is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for both PUCCH beams
  + Option.2: A single TPC field is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for one of two PUCCH beams at a slot. The TPC value may be applied for the other PUCCH beam at an another slot.
  + Option 3: A second TPC field is added in DCI formats 1\_1 / 1\_2.
  + Option 4: A single TPC field is used in DCI formats 1\_1 / 1\_2, and indicates two TPC values applied to two PUCCH beams, respectively.
* FFS: Transition period for beam / power / frequency change.
* FFS: Required power control enhancements for FR1

**Agreement**

For configuration/indication of the number of PUCCH repetitions for Scheme 1, there is no restriction on using Rel-15 framework on configuring the number of repetitions.

* Rel-17 feMIMO may additionally consider supporting the dynamic indication of the number of repetitions in RAN1 #104 meeting.

**Agreement**

For PUCCH multi-TRP enhancements in FR1,

* Support separate power control for different TRP.
* FFS: how to define the association between PUCCH and TRP.
* FFS: required enhancements.

**Working Assumption**

For PUCCH multi-TRP enhancements in Scheme 1, it is possible to configure either cyclic mapping or sequential mapping of spatial relation info’s over PUCCH repetitions.

* FFS: Applicability of mapping patterns for different beam switching gaps
* The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.
* Note: For Scheme 1, cyclical mapping pattern and sequential mapping pattern are as follows,
  + Cyclical mapping pattern: the first and second beam are applied to the first and second PUCCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUCCH repetitions.
  + Sequential mapping pattern: the first beam is applied to the first and second PUCCH repetitions, and the second beam is applied to the third and fourth PUCCH repetitions, and the same beam mapping pattern continues to the remaining PUCCH repetitions.

**Agreement**

LS to RAN4 on beam switching gaps for multi-TRP UL transmission is endorsed in R1-2009807.

### 104-e (February 2021)

**Agreement**

For M-TRP PUCCH scheme 1,

* Support PUCCH formats 0 and 2 (in addition to agreed PUCCH formats 1,3,4)

**Agreement**

For M-TRP PUCCH scheme 1,

* For PUCCH formats 1/3/4, values for the total number of repetitions at least contain values 2, 4, and 8.
  + FFS: maximum repetition number can be extended to 16.
* For PUCCH formats 0/2, the total number of repetitions at least contain 2.
  + FFS: other values.
* RRC configured number of slots (repetitions) are applied across both TRPs (e.g if the number of repetitions given by *nrofSlots* in *PUCCH-config* is 8, per TRP limit is 4).

**Agreement**

To support per TRP power control for multi-TRP PUCCH schemes in FR1,

* Two sets of power control parameters are used, and each set has a dedicated value of p0, pathloss RS ID and a closed-loop index.
* FFS: details on how a PUCCH resource can be linked to one or both of the two sets of power control parameters.
* FFS: whether PUCCH resource group can be linked to power control parameter sets.

**Working Assumption**

For PUCCH reliability enhancement, support multi-TRP intra-slot repetition (Scheme 3) for all PUCCH formats.

* The same PUCCH resource carrying UCI is repeated for X = 2 [consecutive] sub-slots within a slot.
* Refer the design details related to sub-slot configurations (e.g. other values of X) to Rel-17 eIIoT

Note1: The decision of supporting scheme 3 is only applicable for multi-TRP operation.

**Conclusion**

For Multi-TRP PUCCH Scheme 1/3 at least containing HARQ ACK, supporting dynamic switching between multi-TRP PUCCH scheme and single-TRP PUCCH transmission is not restricted, and can be done by associating,

* a PUCCH resource activated with one or two spatial-relation-info and PRI bit-field indicating a PUCCH resource,
* or a PUCCH resource with one or two power control parameter sets and PRI bit-field indicating a PUCCH resource

FFS: Support of dynamic switching for Scheme 2 (if the schemes supported)

**Conclusion**

Strive to reuse the specification support for dynamic indication of number of repetitions introduced in the Rel-17 coverage enhancement work item for multi-TRP operation. Decide whether further enhancements for multi-TRP operation are necessary in RAN1#106bis. No further discussion on this topic until RAN1#106bis under agenda item 8.1.

**Agreement**

Further study following aspects related to beam mapping and default behaviors for multi-TRP PUCCH/PUSCH schemes,

* Whether enhancements needed on beam mapping in case of PUCCH/PUSCH dropping due to invalid UL symbols
* Whether frequency hopping is performed among the repetitions with the same beam
* Whether defining default beam for PUSCH is needed when PUSCH scheduled by DCI format 0\_0 when two spatial relation info’s are configured for a PUCCH resource

**Agreement**

Further study following alternatives to support per TRP closed-loop power control for PUCCH , select  from the below options during the RAN1 #104-e-bis meeting.

* Option.1: A single TPC field (the existing TPC field) is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for both PUCCH beams
* Option.2: A single TPC field (the existing TPC field) is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for one of two PUCCH beams at a slot. The TPC value may be applied for the other PUCCH beam at an another slot.
* Option 3: A second TPC field (similar to the existing TPC field) is added in DCI formats 1\_1 / 1\_2.
* Option 4: A single TPC field is used in DCI formats 1\_1 / 1\_2, and indicates two TPC values applied to two PUCCH beams, respectively.

**Working assumption**

For beam mapping /power control parameter set mapping for PUCCH repetitions,

* For M-TRP PUCCH Scheme 1 in FR1, it is possible to configure either cyclic mapping or sequential mapping of power control parameter sets over PUCCH repetitions (similar to spatial relation info’s over PUCCH repetitions).
* For M-TRP PUCCH Scheme 3, reuse the same methods as Scheme 1 (by replacing slots with sub-slots) for beam mapping or power control resource set mapping to sub-slots.
* This working assumption is also subjected to the RAN4 LS R1-2009807 and confirmed based on the RAN4 reply.

## 5.2 PUSCH

### 102-e (August 2020)

**Agreement**

For M-TRP PUSCH reliability enhancement, support single DCI based PUSCH transmission/repetition scheme(s).

* Further study multi-DCI based PUSCH transmission/repetition scheme(s) to identify potential gains and required enhancements.
* Note: This agreement does not reflect any prioritization of single DCI based PUSCH transmission/repetition over multi-DCI based PUSCH transmission/repetition. Ran1 can further discuss that in the next meeting.

**Agreement**

For single DCI based M-TRP PUSCH reliability enhancement, support TDMed PUSCH repetition scheme(s) based on Rel-16 PUSCH repetition Type A and Type B.

* Further study PUSCH transmission without repetition as a potential candidate M-TRP PUSCH scheme

**Agreement**

To support single DCI based M-TRP PUSCH repetition scheme(s), up to two beams are supported. RAN1 shall further study the details considering,

1. Codebook based and non-codebook based PUSCH
2. Enhancements on SRI/TPMI/power control parameters/any other

Note1: Companies are encouraged to provide additional details on how above enhancements are applied to different PUSCH repetitions (e.g. mapping between PUSCH repetitions and beams)

Note2: Studying enhancements/aspects related to TA is not precluded.

**Agreement**

Further study M-TRP CG PUSCH reliability enhancements in Rel-17.

**Agreement**

On the mapping between PUSCH repetitions and beams in single DCI based multi-TRP PUSCH repetition Type A and Type B, further study the following,

* For both PUSCH repetition Type A and B, how the beams are mapped to different PUSCH repetitions (or slots/frequency hops),
  + Alt.1: cyclical mapping pattern (the first and second beam are applied to the first and second PUSCH repetition, respectively, and the same beam mapping pattern continues to the remaining PUSCH repetitions).
  + Alt.2: sequential mapping pattern (the first beam is applied to the first and second PUSCH repetitions, and the second beam is applied to the third and fourth PUSCH repetitions, and the same beam mapping pattern continues to the remaining PUSCH repetitions).
  + Alt.3: Half-Half pattern (the first beam is applied to the first half of PUSCH repetitions, and the second beam is applied to the second half of PUSCH repetitions)
  + Alt.~~3~~4: Other variants (e.g. configurable mapping patterns)
  + Note1: For PUSCH repetition type B, the variants considering slot level beam mapping with the same mapping principals (replacing repetition with slot) in Alt.1/2/3 are also included.
  + Note2: For PUSCH repetition type A and B with frequency hopping, the variants considering frequency hop level beam mapping with the same mapping principals (replacing repetition with frequency hop) in Alt.1/2/3 can also be studied further. Final selection of such schemes also depends on the number of beams allowed per PUSCH repetition.
* For PUSCH repetition Type B, which repetition type that the beams shall consider for the mapping,
  + Alt.1: beams are mapped to the nominal repetitions
  + Alt.2: beams are mapped to the actual repetitions
  + Alt.3: beams are mapped to different slots (not in the granularity of actual/nominal repetition)
  + Alt.4: Other variants
* Consider additional requirements on switching gap(s) between two PUSCH repetitions towards different TRPs considering beam switching latency aspects.
* Note: use of the above solutions to multi-DCI based PUSCH repetition and TDMed PUSCH transmission without repetition (when there are agreed to support) is not precluded.

### 103-e (November 2020)

**Agreement**

For single DCI based M-TRP PUSCH repetition schemes, support codebook based PUSCH transmission with following enhancements.

* Support the indication of two SRIs.
  + Alt1: Bit field of SRI shall be enhanced.
  + Alt2: No changes on SRI field
* Support the indication of two TPMIs.
  + The same number of layers are applied for both TPMIs if two TPMIs are indicated
  + The number of SRS ports between two TRPs should be same.
  + FFS: Details on indicating two TPMIs (e.g, one TPMI field or two TPMI fields)
* Increase the maximum number of SRS resource sets to two
* FFS: configuration details of each SRS resource set (e.g., number of SRS resources in a resource set)

**Agreement**

For single DCI based M-TRP PUSCH repetition schemes, support non-codebook based PUSCH transmission with following considerations.

* Increase the maximum number of SRS resource sets to two, and associated CSI-RS resource can be configured per SRS resource set.
* FFS: Enhancements on SRI field in DCI to indicate the two beams for repetitions

**Agreement**

For single DCI based M-TRP PUSCH repetition Type B, at least nominal repetitions are used to map beams

* Further study details and applicability of each mapping method
* Further study the slot based beam mapping in the cases of nominal repetition across slot boundaries

**Agreement**

For PUSCH multi-TRP enhancements,

* For per TRP closed-loop power control for PUSCH, further study the following alternatives when the “closedLoopIndex” values are different.
  + Option.1: A single TPC field is used in DCI formats 0\_1 / 0\_2, and the TPC value applied for both PUSCH beams
  + Option.2: A single TPC field is used in DCI formats 0\_1 / 0\_2, and the TPC value applied for one of two PUSCH beams at a slot.
  + Option 3: A second TPC field is added in DCI formats 0\_1 / 0\_2.
  + Option 4: A single TPC field is used in DCI formats 0\_1 / 0\_2, and indicates two TPC values applied to two PUSCH beams, respectively.
* FFS: Transition period for beam / power / frequency change.

**Agreement**

Support both type 1 and type 2 CG PUSCH transmission towards MTRP. Further study the following alternatives,

* Alt.1 : single CG configuration
  + Repetitions of a TB transmitted towards MTPR on multiple PUSCH transmission occasions of single CG configuration.
  + At least for codebook-based CG PUSCH, support configuring 2 SRIs/TPMIs.
* Alt.2 : multiple CG configurations
  + Repetitions of a TB transmitted towards MTRP on more than one PUSCH transmission occasions, where one or more transmission occasions are from one CG configuration and another one or more PUSCH transmission occasions are from another CG configuration.
  + 1 SRI/TPMI is configured/indicated for each CG configuration.
* Further study required beam mapping principals, low overhead mechanisms for beam selection, and other enhancements for Alt.1 and Alt.2.

**Agreement**

For M-TRP PUSCH reliability enhancement, further discuss multi-DCI based PUSCH transmission/repetition scheme(s) considering the following aspects.

* The same TB is repeated towards multiple TRPs with different beams, where one or more PUSCH repetitions are scheduled by one DCI and another one or more PUSCH repetitions are scheduled by another DCI.
* FFS: Details related to timeline restrictions and beam mapping
* Changes on Rel-15/16 MCS, TBS determination, and UL resource allocation are not expected from this scheme.
* The scheme is considered to be supported only if there are gains over single DCI based PUSCH repetition schemes and a similar scheme is not supported by m-TRP PDCCH (e.g. Option 3).

Companies are encouraged to provide simulation results to decide the support of the scheme in next RAN1 meetings

The support of multi-DCI based PUSCH transmission/repetition scheme(s) in Rel-17 will be decided in RAN1#104-e

**Agreement**

For single DCI based PUSCH multi-TRP enhancements, support the following RV mapping for PUSCH repetition Type A,

* DCI indicates the first RV for the first PUSCH repetition, and the RV pattern (0 2 3 1) is applied separately to PUSCH repetitions of different TRPs with a possibility of configuring RV offset for the starting RV for the second TRP (The same method as PDSCH scheme 4)
* FFS: Reuse of the same method for PUSCH repetition Type B.

**Agreement**

For single DCI based M-TRP PUSCH repetition Type A and B, further study required enhancements on PTRS-DMRS association.

**Working Assumption**

For single DCI based M-TRP PUSCH repetition Type A and B, it is possible to configure either cyclic mapping or sequential mapping of UL beams.

* The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.
* FFS: Support of half-half mapping.
* FFS: Additional considerations on mapping patterns (including required beam switching gaps)
* Companies are encouraged to provide further simulation results to decide details.

**Agreement**

LS to RAN4 on beam switching gaps for multi-TRP UL transmission is endorsed in R1-2009807.

### 104-e (February 2021)

**Agreement**

For single DCI based M-TRP PUSCH repetition Type B, support the following RV mapping,

* DCI indicates the first RV for the first PUSCH actual repetition, and the RV pattern (0 2 3 1) is applied separately to PUSCH actual repetitions of different TRPs with a possibility of configuring RV offset for the starting RV for the first actual repetition towards second TRP (The same method as PDSCH scheme 4).

**Agreement**

Support CG PUSCH transmission towards M-TRPs using a single CG configuration.

* Use same beam mapping principals as dynamic grant PUSCH repetition scheme.
* FFS: Required changes on CG parameters (ConfiguredGrantConfig)
* The feature is UE optional

**Agreement**

For single-DCI based M-TRP PUSCH repetition schemes, up to two power control parameter sets (using *SRI-PUSCH-PowerControl*) can be applied when SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2.

* FFS1: Details on linking SRI fields to two power control parameters,
  + Alt. 1: Add second *sri-PUSCH-MappingToAddModList*, and select two *SRI-PUSCH-PowerControl* from two *sri-PUSCH-MappingToAddModList*
  + Alt. 2: Add SRS resource set ID in *SRI-PUSCH-PowerControl*, and select *SRI-PUSCH-PowerControl* from *sri-PUSCH-MappingToAddModList* considering the SRS resource set ID
  + Alt. 3: Let RAN2 handle this
  + Alt.4: Add second *sri-PUSCH-PathlossReferenceRS-Id*/*sri-P0-PUSCH-AlphaSetId*/*sri-PUSCH-ClosedLoopIndex* in *SRI-PUSCH-PowerControl*.
* FFS2: Enhancements on open-loop power control parameter set indication
* FFS3: Consideration on *srs-PowerControlAdjustmentStates*
* FFS4: Impact of multi-TRP PUSCH repetition on PHR reporting
* FFS5: Enhancement on power control parameters per TRP when SRI(s) indication of two SRS resource sets is absent.

**Agreement**

For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,

* Support two SRI fields corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.
  + Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework
* Support dynamic switching between multi-TRP and single-TRP operation
* FFS: Support dynamic switching the order of two TRPs

**Agreement**

For single DCI based M-TRP PUSCH Type B repetition schemes,

* For maxRank = 2, the number of bits for the indication of PTRS-DMRS association is the same as Rel-15/16, MSB and LSB separately indicating the association between PTRS port and DMRS port for two TRPs.
* FFS: the indication of PTRS-DMRS association for maxRank > 2.

**Agreement**

For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules A-CSI, support multiplexing A-CSI on the first PUSCH repetition corresponding to the first beam and the X-th PUSCH repetition corresponding to the second beam.

* For PUSCH repetition Type A, X=1 (the first PUSCH repetition corresponding to the second beam)
* For PUSCH repetition Type B, the first actual PUSCH repetition corresponding to the first beam and the X-th actual repetition corresponding to the second beam are considered,
  + The UE does not expect the first actual repetition corresponding to the first beam and the X-th actual repetition corresponding to the second beam to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).
  + The first actual repetition corresponding to the first beam and the X-th actual repetition corresponding to the second beam are expected to have the same number of symbols
  + FFS: X = 1 or X = the first actual repetition corresponding to the second beam that contains the same number of symbols as the first actual repetition with the first beam
* FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions
* FFS: whether to support multiplexing SP-CSI/P-CSI on PUSCH repetitions towards multiple TRPs.

**Agreement**

Further study following aspects related to beam mapping and default behaviors for multi-TRP PUCCH/PUSCH schemes,

* Whether enhancements needed on beam mapping in case of PUCCH/PUSCH dropping due to invalid UL symbols
* Whether frequency hopping is performed among the repetitions with the same beam
* Whether defining default beam for PUSCH is needed when PUSCH scheduled by DCI format 0\_0 when two spatial relation info’s are configured for a PUCCH resource

**Agreement**

For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,

* Two TPMI fields are indicated in DCI formats 0\_1/0\_2.
  + The first TPMI field uses the Rel-15/16 TPMI field design (which includes TPMI index and the number of layers) of DCI format 0\_1/0\_2. The second TPMI field only contains~~indicates~~ the second TPMI index. The same number of layers are applied as indicated in the first TPMI field.
  + FFS: Details of second TPMI field interpretation including changes expected in Tables 7.3.1.1.2-2/2A/2B/3/3A/4/4A/5/5A in 38.212
  + FFS: Interpreting TPMI fields when multi-TRP and single-TRP PUSCH repetition is applied.
* FFS: whether to support of PUSCH repetitions transmitting towards two TRPs sharing the same TPMI indicated by a TPMI field.
* FFS: The size of the second TPMI field can be equal to or smaller than the size of the first TPMI field

**Agreement**

For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,

* Support two SRI field(s) corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.
  + Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework,
  + Support the same number of layers applied over repetitions
  + FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212.
* Support dynamic switching between multi-TRP and single-TRP operation
  + FFS: whether/how to use SRI field(s) and additional details of SRI field(s) interpretations
* FFS: Minimizing the DCI overhead for PUSCH repetition Type A as a result of number of layers being limited to 1 when more than one repetition is scheduled.
* FFS: Support dynamic switching the order of two TRPs
* Companies are encouraged to provide total payload size of the two SRI fields and scheduling restriction, if any

**Agreement**

Further study following alternatives to support per TRP closed-loop power control for PUSCH , select from the below options during the RAN1 #104-e-bis meeting.

* Option.1: A single TPC field (the existing TPC field) is used in DCI formats 0\_1 / 0\_2, and the TPC value applied for both PUSCH beams
* Option.2: A single TPC field (the existing TPC field) is used in DCI formats 0\_1 / 0\_2, and the TPC value applied for one of two PUSCH beams at a slot.
* Option 3: A second TPC field (similar to the existing TPC field) is added in DCI formats 0\_1 / 0\_2.
* Option 4: A single TPC field is used in DCI formats 0\_1 / 0\_2, and indicates two TPC values applied to two PUSCH beams, respectively.