**\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.

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| --- | --- | --- |
| Company | Name | Email Address |
| Samsung | Seungri JinAnil Agiwal | seungri.jin@samsung.comanilag@samsung.com |
| OPPO | Xin You | youxin@oppo.com |
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# 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.

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| --- |
| **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*?**

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| 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. |
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**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?**

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| 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. |
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**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.

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| 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?**

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| Company name | Yes/No | Comments |
| Samsung | Yes | It is aligned with the RAN1 agreement. |
| OPPO | Yes  | We should follow RAN1 agreements. |
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**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?**

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| Company name | Yes/No | Comments |
| Samsung | Yes | It is aligned with the RAN1 agreement. |
| OPPO | Yes  |  |
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**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.

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| 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?**

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| Company name | Yes/No | Comments |
| Samsung | Yes | We think this issue is valid and some clarification is needed. |
| OPPO | Yes |  |
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**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.

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| 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?**

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| Company name | Yes/No | Comments |
| Samsung | Yes | It is reasonable to consider both PDCCH candidates. |
| OPPO | Yes |  |
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**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)?**

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| 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. |
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**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)*.

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| **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?**

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| 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. |
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**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:

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| 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?**

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| 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. |
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**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?**

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| 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.  |
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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.**

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| 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.  |
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## 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, 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 ?**

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| Company name | Option | Comments |
| OPPO | Yes  |  |
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It is further proposed in [14] that, If RACH is initiated on a SpCell for BFR and one TRP has recovered before the RACH is complete, the ongoing RACH can be stopped.

**Q13: Do you agree that, if RACH is initiated on a SpCell for BFR and one TRP has recovered before the RACH is complete, the ongoing RACH can be stopped?**

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| 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. |
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## 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.**

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| Company name | Option | Comments |
| OPPO | Agree  |  |
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# Conclusion

**TBD**

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