**3GPP T****SG-RAN WG2 Meeting#109e R2-200xxxx**

**Athens, Greece, 24th – 6th March 2020**

**Agenda item: 6.16.4**

**Source: Samsung**

**Title: Offline Discussion 112 : Beam Management Enhancements**

**Document for: Discussion and Decision**

# Introduction

[AT109e][112][EMIMO] Beam management enhancements (Samsung)

Scope: Continue the discussion on beam management enhancements, based on [R2-2001672](file:///C:\Data\3GPP\Extracts\R2-2001672_Summary%20of%20Beam%20Management%20Enhancements.docx)

Initial intended outcome:

* + - Set of proposals with full consensus (aim to agree to those over email)
    - Set of proposals that need further (online) discussion

Initial intermediate deadline: Tuesday 2020-02-25 20:00 CET

Final intended outcome:

* + - (Further) set of proposals with full consensus (aim to agree to those over email)
    - Set of proposals with almost full consensus and easy to agree
    - Set of open issues and proposals to postpone to next meeting
    - Open issues that should no longer be pursued

Final deadline: Friday 2020-02-28 12:00 CET

# Issues

## SCell Beam Failure Recovery

### UL grant selection for SCell BFR MAC CE

*Issue: Whether the UE can transmit BFR MAC CE using UL grant of any serving cell or should there be a restriction not to send it on failed serving cell(s).*

RAN2 has previously sought RAN1's opinion on this issue. RAN1 has replied that there is no need for introducing such restrictions for SCell BFR MAC CE transmission. In RAN2 #108, RAN2 has discussed the RAN1's response but there was no conclusion. The various options [1][2][8] proposed by companies to resolve the issue are as follows:

Option 1: SCell BFR MAC CE can be transmitted using UL grant of any serving cell [2]. This option means that there is no restriction.

Option 2: It is up to UE implementation whether it can use UL grant scheduled in a cell where beam failure recovery has been triggered to send SCell BFR MAC CE [1].

Option 3: If UE has a configured UL grant that is not on the failed SCell(s), UE should first select the PUSCH to transmit the BFR MAC CE. Otherwise UE follows the UL grant [8].

**Q1. Which option do you prefer for selecting UL grant for SCell BFR MAC CE transmission?**

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| **Company** | **Preference** | **Detailed Comments** |
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### Priority of SCell BFR MAC CE

*Issue: According to RAN1 LS, SCell BFR MAC CE has higher priority than at least uplink data. RAN2 has discussed this aspect and SCell BFR MAC CE prioritization over BSR, PHR, or Configured Grant Confirmation MAC CEs is FFS.*

The various options [1][4][8] proposed by companies to resolve the issue are as follows:

Option 1: The priority of SCell BFR MAC CE is higher than Configured Grant Confirmation MAC CE [4].

Option 2:BFR MAC CE has an LCP priority higher than BSR MAC CE but lower than Configured Grant Confirmation MAC CE [1].

Option 3: SCell BFR MAC CE has higher priority than “data from any Logical Channel, except data from UL-CCCH” but lower priority than “Single Entry PHR MAC CE or Multiple Entry PHR MAC CE”[8].

**Q2. Which option do you prefer for prioritising SCell BFR MAC CE?**

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| **Company** | **Preference** | **Detailed Comments** |
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### SCell BFR MAC CE retransmission(s)

According to [4]:

* From UE perspective, if UE does not receive “ACK” (i.e. uplink grant for the same HARQ process as PUSCH carrying BFR MAC CE), UE cannot judge whether BFR MAC CE is transmitted successfully or not. From NW perspective, NW may not provide “ACK” if NW does not receive it successfully. Therefore, SCell BFR procedure will remain suspended until “ACK” is received. SCell BFR procedure suspension for a long time will lead to SCell link failure.

According to [5]:

* The UE may trigger BFRQ MAC CE and BFRQ SR frequently if BFR\_COUNTER is increased continuously. Considering it is agreed that only one dedicated SR configuration is shared among all active serving cells in one cell group, the SR maybe always pending and easily reach the maximum number in this case. Therefore, CBRA procedure will be triggered frequently.
* After a BFRQ MAC CE is triggered, the BFR\_COUNTER may be reset at an early time because of expiration of *beamFailureDetectionTimer.* Due to the lack of beam training step, if the current DL beam indicated by BFRQ MAC CE cannot work or the BFRQ MAC CE is lost, or in any other cases where ACK cannot be received, the UE needs to wait for the BFI\_COUNTER reaching the maximum number again in order to re-trigger a new BFRQ MAC CE. This is similar to issue raised in [4].

To overcome the issue it is proposed to introduce a timer for handling BFR MAC CE retransmission(s) or not. Timer is configured per SCell. The timer operates as follows:

* The timer is (re-)started when the MAC PDU including BFRQ MAC CE for the associated SCell is transmitted.
* The timer is stopped when the ACK is received from the NW.
* While the timer is running, UE does not trigger another BFRQ MAC CE for the associated SCell and monitors PDCCH for receiving ACK.
* Upon expiry of the timer, UE triggers a new BFRQ MAC CE for the associated SCell
* If BFR MAC CE retransmission number reaches the configured max number, UE will trigger RACH procedure on PCell for BFR MAC CE transmission.

**Q3. Do you agree to introduce a timer for handling BFR MAC CE retransmission(s)?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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**Q4. If answer to Q3 is yes, do you agree that timer is configured per SCell?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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**Q5. If answer to Q3 is yes, which of the following timer operation(s) are agreeable to you?**

1. **The timer is (re-)started when the MAC PDU including BFRQ MAC CE for the associated SCell is transmitted.**
2. **The timer is stopped when the ACK is received from the NW.**
3. **While the timer is running, UE does not trigger another BFRQ MAC CE for the associated SCell and monitors PDCCH for receiving ACK.**
4. **Upon expiry of the timer, UE triggers a new BFRQ MAC CE for the associated SCell**

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| **Company** | **Preference** | **Detailed Comments** |
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### Handling insufficient UL grant size for SCell BFR MAC CE transmission

*Issue: How to handle SCell BFR MAC CE transmission when UL grant size is not large enough to accommodate BFR information of all failed SCells.*

In [8][11] it is proposed to support truncated SCell BFR MAC CE to address the scenario where UL grant cannot include BFR information of all failed SCells(s). In the proposed truncated SCell BFR MAC CE format in [11], Ci field is included but octet(s) containing candidate beam availability indication (AC) and Candidate RS ID fields are truncated in order not to exceed remaining UL resource, similar to Long Truncated BSR. It is also proposed in [8][11] to use separate LCID for truncated SCell BFR MAC CE.

In [10] it is proposed that such a truncated SCell BFR MAC CE has limited usage and should not be supported.

In [2] it is proposed that if UL grant size is not large enough, UE can report a subset of failed SCell(s) in SCell BFR MAC CE. Ci bit of SCell(s) not reported in SCell BFR MAC CE is set to 0. This does not require any change in SCell BFR MAC CE format. GnB assumes that beam failure is detected and perform BFR for serving cell for which Ci bit is set to 1. gNB ignore the Ci bit set to 0. It does not make any assumption about the beam failure status of serving cell whose Ci bit is set to 0.

**Q6. Which option do you prefer for selecting UL grant for Scell BFR MAC CE transmission?**

* **Option 1: Introduce a truncated SCell BFR MAC CE format where,** 
  + **Ci field is included but octet(s) containing candidate beam availability indication (AC) and Candidate RS ID fields of one or more SCells are truncated in order not to exceed remaining UL resource.**
  + **LCID for Truncated BFR MAC CE is different from non-truncated BFR MAC CE**
* **Option 2: Allow UE to report a subset of failed SCell(s) in SCell BFR MAC CE. Ci bit of SCell(s) not reported in SCell BFR MAC CE is set to 0.**
* **Option 3: No truncation**

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| **Company** | **Preference** | **Detailed Comments** |
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### Cancellation of SR triggered for SCell BFR

Pending SR for SCell beam failure recovery triggered prior to the MAC PDU assembly shall be cancelled and the respective *sr-ProhibitTimer* shall be stopped when the MAC PDU is transmitted and this PDU includes a SCell BFR MAC CE which contains beam failure recovery information of SCell(s) for which BFR was triggered prior to the MAC PDU assembly.

*Issue: The issue is whether all pending SR(s) which were triggered before the MAC PDU assembly are cancelled or only those pending SR(s) which were triggered before the MAC PDU assembly and which were triggered for BFR of SCell(s) whose beam failure recovery information is included in BFR MAC CE are cancelled.*

In [8] it is proposed that pending SR for SCell BFR is not cancelled if only truncated format is sent by the UE. According to [9], the transmission of the beam failure information of a certain SCell only cancels the pending BFR SR triggered by this SCell. In [11] it is proposed that all triggered BFR SR(s) prior to MAC PDU assembly should be cancelled when the MAC PDU including a BFR MAC CE is transmitted.

**Q7. Which option do you prefer for cancelling SR triggered for SCell BFR?**

* **Option 1: All triggered BFR SR(s) prior to MAC PDU assembly should be cancelled when the MAC PDU including a BFR MAC CE is transmitted.**
* **Option 2: The transmission of the beam failure information of a certain SCell only cancels the pending BFR SR triggered by this SCell.**
* **Option 3: Pending SR for SCell BFR is not cancelled if only truncated format is sent by the UE.**

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| **Company** | **Preference** | **Detailed Comments** |
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### RA prioritisation for SCell BFR

RAN1 has agreed that SR resource for SCell BFR is not always configured. In RAN2, it was also agreed that, When SCell BFR SR resource is not configured and SCell BFR MAC CE transmission triggers SCell BFR SR, Random Access procedure on SpCell is triggered to request UL resources to transmit the SCell BFR MAC CE.

*Issue: In R15, random access procedure for SpCell BFR can be prioritised by including ra-Prioritization parameters (powerRampingStepHighPriority and scalingFactorBI ) in BeamFailureRecoveryConfig. The issue is whether RA prioritisation can be applied for SCell BFR or not.*

According to [2], it is beneficial to include ra-Prioritization parameters in *BeamFailureRecoverySCellConfig* for SCell BFR as well to expedite the BFR procedure when SR resource for SCell BFR is not configured.

**Q8. Do you agree to support RA prioritisation for SCell BFR?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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**Q9. If answer to Q8 is yes, do you agree that ra-Prioritization parameters are included in *BeamFailureRecoveryConfigSCell?***

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| **Company** | **Preference**  **(Y/N)** | **Detailed Comments (if preference is no, you can suggest alternatives)** |
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### Handling pending BFR upon SCell deactivation

*Issue: Whether to cancel the ongoing BFR procedure upon deactivation of SCell or not.*

According to [6], a BFR triggered SCell, may be deactivated before a beam failure recovery procedure initiated for the BFR is consider completed. For example, the gNB may deactivate the SCell for the UE if the gNB considers the quality of the SCell is too low for the UE or if the gNB attempts to reduce power usage of the UE. Alternatively, the UE may deactivate the SCell due to expiry of *SCellDeactivationTimer* associated with the SCell. The timer may expire due to no successful PDCCH reception from a BFR-triggered SCell. In [6] it is proposed to cancel the ongoing BFR procedure upon deactivation of SCell.

**Q10. Do you agree that the triggered BFRs for the SCell are cancelled upon Scell deactivation?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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### Handling measurement gaps

After sending a BFRQ SR, the UE expects to receive a UL grant (i.e. monitor PDCCH addressed to C-RNTI/CS-RNTI) for transmitting subsequent BFRQ MAC-CE. According to [12], if PDCCH monitoring occasion is overlapped with measurement gap, the monitoring may be dropped and extra latency is produced to finish the SCell BFR procedure. It is proposed [12] that after UE transmits a BFRQ SR, UE monitors a PDCCH addressed to C-RNTI/CS-RNTI regardless of measurement gaps.

**Q11. Do you agree that the UE is allowed to ignore measurement gaps while monitoring PDCCH addressed to C-RNTI/CS-RNTI for receiving an UL grant for new transmission after transmitting BFRQ SR and BFRQ MAC CE?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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### 2.1.9 Others

In the current MAC CE design, octet containing 'AC' field is included for each serving cell with Ci bit set to 1, irrespective of whether candidate beam is available or not. According to [2] consecutive octets containing 'AC' field at the end of MAC CE can be omitted to reduce overhead. It is proposed that if candidate beam is not available for a failed SCell with serving cell index i, octet containing AC for this SCell is skipped, if candidate beam is not available for all the failed SCell(s) with serving cell index j > i.

**Q12. Do you agree that the consecutive octets containing 'AC' field at the end of MAC CE can be omitted?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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## SpCell Beam Failure Recovery

*Issue: Upon beam failure detection on SpCell, MAC entity initiates a Random Access procedure on the SpCell. The issue is whether BFR procedure on SpCell needs to be enhanced to use BFR MAC CE.*

*Issue: If BFR MAC CE can be used for BFR on SpCell, when does the UE trigger transmission of BFR MAC CE for BFR on SpCell.*

*Issue: If BFR MAC CE can be used for BFR on SpCell, what should be the format of this BFR MAC CE.*

During Rel-15 it was discussed to introduce a MAC CE for BFR on SpCell for CBRA to enable network to identify whether the random access initiated by UE was for BFR or not. The conclusion of the discussion was that the network could deduce the cause of the random access based on the UE switching beams. According to [3][5] this method is not perfect as there is no requirement for the UE to use the serving beams for CBRA when the random access is not performed for BFR, and consequently, network may unnecessarily reconfigure the UE. According to [1], even if CFRA based BFR is performed, depending on PRACH configuration for BFR, there can be some latency before UE can use the RACH occasion associated with its new candidate beam.

**Q13. Do you agree to introduce BFR MAC CE for BFR on SpCell in R16?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
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**Q14. If BFR MAC CE for BFR on SpCell is supported, which option do you prefer for triggering transmission of the BFR MAC CE?**

* **Option 1: Initiate random access procedure on SpCell and also trigger transmission of the BFR MAC CE.**
* **Option 2: It is up to UE implementation whether to trigger random access procedure or send BFR MAC CE to perform BFR for SpCell.**
* **Option 3: BFRQ MAC CE is generated during CBRA based BFR procedure on SpCell and transmitted in Msg3.**

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| **Company** | **Preference** | **Detailed Comments** |
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Q15. Which option do you prefer for BFR MAC CE format for SPCell?

* Option 1: Replace one of the R-bits in the proposed SCell BFR MAC CE with a one-bit field indicating BFR on the SpCell.
* Option 2: New MAC CE of fixed size with zero bits.

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| **Company** | **Preference** | **Detailed Comments** |
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# References

1. R2-2001484, " Remaining issues on SCell BFR", Qualcomm
2. R2-2000226, " Remaining issues of SCell BFR", Samsung
3. R2-2001652, "BFR MAC CE for SpCell", Ericsson, Nokia, Nokia Shanghai Bell, Apple
4. R2-2000587, "SCell BFR Operation", Nokia, Nokia Shanghai Bell, Apple
5. R2-2001509, "The remaining issue on BFR on SpCell and SCell", ZTE Corporation, Sanechips, Asia Pacific Telecom co. Ltd
6. R2-2001600, "SCell BFR regarding Scell deactivation", ASUSTeK
7. R2-2001421, "Remaining issues on SCell BFR procedure", Asia Pacific Telecom co. Ltd
8. R2-2000891, "Views on Remaining Issues of SCell BFR", CATT
9. R2-2000386, "SR cancellation due to the truncated BFR MAC CE", VIVO
10. R2-2001304, "Consideration on Truncated format on SCell BFR MAC CE ", LG Electronics Inc
11. R2-2000658, "Open issues on SCell BFR", OPPO
12. R2-2001599, "Remaining issues of SCell BFR", ASUSTeK