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

e-Meeting, January 25th – February 05th, 2021

**Agenda item: 8.1.2.1**

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

**Title: Summary #3 of Multi-TRP for PUCCH and PUSCH**

**Document for: Discussion and Decision**

# Introduction

Previous versions of FL summaries are listed below,

**R1-2101784** Summary of Multi-TRP for PUCCH and PUSCH Moderator (Nokia, Nokia Shanghai Bell)

**R1-2101900** Summary #2 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia, Nokia Shanghai Bell)

The remaining discussions are summarized in Section 2 and 3, where section 2 has proposals coming from Phase #1/#2, and Section 3 contain two new proposals.

Colour coding,

* Proposals coming from Phase 1 and 2: highlighted.
* New proposals: highlighted
* FL comments: highlighted

# Remaining proposals

## 2.1 Proposals coming from Phase #1 and #2

For both PUCCH and PUSCH TPC command enhancements, Option 3 is the majority view, but the group is not yet ready to make the down selection. Depending on online time availability, RAN1 could agree on one option (the majority is option 3) or keep everything alive for the next meeting.

**Proposal 2.4-A:**

Further study following alternatives to support per TRP closed-loop power control for PUCCH, select one from the below options based on the majority support 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.

Please comment on preferred changes to the proposal or if you object.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Support the proposal |
| ZTE | Support FL’s proposal. |
| Lenovo&MotM | Support the proposal while Option 3 is preferred. |
| QC | Ok with the Proposal. |
| OPPO | Support |
| CMCC | Support. |
| NTT Docomo | Support FL proposal. |
| Samsung | Support the FL’s proposal. |
| NEC | Support the proposal. |
| Xiaomi | Support FL’s proposal |
| Huawei, HiSilicon | We support the proposal, we don’t think we need to rush into down-selection before thorough discussion on DCI size increment and the impact on DCI reliability. |
| FL update #1 | We can suggest the chairman to endorse this. |
| Futurewei | Support |
| InterDigital | We support FL’s proposal. |
| Intel | Our suggestion is this:  Further study following alternatives to support per TRP closed-loop power control for PUSCH, select ~~one~~ from the below options ~~based on the majority support~~ during the RAN1 #104-e-bis meeting. |
| TCL | Support FL proposal. |
| Ericsson | Support FL proposal. |
| FL update #2 | @Intel >> your suggestion is ok as long as we all understand that we should be taking a decision in the next meeting.  **Proposal 2.4-A:**  Further study following alternatives to support per TRP closed-loop power control for PUCCH, select ~~one~~ from the below options ~~based on the majority support~~ 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. |
| vivo | Support |

**Proposal 2.4-B:**

Further study following alternatives to support per TRP closed-loop power control for PUSCH, select one from the below options based on the majority support 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.

Please comment on preferred changes to the proposal or if you object

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| --- | --- |
| **Company** | **Comments** |
| LG | Support the proposal |
| ZTE | Support FL’s proposal. |
| Lenovo&MotM | Support the proposal while Option 3 is preferred. |
| QC | Ok with the proposal |
| OPPO | Support |
| CMCC | Support. |
| NTT Docomo | Support FL proposal. |
| Samsung | Support the FL’s proposal. |
| NEC | Support the proposal. |
| Xiaomi | Support FL’s proposal |
| Huawei, HiSilicon | We support the proposal, we don’t think we need to rush into down-selection before thorough discussion on DCI size increment and the impact on DCI reliability. |
| FL update #1 | We can suggest the chairman to endorse this. |
| Futurewei | Support |
| InterDigital | We support FL’s proposal. |
| Intel | Our suggestion is this:  Further study following alternatives to support per TRP closed-loop power control for PUSCH, select ~~one~~ from the below options ~~based on the majority support~~ during the RAN1 #104-e-bis meeting. |
| TCL | Support FL proposal. |
| Ericsson | Support FL proposal. |
| FL update #2 | @Intel >> your suggestion is ok as long as we all understand that we should be taking a decision in the next meeting.  **Proposal 2.4-B:**  Further study following alternatives to support per TRP closed-loop power control for PUSCH, select ~~one~~ from the below options ~~based on the majority support~~ 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. |
| vivo | Support |

Beam mapping or power control parameter set mapping can follow the same method as Scheme 1 beam mapping methods.

**Proposal for working assumption 2.7:**

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.

Please comment on preferred changes to the proposal or if you object

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| **Company** | **Comments** |
| LG | Support the proposal |
| ZTE | Support FL’s proposal. |
| Lenovo&MotM | Support. |
| QC | Support the proposal |
| OPPO | Support |
| CMCC | Support. |
| NTT Docomo | Support FL proposal. |
| Samsung | Support the FL’s proposal. |
| NEC | Support the proposal. |
| Xiaomi | Support FL’s proposal |
| Huawei, HiSilicon | Support FL’s proposal. |
| FL update #1 | We can suggest the chairman to endorse this. |
| Futurewei | Support |
| InterDigital | We support FL’s proposal. |
| TCL | Support FL proposal. |
| Ericsson | Support FL proposal. |
| FL update #2 | We can suggest the chairman to endorse this. |

DMRS-PTRS mapping was also discussed in phase 1, and the majority support the following.

**Proposal 3.4:** For single DCI based M-TRP PUSCH repetition schemes, the number of bits for the indication of PTRS-DMRS association is the same as Rel-15/16.

* For maxRank = 2, MSB and LSB separately indicating the association between PTRS port and DMRS port for two TRPs.
* FFS: Interpretation for other scenarios when maxRank > 2.

Please comment on preferred changes to the proposal or if you object

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| **Company** | **Comments** |
| LG | We don’t see the need of supporting high rank for reliability enhancement, which causes degradation of BLER performance. We suggest to remove last bullet.  **Proposal 3.4:** For single DCI based M-TRP PUSCH repetition schemes, the number of bits for the indication of PTRS-DMRS association is the same as Rel-15/16.   * For maxRank = 2, MSB and LSB separately indicating the association between PTRS port and DMRS port for two TRPs. * ~~FFS: Interpretation for other scenarios maxRank > 2.~~ |
| ZTE | Support FL’s proposal. |
| QC | Support FL’s proposal. |
| OPPO | Share similar with LG. |
| NTT Docomo | Support FL proposal. |
| Samsung | Support the FL’s proposal.  Because rank restriction for mTRP PUSCH was not agreed in this meeting, second bullet (Interpretation for PTRS-DMRS association when maxRank >2) is needed to cover whole cases. |
| NEC | Support the proposal. |
| Xiaomi | Similar view with LG and OPPO |
| ZTE2 | It can not be seen the logic to penalize Rel-17 MTRP PUSCH by disallowing it to use higher transmission rank (*maxRank* = 3, 4).  In Rel-15/16 NR, the uplink precoders are designed and endorsed for rank 3 and 4 based PUSCH transmission/repetition to obtain better performance (i.e., spectrum efficiency), it makes no sense to limit *maxRank* for Rel-17 MTRP PUSCH transmission/repetition. Besides, FL assessed in Proposal 3.2 in last week Phase 1 that majority did not agree to restrict rank # for MTRP PUSCH. Therefore, it is reasonable to remain the FFS in FL’s Proposal 3.4 for avoiding any repeat discussion on the same issue. |
| Huawei, HiSilicon | Support FL’s proposal. |
| FL update #1 | @LG >> We tried to agree on limiting *maxRank*, but companies objected to that. Therefore, it is not accurate to remove the FFS. |
| Futurewei | Support |
| TCL | Support FL’s proposal. |
| Ericsson | Support FL’s proposal |
| FL update #2 | We can suggest the chairman to endorse this. |
| vivo | We have concerns on the proposal.  If we understand correctly, legacy 2bits of PTRS-DMRS association is not enough to indicate PTRS-DMRS association for both TRPs when maxRank>2 in some cases. Considering the case that maxRank is configured to 4 and number of PTRS ports is configured to 2, 4 bits may be required with the following interpretation:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **value** | **TRP1** | | **TRP2** | | | **The 1st bit** | **The 2nd bit** | **The third bit** | **The fourth bit** | | **PTRS port0** | **PTRS port1** | **PTRS port0** | **PTRS port1** | | 0 | 1st DMRS port | 1st DMRS port | 1st DMRS port | 1st DMRS port | | 1 | 2nd DMRS port | 2nd DMRS port | 2nd DMRS port | 2nd DMRS port |   We recognize that by interpreting the origin two bits, maybe all the cases can be enabled, which still needs further study. Also, enhanced PTRS-DMRS association field cannot be precluded at this stage. We would like to further study PTRS-DMRS association for maxRank >2 with/without limiting the bit width of PTRS-DMRS association field as legacy. So, we propose to modify the proposal as:  **Proposal 3.4:** For single DCI based M-TRP PUSCH ~~Type B~~ repetition schemes, ~~the number of bits for the indication of PTRS-DMRS association is the same as Rel-15/16.~~   * 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: Interpretation for other scenarios (if maxRank >2 is agreed).~~ * FFS: the indication of PTRS-DMRS association for maxRank >2. |

The following was discussed many times during the last few meetings and this meeting and should be able to conclude given the majority view.

**Conclusion**

The dynamic indication of the number of repetitions supported for Rel-17 coverage enhancement can be used for multi-TRP operation.

Please comment on preferred changes to the proposal or if you object.

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| **Company** | **Comments** |
| LG | Support the proposal |
| ZTE | Support FL’s proposal. |
| QC | Support the proposal |
| OPPO | Support |
| CMCC | Support. |
| NTT Docomo | Support FL proposal. |
| Samsung | Support the FL’s proposal. |
| NEC | Support the proposal. |
| Xiaomi | Support FL’s proposal |
| Huawei, HiSilicon | Support FL’s proposal. |
| FL update #1 | We can suggest the chairman to endorse this. |
| Futurewei | Support |
| InterDigital | We support FL’s proposal. |
| TCL | Support FL’s proposal. |
| Ericsson | Support FL’s proposal |
| FL update #2 | We can suggest the chairman to endorse this. |

## 2.2 Proposals on SRI and TPMI indications

FL kept the phase #2 discussion on SRI and TPMI to enable down-selection in this meeting.

### Proposal 3.1

**Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,

* Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.
  + **Option 1:** Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework
  + **Option 2**: One enhanced SRI field indicating two SRIs
    - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-32/32A/32B in 38.212.
* Support dynamic switching between multi-TRP and single-TRP operation
  + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.
    - When the SRI fields do not have a reserved entry, the dynamic switching cannot be supported.
    - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry
  + **For Option 1 - Alt2 :** by using two SRI fields or TPMI field(s).
    - FFS: Additional details of SRI/TPMI field interpretations
  + **For Option 2:** by using one enhanced SRI field or TPMI field(s).
    - FFS: Additional details of SRI field interpretations

**Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,

* Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.
  + **Option 1:** Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework
  + **Option 2:** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, the second SRI field does not indicate the number of layers
    - FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212.
  + **Option 3**: One enhanced SRI field indicating two SRIs
    - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-28/29/30/31 in 38.212.
* Support dynamic switching between multi-TRP and single-TRP operation
  + **For Option 1:** by using two SRI fields at least when there is a reserved entry for one SRI field.
    - When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.
    - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry
  + **For Option 2:** by using one or two SRI field(s)
    - FFS: Additional details of SRI field(s) interpretations
  + **For Option 3:** by using one enhanced SRI field.
    - FFS: Additional details of SRI field 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.

This discussion is copied from Phase #2, and please see the bottom of the table for the FL update.

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| **Company** | **Comments** |
| LG | We would like to continue comparing payload size and scheduling restriction of what companies have in mind. We share our design and provide bit size in the Table below.   * A single joint field   + Supporting dynamic switching among STRP1, STRP2, MTRP   + Assuming the same rank restriction between MTRP PUSCHs.   + Not supporting dynamic switching the order of TRP for MTRP transmission   It would be appreciated if other companies share their detail design and provide bit size in the Table.  **Table for payload size of NCB SRI field(s) (without SRI ordering switching)**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | Lmax=1 | | | | Lmax=2 | | | | Lmax=3 | | | | Lmax=4 | | | | |  | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | | LG  vivo | 2 | 3 | 4 | 5 | 2 | 4 | 5 | 7 | 2 | 4 | 6 | 7 | 2 | 4 | 6 | 7 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   **Table for payload size of NCB SRI field(s) (with SRI ordering switching)**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | Lmax=1 | | | | Lmax=2 | | | | Lmax=3 | | | | Lmax=4 | | | | |  | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | Nsrs=1 | Nsrs=2 | Nsrs=3 | Nsrs=4 | | vivo | 2 | 4 | 5 | 6 | 2 | 4 | 6 | 7 | 2 | 4 | 6 | 8 | 2 | 4 | 6 | 8 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| ZTE | * Regarding CB-related Proposal 3.1-A, we support option 1 - Alt2.   For CB PUSCH in Rel-15/16, SRI is used to indicate SRS selection and TPMI is used to indicate precoder and rank. W.r.t. single-DCI based MTRP PUSCH, the design of both SRI and TPMI should be considered simultaneously for DCI overhead, STRP/MTRP dynamic switching, configured mapping of SRI and PC parameter sets, etc.  As we introduced in phase 1, exploit two entries in 2nd TPMI field can enable STRP/MTRP dynamic switching as well as minimizing DCI overhead. Besides, the mapping between SRIs and TRPs can be crystal clear. More specifically, when MTRP operation, two TPMI fields towards two TRPs/ SRS resource sets, respectively. When STRP operation, one entries in 2nd TPMI filed indicate PUSCH towards which one out of two TRPs, then 1st TPMI field indicate the specific TPMI value. Based on that, two SRI fields can be same to based on Rel-16 for minimizing DCI overhead.  For example, when STRP and configure only one SRS in each SRS resource set, such as SRS resource set {SRS 0} and SRS resource set 1 {SRS 0}, the DCI overhead of SRI fields is 0bit due to 2nd TPMI field can used for specific TRP/SRS resource set selection, which means up to 2bits can be saved versus single joint SRI field. For one clarification, when at least two entries are reserved in 2nd TPMI filed, 1 bit or 2 bits can be saved compared with other solutions. When less than two entries are reserved in 2nd TPMI field and one or two new entries should be enabled, 1 bit can be saved compared with option 2 and overhead is equal to option1 - Alt1.   * Regarding NCB-related Proposal 3.1-B, we support Option 2.   For NCB PUSCH in Rel-15/16, only SRI is used to indicate SRS selection, SRS port number, precoder and rank. From the prospective of rank indication, unified design of CB and NCB PUSCH should be adopted, due to it is enough to use both 1st TPMI field of CB PUSCH and 1st SRI field of NCB PUSCH to indicate rank value.  For STRP/MTRP dynamic switching, we also can use unified design of CB and NCB PUSCH, where two entries in 2nd SRI field can be exploited. Likewise, the method can guarantee minimized DCI overhead and indicate the mapping between SRIs and TRPs no matter STR or MTRP operation.  From technical prospective, two SRI fields and two TPMI fields for CB and NCB PUSCH with such advantages as follows: (1) adopt the unified design for rank indication for both codebook and non-codebook based PUSCH, (2) enable dynamic switching between STR and MTRP and minimize the DCI overhead as much as possible, (3) clearly indicate the mapping between SRIs and TRPs no matter CB or NCB operation, (4) easily and intuitively configure the mapping between SRI and power control parameters of PUSCH with low spec impact, and (5) guarantee the specs to be legibility and make the spec effort as ease as possible. |
| Ericsson | Our current preference is Option1 and Option 1 – Alt 1 for Proposal 3.1-A.  For Proposal 3.1-B, we prefer Option1 and Option 1.  For other options in the two proposals, there will be significant specification effort needed (e.g., new tables to replace Table 7.3.1.1.2-32/32A/32B in 38.212, new tables to replace Table 7.3.1.1.2-28/29/30/31 in 38.212, etc). |
| NEC | We support Option 1 –Alt 1 for Proposal 3.1-A, and Option 2 for Proposal 3.1-B  While in our opinion, there seems an issue which can be discussed firstly, which is the details of the two SRS resource sets, including **the number of SRS resources in each SRS resource set, and the number of SRS ports of each SRS resource** for codebook based transmission.  It seems some assumptions are that the number of SRS resources should be same in the two SRS resource sets, while in our opinion, the restriction seems not necessary.  And in previous agreements, the number of SRS ports between two TRPs should be same, in our understanding, here “same” is to restrict the SRS ports of the selected SRS resources for two TRPs, there is no need to restrict all the SRS resources in the two SRS resource sets to be same, especially in case of full power transmission mode, which is quite useful to be combined with M-TRP transmission for reliability enhancement. In this case, not any one of the SRS resources can be combined in the two SRS resource sets.  So in our opinion, introducing two SRI fields seems quite straightforward and simple, just to select SRS resource in the corresponding SRS resource set.  If not easy to move forward, maybe we can discuss the details for the two SRS resource sets firstly? |
| Spreadtrum | For Proposal 3.1-A, we are OK with Option1+Alt1.  For Proposal 3.1-B, we prefer Option2 for minimizing DCI payload size. With respect to dynamic switching between multi-TRP and single-TRP operation for NCB based PUSCH, we prefer Option1 with unified design with CB based PUSCH. |
| Samsung | Support Option 1 for both 3.1-A and 3.1-B in principle.  Besides, if UE can support M-TRP PUSCH repetition, we can consider new option for dynamic switching between sTRP PUSCH and mTRP PUSCH. Therefore, we want to suggest the Option 1 – Alt3 for dynamic switching. And also, we suggest the editorial changes for Proposal 3.1-A and B as follows:  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1: Two SRIs are indicated by two SRI fields and** ~~E~~each SRI field ~~indicating~~ **indicates** SRI per TRP, where the SRI field based on Rel-15/16 framework   + **Option 2**: two SRIs are indicated by one enhanced SRI field     - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-32/32A/32B in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   + **For Option 1 - Alt2 :** by using two SRI fields or TPMI field(s).     - FFS: Additional details of SRI/TPMI field interpretations   + **For Option 1 - Alt3 :** whether the number of SRI fields in a DCI is 1 or 2.     - If one SRI field is indicated in DCI, UE transmits PUSCH into sTRP. If two SRI fields are indicated in DCI, UE transmits PUSCH into mTRP     - FFS: how to decide the number of SRI fields in DCI formats 0\_1/0\_2 (e.g. MAC CE,…)   + **For Option 2:** by using one enhanced SRI field or TPMI field(s).     - FFS: Additional details of SRI field interpretations   **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1: Two SRIs are indicated by two SRI fields and ~~E~~**each SRI field ~~indicating~~ indicates SRI per TRP, where the SRI field based on Rel-15/16 framework   + **Option 2: Two SRIs are indicated by two SRI fields and ~~E~~**each SRI field ~~indicating~~ indicates SRI per TRP, where the first SRI field based on Rel-15/16 framework,     - FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212.   + **Option 3**: One enhanced SRI field indicating two SRIs     - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-28/29/30/31 in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   + **For Option 1 - Alt2:** by using two SRI fields     - FFS: Additional details of SRI field interpretations   + **For Option 1 - Alt3 :** whether the number of SRI fields in a DCI is 1 or 2.     - If one SRI field is indicated in DCI, UE transmits PUSCH into sTRP. If two SRI fields are indicated in DCI, UE transmits PUSCH into mTRP     - FFS: how to decide the number of SRI fields in DCI formats 0\_1/0\_2 (e.g. MAC CE,…)   + **For Option 2:** by using one enhanced SRI field.     - FFS: Additional details of SRI field interpretations |
| Apple | For proposal 3.1-A, we are OK for both option 1-Alt1 and option 1-Alt2.  For proposal 3.1-B, we are OK for both option 1 and option 2.  We acknowledge that joint coding should be with lowest overhead. The best way is to perform joint coding for all DCI fields if our target is overhead only. When designing signaling, we think we should consider forward compatibility. If joint coding cannot save overhead too much, separate coding should be much better. |
| vivo | We support a single enhanced SRI field for both CB and NCB(**Option2**).   * + - * Firstly, we want to confirm that switching the order of SRIs is necessary or not.   We see benefits of dynamic TRP ordering switching. We can recall that it has been supported in Rel-16 MTRP PDSCH by configuring two TCI codepoint with swapping TCI state pairs. For UL, TRP (SRI) ordering switching is also beneficial for scheduling flexibility. Examples are given below:  The beam of the first TRP may not always be available for the first PUSCH repetition transmission. As show in the following figure, when gNB scheduling a URLLC data packet starting at slot n, the indicated beam of TRP1 in slot n is unavailable. In this case, the first repetition can be scheduled to transmit towards the second TRP instead of waiting for the first beam to be valid to reduce the transmission latency.    On the other hand, for the perspective of NW scheduling multiple UE, dynamic switching the order of TRPs is also beneficial. As shown in the following figure, TRP\_x is configured for UE1 as the first TRP while it is also configured for UE2 as the second TRP. If cyclic beam mapping pattern is configured for both UE1 and UE2, and same RX beam1 is required for TRP\_x to receive certain PUSCH repetitions from UE1 and UE2. In a), RX beam1 of TRP\_x will be occupied until the end of last PUSCH repetition, i.e., from slot n to n+3, because the TRP\_x has to receive the PUSCH repetitions from two UEs alternatively in different slots. Under this circumstance, TRP\_x cannot schedule a third UE with other Rx beams in any slots from n to n+3. If the scheduling DCI of UE2 dynamically indicates that TRP\_x is the first TRP that the first PUSCH repetition targeting to, TRP\_x is available to schedule other UEs at slot n+1 and n+3, which is shown in b).    a)    b)  Unfortunately, we can’t find a solution for Options to support dynamic TRP ordering switching. While it can be indicated by the single SRI field in Option 2.   * + - * Table structure with single SRI   For SRI Table, Option 2 is also easy to implement with a field. For example, we can set up a new table between two SRIs and the combinatorial SRI by certain formulas. Details can be FFS. On the contrary, we still see difficulties in constructing the second table in Option 2.  Based on the above elaboration, we still prefer to modify the proposal as  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework   + **Option 2**: One enhanced SRI field indicating two SRIs     - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-32/32A/32B in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   + **For Option 1 - Alt2 :** by using two SRI fields or TPMI field(s).     - FFS: Additional details of SRI/TPMI field interpretations   + **For Option 2:** by using one enhanced SRI field or TPMI field(s).     - FFS: Additional details of SRI field interpretations * Support dynamic switching the order of two TRPs.   **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework   + **Option 2:** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework,     - FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212.   + **Option 3**: One enhanced SRI field indicating two SRIs     - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-28/29/30/31 in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + **For Option 1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   + **For Option 2:** by using two SRI fields     - FFS: Additional details of SRI field interpretations   + **For Option 3:** by using one enhanced SRI field.     - FFS: Additional details of SRI field interpretations * Support dynamic switching the order of two TRPs. |
| Nokia | For proposal 3.1-A, we support for option 1-Alt1.  For proposal 3.1-B, we support for option 1. |
| NTT Docomo | For proposal 3.1-A   * we support option1. * For dynamic switching, we prefer Alt.2. We think dynamic switching should be supported and whether there is or is not reserved entry.   For proposal 3.1-B   * we prefer option1. It is simplest design to reuse Rel-15/16 table. * For dynamic switching, we prefer option2. Similar as CB, we think dynamic switching should be supported whether there is or is not reserved entry. And a unified signaling design for CB and NCB should be considered. |
| QC | **Proposal 3.1-A**: We support **Option 1** and **Option 1 – Alt1**  **Proposal 3.1-B**: We support **Option 1** (can also accept Option 2) for both bullets.  Share similar view as other companies that joint coding while obviously has lower overhead, the aspects related to the specification impact including some very large tables / complicated formulas to be agreed upon should be also considered.  If we really want to optimize by using joint coding, we have to also consider Repetition Type A versus Repetition Type B separately (in addition to considering CB-based and NCB-based separately). This is because:   * Whether Repetition Type A or Repetition Type B is RRC configured per DCI format (not dynamic) * For Repetition Type A, max number of layers is 1. At the same time   + Single-TRP with one repetition and multi-TRP can be switched dynamically   + There is no rank limitation for single-TRP but only one SRI is needed (larger SRI bitwidth)   + For multi-TRP, two SRIs are needed, but each with smaller number of possibilities due to rank limitation * As a result, with joint coding, we can optimize even further for Repetition Type A   Generally, we do not like to make specification more complicated. However, **if down-selection to reasonable options (from spec impact point of view) is not achieved**, we suggest to also add the following for the case of non-codebook based (Proposal 3.1-B) and codebook-based (Proposal 3.3 below):  FFS: Minimizing the DCI overhead for Repetition Type A as a result of number of layers being limited to 1 when more than one repetition is scheduled. |
| CMCC | For Proposal 3.1-A,   * We support Option 1. * For dynamic switching, we support option 1-Alt 2. Because we think dynamic switching should always be supported whether or not the SRI fields have a reserved entry. It’s both fine to enhance or reinterpret the two SRI or TPMI field(s) for Alt 2.   For Proposal 3.1-B,   * We support Option 2. * For dynamic switching, we support Option 2. To reduce the DCI overhead, the second SRI field could be well redesigned based on the rank restriction between the two SRI fields. |
| OPPO | For proposal 3.1-A, we prefer Option1-Alt 1.  For proposal 3.1-B, we support Option 2 since RI is indicated in the first SRI field and same number of layers is expected for two TRPs. |
| ZTE2 | Regarding CB-related Proposal 3.1-A, due to DCI overhead should simultaneously consider SRI and TPMI, we have elaborated above the solution for indicating STRP/MTRP dynamic switching via 2nd TPMI field (Option 1 - Alt2). Please note that SRI for CB PUSCH only used for SRS selection, it is benefit to design two SRI fields based on Rel-15/16 for minimizing DCI overhead and spec legibility, where the configured mappings between SRI and PC parameters are very clear.  Regarding NCB-related Proposal 3.1-B, some companies held the view that unified design should be used for both CB and NCB PUSCH. From the perspective of rank indication and SRI’s functionality in Rel-15/16 for CB and NCB PUSCH, due to TPMI used for CB PUSCH as well as SRI used for NCB PUSCH, it makes sense to use unified framework for rank indication to adopt Option 2, instead of **Option 1 which is just literal unified design rather than technical**. Although some companies have concern of spec effort, Option 2 can be easily captured in specs compared with Option 3. Generally speaking, 3GPP aims to solve every issue technically even if few spec effort needed. Here, some corrections should be made as follows for clarification of Option 2.  **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** Each SRI field indicating SRI per TRP, where the SRI field based on Rel-15/16 framework   + **Option 2:** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, the second SRI field dose not indicates the number of layers.     - FFS: details of second SRI field including the specification change for Table 7.3.1.1.2-28/29/30/31 in 38.212.   + **Option 3**: One enhanced SRI field indicating two SRIs     - FFS: details of enhanced SRI field including the specification effort to replace Table 7.3.1.1.2-28/29/30/31 in 38.212. * Support dynamic switching between multi-TRP and single-TRP operation   + **For Option 1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   + **For Option 2:** by using one or two SRI field(s)     - FFS: Additional details of SRI field(s) interpretations   + **For Option 3:** by using one enhanced SRI field.     - FFS: Additional details of SRI field interpretations |
| Huawei, HiSilicon | For codebook based PUSCH, we support option 2, regarding the DCI overhead and benefits of dynamic switching of order of repetition mentioned by Vivo. In addition, we don’t think the spec impact for option 2 would be very large, as for CB based PUSCH, SRI is just to indicate the SRS resource instead of layers etc. for NCB based PUSCH. Anyway, as discussed in proposal 3.3, new tables for TPMI of CB based PUSCH is needed.  For NCB based PUSCH, we support option 2. In last meeting, we have agreed to have the same rank for CB, and it can also be used for NCB to reduce DCI overhead. |
| CATT | For Proposal 3.1-A, we support Option 1 - Alt2  For Proposal 3.1-B, we support Option 2. |
| FL update #1 | Each comment and side have valid inputs. It is clear that few companies are having different views than majority.  I am addressing few comments on proposals and alternatives listed above.  **LG**>> your table copied to your comment box to avoid mixing things.  **SS** >> I would not generalize option 1 in proposal 3.1 – A as that is majority view. I do not think the proposal you have below is accurate.  ***For Option 1 - Alt3 :*** *whether the number of SRI fields in a DCI is 1 or 2.*   * *If one SRI field is indicated in DCI, UE transmits PUSCH into sTRP. If two SRI fields are indicated in DCI, UE transmits PUSCH into mTRP* * *FFS: how to decide the number of SRI fields in DCI formats 0\_1/0\_2 (e.g. MAC CE,…)*   In general, RRC configures the fields of DCI and there should be either one or two fields. It seems that your thinking is different here. Please clarify how this actually work if that is to include as alternative. A similar comment is valid for the option suggested in Proposal 3.1-B.  **vivo** >> you suggested to include “*Support dynamic switching the order of two TRPs*”. But, this can not be in the main bullet as that is not the majority view. It could be addressed within option 2 that you support where lot of details are FFS.  **Spreadtrum, DCM** >> you commented that support option 2 for dynamic switching in proposal 3.1-B. what do you have in mind as you also support option 1 which means two SRI field as legacy. May be something to clarify. Do you have the same proposal in mind as option 1.  **QC** >> FFS you suggested is added.  **ZTE**>> your suggestions are considered in the update.  **All**>> latest version based on QC/ZTE suggestion can be found in the proposals. Add your support each proposal. Nothing much we can do other than going into online session.  For now, FL thinks the following should be the way forward,  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 2:** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, the second SRI field does not indicate the number of layers     - 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   + **For Option 2:** by using one or two SRI field(s)     - FFS: Additional details of SRI field(s) interpretations * FFS: Minimizing the DCI overhead for PUSCH repetition DG based only Type A as a result of number of layers being limited to 1 when more than one repetition is scheduled. |
| InterDigital | For Proposal 3.1-A, we support Option 1, and Option 1 – Alt1. For Proposal 3.1-B, we support Option 1, and Option 1. |
| Futurewei | Support the FL’s updated proposal 3.1-A, though we are also ok with Option 2.  Support the FL’s updated proposal 3.1-B. |
| Intel | For 3.1-A,  option-1 – alt-1 is not a complete solution, doesn’t allow re-ordering of SRS resource sets  option-1- alt-2 and option 2 – we need to check further details in order to consider specification impact.  For 3.1-B, similar situation that option 1 is not complete and doesn’t allow re-ordering of SRS resource sets while option 2 and 3 needs additional details to be studied.  we think further discussion and study is need to down-select |
| ZTE3 | We have strong concern and technical consideration of CB-related Proposal 3.1-A.  From the technical prospective, it is critical to minimize DCI overhead for single-DCI based MTRP PUSCH. For CB PUSCH, due to both TPMI and SRI indications are needed, **it makes sense to consider DCI overhead of both TPMI fields and SRI fields**. Comparing Option 1-Alt1 with Option1-Alt2, SRI fields are always needed for Alt1, but Alt2 is not. One intuitive example, only one SRS in each SRS resource set for STRP operation, Alt1 always needs at least 1bit of SRI fields to indicate SRS set/TRP selection, meanwhile Alt2 does not need SRI fields due to 2nd TPMI field is used to indicate this selection.  Besides, **unified design of STRPMTRP dynamic switching should based on technical driven instead of literal likeness**. With respect to rank indication in Rel-15/16, due to TPMI is used for CB PUSCH and SRI is used for NCB PUSCH, consequently option 1-Alt2 in Proposal 3.1-A for CB PUSCH is unified with option 2 in Proposal 3.1-B for NCB PUSCH. Based on that, the indications of rank and STRP/MTRP dynamic switching for CB and NCB based MTRP PUSCH is aligned.  For the sake of progress with technical consideration, we suggest:  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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: by using two SRI fields or TPMI field(s) at least when there is a reserved entry for one SRI or TPMI field, further discuss whether to support dynamic switching if the SRI fields does not have a reserved entry and the addition detail of SRI/TPMI field interpretations. |
| NTT Docomo2 | We would like to clarify our understanding of option1-alt.1 in proposal 3.1A and option1-option1 in proposal 3.1B.  In case the SRI field has no reserved entry, by using two SRI fields for dynamic switching, does it mean new entries can be introduced in addition to Rel-15/16 entries, otherwise, how to support dynamic switching by using two SRI fields when there is no reserved entry? |
| Xiaomi | Support the updated proposal 3.1 A, also we have the same concern that if further extension is needed when cases that SRI without a reserved codepoint to support the dynamic switching.  For 3.2B, we agree in principle |
| FL update #2 | Intel >> based on FL understanding, SRS resource set reordering is not considered essential by the majority. Since RV and beam patterns allows some flexibility, FL assumes this is not a critical thing.  ZTE >> RAN1 shall move forward and FL assume the situation is clear with the supporting companies. It is not recommended to wait for design details as there are many other details are still to be discussed on beam mapping after RAN4 LS is received. .  DCM, Xiaomi >> no additional entry. If there are no reserved entry, FL assume the default solution would be no dynamic switching in that case. Tried to capture that in the updated proposal.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry   Intel, ZTE have concerns  **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 2:** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, the second SRI field does not indicate the number of layers     - 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   + **For Option 2:** by using one or two SRI field(s)     - FFS: 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.   Intel has concerns |
| LG | On proposal 3.1-B: we support joint single field design to minimize DCI overhead. Regarding the last FFS point, could QC elaborate what you have in mind? |
| ZTE4 | We still have strongly technical concern of FL update #2 Proposal 3.1-A.  From our prospective, RAN1 aims to address every severe issue for the sake of progress as well as respecting technology.  For the technical motivation, due to DCI overhead is the most critical issue for STRP/MTRP dynamic switching when single-DCI based MTRP PUSCH, using TPMI fields to indicate this switching can guarantee to minimize DCI overhead, where both SRI and TPMI are considered in DCI overhead for CB PUSCH. Besides, due to TPMI is used for rank indication of CB PUSCH and SRI is used for NCB PUSCH, it is evident that option 1-Alt2 (dynamic switching indicated by TPMI field) in Proposal 3.1-A for CB PUSCH is unified with option 2 (dynamic switching indicated by SRI field) in Proposal 3.1-B for NCB PUSCH. Therefore, the unified design of STRP/MTRP dynamic switching for CB and NCB based MTRP PUSCH can be fulfilled technically by option 1-Alt2 in Proposal 3.1-A and option 2 in Proposal 3.1-B.  For the sake of progress as well as technical motivation, the following updated proposal can be used for compromise.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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   + **For Option 1:** by using two SRI fields at least when there is a reserved entry for one SRI field, or by using TPMI filed(s).   FFS: when the SRI fields does not have a reserved entry, the dynamic switching cannot be supported, and whether to support dynamic switching if the SRI fields does not have a reserved entry.  FFS: Additional details of TPMI field(s) interpretations when using the TPMI field(s) for indicating STRP/MTRP dynamic switching. |
| Lenovo&MotM | Support. |
| QC | On Proposal 3.1-A: We prefer to remove the added red text “When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported”. This is already the FFS part and can be studied further.  On Proposal 3.1-B: Support the proposal.  Response to LG: Please refer to our comment above. I am copy-pasting it here:  “If we really want to optimize by using joint coding, we have to also consider Repetition Type A versus Repetition Type B separately (in addition to considering CB-based and NCB-based separately). This is because:   * Whether Repetition Type A or Repetition Type B is RRC configured per DCI format (not dynamic) * For Repetition Type A, max number of layers is 1. At the same time   + Single-TRP with one repetition and multi-TRP can be switched dynamically   + There is no rank limitation for single-TRP but only one SRI is needed (larger SRI bitwidth)   + For multi-TRP, two SRIs are needed, but each with smaller number of possibilities due to rank limitation * As a result, with joint coding, we can optimize even further for Repetition Type A   “  For example, assuming 4 SRS resources in each of the two SRS resource sets and max rank=4, required number of bits with joint coding for Repetition Type A is bits. This is due to the fact that number of layers is always one in the case of multi-TRP for Repetition Type A. We would be ok with not making specification more complicated by reusing the same enhancements for Repetition Type A and Type B. However, my point was that if we are going after the absolute minimized DCI overhead (as you and some other companies are suggesting), then this aspect above should be also considered. |
| OPPO | For Option 2 of Proposal 3.1-B   * + **For Option 2:** by using one or two SRI field(s)   we would like to get some clarification. As the existence of SRI field depends on RRC signaling, is Option 2 only based on interpretation of the value(s) of one SRI filed or two SRI fields, rathe than based on the number of SRI filed? If the above understanding is correct, we prefer to add some description to avoid potential confusion, e.g.,   * + **For Option 2:** by using one or two SRI field(s) (The number of SRI fields is not affected here) |
| MediaTek | Support the proposal in FL update #2 |
| vivo | We don’t support the updated proposal.  We think the majority support dynamic switching between STRP and MTRP. So we don’t think we need to discuss whether to support dynamic switching or not.  The statement “When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported” and FFS in Option 1-Alt1 is NOT a good way to go. However, there are so many cases that reserved entries are not available except full power mode 2. For Option 1, if dynamic switching is supported when SRI fields does not have a reserved entry, then another 1 or 2 bits are needed to indicate the dynamic switching. Otherwise, there is no such bits. This would be an ugly signaling design.  In our mind, an enhanced SRI field for both CB and NCB is a clear, neat design with minimal DCI overhead. Some companies have noticed this.  Besides, some companies have also raised their preference on dynamic SRI ordering switching. And we don’t think the flexibility of SRI order switching can be achieved by RV and beam pattern, etc.  As we have commented, we should first agree on the basic requirement and principle in DCI design first. |
| CMCC | For Proposal 3.1-A, we are ok with ZTE’s version.  For Proposal 3.1-B, we support FL’s updated version. |
| NTT Docomo | For proposal 3.1-A, we think whether dynamic switching is supported should not be restricted by whether there is reserved entry. Whether and how to support dynamic switching if there is no reserved entry can be further studied. A candidate solution is new entries are added on top of Rel-15/16 framework for dynamic switching. We suggest following modification.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - ~~When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.~~     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry     - FFS: whether new entries of SRI fields are introduced on top of Rel-15/16 framework to support dynamic switching if the SRI fields does not have a reserved entry   Fine to support proposal 3.1-B |
| Samsung | Support Proposal 3.1-A in FL update #2.  Don’t support Proposal 3.1-B in FL update #2.  If single-TRP operation with TRP 2 is supported by dynamic switching and second SRI field doesn’t indicate the number of layers, how can UE know the number of layers for single-TRP operation with TRP 2? For example, if NCB based single-TRP PUSCH operation via TRP 2 is supported by indicating first SRI field as the reserved field, second SRI field without layer information is only available. Because UE refers to the layer information in first SRI field (if first SRI field is indicated as a reserved field), UE cannot decide the number of layer for TRP 2 in this case. However, this problem can be solved naturally by Option 1 in initial FL’s Proposal 3.1-B.  Therefore, we support Option 1 in initial FL’s Proposal 3.1-B. |
| NEC | Regarding Proposal 3.1-A, we share similar view with DoCoMo, and we are fine with DoCoMo’s update.  Regarding Proposal 3.1-B, we support the proposal in FL update #2. |
| Xiaomi | For Proposal 3.2A, we suggest the following :  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **Option 1:** 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   + **For Option 1 - Alt1:** by using two SRI fields at least when there is a reserved entry for one SRI field.     - ~~When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.~~     - FFS: whether/how to support dynamic switching if the SRI fields does not have a reserved entry   Intel, ZTE have concerns  For Proposal 3.2B, we still prefer Option.1,a unified solution with CB PUSCH is more preferred for dynamic switching which is the same as revised in 3.1A above |
| Huawei, HiSilicon | We have concern on Proposal 3.1-A, as we believe that for SRI, using one field is more efficient and can also support dynamic switching of the order of SRS resources. In fact, with two SRI fields, there are redundant states, which increases the DCI overhead. In addition, dynamic switching between single-TRP and multi-TRP should not depend on the existence of reserved states, and it should be supported in any cases.  We support Proposal 3.1-B. |
| Nokia | For Proposal 3.1-A, we are fine to keep the FFS point “FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry” and remove “When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported”, as also suggested by other companies.  For Proposal 3.1-B, in our view it’s OK to further consider the point/issue raised by Samsung. In principle, we agree that Option 1 in the initial FL’s Proposal could be one potential way to go in that regard.  On the SRS resource set reordering, in principle we are fine to also study whether a dynamic way should be adopted or not. |
| FL update #3 | @ZTE: Thanks for the further details. In proposal 3.1-A, my thinking that “ FFS whether to support dynamic switching if the SRI fields does not have a reserved entry” already covered whatever you wanted to consider there with TPMI. We could capture the scenario as you mentioned as an example.  @QC/NEC/Xiaomi/Nokia: yes, added red text “When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported” is not fully matching with FFS if we are further enhancing the SRI field. Removed that.  @Oppo: Yes, your understanding is correct, the number of SRI fields can be changed as it is RRC configured. I am not sure that needs further clarification as it is clear from earlier text. Anyways, please check the update below is not acceptable for you.  @Vivo:   * This is removed “When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported” as also suggested by QC, NEC,DCM. * Your comment on “an enhanced SRI field for both CB and NCB is a clear, neat design with minimal DCI overhead”, after one week of discussion, others are not convinced to go in this direction. I can not do much as FL. * “dynamic SRI ordering switching”: this is not out of the discussion yet. Please feel free to discuss this with the framework we agree with the latest version below.   @DCM: Intension of the Proposal 3.1-A is to use SRI fields as in Rel-15/16. Your suggestion of FFS is going away from that. But, I removed the red text as commented before.  @SS/Nokia: Yes, with option 2, there is a problem that you mentioned. I tried to solve your concern by the latest update.  @HW: Majority is not ok with the direction you suggest. I hope we reach an agreement here to complete the work.  @All: Made few changes as suggested by few companies. Please check the latest versions.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 1:~~** 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   + **~~For Option 1 - Alt1:~~** by using two SRI fields at least when there is a reserved entry for one SRI field.     - ~~When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.~~     - FFS: whether to support dynamic switching if the SRI fields does not have a reserved entry (e.g. by using TPMI field(s))   **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 2:~~** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, ~~the second SRI field does not indicate the number of layers~~     - 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   + **~~For Option 2:~~** by using one or two SRI field(s)     - FFS: 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. |
| Futurewei | Support the latest FL proposal |
| InterDigital | We agree with NTT Docomo’s revision of proposal 3.1-A. Otherwise we are fine with FL’s proposals. |
| ZTE5 | Regarding CB-related Proposal 3.1-A for indicating STRP/MTRP dynamic switching, we have strong concerns with two main technical considerations:   * DCI overhead for CB PUSCH takes both TPMI fields and SRI fields into account.   As we elaborated times in the previous discussion that the DCI overhead of using 2nd TPMI field is always equal to or smaller than using SRI field(s), especially up to 2 bits can be saved in some cases (e.g., only one SRS resource in each SRS resource set when STRP operation).   * Unified design of indicating STRP/MTRP dynamic switching for CB PUSCH and NCB PUSCH based on the consistency of technical interpretation.   For NCB-related Proposal 3.1-B, STRP/MTRP dynamic switching is indicated by SRI field(s), which is used for rank indication in Rel-15/16 NCB PUSCH. Correspondingly, due to rank for CB PUSCH is indicated by TPMI, using TPMI field to indicate STRP/MTRP dynamic switching for CB PUSCH is unified with NCB-related Proposal 3.1-B.  Based on the elaboration above, it makes no reason to prioritize two SRI fields based indicating than TPMI field, such as those described in the current Proposal 3.1-A. On the contrary, using TPMI field to indicate STRP/MTRP dynamic switching for MTRP CB PUSCH is the technical and unified design. With these strong technical concerns in mind, the following update Proposal 3.1-A can be used to compromise to make progress.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 1:~~** 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   + **~~For Option 1 - Alt1:~~** by using two SRI fields or TPMI field(s).     - ~~When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.~~     - FFS: details of two SRI field or TPMI field(s) interpretations which used for indicate dynamic switching between multi-TRP and single-TRP operation. Further analysis is needed from DCI overhead perspective.   Regarding NCB-related Proposal 3.1-B, OPPO’s previous comments are related to whether the number of SRI fields can impact the indication of STRP/MTRP dynamic switching, rather than whether rank value needs to be indicated by 2nd SRI field. Based on our previous discussions, it is clear that the 2nd SRI field is not needed to indicate rank value due to which can be indicated by 1st SRI field. Only for the sake of our understanding, due to there is only one assessment from FL in last week Phase 1 that the number of layers for NCB PUSCH repetition between two TRPs are same, the wording “the second SRI field does not indicate the number of layers” should be remained here for avoiding any ambiguities and circular discussions.  **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 2:~~** Each SRI field indicating SRI per TRP, where the first SRI field based on Rel-15/16 framework, the second SRI field does not indicate the number of layers     - 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   + **~~For Option 2:~~** by using one or two SRI field(s)     - FFS: 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. |
| Samsung | We support the latest FL’s proposal. |
| LG | On proposal 3.1-A:  Rather than mixing up TPMI and SRI for dynamic switching, we prefer to keep using either SRI or TPMI by adding some codepoint if there is no reserved entry. Our suggestion (in red) is shown below on top of ZTE’s proposal.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 1:~~** 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   + **~~For Option 1 - Alt1:~~ Alt 1:** by using two SRI fields   + **Alt 2:** ~~or~~ by using TPMI field(s).     - ~~When the SRI fields does not have a reserved entry, the dynamic switching cannot be supported.~~     - FFS: details of two SRI field or TPMI field(s) interpretations which used for indicate dynamic switching between multi-TRP and single-TRP operation. Further analysis is needed from DCI overhead perspective.   On proposal 3.1-B:  We understand that it is good to have unified design for CB and NCB. However, more importantly, minimizing DCI payload should be taken into account with priority. Considering majority support 2 TPC fields, both SRI and TPC field size will be increased almost double. Therefore, 1 or 2 bits save with single SRI field is precious. Another direction for progress in this meeting, basic requirement and principle in DCI design is agreed first, as vivo suggested. |
| Intel | 3.1-A: suggest:  FFS: ~~whether~~ how to support dynamic switching if the SRI fields does not have a reserved entry  Q: what if a single SRS resource is configured per TRP and SRI is not needed to indicate SRS resource ? how is this case handled in the agreement ?  For 3.1-B: we are not sure how the current proposed agreement helps to make progress, it seems everything is open except we decide on 1 SRI field. we still have concerns on  We have similar concerns as Vivo indicated above without repeating them again. |
| TCL | For Proposal 3.1-A, we share the same view with ZTE that a unified design of STRP/MTRP dynamic switching for CB and NCB based MTRP PUSCH is preferred.  For Proposal 3.1-B, we support FL’s updated version. |
| NTT Docomo | For proposal3.1-B, we also see the problem raised by Samsung/Nokia in last round, we are fine with current proposal3.1-B.  For proposal3.1-A, in our understanding, the intension of “based on Rel-15/16 framework” is to differentiate from previous proposal3.1-B or proposal3.3. that the 2nd SRI field/TPMI filed can have different interpretation from Rel-15/16.  And we share similar understanding with LG that a unified solution is preferred when there is reserved entry or there is not reserved entry, rather than using different solutions in different cases. By using SRI fields to indicate dynamic switching, in our understanding, new entries will be needed. We suggest not to preclude adding new entries in addition to existing entries in Rel-15/16.  We suggest following modification on top of LG’s revision.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs corresponding to two SRS resource sets are included in DCI formats 0\_1/0\_2.   + **~~Option 1:~~** 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   + **Alt 1:** by using two SRI fields     - FFS: details SRI fields interpretation which used to indicate dynamic switching between multi-TRP and single-TRP operation.     - FFS: whether new entries are needed in addition to existing entries in Rel-15/16   + **Alt 2:** by using TPMI field(s)     - FFS: details TPMI field(s) interpretations which used for indicate dynamic switching between multi-TRP and single-TRP operation. Further analysis is needed from DCI overhead perspective. |
| OPPO | We support the updated proposal from FL (FL update #3) |
| Ericsson | We are fine with the FL’s proposal from Update #3. |
| CMCC | For Proposal 3.1-A, we share the same view with DCM, we should design a unified solution whether there is reserved entry or not. And we are ok with DCM’s revised version.  For Proposal 3.1-B, we are fine with FL’s latest version. |
| FL update #4 | **ZTE** >> your previous compromise was much better than the latest version for proposal 3.1-A. In the latest version you suggest even to delete “*by using two SRI fields at least when there is a reserved entry for one SRI field*”. I do not think we are going anywhere with approach.  Same with Proposal 3.1-B: As I explained before, SS and others raised a good question on how the UE reads number of layers when TRP2 is transmitting. Your addition is very specific to proposal you would like to drive, but that is not the majority view. I think your proposal is included in the current form.  **LG**>> on proposal 3.1-A, no need to add alternatives when we discussed already what should be the majority direction. On proposal 3.1-B, as we discussed a lot DCI overhead reduction is not the main motivation here, but something would be good to have. If that is not the common understanding, we should select a method to finalize the work.  **Intel**>> your suggestion “FFS: ~~whether~~ how to support dynamic switching if the SRI fields does not have a reserved entry” is considered in the latest version.  *Q: what if a single SRS resource is configured per TRP and SRI is not needed to indicate SRS resource ? how is this case handled in the agreement ?*  The agreement is assuming SRIs to indicate resources in two SRS resource sets. May be the error cases of RRC or other scenarios can be handled later  For 3.1-B: We are progressing of using two fields. We had three options for this proposal and going forward with one. I think there is progress.  **DCM**>> I see that another option is listed there, as also suggested by LG. I would suggest we go ahead with the reserved entries Alt.1 as that is majority view, and we could consider alt.2 is there is strong need to support dynamic switch in all scenarios and companies agree that TPMI is also applicable. It is already covered with the bullets I had.  **Proposal 3.1-A:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * Support two SRIs 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   + by using two SRI fields at least when there is a reserved entry for one SRI field.   + FFS: ~~whether~~ how to support dynamic switching if the SRI fields does not have a reserved entry (e.g. by using TPMI field(s))   **Proposal 3.1-B:** For single DCI based M-TRP PUSCH repetition schemes, in non-codebook based PUSCH,   * Support two SRIs 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,   + 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 by using one or two SRI field(s)   + FFS: 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. |
| vivo | We have technical concerns on current proposal 3.1-A and 3.1-B with two SRI fields to support dynamic switching between multi-TRP and single-TRP operation since there are several cases that no reserved entries are available.   * + - 1. As we have commented, in-CB based UL transmission, there is no reserved entry when the number of SRS resources (N\_SRS) per set is configured to 1,2 or 4. In NCB based UL transmission, when Lmax=1, there is no reserved entry when the number of SRS resources per set is configured to 1,2 or 4 either. If dynamic switching is supported when SRI fields does not have a reserved entry, then another 1 or 2 bits are needed to indicate the dynamic switching. Otherwise, there is no such bits. The cases highlighted in yellow are the cases without reserved entry.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | codebook | N\_SRS =1 | N\_SRS =2 | N\_SRS =3 | N\_SRS = 4 |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | Non-codebook | Lmax = 1 | | | | | N\_SRS 1 | N\_SRS 2 | N\_SRS 3 | N\_SRS 4 |  * + - 1. If the reserved entries in the second TPMI field are used for dynamic switching between multi-TRP and single-TRP operation, there are 10 configuration cases, as listed below (please correct me if I am wrong), in which the reserved codepoint is absent or the reserved codepoints are not enough to indicate all dynamic switching options: TRP0, or TRP1, not to mention dynamic SRI ordering of two TRPs. In these cases, additional 1 bit is also needed in the second TPMI field to enable dynamic switching. Unfortunately, if 1 bit is added to the second field, the second TPMI field may be even greater than the first TPMI field in some cases (five cases marked in green), which seems unacceptable.  |  | | --- | | Cases that the second TPMI field without enough reserved entry to indicate dynamic switching options (assuming same layers as the first TPMI field) | | maxRank=2;  4 ports;  codebookSubset = partialAndNonCoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-2A)** | | maxRank=2;  4 ports;  codebookSubset = nonCoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-2A)** | | maxRank = 3 or 4,  4 ports;  codebookSubset = partialAndNonCoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-2B)** | | maxRank = 3 or 4,  4 ports;  codebookSubset = nonCoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-2B)** | | maxRank=1;  4 ports;  codebookSubset= noncoherent  **(Table 7.3.1.1.2-3)** | | maxRank=1;  4 ports;  codebookSubset=partialAndnoncoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-3A)** | | maxRank = 2; 2 ports;  codebookSubset = noncoherent  **(Table 7.3.1.1.2-4)** | | maxRank = 2;  2 ports;  codebookSubset = noncoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-4A)** | | maxRank = 1;  2 ports;  codebookSubset = noncoherent  **(Table 7.3.1.1.2-5)** | | maxRank = 1;  2 ports;  codebookSubset = noncoherent;  ul-FullPowerTransmission-r16 = fullpowerMode1  **(Table 7.3.1.1.2-5A)** |   Therefore, we don’t think current design assumption is a good solution:   * For NCB-based UL, dynamic switching sometimes uses legacy SRI field, sometimes uses a new bit field. * For CB-based UL, dynamic switching sometimes uses SRI field, sometimes uses TPMI field, while other times uses a new bit field.   We think such an ugly signaling design should be avoided. As we have mentioned, an enhanced SRI field for both CB and NCB is a clear, neat design with minimal DCI overhead since the only a few numbers of SRI will limit the entries in the joint SRI field.  Some companies have also raised their preference on dynamic SRI ordering switching. And this feature can also be tied to SRI field indication, so we cannot make a resolution on SRI field indication before deciding on whether we need such function.  For the purpose of progress, we still suggest to first agree on the basic requirement and principle in DCI design first. |

### Proposal 3.3

**Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,

* **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.
  + **Alt.1** : 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 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
  + **Alt.2** : The first and second TPMI fields use the Rel-15/16 TPMI field design (which includes TPMI index and the number of layers) of DCI format 0\_1/0\_2.
* **Option 2**: enhanced TPMI field is indicated in DCI formats 0\_1/0\_2.
  + The enhanced TPMI field indicates first TPMI index, second TPMI index, and the number of layers. The same number of layers are applied for both TPMI indexes.
    - FFS: Details of TPMI field interpretation including the specification effort to replace Tables 7.3.1.1.2-2/2A/2B/3/3A/4/4A/5/5A in 38.212

This discussion is copied from Phase #2, and please see the bottom of the table for the FL update.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Considering the large number of codepoints in conventional TPMI field, we are fine with Option 1 and Alt 1. |
| ZTE | Support Option 1 - Alt1. |
| Ericsson | Support Option 1 – Alt2. |
| NEC | Support Option 1 - Alt.1 |
| Spreadtrum | We are fine with Option1-Alt1. |
| Samsung | Support Option 1 - Alt. 2 (simplest design. We can reuse Rel-15/16 TPMI table instead of new complicated table). |
| Apple | We are fine with option 1, either Alt1 or Alt2 is ok. |
| vivo | Support Option 2 and a single TPMI shared for PUSCH repetitions towards different TRPs.   * + - * **Shared TPMI indicated by a TPMI field for PUSCH repetitions towards two TRPs**   Besides, a single TPMI field indicating one shared TPMI between the PUSCH repetitions towards different TRPs should be supported as well to reduce DCI overhead, at lease in FR1. Actually, through thorough evaluation on performance of PUSCH repetitions sharing one TPMI and using two separate TPMIs in FR1, in which joint detection of multi-TRPs can be implemented. Received signals are combined in antenna domain and then decoding them as a large distributed antenna array. We observed that the performance of PUSCH repetitions sharing one TPMI is close to PUSCH repetitions using separate TPMIs. To further reduce DCI overhead, one shared TPMI using Rel-15/16 framework for PUSCH transmission towards two TRPs can be supported at least in FR1.    Performance of PUSCH repetitions under joint or separate detection with shared or separate TPMIs.   * + - * **Benefits of Option 2**   Compared to Option1, Option2 can save 1bit in some cases listed in the following table. So, we have preference on Option2 from perspective of DCI overhead.      The new TMPI tables can also be set up a new TPMI table between two TPMIs and the combinatorial TPMI by certain formulas.   * + - * **Further overhead reduction**   For both options, the bit width of the TPMI field(s) can be further reduced. Take Option 1 for example, the bit width of the second TPMI can be reduced by further limiting the coherent codebook subset through MAC CE. Assuming the codebook subset is configured with 'fullyAndPartialAndNonCoherent', gNB often select fully coherent codebook to take full advantage of Tx diversity, unless gNB detects that the wireless channel quality of some antenna ports of SRS resource is poor, e.g. when antenna ports are blocked by hands or other objects, in which case a codebook with the feature of partial coherent or non-coherent may be indicated by TPMI field in DCI to save UE power consumption. To respectively inform the coherence, the second field can save another 1bit at least.  Hence, we propose to modify the proposal as:  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **Alt.1** : 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 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   + **Alt.2** : The first and second TPMI fields use the Rel-15/16 TPMI field design (which includes TPMI index and the number of layers) of DCI format 0\_1/0\_2. * **Option 2**: enhanced TPMI field is indicated in DCI formats 0\_1/0\_2.   + The enhanced TPMI field indicates first TPMI index, second TPMI index, and the number of layers. The same number of layers are applied for both TPMI indexes.     - FFS: Details of TPMI field interpretation including the specification effort to replace Tables 7.3.1.1.2-2/2A/2B/3/3A/4/4A/5/5A in 38.212 * **Option 3**: Support PUSCH repetitions transmitting towards two TRPs sharing the same TPMI indicated by a TPMI field designed in Rel-15/16. * FFS: further overhead reduction methods, such as overhead of the second TPMI field. |
| Nokia | Support Option 1 - Alt.1 |
| NTT Docomo | We support option1. And prefer alt.2. It is simplest design to reuse R15/16 table. |
| QC | Option 1 – Alt1. |
| CMCC | Support Option 1 - Alt.1 |
| OPPO | Support Option1-Alt1. |
| ZTE2 | @Samsung, E///, DOCOMO>> please note simplest way does not means useful and technical design. For single-DCI based MTRP CB PUSCH, it was agree that the number of layers of two TRPs/SRS resource sets should be same. Based on that, it makes no sense to indicate same layers value twice by 2nd TPMI because that will lead to the wasting of overhead.  Besides, option 2(one single TPMI design) is the worst solution, due to it will cause pretty huge spec efforts, such as 4-Tx and maxRank 4 based PUSCH, and which also make a poor readability for spec. Shall the proponent of option 2 show us how to edit the single TPMI field in Tables 7.3.1.1.2-2/2A/2B/3/3A/4/4A/5/5A in 38.212? Specially, up to 1404 candidates needed to be included for the case of 4-Tx and maxRank 4 based PUSCH. |
| Huawei, HiSilicon | Support Option 1-Alt 1. |
| CATT | Support Option 1 - Alt1. |
| FL update #1 | Company support showed in the proposal.  **Vivo** >> you are supporting option 2 and proposing another option (option 3) to add. You could suggest which one you like the most to keep that, also text provided for option 3 is not clear. Also, FFS added is not matching as a general statement.  There is clear majority on option alt. 1.  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **Alt.1** : 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field. |
| InterDigital | We support Option 1 with either option. |
| Futurewei | Support the FL’s proposal. |
| Intel | It is clear that option-1, alt-2 is the most inefficient but it is not clear how option-1-alt-1 compares to option-2 in terms of performance/specification impact. We are okay to down-select to Option-1, Alt-1 and option 2 in this meeting. |
| Xiaomi | Support Option 1 - Alt.1 |
| FL update #2 | Proposal 3.3. is kept as the majority seems ok with it.  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **Alt.1** : 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field. |
| ZTE | Support FL update #2 proposal. |
| Lenovo&MotM | Support the updated proposal. |
| QC | Support. |
| OPPO | Support the update proposal |
| LG | Support the update proposal |
| MediaTek | Support the proposal in FL update #2. |
| vivo | We can compromise to support two TPMI fields. And we also think the bit size of second TPMI can be further reduced to save DCI overhead besides the restriction of same number of layers.  But we want to consider a shared TPMI field for all PUSCH repetitions to different TRPs. We observe the performance of a single shared TPMI is comparable to separate TPMIs at least for FR1, when joint detection is implemented at the receiver, in which received signals are combined in antenna domain and then decoding them as a large distributed antenna array. It is up to the network to configure such mode. When UE operates in this mode, one TPMI field indicates one common shared TPMI for transmission towards both TRP, which will reduce the overhead of scheduling DCI. So, we propose to add one FFS.    **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **Alt.1** : 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 indicates the second TPMI index.     - The same number of layers are applied as indicated in the first TPMI field.     - Size of the second TPMI field can be equal to or smaller than size of first TPMI field with the same number of layers. * **FFS: Support of PUSCH repetitions transmitting towards two TRPs sharing the same TPMI indicated by a TPMI field.** |
| CMCC | Support FL’s updated proposal. |
| NTT Docomo | Support. |
| Samsung | For the sake of progress, we can live with FL update #2 Proposal 3.3. However, we have similar concerns to Proposal 3.1-B. If single-TRP PUSCH operation via TRP 2 is supported by using two SRI fields (Option 1- Alt 1 in FL update #2 Proposal 3.1-A), UE cannot decide the number of layers according to second TPMI field because second TPMI field doesn’t indicate the number of layers. To solve this problem, more details are required to interpret two TPMI fields as dynamic switching. E.g., if multi-TRP PUSCH operation is supported by dynamic switching, both TPMI fields are available. On the other case, if single-TRP PUSCH operation is supported by dynamic switching, only first TPMI field is available because first TPMI field contains both TPMI index and the number of layers.  Therefore, we suggest that the FL updated #2 Proposal 3.3 is modified as follow:  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **Option 1**: two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **Alt.1** : 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field.     - FFS: Details to interpret two TPMI fields as dynamic switching between multi-TRP and single-TRP PUSCH operation |
| NEC | Support the proposal in FL update #2. |
| Xiaomi | Support FL’s updated proposal. |
| Huawei, HiSilicon | Support FL’s updated proposal. |
| Nokia | Support the proposal in principle. We are OK to clarify/consider the point raised by Samsung. |
| FL update #3 | @vivo: to address your concerns, I added one FFS item from your suggestions which I felt matching to the proposal below. I hope we move-on here.  @SS: Yes, the first field could be TRP1 or TRP2 if the second field is enhanced to indicate that. I assume that is what you also trying to suggest. It is covered by the wording used now. But I could add a clarification.  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **~~Option 1~~**~~:~~ two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **~~Alt.1~~**~~:~~ 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field.   + FFS: Interpreting TPMI fields when multi-TRP and single-TRP PUSCH repetition is applied.   + FFS: whether the size of the second TPMI field can be equal to or smaller than the size of the first TPMI field |
| Futurewei | Support the latest FL proposal |
| InterDigital | We support FL’s updated proposal. |
| Samsung | We support the latest FL’s proposal. |
| LG | For the last FFS point, the size of the second TPMI field is equal to or smaller than the size of the first TPMI field if the second TPMI field only indicates the second TPMI index. This is the only reason why we omit RI in the second TPMI. Therefore, we suggest the following:  **Proposal 3.3:** For single DCI based M-TRP PUSCH repetition schemes, in codebook based PUSCH,   * **~~Option 1~~**~~:~~ two TPMI fields are indicated in DCI formats 0\_1/0\_2.   + **~~Alt.1~~**~~:~~ 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field.     - The size of the second TPMI field can be equal to or smaller than the size of the first TPMI field   + FFS: Interpreting TPMI fields when multi-TRP and single-TRP PUSCH repetition is applied.   + ~~FFS: whether the size of the second TPMI field can be equal to or smaller than the size of the first TPMI field~~ |
| Intel | Q: is the case of no second TMPI field included in the agreement or not included in the agreement ? |
| TCL | Support the proposal in FL update #3. |
| OPPO | Support FL’s updated proposal. We are also ok with LG’s revision since overhead reduction of 2 TPMI index is the main motivation of Alt.1 |
| Ericsson | Support FL’s proposal in update #3. |
| CMCC | Support the proposal in FL update #3. |
| FL update #4 | @Intel : Fields are determined based on RRC config, it may not require any special handling for the case you mentioned. If there is only one field, I would count that as legacy procedures.  @LG: your suggestion taken into account.  **Proposal 3.3:** 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 indicates the second TPMI index. The same number of layers are applied as indicated in the first TPMI field.     - The size of the second TPMI field can be equal to or smaller than the size of the first TPMI field   + FFS: Interpreting TPMI fields when multi-TRP and single-TRP PUSCH repetition is applied.   + ~~FFS: whether the size of the second TPMI field can be equal to or smaller than the size of the first TPMI field~~ |
| vivo | We are OK with two TPMI fields as majority supports.  However, as we evaluated in FR1, PUSCH repetitions with shared TPMI indicated by one TPMI field can reach a comparable performance as two separate TPMI when joint detection is applied in the receiver. When UE operates in this mode, one TPMI field indicates one common shared TPMI for transmission towards both TRP, which will reduce the overhead of scheduling DCI.  From our point of view, it’s up to NW to configure one or two TPMI fields to enable such sharing TPMI mode which can be part of Proposal 3.3.  So, we still propose to add FFS in Proposal 3.3.  **FFS: Support of PUSCH repetitions transmitting towards two TRPs sharing the same TPMI indicated by a TPMI field.** |

# Phase #3 proposals

Several companies highlighted high-priority proposals that they would like to discuss. Few suggestions are considered below.

**Proposal 1:** For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules aperiodic CSI, support multiplexing A-CSI on the first PUSCH repetitions corresponding to two beams.

* For PUSCH repetition Type B, the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).
  + FFS: whether first actual repetitions corresponding to two beams are expected to have the same number of symbols
* FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions

Please add comments below.

|  |  |
| --- | --- |
| Company | Comments |
| LG | We don’t see the strong need to support this but we are fine if majority supports it. |
| ZTE | Support |
| Apple | We suggest we add a condition that if it meets the minimal processing delay requirement. For example, if the multiplexing comes from the collision between last PUSCH repetition and PUCCH, UE may not have enough time to do it. So we suggest the following change.  **Proposal 1:** For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules aperiodic CSI, support multiplexing A-CSI on the first PUSCH repetitions corresponding to two beams if it meets the minimal processing delay requirement.   * For PUSCH repetition Type B, the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).   + FFS: whether first actual repetitions corresponding to two beams are expected to have the same number of symbols * FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions |
| QC | Support the proposal. We think this enhancement is necessary for a complete multi-TRP PUSCH repetition design in Rel. 17. Otherwise, reliability of A-CSI report cannot be ensured.  For repetition Type B, we suggest to clarify the proposal as follows:  **Proposal 1:** For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules aperiodic CSI, support multiplexing A-CSI on the first PUSCH repetitions corresponding to two beams.   * For PUSCH repetition Type B, the first actual PUSCH repetitions corresponding to two beams are considered, and the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).   + FFS: whether first actual repetitions corresponding to two beams are expected to have the same number of symbols   FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions  Question to Apple: Can you elaborate more on the timeline issue? This proposal is not for multiplexing due to PUCCH/PUSCH overlap. This proposal is for the case that A-CSI is requested in UL DCI (no PUCCH involved). In Rel. 16, A-CSI is always multiplexed on the first PUSCH repetition. The proposal is to also multiplex the A-CSI on another subsequent PUSCH repetition. In Rel. 16, the timeline has to be satisfied for the first repetition. Then, timeline is also fine for a subsequent repetition. |
| Apple2 | To QC, according to our understanding, this formulation is quite general, which covers A-CSI multiplexing due to PUCCH/PUSCH overlap as well. If that’s not the intention, we suggest we exclude it, but it seems we should have a unified solution for all cases. |
| OPPO | Support |
| Spreadtrum | We are fine with the proposal if majority supports it. |
| MediaTek | Support |
| vivo | Support. |
| CMCC | Support. |
| Samsung | Don’t support this proposal. For PUSCH repetition Type B in Rel-16, aperiodic CSI report is multiplexed only on the first actual repetition because the symbol length of actual repetitions can be different. In the same manner of Rel-16 aperiodic CSI reporting with PUSCH repetition Type B, the enhancement should not be acceptable because we cannot guarantee that the symbol length of first actual repetitions corresponding to two beams is same. |
| NEC | We can follow majority view. |
| Xiaomi | suppot |
| Huawei, HiSilicon | Support. |
| Nokia | We are fine with the proposal.  In our view, having the same number of symbols for “first actual repetitions corresponding to two beams” is a restriction but it’s not really a strong reason to not support the proposal.  (As a minor comment, for consistency, A-CSI could be replaced by aperiodic CSI or vice versa) |
| FL update #1 | @QC: added your clarification text.  @SS: Your concern can be already solve by making the FFS bullet I had as a restriction. Please check that solves your concern.  **Proposal 1:** For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules ~~aperiodic~~ A-CSI, support multiplexing A-CSI on the first PUSCH repetitions corresponding to two beams.   * For PUSCH repetition Type B, the first actual PUSCH repetitions corresponding to two beams are considered,   + the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).   + ~~FFS: whether~~ the first actual repetitions corresponding to two beams are expected to have the same number of symbols * FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions |
| Futurewei | Support |
| InterDigital | We support FL proposal. |
| Fujitsu | Support the updated proposal. |
| Samsung | For the sake of progress, we can live with Proposal 1 in principle. However, we still not sure that how to guarantee the first actual repetitions corresponding to two beams always have the same number of symbols. Therefore, as a compromised one, we suggest to change ‘first’ into ‘X-th’ that actual repetitions corresponding to two beams have the same number of symbols in the Proposal 1. Also, it is possible that there can be no actual repetition pairs corresponding to two beams with the same number of symbols during mTRP PUSCH repetition type B and this case also should be considered in the last FFS.  **Proposal 1:** For s-DCI based multi-TRP PUSCH repetition Type A and B, if the DCI schedules ~~aperiodic~~ A-CSI, support multiplexing A-CSI on the first PUSCH repetitions corresponding to two beams.   * For PUSCH repetition Type B, the ~~first~~ X-th actual PUSCH repetitions corresponding to two beams are considered,   + the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).   + ~~FFS: whether~~ the ~~first~~ X-th actual repetitions corresponding to two beams are expected to have the same number of symbols * FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions |
| TCL | Support the proposal. Multiplexing the A-CSI on another subsequent PUSCH repetition is preferred. |
| CATT | Support. |
| Ericsson | We support the proposal in FL Update #1. |
| APT | We are supportive of the proposal in general. However, we share the similar view with Samsung. We fail to see the need for restricting both repetitions to have same number of symbols. This may complicate the determination of which repetitions for A-CSI. We prefer to keep it as FFS to check the necessity. |
| FL update #1 | @SS: Your suggestion may create further work on defining or deriving X in some means and go against a bit from Rel-16 design of multiplexing on the first repetition. Where to multiplex A-CSI was discussed a lot in Rel-16 URLLC, and we should not do any optimization for that. There will be gNB restriction on A-CSI triggering, but with proper TDRA such that it allows equal number of symbols for both first actual repetitions.  No changes to the proposal and can be endorsed.  **Proposal 1:** 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 repetitions corresponding to two beams.   * For PUSCH repetition Type B, the first actual PUSCH repetitions corresponding to two beams are considered,   + the UE does not expect the first actual repetitions corresponding to two beams to have a single symbol duration (similar restriction as in Rel-16 NR for the single TRP case).   + The first actual repetitions corresponding to two beams are expected to have the same number of symbols * FFS: Any further restrictions/enhancements needed on supporting A-CSI multiplexing on PUSCH repetitions |
| vivo | Support FL update #1. |

**Proposal 2:** 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

Please add comments below.

|  |  |
| --- | --- |
| Company | Comments |
| LG | Support |
| ZTE | Support |
| Lenovo&MotM | Support. |
| Apple | We support it in general. But we would like to ask for some clarifications for “invalid UL symbols” for the first sub-bullet, any examples? |
| QC | Support to further study second and third aspects.  For the first aspect, we would like to note that for PUCCH repetition, this (counting number of repetitions based on available/valid slots) is already the behavior in the spec (no enhancements seem to be needed). For PUSCH repetition, this is under discussions in coverage enhancements WI, and another overlapping enhancement should be avoided at this point. |
| OPPO | Support |
| Spreadtrum | Support |
| LG | @Apple: For example, if gNB dynamically schedules PDSCH in PUSCH/PUCCH TO or indicates DL slot for flexible slot by DCI 2-0, the overlapped symbols become invalid UL symbols. In that case, the issue is whether beam are mapped considering invalid UL symbols or not.  @QC  For PUCCH, UE counts number of repetition only based on valid slots if invalid symbols/slots are configured in semi-static manner. However, in case of dynamic DL symbols/slots indication as I mentioned as an example above, UE just drops the invalid UL symbols/slots so that actual number of repetition is less than the configured number. Therefore, further study on beam mapping is needed for that case. For PUSCH, in CE WI, if PUSCH is enhanced in the same way as the PUCCH drop, we have the same issue. However, we understand your point and it seems better to check how PUSCH enhancement goes in CE and MTRP beam mapping enhancement for PUSCH may or may not be needed depending on CE enhancement. Current proposal does not propose to support enhancement but points out something we need to study. Therefore, we need to keep it as FFS. |
| MediaTek | Support |
| vivo | Agree for further study. |
| CMCC | Support. |
| NTT Docomo | Support. |
| Samsung | Support |
| NEC | OK for further study. |
| Xiaomi | Agree for further study. |
| Huawei, HiSilicon | Support for further study. |
| Nokia | Ok with the proposal to study further those aspects. |
| FL update 1 | @QC: I assume LG’s explanation is good enough. In any case, this is further study, and everyone can further discuss he concerns.  **Proposal 2:** 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 |
| Futurewei | Support |
| InterDigital | We are OK with further studying these issues. |
| Fujitsu | Support |
| TCL | Support for further study. |
| CATT | Support. |
| Ericsson | Support Proposal n FL update #2. |
| APT | We are generally fine to support these bullets for further study, but we are also wondering if the invalid symbol pattern introduced in Rel-16 Type-B PUSCH for URLLC is taken into account in the first bullet as well. In Rel-16 Type-B PUSCH repetition, a nominal PUSCH repetition may be segmented into more than one actual PUSCH repetition or may be omitted since the PUSCH repetition is to be mapped in symbols indicated as invalid in the pattern. Specially, if two beams are configured, some enhancements may need to be introduced (e.g., invalid symbol pattern configured per BWP may be not feasible for multiple TRP operation). If the invalid symbol pattern is not considered in the first bullet, we proposed to capture it as one of bullet in the proposal 2:  **Proposal 2:** 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 * Whether enhancement on Rel-16 invalid symbol pattern is needed |
| FL update #2 | @APT: Invalid pattern may not fully related to beam mapping or default behaviour listed in the main bullet.  No changes to the proposal and can be endorsed.  **Proposal 2:** 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 |
| vivo | We would like to add one more future discussion point on the beam mapping.  **Proposal 2:** 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 * Whether support beam mapping based on slot index or repetition index, or both |

# Agreements

**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 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.

**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,* andselect 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.

**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)