3GPP TSG RAN WG1 #104-bis-e R1-2104052

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

**Agenda item: 8.1.2.1**

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

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

**Document for: Discussion and Decision**

#  Introduction

The document is based on the earlier version

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

R1-2103844 Summary #2 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

R1-2103844 Summary #3 of Multi-TRP for PUCCH and PUSCH Moderator (Nokia)

* Proposals to endorse in email tread are in purple.

#  Proposals after Phase #1/#2/#3 – Endorsement via Email

### Proposal 2.2/3.1: Power control TPC

**Proposal 2.2**: To support per TRP closed-loop power control for PUCCH , a second TPC field can be configured via RRC .

* When the second field is configured by RRC , a second TPC field (similar to the existing TPC field) is added in DCI formats 1\_1 / 1\_2 (option 3).
* When the second field is not configured by RRC ,  a single TPC field (the existing TPC field) is used in DCI formats 1\_1 / 1\_2, and the TPC value applied for both PUCCH beams.
* This feature is subjected to whether UE support 2 closed-loop power control processes

**Proposal 3.1**: To support per TRP closed-loop power control for PUSCH with DCI formats 0\_1 / 0\_2, adopt the same solution as with M-TRP PUCCH schemes.

### Proposal 2.3-2/3: Working assumptions one beam mapping

**Proposal 2.3-2:** Confirm the following Working Assumption:

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

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

**Proposal 2.3-3:** Confirm the following Working Assumption (with small correction of typo and clarification on UE capability):

* For beam mapping /power control parameter set mapping for PUCCH repetitions,
	+ For M-TRP PUCCH Scheme 1 in FR1, it is possible to configure either cyclic mapping or sequential mapping of power control parameter sets over PUCCH repetitions (similar to spatial relation info’s over PUCCH repetitions).
	+ For M-TRP PUCCH Scheme 3, reuse the same methods as Scheme 1 (by replacing slots with sub-slots) for beam mapping or power control ~~resource~~ parameter set mapping ~~to sub-slots~~.
	+ The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.

### Proposal 3.2-2: Open-loop power control

**Proposal 3.2-2:** For the indication of open-loop power control parameter (OLPC) in DCI format 0\_1/0\_2, support enhanced open-loop power control parameter (OLPC) set indication by indicating per-TRP OLPC set.

* + FFS: Details of indication.

### Proposal 3.2-5: SRI indication is absent

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

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

Hold proposal until 3.9 gets agreed. **Discuss in the next meeting.**

### Proposal 3.3-2: Working assumption on PUSCH beam mapping

**proposal 3.3-2:** Confirm the following working assumption (with removing the last bullet):

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

* The support of cyclic mapping can be optional UE feature for the cases when the number of repetitions is larger than 2.
* FFS: Support of half-half mapping.
* FFS: Additional considerations on mapping patterns (including required beam switching gaps)

~~Companies are encouraged to provide further simulation results to decide details~~

### Proposal 3.4: PT-RS DMRS association

**Proposal 3.4:** For single DCI based M-TRP PUSCH Type B repetition, the indication of PTRS-DMRS association for maxRank > 2 is supported, down select one of the following options in RAN1 #1054~~bis~~-e meeting,

* Option 1 (4 bits): with a second PTRS-DMRS association field (similar to the existing field), and each field separately indicating the association between PTRS port and DMRS port for two TRPs.
* Option 2 (2 bits): using the existing PTRS-DMRS association field in DCI for the first TRP, and using reserved entries/bits in DM-RS port indication field for the second TRP.
* Option 3 (2 bits): 1 bit MSB is used to indicate PTRS-DMRS association for the first TRP, and 1 bit LSB is used to indicate PTRS-DMRS association for the second TRP
	+ if *maxNrofPorts* = 1, the 1 bit indicates one of the first two DMRS ports.
	+ if *maxNrofPorts* = 2, the 1 bit indicates one of two DMRS ports sharing the same PTRS port.

### Proposal 3.6: CG PUSCH

**Proposal 3.6:** For type 1 or type 2 CG based multi-TRP PUSCH repetition,

* Introduce the second fields of 'p0-PUSCH-Alpha' and 'powerControlLoopToUse' in 'ConfiguredGrantConfig’
* For type 1 CG based m-TRP PUSCH repetition, introduce the second fields of ‘pathlossReferenceIndex’, 'srs-ResourceIndicator' and 'precodingAndNumberOfLayers' in 'rrc-ConfiguredUplinkGrant'.
* For type 2 CG based M-TRP PUSCH, two SRIs/TPMIs are indicated via the activating DCI.
* FFS1: UL PT-RS port(s) and DM-RS port(s) for CG type 1
* FFS3: Details on RV mapping.
* FFS4: Possible transmission occasion for initial transmission
* FFS5: Other TRP specific parameters in 'rrc-ConfiguredUplinkGrant', e.g., 'dmrs-SeqInitialization'.

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

**Proposal 3.7:** For CB based M-TRP PUSCH repetition, the first TPMI field is used to determine the entry of the second TPMI field which only contains TPMIs corresponding to the indicated rank (number of layers) of the first TPMI field. The second TPMI field’s bit width, $M\_{2}$, is determined by the maximum number of TPMIs per rank among all ranks associated with the first TPMI field. For each rank y, the first $K\_{y}$ codepoint(s) of the second TPMI field are mapped to $K\_{y}$ TPMI(s) of rank y associated with the first TPMI field in increasing order codepoint index, the remaining $(2^{M\_{2}}- K\_{y})$ codepoint(s) are reserved.

* How to describe/capture this in 38.212 is up to the editor.

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

**Proposal 3.8:** For non-codebook based multi-TRP PUSCH, the first SRI field is used to determine the entry of the second SRI field which only contains the SRI(s) combinations corresponding to the indicated rank (number of layers) of the first SRI field. The number of bits, $N\_{2}$, for the second SRI field is determined by the maximum number of codepoint(s) per rank among all ranks associated with the first SRI field. For each rank x, the first $K\_{x}$ codepoint(s) are mapped to $K\_{x}$ SRIs of rank x associated with the first SRS field, the remaining $(2^{N\_{2}}- K\_{x})$ codepoint(s) are reserved.

### Proposal 2.7: Default PUSCH beam

**Proposal 2.7:** The UE expect that the PUCCH resource with the lowest ID is always activated with single spatial relation info.

**Discuss in the next meeting.**

# Agreements after Phase #1/#2/#3

**Agreement**

For the case of multi-TRP, to support per-TRP power control in FR1, the linking of PUCCH resource with [one or] two power control parameter sets, the following is supported

* MAC-CE indicates RRC IE that configures power control parameter sets (p0, pathloss RS ID, and a closed-loop index).
	+ The exact design of RRC IE is up to RAN2 but from RAN1 point of view, one possible example is to reuse *PUCCH-SpatialRelationInfo* except for the *referenceSignal*

Note: It is common understanding in RAN1 that one PUCCH resource can be linked to one power control parameter set.

**Conclusion**

With reference to the normative work on NR-feMIMO:

Related to the support of switching gap between UL transmissions towards two TRPs in RAN1 specifications, there is no consensus in RAN1 to specify symbol gap(s) for the following cases

* PUSCH Type A
* PUCCH scheme 1
* PUSCH Type B
* PUCCH scheme 3

The above applies for the case included in the LS from RAN4 in R1-2102297.

**Agreement**

When inter-slot frequency hopping is configured with Scheme 1, decide one from the below options in RAN1#105-e meeting,

* Option 1
	+ If sequential mapping pattern is configured, frequency hopping is performed on slot level (as in Rel-15).
	+ If cyclical mapping pattern is configured, frequency hopping is performed among the repetitions with the same beam.
* Option 2:
	+ gNB always configures sequential mapping pattern and frequency hopping is performed on slot level. (no spec impact)
* Option 3:
	+ Frequency hopping is performed on slot level as in Rel-15 (no spec impact).

**Agreement**

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

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

**Agreement**

For PHR reporting related to M-TRP PUSCH repetition, select one from the following options in RAN1 #105-e meeting.

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

**Agreement**

When MAC-CE indicates a PL-RS ID for one or more SRI IDs, it also indicates whether the SRI IDs are associated with the first or the second SRS resource set.

**Agreement**

For multiplexing A-CSI on two PUSCH repetitions in the case of multi-TRP PUSCH repetition,

* For S-DCI based multi-TRP PUSCH repetition Type B, support multiplexing A-CSI on the first PUSCH repetition corresponding to the first beam and the first (X = 1) PUSCH repetition corresponding to the second beam.
	+ The UE is expected to follow the above operation for multiplexing A-CSI on two PUSCH repetitions only if
		- the first actual repetition corresponding to the first beam and the first actual repetition corresponding to the second beam does not have the same number of symbols, and
		- UCIs other than the A-CSI are not multiplexed on any of the two PUSCH repetitions.
	+ When the UE does not follow the above operation, UE multiplexes A-CSI only on the first PUSCH repetition similar to Rel. 15/16.
* The content for the two A-CSI should be the same
* Note: RAN1 has the assumption on CSI timelines are followed as rel-15/16, including UE shall expect the timeline for the first A-CSI meets Z and Z’ requirement
* FFS: For s-DCI based multi-TRP PUSCH repetition Type A and B, support multiplexing of A-CSI on the first PUSCH repetition corresponding to the first beam and the first PUSCH repetition corresponding to the second beam when there is no TB carried in the PUSCH.
	+ The UE assumes that the number of repetitions is 2 regardless of the indicated number of repetitions.
	+ For PUSCH repetition Type B, the first and second nominal repetitions are expected to be the same as the first and second actual repetitions, respectively (no segmentation).

**Working Assumption**

For indicating STRP/MTRP dynamic switching for non-CB/CB based MTRP PUSCH repetition,

* Introduce a new field in DCI to indicate at least the S-TRP or M-TRP operation
	+ FFS: Whether the new field is 1 bit or 2 bits