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**1st June – 12th June 2020**

**Agenda item: 6.16.3**

**Source: Samsung**

**Title: Summary of proposed corrections (AI 6.16.3)**

**Document for: Discussion and Decision**

# Introduction

This contribution summarises proposed corrections in the contributions submitted to agenda item 6.16.3.

# Issues/proposals

## Stopping SR Prohibit Timer

According to MAC CR [12], section 5.4.4: " Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) prior to the MAC PDU assembly shall be cancelled and each respective *sr-ProhibitTimer* shall be stopped when the MAC PDU is transmitted, regardless of LBT failure indication from lower layers, and this PDU includes a Long or Short BSR MAC CE which contains buffer status up to (and including) the last event that triggered a BSR (see clause 5.4.5) prior to the MAC PDU assembly. Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) shall be cancelled and each respective *sr-ProhibitTimer* shall be stopped when the UL grant(s) can accommodate all pending data available for transmission. Pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell shall be cancelled when the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell. Pending SR triggered for beam failure recovery of a SCell shall be cancelled upon deactivation of that SCell (as defined in clause 5.9). If all the SR(s) triggered for SCell beam failure recovery are cancelled the MAC entity shall stop *sr-ProhibitTimer* of corresponding SR configuration."

According to [3], it is possible that one or more SRs triggered for SCell beam failure recovery remains pending upon trasmission of BFR MAC CE or Truncated BFR MAC CE. For example, SR(s) for BFR which were triggered after initiation of MAC PDU assembly. If there is at least one pending SR of corresponding SR configuration the *sr-ProhibitTimer* is not stopped (see highlighted text in grey above). As a result, SR transmission and hence BFR can be delayed for SCell whose BFR was triggered after initiation of MAC PDU assembly. **It is proposed [3] that for a pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell *sr-ProhibitTimer* shall be stoppedwhen the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell.** The intention is to have same behaviour as in case of BSR. The TP is annexure 1.

*Rapporteur Comments: The current rule for stopping sr-ProhibitTimer for BFR is different from that of BSR. For BSR, if there are one or more pending SR(s) triggered after initiation of MAC PDU assembly, sr-ProhibitTimer is stopped. For BFR, if there are one or more pending SR(s) triggered after initiation of MAC PDU assembly, sr-ProhibitTimer is not stopped. Need discussion.*

**Q1. Do you agree that for a pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell *sr-ProhibitTimer* shall be stoppedwhen the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N | This seems to suggest the *sr-ProhibitTimer* would be run per SCell while we currently have *sr-ProhibitTimer* per SR configuration – and there is only one SR configuration for BFR currently. On the other hand, we agree there is some issue with the current modelling which does not take into account the BFR triggers that were not accounted in the BFR MAC CE.  It seems that:  - when Truncated BFR MAC CE is transmitted -> no need to stop the *sr-ProhibitTimer* since the NW knows there is more to be transmitted (it was also agreed last time not to trigger SR in case Truncated BFR MAC CE is only transmitted);  - when BFR MAC CE is transmitted -> *sr-ProhibitTimer* should be stopped in case there is pending SR for an SCell that was not included in the BFR MAC CE.  Furthermore, it seems we do not need to take the MAC PDU assembly time as reference point but rather the MAC PDU transmission point (unlike in BSR).  Hence, we could modify the current text as follows:  “Pending SR for beam failure recovery of an SCell shall be cancelled when the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell or upon deactivation of that SCell (as defined in clause 5.9). When the MAC PDU is transmitted and this PDU includes a BFR MAC CE or if all the SR(s) triggered for SCell beam failure recovery are cancelled, the MAC entity shall stop *sr-ProhibitTimer* of corresponding SR configuration.” |
| Ericsson | Agree | We agree with the proposal. Seems reasonable to have similar behaviour as for BSR. |
| ZTE | N | In our understanding ,as we described in [9], the sr-ProhibtTimer is related to one SR configuration. If not all the failed serving cells can be included into the current MAC PDU, the SR is still pending for several serving cells, the sr-ProhibitTimer shall keep running since the sr-ProhibitTimer is configured by NW’s intention and make UE avoid dropping into RACH procedure earlier. |
| Samsung | Agree | Same view as Ericsson |
| LG | Y | We want to align the behavior between BSR and BFR. |
| Futurewei | Y | It is reasonable to align with the behavior for BSR in this case. |
| Qualcomm | Y |  |
| CATT | Y | We agree with the proposal. |
| ASUSTeK | Y | We are ok to align with the BSR. |
| OPPO | Y |  |
| Intel |  |  |
| vivo | Y |  |
| MeidaTek | Y | We are fine to align with BSR behavior. |

[9] discusses the case when one SR configuration is shared between BFR and one or more LCHs. If multiple SRs are pending for both BFR and BSR, the *sr-ProhibitTimer* may be stopped even though not all pending SRs for this SR configuration are canceled. For example, pending SRs for BFR are cancelled upon transmission of BFR MAC CE but SRs for BSR will be pending as MAC PDU could not include BSR MAC CE. **In [9], it is proposed that in the case that one SR configuration are shared between BSR and BFR, the corresponding *sr-ProhibitTimer* only can be stopped by all pending SRs related to this SR configuration are canceled.** The TP is annexure 2.

*Rapporteur Comments: According to release 15 rule for stopping sr-ProhibitTimer, sr-ProhibitTimer is stopped even if there are pending SRs (for example the SRs triggered upon MAC PDU assembly). Need discussion.*

*Summary: There is significant majority in support of the proposal. So it is proposed to agree the following:*

**Proposal 1: For a pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell *sr-ProhibitTimer* shall be stoppedwhen the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that Scell.**

**Q2. Do you agree that in the case that one SR configuration is shared between BSR and BFR, the corresponding sr-ProhibitTimer is stopped when all pending SRs related to this SR configuration are canceled?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N | NW may not know there was a triggered BSR corresponding to the same SR configuration as well. Hence, we should follow the currently specified behaviour for BSR in which case the prohibit timer is stopped when BSR is transmitted. Also we can modify the timer stop condition for BFR as proposed in Q1. |
| Ericsson | Disagree | We do not think the problem raised in [9] is severe. It can easily be avoided if the network configures a separate SR configuration for BFR instead of sharing it. |
| ZTE | Yes | Regarding the comments from Samsung, I think this is a totally different story with our suggestion.  In Rel-15, the filling of BSR MAC CE information is up to the timing of the MAC PDU generation, and the cancellation of the corresponding SR/stopping of the SR prohibitTimer is up to the timing of the MAC PDU generation. Thus if another SR is triggered and pending within the period between the generation and transmission of the BSR MAC CE, it may result in that the SR is still pending but the sr-ProhibitTimer is stopped. We believe this is an exceptional and rare case since the timing of MAC PDU generation is much close to the timing of MAC PDU transmission.  However, for the case that the SR is triggered prior to the MAC PDU assembly, if this SR is still pending , the associated sr-ProhibitTimer shall not be stopped. |
| Samsung | N |  |
| LG | Y | There is only one SR per SR configuration, and *sr-ProhibitTimer* is running per SR configuration. If any SR is pending, the *sr-ProhibitTimer* shall be running. We think this is the original intention of using *sr-ProhibitTimer*. |
| Futurewei | N | SR triggered for BSR and BFR should be handled separately. |
| Qualcomm | N | We don’t think this change is necessary. |
| CATT | N | We feel the explanations from the rapporteur make sense, so we think this proposal is not necessary. |
| ASUSTeK | Y |  |
| OPPO | N | We share same view with Nokia. |
| Intel | N | Similar view a s Ericsson. If the NW configures such that the same SR configuration is shared, then this problem exists, but we do not think this happens often and so no need to change the behaviour. |
| vivo | N |  |
| MediaTek | N | Share same view from Ericsson. If there is a concern of delaying SR transmission triggered by BFR, NW just configure separate SR configurations for BFR and BSR. |

*Summary: There is significant majority against the proposal. So the proposal is not pursued.*

## RA Cancellation upon SCell deactivation

According to RAN2 agreement in RAN2 #109bis-e and as captured in MAC CR [12], “Upon deactivation of Scell (as specified in clause 5.9) configured with beam failure detection the ongoing Random Access procedure due to a pending SR for BFR may be stopped if all triggered BFRs for Scells are cancelled”

In [5], it was pointed out that if the RACH is cancelled after the Msg3 transmission, the gNB would need to schedule the Msg3 retransmission for several times or send the Msg4 for several times (in order to get the confirmation feedbacks of the Msg4 from the UE), which causes unnecessary resource waste. For the 2-step CBRA, if the RACH is cancelled after the MsgA transmission, the gNB would still need to schedule the Msg3 transmission of the fallbackRAR for several time or send the successRAR for several time. **It is proposed in [5] that RACH should be cancelled only before Msg3/MsgA transmission.**

According to [3], even if the Msg3 is transmitted during the ongoing RA attempt, contention resolution may or may not be successful. If contention resolution is not successful, UE will continue subsequent RA attempts which would also leads to resource wastage. **So the preference is to not change the agreement made in last meeting.** **If majority of companies think that there is an issue and it needs to be fixed, it is proposed in [3], to not cancel the random access procedure while contention resolution timer is running.** This ensures that RA procedure is stopped if contention resolution is not successful

**Q3. Do you agree that there should be restrictions (in addition to agreement made in last meeting) on RA cancellation upon deactivation of Scell?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N | It should be noted that in both cases the re-transmission grants are provided with C-RNTI scheduling for which we have separate rules when the RA procedure is cancelled by the UE. No additional restrictions needed. |
| Ericsson | Disagree | In general, aborted RA processes comes with a cost in the network, but given the time left we need precisely defined restrictions to be able to standardize them in time for the completion. This question is very open. |
| ZTE | N | Firstly, According to the NW point of view, the MSG.3 for contention based RACH always have a risk to be lost, and NW can control the wastage of resources.  Secondly, we use a soft word ‘may’ to make the stop of ongoing RACH procedure be up to UE implementation.  Thus we do not need to over specify anything for stopping ongoing RACH procedure.\. |
| Samsung | N |  |
| LG | N | Since the network indicates to deactivate the Scell, the network can deduce RA cancellation and may not schedule Msg3/Msg4/fallbackRAR/successRAR. Moreover, we want to avoid over-specifying the optional UE behaviour. |
| Futurewei | N | There is not need of over-sepcifying a UE “may” action. |
| Qualcomm | N |  |
| CATT | N | We do not see a need to optimize the procedure further for this case. |
| ASUSTeK | N |  |
| OPPO | N |  |
| Intel | N | No need to optimize further. |
| vivo | Y | The proposed change is to align with the legacy RACH cancellation behaviours. |
| MediaTek | N |  |

*Summary: There is significant majority against the proposal. So the proposal is not pursued.*

**Q4. If answer to Q3 is yes, which of the following options do you prefer:**

* **Option 1: Upon deactivation of SCell (as specified in clause 5.9) configured with beam failure detection the ongoing Random Access procedure due to a pending SR for BFR is not stopped if MsgA/Msg3 has been transmitted during the ongoing Random Access procedure.**
* **Option 2: Upon deactivation of SCell (as specified in clause 5.9) configured with beam failure detection the ongoing Random Access procedure due to a pending SR for BFR is not stopped while the contention resolution timer is running.**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Option 2 |  |
| Samsung | Option 2 |  |
| vivo | Option 1 | For NR-U, the contention resolution timer could be started even though the Msg3 is not transmitted due to the LBT failure. |

## Handling reconfiguration of *BeamFailureRecoverySCellConfig*

[3] discusses aspects related to reconfiguration of *BeamFailureRecoverySCellConfig* while BFR for SCell is ongoing.The reconfiguration of *BeamFailureRecoverySCellConfig* resultsin an updated *candidateBeamRSSCellList*. If the BFR MAC CE or truncated BFR MAC CE including beam failure recovery information of SCell is generated before the reconfiguration of that SCell's *BeamFailureRecoverySCellConfig* and the MAC PDU including this generated BFR MAC CE or truncated BFR MAC CE is transmitted after the reconfiguration, the candidate beam determined by gNB based on candidate RS ID in received MAC CE will be incorrect (For example, UE may report candidate RS ID X in MAC CE; entry X in the candidate beam RS list before and after the configuration can be different). This can occur if BFR MAC CE or truncated BFR MAC CE is included in MSGA or Msg3 during an RA attempt, actual MsgA/Msg3 is transmitted later after several RA attempts and reconfiguration occurs in between. **It is proposed [3] to consider the following**:

* If the *BeamFailureRecoverySCellConfig* is reconfigured for a SCell and if the BFR MAC CE or truncated BFR MAC CE including beam failure recovery information of that SCell is included in MAC PDU in MsgA or Msg3 buffer of an ongoing random access procedure:
  + Option 1: Flush the MsgA/Msg3 buffer. Re-trigger BFR (if not pending) for all the SCells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer. In the subsequent RA attempt, generate MsgA/Msg3 MAC PDU again. The TP for implementing this option is provided in annexure 3.
  + Option 2: Stop the ongoing RA procedure, re-trigger BFR (if not pending) for all the SCells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer and initiate a random access procedure if SpCell BFR is ongoing. The TP for implementing this option is provided in annexure 4.

**Q5. Do you agree with the issue i.e. reconfiguration of *BeamFailureRecoverySCellConfig* while BFR for SCell is ongoing may result in gNB determining the candidate beam incorrectly?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell |  | We agree such occasion may happen, however, we think this is a rare case which the NW can also take into account and we don’t need to enhance the specification for this. |
| Ericsson | Disagree | We think this is a corner case, no need to address it. For example, also when the BFR MAC CE is not transmitted in msg3 (i.e. normal dynamic scheduling) the configuration can be changed. So the network has to understand that the information provided can be sent using an older configuration. |
| ZTE | No/Yes? | In our understanding, the ***BeamFailureRecoverySCellConfig*** is not similar with the R-15 IE since there is no any configuration within it which is related to RACH procedure , it means the RACH can be terminated successfully even though the beam information is not in the candidate beam list, but NW still can identify the beam information since the SSB ID and CSI-RS ID in beam information is still workable in most case. However, to provide more precise information is also beneficial for beam recovery but it will complicate the current UE behavior.  Thus we can follow the majorities’ view for this issue. |
| Samsung | Agree |  |
| LG |  | The candidate beam is anyway determined by the gNB. The gNB may consider the candidate RS ID in the MAC CE, but it does not mean that the gNB shall always follow the UE’s suggestion. |
| Futurewei |  | This kind of race case can occur, but would be rare. Hence, it is not critical to have specific procedure for it. |
| Qualcomm | N | It is the different from the Rel-15 *beamFailureRecoveryConfig* case which is related to the RACH. For SCell BFR, the BFR MAC CE may only use the UL grant from RAR in the RACH, and it is similar to the case of MAC CE transmission through normal UL grant. So, Network should know which (new/old) configuration UE may use. We are not sure how often it might happen that network will reconfigure the *BeamFailureRecoverySCellConfig* when BFR for SCell is ongoing and BFR MAC CE is transmitted through a RACH procedure. |
| CATT | See comments | The issue exists during reconfiguration. But we tend to agree with companies’ comments above that this is a corner case which requires no further optimization. There are always fast changing beam conditions, in which cases the even if there is no reconfiguration the beam reported is not very accurate. Network needs to take this into consideration by implementation. |
| ASUSTeK | N |  |
| OPPO | N | We think this is a corner case and no optimization is needed. |
| Intel | N | No need to optimize a corner case, even if this happens, the UE would send a BFR with incorrect info, and then in later beam management procedures, it would recovered (that is if the NW truly didn’t realize what is going on). |
| vivo |  | This is a corner case. We don’t think we should over-optimize the UE behaviours. |
| MediaTek | N | This seems to be a corner case because the network may not reconfigure the *BeamFailureRecoverySCellConfig* of a SCell very often. And we share same view with Qualcomm that in case the concern situation happens, the network should be able to know that the UE perform RA procedure for SCell BFR based on old configuration. |

*Summary: There is significant majority against the proposal. So the proposal is not pursued.*

**Q6. If answer to Q5 is yes, which option do you prefer to resolve the issue**

* **If the *BeamFailureRecoverySCellConfig* is reconfigured for a SCell and if the BFR MAC CE or truncated BFR MAC CE including beam failure recovery information of that Scell is included in MAC PDU in MsgA or Msg3 buffer of an ongoing random access procedure:**
  + **Option 1: Flush the MsgA/Msg3 buffer. Re-trigger BFR (if not pending) for all the Scells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer. In the subsequent RA attempt, generate MsgA/Msg3 MAC PDU again.**
  + **Option 2: Stop the ongoing RA procedure, re-trigger BFR (if not pending) for all the Scells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer and initiate a random access procedure if SpCell BFR is ongoing.**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Option 2 | It seems to have less impact on the spec than option 1. |
| ZTE | Option 2 | option 2 is a simple way and we suggest to use the soften wording “UE may stop…” Since in some case , UE still can continue his RACH procedure even though the ***BeamFailureRecoverySCellConfig*** is reconfigured by NW |
| Samsung | Option 2 |  |

*Summary: There is significant majority against the proposal. So the proposal is not pursued.*

## SR/PUSCH priority of Scell BFR

[3][4] discusses aspects related SR/PUSCH priority. In the eMIMO work item we have agreed to prioritize the transmission of the PUSCH/SR of the Scell BFR over the PUSCH of data and the normal SR (i.e. the SR triggered by BSR). IIOT work item has discussed prioritisation aspects and have agreed on a prioritisation framework [14][15] based on *lch-basedPrioritization*. This framework when applied to Scell BFR will result in dropping the PUSCH/SR of the Scell BFR MAC CE if it is collided with another PUSCH or SR. If the PUSCH/SR for the Scell BFR MAC CE is dropped, the transmission of the Scell BFR MAC CE will be delayed, and the failed beam will cause lots of packet loss including the URLLC data. This is also not aligned with agreement made in eMIMO work item. It is proposed in [4] that

* The PUSCH including the Scell BFR MAC CE is prioritized over any other PUSCH and any SR.
* The SR triggered by the Scell BFR is prioritized over PUSCH.

**Q7. Do you agree the following irrespective of whether MAC entity is configured with *lch-basedPrioritization* or not**

1. **The PUSCH including the Scell BFR MAC CE is prioritized over any other PUSCH and any SR.**
2. **The SR triggered by the Scell BFR is prioritized over PUSCH.**

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| **Company** | **Preference** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N | a) The Scell BFR MAC CE is anyway included to the prioritized PUSCH. In case some SR gets prioritized very late after MAC PDU assembly, this seems not a critical issue as this is anyway only about Scell BFR.  b) In case there was UL resources available, BFR MAC CE would have been already included into the PUSCH, prioritizing SR for Scell BFR could in worst case even delay the BFR MAC CE transmission. |
| Ericsson | Disagree | We understand the BFR MAC CE was evaluated in the IioT work and thus we do not see a need to overturn that agreement. |
| ZTE | No | The intra-UE multiplexing is not in the scope of the eMIMO discussion. |
| Samsung | Agree | For b), the SR triggered by the Scell BFR is prioritized over PUSCH which does not include Scell BFR MAC CE. |
| LG | N | The issue was already discussed in IIOT, and RAN2 agreed not to consider the priority of MAC CE. Moreover, the Scell BFR MAC CE has higher priority, and it is anyway included in the MAC PDU. |
| Futurewei | N | It has already been discussed in IioT WI, and agreed to not consider priority of MAC CE in intra-UE transmission prioritization. In most cases, Scell BFR MAC CE would have been included in the MAC PDU of the prioritized PUSCH anyway. |
| Qualcomm | Y | SR triggered by Scell BFR or BFR MAC CE should be prioritized over other PUSCH which does not contain the BFR MAC CE. |
| CATT |  | We agree with Ericsson that this shall be discussed and handled under IIOT. If there are agreements made there, let’s just follow those. |
| ASUSTeK | N | In IIOT, MAC CE is not considered for intra-UE prioritization, which implies that PUSCH is prioritized over SR triggered by SCell BFR. |
| OPPO | N | It was agreed in IIOT session that MAC CE priority is not considered for intra-UE prioritization. We don't think this should be discussed in eMIMO. |
| Intel | N |  |
| vivo | Y | We think the eMIMO WI should follow the eMIMO agreement (made previously by RAN1 and RAN2) to prioritize the BFR MAC CE/SR. |
| MediaTek | N | In R6, we can follow IIoT agreement to not consider UL MAC CE in intra-UE prioritization. |

*Summary: There is significant majority against the proposal. So the proposal is not pursued.*

## SpCell BFR

In case of fallback from CBRA to CFRA, the MAC PDU including BFR MAC CE may be transmitted if UL grant is received in CFRA RAR. In [8], it is mentioned that this is against the current RAN2 agreement: “BFR MAC CE for SpCell is only transmitted in Msg3 and MsgA via CBRA”.It is proposed [8] that RAN2 confirm that BFR MAC CE for SpCell can be transmitted in Msg3 for CFRA which fallback from a CBRA.

*Rapporteur Comments: This issue was raised during the email discussion in last meeting. According to agreed TP, there is no rebuilding upon fallback from CBRA to CFRA to remove the BFR MAC CE for SpCell. No additional change is needed in spec.*

## Others for BFR MAC CE

When beam failure recovery occurs for both PCell and Scell for a UE, it is possible that the UE will generate more than one BFR MAC CE for Msg3/MsgA transmission [11]. A possible scenario is as follows: A UE triggers a beam failure recovery for Pcell and initiate a CBRA to gNB. The UE receives a RAR containing a UL grant for Msg3. According to section 5.1.4, the UE will generate a BFR MAC CE for Msg3 transmission to indicate the gNB the purpose of this RA procedure is for Pcell beam failure recovery. However, if the UE has pending BFR for a Scell during the RA procedure, the UE may generate another BFR MAC CE for Scell according to section 5.17, and the Msg3 will contain 2 BFR MAC Ces that may have overlapping beam failure information. **So it is proposed in [11], to clarify that a MAC PDU shall contain at most one BFR MAC CE.** TP is in annexure 5.

*Rapporteur Comments:* *It can be clarified in section 6.1.3.23.*

**Proposal 2: Clarify that a MAC PDU shall contain at most one BFR MAC CE.**

## SP/AP SRS Spatial Relation Indication MAC CE for Multiple Serving Cells

In the RAN2 #109e meeting, the SP/AP SRS spatial relation indication MAC CE for multiple serving cells has been discussed and hasn’t been decided yet i.e. left for FFS in the latest MAC CR [12]. Companies have different opinions on whether this MAC CE should be designed for per SRS resource set or per SRS resource and whether more than one SRS resource can be indicated in this MAC CE if per SRS resource scheme is selected.

RAN1 replied to RAN2 questions in R1-2002798/ R2-2004251 [15] on SRS activation/deactivation MAC CE for the list of serving cells:

**Question 4.** RAN2 would like to ask RAN1 whether the intention is to activate per SRS resource set or per SRS resource. Further, if per SRS resource, whether RAN1 sees any issues in indicating spatial relation, potentially different, for more than one resource in one MAC CE in order to save overhead.

**Answer 4.**

RAN1 understands that the intention of the agreement is to support activating the independent spatial relations for SRS resource(s) in an SRS resource set.  Furthermore, RAN1 see no issue in using one MAC CE (to save overhead) to activate/deactivate spatial relations for >1 SRS resources from an SRS resource set.

According to the above response from RAN1, it can be observed that the requirement from RAN1 is to support activating the spatial relation information for the indicated SRS resource. Regardless of per SRS resource or per SRS resource set, both two design principles can support this requirement, and RAN1 doesn’t restrict the detailed design schemes. Based on the companies proposal’s from the contributions [2][6][10], there are two options for this MAC CE design:

* Option 1. Reuse the Enhanced SP/AP SRS spatial relation indication MAC CE [10]
* Option 2. Design new SP/AP SRS spatial relation indication MAC CE for multiple serving cells case [2][6]

One remark is that it has been agreed to consider supporting update spatial relation for both the AP and SP SRS source inside one MAC CE as well as extending the spatial relation resource ID field for larger ID space of NZP CSI-RS resource in the RAN2 #109bis-e meeting i.e. Enhanced SP/AP SRS spatial relation indication MAC CE in [12].

In addition, option 1 has advantages to saves specification effort and LCID field but it also forces to override spatial relation to all SRS resources in a set.

**Q8. Which option is better for SP/AP SRS Spatial Relation Indication MAC CE for Multiple Serving Cells?**

1. **Option 1: Reuse the Enhanced SP/AP SRS spatial relation indication MAC CE [10].**
2. **Option 2: Design new SP/AP SRS spatial relation indication MAC CE for multiple serving cells case [2][6]. If option 2 is prefer, please provide the suggested design compared to the Annexure 6.**

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| **Company** | **Preference** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | b) | It seems simpler to re-design the MAC CE for the new purpose: the existing MAC CE can then be used for a single cell without modifications and saving one LCID is not so meaningful.  We also think that eLCID could be used for this MAC CE. |
| Ericsson | Option2 | Annexure 6 is good baseline. We think A/D field is needed as it is activation/deactivation MAC CE. Thus, suggest to change SUL field to A/D field. |
| ZTE | Option 1 | We would like to Go for the simple solution. And we suggest we can merge it into the subclause of the enhanced SP/AP SRS spatial relation indication MAC CE. |
| Samsung | Option 2 | Annexure 6 can be a baseline. |
| LG | Option 2 | Introducing a new MAC CE for a new purpose is the baseline. |
| Futurewei | Option 2 | It’d be clear to have a specific MAC CE for multiple serving cells. |
| Qualcomm | Option 1 | Option 1 is the simpler solution. The only additional work is to add some description in the agreed single cell SRS MAC CE format to support multiple serving cells case. |
| CATT | Option 2 | We have a slight preference for a new MAC CE as that makes things clearer. |
| ASUSTeK | Option 2 |  |
| OPPO | Option 1 | We prefer the simpler way which is also used to design the other two MAC Ces for multiple Serving Cells. |
| vivo | Option 1 | We think that both Options can work. Then reusing the current MAC CE would save the LCID and bring less specification changes. |
| MediaTek | Option 2 |  |

*Summary: Companies are agreed that either option between option 1 and option 2 can work. There is significant majority in support of the Option 2 i.e. 4:8 (opt 1: opt 2), so it is proposed to agree the following:*

**Proposal 3: Design new SP/AP SRS spatial relation indication MAC CE for multiple serving cells case. Annexure 6 is the baseline.**

## SRS Pathloss Reference RS

During RAN2#109bis-e meeting, for pathloss reference RS configuration and related MAC CEs have FFS as shown below as it is not clear in RAN2 how the operation of mapping SRIs to PUSCH pathloss reference RS operate together with 64 configured PUSCH pathloss reference RSs.

FFSs:

- Whether PUSCH Pathloss RS Activation/Deactivation MAC CE have A/D field to deactivate the PUSCH Pathloss RS which is mapped with SRI ID(s).

- What is the initial state of RRC configured PL RSs when RRC configures more than 4 PL RSs (e.g. all are deactivated or first 4 PL RSs are activated.)

According to [1][7][10], companies explained why deactivation function for PUSCH Pathloss RS Activation/Deactivation MAC CE is not needed based on actual UE operation based on current specification. Below is the excerpt from [7].

In Rel-15, RRC configures the linkage between *sri-PUSCH-PowerControlId* and *PUSCH-PathlossReferenceRS-Id*. Furthermore, the pathloss RS for a PUSCH transmission (codebook-based or non-codebook-based) scheduled by DCI format 0\_1 is implicitly indicated through the SRI indicated in the scheduling DCI. UE determines the pathloss RS based on the value of PUSCH-pathlossReferenceRS-Id that is mapped to the SRI field in DCI format 0\_1. RRC reconfiguration message is required to update the mapping between sri-PUSCH-PowerControlId and PUSCH-PathlossReferenceRS-Id.

SRI-PUSCH-PowerControl ::= SEQUENCE {

sri-PUSCH-PowerControlId SRI-PUSCH-PowerControlId,

sri-PUSCH-PathlossReferenceRS-Id PUSCH-PathlossReferenceRS-Id,

sri-P0-PUSCH-AlphaSetId P0-PUSCH-AlphaSetId,

sri-PUSCH-ClosedLoopIndex ENUMERATED { i0, i1 }

In Rel-16, the maximal configurable pathloss reference RS in 64. To avoid frequent RRC reconfiguration and reduce the latency caused by RRC reconfiguration message, RAN1 has agreed introduce the PUSCH Pathloss Reference RS Update MAC CE to update the value of *PUSCH-PathlossReferenceRS-Id* corresponding to *sri-PUSCH-PowerControlId*. The current MAC CE design can always re-activate or update a new pathloss reference RS with the associated SRI IDs w/o deactivating anything. Network should guarantee the updates can comply with the rule for the target UE, so it seems the A/D filed is not required for this MAC CE.

However, other side has some concern on the signalling to update the mapping between Pathloss RSs and SRI IDs [6]. Refer to [16] in the RAN2#109bis-e meeting, and see the example below which is updated example in [16]. For example, there are 64 RRC configured pathloss RSs and 16 SRI IDs, and following mapping between SRI IDs and PL RSs is configured:

* Initial phase
  + PL RS#1 is associated with SRI ID #0, SRI ID #1, SRI ID #2 and SRI ID #3
  + PL RS#2 is associated with SRI ID #4, SRI ID #5, SRI ID #6 and SRI ID #7
  + PL RS#3 is associated with SRI ID #8, SRI ID #9, SRI ID #10 and SRI ID #11
  + PL RS#4 is associated with SRI ID #12, SRI ID #13, SRI ID #14 and SRI ID #15
* Second phase: MAC CE can update the mapping rule as below

Below scenario is not allowed: some mappings of SRI IDs are deactivated.

* + PL RS#5 is associated with SRI ID #0, SRI ID #1
  + PL RS#1 is deactivated with SRI ID #2, SRI ID #3
  + PL RS#2 is associated with SRI ID #4, SRI ID #5, SRI ID #6 and SRI ID #7
  + PL RS#3 is associated with SRI ID #8, SRI ID #9, SRI ID #10 and SRI ID #11
  + PL RS#4 is associated with SRI ID #12, SRI ID #13, SRI ID #14 and SRI ID #15

Below scenario is allowed: all SRI IDs should be mapped to some PL RSs

* + PL RS#5 is associated with SRI ID #0, SRI ID #1
  + PL RS#2 is associated with SRI ID #2 and SRI ID #3, SRI ID #4, SRI ID #5, SRI ID #6 and SRI ID #7
  + PL RS#3 is associated with SRI ID #8, SRI ID #9, SRI ID #10 and SRI ID #11
  + PL RS#4 is associated with SRI ID #12, SRI ID #13, SRI ID #14 and SRI ID #15

For the allowed scenario above i.e. initial to second phase, network should first transmit the MAC CE for updating PL RS#2 with SRI ID #2 and SRI ID #3 and then transmit the MAC CE for updating PL RS#5 with SRI ID #0 and SRI ID #1 or transmit both MAC CE in the same MAC PDU.

However, there will be 5 mappings for PL RSs and SRI IDs between the time duration of the reception for both MAC CEs, if the order of transmission of both MAC CE is changed i.e. network first transmit the MAC CE for updating PL RS#5 with SRI ID #0 and SRI ID #1 and then transmit the MAC CE for updating PL RS#2 with SRI ID #2 and SRI ID #3. In other words, SRI ID#2 and SRI ID #3 are associated with PL RS#1 before receiving the MAC CE for updating PL RS#2 with SRI ID #2 and SRI ID #3.

Rapporteur think that this kind of operation problem can be handled by the smart network implementation without any further restrictions on the current specification. In addition, one company [1] proposes to clarify the pathloss reference RS is updated by this MAC CE in the SRI-PUSCH-powercontrol mappings provided in the same MAC CE.

**Q9. Do you agree that PUSCH pathloss reference update MAC CE does not need A/D field?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference**  **(Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell |  | No strong view – we agree the MAC CE doesn’t necessarily need the A/D field, but are not opposed to adding it. |
| Ericsson | Y | As explained above |
| ZTE | Yes | From specification perspective, UE will have no idea about the meaning of that one SRI is not mapped to any one PL RS |
| Samsung | Y | It seems A/D field is not needed as explained above. |
| LG | Y |  |
| Futurewei |  | We see A/D field not necessary, but also see it beneficial for network flexibility. We can go with majority companies. |
| Qualcomm | Y | A/D field is not needed in this MAC CE. |
| CATT | Y |  |
| ASUSTeK | Y |  |
| OPPO | Y |  |
| Intel | Y | No strong view |
| vivo | Y |  |
| MediaTek | Y |  |

*Summary: There is significant majority agree that PUSCH pathloss reference update MAC CE does not need A/D field. It seems no proposal is needed for that. so it is proposed to agree the following:*

**Q10. Do you think any further restrictions or clarifications are needed in the PUSCH MAC CE that the pathloss reference RS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference**  **(Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N |  |
| Ericsson | Y | Clarification similar as suggested in [1] |
| Samsung | Y | Fine for adding Ericsson’s suggestion. |
| LG | N |  |
| Futurewei | N | We don’t see it really necessary, but would be fine with a note for clarification. |
| Qualcomm | Y | It is fine for clarification in [1] |
| CATT | Y | Fine with clarification in [1]. |
| OPPO | N |  |
| vivo | Y | We are fine with the clarification in [1]. |
| MediaTek | Y | Fine for adding clarification suggested in [1]. |

*Summary: There is significant majority agree to clarify that the pathloss reference RS is updated by this MAC CE in the SRI-PUSCH-powercontrol mappings provided in the same MAC CE. So, the proposed change in [1] can be acceptable.*

**Proposal 4: Clarify that the pathloss reference RS is updated by this MAC CE in the SRI-PUSCH-powercontrol mappings provided in the same MAC CE.**

Another open issue is that how to define the initial state of RRC configured PL RSs when RRC configures more than 4 PL RSs. Companies provided the RAN1 agreements for this issue and mentioned it is already covered by RAN1 specifications in TS 38.213:

|  |
| --- |
| **7                 Uplink Power control**  Uplink power control determines a power for PUSCH, PUCCH, SRS, and PRACH transmissions.  A UE does not expect to simultaneously maintain more than four pathloss estimates per serving cell for all PUSCH/PUCCH/SRS transmissions as described in Clauses 7.1.1, 7.2.1, and 7.3.1, except for SRS transmissions configured by IE SRS-Positioning-Config as described in Clause 7.3.1. If the number of RS resources configured by RRC for pathloss estimation for PUCCH, PUSCH and SRS is greater than 4, UE is only required to maintain the RS resources which are used as qd for pathloss estimation in 7.1.1, 7.2.1 and 7.3.1 for any uplink channels or signals. |

Therefore, when more than 4 pathloss reference RSs are configured in network, UE only maintains pathloss reference RS explicitly instructed by network which has been specified from RAN1.

**Q11. Do you agree that RAN2 does not need to specify the initial state of RRC configured pathloss reference RS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference**  **(Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell | N | It seems this has already been considered in RAN1 |
| Ericsson | Y | As explained above |
| ZTE | Yes | Nothing shall be captured in RAN2, |
| Samsung | Y | No need to capture further in RAN2 specifications. |
| LG | Y |  |
| Futurewei | Y | It is already clear from RAN1 specification. |
| Qualcomm | Y | No need to further specify in RAN2. |
| CATT | Y |  |
| ASUSTeK | Y |  |
| OPPO | Y |  |
| Intel | Y | No need to further specify |
| vivo | Y |  |
| MediaTek | Y |  |

*Summary: There is significant majority agree that RAN2 does not need to specify the initial state of RRC configured pathloss reference RS.*

## Others for DL MAC CEs

RAN2 made following agreements on RAN2#109-e meeting and this aspect is kept as Editor’s note for further considerations in the MAC CR [12].

6. We have only one MAC CE for PUCCH resource-based and PUCCH resource group-based spatial relation activation/deactivation (reverts the agreement in the first conf call). In the same MAC CE it will be possible to indicate multiple PUCCH resources (i.e. variable size MAC CE). Details to be discussed in the MAC CR drafting (if we cannot converge we might also go back to the initial agreement).

Editor's note: Whether to allow multiple PUCCH resources in a MAC CE.

Whether to allow multiple PUCCH resource activation/deactivation is optimization problem and it seems there are no concerns on this approach. So, RAN2 can confirm to allow that multiple PUCCH resources can be indicated in a MAC CE i.e. remove the Editor’s note.

**Q12. Do you agree that RAN2 confirm to allow that multiple PUCCH resources can be indicated in an Enhanced PUCCH spatial relation Activation/Deactivation MAC CE?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference**  **(Y/N)** | **Detailed Comments** |
| Nokia, Nokia Shanghai Bell |  | We are fine to allow that but don’t think it’s absolutely necesssary. |
| Ericsson | Y | When UE is not configured with PUCCH groups there should be a mechanism to enable indicating spatial relation to more than one PUCCH resource is same go. Note that there is no RRC configured initial state if more than one spatial relation is configured. |
| ZTE | Yes |  |
| Samsung |  | Same view with Nokia, no strong view on this. |
| LG | Y |  |
| Futurewei | Y | It’s fine to confirm it. |
| Qualcomm | Y | Support multiple PUCCH resources in MAC CE. |
| CATT | Y |  |
| ASUSTeK | Y |  |
| OPPO |  | Same view with Nokia. |
| Intel | Y |  |
| vivo | Y |  |
| MediaTek | Y |  |

*Summary: There is significant majority agree to confirm that multiple PUCCH resources can be indicated in an Enhanced PUCCH spatial relation Activation/Deactivation MAC CE. RAN2 had already agreements for this aspect only required work is removing the Editor’s note in the MAC specification.*

**Proposal 5: RAN2 confirm that the multiple PUCCH resources can be indicated in an Enhanced PUCCH spatial relation Activation/Deactivation MAC CE.**

In [1], some company pointed out that the actual field name of SRS-PathlossReferenceRS-Id is not captured in the MAC CR [12]. The SRS Pathloss Reference RS Update MAC CE updates mapping between one pathloss reference RS and SRS resource set. The MAC CE should be corrected to point to SRS-PathlossReferenceRS-Id instead of pathlossReferenceRS and it should be clarified that the MAC CE updates the pathloss reference RS to be assumed for the SRS resource set. See the below changes provided in [1]

- SRS Resource Set ID: This field indicates the SRS Resource Set ID identified by *SRS-ResourceSetId* as specified in TS 38.331 [5]. The length of the field is 4 bits;

- Pathloss Reference RS ID: This field indicates the Pathloss Reference RS ID identified by *~~pathlossReferenceRS~~*SRS-PathlossReferenceRS-Id as specified in TS 38.331 [5]. It updates the pathloss reference RS for a SRS-resource set indicated by SRS Resource Set ID field. The length of the field is 6 bits;

*Rapporteur Comments: Above changes can be included in the MAC CR.*

# Summary

**In this offline discussion following proposals are made based on the comments from companies.**

**Proposal 1: For a pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell *sr-ProhibitTimer* shall be stoppedwhen the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that Scell.**

**Proposal 2: Clarify that a MAC PDU shall contain at most one BFR MAC CE.**

**Proposal 3: Design new SP/AP SRS spatial relation indication MAC CE for multiple serving cells case. Annexure 6 is the baseline.**

**Proposal 4: Clarify that the pathloss reference RS is updated by this MAC CE in the SRI-PUSCH-powercontrol mappings provided in the same MAC CE.**

**Proposal 5: RAN2 confirm that the multiple PUCCH resources can be indicated in an Enhanced PUCCH spatial relation Activation/Deactivation MAC CE.**

# References

1. R2-2004463 On pathloss reference RS MAC CE for SRS and PUSCH Ericsson
2. R2-2004464 On SRS activation/deactivation MAC CE for the list of serving cells Ericsson
3. R2-2004524 Issues - Beam Failure Recovery Samsung Electronics Co., Ltd
4. R2-2004646 Discussion on the priority of the BFR MAC CE and SR vivo, Samsung
5. R2-2004647 RACH cancellation after the transmission of Msg3 or MsgA vivo
6. R2-2004832 Remaining issues on the MAC CEs for beam enhancements Samsung
7. R2-2004897 Open issues for PUSCH Pathloss Reference RS Update MAC CE OPPO
8. R2-2004898 Open issues on Spcell BFR OPPO
9. R2-2005122 The Remaining issue on stopping the sr-ProhibitTimer ZTE, Sanechips
10. R2-2005185 Remaining issues on DL MIMO MAC CE Qualcomm Incorporated
11. R2-2005568 Clarification on generation of BFR MAC CE ASUSTeK
12. R2-2003911, "Miscellaneous corrections on eMIMO"
13. 3GPP TS 38.321-g00, “NR; Medium Access Control (MAC) protocol specification”.
14. R2-2004195 MAC Corrections for IIOT.
15. R1-2002798/ R2-2004251 LS reply on eMIMO RRC parameters, RAN1.
16. R2-2002882 Considerations on the number of pathloss RSs indicated by MAC CE Samsung

# Annexure 1

### 5.4.4 Scheduling Request

:

Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) prior to the MAC PDU assembly shall be cancelled and each respective *sr-ProhibitTimer* shall be stopped when the MAC PDU is transmitted, regardless of LBT failure indication from lower layers, and this PDU includes a Long or Short BSR MAC CE which contains buffer status up to (and including) the last event that triggered a BSR (see clause 5.4.5) prior to the MAC PDU assembly. Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) shall be cancelled and each respective *sr-ProhibitTimer* shall be stopped when the UL grant(s) can accommodate all pending data available for transmission. Pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell shall be cancelled and respective *sr-ProhibitTimer* shall be stopped when the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell. Pending SR triggered for beam failure recovery of a SCell shall be cancelled upon deactivation of that SCell (as defined in clause 5.9).

The MAC entity shall for each pending SR triggered by consistent LBT failure:

1> if a MAC PDU is transmitted, regardless of LBT failure indication from lower layers, and the MAC PDU includes an LBT failure MAC CE that indicates consistent LBT failure for the Serving Cell that triggered this SR; or

1> if the corresponding consistent LBT failure is cancelled (see clause 5.21):

2> cancel the pending SR and stop the corresponding *sr-ProhibitTimer*.

# Annexure 2

### 5.4.4 Scheduling Request

*<omit for short>*

Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) prior to the MAC PDU assembly shall be cancelled when the MAC PDU is transmitted, regardless of LBT failure indication from lower layers, and this PDU includes a Long or Short BSR MAC CE which contains buffer status up to (and including) the last event that triggered a BSR (see clause 5.4.5) prior to the MAC PDU assembly. Except for SCell beam failure recovery, all pending SR(s) for BSR triggered according to the BSR procedure (clause 5.4.5) shall be cancelled when the UL grant(s) can accommodate all pending data available for transmission. Pending SR triggered prior to the MAC PDU assembly for beam failure recovery of an SCell shall be cancelled when the MAC PDU is transmitted and this PDU includes an BFR MAC CE or Truncated BFR MAC CE which contains beam failure recovery information of that SCell. Pending SR triggered for beam failure recovery of a SCell shall be cancelled upon deactivation of that SCell (as defined in clause 5.9). If all the SR(s) related to one SR configuration are cancelled, the MAC entity shall stop sr-ProhibitTimer of corresponding SR configuration.

*<omit for short>*

# Annexure 3

### 5.1.3a MSGA transmission

The MAC entity shall, for each MSGA:

1> if *PREAMBLE\_TRANSMISSION\_COUNTER* is greater than one; and

1> if the notification of suspending power ramping counter has not been received from lower layers; and

1> if LBT failure indication was not received from lower layers for the last MSGA Random Access Preamble transmission; and

1> if SSB or CSI-RS selected is not changed from the selection in the last Random Access Preamble transmission:

2> increment *PREAMBLE\_POWER\_RAMPING\_COUNTER* by 1.

1> select the value of *DELTA\_PREAMBLE* according to clause 7.3;

1> set *PREAMBLE\_RECEIVED\_TARGET\_POWER* to preambleReceivedTargetPower + *DELTA\_PREAMBLE* + (*PREAMBLE\_POWER\_RAMPING\_COUNTER* – 1) × *PREAMBLE\_POWER\_RAMPING\_STEP*;

1> if MSGA buffer is empty:

2> if the transmission is not being made for the CCCH logical channel:

3> indicate to the Multiplexing and assembly entity to include a C-RNTI MAC CE in the subsequent uplink transmission.

2> if the Random Access procedure was initiated for SpCell beam failure recovery:

3> indicate to the Multiplexing and assembly entity to include a BFR MAC CE or a Truncated BFR MAC CE in the subsequent uplink transmission.

2> obtain the MAC PDU to transmit from the Multiplexing and assembly entity and store it in the MSGA buffer.

1> compute the MSGB-RNTI associated with the PRACH occasion in which the Random Access Preamble is transmitted;

1> instruct the physical layer to transmit the MSGA using the selected PRACH occasion and the associated PUSCH resource, using the corresponding RA-RNTI, MSGB-RNTI, *PREAMBLE\_INDEX*, *PREAMBLE\_RECEIVED\_TARGET\_POWER, preambleReceivedTargetPower*, and the amount of power ramping applied to the latest MSGA preamble transmission (i.e. (*PREAMBLE\_POWER\_RAMPING\_COUNTER* – 1) × *PREAMBLE\_POWER\_RAMPING\_STEP*);

1> if LBT failure indication is received from lower layers for the transmission of this MSGA Random Access Preamble:

2> instruct the physical layer to cancel the transmission of the MSGA payload on the associated PUSCH resource;

2> perform the Random Access Resource selection procedure for 2-step RA type (see clause 5.1.2a).

NOTE: The MSGA transmission includes the transmission of the PRACH Preamble as well as the contents of the MSGA buffer in the PUSCH resource corresponding to the selected PRACH occasion and PREAMBLE\_INDEX (see TS 38.213 [6])

The MSGB-RNTI associated with the PRACH occasion in which the Random Access Preamble is transmitted, is computed as:

MSGB-RNTI = 1 + s\_id + 14 × t\_id + 14 × 80 × f\_id + 14 × 80 × 8 × ul\_carrier\_id + 14 × 80 × 8 × 2

where s\_id is the index of the first OFDM symbol of the PRACH occasion (0 ≤ s\_id < 14), t\_id is the index of the first slot of the PRACH occasion in a system frame (0 ≤ t\_id < 80), where the subcarrier spacing to determine t\_id is based on the value of μ specified in clause 5.3.2 in TS 38.211 [8], f\_id is the index of the PRACH occasion in the frequency domain (0 ≤ f\_id < 8), and ul\_carrier\_id is the UL carrier used for Random Access Preamble transmission (0 for NUL carrier, and 1 for SUL carrier). The RA-RNTI is calculated as specified in clause 5.1.3.

### 5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the MAC entity shall:

1> if the contention-free Random Access Preamble for beam failure recovery request was transmitted by the MAC entity:

2> start the *ra-ResponseWindow* configured in *BeamFailureRecoveryConfig* at the first PDCCH occasion as specified in TS 38.213 [6] from the end of the Random Access Preamble transmission;

2> monitor for a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* of the SpCell identified by the C-RNTI while *ra-ResponseWindow* is running.

1> else:

2> start the *ra-ResponseWindow* configured in *RACH-ConfigCommon* at the first PDCCH occasion as specified in TS 38.213 [6] from the end of the Random Access Preamble transmission;

2> monitor the PDCCH of the SpCell for Random Access Response(s) identified by the RA-RNTI while the *ra-ResponseWindow* is running.

1> if notification of a reception of a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* is received from lower layers on the Serving Cell where the preamble was transmitted; and

1> if PDCCH transmission is addressed to the C-RNTI; and

1> if the contention-free Random Access Preamble for beam failure recovery request was transmitted by the MAC entity:

2> consider the Random Access procedure successfully completed.

1> else if a valid (as specified in TS 38.213 [6]) downlink assignment has been received on the PDCCH for the RA-RNTI and the received TB is successfully decoded:

2> if the Random Access Response contains a MAC subPDU with Backoff Indicator:

3> set the *PREAMBLE\_BACKOFF* to value of the BI field of the MAC subPDU using Table 7.2-1, multiplied with *SCALING\_FACTOR\_BI*.

2> else:

3> set the *PREAMBLE\_BACKOFF* to 0 ms.

2> if the Random Access Response contains a MAC subPDU with Random Access Preamble identifier corresponding to the transmitted *PREAMBLE\_INDEX* (see clause 5.1.3):

3> consider this Random Access Response reception successful.

2> if the Random Access Response reception is considered successful:

3> if the Random Access Response includes a MAC subPDU with RAPID only:

4> consider this Random Access procedure successfully completed;

4> indicate the reception of an acknowledgement for SI request to upper layers.

3> else:

4> apply the following actions for the Serving Cell where the Random Access Preamble was transmitted:

5> process the received Timing Advance Command (see clause 5.2);

5> indicate the *preambleReceivedTargetPower* and the amount of power ramping applied to the latest Random Access Preamble transmission to lower layers (i.e. (*PREAMBLE\_POWER\_RAMPING\_COUNTER* – 1) × *PREAMBLE\_POWER\_RAMPING\_STEP*);

5> if the Random Access procedure for an SCell is performed on uplink carrier where *pusch-Config* is not configured:

6> ignore the received UL grant.

5> else:

6> process the received UL grant value and indicate it to the lower layers.

4> if the Random Access Preamble was not selected by the MAC entity among the contention-based Random Access Preamble(s):

5> consider the Random Access procedure successfully completed.

4> else:

5> set the *TEMPORARY\_C-RNTI* to the value received in the Random Access Response;

5> if Msg3 buffer is empty:

6> if the transmission is not being made for the CCCH logical channel:

7> indicate to the Multiplexing and assembly entity to include a C-RNTI MAC CE in the subsequent uplink transmission.

6> if the Random Access procedure was initiated for SpCell beam failure recovery:

7> indicate to the Multiplexing and assembly entity to include a BFR MAC CE or a Truncated BFR MAC CE in the subsequent uplink transmission.

6> obtain the MAC PDU to transmit from the Multiplexing and assembly entity and store it in the Msg3 buffer.

NOTE: If within a Random Access procedure, an uplink grant provided in the Random Access Response for the same group of contention-based Random Access Preambles has a different size than the first uplink grant allocated during that Random Access procedure, the UE behavior is not defined.

1> if *ra-ResponseWindow* configured in *BeamFailureRecoveryConfig* expires and if a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* addressed to the C-RNTI has not been received on the Serving Cell where the preamble was transmitted; or

1> if *ra-ResponseWindow* configured in *RACH-ConfigCommon* expires, and if the Random Access Response containing Random Access Preamble identifiers that matches the transmitted *PREAMBLE\_INDEX* has not been received:

2> consider the Random Access Response reception not successful;

2> increment *PREAMBLE\_TRANSMISSION\_COUNTER* by 1;

2> if *PREAMBLE\_TRANSMISSION\_COUNTER* = *preambleTransMax* + 1:

3> if the Random Access Preamble is transmitted on the SpCell:

4> indicate a Random Access problem to upper layers;

4> if this Random Access procedure was triggered for SI request:

5> consider the Random Access procedure unsuccessfully completed.

3> else if the Random Access Preamble is transmitted on an SCell:

4> consider the Random Access procedure unsuccessfully completed.

2> if the Random Access procedure is not completed:

3> select a random backoff time according to a uniform distribution between 0 and the *PREAMBLE\_BACKOFF*;

3> if the criteria (as defined in clause 5.1.2) to select contention-free Random Access Resources is met during the backoff time:

4> perform the Random Access Resource selection procedure (see clause 5.1.2);

3> else if the Random Access procedure for an SCell is performed on uplink carrier where *pusch-Config* is not configured:

4> delay the subsequent Random Access transmission until the Random Access Procedure is triggered by a PDCCH order with the same *ra-PreambleIndex, ra-ssb-OccasionMaskIndex* and UL/SUL indicator TS 38.212 [9].

3> else:

4> perform the Random Access Resource selection procedure (see clause 5.1.2) after the backoff time.

The MAC entity may stop *ra-ResponseWindow* (and hence monitoring for Random Access Response(s)) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted *PREAMBLE\_INDEX*.

HARQ operation is not applicable to the Random Access Response reception.

## 5.17 Beam Failure Detection and Recovery procedure

The MAC entity may be configured by RRC per Serving Cell with a beam failure recovery procedure which is used for indicating to the serving gNB of a new SSB or CSI-RS when beam failure is detected on the serving SSB(s)/CSI-RS(s). Beam failure is detected by counting beam failure instance indication from the lower layers to the MAC entity. If *beamFailureRecoveryConfig* is reconfigured by upper layers during an ongoing Random Access procedure for beam failure recovery for SpCell, the MAC entity shall stop the ongoing Random Access procedure and initiate a Random Access procedure using the new configuration. If the *BeamFailureRecoverySCellConfig* is reconfigured for a SCell and if the BFR MAC CE or truncated BFR MAC CE including beam failure recovery information of that SCell is included in MAC PDU in MsgA or Msg3 buffer of an ongoing random access procedure, flush the MsgA or Msg3 buffer respectively and re-trigger BFR (if not pending) for all the SCells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer.

# Annexure 4

## 5.17 Beam Failure Detection and Recovery procedure

The MAC entity may be configured by RRC per Serving Cell with a beam failure recovery procedure which is used for indicating to the serving gNB of a new SSB or CSI-RS when beam failure is detected on the serving SSB(s)/CSI-RS(s). Beam failure is detected by counting beam failure instance indication from the lower layers to the MAC entity. If *beamFailureRecoveryConfig* is reconfigured by upper layers during an ongoing Random Access procedure for beam failure recovery for SpCell, the MAC entity shall stop the ongoing Random Access procedure and initiate a Random Access procedure using the new configuration. If the *BeamFailureRecoverySCellConfig* is reconfigured for a SCell and if the BFR MAC CE or truncated BFR MAC CE including beam failure recovery information of that SCell is included in MAC PDU in MsgA or Msg3 buffer of an ongoing random access procedure, stop the ongoing RA procedure, re-trigger BFR (if not pending) for all the SCells whose beam failure recovery information was included in BFR MAC CE or truncated BFR MAC CE in flushed MsgA or Msg3 buffer and initiate a random access procedure if SpCell BFR is ongoing.

# Annexure 5

6.1.3.23 BFR MAC CEs

The MAC CEs for BFR consists of either:

- BFR MAC CE; or

- Truncated BFR MAC CE.

The BFR MAC CE and Truncated BFR MAC CE are identified by a MAC subheader with LCID/eLCID as specified in Table 6.2.1-2 and Table 6.2.1-2b.

The BFR MAC CE and Truncated BFR MAC CE have a variable size. They includes a bitmap and in ascending order based on the *ServCellIndex*, beam failure recovery information i.e. octets containing candidate beam availability indication (AC) for SCells indicated in the bitmap. For BFR MAC CE, a single octet bitmap is used when the highest *ServCellIndex* of this MAC entity's SCell for which beam failure is detected is less than 8, otherwise four octets are used. A MAC PDU shall contain at most one BFR MAC CE.

# Annexure 6

#### 6.1.3.29 Serving Cell set based SRS Activation/Deactivation MAC CE

The Serving Cell set based SRS Activation/Deactivation MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-1b. It has a variable size and consists of the following fields:

- SUL: This field indicates whether the MAC CE applies to the NUL carrier or SUL carrier configuration. This field is set to 1 to indicate that it applies to the SUL carrier configuration, and it is set to 0 to indicate that it applies to the NUL carrier configuration;

- SRS Resource’s Cell ID: This field indicates the identity of the Serving Cell, which contains the indicated SP/AP SRS Resource Set. If the C field is set to 0, this field also indicates the identity of the Serving Cell which contains all resources indicated by the Resource IDi fields. The length of the field is 5 bits. If the indicated Serving Cell is configured as part of a *simultaneousSpatial-UpdatedList1-r16* or *simultaneousSpatial-UpdatedList2-r16* as specified in TS 38.331 [5], this MAC CE applies to all the Serving Cells configured in the set *simultaneousSpatial-UpdatedList1-r16* or *simultaneousSpatial-UpdatedList2-r16, respectively;*

- SRS Resource's BWP ID: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], which contains the indicated AP/SP SRS Resource. If the C field is set to 0, this field also indicates the identity of the BWP which contains all resources indicated by the Resource IDi fields. The length of the field is 2 bits;

- C: This field indicates whether the octets containing Resource Serving Cell ID field(s) and Resource BWP ID field(s) are present. If this field is set to 1, the octets containing Resource Serving Cell ID field(s) and Resource BWP ID field(s) are present, otherwise they are not present;

- SP/AP SRS Resource IDi: This field indicates the SP/AP SRS Resource ID identified by *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 6 bits;

- Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource within SP/AP SRS Resource Set indicated with SP/AP SRS Resource IDi field. F0 refers to the first SRS resource which is indicated SP/AP SRS Resource ID1, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index is used. The length of the field is 1 bit;

- Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource which is indicated SP/AP SRS Resource ID1, Resource ID1 to the second one and so on. If Fi is set to 0, the first bit of this field is always set to 0. If Fi is set to 0, and the second bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, and the second bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 8 bits.

- Resource Serving Cell IDi: This field indicates the identity of the Serving Cell on which the resource used for spatial relationship derivation for SP/AP SRS Resource IDi is located. The length of the field is 5 bits;

- Resource BWP IDi: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], on which the resource used for spatial relationship derivation for SP/AP SRS Resource IDi is located. The length of the field is 2 bits;

- R: Reserved bit, set to 0.



**Figure 6.1.3.29-1: Serving Cell set based SRS Activation/Deactivation MAC CE**