**3GPP TSG RAN WG1 #108-e R1-220nnnn**

**e-Meeting, February 21st – March 3rd, 2022**

**Title:** Draft LS on feMIMO RRC parameters

**Response to:** R2-2202002

**Release:** Rel-17

**Work Item:** NR\_feMIMO-Core

**Source:** 3GPP TSG-RAN WG1, Ericsson

**To:** 3GPP TSG-RAN WG2

**Cc:** 3GPP TSG-RAN WG3, 3GPP TSG-RAN WG4

**Contact Person:**

#### Name: Mattias Frenne

E-mail Address: mattias.frenne@ericsson.com

**Send any reply LS to: 3GPP Liaisons Coordinator,** [**mailto:3GPPLiaison@etsi.org**](mailto:3GPPLiaison@etsi.org)

**Attachments:** None

# 1. Overall Description:

This is a reply LS to RAN2 to address the RAN2 questions on several L1 parameter related open issues as well as overall the implementation of all L1 feMIMO RRC parameters.

**2. MultiBeam related questions**

**CORESET** **to follow Unified TCI state**

RAN2 has discussed the per CORESET RRC based indication based on RAN1 agreements.

* + *For any PDCCH reception on a ‘CORESET B’ and the respective PDSCH reception, whether or not UE to apply the indicated Rel-17 TCI state associated with the serving cell is determined per CORESET by RRC*

RAN2 understands that the 1 bit RRC indication “*followUnifiedTCI-State*” would be needed for CORESET type “B”. RAN2 understanding is that it seems to indicate how the CORESET behaves with respect to the TCI state of PDSCH depending on the type (i.e. CSS or USS) of the SearchSpace that is linked to that CORESET. However, as in RRC there is no types of CORESETs RAN2 would like to ask RAN1 to clarify the intention of the indication in more details.

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**Question 1.1:** What is the intent behind this indication and why was it put to CORESET but not per SearchSpace?

**Answer 1.1:**

RAN1 introduced the terms CORESET ‘A’, ‘B’ and ‘C’ for discussion purposes only, and RAN1 has no intention to introduce CORESET types in specification. The 1-bit indication was put in the CORESET to mimic legacy that TCI state is configured and activated (if needed) per CORESET, but not per search space set. RAN1 will describe in RAN1 specifications how the UE should expect/interpret this 1- bit indication.

Note that RAN1 has discussed both options (per CORESET or per SS) for application of indicated Rel-17 TCI state, but it was agreed to support per CORESET indication.

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**Question 1.2:** Are there any limitation or conditions needs to specified for the "*followUnifiedTCI-State*" parameter?

**Answer 1.2:**

The limitations or conditions are currently under discussion in RAN1. RAN1 will inform this information to RAN2 as early as possible.

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**Question 1.3:** How are the “DM-RS for non-UE dedicated PDCCH” in parameter "*applyTCI-State-DL-List-r17"* and the CORESET B “*followUnifiedTCI-State*” related?

**Answer 1.3**:

Whether or not a CORESET, and consequently the corresponding DM-RS, is configured to follow the unified TCI state is determined by “followUnifiedTCI-State”. The parameter "applyTCI-State-DL-List-r17" is not needed for DM-RS associated with a CORESET.

**Parameter *applyTCI-StateDL-List-r17***

RAN2 notes there is discrepancy with the description and comment related to *applyTCI-State-DL-List-r17*. RAN2 has baseline implementation for this functionality where 1 bit “followUnifiedTCI-State" indication is added to “AssociatedReportConfigInfo” IE where QCL per an aperiodic resource set is currently configured i.e. all resource within NZP-CSI-RS resource set follow unified TCI state in DCI.

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**Question 1.4:** Is this RRC parameter implementation is according to intended functionality or should the indication be placed per NZP-CSI-RS resource set or resource. Note that these NZP-CSI-RS resource sets and resource configurations are not specific to AP?

Note that it will be RAN2 signalling design whether supporting this functionality is 1 bit indication per field X, or by maintaining lists of field X.

**Answer 1.4:**

It is not fully aligned with the intended functionality. RAN1 has agreed that only aperiodic CSI-RS for beam management and aperiodic CSI-RS for CSI acquisition can follow the indicated Rel-17 TCI state, which can all be configured using CSI-AssociatedReportConfigInfo. RAN1 has also agreed that periodic CSI-RS, and semi-persistent CSI-RS (therefore CSI-RS for tracking) never follow the indicated Rel-17 TCI state. Provided that these restrictions are captured in the field description of followUnifiedTCI-State in CSI-AssociatedReportConfigInfo, the proposed RRC implementation would be fine.

**Parameter ApplyTCI-State-r17forSRS**

RAN2 intends to add the parameter “*followUnifiedTCI-State-r17*” (*ApplyTCI-State-r17forSRS* in RAN1 RRC parameter list) to *SRS-ResourceSet* IE according to RAN1 guidance.

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**Question 1.5:** Are the stated restrictions indicated in the L1 parameter excel (i.e. “This applies to the following: 1) Aperiodic SRS for BM, 2) SRS (of any time-domain behavior) for codebook, non-codebook, and antenna switching “) should be placed in TS 38.331 or these will be specified by RAN1? If they should be specified in RAN2, are there any additional restrictions that have not yet been communicated?

**Answer 1.5:**

RAN1 is okay to implement the stated restrictions in TS 38.331, and there are no additional restrictions. If there are new restrictions agreed, RAN1 will communicate them to RAN2.

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**Question 1.6:** RAN2 would also like to confirm whether also semi-persistent SRS (as RAN1 mentioned “of any time-domain behaviour) will follow unified TCI state in DCI or some coordination between RRC signalling, MAC CE and DCI is needed?

**Answer 1.6:**

For AP/SP/P SRS for codebook/non-codebook/antenna switching, it can also be configured by RRC on whether to follow Rel-17 indicated TCI.

Regarding to SRS for BM, only AP SRS for BM can be configured by RRC on whether to follow Rel-17 indicated TCI. Thus, if the parameter “followUnifiedTCI-State-r17” is used, then the restriction should be captured by RAN2 that it cannot be configured or applied when the SRS for BM is transmitted in SP/P manner.

**MPE**

**Question 1.7:** Please clarify the structure of the *mpe-ResourcePool*: Is it a list of SSB or CSI-RS resources (i.e. SSBRI or CRI), and what is the maximum number of resources configured in the pool?

**Answer 1.7:**

It should be a list/set of SSB or CSI-RS resources index. Each SSB or CSI-RS resource index must also be associated with a serving cell index. RAN1 doesn’t preclude the re-use of existing IEs for the CSI-RS/SSB resource sets.

There is no RAN1 agreement, on the maximum number of resources in the pool. The maximum number of resources is 64.

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**Question 1.8:** Does the enhanced MPE reporting applies also to mTRP operation, and, if it does, will this be configured by *mpe-Reporting-FR2* or is another RRC configuration needed?

**Answer 1.8:**

RAN1 are still discussing and are considering the two alternatives below (exact formulations TBD)

***Alt1.***

Note that enhanced MPE reporting and the multi-TRP PHR enhancement are two different features in Rel-17. Hence, the enhanced MPE reporting cannot be combined with the multi-TRP PHR specified in Rel-17. In addition, the enhanced MPE reporting can be applied to mTRP operation as long as the mTRP PHR is not enabled. Note that there is no problem to reuse MAC CE structure defined for mTRP if RAN2 finds it beneficial.

***Alt.2***

The enhanced MPE reporting can be applied to mTRP operation, and enhanced MPE reporting can be combined with mTRP PHR reporting specified in Rel-17’

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**Question 1.9:** RAN1 to confirm whether the RAN2 should keep the MPE-Config-FR2-r17 in the PHR-Config IE, which is per cell group, or move it to (per-cell) per BWP level as indicated in L1 parameter excel?

**Answer 1.9:**

The enhanced MPE reporting doesn't impact how the PHR-Config is provided, and RAN2 can keep the MPE-Config-FR2-r17 in the PHR-Config IE, which is per cell group. The mpe-ResourcePool-r17 under MPE -Config-FR2-r17 should be BWP /CC-specific.

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**Question 1.10:** Is reporting of PCMax,f,c needed for MPE information and if it is, should it be included per indicated SSBRI/CRI value or is it cell-specific?

**Answer 1.10**:

RAN1 is still discussing and more time is needed.

**BeamAppTime value range**

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**Question 1.11:** RAN2 would like to further confirm whether this parameter is per-UE (i.e. applicable to all cell groups per SCS), per cell group (i.e. within the same cell group, all cells use the same values per SCS), per cell (i.e. different cells may use different value per SCS), or something else?

**Answer 1.11:**

RAN1 only has agreed that the BAT shall be the same for all the CCs configured with the common TCI state ID update based on the smallest SCS of the active BWP. How to provide the BAT for CA is currently under discussion in RAN1, and RAN1 will inform to RAN2 as early as possible if any conclusion is made.

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**Question 1.12:** Is it correct understanding that the common TCI state ID update is when the same TCI state list is configured for multiple CCs with reference BWP/CC?

**Answer 1.12:**

The understanding is not correct. Common TCI state ID update can be configured not only when the same TCI state list is configured for multiple BWPs/CCs with reference BWP/CC, but also when TCI state list is provided for each BWP/CC as in Rel-15/16

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**Question 1.13:** Please indicate what should be the value range for parameter *beamAppTime-r17?*

**Answer 1.13:**

RAN1 has agreed the following:

**Agreement**

The value range of beamAppTime-r17 is (1, 2, 4, 7, 14, 28, 42, 56, 70, 84, 98, 112, 224, 336) symbols.

* Discuss the applicability of 84, 98, 112, 224, 336 for FR2/FR2-2 in UE features session
  + These values are not applicable for FR1

**CSI-SSB-ResourceSet**

**Question 1.13:** Should it be possible for different SSB indexes in the same *CSI-SSB-ResourceSet* to be associated with different *additionalPCI*?

**Answer 1.13:**

Yes, it should be possible that different SSB indexes in the same CSI-SSB-ResourceSet are associated with different additionalPCI.

**Simultaneous usage of different operation for different serving cells**

RAN2 understanding is that all channels and RS in one serving cell have to follow one TCI state framework, either Rel-17 or Rel 15/16.

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**Question 1.14:** Please confirm whether above RAN2 understanding is correct.

**Answer 1.14:**

RAN1 confirms this understanding. It should be clarified that spatial relation info for positioning RS can still be configured using legacy framework together new unified TCI framework

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**Question 1.15:** can different serving cells in a cell group use different TCI framework (Rel-16 or Rel-17)?

**Answer 1.15:**

Yes, different serving cells in a cell group can use different TCI framework.

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**Question 1.16:** can different serving cells in a cell group use different TCI mode (joint or separate) if Rel-17 unified TCI framework is configured?

**Answer 1.16:**

Yes, different serving cells in a cell group can use different TCI mode (joint or separate).

**BM power control configuration**

In current running RRC CR the PO set(P0, alpha, closed loop index) is encoded in both UL TCI state as well in *BWP-UL-Dedicated* (that is outside of UL TCI state) and different values are enabled for each UL channel PUSCH, PUCCH, SRS. UE receives the UL pc configuration in either UL TCI states or in BWP UL-dedicated.

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**Question 1.15:** Is it correct understanding that network may provide UE the UL pc configuration in either UL TCI states or in *BWP-UL-dedicated* or should RAN2 choose one? If UL PC configuration is signalled in BWP-UL-dedicated only, how can the specific PC configuration (actually applied) be decided in PHY layer?

**Answer 1.15:**

RAN1 has reached agreement that it should be possible to associate the UL pc configuration with a UL or joint TCI state. RAN1 also agreed not to include the UL pc configuration in an UL or joint TCI state. Therefore, UL pc configuration should not be provided in an UL or joint TCI state.

However, the agreement also states that it should be possible to not configure any association, meaning that irrespective of which UL or joint TCI state is currently indicated, the same set of channel/RS-specific PC parameters should be used for each of the PUSCH, PUCCH, and SRS.. Implementing the UL PC configuration in the UL BWP provides the desired functionality. In the field descriptions, it could be stated that the NW should configure the PC parameters in the UL BWP.

**2. mTRP (PUCCH, PDCCH) related questions**

**Question 2.1:** How many power control sets needs to be configured with respect to the each TRP and then in relation to the corresponding MAC CE per UE/cell/BWP?

**Answer 2.1:**

The maximum number of power control parameter sets is 8, which is subjected to UE capability. The power control sets can be configured per BWP. MAC-CE can then activate up to two power control sets

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**Question 2.2:** Should the *searchSpaceLinking* be applied to all or selected set of SearchSpaces under Rel-15 and Rel-16 configurations?

**Answer 2.2:**

RAN1 confirms that searchSpaceLinking should be applied to SearchSpaces under both Rel-15 and Rel-16 configurations. As RAN2 is aware, several limitations are agreed by RAN1, some of which are already captured in RAN1 spec. RAN1 would like to suggest RAN2 to capture the following agreements (or the highlighted parts of the last agreement below) in 38.331 as they have not been captured by RAN1 spec, and they may be more suitable to be captured by RRC spec. For other limitations that are already captured in RAN1 spec, it is up to RAN2 whether to also include them in RRC spec or not.

Related agreements:

**Agreement**

The following SS sets cannot be linked with another SS set for PDCCH repetition: *SS set 0, searchSpaceSIB1, searchSpaceOtherSystemInformation, pagingSearchSpace, ra-SearchSpace*.

**Agreement**

SS set configured by *recoverySearchSpaceId* cannot be linked to another SS set for PDCCH repetition.

**Agreement**

The following SS sets cannot be linked with another SS set for PDCCH repetition: *searchSpaceBroadcast, peiSearchSpace, and sdt-SearchSpace*.

**Agreement**

Confirm the following working assumption in RAN1 #106-bis-e:

When a scheduled CC is configured to be cross-carrier scheduled by a scheduling CC, two PDCCH candidates (with the same AL and candidate index associated with the scheduled CC) are linked only if the corresponding two SS sets in the scheduling CC are linked and two SS sets in the scheduled CC with the same SS set IDs are also linked.

* Note: The PDCCH candidates associated with the scheduled CC are defined as part of SS sets for scheduled CC instead of SS sets for scheduling CC (Same as Rel-15)

**Agreement**

For PDCCH repetition, support linking two SS sets by RRC configuration:

* FFS: Whether MAC-CE can be used additionally
* When PDCCH repetition is monitored in two linked SS sets, the UE does not expect a third monitored SS set to be linked with any of the two linked SS sets.
* The two linked SS sets have the same SS set type (USS/CSS)
  + The two linked SS sets have the same DCI formats to monitor
* For intra-slot PDCCH repetition,
  + The two SS sets should have the same periodicity and offset (monitoringSlotPeriodicityAndOffset), and the same duration
  + For linking monitoring occasions across the two SS sets that exist in the same slot:
    - The two SS sets have the same number of monitoring occasions within a slot and n-th monitoring occasion of one SS set is linked to n-th monitoring occasion of the other SS set

**Question 2.3:** How is the "TRP identity" defined for this MAC CE or other potential per TRP MAC CEs?- is it based on *SRS-ResourceSet* ID, BFD RS SET ID or something else? Note that current ASN1 does not have yet BFD RS SETs implemented.

**Answer 2.3:**

RAN1 specifications use the SRS resource set with same usage, either ‘codebook’ or ‘nonCodebook’, to represent TRP identify in case of mTRP operation for codebook-based and non-codebook based PUSCH transmission. Hence, 1 bit field for indicating 1st or 2nd ‘SRS-ResourceSet ID’ should be used in the above MAC CE

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**Question 2.4:** Please inform how to implement beam failure detection RS sets for mTRP. Also what is the maximum number of detection resources to be configured per UE per cell or per TRP? What is the maximum number of recovery resources to be configured per UE per cell or per TRP?

**Answer 2.4:**

RAN1 agreed to support both explicit and implicit beam failure detection (BFD) RS sets configurations for mTRP, and the implicit BFD RS sets can only be configured for mDCI based mTRP (i.e., when PDCCH-Config contains two different values of coresetPoolIndex). The two beam failure detection RS sets are to be configured per DL BWP (BWP-DonwlinkDedicated).

For implicit configuration, the UE determines the two BFD RS sets including periodic CSI-RS resource configuration indexes having the same values as the source RS indexes in the TCI states for the CORESETs associated with respective pool indexes 0 and 1.

Details on explicit configuration (RRC, MAC-CE or RRC+MAC-CE) are still under discussion in RAN1. RAN1 will notify RAN2 after RAN1 reach any consensus.

The maximum number of detection resources per set per CC is 64, which is subject to UE capability.

**3. CSI mTRP related question**

**Question 3.1:** Which CBSRs are intended to be used and whether there are specific restrictions to be applied for the RRC configuration? Also whether is it introduced for both typeI-SinglePanel1 and typeI-SinglePanel2 and also for both 2Tx and more than 2Tx?

**Answer 3.1:**

RAN1 is still discussing, and more time is needed.

**4. SRS related question**

**Question 4.1:** Should the parameter *startPosition* should be included in *resourceMapping* also for Rel-17 (similarly as it was there in Rel-15 and Rel-16 configurations)?

**Answer 4.1**:

The startPosition should be included in resourceMapping for Rel-17 which can be all symbol locations within a slot (i.e., INTEGER (0,…,13), which is same as startPosition-r16).

**2. Actions:**

**To RAN2 group:**

**ACTION:** RAN1 respectfully asks RAN2 to take the answers to the questions into account in your further work.

**3. Date of Next TSG-RAN WG1 Meetings:**

TSG-RAN WG1 Meeting #109-e 15 – 27 May 2022 Electronic Meeting

TSG-RAN WG1 Meeting #110 22 – 26 August 2022 Toulouse, France