3GPP TSG-RAN WG2 Meeting #116 Electronic R2-2200015

Elbonia, 01 – 12 November 2021

**Agenda item: 8.17.2**

**Source: Ericsson**

**Title: Report of [Post116-e][086][feMIMO] RRC (Ericsson)**

**WID/SID: NR\_FeMIMO-Core - Release 17**

**Document for: Discussion and Decision**

# Introduction

**Typically Long discussions should start after 1 week short discussions have finished. Taking into account inactive period, the expected start is Nov 29.**

* [Post116-e][086][feMIMO] RRC (Ericsson)

 Scope: Progress the RRC discussion points, TCI state RRC modelling with MAC CE and DCI implications, Review selected L1 parameters, possibly taking into acct new outcomes from RAN1, Collect comments on related RRC TPs,

 Intended outcome: Report, and the related Running CR updates for discussion and decision next meeting

 Deadline: Long (allowed to start in parallel with 1st week short discussions)

RAN2#116 agreements are listed in the appendix.

Official RRC parameter email discussion covering all WIs starts 29th November thus here we discuss based on the unofficial version found in RAN1 draft folders. This discussion covers RAN1 parameters that have indication “up to RAN2” or “RAN2 to design”. UL mTRP, mTRP BM, SRS, “HST, URLLC PDCCH” intermediate excels did not have parameters listed for RAN2 to design. Thus, this discussion covers some BM and mTRP parameters. Intermediate DL for companies to provide responses to this questionnaire is 10th December.

Running RRC CR is provided covers what was agreed by RAN2 so far.

Updated Running CR taking into count this email disc outcome is provided around 14th Dec.

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Ericsson | Helka-Liina Määttänen | Helka-liina.maattanen@ericsson.com |
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# 4 Beam management

The latest unofficial version on BM RRC parameters can be found in:

<https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Inbox/drafts/8.1.1/RRC>

Document is based on the unofficial version RAN1#107-e\_Rel-17\_RRC FeMIMO-8.1.1 -V2. *All conclusions are assumed tentative and to be updated based on any new input from RAN1.*

## 4.1 Unified TCI state operation

RAN1 is providing reply for LS RAN2 [9] sent out in last meeting. Response can be found in [10].

f) **TCI switching signalling:** Which signalling should be used for TCI switching for inter-cell beam management?

**Answer 2.f**: Inter-cell beam management is going to use Rel-17 unified TCI signaling where RAN1 agreed that a MAC-CE activates one or multiple TCI states out of RRC configured TCI state pool. If multiple TCI states are activated, DCI selects one TCI state among activated ones. If only one TCI state is activated, the activated TCI state is also implicitly selected without further DCI indication.

Further, RAN1 is sending MAC CE impact in an LS R1-2112842 wherein an attachment R1-211280 has the actual MAC CE excel. For BM, the following is stated:

|  |  |
| --- | --- |
| Description | Comment |
| Activation of up to 8 TCI state codepoints for UE-dedicated channel/signals beam indicationThis can be- For joint beam indicationo A joint TCI state- For separate beam indicationo DL only TCI stateo UL only TCI stateo DL TCI state + UL TCI state | Agreement RAN1#106bis-eOn Rel.17 unified TCI framework, for Rel-17 unified TCI:• For the number of codepoints in the TCI field for DCI-based beam indication (hence the number of codepoints activated via MAC-CE-based TCI state activation), the largest value is 8• Further discuss and finalize in RAN1#106bis-e: the largest number of configured TCI states (including joint TCI state(s), DL-only TCI state(s), and/or UL-only TCI state(s))Agreement RAN1#105-eFor M=N=1, on Rel-17 unified TCI, for separate DL/UL TCI, one instance of beam indication using DCI formats 1\_1/1\_2 (with and without DL assignment) can be used as follows: • One TCI field codepoint represents a pair of DL TCI state and UL TCI state. If the DCI indicates such a TCI field codepoint, the UE applies the corresponding DL TCI state and UL TCI state.• One TCI field codepoint represents only a DL TCI state. If the DCI indicates such a TCI field codepoint, the UE applies the corresponding DL TCI state, and keeps the current UL TCI state.• One TCI field codepoint represents only an UL TCI state. If the DCI indicates such a TCI field codepoint, the UE applies the corresponding UL TCI state, and keeps the current DL TCI state.FFS: the cases of M or N>1 |

As seen in the comment field, the existing DCI formats 1\_1 and 1\_2 are reused (as in Rel-15/16 beam management framework) for beam indication, both with and without DL assignment.

For “Joint DL/UL TCI” operation, one Joint TCI state can be activated per TCI codepoint of the DCI. One schematic example of how this may look is illustrated in Figure 1. In case the indicated TCI codepoint is “3” in the DCI UE receives as DL assignment, the UE should apply “Joint TCI state 10” as common QCL source for both DL and UL signals/channels in this example.



Figure 1 Example of activated TCI states and their mapping to TCI field codepoints for “Joint DL/UL TCI”

For “Separate DL/UL TCI” up to two TCI states can be activated per TCI codepoint of the DCI, one for DL signals/channels (DL-only TCI state) and one for UL signals/channels (UL-only TCI state). One schematic example of how this may look is illustrated in Figure 2. In case the TCI codepoint is “0”, the UE should apply “DL-only TCI state 3” as common QCL source for DL signals/channels, and not update the QCL source for UL signals channel. In case the TCI codepoint is “7”, the UE should apply “UL-only TCI state 57” as QCL source for UL signals/channels, and not update the QCL source for DL signals/channel. In case the TCI codepoint is “3”, the UE should apply “DL-only TCI state 10” as QCL source for DL signals/channels and apply “UL-only TCI state 12” as QCL source for UL signals/channels. It is also assumed that it is specified in one of L1 specifications what does the UE assume e.g. for PDCCH upon receiving the RRC configuration and before receiving the first DCI doing beam switching.



Figure 2 Example of activated TCI states and their mapping to TCI field codepoints for “Joint DL/UL TCI”

**Q1. Do companies agree with the above described mapping of “Joint DL/UL TCI” and “Separate DL/UL TCI” to DCI codepoint for TCI state indication?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | See comments | We are fine with the basic interpretation, i.e., “Joint DL/UL TCI” means that there is one TCI state ID for each codepoint, while “separate DL/UL TCI” means that there may be two TCI state IDs for each codepoint.  |
| Nokia, Nokia Shanghai Bell | Yes but | These are RAN1 details and RAN2 shouldn't have any say in this. The question is irrelevant to RAN2 except for the number of TCI states activated via MAC CE, and how to map the DCI codepoints. For the UL+DL case, it seems RRC configuration is needed to "tie" the UL and DL TCI states to a DCI codepoint. That hasn't been done so far in the RRC CR draft. We would also note that the **TCI state activation (done via MAC CE) is different from TCI state indication (done via DCI)**, which is a change to PDCCH compared to Rel-16 (although PDSCH already operated in that way).The activation and indicationneed not be done at the same time, and usually MAC CE is sent first and then DCI indicates the used TCI. So the RAN1 details only matter insofar as they show which **TCI states can be indicated via DCI**, but that is different from **MAC CE-based TCI state activation**.To make this clearer, please see the below figure illustrating how the Rel-17 unified TCI states (roughly) work in each layer. |
| Ericsson | yes | Exactly as Mediatek says: “Joint DL/UL TCI” means that there is one TCI state ID for each codepoint, while “separate DL/UL TCI” means that there may be two TCI state IDs for each codepoint.  |
| Nokia, Nokia Shanghai Bell | See above | There is no requirement the MAC CE structure needs to be exactly the same as DCI structure. All that is needed is the mapping of each codepoint.  |
| ZTE | Yes, See comments | According to the RAN1 LS, we tend to agree with the basic interpretation on the mapping principle between joint TCI/separate TCI and codepoint, which is one codepoint in DCI is mapping to one joint TCI which can indicate both UL/DL TCI state, and one codepoint in DCI is mapping to the separate TCI can indicate either UL or DL TCI state or both. |
| OPPO | Yes | The question itself only refer to the mapping between code point in DCI and the TCI state ID(s) i.e. it has nothing to do with enabler solution, which is debated by Nokia. But we also think this is related to RAN1, we’d better check with RAN1 once RAN2 conclude on this. |
| Intel | See comments | We have the same understanding as MediaTek. In addition, TCI code-point is not associated to TCI state via RRC signaling. RAN1 assumes that it is going to be decided upon MAC CE signaling. For example, if MAC CE includes 4 TCI states and then they are autonomously mapped to Code point #0-#3.  |
| Xiaomi | Yes | We agree with the understanding provided by MediaTek. |
| Samsung | Yes | We have same view with MediaTek i.e. high level interpretation seems fine.BTW we think the structure could be more simple if only one TCI state pool is used.  |
| Huawei, HiSilicon | Yes | Agree with MediaTek and Ericsson |
| Qualcomm | Yes | Agree with MTK and Intel as well. |
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**Conclusion:**

The formulation provided by Mediatek which is also according to the Figures 1 and 2 seems to be acceptable:

“Joint DL/UL TCI” means that there is one TCI state ID for each codepoint, while “separate DL/UL TCI” means that there may be two TCI state IDs for each codepoint.

**Proposal 1 RAN2 to conclude ““Joint DL/UL TCI” means that there is one TCI state ID for each codepoint, while “separate DL/UL TCI” means that there may be two TCI state IDs for each codepoint.”**

An example MAC CE design supporting the above operation can be described as depicted below.

|  |  |  |
| --- | --- | --- |
| E | Serving cell ID | BWP id |
| C | DL/joint TCI state ID |
| F | UL TCI state ID |
| C | DL/joint TCI state ID |
| F | UL TCI state ID |

E field describes whether the Mac CE is for “joint beam indication” or for “separate beam indication”. C field describes whether octet with UL TCI state ID is present (only needed for “separate beam indication”) and F field describes whether UE should consider the preceding octet as badding or as DL TCI state.

It is acknowledged that is this is not the only possibility to design the MAC CE.

**Q2. Do companies agree that the presented MAC CE example is technically correct? Note that this is not an attempt to agree on MAC CE design but to align understanding of the operation principle.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | If we have separate TCI state lists for DL/Joint and UL TCI states, for a “UL only” codepoint, we may need some dummy bits in the octet before UL TCI state ID so that UE won’t be confused with which list the TCI state ID refers to. The MAC CE example is technically correct, but maybe we should have more efficient format.Moreover, RAN1 has concluded that the mode of “joint beam indication” or “separate beam indication” is configured by RRC, and thus the ‘E’ field is not needed. |
| Nokia, Nokia Shanghai Bell | Not necessarily | This question is a bit strange: We can also present other "technically correct" MAC CE formats, but that really should not be a discussion point: Everything we do has to be "technically correct".The real question we need to consider is **what should be contained in the MAC CE for the unified TCI state indication? Do we have multiple TCI state IDs, and will we use the same or different TCI state ID for representing UL, DL and joint TCI states?**The above example seems to be based on the "separate TCI state ID" qassumption, and for that it could be one way to handle the MAC CE. But it's missing details on 1) how many TCI states can be activated per MAC CE (above example only allows for 2 UL and 2 DL/joint)? 2) Can one MAC CE activate both DL **and** joint DL TCI state? and 3) can one MAC CE activate TCI states for more than one serving cell?If we consider the "common TCI state ID", the picture becomes slightly different:The MAC CE size with this is 2+N octets, where N is the number of TCI states activated (max 8 according to RAN1 decision), so the size is **2-10 octets**. To compare with the above MAC CE structure, it can be better described as follows (using also 8 TCI states/max per MAC CE): The MAC CE size with this is 3+N octets, where N is the number of TCI states activated (max 8). Due to the separate TCI IDs, the structure is alternating so that the E-bit presence in the header indicates whether the octets with F-bit are present or not, which makes the structure more complex. It appears that the size would be 2+N octets, where N is max 8, so the size is **2-10 octets**. However, we note that there are no R-bits, and when the "separate" TCI states are used, the design assumes both UL and DL TCI states are always present, even if the E/F-bits are set to zero. Based on above, we observe the following:* There is no size difference in either design.
* The "separate" TCI state design has no R-bits, so cannot be extended. The common TCI state design has 1 R-bit, so can be extended.
* The structure of "separate" TCI states is more complex due to alternating between UL and DL TCI states.

This illustrates that from MAC CE perspective, the "common TCI state" design is clearly simpler and the "separate TCI state" has no size advantage. |
| r Ericsson | yes | FFS detailed design considering all the Better design options |
| ZTE | Not sure | To our understanding, it is earlier and not safe to provide the MAC CE detail design before we have a clear/solid agreement on RRC structure for the TCI state list.  |
| OPPO | See comment | Usually MAC CE is designed as such that RRC IEs are referred. Without concluding RRC structure of joint and/or separate TCI state, it is bit difficult. Nevertheless we think RRC should define separate TCI state pool for DL/Joint TCI state in PDSCH-Config and BWP-UplinkDedicated respectively. Then it would be natural that the TCI state id from these two TCI state pools will be referred in MAC CE in order to activate/deactivate joint or separate TCI state.Neverthless we can already find the answer in latest list of MAC CE in RAN1 LS in R1-2112842:Activation of up to 8 TCI state codepoints for UE-dedicated channel/signals beam indicationThis can be- For joint beam indicationo A joint TCI state- For separate beam indicationo DL only TCI stateo UL only TCI stateo DL TCI state + UL TCI stateRAN2 can figure out detail MAC CE design at next stage |
| Intel  | See comment | Although we are not sure if it is efficient, the proposed MAC CE structure from the moderator seems aligned with RAN1’s agreement except “E” field. We understand that MAC CE activates only joint TCI states or only separate TCI states. Not mixed up. “E” field can be used to differentiate joint and separate TCI state MAC CE type but it is also possible for the UE to know the MAC CE type based on the first TCI state index. In that sense, we don’t need “E” field.We have the same understanding that In case of separate TCI state, one code-word needs to be mapped to two TCI states (one for DL only TCI and one for UL only TCI) |
| Xiaomi | See comments | We think that it is probably too early to decide the MAC CE format without considering the RRC signalling details (e.g. common/separate TCI state ID). It seems that the concerns raised by Nokia are valid. |
| Samsung | Yes, see comments | The example of MAC CE design is technically correct in case that we will introduce the separate TCI state lists for DL/Joint and UL TCI states. As RAN1 mentioned in the LS, the functionality is already clear but detail MAC CE design should be considered later when the whole picture of RRC structure is drawn. |
| Huawei, HiSilicon | See comments | We share the similar concerns from above companies, it is too early to conclude the MAC CE details as we still see room for optimization to avoid redundancy field/information. For instance, “E field” is not needed according to RAN1 agreements below.RAN1 #105-e:*“[Conclusion] On Rel-17 unified TCI framework, for a UE configured with both joint TCI and separate DL/UL TCI, configuration of joint TCI or separate DL/UL TCI is based on RRC signaling* *There is no consensus in RAN1 on how to support dynamic switching (either MAC-CE or codepoint based)”* |
| Qualcomm | Yes but | The proposed MAC CE works but agree with Nokia and others that we should first agree on the functionality before the structure. |
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**Conclusion:**

Seems most companies are ok with the technical principle of the MAC, and that was what the question intended to clarify. However, like pointed out with one company, it is a possible MAC CE design for the case we have separate lists for UL/DL and joint TCI state. As there was no consensus in Q8 about common/separate list, it is better not to attempt specific proposal from this question. We can come back to MAC CE design later.

In RAN2#106, RAN2 agreed

* RAN2 to support separate DL and UL and joint TCI state configurations. Details FFS.

In RAN1#107 the following agreement was taken:

**Agreement**

On Rel.17 unified TCI framework, for Rel-17 unified TCI, when a UE is configured with separate DL/UL TCI

* The number of configured TCI states a UE can support is a UE capability including the following candidate values per BWP per CC:
	+ DL TCI: 64, 128
	+ UL TCI: 32, 64
* Note: This doesn’t imply that UL TCI shares the same TCI state pool as or uses a different TCI state pool from joint DL/UL TCI.

The latest but unofficial excel has the following items

|  |  |  |  |
| --- | --- | --- | --- |
| Ran2 parent IE | Param name | Description | Comment |
| PDSCH-Config | TCI-State\_r17 | TCI state definition for Rel-17 unified TCI framework along with the components. | An additional field for UL spatial relation info may be needed when tci-StateType is 'ULO' (UL TCI only), or this function can be performed with qcl-Type1. It is up to RAN2 to decide.It can be discussed in RAN2 whether tci-StateType values are needed or not (e.g. whether RAN2 can supersede/build on current RAN1 agreements to combine DL-only and joint TCI into one designation for RRC optimization)It can be discussed in RAN2 whether a separate IE for UL-only TCI is needed (separately from the rest) as a part of RRC and/or MAC CE optimizationApplies only to Rel-17 unified TCI Framework |
|  |  | PDSCH configuration for each CC/BWP. The reference CC/BWP includes the Rel-17 TCI state pool (a list of TCI states) for PDSCH | Applies only to Rel-17 unified TCI Framework |
|  | UL\_TCI-State\_r17 | UL TCI. Analogous to Rel-15/16 spatial relation, this includes UL TCI state ID, an an identifier for a reference signal (SSB, CSI-RS or SRS). In addition, the IE may contain a separate pathloss RS. | It can be discussed in RAN2 if UL\_TCI-State\_r17 and TCI\_State\_r17 can be combined into the same IE. |

The list of TCI-state of DL/joint is suggested to be places in PDSCH-Config.

Further, RAN1 indicates a functionality(middle row), where DL/joint TCI state list is configured only for one/some serving cell and one/some BWP within it and other PDSCH-Configs could just refer to serving cell/BWP where the TCI state list is configured and assume the same for also this serving cell/BWP. This functionality intends to save RRC overhead in case the TCI state list is actually same for CC/BWPs of the UE.

**Q3. Do companies agree that A) the list of TCI-state of DL/joint is placed in PDSCH-Config? B) Indication where(which serving cell) joint/DL TCI state list can be found is placed in PDSCH-Config?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | See comments | (A): Yes.(B): No. An explicit indication placed in PDSCH-Config is not needed since there should be only one BWP/CC is configured with DL/joint TCI state list and it is shared with all BWPs/CCs in a list according to RAN1 agreement. UE can determine it from these BWPs/CCs in the same list without explicit indication. |
| Nokia, Nokia Shanghai Bell | See comments | Actually we think the first question is: **Do we extend existing TCI state configuration (within *TCI-State* IE) with the "joint" TCI state indication? --> For that, we would say "yes".**For A), we agree that at least the joint TCI state is handled as extension to the TCI-State IE (within *PDSCH-Config*, which is per BWP). For B), we don't see why this is needed and would like to clarify why the TCI state lists would NOT be part of the same serving cell always (since the inter-cell TCI states are still defined within one serving cell)? |
| Ericsson | yes | 1. Yes
2. Yes but open to other options as well
 |
| Nokia, Nokia Shanghai Bell v2 | See comments | To make the discussion more concrete: This is the current signalling of TCI states for PDSCH and PDCCH - the TCI states are defined under PDSCH-Config (per BWP configuration), and CORESET configuration (for PDCCH) points to those:PDSCH-Config ::= SEQUENCE { tci-StatesToAddModList SEQUENCE (SIZE(1..maxNrofTCI-States)) OF TCI-State OPTIONAL, -- Need N tci-StatesToReleaseList SEQUENCE (SIZE(1..maxNrofTCI-States)) OF TCI-StateId OPTIONAL, -- Need NControlResourceSet ::= SEQUENCE { tci-StatesPDCCH-ToAddList SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP tci-StatesPDCCH-ToReleaseList SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWPWe would note that currently, only QCL information type C/D allows serving cell ID indication to be used for other cells, as shown below:QCL-Info ::= SEQUENCE { cell ServCellIndex OPTIONAL, -- Need R bwp-Id BWP-Id OPTIONAL, -- Cond CSI-RS-Indicated

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| --- |
| ***cell***The UE's serving cell in which the *referenceSignal* is configured. If the field is absent, it applies to the serving cell in which the *TCI-State* is configured. The RS can be located on a serving cell other than the serving cell in which the *TCI-State* is configured only if the *qcl-Type* is configured as *typeC* or *typeD*. See TS 38.214 [19] clause 5.1.5. |

So it was not clear to us what would be the additional part here: Is something additional needed in *PDSCH-Config*, considering that the *TCI-State* itself already allows the cross-cell indication? We thought that can be used here and no additional aspects are needed, and it would be good to hear clear explanation from RAN1 on what they meant with the parameter list entry on that. |
| ZTE | See comments | 1. Yes
2. We need more information from RAN1 about the ‘middle row’ in the unofficial excel to determine whether an extra IE is needed for indicating the TCI state resource pool applied range.
 |
| OPPO | Yes | 1. Yes, the column E in latest agreed RAN1 RRC parameter table (R1-2112976),

PDSCH-Config is taken as parent IE and in column p (comment column) it is not open for RAN2 to discuss. So we interpret RAN1 also prefer to define it in PDSCH-Config.For B), we believe the relevant RAN1 agreements are from RAN1#106:**Agreement**On Rel.17 unified TCI framework, confirm the following working assumption as an agreement with a minor refinement highlighted in red For common TCI state ID update and activation to provide common QCL information at least for UE-dedicated PDCCH/PDSCH and/or common UL TX spatial filter(s) at least for UE-dedicated PUSCH/PUCCH across a set of [configured] CCs/BWPs: * RRC-configured TCI state pool(s) can be configured in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC as in Rel-15/16
	+ Note: Such RRC-configured TCI state pool(s) configuration doesn’t imply that separate DL/UL TCI state pool is excluded or supported
* RRC-configured TCI state pool(s) can be absent in the PDSCH configuration (*PDSCH-Config*) for each BWP/CC, and replaced with a reference to RRC-configured TCI state pool(s) in a reference BWP/CC
	+ In the PDSCH configuration (*PDSCH-Config*) of the reference BWP/CC, RRC-configured TCI state pool(s) shall be configured
	+ For a BWP/CC where the PDSCH configuration contains a reference to the RRC-configured TCI state pool(s) in a reference BWP/CC, the UE applies the RRC-configured TCI state pool(s) in the reference BWP/CC
* When the BWP/CC ID (i.e. *bwp-Id* or *cell*) for QCL-Type A/D source RS in a *QCL-Info* of the TCI state is absent, the UE assumes that QCL-Type A/D source RS is in the BWP/CC to which the TCI state applies
* Introduce a UE capability to report maximum number of TCI state pools it can support across BWPs and CCs in a band, and the candidate value at least includes 1
* FFS: Introduce a UE capability to report maximum number of configured TCI states that it can support across BWPs and CCs in a band
* FFS: How to define reference BWP/CC

Following RAN1’s suggestion, we think proposal from rapporteur is fine. The suggestion from Mediatek can also work.We think the reference to common TCI state pool by other BWP/CC is different from the cross reference between serving cell where source RS is configured and TCI state pool is defined. |
| Xiaomi | See comments | (A): Yes.(B): We think this is a valid option, but are also open to other options. From our understanding, there is only one serving cell configuration, and this would mean that we only have one PDSCH configuration per BWP per serving cell, when two PCIs are configured for the same serving cell. Maybe companies can firstly align the understanding on the serving cell configuration. |
| Samsung | Yes | 1. Yes
2. This functionality seems agreed by RAN1 and it could be supported by Ericsson’s proposal. But we also want to further see this is the only way and it is really required as Nokia mentioned.
 |
| Huawei, HiSilicon | A): YesB): See comments | Regarding B), we share the concerns from MediaTek. We need to first figure out how many reference CCs/BWPs can be configured to UE. If only one needs to be configured, we see no need to indicate it explicitly. |
| Qualcomm | Yes | For B, we can consider other options if we can identify any problem with the RAN1 method. |
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**Conclusion:**

Companies are ok to have also unified TCI states in PDSCH config. However, whether the suggested RRC signaling optimization is needed or not can be further discussed. To clarify, this is over serving cells on different frequencies and not relevant for the addition “cell” aka additional TRP which is to be configured within the serving cell and of which the associated SSB is on same frequency as the primary cell/PCI/SSB.

For now, a placeholder for unified TCI state related parameters is implemented in running RRC in PDSCH-Config.

**Proposal 2 RAN2 to conclude that unified TCI state related parameters(placeholder for now) is implemented in running RRC in IE PDSCH-Config.**

**Proposal 3 RAN2 to clarify from RAN1 how many CC UE is expected to be configured with unified TCI state operation.**

Last round, RAN2 discussed on the meaning of the beam application time parameter *BeamAppTime\_r17.* The RAN1 agreement(one batch) about it reads:

**Agreement**

On Rel-17 DCI-based beam indication, regarding application time of the beam indication, the first slot that is at least X ms or Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication.

* Note: The gap between the last symbol of the beam indication DCI and that first slot shall satisfy the UE capability
* FFS: Application time and whether additional offset is needed for the application time in case of cross carrier beam indication and common TCI state ID update across a set of configured CCs if CCs have different SCSs
* FFS: Whether inter-cell beam switching needs higher X/Y values than intra-cell
* FFS: Whether application time can be indicated/determined dynamically for different scenarios, e.g. cross CC, inter-cell, inter-panel without reverting previous RAN1 agreements

This means that for DCI-based beam indication the first slot to apply the indicated TCI is at least Y symbols after the last symbol of the acknowledgment of the joint or separate DL/UL beam indication. The Y symbols are configured by the gNB based on UE capability, which is also reported in units of symbols. The values of Y are yet not determined and is left to RAN4 to decide. It is understood that the parameter *BeamAppTime\_r17* is the beam application time in symbols. The latest excel suggest to configure this in PDSCH-Config and states it is per UE and per BWP.

Another batch of agreements from latest RAN1 meeting 107 describe per list of CC type of operation for it:

**Agreement**

On Rel-17 DCI-based beam indication, regarding application time of the beam indication, the UE can assume that one beam application time (BAT) for a given SCS is configured for all the CCs configured with the common TCI state ID update,

* Note: It was agreed that the BAT associated with the carrier(s) (hence BWP(s)/CC(s)) on which the beam indication applies is determined based on the carrier with the smallest SCS among the carrier(s) (hence BWP(s)/CC(s)) applying the beam indication
* TBD (maintenance): whether a second configured BAT is also supported, e.g. for MPUE or inter-cell BM
* The detailed signaling of the BAT is up to RAN2
* FFS: For CC(s) not configured with a common TCI state ID update

However, the excel does not yet reflect the operation where DCI updating TCI state on one serving cell/BWP would update simultaneously the TCI state(joint or separate operation) across CC/BWPs which are configured for this operation.

For now, RAN2 could try to converge on the understanding that the parameter *BeamAppTime\_r17* is a configuration parameter and not a capability. Although there is likely a related capability signalling separately

**Q4. Do companies agree that the parameter *BeamAppTime\_r17* is a configuration parameter and that it is placed in PDSCH-Config?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes | This seems to be the RAN1 agreement currently. The exact definition does relate to UE capability, so we assume the configured BAT values are always >= BAT UE capability (i.e. the UE capability defines the time UE always needs, and network can configure UE with larger application time if it so desires). |
| Ericsson | yes |  |
| ZTE | No | The parameter BeamAppTime\_r17 is a configuration parameter but that should not be placed in PDSCH-Config. As RAN1 mentioned, it is configured for all the CCs configured with the common TCI state ID. It implies that the configuration should be per CC group or CC list for common TCI state ID update, like per simultaneousTCI-UpdateList1-r16. |
| OPPO | No | This is a configuration parameter for sure. But network’s configuration is subject to UE capability. There is note in 1st agreement under this question:* Note: The gap between the last symbol of the beam indication DCI and that first slot shall satisfy the UE capability

And there is one component as following in the latest feature list RAN1 sent to RAN2 in R1-2112902:[11. The minimum beam application time in Y symbols] So we think there is another parameter as UE capability which can be subject to the UE feature discussion.In addition we think this parameter should be configured per cell group instead of per BWP per cell i.e. it should be applicable for all CC/BWPs as long as SCS is the same. |
| Xiaomi | Yes |  |
| Samsung | Yes, but not sure | As RAN1 mentioned configuration of BAT in PDSCH-Config could be work but we are not sure how gNB differently configures this parameter per BWP i.e. there are no ways to differentiate the UE capability per BWP.As Nokia mentioned, if gNB configures BAT values are always >= BAT UE capability it works so we are fine for the proposal but not sure the exact operations.In addition, we think there are two points to consider:In case of CA, and a TCI state ID applies to multiple CCs, the UE selects the BAT of the CC with the smallest SCS.All CCs with the same SCS should be configured the same BAT value. |
| Huawei, HiSilicon | Not sure | We are not sure if this parameter is configured per BWP.  |
| Qualcomm | Yes |  |
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**Conclusion:**

Companies share the view BAT is a configuration parameter but some doubt is expressed whether PDSCH-Config is the best location. Suggestion is it is placed there now with editor’s note about possible replacement

**Proposal 4 the parameter BeamAppTime\_r17 is placed under PDSCH-Config with editor’s note about it’s final location.**

The below agreement states how different coresets may assume different TCI state assumption.

**Agreement**

For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception:

* For discussion purposes, define as follows:
	+ ‘CORESET A’: A CORESET other than CORESET#0 associated with only UE-dedicated reception on PDCCH in a CC, comprising CORESETs in association with:
		- [USS and/or CSS Type 3]
	+ ‘CORESET B’: A CORESET other than CORESET#0 associated with only non-UE-dedicated reception on PDCCH in a CC, comprising CORESETs in association with:
		- [CSS or CSS other than Type 3]
	+ ‘CORESET C’: A CORESET other than CORESET#0 associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC
	+ CORESET#0
* For Rel-17 TCI state indication, support per CORESET determination as follows:
	+ For any PDCCH reception on a ‘CORESET A’ and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.
	+ 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
		- FFS: For intra-cell BM, whether CORESET C is supported or not
	+ If CORESET C is supported, the TCI state of CORESET C
		- FFS: For inter-cell BM, whether CORESET C is supported or not
	+ If CORESET C is supported, the TCI state of CORESET C
		- FFS: The TCI state of CORESET 0

In RRC there is currently no concept of CORESET A or CORESET B, and there for CORESET C. Thus, a way to configure above behaviour for a CORESET in RRC is to enable Unified TCI state per CORESET. Any restrictions can be specified separately. ASN1 example is given as below:

####  – *ControlResourceSet*

The IE *ControlResourceSet* is used to configure a time/frequency control resource set (CORESET) in which to search for downlink control information (see TS 38.213 [13], clause 10.1).

***ControlResourceSet* information element**

-- ASN1START

-- TAG-CONTROLRESOURCESET-START

ControlResourceSet ::= SEQUENCE {

 controlResourceSetId ControlResourceSetId,

 frequencyDomainResources BIT STRING (SIZE (45)),

 duration INTEGER (1..maxCoReSetDuration),

 cce-REG-MappingType CHOICE {

 interleaved SEQUENCE {

 reg-BundleSize ENUMERATED {n2, n3, n6},

 interleaverSize ENUMERATED {n2, n3, n6},

 shiftIndex INTEGER(0..maxNrofPhysicalResourceBlocks-1) OPTIONAL -- Need S

 },

 nonInterleaved NULL

 },

 precoderGranularity ENUMERATED {sameAsREG-bundle, allContiguousRBs},

 tci-StatesPDCCH-ToAddList SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP

 tci-StatesPDCCH-ToReleaseList SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP

 tci-PresentInDCI ENUMERATED {enabled} OPTIONAL, -- Need S

 pdcch-DMRS-ScramblingID INTEGER (0..65535) OPTIONAL, -- Need S

 ...,

 [[

 rb-Offset-r16 INTEGER (0..5) OPTIONAL, -- Need S

 tci-PresentDCI-1-2-r16 INTEGER (1..3) OPTIONAL, -- Need S

 coresetPoolIndex-r16 INTEGER (0..1) OPTIONAL, -- Need S

 controlResourceSetId-v1610 ControlResourceSetId-v1610 OPTIONAL -- Need S

 ]],

 [[

 followUnifiedTCIstate-r17 ENUMERATED {enabled} OPTIONAL -- Need R

 --Editor’s note: Rel-17 DL TCI/joint state is enabled for this CORESET and tci-StatesPDCCH-ToAddList is not configured

 ]]

}

-- TAG-CONTROLRESOURCESET-STOP

-- ASN1STOP

**Q5: Do you agree with the given ASN1 example of how PDCCH/CORESET is configured to follow the unified TCI state?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | No | First, to be clear: The "CORESET X"-type notation is not intended to be used in RAN1 specifications. It was only used for discussion purposes. RAN1 intention seem to be to "mark" some CORESETs based on whether they use USS, CSS or both. Second, it's not at all clear why this kind of "marking" of CORESETs is needed: Currently TCI state activation (for PDCCH) has always indicated the CORESET ID inside the MAC CE, and this seems like just a way to bundle some CORESETs together. So we wonder how this would work together with the MAC CEs - is the intention still that the MAC CEs for PDCCH TCI state activation would contain CORESET ID, or would that be omitted?We would propose that RAN2 asks from RAN1 about the usage of this flag in relation to the MAC CE: Is the MAC CE for PDCCH TCI state iondication supposed to contain CORESERT ID (as it does in Rel-16)? In our understanding, this would do exactly the same as this kind of flag. And if we do it this way, the flag needs to be restricted only to the "CORESET type B" usage, i.e. for CORESETs linked with CSS SearchSpaces. |
| Ericsson | Yes |  |
| Nokia, Nokia Shanghai Bell v2 | No | Every SearchSpace is associated to a CORESET, as shown below:SearchSpace ::= SEQUENCE { searchSpaceId SearchSpaceId, controlResourceSetId ControlResourceSetId OPTIONAL, -- Cond SetupOnlyThe SearchSpace also has the attribute that defines whether it is CSS (Type 3) or USS: searchSpaceType CHOICE { common SEQUENCE {--(content omitted) }, ue-Specific SEQUENCE {--(content omitted) } } OPTIONAL -- Cond Setup2

|  |
| --- |
| ***searchSpaceType***Indicates whether this is a common search space (present) or a UE specific search space as well as DCI formats to monitor for. |

Common SearchSpaces can also be configured via *PDCCH-ConfigCommon* as shown below (which also includes SearchSpace#0):PDCCH-ConfigCommon ::= SEQUENCE { controlResourceSetZero ControlResourceSetZero OPTIONAL, -- Cond InitialBWP-Only commonControlResourceSet ControlResourceSet OPTIONAL, -- Need R searchSpaceZero SearchSpaceZero OPTIONAL, -- Cond InitialBWP-Only commonSearchSpaceList SEQUENCE (SIZE(1..4)) OF SearchSpace OPTIONAL, -- Need RSo it's a bit difficult to underwhat why this kind of marking should be property of CORESET, when it's applied depending on CSS/USS and whether the CORESET is linked to multiple SearchSpaces. From UE perspective, this implies that even with this "marking", UE has to know which CORESET is associated to which kind of SearchSpace, and requires also network to track what kinds of configurations are allowed (assuming this somehow impacts UE behaviour). So it would be good to ask from RAN1 why this is needed, and whether it implies some sort of configuration restrictions as well (as could be interpreted based on the description). That was why we proposed to ask from RAN1 to clarify what this means. |
| ZTE | Yes, but | Regarding RAN1 agreements, there is some ambiguities:**Agreement**For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception:* For discussion purposes, define as follows:
	+ ‘CORESET A’: A CORESET other than CORESET#0 associated with only UE-dedicated reception on PDCCH in a CC, comprising CORESETs in association with:
		- [USS and/or CSS Type 3]
	+ ‘CORESET B’: A CORESET other than CORESET#0 associated with only non-UE-dedicated reception on PDCCH in a CC, comprising CORESETs in association with:
		- [CSS or CSS other than Type 3]
	+ ‘CORESET C’: A CORESET other than CORESET#0 associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC
	+ CORESET#0
* For Rel-17 TCI state indication, support per CORESET determination as follows:
	+ For any PDCCH reception on a ‘CORESET A’ and the respective PDSCH reception, UE always applies the indicated Rel-17 TCI state.
	+ 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
		- FFS: For intra-cell BM, whether CORESET C is supported or not
	+ If CORESET C is supported, the TCI state of CORESET C
		- FFS: For inter-cell BM, whether CORESET C is supported or not
	+ If CORESET C is supported, the TCI state of CORESET C
		- FFS: The TCI state of CORESET 0

it seem only CORESET B need an indication for determining whether the R17 TCI state shall be followed or not. And for agreements, It is said that the CORESET B is associated CSS or CSS other than Type 3, it is hard to understand the description for what is CORESET B, so the issue is, of one CORESET is configured with a flag indication, but it is associated with more than one search space (i.e CSS type 3 and other CSS), it is hard to know what is the COREST’s beam instance since this CORSET maybe CORESET A or CORESET B according to the RAN1 agreements |
| OPPO | No | RAN1 agreement suggests that per CORESET determination on unified TCI state is needed. But we think it can be done via implicit way. To activate a TCI state of PDCCH, CORESET ID is necessary in MAC CE since a list of TCI state IDs will be configured within the CORESET ID. In R17 the same logic will apply i.e. unified TCI state IDs supposes to be configured in CORESET which is subject to unified TCI state.  |
| Xiaomi | No | We agree with the concerns provided by Nokia. To be on the safe side, we can also for further clarifications from RAN1. |
| Samsung | Comments | For CORESET A (i.e., a CORESET that is associated with only USS set or CCS set Type 3) always follows the unified TCI state ID. There is no need for configuration in this case.For CORESET B (i.e., a CORSET associated with only CCS (Type 0,0A, 1, 2), ASN1 proposal from the moderator is one possible solution. Another possible solution is in the MAC CE activating the TCI state ID for the CORESET (TS 38.321 section 6.1.3.15) can indicate the CORESET follows the unified TCI state.For CORESET C (i.e., a CORESET that is associated with USS set or CCS set Type 3 and associated with CCS set (Type 0,0A, 1, 2)), more RAN1 agreements are needed before we can discuss and progress, |
| Huawei, HiSilicon | See comments | We share the similar view from Nokia, and further clarification from RAN1 would help. |
| Qualcomm | Comments | The example ASN.1 does implement what RAN1 agreed. However, it would be good to understand the logic behind RAN1 agreements which change the SS-Coreset relationship as pointed out by Nokia. |
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**Conclusion:**

Companies share the view that presented ASN1 implements RAN1 agreement however, RAN1 should explain better the functionality of this. Thus, it seems better not to introduce this in running CR for now but to formulate question about it to Ran1

**Proposal 5 RAN2 to formulate question to RAN1 on the functionality of unified TCI state on PDCCH. In detail, why the marking is on CORESET level and not searchspace level and whether there are any configuration limitation implied by this.**

Another aspect is how to configure possible aperiodic NZP CSI-RS resource or DMRS to follow the DL(or joint) unified TCI state. The latest but unofficial excel has the following item:

|  |  |  |  |
| --- | --- | --- | --- |
| Ran2 parent IE | Param name | Description | Comment |
|  | ApplyTCI-State-r17-DLList | a list of the resource and/or resource set ID of the RS(s) which share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC | Candidates include: AP-CSI-RS for BM, AP-CSI-RS for CSI, DL DMRS for non-UE-dedicated PDCCH/PDSCH from the serving cell, AP-SRS for BM. |

The DMRS does not have an ID but DMRS is configured in PDSCH-config for PDSCH DMRS and PDCCH-Config for PDCCH DMRS. It is unclear why DMRS of PDSCH or DMRS PDCCH would not follow the TCI state configured for respective PDxCH. The related latest RAN1 agreements are:

**Agreement**

On Rel.17 unified TCI framework, discuss and decide by RAN1#106-e (August 2021)

* Whether each of the following DL RSs can share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC
	+ CSI-RS resources for CSI
	+ Some CSI-RS resources for BM, if so, which ones (e.g. aperiodic, repetition ‘ON’)
	+ CSI-RS for tracking
	+ DMRS(s) associated with non-UE-dedicated reception on PDSCH and all/subset of CORESETs
* Whether some SRS resources or resource sets for BM can share the same indicated Rel-17 TCI state as dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC

**Agreement**

On Rel.17 unified TCI framework, for any DL RS that does not share the same indicated Rel-17 TCI state(s) as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC, but can be configured as a target DL RS of a Rel-17 DL TCI (hence the Rel-17 DL TCI state pool), discuss and down-select by RAN1#106-e (August 2021) between the following two alternatives:

* Alt1. Rel-15/16 TCI state update signaling/configuration mechanism(s) are reused to update/configure the Rel-17 TCI state
* Alt2. Rel-17 TCI state update signaling/configuration mechanism(s) are used, e.g. with Rel-17 MAC-CE/DCI-based beam indication for Rel-17 joint/separate TCI

Note: The DL RS includes CSI-RS and DMRS for PDSCH or PDCCH

Note: For some channels/signals, only one of the above two alternatives may apply (to be discussed).

It remains unclear how DMRSs could be pointed to in a list of different TCI state from PDxCH is expected to be enabled. It is assumed this aspect will be clarified by RAN1.

Also the aperiodic NZP-CSI RS does not have an ID as such. Instead, the UE is configured with a list of aperiodic CSI-RS states where each consists of a set of CSI hypothesis. One CSI hypothesis consist of assumption on channel measurement and assumption on interference measurement where the latter may be CSI-IM(a window to inspect interference) or NZP CSI RS(an actual dedicated RS for interference measurement). Thus, there are two levels/options to easily indicate whether the aperiodic trigger state should assume Unified TCI state, or the TCI state configured specifically for the aperiodic trigger state.

The two levels are

* Option 1: at trigger state level, which means all CSI hypothesis follow unified TCI state.
* Option 2: per CSI hypothesis within a trigger state.

ASN1 code for both options is presented below

– *CSI-AperiodicTriggerStateList*

The *CSI-AperiodicTriggerStateList* IE is used to configure the UE with a list of aperiodic trigger states. Each codepoint of the DCI field "CSI request" is associated with one trigger state (see TS 38.321 [3], clause 6.1.3.13). Upon reception of the value associated with a trigger state, the UE will perform measurement of CSI-RS, CSI-IM and/or SSB (reference signals) and aperiodic reporting on L1 according to all entries in the *associatedReportConfigInfoList* for that trigger state.

***CSI-AperiodicTriggerStateList* information element**

-- ASN1START

-- TAG-CSI-APERIODICTRIGGERSTATELIST-START

CSI-AperiodicTriggerStateList ::= SEQUENCE (SIZE (1..maxNrOfCSI-AperiodicTriggers)) OF CSI-AperiodicTriggerState

CSI-AperiodicTriggerState ::= SEQUENCE {

 associatedReportConfigInfoList SEQUENCE (SIZE(1..maxNrofReportConfigPerAperiodicTrigger)) OF CSI-AssociatedReportConfigInfo,

 ... ,

 [[

 followUnifiedTCIstate-r17 ENUMERATED {enabled} OPTIONAL -- Need R

 -- Editor’s note: OPTION 1: at trigger state level, which means all CSI hypothesis follow unified

-- TCI state is this is enabled

-- Editor’s note: this applies only to CMR

 ]]

}

CSI-AssociatedReportConfigInfo ::= SEQUENCE {

 reportConfigId CSI-ReportConfigId,

 resourcesForChannel CHOICE {

 nzp-CSI-RS SEQUENCE {

 resourceSet INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig),

 qcl-info SEQUENCE (SIZE(1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId

 OPTIONAL -- Cond Aperiodic

 },

 csi-SSB-ResourceSet INTEGER (1..maxNrofCSI-SSB-ResourceSetsPerConfig)

 },

 csi-IM-ResourcesForInterference INTEGER(1..maxNrofCSI-IM-ResourceSetsPerConfig) OPTIONAL, -- Cond CSI-IM-ForInterference

 nzp-CSI-RS-ResourcesForInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig) OPTIONAL, -- Cond NZP-CSI-RS-ForInterference

 ... ,

 [[

 followUnifiedTCIstate-r17 ENUMERATED {enabled} OPTIONAL -- Need R

 -- Editor’s note: OPTION 2: at CSI hypothesis level, which means each CSI hypothesis can separately be configuredd

-- Editor’s note: this applies only to CMR

 ]]

}

-- TAG-CSI-APERIODICTRIGGERSTATELIST-STOP

-- ASN1STOP

 **Q6: Do you agree with the presented ASN1(whether option1 or option2 FFS) to indicate unified TCI state for aperiodic NZP CSI-RS(CMR)? FFS: further consult RAN1 which level(that is option1 or option2) is functionally intended.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | Our preference is option 2. A note should be added to indicated that the parameter applies only to aperiodic NZP CSI-RS of the trigger state.Moreover, there is a similar issue for SRS. RAN1 also agreed that AP/SP/P SRS for CSI and AP SRS for BM can optionally follow the unified TCI state, which is configured by RRC. This issue is also important one for unified TCI framework. A same parameter (*followUnifiedTCIstate-r17*) is also needed for SRS resource or SRS resource set configuration.  |
| Nokia, Nokia Shanghai Bell | No | As DMRS follows PDCCH TCI state by default in Re-15, same would continue in Rel-17. Similarly, for AP-CSI-RS, the report configuration already includes associated TCI state configuration. Why would the UE ever NOT use the TCI state as per its configuration (as the absence of the flag would enable)? If AP-CSI-RS is tied to a certain (unified) TCI state, why would the TCI state switch nojt work for that case? Similarly as with the CORESET flag above, we think RAN2 should ask RAN1 to explain the rarionale behind this. |
| Ericsson | yes | Either option is ok. |
| Nokia, Nokia Shanghai Bell v2 | No | To be more clear: Thew current aperiodic CSI-RS already refers to a TCUI state:CSI-AssociatedReportConfigInfo ::= SEQUENCE { reportConfigId CSI-ReportConfigId, resourcesForChannel CHOICE { nzp-CSI-RS SEQUENCE { resourceSet INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig), qcl-info SEQUENCE (SIZE(1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId OPTIONAL -- Cond Aperiodic },So if the TCI state is changed to a Rel-17 unified TCI state and there is no "marking" for this AP-CSI-RS, what happens when it's triggered? Why would the network trigger AP-CSI-RS that refers to TCI state that is then NOT used at all? This all seems rather unclear so asking RAN1 to explain why this whole thing is needed would be helpful. |
| ZTE | Option 2, maybe | We understand option 2 much more flexible. for option 1, it seems all CSI hypothesis need to follow the R17 unified TCI state, we are not sure whether this is correct understanding, and it shall be confirmed by RAN1. |
| OPPO | Option2 | We think Rel17 unified TCI state for aperiodic CSI measurement and report should have same flexibility as legacy TCI state frame work i.e. option2 is preferred.But it is not clear whether an ENUMERATED parameter is sufficient since in legacy TCI state framework, one TCI state is assigned to each NZP CSI RS resource within one resource set for CMR. Our understanding is that explicit unified TCI state id should be also referred. In case such new parameter is configured, legacy TCI state IDs are not valid anymore.  |
| Xiaomi | Yes | Our preference is option 2, as option 2 is more flexible. We also agree with the concerns raised by Nokia, and are ok to asking RAN1 for further clarifications. |
| Samsung | Yes | Either option can work, but prefer the direction of Option 2 as it provides more flexibility. It might be better to have this parameter within “nzp-CSI-RS” as an alternative to “qcl-info”. If the Aperiodic CSI-RS follows the unified TCI state, “qcl-info” is not used. |
| Huawei, HiSilicon | No | We should first clarify the UE behaviour on how to deal with the legacy IE of gcl-info if the ap CSI-RS follows the unified TCI state. So it is too early to decide to go with either Option 1 or 2. |
| Qualcomm | Yes | Agree Option 2 is more flexible and thus preferred. But we should also clarify the relationship of the new IE with existing qcl-info as pointed out by HW. |
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**Conclusion:**

Companies share the view that option 2 is preferred however, more clarifications are needed from RAN1. Suggestion is that running CCR is updated with Option 2 and editor’s note on any update. Further, RAN2 should formulate corresponding question to Ran1.

**Proposal 6 Option 2 is implemented in running CR with editor’s note on FFS**

**Proposal 7 RAN2 to formulate question to RAN1 on the functionality of unified TCI state on PDCCH. In detail, why the marking is on CORESET level and not searchspace level and whether there are any configuration limitation implied by this.**

***UL TCI state for joint and separate operation***

When UE is configured with joint TCI state, it is assumed that PUxCH follows the DL TCI state of the PDSCH of the same BWP. For SRS however, there seems to be a parameter controlling whether it follows “UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC”.

|  |  |  |  |
| --- | --- | --- | --- |
| Ran2 parent IE | Param name | Description | Comment |
|  | ApplyTCI-State-r17forSRS | Whether all SRS resources in resource set(s) configured for antenna switching/codebook-based/non-codebook-based UL transmissions share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC | Exact design including whether an explicit RRC parameter is needed or not is up to RAN2.Applies only to Rel-17 unified TCI FrameworkComment from LG: For the value range, it should be considered further for applying the indicated beam with configurability on SRS resource or resource set level instead of ON-OFF decision for all SRSs. Also, similar configuration parameters are required for other DL/UL target channels, e.g. for some CSI-RS resources, for some CORESETs, for some PUCCH resources, etc. |

For the separate state operation, somewhere UE should be given the UL TCI states. As both PUSCH and PUCCH should follow the same unified UL TCI state, a natural location for UL TCI state configuration is in the UL-BWP-Dedicated. Another option is to configure is in PUSCH-Config and PUCCH-Config separately. For this option, one can give the UL TCI states in PUSCH-config and configure whether PUCCH resources follow the unified UL TCI state.

**Q7: Which option is preferred for UL TCI state configuration for the separate beam indication option:**

* **Option 1: In UL BWP-dedicated**
* **Option 2: In PUSCH-Config**
* **Option 3: other**

|  |  |  |
| --- | --- | --- |
| Company | Option 1, 2, 3 | Comments |
| MediaTek | 1 | Consider that a DL-only cell (w/o PUSCH/PUCCH) may still need SRS transmission for DL CSI (i.e., SRS for antenna switching), we prefer Option 1. |
| Nokia, Nokia Shanghai Bell | 3 (PUSCH-Config also SRS-Config) | Since UL resources have never used TCI state but instead the spatial relations, how to use the UL/joint TCI state for those is less obvious. In terms of details, the question is **whether the UL TCI state should be part of *TCI-State*, *PUCCH-SpatialRelation* or some other IE?** We would prefer to use TCI-State IE for all of DL, joint and UL TCI states - that would mean that both *SRS-Config* and *PUSCH-Config* are extended with TCI state ID information similar to DL. Hence, we should **not** touch the *PUCCH-SpatialRelation* at all, and leave that for legacy functionality. If the whole of "UL TCI state" configuration can be contained within the TCI-State IE, then it will become far clearer and ensure the existing UL functionality is not modified. |
| Ericsson | 1 |  |
| Nokia, Nokia Shanghai Bell v2 | See above | It would be also good to understand the options: What do options 1 and 2 mean? Since PUSCH-Config is contained wtihin BWP-UplinkDedicated, is the intent to ask for the exact level, or the eact IE position? * Does 1) (=*BWP-UplinkDedicated*) mean this (or something else)?

BWP-UplinkDedicated ::= SEQUENCE {-- legacy parts omitted ul-TCI-StatesToAddModList-r17 SEQUENCE (SIZE(1..maxNrofUL-TCI-States-r17)) OF TCI-State OPTIONAL, -- Need N tci-StatesToReleaseList-r17 SEQUENCE (SIZE(1..maxNrofUL-TCI-States-r17)) OF TCI-StateId OPTIONAL, -- Need N* Does 2) (=*PUSCH-Config*) mean this (or something else)?

PUSCH-Config ::= SEQUENCE {-- legacy parts omitted ul-TCI-StatesToAddModList-r17 SEQUENCE (SIZE(1..maxNrofUL-TCI-States-r17)) OF TCI-State OPTIONAL, -- Need N tci-StatesToReleaseList-r17 SEQUENCE (SIZE(1..maxNrofUL-TCI-States-r17)) OF TCI-StateId OPTIONAL, -- Need NWe answered 3) because we thought it would be neither of the above, but something slightly different as shown below (new parts highlighted):TCI-State ::= SEQUENCE { tci-StateId TCI-StateId, qcl-Type1 QCL-Info, qcl-Type2 QCL-Info OPTIONAL, -- Need R ..., [[ unifiedTCI-State-r17 SetupRelease{ UnifiedTCI-Stage-17 } OPTIONAL -- Need M ]]}QCL-Info ::= SEQUENCE { cell ServCellIndex OPTIONAL, -- Need R bwp-Id BWP-Id OPTIONAL, -- Cond CSI-RS-Indicated referenceSignal CHOICE { csi-rs NZP-CSI-RS-ResourceId, ssb SSB-Index }, qcl-Type ENUMERATED {typeA, typeB, typeC, typeD}, ..., [[ referenceSignal-r17 CHOICE { dl-RS-r17 NULL,--Editor’s note: this field indicates UE uses the legacy DL RS configuration for this TCI state srs-r17 PUCCH-SRS--Editor’s note: this field is only used for UL TCI states and indicates SRS as UL TCI state source RS } OPTIONAL, -- Need R ]]}UnifiedTCI-Stage-r17 ::= SEQUENCE { unifiedTCI-State-r17 ENUMERATED {downlink, joint, uplink}, additionalPCI-r17 AdditionalPCI-Index-r17 OPTIONAL -- Need R}This subsumes the UL TCI state inside the existing TCI-State IE, which can then be added to PUSCH-Config as shown for 2) above. This also assumes common TCI state ID, but in case separate ID is used that can still be just added e.g. as shown below:UnifiedTCI-Stage-r17 ::= SEQUENCE { unifiedTCI-State-r17 ENUMERATED {downlink, joint, uplink}, additionalPCI-r17 AdditionalPCI-Index-r17 OPTIONAL -- Need R ul-TCI-StateId-r17 UL-TCI-StateId-r17 OPTIONAL -- Cond UL-TCI}We also note that the first rapporteur version of the RRC CR seems to put the UL TCI state as part of the PUCCH Spatial relation, but those are neither defined within *BWP-UplinkDedicated* nor within *PUSCH-Config*, but within *PUCCH-Config*. So the question is quite ambiguous and would benefit from further clarifications. |
| ZTE | option 1 | First of all, we need to clarify whether the TCI state for SRS and the TCI state for PUSCH is from the same resource pool, if so, we think only one TCI state pool is enough which is configured in UL-BWP dedicated.We think we can directly refer the TCI state ID for SRS/PUCCH from a reference BWP/Cell which is associated with a UL-only TCI state. |
| OPPO | Option1 | We think UL TCI state will be shared by PUSCH, PUCCH and SRS. So option1 is better. |
| Xiaomi | 1 |  |
| Samsung | Option 3 | The intention of the question is not clear.For SRS, whether it follows the unified TCI state (which can be an UL TCI state or a Joint TCI state depending on the configuration of joint and separate TCI states), then this parameter can be within the “SRS Resource” configuration where the SRS spatial relation is being configured. |
| Huawei, HiSilicon | Option 1 (maybe) | Agree with ZTE that we should first clarify whether the TCI state for SRS and the TCI state for PUSCH is from the same resource pool. If so, then Option 1 is okay. |
| Qualcomm | Option 1 | Fine to verify that SRS and PUSCH share the same TCI configuration. |
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**Conclusion:**

Option 1 has largest support thus suggestion is that placeholder is added to UL BWP-Dedicated IE with editor’s note on whether it is the final location.

**Proposal 8 A placeholder for UL TCI state is UL BWP-Dedicated IE with editor’s note on whether it is the final location**

Finally, the form of the TCI state IE should be discussed. Most important aspect is the ID space for the separate DL/UL indication. If common ID space is used, 7 bits is not enough to represent 128+64=192 but 8 bits are needed. Going back to the MAC CE design, two times the 8 bits needs to be present in the MAC CE as one DL and one UL TCI state needs to be mapped to one DCI codepoint. As 8 bits does not leave any fields available for flexible indication, this Mac CE would have always 16 octets to map TCI states to DCI codepoint. Additionally, in RRC, one would need to describe that when TCI state list is configured in PDSCH-Config(or other DL IE) certain part of the ID space can be used and likewise when in an UL IE, the other part of the ID space can be used. However, it is possible to lift the TCI state configuration to cell level and not to have it in BWP level and use common list. This would deviate from legacy and would loose possibility to configure TCI states per BWP.

**Q8: Do companies prefer separate ID space for DL/joint and UL TCI state or a common ID to cover both DL and UL TCI states?**

|  |  |  |
| --- | --- | --- |
| Company | Common/separate | Comments or other variations |
| MediaTek | Separate | Easier for MAC CE design |
| Nokia, Nokia Shanghai Bell | Common  | This question has proven to be very confusing to everyone: So far almost nobody has showed how the common/separate TCI states really work. See also our comments to the MAC CE design, where the differences between each approach really becomes visible: **The question on "ID space" boils down to the number of bits used for the encoding of the TCI state ID in the MAC CE**. We would also note that RAN2 often puts complexity to RRC configuration instead of MAC/PHY, and the same principle here would be sensible unless blocking issues are found.On the actual ID space, it seems 8 bits is sufficient for the common case (as also seems to be agreed by the rapporteur). This means that the TCI state ID would take up one octet in MAC and one TCI state ID, which is easy for decoding. Finally, we would also want to comment on the rapporteur claims above, since we disagree with basically the entire text from above:* **UL+DL TCI state mapping:** "*Going back to the MAC CE design, two times the 8 bits needs to be present in the MAC CE as one DL and one UL TCI state needs to be mapped to one DCI codepoint.* " --> This statement is not quite correct as the UL+DL TCI mapping can be simply done via RRC configuration.
* **MAC CE bit count:** "*As 8 bits does not leave any fields available for flexible indication, this Mac CE would have always 16 octets to map TCI states to DCI codepoint.*" --> This statement likely comes from not considering the actual bit design of MAC CE - see our earlier example of the MAC CE design. In fact, the **common ID space MAC CE** design seems to have the problem of having 1) no R-bits AND 2) inserting excess octets for the MAC CE due to the UL+DL TCI state linking and 3) complex definition of MAC CE.
* **ID space limitations by configuration:** "*Additionally, in RRC, one would need to describe that when TCI state list is configured in PDSCH-Config(or other DL IE) certain part of the ID space can be used and likewise when in an UL IE, the other part of the ID space can be used.* " --> The only limitation needed in RRC is that the number of IDs does not exceed UE capabilities. This is business as usual, and the exact used "ID numbers" do not matter as long as they are possible within configuration. To give a concrete example: Assume UE can be configured with 4 DL TCI states, 4 joint TCI states and 4 UL TCI states, i.e. total of 12 TCI states. Why would RRC need to limit that (e.g.) the IDs from 1-4 are for DL, the IDs from 5-8 are for joint and the IDs from 9-12 are for UL? As long as the configuration works, ID = 1 could be for UL, ID = 2-4 for joint, ID = 5-7 for DL, ID = 8-10 for UL, ID=11 for joint and ID=12 for DL. We often do configuration with some maximum number of IDs that not all UEs support, and assume network ensures correct configuration. So we think the statement from rapporteur is simply incorrect here.
* **Cell-level configuration:** "*However, it is possible to lift the TCI state configuration to cell level and not to have it in BWP level and use common list. This would deviate from legacy and would loose possibility to configure TCI states per BWP*" --> Certainly this would be possible, and actually it would have been a much better design in Rel-15 to have the TCI states be at cell level (as there's no real reason for themn to be BWP-specific). But at least we are not proposing that, as it doesn't seem necessary.
 |
| Ericsson | separate | Easier RRC and Mac CE design |
| Nokia, Nokia Shanghai Bell | See above  | We have heard it repeated very often that "seprate is easier for RRC and MAC", but without any analysis. So hopefully the proponents can clarify it now: Why is the RRC and MAC CE design easier with the separate IDs? What exactly is the benefit that creates (in concrete terms)? Based on our analysis (see Q2) it seems like the separate ID space easily wastes space in MAC, and causes more complexity than the common ID. If we anyway need at least 7 bits for the TCI state ID for UL and DL with the separate ID, then 8 bits would work for the common ID and this would fit within the MAC CE as well. So it's not so clearcut to claim there is any benefit for separate ID because the example MAC CE design for that was already less efficient than the one we provided for the common MAC CE design. |
| ZTE | Common | We also have no idea why the separate TCI state list is more benefit than the common TCI state list for designing MAC CE, If the concern is flexibility indication for the TCI state list, it is one way where an overall flexibility indication filed is introduced above the TCI sates fields as mentioned by NOKIA in Q1. |
| OPPO | Separate | From RRC point of view, joint/DL TCI state pool and UL TCI state pool are defined in PDSCH-config and BWP-UplinkDedicated respectively, likely. So it is not so obvious why these two separate TCI resource pool should share same ID space. Then from RAN1 LS R1-2112842, RAN1 concluded that within activation/deactivation MAC CE:*Activation of up to 8 TCI state codepoints for UE-dedicated channel/signals beam indication. This can be**- For joint beam indication**o A joint TCI state**- For separate beam indication**o DL only TCI state**o UL only TCI state**o DL TCI state + UL TCI state*For separate beam indication, another bit is needed to differentiate between UL and DL for separate ID space approach with overlapping. In this case 8 or 7 bit is needed for DL/UL TCI state ID respectively. For common ID space approach, this additional bit can be saved, but still 8 bit is needed per id since the maximum TCI state id is now become 128+64 for both DL and UL TCI state ID. From MAC CE overhead perspective, separate ID space is better. From RRC configuration point of view, separate id space is also natural and clean. |
| Xiaomi | Common | We understand that the question is to facilitate the MAC CE design. From our understanding, a common ID space would need less fields included in the MAC CE, which could simplify the UE implementation. Regarding the extra signalling overhead analysis provided above, we do not think the extra signalling overhead for common ID is a big issue, as the MAC CE will not be sent frequent. |
| Samsung | Common | Agree with Nokia’s observations. |
| Huawei, HiSilicon | Separate  |  |
| Qualcomm | Common | Nokia arguments looked convincing. However, it would be good to compare the corresponding MAC CEs for verification. |
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**Conclusion:**

No convergence for this.

**Proposal 9 Companies to bring to next meeting their suggested design for the unified TCI state lists and corresponding MAC CE**

## 5.1 UL power control framework for BM

For other UL power control parameters except for PL-RS (P0, alpha, closed loop index), a setting of P0, alpha, closed loop index can be associated per signal/channel. The excel seems to also givfe the option that one set is given that is common to all PUSCH, PUCCH and SRS. In addition, the excel suggest that an UL TCI state may be associate to a set (P0, alpha, closed loop index).

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| --- | --- | --- | --- | --- |
| **RAN2 Parant IE** | **Parameter name in the spec** | **Description** | **Per (UE, cell, TRP, …)** | **Comment** |
| PUSCH-PowerControl | p0\_Alpha\_CLIdPUSCHSet | UL PC parameters other than PLRS (Set of P0, alpha and closed loop index): PUSCH | Per UE per cell per BWP | It can be discussed in RAN2 whether a new parameter is needed or the associated legacy parameter can be reused. Or if one parameter that includes all UL PC setting (other than PLRS) pars can be used.It was agreed that one setting can (optionally) be associated with an UL or if applicable joint TCI state via RRC. The details are up to RAN2Applies only to Rel-17 unified TCI FrameworkUp to RAN2 whether the ones for PUSCH, PUCCH, and SRS are combined into one structure (RAN1 thinks this can be done) |
| PUCCH-PowerControl | p0\_~~Alpha\_~~CLIdPUCCHSet | UL PC parameters other than PLRS (Set of P0, alpha and closed loop index): PUCCH  | Per UE per cell per BWP | It can be discussed in RAN2 whether a new parameter is needed or the associated legacy parameter can be reused. Or if one parameter that includes all UL PC setting (other than PLRS) pars can be usedIt was agreed that one setting can (optionally) be associated with an UL or if applicable joint TCI state via RRC. The details are up to RAN2Applies only to Rel-17 unified TCI FrameworkUp to RAN2 whether the ones for PUSCH, PUCCH, and SRS are combined into one structure (RAN1 thinks this can be done) |
| SRS-Config | p0\_Alpha\_CLIdSRSSet | UL PC parameters other than PLRS (Set of P0, alpha and closed loop index): SRS  | Per UE per cell per BWP | It can be discussed in RAN2 whether a new parameter is needed or the associated legacy parameter can be reused. Or if one parameter that includes all UL PC setting (other than PLRS) pars can be used.It was agreed that one setting can (optionally) be associated with an UL or if applicable joint TCI state via RRC. The details are up to RAN2Applies only to Rel-17 unified TCI FrameworkUp to RAN2 whether the ones for PUSCH, PUCCH, and SRS are combined into one structure (RAN1 thinks this can be done) |
| p0\_Alpha\_CLIdPUSCHSetp0\_Alpha\_CLIdPUCCHSetp0\_Alpha\_CLIdSRSSet | p0\_~~Alpha\_~~CLIdSetId | p0\_Alpha\_CLIdSet ID (Set of P0, alpha and closed loop index) | Per UE per cell per BWP | It can be discussed in RAN2 whether a new parameter is needed or the associated legacy parameter can be reused. Or if one parameter that includes all UL PC setting (other than PLRS) pars can be used.It was agreed that one setting can (optionally) be associated with an UL or if applicable joint TCI state via RRC. The details are up to RAN2Applies only to Rel-17 unified TCI Framework |

A related parameter is the pathloss reference refence signal

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| --- | --- | --- | --- | --- |
| **RAN2 Parant IE** | **Parameter name in the spec** | **Description** | **Per (UE, cell, TRP, …)** | **Comment** |
| [TCI-State\_r17 or new IE list for PLRS in PUSCH\_Config] | SourceRS-Info\_r17-PLRS | ~~Source RS and QCL Info definition for~~ Rel-17path-loss measurement RS (PL-RS) | Per UE per cell per BWP | Detailed design up to RAN2Can be included in UL or Joint TCI if included in TCI state, or can be a separate list in PUSCH Config if associated. Detailed design is up to RAN2.Applies only to Rel-17 unified TCI Framework |

**RAN1 agreed that:**

**Agreement**

On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework,

* For each of PUSCH and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state per BWP.
	+ In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.
	+ (Working Assumption) In this case, for each of the PUSCH and PUCCH, each of the activated UL or (if applicable) joint TCI states is associated with one of the settings.
* If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states
* FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.
* FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state

Excel guides RAN2 to discuss and decide on the power control parameters thus it is checked whether RAN2 can converge on some aspects related to the power control design.

**Q9: Do companies agree to make RAN2 decision to have common PO set (P0, alpha, closed loop index) for PUSCH, PUCCH and SRS and configure that in UL-BWP-dedicated?**

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| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | Maybe | We assume the design is as follows:1. A set (of 1..N) of UL PC parameters (P0, alpha, etc.)
2. A TCI state can be associated with one UL PC set

With this, the UL PC parameter set can be "pooled" in one placed, and other IEs can refer to that. However, while RAN1 indicates this should be per BWP, it's not at all clear why that is necessary: The UL PC parameters are anyway cell-specific information, so could be part of serving cell-level IEs (e.g. *ServingCellConfig*). Then each UL PC set can be referred to via an ID where needed. |
| Ericsson | yes |  |
| Nokia, Nokia Shanghai Bell v2 | See above | Just to be more concrete: This is the configuration we assumed:PowerControlSet-r17 ::= SEQUENCE { pathlossRef-RS-ToAddModList-r17 SEQUENCE (SIZE (1..max-PLR-RS-r17)) OF PUSCH-PathlossReferenceRS OPTIONAL, -- Need N pathlossRef-RS-ToReleaseList-r17 SEQUENCE (SIZE (1..max-PLR-RS-r17)) OF PUSCH-PathlossReferenceRS-Id OPTIONAL, -- Need N powerControlSet-r17 SEQUENCE (SIZE (1..maxPC-Sets-r17)) OF UL-PC-Set-r17 OPTIONAL -- Need M}UL-PC-Set-r17 ::= SEQUENCE { pc-SetId-r17 UL-PC-SetId-r17, plr-RS-Id-r17 PUSCH-PathlossReferenceRS-Id, p0-r17 INTEGER (-16..15) OPTIONAL, -- Need S alpha-r17 Alpha OPTIONAL, -- Need S pusch-ClosedLoopIndex-r17 ENUMERATED { i0, i1 }}Then the *UL-PC-SetId-r17* can be used for referrring tot he correct UL PC set where needed.Then whether these are put into *BWP-UplinkDedicated* or to *ServingCellConfig* can be checked in the next phase. |
| ZTE | No | Based on RAN1 agreement, the PC set should be provided per channel/RS, regardless of whether we use a common pool or not. Technically speaking, the P0 for PUCCH may be much higher than PUSCH/SRS for guaranteeing the reliability of PUCCH transmission. Please review the following RAN1 agreement. Regarding Nokia’s suggestion, from our perspective, channel/RS-specific power control setting seems not to be provided.**Agreement(RAN1#104)**On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework: * The setting of (P0, alpha, closed loop index) is at least associated with UL channel or UL RS
* Select or modify from one of the following alternatives by RAN1#104bis-e for PUCCH, PUSCH, and SRS separately:
	+ Alt1. The setting of (P0, alpha, closed loop index) is also associated with UL or (if applicable) joint TCI state
	+ Alt2. The setting of (P0, alpha, closed loop index) is included with UL or (if applicable) joint TCI state
	+ Alt3. The setting of (P0, alpha, closed loop index) is neither associated with nor included in UL or (if applicable) joint TCI state
	+ Alt4. The setting of (P0, alpha, closed loop index) is determined as in Rel-16 without enhancement

Therefore, we prefer to reuse the same framework of Rel-15/16 power control RRC framework as much as possible. BTW, it seems that we do not need to provide closed loop index for SRS, due to the fact that for unified TCI framework, the closed loop of SRS should be always tied with the indciated PUSCH closed loop.

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| --- | --- |
| TCI-State-PUSCH-PUCCH-SRS-PowerControl | TCI-State-PUSCH-PUCCH-SRS-PowerControl includes the following fields:**tci-StateId\_r17****P0-PUSCH-AlphaSetId****PUSCH-ClosedLoopIndex** ENUMERATED { i0, i1 }**P0-PUCCH-Id****PUCCH-ClosedLoopIndex** ENUMERATED { i0, i1 }**Alpha-SRS****P0-SRS****pathloss RS** - choice of {SSB-Index, NZP-CSI-RS (periodic CSI-RS)} |

 |
| OPPO | Yes | In the latest RRC parameter list R1-2112976, RAN1 agreed those power control parameters are configured per BWP.The RAN1 agreement says:* *FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.*

i.e. it is not settled yet for SRS. RAN2 may come back to SRS againThe RAN1 agreement says:*In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time*.It means even same TCI state is applied for PUSCH and PUCCH channel, still the power control set could be different. I don’t know whether this address ZTE’s concern. |
| Xiaomi | Yes |  |
| Samsung | Yes | We are fine to follow the RAN1 agreements.  |
| Huawei, HiSilicon | Maybe Yes | We share the same view as OPPO. |
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**Q10: Do companies agree to make RAN2 decision that if the PO (P0, alpha, closed loop index) set is associated to a UL/joint TCI state, only one PO (P0, alpha, closed loop index) set is configured per UL/joint TCI state?**

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| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes but | As indicated above, the TCI state should be associated with UL PC parameter set, not the other way around. Otherwise we agree that a single TCI state only associates to a single UL PC parameter set. |
| ericsson | yes |  |
| Nokia, Nokia Shanghai Bell v2 | See above | To be concrete on this: WE assume the TCI state to UL PC parameter association is done like this (see above for where this comes from):UnifiedTCI-Stage-r17 ::= SEQUENCE { unifiedTCI-State-r17 ENUMERATED {downlink, joint, uplink}, additionalPCI-r17 AdditionalPCI-Index-r17 OPTIONAL, -- Need R pc-SetId-r17 UL-PC-SetId-r17 OPTIONAL -- Need R}So when UE is using this particular TCI state, it also utilizes the indicate UL PC parameter set. |
| ZTE | Yes | It seems so according to the information from RAN1 so far. |
| OPPO | Yes but | It seems contradicts with RAN1 following agreement:* + *In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.*

RAN1’s agreement suggests that one TCI state could be associated different power control set at least for PUSCH and PUCCH. If one TCI state is only associated with one power control set, and this TCI state is applied for e.g. PUSCH and PUCCH, it mean PUSCH and PUCCH has to follow same power control parameters which is weird. RAN1’s agreement the mapping between power control set and TCI states are m-to-n relationship. So additional IE need be introduced for such m-to-n association. Such IE can be defined in PUSCH-Config/PUCCH-Config/ SRS-ResourceSet respectively. |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
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**Q11: Do companies agree to make RAN2 decision that if the PO (P0, alpha, closed loop index) set is NOT associated to a UL/joint TCI state only one set is configured per UL BWP?**

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| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | - | This proposal is unclear. Further clarification may be needed. |
| Nokia, Nokia Shanghai Bell | Unclear | We are not sure what the question means, but if it intends to say that, **as per legacy**, there is only one set of PC parameters (per channel), then we agree with that. But if it means that the UL PC parameter sets can only be configured when they are associated to TCIs, this seems overly restrictive: TCI states can be configured at any time, so we don't see a reason to avoid configuring the parameter sets and then later configuring additional TCI states linked to those. |
| Ericsson | yes | Intetion is to vaoid configuring UE with several sets without UE to know which one to use. TCI state would tell which one to use but if there is no link how does the UE know which one to select? |
| Nokia, Nokia Shanghai Bell v2 | See above | See above - we assume that if the UL PC set ID is provided, UE uses that. Otherwise it used the legacy UL PC parameterization. |
| ZTE | - | It is hard for us to relate the proposal with the E//’s above comments, need further clarify. |
| OPPO | Yes but | We think the relevant RAN1 agreement is:* *If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal per BWP is independent of the UL or (if applicable) joint TCI states*

But the statement from rapporteur is bit confusing. It should be another around i.e. for one specific TCI state, if no power control set is associated, then UE should fall back to a default power control set which is defined per BWP. |
| Xiaomi | Yes | With the clarification provided by Ericsson, we think that only one **PO** set is needed. |
| Samsung | Unclear | If there is more than one PO set configured, then there are association with TCI states. If one PO set is configured, no need for association with TCI states as it is only one. |
| Huawei, HiSilicon | Unclear |  |
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Separate from the PO (P0, alpha, closed loop index) set, also pathloss reference reference signal needs to be configured for the UE. Excel suggest as one option to configure this in joint/UL TCI state and guides RAN2 to discuss and make the decision.

**Q12: Do companies agree to make RAN2 decision that the pathloss reference reference signal can be configured in the UL/joint TCI state?**

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| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | No | We should look at the CR first: This should just follow the design decisions we make. That said, we assume configuring the PL reference signal via the PCI information could be a better way: The signal for PL reference is based on DL signal, so presumably it would be part of the UL+DL TCI state linking configuration where applicable. |
| Ericsson | yes |  |
| Nokia, Nokia Shanghai Bell v2 | See above | See Q9 for more consideration on how to configure PLR-RS for the UL PC. |
| ZTE | - | We understand RAN1 had given two options, one option is to directly put the Pathloss reference RS into TCI state configuration, and the other one is to make a new list in the PUSCH-Config, and make an association with TCI state.For the first one, it is quite simple and strait forward,the pathlossReferenceRS is associated with the TCI state where it is put in. But for the second option, RAN2 have no idea what’s the association is between TCI state and PathlossReferenceRS, if the association is provided by DCI which is similar as legacy behavior, we would like to follow the legacy behavior to build a new list for pathlossReferenceRS in PUSCH-Config. |
| OPPO | Yes |  |
| Xiaomi | Yes | We think this is valid option, and are also open to the discussion of other options as provided by Nokia and ZTE. |
| Samsung | Yes | If PLRS is absent, the periodic DL RS used as a source RS for UL can be used as the PLRS. |
| Huawei, HiSilicon |  | Agree with ZTE’s comments.  |
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**Conclusion for Q9, Q10, Q11 and Q12:**

Add example implementation to UL-BWP dedicated for UL TCI state, power control set and PL RS RS.

**Proposal 10 Add example implementation in running RRC to UL-BWP dedicated for UL TCI state, power control set and PL RS RS.**

# 3 mTRP

Intermediate excel for mTRP can be found in:

<https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Inbox/drafts/8.1.4/RRC>

Document is based on the unofficial version RAN1#107-e\_Rel-17\_RRC FeMIMO-8.1.4\_V01. *All conclusions are assumed tentative and to be updated based on any new input from RAN1.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter name in the text** | **Description** | **Per (UE, cell, TRP, …)** | **Comment** |
| Two CMR groups  | For Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR, UE is configured with two CMR groups with Ks=K1+K2 CMRs. K1 and K2 are the number of CMRs in two groups respectively. K1\_max =7, K2\_max =7, Ks\_max=8. it is up to RAN2 to determine how to configure two CMR groups | Per DL BWP, per NZP-CSI-RS-ResourceSet | Conclusion (Alt 1-2):• “N CMR pairs” and “Two CMR groups” are configured in NZP-CSI-RS-Resource-Set• “sharedCMR” is configured in CSI-ReportConfig  |
| N CMR pairs | For Ks ≥ 2 NZP CSI-RS resources in a CSI-RS resource set for CMR, UE is configured with N ≥ 1 NZP CSI-RS resource pairs whereas each pair is used for a NCJT measurement hypothesis. N\_max = 2it is up to RAN2 to determine how to configure N CMR pair by selecting from all possible pairs.  | Per DL BWP, per NZP-CSI-RS-ResourceSet | Conclusion (Alt 1-2):• “N CMR pairs” and “Two CMR groups” are configured in NZP-CSI-RS-Resource-Set• “sharedCMR” is configured in CSI-ReportConfig  |

Here is a suggestion how to configure the two CMR groups and the CMR pairs in an efficient way. Idea is to mark first k1 resources of the NZP-CSI-RS set to belong to group 1 and the next k2 resources to belong to group 2. Total number is limited to 8 as excel says. Then a pairing IE selects NZP-CSI-RS from each group for pairing.

– *NZP-CSI-RS-ResourceSet*

The IE *NZP-CSI-RS-ResourceSet* is a set of Non-Zero-Power (NZP) CSI-RS resources (their IDs) and set-specific parameters.

***NZP-CSI-RS-ResourceSet* information element**

-- ASN1START

-- TAG-NZP-CSI-RS-RESOURCESET-START

NZP-CSI-RS-ResourceSet ::= SEQUENCE {

 nzp-CSI-ResourceSetId NZP-CSI-RS-ResourceSetId,

 nzp-CSI-RS-Resources SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerSet)) OF NZP-CSI-RS-ResourceId,

 repetition ENUMERATED { on, off } OPTIONAL, -- Need S

 aperiodicTriggeringOffset INTEGER(0..6) OPTIONAL, -- Need S

 trs-Info ENUMERATED {true} OPTIONAL, -- Need R

 ...,

 [[

 aperiodicTriggeringOffset-r16 INTEGER(0..31) OPTIONAL -- Need S

 ]],

 [[

 k1-r17 INTEGER {1..7}

OPTIONAL, -- Need R

 k2-r17 INTEGER {1..7} OPTIONAL, -- Need R

 pair1OfNZP-CSI-RS-r17 NZP-CSI-RS-Pairing OPTIONAL, -- Need R

 pair2OfNZP-CSI-RS-r17 NZP-CSI-RS-Pairing OPTIONAL -- Need R

 ]]

}

NZP-CSI-RS-Pairing-r17 ::= SEQUENCE {

 NZP-CSI-RS-ResourceId

 NZP-CSI-RS-ResourceId

}

-- TAG-NZP-CSI-RS-RESOURCESET-STOP

-- ASN1STOP

|  |
| --- |
| ***NZP-CSI-RS-ResourceSet* field descriptions** |
| ***aperiodicTriggeringOffset, aperiodicTriggeringOffset-r16***Offset X between the slot containing the DCI that triggers a set of aperiodic NZP CSI-RS resources and the slot in which the CSI-RS resource set is transmitted. For *aperiodicTriggeringOffset*, the value 0 corresponds to 0 slots, value 1 corresponds to 1 slot, value 2 corresponds to 2 slots, value 3 corresponds to 3 slots, value 4 corresponds to 4 slots, value 5 corresponds to 16 slots, value 6 corresponds to 24 slots. For *aperiodicTriggeringOffset-r16*, the value indicates the number of slots. The network configures only one of the fields. When neither field is included, the UE applies the value 0. |
| ***NZP-CSI-RS-Pairing*** A pair of NZP CSI-RS resources. In one pair, one resource shall belong to group 1 and the other resource shall belong to group 2 as configured by k1 and k2. (see TS 38.214 [19], clause xx) |
| ***nzp-CSI-RS-Resources***NZP-CSI-RS-Resources associated with this NZP-CSI-RS resource set (see TS 38.214 [19], clause 5.2). For CSI, there are at most 8 NZP CSI RS resources per resource set. First k1 resources belong to group 1 and the following k2 belong to group 2. Maximum total number in in group1 and group 2 is 8 (see TS 38.214 [19], clause xx) |
| ***repetition***Indicates whether repetition is on/off. If the field is set to *off* or if the field is absent, the UE may not assume that the NZP-CSI-RS resources within the resource set are transmitted with the same downlink spatial domain transmission filter (see TS 38.214 [19], clauses 5.2.2.3.1 and 5.1.6.1.2). It can only be configured for CSI-RS resource sets which are associated with *CSI-ReportConfig* with report of L1 RSRP, L1 SINR or "no report". |
| ***trs-Info***Indicates that the antenna port for all NZP-CSI-RS resources in the CSI-RS resource set is same. If the field is absent or released the UE applies the value *false* (see TS 38.214 [19], clause 5.2.2.3.1). |

**Q13: Do companies agree to make RAN2 decision of the above ASN1 principle for configuring CMR groups and CMR pairs? (FFS final ASN1 review)**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| MediaTek | Yes |  |
| Nokia, Nokia Shanghai Bell | Partly | The above construction seems to assume that network ensures the CMR groups use consecutive IDs - e.g. CMR group 1 uses 1-3 and CMR group 2 uses 4-6. While this does limit the NW flexibility, we would be fine with that. However, the parameter names and ASN.1 from rapporteur could be improved - see below for our proposal .Finally, the naming could follw the notion of "CMR" for ease iof readability (using magic variables names such as "k1" and "k2" should be avoided where possible).Below shows an example ASN.1 with both of the above: [[cmrGrouping-r17 CMR-Group-r17 OPTIONAL, -- Need R cmrPairList-r17 SEQUENCE (SIZE 1..2)) OF CMR-Pair-r17 OPTIONAL, -- Need R ]]}CMR-Pair-r17 ::= SEQUENCE { pairElement1 NZP-CSI-RS-ResourceId, pairElement2 NZP-CSI-RS-ResourceId}CMR-Pair-r17 ::= SEQUENCE { k1-r17 INTEGER (1..7), k2-r17 INTEGER (1..7)}

|  |
| --- |
| ***cmrPairList***A list of paired of NZP CSI-RS resources belonging to different CMR groups, as defined in TS 38.214 [19], clause xx. |
| ***cmrGrouping***Defines which NZP-CSI-RS-Resources belong to a CMR group. The value 0 in the bit string indicates the corresponding CSI-RS resource within *nzp-CSI-RS-Resources* belong to the CMR group 1, and the vcalue 1 in the bit string indicates the correspoding CSI-RS resource within nzp-CSI-RS-Resources belong to the CMR group 2 (see TS 38.214 [19], clause xx) |

|  |
| --- |
| ***CMR-Pair* field descriptions** |
| ***pairElement1, pairElement2***A list of paired of NZP CSI-RS resources belonging to different CMR groups. The CSI-RS indicated by the field *pairElement1* belongs to group 1 and CSI-RS indicated by the field pairElement2 belongs to group 2 as configured by the field *cmrGrouping* (see TS 38.214 [19], clause xx) |

 |
| Ericsson | yes |  |
| ZTE | Yes |  E//’s version is fine to us, The cmrGrouping-r17 defined in Nokia’s version seems not being able to work because the maximum number of K1 and K2 shall be equal to 8, and the bit string may reach to 64 bits, using 1 or 0 cannot select 8 NZP-CSI-RS resources for CMR groups from 64 bits string. |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
| Huawei, HiSilicon | Yes |  |
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**Conclusion**

There is support for the suggestion thus it can be implemented.

**Proposal 11 Add ASN1 as presented in the question for CMR groups and CMR pairing**

There are two more parameters related to codebookconfig where it states up to RAN2 for a specific aspect. It is suggested these are discussed later after other CB related parameters from official parameter excel are implemented.

# 6 Conclusion

**Proposal 1 RAN2 to conclude ““Joint DL/UL TCI” means that there is one TCI state ID for each codepoint, while “separate DL/UL TCI” means that there may be two TCI state IDs for each codepoint.”**

**Proposal 2 RAN2 to conclude that unified TCI state related parameters(placeholder for now) is implemented in running RRC in IE PDSCH-Config.**

**Proposal 3 RAN2 to clarify from RAN1 how many CC UE is expected to be configured with unified TCI state operation.**

**Proposal 4 the parameter BeamAppTime\_r17 is placed under PDSCH-Config with editor’s note about it’s final location.**

**Proposal 5 RAN2 to formulate question to RAN1 on the functionality of unified TCI state on PDCCH. In detail, why the marking is on CORESET level and not searchspace level and whether there are any configuration limitation implied by this.**

**Proposal 6 Option 2 is implemented in running CR with editor’s note on FFS**

**Proposal 7 RAN2 to formulate question to RAN1 on the functionality of unified TCI state on PDCCH. In detail, why the marking is on CORESET level and not searchspace level and whether there are any configuration limitation implied by this.**

**Proposal 8 A placeholder for UL TCI state is UL BWP-Dedicated IE with editor’s note on whether it is the final location**

**Proposal 9 Companies to bring to next meeting their suggested design for the unified TCI state lists and corresponding MAC CE**

**Proposal 10 Add example implementation in running RRC to UL-BWP dedicated for UL TCI state, power control set and PL RS RS.**

**Proposal 11 Add ASN1 as presented in the question for CMR groups and CMR pairing**

# 6 Appendix

RAN2 agreements

[R2-2110666](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110666.zip) Running RRC CR for FeMIMO Rel-17 Ericsson draftCR Rel-16 38.331 16.6.0 NR\_feMIMO-Core

* Endorsed as baseline (last meeting agreements included). Comments to be incorporated in CR after the meeting.

[R2-2110960](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110960.zip) MAC Running CR for Rel-17 feMIMO Samsung draftCR Rel-17 38.321 16.6.0 B NR\_feMIMO-Core Late

* Endorsed as baseline (last meeting agreements included). Comments to be incorporated in CR after the meeting.

RAN2 impacts of inter-cell beam mgmt

[R2-2110341](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110341.zip) On Rel-17 FeMIMO Ericsson discussion NR\_feMIMO-Core

DISCUSSION

- Samsung think there are ongoing discussions in R1. UL could be common or separate.

- MTK support this proposal. Think that what could make it complex is if we have to mix both R16 and R17 new frameworks for one UE.

- Chair proposes a high level text. OPPO want to wait. CATT think we can agree on a high level.

* RAN2 to support separate DL and UL and joint TCI state configurations. Details FFS.
* [AT116-e][015][feMIMO] (Nokia [lead], Ericsson, vivo)

 Scope: On RAN1 LSes [R2-2111214](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2111214.zip), [R2-2111246](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2111246.zip), [R2-2109326](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2109326.zip) and their General and high level consequences. Review impacts to RRC (top down) and R2 work, e.g. general observations, structure, common impacts and impact specific to mTRP and MCBF - Find Easy/Potential Agreements, identify points for online discussion, can also identify and capture open issues, and whether LS out is needed. (Comment: please focus on points that need to be discussed/decided to pave the way for more detailed later discussions).

 Intended outcome: Report

 Deadline: For online W2 Wednesday

* 1a: RAN2 to use the terminology "primary TRP (pTRP)" and "additional TRP (aTRP)" for RAN2 discussion purposes. FFS whether these will really be needed in Stage-2/3 specifications.
* 1b: RAN2 does not consider RLM for aTRP in Rel-17 work
* 2a: No RRM enhancements are done in Rel-17 (unless later found critical to the functionality).
* 2b: Add SSB/PCI information for ICBM as cell-level information and link unified TCI state information to that. FFS on exact Stage-3 details.
* 2c: RAN2 starts the RRC CR work based on latest RAN1 input before sending general RRC LS to RAN1.
* 3: The RAN1 parameters for "MultiBeam" are only applicable to ICBM with unified TCI framework (i.e. not to mTRP). Discuss further in Stage-3 phase how the UL PC configuration parameters are defined.
* 4: Rel-17 MPE configuration can be included in PHR-Config. Will ask R1 whether MPE information can apply to both ICBM and mTRP
* 6: RAN2 assumes "mTRP" parameters are not for ICBM and starts Stage-3 work based on that assumption. If ambiguities are found, LS can be sent to RAN1 to ask for clarification from next meeting.
* 7: RAN2 will use one RRC CR for the FeMIMO WI and start the work in post-meeting email discussion. Can discuss RRC structure during the discussion before going for final Stage-3 details.
* [AT116-e][016][feMIMO] MAC CE impacts (Samsung)

 Scope: Based on [R2-2110962](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110962.zip), [R2-2110035](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110035.zip), RAN LS’s and RAN1 progress. Do an initial review of impacts to MAC (MAC CEs) and related R2 work, collect initial comments, assess maturity and if possible Find Potential Agreements, identify points for online discussion, can also identify open issues.

 Intended outcome: Report

 Deadline: For online W1 Thursday, CLOSED

* FFS if to Introduce the new PUCCH spatial relation activation/deactivation MAC CE for mTRP PUCCH repetition i.e. activating two spatial relation info’s (for FR2) for a group of PUCCH resources in a CC.
* RAN2 to discuss how to support PHR reporting for mTRP PUSCH repetition, and may address e.g:

New MAC CE design including the function which TRP is applied for PHR reporting.

How to incorporate the additional MPE information coming in Rel-17 to the new PHR format

Whether use legacy parameters (timer, threshold, etc.) or adding TRP specific parameters

PHR triggering conditions

* R2 assumes to revise the legacy PUSCH Pathloss Reference RS Update MAC CE with additional field(s) to differentiate the TRP for mTRP PUSCH repetition. other aspects are FFS.
* [AT116-e][017][feMIMO] BFD BFR and Initial Running CRs (Samsung)

 Scope: 1) Review the submitted Running CRs in [R2-2110666](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110666.zip) (RRC) and [R2-2110960](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116-e%5CDocs%5CR2-2110960.zip) (MAC), collect comments with the goal of endorsement, save comments to be applied to the CRs after this meeting. 2) Treat the proposals in BFD BFR tdocs under AI 8.17.3, identify agreeable points, points for discussion, identify open issues, whether LS out is needed etc.

 Intended outcome: Report

 Deadline: W2 Wednesday.

 CLOSED

* All green-marked proposals are agreed, see below. For Running CR endorsement see R2-2110666 and R2-2110960.
* New BFR MAC CE including beam failure recovery information of both failed TRPs is transmitted when beam failure is detected for both TRPs of SCell. The Following pieces of information are included in enhanced BFR MAC CE for M-TRP BFR

Info 1: For the Identity of serving cell of failed TRP, Ci/SP fields are included.

Info 2: For indicating whether candidate beam is available or not for a failed TRP of serving cell, AC field is included.

Info 3: Candidate beam (if available) for a failed TRP is indicated by including the Candidate RS ID field.

* Both single octet bitmap (7 Ci bits and 1 SP bit) and 4 octet bitmap (31 Ci bits and 1 SP bit) formats are supported for enhanced BFR MAC CE.
* Both truncated and non-truncated enhanced BFR MAC CE are supported.
* Triggered BFRs for a BFD-RS set of a SCell shall be cancelled when a MAC PDU is transmitted and this PDU includes enhanced BFR MAC CE (or Truncated enhanced BFR MAC CE, if supported) which contains beam failure recovery information (i.e. candidate beam available or not, candidate beam if available) of that BFD-RS set of the SCell.
* if a PDCCH addressed to C-RNTI indicating uplink grant for a new transmission is received for the HARQ process used for the transmission of the enhanced BFR MAC CE which contains beam failure recovery information of a BFD-RS set of a serving cell: *BFI\_COUNTER* corresponding to the BFD-RS set of the serving cell is set to 0.
* if the SCell is deactivated, *BFI\_COUNTER* corresponding to each BFD-RS set of the serving cell is set to 0.
* if Random Access procedure initiated on SpCell due to beam failure detection on both TRPs (i.e. BFD-RS sets) of SpCell is successfully completed: *BFI\_COUNTER* corresponding to each BFD-RS set of the SpCell is set to 0.
* if the beamFailureDetectionTimer corresponding to a BFD-RS set of a serving cell expires; or if beamFailureDetectionTimer, beamFailureInstanceMaxCount, or any of the reference signals used for beam failure detection corresponding to a BFD-RS set of a serving cell is reconfigured by upper layers: BFI\_COUNTER for this BFD-RS set of the serving cell is set to 0.
* For SCell configured with multiple TRPs, SR can be triggered irrespective of whether beam failure is detected on one or both TRPs of SCell.
* For SpCell configured with multiple TRPs, SR can be triggered if beam failure is detected on only one TRP of SpCell.
* The cases for which SR is allowed (as per proposal 15, 16), SR is triggered if either of conditions a) and b) below are met:

- If UL-SCH resources are not available for a new transmission; or

- If UL-SCH resources are available for a new transmission but cannot accommodate the enhanced BFR MAC CE or enhanced truncated BFR MAC CE plus its sub header as a result of LCP.

* If a SR was triggered by BFR for a BFD-RS set of a serving cell and a MAC PDU is transmitted and this PDU includes an enhanced BFR MAC CE or a Truncated enhanced BFR MAC CE which contains beam failure recovery information for this BFD-RS set of the serving cell, pending SR is cancelled and the corresponding *sr-ProhibitTimer* is stopped, if running.
* If a SR was triggered by BFR for a BFD-RS set of an SCell and this SCell is deactivated, pending SR is cancelled and the corresponding *sr-ProhibitTimer* is stopped, if running.
* It is assumed that If beam failure is detected on both TRPs (i.e. BFD-RS sets) of an SpCell, UE initiate RACH procedure and transmits new BFR MAC CE including beam failure recovery information needed to recover both TRPs. (other options not excluded for now, it is FFS whether the UE can skip BFR information needed to recover one of the TRPs if there is not enough bits).
* The meaning of “beam failure is detected on both TRPs” is to be clarified, It is FFS which of the following options shall be applied:

Option 1 (12/17): “beam failure is detected on both TRPs” means that BFR is triggered for a TRP of the serving cell while the BFR for another TRP of same serving cell is still pending (i.e. not cancelled).

Option 2 (4/17): “beam failure is detected on both TRPs” means that BFR is triggered for a TRP of the serving cell while the BFR for another TRP of same serving cell is still pending (i.e. not successfully completed)

* Cell specific or TRP specific BFR / BFR cancellation when beam failure is detected on on both TRPs of SCell is to be determined. It is FFS which of the following options shall be applied:

Option 1(5/17): Cell specific BFR of SCell is triggered. Triggered Cell specific BFR of SCell is cancelled when BFR MAC CE containing beam failure information of both TRP of the SCell is transmitted.

Option 2 (12/17): TRP specific BFR for both the failed TRPs remains as pending. TRP specific BFR cancellation procedure (as discussed in Proposal 10) is applied for each TRP independently.

* It is FFS whether Triggered BFRs for a BFD-RS set of a SpCell shall be cancelled when a MAC PDU is transmitted and this PDU includes enhanced BFR MAC CE (or Truncated enhanced BFR MAC CE, if supported) which contains beam failure recovery information (i.e. candidate beam available or not, candidate beam if available) of that BFD-RS set of the SpCell.