3GPP TSG-RAN WG2 Meeting #116 Electronic [R2-21xxxxx](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2111325.zip)

Elbonia, 01 – 12 November 2021

**Agenda item: 8.17.2**

**Source: Ericsson**

**Title: Summary**

**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.

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| --- | --- | --- |
| 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 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 | Agreement RAN1#106bis-e On 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-e For 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.

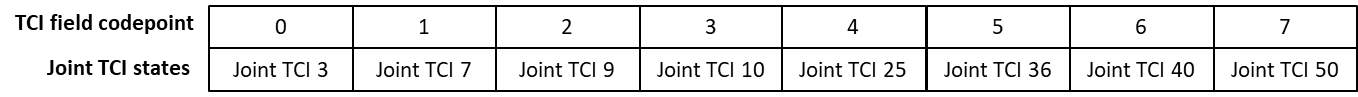


Figure 1 Example of activated TCI states and their mapping to TCI field codepoints for “Joint DL/UL TCI”

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.

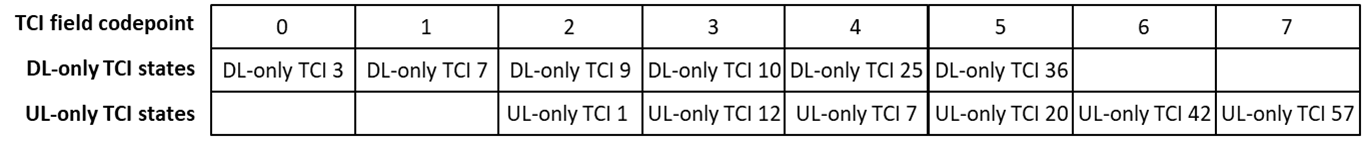


Figure 2 Example of activated TCI states and their mapping to TCI field codepoints for “Joint DL/UL TCI”

**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?**

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

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| 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.**

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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

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| 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 optimization  Applies 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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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?**

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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

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}

-- 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?**

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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:

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| --- | --- | --- | --- |
| 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

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}

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

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}

-- 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.**

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***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”.

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| 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 Framework  Comment 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**

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| Company | Option 1, 2, 3 | Comments |
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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?**

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| Company | Common/separate | Comments or other variations |
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## 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 RAN2  Applies only to Rel-17 unified TCI Framework  Up 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 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 RAN2  Applies only to Rel-17 unified TCI Framework  Up 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 RAN2  Applies only to Rel-17 unified TCI Framework  Up to RAN2 whether the ones for PUSCH, PUCCH, and SRS are combined into one structure (RAN1 thinks this can be done) |
| p0\_Alpha\_CLIdPUSCHSet  p0\_Alpha\_CLIdPUCCHSet  p0\_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 RAN2  Applies 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 RAN2  Can 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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**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 |
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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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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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# 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.*

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| --- | --- | --- | --- |
| **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 = 2  it 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)**

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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

**TBA**

# 6 Appendix

RAN2 agreements

[R2-2110666](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110666.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:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110960.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:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110341.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:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2111214.zip), [R2-2111246](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2111246.zip), [R2-2109326](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2109326.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:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110962.zip), [R2-2110035](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110035.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:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110666.zip) (RRC) and [R2-2110960](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110960.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.