**\3GPP TSG-RAN** **WG2 Meeting #114 electronic R2-220xxxx**

**Online, January 17 – January 25, 2022**

**Agenda item: 8.17.3**

**Source: Samsung**

**Title: Summary of [AT116bis-e][060][feMIMO] MAC general (Samsung)**

**Document for: Discussion & Decision**

# Introduction

This document summarizes the following email discussion.

* [AT116bis-e][060][feMIMO] MAC general (Samsung)

Scope:

1) Further progress based on R2-2201699, taking into account on-line discussion etc.

- Attempt agree on points that seem easy agreeable, if any.

- Collect comments in order to find ways forward, identify open issues etc on RAN1-defined MAC CEs, and on selected basic aspects (rapporteur to select), e.g. contents of BFR MAC CE.

2) Take into account RRC agreements and some relevant input in 8.17.2 (e.g. R2-2200316) and attempt further progress on MAC CE for TCI state activation (at least identify issues).

Intended outcome: Report, with agreements if any, proposed way forwards, open issues etc.

Deadline: EOM

NOTE: Deadline for companies comments to 2400 UTC 24 Jan. 2022. (to collect and summarize the proposals)

MAC CE impacts handled in this offline discussion are mainly the RAN1-defined MAC CEs in [1][2], and aim to further progress based on R2-2201699 [3]. Some MAC CE impacts handled in other email discussions are not treated in this offline discussion:

* “Unified TCI state MAC CE for separate Id pool” is handled in offline discussion [052][feMIMO] RRC progress (Ericsson) [4].
* “Enhanced PHR MAC CE for mTRP PUSCH repetition” is handlied in offline discussion [059][feMIMO] Specific items: SI, MPE (Nokia) [5].

# Contact Points

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

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Samsung | Seungri Jin  Anil Agiwal | seungri.jin@samsung.com  anilag@samsung.com |
| OPPO | Xin You | youxin@oppo.com |
| Nokia, Nokia Shanghai Bell | Samuli Turtinen  Tero Henttonen | samuli.turtinen@nokia.com  tero.henttonen@nokia.com |
| vivo | Chenli | Chenli5g@vivo.com |
| Apple | Fangli XU | fangli\_xu@apple.com |
| Qualcomm | Ruiming Zheng | rzheng@qti.qualcomm.com |
| Intel | Youn Heo | Youn.hyoung.heo@intel.com |
| CATT | Erlin Zeng | Erlin.zeng@catt.cn |
| Huawei, HiSilicon | David Lecompte | david.lecompte@huawei.com |
| Fujitsu | Meiyi Jia | jiameiyi@fujitsu.com |
| LGE | Hanul Lee | hanul.lee@lge.com |
|  |  |  |
|  |  |  |
|  |  |  |

# Discussion:

## MAC CE impacts and others

### 3.1.1 Enhanced TCI state indication for UE-specific PDCCH MAC CE

Based on the endorsed running MAC CR [6], a new MAC CE is already introduced as the enhanced TCI state indication for UE specific PDCCH MAC CE. There are some FFS points and corresponding RAN1 agreements so far. Company contributions [7][8] provide the related proposals on this issues.

For the first FFS point in the MAC running CR [6]:

Editor’s NOTE: FFS whether the MAC CE can be applied to a set of serving cells.

RAN1 agreed the following in RAN1 #107-e meeting.

|  |
| --- |
| **Agreement**  Confirm the working assumption from RAN1 #106b-e meeting to reuse legacy Rel-16 RRC parameters *simultaneousTCI-UpdateList1*, *simultaneousTCI-UpdateList2* to define set of the serving cells which can be addressed by a single MAC CE for activation of two TCI states of CORESET with the same CORESET ID for all the BWPs. |

Following RAN1 agreement, RAN2 can confirms that the enhanced TCI state indication for UE specific PDCCH MAC CE can be applied to a set of serving cells configured in *simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2*.

**Q1: Do you agree that the “Enhanced TCI state indication for UE-specific PDCCH MAC CE” can be applied for simultaneously activating two TCI states for a set of serving cell(s) defined by legacy R16 parameters *simultaneousTCI-UpdateList1* and *simultaneousTCI-UpdateList2*?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | It is aligned with the RAN1 agreement. |
| OPPO | Yes | R16 way for supporting group-based TCI state update can be reused for Enhanced TCI state indication for UE-specific PDCCH MAC CE. |
| Nokia | Yes but | We may need another configuration parameter to differentiate R16 and R17 functionality at UE. |
| vivo | Yes | Aligned with RAN1 agreement. |
| Apple | Yes |  |
| Qualcomm | Yes |  |
| Intel | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| LGE | Yes |  |

**Rapporteur summary**

**TBD**

For the second FFS point in the MAC running CR [6]:

Editor’s NOTE: FFS whether the MAC CE can be applied to CORESET zero.

There is no explicit agreement in RAN1 regarding this FFS. RAN2 may assumed that “Enhanced TCI state indication for UE specific PDCCH MAC CE” can be applicable to CORESET zero because it will assumed the same operation with legacy i.e. legacy MAC CE is applicable to CORESET zero. However, some companies think it is better to ask RAN1 whether the “Enhanced TCI state indication for UE specific PDCCH MAC CE” can be applied to CORESET zero or not.

**Q2: Do you agree to send LS to RAN1 whether the “Enhanced TCI state indication for UE specific PDCCH MAC CE” can be applied to CORESET zero or not?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | No strong view | We assumed that the same operation with legacy is applicable on this MAC CE as well, but if companies think it is not clear we are fine to ask this to RAN1. |
| OPPO | Yes | RAN1 has not concluded on whether the “Enhanced TCI state indication for UE specific PDCCH MAC CE” can be applied to CORESET zero or not, it is preferred to send LS to RAN1 to ask. |
| Nokia | No strong view | Since we are anyway asking RAN1 to clarify other things, fine to ask also this. |
| vivo | Yes | This could be further discussed in RAN1. |
| Apple | No strong view |  |
| Qualcomm | Yes | Fine to ask. |
| Intel | No strong view | Our understanding is that RAN1 has not discussed and not identified as open issue as the same behavior in Rel-16 can be applicable. But, we are ok if the majority wants to ask RAN1. |
| ZTE | Yes | It shall be confirmed by RAN1 |
| CATT | Yes | This issue should be firstly discussed by RAN1, and RAN2 to wait for RAN1 conclusion. |
| Huawei, HiSilicon | No strong view | Can ask RAN1 to confirm. |
| Fujitsu | Yes |  |
| LGE | No strong view | We are OK if the majority companies want to ask RAN1. |

**Rapporteur summary**

**TBD**

For the third FFS point in the MAC running CR [6]:

Editor’s NOTE: FFS whether or not enhanced MAC CE signaling is applicable to a CORESET configured with CORESETPoolindex.

RAN1 mad following agreement which means that the enhanced MAC CE is applied if *CORESETPoolindex* is not configured or configured as 0.

|  |
| --- |
| Enhanced MAC CE signaling is not applicable to any of the configured CORESETs in a BWP if the CORESETs are configured with different *CORESETPoolindex* values in the BWP. |

**Q3: Do you agree that “Enhanced TCI state indication for UE specific PDCCH MAC CE” is applicable if CORESETPoolindex is not configured or configured as 0?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | It is aligned with the RAN1 agreement. |
| OPPO | Yes | We should follow RAN1 agreements. |
| Nokia | Yes |  |
| vivo | No, see comments | If all CORESETs are configured with *CORESETPoolindex*=1, enhanced TCI state indication for UE specific PDCCH MAC CE should also be applicable. |
| Apple | Yes |  |
| Qualcomm | Yes | Simply follow the RAN1 agreement. |
| Intel |  | We are still checking with our RAN1 on vivo’s interpretation. |
| ZTE | Yes |  |
| CATT | Yes with comments | RAN2 to further check with RAN1 if the enhanced MAC CE is applicable with CORESETPoolindex configured as 1 |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| LGE | Yes | Align with the RAN1 agreement. |

**Rapporteur summary**

**TBD**

In [2], RAN1 indicates that the “Enhanced TCI state indication for UE specific PDCCH MAC CE” should be applied for SFN-based PDCCH transmission. For SFN-based PDCCH transmission based on RAN1 parameters provided by RAN1, gNB will configure *sfnSchemePdcch*. Therefore, it is reasonable to update MAC CR such that PDCCH enhanced TCI States Indication MAC CE is applied when *sfnSchemePdcch* is configured.

**Q4: Do you agree that “Enhanced TCI state indication for UE specific PDCCH MAC CE” is applied only if *sfnSchemePdcch* is configured?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | It is aligned with the RAN1 agreement. |
| OPPO | Yes |  |
| Nokia | Yes |  |
| vivo | Yes | RAN1 has agreed that SFN-based PDCCH is determined by both sfnSchemePdcch and two TCI states in MAC CE. Therefore, ‘*sfnSchemePdcch* is configured’ is a necessary condition, otherwise two TCI states indicated by MAC CE would be an error case. |
| Apple | Yes |  |
| Qualcomm | Yes |  |
| Intel | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| LGE | Yes |  |

**Rapporteur summary**

**TBD**

### 3.1.2 PDCCH repetition impact on MAC

Company contribution [9] propose that the current procedure text regarding *drx-InactivityTimer* and Active Time should be updated based on RAN1 agreements in PDCCH repetition case.

According to RAN1 agreements captured in [9], if the PDCCH is enabled with PDCCH repetition through RRC configuration, the timeline involved/related to DCI decoding may have impacts on the reference point of starting a timer which is defined in MAC spec, for example, starting *drx-InactivityTimer*.

In current MAC spec, the *drx-InactivityTimer* start or restart in the first symbol after the end of the PDCCH reception. However, it is unclear for the PDCCH repetition case, i.e., whether the PDCCH reception is the first PDCCH candidate or the second one of one PDCCH repetition.

Therefore, a note can be introduced to clarify the reference point of starting a timer when PDCCH repetition if configured.

|  |
| --- |
| NOTE 1: If the PDCCH reception includes two PDCCH candidates from corresponding search space sets, as described in clause 10.1 in 38.213, start or restart *drx-InactivityTimer* for this DRX group in the first symbol after the end of the PDCCH candidate that ends later in time. |

**Q5: Do you agree to add above NOTE 1 in the MAC specification to clarify the reference point of starting a timer?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | We think this issue is valid and some clarification is needed. |
| OPPO | Yes |  |
| Nokia | Yes but as normative text | NOTE does not suffice in this case as the timer start position has to be known to NW as well. |
| vivo | Yes | Taking the PDCCH candidate that ends later in time among the two linked PDCCH candidates used as reference for starting drx-InacitivityTimer has been agreed in RAN1#106-e and which should be captured in TS 38.321. |
| Apple | Yes | The clarification is needed. |
| Qualcomm | Yes |  |
| Intel | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | No | With the current spec, the drx-InactivityTimer will start/re-start after the first PDCCH candidate reception (on slot #x) and after the second PDCCH candidate reception (on slot #y).  This allows to avoid expiry of drx-InactivityTimer between the two transmissions. We think it is better to keep this behaviour. |
| Fujitsu | Yes |  |
| LGE | Yes | RAN1 already agreed "the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used as a reference". |

**Rapporteur summary**

**TBD**

The other issues related to the PDCCH repetition which was identified in [9] is that one of the linked candidates is inside a timer window while the other one is outside. UE may not be able to monitor the second PDCCH candidate due to outside the monitor window. All DRX related timers (e.g. *drx-onDurationTimer*, *drx-RetransmissionTimerDL*, *drx-RetransmissionTimerUL*) in between of the two repetitions may be impacted. Therefore, it may required to clarify how Active Time is determined when the PDCCH repletion is configured.

|  |
| --- |
| Note 2: If the Active Time for Serving Cells in a DRX group includes a first PDCCH candidate that is linked to a second PDCCH candidate from two corresponding search space sets, as described in clause 10.1 in 38.213, the Active Time for Serving Cells in a DRX group also includes the second PDCCH candidate |

**Q6: Do you agree to add above NOTE 2 in the MAC specification to clarify the Active Time** **when the PDCCH repletion is configured?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | It is reasonable to consider both PDCCH candidates. |
| OPPO | Yes |  |
| Nokia | No | We have the following text in the current TS 38.321:  “The MAC entity needs not to monitor the PDCCH if it is not a complete PDCCH occasion (e.g. the Active Time starts or ends in the middle of a PDCCH occasion).  ”  Same analogy can apply in this case and we could even reuse the existing text but OK also to update it if companies think it would be unclear. |
| vivo | No | This issue is an error case which should be avoided by gNB implementation and there is no need to clarify anything in specification. |
| Apple | Yes | The clarification is needed. |
| Qualcomm | Yes | This is possible that network may configure the second PDCCH candidate is outside of the DRX monitor window. How to handle this case should be clarified in the spec.  The quoted text by Nokia is only about ‘not a complete PDCCH occasion’. We don’t think the existing text is related to the Rel-17 PDCCH repetition case. Thus, clarification is needed. |
| ZTE | DCI monitoring is RAN1’s business | In our understanding, whether to monitor the PDCCH is not RAN2 business, we can include our concern in the LS to RAN1, it is up to RAN1 to decide. |
| CATT | Yes | The clarification is needed. |
| Huawei, HiSilicon | No | The value of DRX related timers should be set properly by gNB to include the second PDCCH candidate in the active time. |
| Fujitsu | Yes |  |
| LGE | No | Same understanding with Nokia. There is no issue with the current specification and the proposal is an optimization.  CSI reporting is aligned drx-onDurationTimer if CSI masking is not configured, and is aligned with Active time if CSI masking is configured. If Active time is not perfectly aligned with DRX timer, RAN2 need to revisit the complicated discussion of how to handle the CSI reporting. We think this effort is not necessary for the optimization. |

**Rapporteur summary**

**TBD**

### 3.1.3 Two PUCCH spatial relation info activation/deactivation MAC CE

During RAN2#116-e meeting RAN2 made following agreement:

* 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.

Based on above RAN2 agreements, many companies provide the clear option for “PUCCH spatial relation activation/deactivation MAC CE for mTRP”. There are two options to support this functionality (i.e. activating two spatial relation info’s (for FR2) for a group of PUCCH resources in a CC

1. Option 1: Introduce the new PUCCH spatial relation activation/deactivation MAC CE for mTRP PUCCH repetition.
2. Option 2: Revise the legacy “Enhanced PUCCH Spatial Relation Activation/Deactivation MAC CE” with additional fields (e.g. indicator for mTRP operation, additional Spatial Relation Info ID(s) for added TRP).

Proponent of Option 1 insisted that this approach is the clean solution in terms of MAC CE design and explained that this MAC CE should support both mTRP and the PUCCH groups i.e. it should be differentiated with the functionality of the legacy MAC CE. Meanwhile, Proponent of Option 2 proposed to update the existing “Enhanced PUCCH spatial relation Activation/Deactivation MAC CE” adding new fields if it is possible. However, the proposed MAC CE format in [10] added the new octet (R R Spatial Relation Info ID) between the legacy fields. From the rapporteur understanding, it will cause the backward compatibility issue i.e. require implementation changes, so it is not good design. Surely, there will be other valid design to reuse the legacy MAC CE, but it is more preferred to introduce the new PUCCH spatial relation activation/deactivation MAC CE for mTRP PUCCH repetition based on the number of proponent companies which is calculated form the number of contribution suppproting this option.

**Q7: Do you agree to introduce the new PUCCH spatial relation activation/deactivation MAC CE for mTRP PUCCH repetition (Option 1)?**

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments |
| Samsung | Yes | We think both options are possible but option 1 is preferred because it is more clean approach in terms of MAC CE design. |
| OPPO |  | We think both options can work well. And we admits that option 1 is a clean solution, while option 2 can also avoid redundant MAC CE design in MAC spec. If majority companies prefer to introduce a new MAC CE, we are also fine. |
| Nokia | Yes | It's better to provide new MAC CE for new functionality, and the MAC CE design becomes simpler that way. |
| vivo | No | We prefer to reuse current MAC CE design without introducing too many new MAC CEs, if the legacy one could work well. Besides, we don’t find any issue for reusing. |
| Apple |  | We are fine with both options, and think Option 1 is cleaner than Option 2. |
| Qualcomm | Yes | It seems the new MAC CE is cleaner. |
| Intel | Yes | From our understanding, two spatial relation info/power control parameter are activated per PUCCH resource group. We wonder if the existing MAC CE can be simply reused.  • Support MAC-CE activating two spatial relation info’s (for FR2) for a group of PUCCH resources in a CC.  • Support MAC-CE activating two sets of power control parameters (for FR1) for a group of PUCCH resources in a CC. |
| ZTE | No | Agree with vivo, we can implement this with a little change on the current MAC CE. But we are fine to having a new MAC CE if majorities would like to. |
| CATT | Yes | Option 1 is a cleaner approach. |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes | We prefer a clean solution. |
| LGE | Yes | We prefer new MAC CE approach. |

**Rapporteur summary**

**TBD**

### 3.1.4 Two PUCCH power control parameter set activation/deactivation MAC CE

Based on below RAN1 agreements, RAN1 agreed that the linking of PUCCH resource with two power control parameter sets is required in case of FR1 mTRP operation (i.e. spatial relation activation/deactivation) in Rel-17. RAN1 agreements are clear enough to explain the required functionality but there are different approaches due to the example from RAN1 (i.e. reuse *PUCCH-SpatialRelationInfo* except for the *referenceSignal)*.

|  |
| --- |
| **RAN1#104-e Agreements**  **Agreement**  For the case of multi-TRP, to support per-TRP power control in FR1, the linking of PUCCH resource with [one or] two power control parameter sets, the following is supported   * MAC-CE indicates RRC IE that configures power control parameter sets (p0, pathloss RS ID, and a closed-loop index).   + The exact design of RRC IE is up to RAN2 but from RAN1 point of view, one possible example is to reuse *PUCCH-SpatialRelationInfo* except for the *referenceSignal*   Note: It is common understanding in RAN1 that one PUCCH resource can be linked to one power control parameter set. |

There are two approaches provided by company contributions:

1. Option 1: Follow the RAN1 suggestion i.e. reuse *PUCCH-SpatialRelationInfo* except for the *referenceSignal*. In this case, the legacy MAC CEs (Enhanced PUCCH Spatial Relation Activation/Deactivation MAC CE and MAC CE and PUCCH spatial relation activation/deactivation MAC CE for mTRP PUCCH repetition) is used for FR1 cases.
2. Option 2: : Introduce the new MAC CE(s) to support PUCCH Power control set update (with power control) for FR1 cases. In this case, new RRC IE for FR1-dedicated power control set is required.

Option 1 has limited RAN2 impacts because the legacy RRC IE and MAC CE(s) can be reused by defining some descriptions for the purpose of supporting FR1 cases. But it requires to describe some restriction to handle the mandatory field i.e. *referenceSignal* in *PUCCH-SpatialRelationInfo*. Meanwhile, Option 2 is clean solution dedicatedly for FR1 so the new RRC IE and MAC CE design is more intuitive for the functionality.

**Q8: Which option is preferred to support per-TRP PUCCH resource power control in FR1?**

|  |  |  |
| --- | --- | --- |
| Company name | Option | Comments |
| Samsung | Option 2 | We think it is better to design MAC CE/ RRC IE to fit the functionality rather than reusing the legacy format which has not well-fitted for FR1 i.e. spatial relation concept is not applicable to FR1.  In addition, handling the mandatory field with some restriction is not preferred. |
| OPPO | Option 1 | We prefer to follow RAN1’s suggestion as less MAC CE design effort is required. |
| Nokia | Option 2 | It's best to define new RRC IE since some fields are no longer valid. Similarly, we can then define new MAC CE as well. |
| vivo | Option 1 | We should follow RAN1 suggestion, and which is simpler and less impact to specification. |
| Apple |  | We are fine with both options, and slightly prefer to follow RAN1 suggestion. |
| Qualcomm | Option 1 but | We can follow RAN1’s suggesntion. However, the legacy MAC CE pointed by rappeteour is not suitable here. Because the legacy MAC CE can not support to indicate two PUCCH power control parameter (via PUCCH-SpatialRelationInfo) for each PUCCH resource ID. |
| Intel | Option 2 | It is reasonable to aligne MAC and RRC discussion. We prefer new RRC parameter as reference signal cannot be precluded. |
| ZTE | Option 1 | Follow RAN1 suggestion |
| CATT | Option 1 | We prefer to follow RAN1 suggestion. |
| Huawei, HiSilicon | Option 2 | We think this should be part of RRC discussion |
| Fujitsu | Option 2 | We prefer a clean solution. |
| LGE | Option 2 | We think Option 2 is simpler than Option 1. We don’t prefer to describe differently to preclude a parameter in some cases. |

**Rapporteur summary**

**TBD**

### 3.1.5 Enhanced PUSCH Pathloss Reference RS Update MAC CE

RAN1 provided the detail description [4] on Enhanced PUSCH Pathloss Reference RS Update MAC CE for mTRP PUSCH repetition:

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

In Rel-16, PUSCH Pathloss Reference RS Update MAC CE was introduced to update the linking information between PUSCH Pathloss Reference RS and SRI PUSCH power control ID(s).

In Rel-17, RAN1 has introduced PUSCH repetition for mTRP, so it is required to enhance PUSCH Pathloss Reference RS Update MAC CE to support mTRP. It needs to be indicated which TRP is applied for this MAC CE i.e. adding TRP indication or SRS resource set associated with TRP information.

RAN2 already made following agreements in RAN2#116 meeting.

* 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.

Based on above RAN2 agreement it is quite clear to add the new field to indicates whether SRI ID(s) are associated with the first SRS resource set or the second SRS resource set.

However, one company [9] triggered the additional issue whether the legacy Rel-16 PUSCH Pathloss Reference RS Update MAC CE can be revised to add additional field to support the multi-TRP case or not. If mTRP support in a MAC CE is not supported UE need to receive

1. Option 1: Replace the Reserve bit (‘R’) to a TRP index field (‘T’)so that the MAC CE can indicate which TRP the PUSCH pathloss reference RS update can apply for.



1. Option 2: Replace the two Reserve bit (‘R’) to indicate or differentiate the TRP for mTRP PUSCH repetition.

* For example, the first optional field (‘S’) indicates whether the second block of pathloss reference RS updating with SRI ID is present or not. If both TRP needs to update the pathloss reference RS, the second optional field (‘T’) can be ignored. Otherwise, the ‘T’ filed indicates the first block of RS updating with SRI ID is for which TRP (In this case, the ‘S’ field is set to 0).



**Q9: Which option is preferred to support Enhanced PUSCH Pathloss Reference RS Update MAC CE?**

|  |  |  |
| --- | --- | --- |
| Company name | Option | Comments |
| Samsung | Option 1 | We don’t see the strong need of this optimization. |
| OPPO | Option1 | RAN2 has agreed to revise the legacy PUSCH Pathloss Reference RS Update MAC CE with additional field(s) to differentiate the TRP for mTRP PUSCH repetition. |
| Nokia | Option 1 | Option 1 seems simpler but this requires NW to send one MAC CE per TRP if needed for both. As long as it's clear that UE may receive (and update) both of them at the same time, option 1 can work. |
| vivo | Option 1 | Option 1 is simpler and with less spec impact. |
| Apple | Option 1 | Option 1 is simpler. |
| Qualcomm | Option 2 | In case network would to update two TRP simulatously while option 1 can not meet the requirement. |
| Intel | Option 2 (option 1 is also acceptabl) | Option 2 is more flexible although the signaling overhead may not be so critical with this MAC CE. |
| ZTE | Option 1 |  |
| CATT | Option 1 |  |
| Huawei, HiSilicon | No strong view |  |
| Fujitsu | Option 1 |  |
| LGE | Option 1 | Option 1 is simpler. |

**Rapporteur summary**

**TBD**

## Multi TRP beam failure detection and recovery

## Enhanced BFR MAC CE Contents

**RAN2#115e Agreement**

* BFD-RS set ID is included in BFR MAC CE to identify the failed TRP

**RAN2#116e Agreement**

* 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.

Depending on whether one TRP of serving cell has failed or both TRPs of serving cell have failed, beam failure recovery information of one TRP or both TRPs needs to be included in enhanced BFR MAC CE. This means that some information is needed in BFR MAC CE which indicates to gNB whether beam failure recovery information of one or both TRPs are included in the enhanced BFR MAC CE.

Several options are proposed [11][12][13][14][15][16][17]:

Option 1 [12]: Include Bi field in the MAC CE.

* Bi field: each cell has two Bi fields and each Bi field corresponds to one BFD-RS set. Accordingly, they are arranged in an ascending order of the BFD-RS set IDs.
* If a Bi field is set to 1, it indicates that beam failure is detected for the corresponding BFD-RS set, the evaluation of the candidate beams according to the requirements as specified in TS 38.133 [4] has been completed. If a Bi field is set to 0, it indicates that beam failure is either not detected or the beam failure is detected but the evaluation of the candidate beams has not been completed for the corresponding BFD-RS set.
* These Bi fields for one cell are present if the SP/Ci field is set to 1 for the corresponding cell.
* Beam failure recovery information does not include TRP ID (i.e. BFD-RS set ID)

Option 2 [13][14][15]: Include two sets of serving cell bitmap in MAC CE.

* The first set of serving cell bitmap indicates the failure information associated with the first BFD-RS set and the second set of serving cell bitmap indicates the failure information associated with the second BFD-RS set.
* Beam failure recovery information does not include TRP ID (i.e. BFD-RS set ID)

Option 3 [16][17][11]: Include a bitmap in addition to serving cell bitmap which indicates per failed Serving Cell configured with mTRP BFD/BFR whether one or both of the TRPs associated with the Serving Cell failed. The R bit of the AC/Candidate RS ID octet indicates the failed TRP ID.

Option 4 [11]: Beam failure recovery information consists of one or two octets.

* 1st octet of beam failure recovery information includes 1-bit F field, 1-bit ID field and 6-bit candidate RS ID 1 field.
  + The candidate RS ID 1 field is for TRP identified by ID field. ID field is set to BFD-RS Set ID.
  + F field indicates whether one TRP is failed or both TRPs are failed.
* 2nd octet of beam failure recovery information included two R bits and 6-bit candidate RS ID 2 field.
  + 2nd Octet is present only if F field is set to 1.
  + 6-bit candidate RS ID 2 field is for TRP other than TRP identified by ID field
* Candidate RS ID field set to 0 indicates candidate beam is not available. Candidate RSs in candidate beam list are sequentially indexed from 1.

**Q10: Which option do you prefer to indicate whether beam failure recovery information of one or both TRPs are included in the enhanced BFR MAC CE?**

|  |  |  |
| --- | --- | --- |
| Company name | Option(s) | Comments |
| OPPO | Option3 | Option3 has less overhead and can be easily truncated if the UL grant is not enough to accommandate full BFR MAC CE. |
| Nokia | Option 3 | Option 3 seems to best preserve the legacy BFR MAC CE format leading to least implementation effort.  Option 1 seems not to include all the information already agreed for the new BFR MAC CE.  Option 2 is more overhead prune than Option 3 since Option 2 always requires two full sets of bitmaps, while Option 3 could indicate the second bitmap only for the failed serving cells with mTRP BFD configuration.  Option 4 does not include the agreed AC field for the candidate but eats one candidate RS ID index for this purpose which is not desirable. |
| vivo | Option 2 (Option 3 acceptable) | It seems sthat option 1 has large overhead.  Opton 2 and option 3 have same overhead. But option 2 is simpler by extending R16 BFR MAC CE format.  For option 4, it requires candidate RS index starts from 1. But there are 6 bits for RS ID filed. In this way, the maximum number of CBD RS is 63, which would have impact to RAN1 spec. |
| Apple | Option 3 | Option 3 has less signaling overhead than Option 1 and 2, and no impact on the candidate RS ID info. |
| Samsung | Option 3 or option 4 | Agree with Nokia’s comment on option 1 to 3.  Option 4 has the least overhead but reduces the number of candidate RSs from 64 to 63 per TRP. In legacy number of candidate RSs is 64 per serving cell. Even if number of candidate RSs is reduced from 64 to 63 per TRP, number of candidate RSs per serving cell is 63\*2 = 126. |
| Qualcomm | Option 2 | Option 2 is simple from the MAC CE format perspective. One disadvantage of option 3 is that Candidate RS ID field is not able to be extended. (Because of T field) |
| Intel | Option 3 | It seems most practical approach without disadvantage. |
| ZTE | Option 2 | Option 2 is much more simpler and straight forward than any other options, regarding the concern of the larger bitmap consumption, we think we can do some enhancement for the serving cell bitmap, for example, the first bit of the bitmap represents the first serving cell which is configured with more than one BFD-RS set, the second bit of the bitmap represents the second serving cell which is configured with more than one BFD-RS set, and so on. |
| CATT | Option 2 | Option 2 has a simple form to satisfy the functionality of the enhanced BFR MAC CE. |
| Huawei, HiSilicon | Option3 | Option 2 is also acceptable. |
| Fujitsu | Option 3 | For Option 1, 2 bytes are required to carry per TRP BFR information for each cell where TRP beam failure is detected even only one TRP has beam failure. So, it is inefficient.  We think that Option 3 and Option 4 carry the equivalent information while Option 2 can provide more information in case of truncation. So, we prefer Option 3 slightly compared to Option 4.  The addition bitmap in Option 3 only includes the information for failed Serving Cell configured with mTRP BFD/BFR, i.e. it can use less bytes compared Option 2. Additonlly, Option 2 requires to revise previous RAN2 agreements. So, we prefer Option 3 slightly. |
| LGE | Option 2 and Option 3 | Option 2 and 3 hves less signaling overhead than Option 1 and are interpreted more intuitively than option 4. |

Truncation Aspects:

According to [18], RAN2 does not support the truncation per TRP, i.e., the UE does not includes BFR information for both TRP for the Serving Cell if there is not enough bits. On the other hand, it is proposed in [17] that in the Truncated Enhanced BFR MAC CE, it can only include the BFR info of one TRP if the BFR of both TRPs are triggered.

**Q11: Which option do you prefer to indicate whether beam failure recovery information of one or both TRPs are included in the enhanced BFR MAC CE?**

**Option 1: In the Truncated Enhanced BFR MAC CE, it can only include the BFR info of one TRP if the BFR of both TRPs are triggered.**

**Option 2: RAN2 does not support the truncation per TRP, i.e., the UE does not includes BFR information for both TRP for the Serving Cell if there are not enough bits.**

|  |  |  |
| --- | --- | --- |
| Company name | Option | Comments |
| OPPO | Option 2 | We see no problem to follow legacy truncation mechanism, i.e. the BFR information are present in ascending order based on the ServCellIndex. |
| Nokia | Neither | There can be requirement to truncate the new BFR MAC CE only with one byte and in that case second TRP could be indicated for many Serving Cells. The UE should naturally encode as much information as possible in the new Truncated BFR MAC CE while Option 1 removes unnecessarily second TRP information of possibly many serving cells.  We agree that we can truncate the second TRP field of a serving cell before truncating BFR information of a complete another serving cell.  We don’t fully understand Option 2, but that seems to provide even less information to the NW, which is not preferred. |
| vivo | Option 1 | We think if the BFR information of one TRP could be included, then, one TRP could be recovered first. |
| Apple | Option 1 | Truncated BFR can be supported in legacy SCell BFR mechanism, so for the TRP specific BFR introduced, it’s obvious to keep the same design and keep the smalleset granularity of the BFR info (TRP level info) in the truncated BFR MAC CE. |
| Samsung | Option 1 | BFR MAC CE can include beam failure recovery information of several cells.  Lets say BFR is needed for 3 serving cells (Cell 1, Cell 2, Cell 3) and both TRPs are failed for all serving cells. Lets say three bytes are available for BFR info of these serving cells. Option 1 may have two different sub-approaches:  Option 1 - Approach 1 (maximise TRP info per serving cell)  Cell 1 (TRP 1 BFR info, TRP 2 BFR Info)  Cell 2 (TRP 1 BFR Info)  Option 1 - Approach 2 (maximise serving cells having failed TRP)  Cell 1 (TRP 1 BFR info)  Cell 2 (TRP 1 BFR Info)  Cell 3 (TRP 1 BFR Info)  Approach 1 seems more aligned with legacy. |
| Qualcomm | Option 1 | It also dpends on Q10 which MAC CE format will be agreed. |
| Intel | Option 1 |  |
| ZTE | Option 1 | Agree with Qualcomm |
| CATT | Option 1 |  |
| Huawei, HiSilicon | Option 2 | Option 1 is too complicated and increases complexity for the network.  With option 1, when receiving a MAC CE, the network needs to think that perhaps the second TRP is failed even though the MAC CE does not says so.  With option 2, there is a similar situation but for other serving cells and this is already handled by the network.  So option 2 is easier for the network, as it is like legacy. |
| Fujitsu | Option 2 | Option 1 requires additional standariztion work compared to Option 2. |
| LGE | Option 2 | We prefer to follow legacy principle and see no critical issue.  However, we are open to discuss the truncation per TRP, i.e., Option 1.  If Option 1 is supported, we think further discussion is needed how to do the truncation. For example, if beam failure is detected on both TRPs and UL resource is not enough, whether BFR information is always included for both TRPs in ascending order of serving cell index or BFR information is included for one TRP first for a cell in ascending order of serving cell index. |

## RA Cancellation

As per legacy procedure, the MAC entity may stop, if any, ongoing Random Access procedure due to a pending SR for BFR of an SCell, which has no valid PUCCH resources configured, if:

* a MAC PDU is transmitted using a UL grant other than a UL grant provided by Random Access Response or a UL grant determined as specified in clause 5.1.2a for the transmission of the MSGA payload, and this PDU contains a BFR MAC CE or a Truncated BFR MAC CE which includes beam failure recovery information of that SCell; or

[11] For multi TRP beam failure detection and recovery, SR can be triggered for a BFD-RS set of a Serving Cell. This pending SR can trigger Random Access procedure if there are no valid PUCCH resources configured. In this case, similar to current principle, it is proposed in [11] that the MAC entity may stop, if any, ongoing Random Access procedure, if

* a MAC PDU is transmitted using a UL grant other than a UL grant provided by Random Access Response or a UL grant determined as specified in clause 5.1.2a for the transmission of the MSGA payload, and this PDU contains an Enhanced BFR MAC CE or a Truncated Enhanced BFR MAC CE which includes beam failure recovery information of that BFD-RS set of the Serving Cell;

**Q12: Do you agree that the MAC entity may stop, ongoing Random Access procedure due to a pending SR for BFR of a BFD-RS set of a serving cell, which has no valid PUCCH resources configured, if a MAC PDU is transmitted using a UL grant other than a UL grant provided by Random Access Response or a UL grant determined as specified in clause 5.1.2a for the transmission of the MSGA payload, and this PDU contains an Enhanced BFR MAC CE or a Truncated Enhanced BFR MAC CE which includes beam failure recovery information of that BFD-RS set of the Serving Cell ?**

|  |  |  |
| --- | --- | --- |
| Company name | Option | Comments |
| OPPO | Yes |  |
| Nokia | Yes for SCell | This is fine for SCell, as in legacy.  However, for SpCell, this needs to be thought more carefully as this would be possible in case only one TRP has failed, however, shall not be cancelled if second TRP failed in the meanwhile.  We would be fine allowing this behaviour only for SCells. Since the SpCell BFR is crucial to work always, it seems reasonable not to cancel the RA even for one TRP case. |
| Vivo | Yes |  |
| Apple | Yes for SCell | Same understanding as Nokia. |
| Samsung | Yes | RA procedure being considered here is the RA procedure triggered by pending SR with no valid PUCCH resources, where SR is triggered for BFR of BFD-RS set ot serving cell.  So we agree to allow UE to stop irrespective of serving cell is SpCell or SCell. |
| Qualcomm | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| LGE | Yes |  |

It is further proposed in [14] that, If RACH is initiated on a SpCell for BFR and one TRP has recovered (i.e. a BFR MAC CE was previously transmitted for BFR on this TRP and the UE has received a PDCCH that makes BFR successful according to existing criteria) before the RACH is complete, the ongoing RACH can be stopped and the UE transmits a BFR MAC CE for the non-recovered TRP.

**Q13: Do you agree that, if RACH is initiated on a SpCell for BFR and one TRP has recovered (i.e. received response to previously transmitted BFR MAC CE for this TRP) before the RACH is complete, the ongoing RACH can be stopped and the UE transmits a BFR MAC CE for the non-recovered TRP?**

|  |  |  |
| --- | --- | --- |
| Company name | Option | Comments |
| OPPO | No | As the ongoing RACH procedure is also aiming to recover another TRP, we think it can be continued. Otherwise, stop the ongoing RACH and re-initiate the BFR MAC CE reporting for the second TRP may cause redundent transmission as well as extra latency. |
| Nokia | No | We are not sure what “TRP has recovered” means here. If RA for BFR has been triggered, then the RA shall be completed.  Huawei: see clarifications |
| Vivo | Not sure | Similar view as Nokia that TRP has recovered is not clear. |
| Apple | No | Same question as Nokia that it’s unclear on the description of “TRP has recovered”. |
| Qualcomm | No |  |
| ZTE | No |  |
| CATT | No |  |
| Huawei, HiSilicon | Yes | See clarification added above for “one TRP has recovered”: a BFR MAC CE has been transmitted for TRP1 recovery before TRP2 has failed, which triggered the RACH. So during the RACH, the UE may receive a recovery response for TRP1.  C:\Users\d73101\AppData\Roaming\eSpace_Desktop\UserData\d73101\imagefiles\941613ED-09EA-495E-B475-ACFCD661BFD1.png  If CFRA is not supported, the UE initiates 4-step CBRA, and the recovery response is received before Msg2 reception, then the UE can send a BFR MAC CE for TRP2 instead of monitoring Msg2 and further transmitting msg3 and waiting for msg4.  This enables recovery on TRP1 and TRP2 much faster. |
| Fujitsu | No | If the majority view is to stop, we suggest relacing “can” with “may”. |
| LGE | No | If the proposal in Q12 is agreed, we think other solution is not needed. |
|  |  |  |

## Handling overlapping between PUCCH resources

Accoriding to legacy procedure

* When the MAC entity has pending SR for SCell beam failure recovery and the MAC entity has one or more PUCCH resources overlapping with PUCCH resource for SCell beam failure recovery for the SR transmission occasion, the MAC entity considers only the PUCCH resource for SCell beam failure recovery as valid

[11] For multi TRP beam failure detection and recovery, when the MAC entity has pending SR for beam failure recovery of a BFD-RS set, the PUCCH resource for beam failure recovery of that BFD-RS set for the SR transmission occasion can overlap with PUCCH resources for other purposes (e.g. BSR). The issue is which one should be prioritized. It is proposed in [11] that,

* When the MAC entity has pending SR for beam failure recovery of a BFD-RS set and the MAC entity has one or more PUCCH resources overlapping with PUCCH resource for beam failure recovery of that BFD-RS set for the SR transmission occasion, the MAC entity considers only the PUCCH resource for beam failure recovery of that BFD-RS set as valid

**Q14: Do you agree with the following proposal?**

* **When the MAC entity has pending SR for beam failure recovery of a BFD-RS set and the MAC entity has one or more PUCCH resources overlapping with PUCCH resource for beam failure recovery of that BFD-RS set for the SR transmission occasion, the MAC entity considers only the PUCCH resource for beam failure recovery of that BFD-RS set as valid.**

|  |  |  |
| --- | --- | --- |
| Company name | Agree/Disagree | Comments |
| OPPO | Agree |  |
| Nokia | Yes | Same as legacy |
| Vivo | Yes |  |
| Apple | Yes |  |
| Samsung | Yes |  |
| Qualcomm | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| LGE | Yes |  |

# Conclusion

**TBD**

# Reference

1. R2-2112842 LS on Rel-17 MAC-CE impacts RAN1.
2. R2-2112840 MAC CE impacts RAN1.
3. R2-2201699 [Pre116bis] [010] [feMIMO] Summary of 8.17.3 Other (Samsung) Samsung.
4. R2-220xxxx [AT116bis-e][052][feMIMO] RRC progress (Ericsson) Ericsson.
5. R2-220xxxx [AT116bis-e][059][feMIMO] Specific items: SI, MPE (Nokia) Nokia.
6. R2-2200660 MAC Running CR for Rel-17 feMIMO Samsung.
7. R2-2200225 Remaining issues on HST-SFN PDCCH Intel Corporation
8. R2-2201255 Remaining MAC Aspects for M-TRP CATT
9. R2-2200721 PDCCH repetition impact on MAC and MIMO MAC CEs Qualcomm Incorporated
10. R2-2200782 Discussion on MAC CEs for FeMIMO OPPO
11. R2-2200205 Multi TRP Beam Failure Detection and Recovery Samsung
12. R2-2200403 Further discussions on BFD and BFR of mTRP NEC Corporation
13. R2-2200719 Remaining issues on multi-TRP BFR Qualcomm Incorporated
14. R2-2201224 Consideration on Implementation of BFR For mTRP ZTE Corporation
15. R2-2201255 Remaining MAC Aspects for M-TRP CATT
16. R2-2201588 Beam failure with mTRP Nokia, Nokia Shanghai Bell
17. R2-2201123 MAC impact of FeMIMO Apple
18. R2-2201359 Remaining issues on BFD/BFR for mTRP LG Electronics Inc.