**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/configured 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].

Option 4: SCell BFR MAC CE can be transmitted using a dynamic UL grant of any serving cell, but not using a configured grant of any cell.

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

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| --- | --- | --- |
| **Company** | **Preference** | **Detailed Comments** |
| Ericsson | 4, 1, 2, 3 (in that order) | It has been identified that only for configured grants there is a real risk the UE may transmit the MAC CE on a failed SCell. Thus, a simple approach could be to avoid only those grants and rely on dynamic grants only. |
| Qualcomm | 2 | As explained in our paper [1], after SCell BFR is triggered, which UL grant to use or whether UE should use an available UL grant or trigger SR for BFR is up to UE implementation.  Dynamic grant may be more “usable” than configured grant for BFR MAC CE, as one may argue that if UE can receive DCI on an SCell, then that SCell is still usable. This argument is somewhat true on a self-scheduled carrier but may not be applicable for a cross-scheduled carrier. For example, a FR2 carrier can be configured with BFD but scheduled by a FR1 SpCell. In that case, UE may still be able to receive UL grant from SpCell on that FR2 SCell, even when BFR is triggered on that FR2 SCell. |
| Samsung | 1 | 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. Since beam management is primarily designed by RAN1, our preference is to follow the RAN1 opinion. |
| CATT | 3 | As discussed in our contribution this seems a possible compromise. We have concern on the performance of using failed CC, also we do not think it a good choice to leave this purely to implementation. |
| OPPO | 1, 2 | As agreed in RAN1, there is no need to introducing such restrictions for SCell BFR. And whether UE use UL grant scheduled in a cell where beam failure recovery has been triggered to send SCell BFR MAC CE is implementation. |
| SHARP | 1 | Share the same view with Samsung |
| Nokia, Nokia Shanghai Bell | Other, or Option 2 after that. | Please note that in NR-U, for LBT failure MAC CE, RAN2 agreed that it shall not be multiplexed on a failed serving cell. Furthermore, we have aligned pretty much completely the design of LBT failure MAC CE handling and SCell BFR MAC CE handling, hence, it seems natural to use the same restriction for the SCell BFR MAC CE.  It seems we could not deduce from the options if this corresponds to any of them.  Option 2 is also possible, however, what needs to be specified is that the UE can trigger BFR SR in case it has UL grant on a failed cell. |
| Lenovo | 4 | We think Option 4 is a good compromise. As Ericsson mentioned the only problematic case is that UE sends MAC CE on CG on a failed SCell. |
| APT | 1 | Respect RAN1’s agreement. However, some retransmission mechanism for SCell BFR MAC CE may be needed if UE could transmit it on the failed SCell via configured grant. Because the NW may not know whether the UE is failed to transmit or skip the CG transmission. |
| ASUS | 1 or 2 | We think there is no need for specific restriction, and it may be up to UE implementation for the UE to determine whether a UL grant on a failed cell is an “available” UL grant. |
| ZTE | 2 or 4 | we suggest it can be left to UE implementation which seems simpler. In addition ,we tend to agree with E//, since the configured grant can be skipped as a default behavior, if the configured grant with BFR MAC CE is dropped , NW may think this configured grant is skipped and no further re-transmission is scheduled. |
| LG | Option 1 | As beam failure is detected based on DL resources, there may be a case where UL is still available, even if beam failure is detected. So, if the transmission for BFR MAC CE is restricted on the SCell with beam failure, the opportunity to send BFR MAC CE may be lost. Moreover, RAN1 think such restriction is not needed. Therefore, we think the restriction for SCell BFR MAC CE transmission is not needed. |
| MediaTek | 1 or 2 | Based on RAN1 agreement, no restriction is really needed. If there is concern then option 2 is a good compromise, i.e., allow UE to select based on its status and leave the detailed selection criterion to UE implementation. |
| Intel | 1 (which implies 2 as well? | Similar view as Samsung and others, use the RAN1 guidance. |

### 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** |
| Ericsson | 1 or 2, then 3 | We think option 3 might have negative impact on the system as a BSR or PHR may replace a SCell BFR MAC CE in msg3 at a time when SCell BFR MAC CE is more important. We have no preference between option 1 or 2. |
| Qualcomm | 2, 1 (in decreasing order of preference) | We do not have strong preference between Option 1 or 2, but we think BFR MAC CE should have higher priority than BSR and PHR. As we all know, PHR is relatively delay tolerant. It is not sensible to prioritize PHR MAC CE over BFR MAC CE. Between BSR and BFR MAC CE, RAN1 has already agreed that SR for BFR should have higher priority than SR for data. This then leads to conclusion that BFR MAC CE should have higher priority than BSR MAC CE during LCP procedure. |
| Samsung | 2 |  |
| CATT | 3 |  |
| OPPO | 1 or 2 |  |
| SHARP | 3 |  |
| Nokia, Nokia Shanghai Bell | Option 1 | In case we want to indicate SpCell failure with the MAC CE, it would be beneficial it could be mapped to Msg3 of RA procedure. |
| Lenovo | 2 |  |
| APT | 1 or 2 | Beam recovery is more important than providing BSR and PHR information. |
| ASUS | 1 or 2 |  |
| ZTE | 1 | It is based on the outcome of subclause 2.2, if we want to include the BFR MAC CE for SpCell into Msg.3. The priority of the BFR MAC CE for SpCell need be taken into account . |
| LG | Option 3 | We think BFR MAC CE is not critical information enough to have higher priority than other MAC CE. This is because that data transmission is possible via other serving cells even if some SCells experience beam failure. There may be rare case where beam failure is happened in all serving cells. |
| MediaTek | 1 or 2 | We think BFR MAC CE should at least be prioritized over BSR and PHR. |
| Intel | 2 | Among all 3 options, the SCell BFR MAC CE has the lowest priority in option 3. We tend to think that SCell BFR MAC has priority at least higher than PHR. But we don’t want to propose option 4 😊 We find Option 2 the closest. |

### 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** |
| Ericsson | N | We think this adds unnecessary complexity. If there is a need to transmit control signalling more reliably than through MAC CEs (where HARQ is used for retransmission) RRC is available. If a timer is acceptable, then the added delay cannot be an issue so RRC should be suitable in that case. |
| Qualcomm | N | We do not see benefits of introducing such a timer. Based on the procedure described above, this timer essentially is a prohibit timer for triggering BFR MAC CE. But that purpose is served by the SR prohibit timer for BFR.  If the concern is on the reliability of MAC CE transmission, our view is that it is rather an overengineering a theoretical problem with small probability of happening. If MAC CE transmission does fail, UE can send another BFR MAC CE. |
| Samsung | N |  |
| CATT | N |  |
| OPPO | N ,but | The timer is not needed if network always send a PDCCH scheduling for new transmission once the BFR MAC CE is successfully received. Otherwise the timer-based retransmission should be introduced to specify UE behaviour. |
| SHARP | Y | Considering BFR MAC CE is allowed be triggered just when *BFI\_COUNTER* >= *beamFailureInstanceMaxCount*, we think the operation below is necessary  “- While the timer is running, UE does not trigger another BFRQ MAC CE for the associated SCell and monitors PDCCH for receiving ACK.”  SR prohibit timer could act for the same target. But it may be not enough. It only works when SR is triggered. However, for the case there is UL-SCH resource available, our concern is unnecessary resource occupation for the same Scell by the sequent triggered BFR MAC CEs. |
| Nokia, Nokia Shanghai Bell | Yes | Since every beam failure instance indication from lower layers will trigger another BFR for the given SCell, the timer prevents the UE from sending the same information again before the UE can be certain the transmission failed. Naturally, the timer should operate on a per serving cell basis. |
| Lenovo | Yes | We think that it cannot be assumed that network always sends an ACK (PDCCH for new transmission), therefore we consider the timer as useful. Also we support the argument brought forward by SHARP. |
| APT | Y | The question may not be very accurate. The purpose of the timer is not only used for handling BFR MAC CE retransmission(s). As the UE behaviours for the timer mentioned in Q5, the timer could also be used to avoid triggering multiple BFRQ MAC CEs, and to ask the UE monitors PDCCH for receiving ACK. The timer should be needed if any of c) or d) of Q5 is agreeable. |
| ASUS | Y, but  see comment | In our understanding, this proposal introduces more of a “prohibit timer” than a “retransmission timer”. For handling retransmission of BFR MAC CE, we also see benefits in proposal 1 and 2 in [4] that a timer is used to control retransmission of a BFR MAC CE for reliability. |
| ZTE | Y | According to LS from RAN1, it is confirmed that the BFR for multiples serving cells can be triggered simultaneously. Assuming that more than one serving cells are failed simultaneously and the first MAC CE was already sent to NW, if without any control, regarding the BFI\_COUNTER of each failed serving cell is still incremented, multiple BFR MAC CE will be triggered by different serving cells again and again , from which, multiple redundant triggered BFR MAC CE would be sent via a number of UL grants until the first ACK is arriving. This is a not resource efficient mechanism.  Moreover, if multiple BFR MAC CEs are sent to NW as we mentioned before, for each time where ACK of these multiple BFR MAC CE is received , the BFI\_COUNTER of the related serving cells shall be reset correspondingly , which may postpone the next detection of beam failure for these serving cells. |
| LG | No | We think there is no problem even if multiple BFR MAC CEs are triggered. The network may perform beam management based on the successfully received BFR MAC CE. In addition, beamFailureDetectionTimer is expired before beam recovery only when beamFailureDetectionTimer is configured with very short value. Therefore, we think the new timer is not needed to handle BFR MAC CE transmission. |
| MediaTek | Y | As companies indicated, the timer can be used as a prohibit timer to avoid redundant BFR MAC CE transmissions, which seems useful from MAC modelling point of view. |
| Intel | N | We do not see the need to over-engineer this at this stage. |

**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** |
| Ericsson | N | As the timer is associated with the transmission of the SCell BFR MAC CE (which includes all SCells) there is no point in having one timer per SCell. |
| Qualcomm | N | We share the same view as Ericsson. |
| Samsung | Y | In our view timer is to retrigger BFRQ for the associated SCell |
| CATT |  | Details can be discussed when there is consensus to introduce a timer. |
| OPPO | Y | The timer should be SCell specific. |
| SHARP | Y |  |
| Nokia, Nokia Shanghai Bell | Yes | See previous comment. |
| Lenovo | Yes |  |
| APT | Y |  |
| ASUS |  | Agree with Ericsson that if the BFR MAC CE carries BFR information for all SCells, there may not be a need to have timer per SCell, but details can be discussed if the timer is actually needed. |
| ZTE | Y | Similar with the BeamFailureDetectionTimer, it can be configured based on the value of beamFailureDetctionTimer |
| LG | No | BFR MAC CE includes the information for all of configured SCell. Thus, the timer should be "a timer per UE". |
| MediaTek | N | The MAC CE included in a MAC PDU may contain failure information for multiple failed SCells. Then it seems not correct to configure the timer per SCell, e.g. may be configured per HARQ process whose MAC PDU includes BFR MAC CE. Details can be discussed if the timer is agreed. |
| Intel | N |  |

**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** |
| Ericsson | Support | The procedure above seems to correctly describe the timer, should the timer be accepted by RAN2. |
| Qualcomm | a, b, c | If such a timer is introduced, we think a, b, and c are correct behaviors. For d, we think the correct behavior should be that UE triggers a new BFR MAC CE only if BFR is still pending. |
| Samsung | a, b, c, d | If timer is supported |
| CATT |  | Details can be discussed when there is consensus to introduce a timer. |
| OPPO | a, b, c, d | If timer is supported |
| SHARP | b, c | For a, we think the timer is started when a BFR MAC CE is triggered for a Scell.  For d, our understanding is upon expiry of the timer, a new BFR MAC CE is allowed to be triggered.  There is no need to always trigger a BFR MAC CE when timer expiries. It depends on the status of *BFI\_COUNTER. Since t*he beam failure detection keeps performing, it is possible when the timer expires, the *BFI\_COUNTER is set* to 0 based a good link quality. |
| Nokia, Nokia Shanghai Bell | All | All operations seem to be needed. |
| Lenovo | a,b,c,d |  |
| APT | All | For c), UE only needs to trigger one BFRQ MAC CE since the BFRQ MAC CE could include the information for all SCells. And the UE should monitor PDCCH to reduce the latency of receiving ACK.  For d), if Q1 is agreed to not have any restriction to transmit the BFRQ MAC CE on failed SCell. The retransmission mechanism is needed to prevent the UE from waiting the ACK for a long time but the NW does not receive the BFRQ MAC CE. |
| ASUS |  | We prefer a timer for retransmission of a BFR MAC CE. |
| ZTE | a,b,c,d | This is a popular timer behavior. |
| LG |  | Details on the new timer can be discussed after the deciding whether to introduce the timer or not. |
| MediaTek | a)b)c)d) | If timer is supported |

### 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** |
| Ericsson | 3, 1 (in that order) | We think truncation adds complexity for limited gain, so we do not think it is necessary. Out of the two options for truncation, we think option 1 is the simplest. |
| Qualcomm | Depends | We disagree with the current bitmap based format, which can be large. But if it is agreed, we can support Option 1. |
| Samsung | Option 2, 3 (in that order) |  |
| CATT | 1 | We prefer simple design. Can go with majority’s view on format details. |
| OPPO | 1 | Truncated BFR MAC CE format can better handle the concern when the UL grant is not big enough to accommodate all the triggered BFR MAC CE(s) with multiple entry format. And even all triggered SR has been cancelled, network can still aware the status of required UL grant for BFR MAC CE transmission through truncated BFR MAC CE. |
| SHARP | Option 1 |  |
| Nokia, Nokia Shanghai Bell | Option 1 | This would be beneficial if we were to agree on reporting SpCell with the BFR MAC CE so to be able to indicate at least the failure in Msg3 of the RA procedure. Otherwise, NW may not be able to identify the RA procedure was initiated for BFR. |
| Lenovo | Option 2 |  |
| APT | 1, 2 | Some information is better than no information for NW |
| ASUS | 3 |  |
| ZTE | 3 or 1 | If we support the truncated BFR MAC CE, the bitmap need to reflect the the current serving cell situation in order to provide valuable information to NW to prepare a continuous scheduling the UL grant. |
| LG | Option 3 | Considering BFR MAC CE has the higher priority than logical channel data, there may be not many case that BFR MAC CE cannot be accommodated in UL resource. In addition, since BFR-SR was introduced, the network should give the UE the amount of UL resource which can accommodate a BFR MAC CE.  Most of all, we think BFR MAC CE is not critical information enough to have truncated format. This is because that data transmission is possible via other serving cells even if some SCells experience beam failure. There may be rare case where beam failure is happened in all serving cells. |
| MediaTek | Option 1 | We prefer UE to send out the BFR MAC CE as soon as possible, so option 3 is not desired. For option 1 and option 2, we prefer option 1 because option 1 can inform all failed SCell to the NW earlier than option 2. |
| Intel | Option 1 then option 2 | We think (atleast for the triggred SR case), the NW should provide sufficient grant. IN cases where the UE uses the current UL grant, opt 2 would be better. |

### 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** |
| Ericsson | 2, 1 (in that order) | We have a slight preference for option 2, as later BFRs on some SCells might not be transmitted otherwise. |
| Qualcomm | Depends | If bitmap based format is agreed, we can support Option 1. |
| Samsung | 2 | Example:  BFR for Scell 1 is triggered at time 't1' and BFR for Scell 1 is triggered at time 't2. MAC PDU is assembled at time 't3'.  t3>t2>t1  At 't1', UE does not trigger SR as UL grant is available (for which MAC PDU is assembled at t3) and based on LCP BFR MAC CE including Scell 1 information can be included in MAC PDU.  At 't2' UE trigger SR as UL grant is available (for which MAC PDU is assembled at t3) but based on LCP BFR MAC CE including Scell 2 information cannot be included in MAC PDU.  In this case, MAC PDU assembled at time 't3', includes BFR MAC CE including Scell 1 information but does not include SCell 2 information. According to option 1, SR triggered for Scell2 BFR is cancelled, In our view it is incorrect to cancel the SR triggered for Scell2 BFR as Scell2 information is not transmitted in BFR MAC CE. |
| CATT | 3 |  |
| OPPO | 1 | Truncated SCell BFR MAC CE can implicit indicate that whether the UL grant is enough for a UE for BFR reporting. Thus all triggered BFR SR(s) prior to MAC PDU assembly can be cancelled when the MAC PDU including a BFR MAC CE is transmitted. |
| SHARP | Option 2 |  |
| Nokia, Nokia Shanghai Bell | Option 1/3 | Same approach with BSR SR. |
| Lenovo | 2 |  |
| APT | 2 | If only truncated format is transmitted, the UE still needs to transmit the remaining BFRQ information via another UL resource. |
| ZTE | Option 2 |  |
| LG | Option 1 + Option 3 | In the current specification, SR is not cancelled when Truncated BSR is transmitted. We prefer the consistency with SR behaviour, i.e., BFR-SR is cancelled when a normal BFR MAC CE is transmitted, but BFR-SR is not cancelled when a Truncated BFR MAC CE is transmitted. |
| MediaTek | Option 2 | For option 1, we think those triggered BFR SR(s) whose BFR information is not yet included into the MAC PDU (e.g. due to UL grant size limit) should not be cancelled. For option 3, we think a pending SR for SCell BFR can be cancelled as long as the beam failure information of the corresponding SCell is included in the truncated format. |
| Intel | Opt 2 |  |

### 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 rioritizat by including ra-Prioritization parameters (powerRampingStepHighPriority and scalingFactorBI ) in BeamFailureRecoveryConfig. The issue is whether RA rioritization 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 rioritization for Scell BFR?**

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| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Not support | We have a slight preference not to support it. Currently RA-prioritization can only be configured for BFR on Pcell and Handover. For the prioritization to be useful there is a point in limiting it to few use cases, hence not supporting it for Scell BFR. On the other hand, as RA may be prioritized for BFR on Pcell it seems appropriate to include it also for Scell. However, as the purpose of the prioritization is to reduce access delay we think a better action from the network would be to configure the UE with a BFR SR instead. |
| Qualcomm | Depends | We see two scenarios:   * If none of UE’s data logical channels is configured with any SR resources, we see some benefits in prioritizing RACH procedure used for Scell BFR. * Otherwise, we do not think it is necessary, because if NW does not bother to configure SR resource for Scell BFR, then it means NW does not consider Scell BFR a high priority and hence there is no need to prioritize RACH for Scell BFR. And for this reason, we think network **shall** configure SR resources for BFR if there is at least one data logical channel is configured with SR resources. |
| Samsung | Y | It is beneficial to include ra-Prioritization parameters in *BeamFailureRecoverySCellConfig* for Scell BFR to expedite the BFR procedure when SR resource for Scell BFR is not configured |
| CATT | Y | The exact complexity, in our view, is limited. we would like to have this flexibility of configuration. |
| OPPO | N | We share same view as Ericsson. |
| SHARP | Not support | We share the same view with Ericsson. |
| Nokia, Nokia Shanghai Bell | No | We share the views with Ericsson. |
| Lenovo | No | Same view as Ericsson and others |
| APT | N | Share the same view with Ericsson |
| ASUS | No strong preference | To achieve fast beam failure recovery, the network should configure SR resources for SCell BFR instead of having the UE perform RA procedure. But we are also fine to have this configuration for network flexibility. |
| ZTE | Not support | We share the same view with E// |
| LG | No | RA procedure on SpCell is triggered when SR resource for SCell BFR is not configured. Thus, we think this should be same as a case that there is no SR resource, i.e., there is no RA prioritisation for RA procedure triggered by SR. |
| MediaTek | N | Share same view with Ericsson |
| Intel | No | Same vies as Ericsson |

**Q9. If answer to Q8 is yes, do you agree that ra-Prioritization parameters are included in *BeamFailureRecoveryConfigSCell?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference**  **(Y/N)** | **Detailed Comments (if preference is no, you can suggest alternatives)** |
| Ericsson | Y | If included, this seems like a suitable place, but we are open to discuss further. |
| Qualcomm | Y | It is included in that IE **only if** none of UE’s data logical channels is configured with any SR resources. |
| Samsung | Y | When to configure can be upto network implementation |
| CATT | Yes | Agree with Samsung above. |
| SHARP | Y |  |
| Nokia, Nokia Shanghai Bell | Unclear | *BeamFailureRecoveryConfigSCell* parameter was to be a SCell DL BWP specific, hence, cannot put the parameters there. We should have a new IE that is configured for SpCell only UL BWP specifically. |
| ASUS | Y |  |
| MediaTek | Y |  |
| Intel | Y | *If RAN2 agrees to this.* |

### 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Y | We agree to this. There is no point in sending MAC CEs for deactivated SCells. |
| Qualcomm | Y |  |
| Samsung | Y |  |
| CATT | Yes |  |
| OPPO | Y |  |
| SHARP | Y |  |
| Nokia, Nokia Shanghai Bell | Yes | It is questionable what the UE reports about an SCell that was deactivated. |
| Lenovo | Yes |  |
| APT | Y |  |
| ASUS | Yes |  |
| ZTE | Yes |  |
| LG | No | Since the network knows whether the SCell is deactivated or not, there is no problem if the triggered BFR is not cancelled. In addition, the triggered BFR MAC CE includes the BFR information for other SCells. Therefore, we think the triggered BFR MAC CE should not be cancelled. |
| MediaTek | Y |  |
| Intel | Y |  |

### 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | No, the UE shall... | It is not enough to say that the UE *may* ignore measurement gaps to monitor PDCCH. The network will not know if the UE monitors or not, so what should it do, send the grant or not?  We think the UE *shall* monitor PDCCH regardless of measurement gaps. |
| Qualcomm | Yes, but… | We agree with the intention but think the proposal needs to be made more precise. For example, if the measurement gap is per-FR gap, we do not see why UE needs to ignore that measurement gap, because it can still monitor PDCCH on the cells without measurement gap for possible beam reconfiguration MAC CE. |
| Samsung | N | Note that SR transmission for BFR is also not prioritised over measurement gap. If measurement gap can lead to increased latency, all aspects of BFRQ procedure should be considered, not just reception of ack. |
| Nokia, Nokia Shanghai Bell | No | Since the UE is not decoding for RAR, NW knows the measurement gap occasions. |
| Lenovo | N | Same view as Samsung |
| APT | Y | To reduce the latency for the completion of SCell BFR procedure. |
| ASUS | Yes | We see benefits in reducing latency for SCell BFR. Also, this is a similar behaviour as RA procedure for BFR where the UE monitors Msg2 and Msg4 regardless of measurement gaps. |
| ZTE | No for waiting for PDCCH scheduling after the transmission of SR | We think the measurement reporting for RRM (e.g. for handover, PSCell/SCell management) shall not be delayed due to the BFR on SCell. For example, if the UE is allowed to ignore the measurement gap for the reception of UL grant or ACK for BFR, then the measurement report for handover may be delayed. |
| LG | No | The basic principle for measurement gap is that the UE does not monitor PDCCH during measurement gap. In addition, as mentioned above, we think beam failure recovery is not important since other serving cell is still available. Therefore, we think the basic principle should be kept. |
| MediaTek | N | We don’t see the need to introduce special handling. As Nokia mentioned, NW knows measurement gap occasions, so NW can avoid scheduling BFRQ-required UL resource overlapped with measurement gap. |
| Intel | No |  |

### 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Y | This is a useful optimization to reduce the size of the MAC CE. |
| Qualcomm | - | It seems an optimization to us. |
| Samsung | Y | If there are consecutive octets containing 'AC' field at the end of MAC CE, they can be omitted without any loss of information. |
| CATT |  | Sounds like optimization. Can go with majority’s view. |
| OPPO | N | It seems like optimization. |
| Nokia, Nokia Shanghai Bell | No | It is an optimization that may or may not be useful in some scenarios. |
| Lenovo |  | No strong view. But this is an optimization to us. |
| ZTE | No strong view | This is a optimization to us. And the benefit of this optimization is not stable. it is quite related to the failed serving cells situation, for example, if the failed serving cell with the largest ID is able to select a suitable DL beam , all failed serving cells shall report the beam information field regardless of the value of AC field. |
| LG | No | It seems like optimization. |
| MediaTek | Y | Seems useful in some cases to reduce MAC CE size without additional cost. |
| Intel | No strong view |  |

## 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference (Y/N)** | **Detailed Comments** |
| Ericsson | Y | We think there is a strong need to improve the design in Rel-15. Explicit indication in form of a MAC CE would be very beneficial. |
| Qualcomm | Y | We agree with all the arguments listed above and support BFR MAC CE for BFR on SpCell. |
| Samsung | - | 1) There is no common view on detail operation and MAC CE format. In our view, it is not an essential feature as the focus of this WI is Scell BFR. Hence this should be discussed only if time permits.  2) The potential issue with SpCell's BFR mechanism is that in case of CBRA, network may not be able to identify that RA procedure was initiated for BFR. So if majority view is to support BFR MAC CE for BFR on SpCell, it should be to address this issue. We do not see any issue with CFRA procedure for BFR on SpCell. |
| CATT |  | This is not part of the WI scope. Also there might be ran1 impact. our preference is not to spend time on this. |
| OPPO |  | Agree with CATT. |
| SHARP | Y but | We think it is necessary to have an MAC CE for BFR on Spcell in R16. But we don’t think it should be the same MAC CE with Scell. It will result complexity.  For example, for a BFR MAC CE with or without Spcell, the same LCP should be applied or not.  And for the RA prioritization, for a BFR MAC CE with or without Spcell, do they share the same RA priority or not?  We prefer to have a separate BFR MAC CE for Spcell to avoid the complexity mentioned above. |
| Nokia, Nokia Shanghai Bell | Yes | The CBRA based BFR specified in Rel-15 is not working well without introducing this. |
| Lenovo |  | Same view as Samsung |
| APT | Y | The bug from R-15 could be fixed in R-16. |
| ASUS |  | The current SpCell BFR procedure seems to work well. We are not sure if this enhancement is needed. |
| ZTE | Y | The BFR MAC CE on SpCell can provide necessary information to complement the drawback of RACH based BFR procedure. |
| LG | No | RAN1 did not introduce BFR MAC CE for SpCell because RAN1 thought that RA procedure is enough to beam failure recovery for SpCell. Our understanding is aligned with RAN1. |
| MediaTek | Y | To reduce unnecessary reconfiguration latency in beam management, we are open for this optimization. |
| Intel | No | Not part of the WI. |

**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.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference** | **Detailed Comments** |
| Ericsson | 1 |  |
| Qualcomm | 2 and 3 | It seems unnecessary to trigger both RACH and MAC CE for the same purpose. |
| Samsung | Option 3 | The potential issue with SpCell's BFR mechanism is that in case of CBRA, network may not be able to identify that RA procedure was initiated for BFR. So we prefer option 3 instead of alternate mechanisms (such as option 1/2) for SpCell BFR. |
| SHARP | 1 |  |
| Nokia, Nokia Shanghai Bell | Option 1 | We don’t see a reason to create rules when RA is triggered and when not. Easiest is to always trigger and we could allow to cancel it if BFR MAC CE is transmitted via another serving cell for which ACK is received. |
| Lenovo | 3 |  |
| APT | 1 |  |
| ZTE | 3 | In our understanding , the RACH based BFR procedure can provide the DL beam training which can not be replaced by MAC CE based BFR procedure . And w.r.t option 1, we can understand the intention, but it should raise more discussion for how to handle two parallel BFR procedures on SpCell. |
| MediaTek | 1 |  |

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.

|  |  |  |
| --- | --- | --- |
| **Company** | **Preference** | **Detailed Comments** |
| Ericsson | 1 |  |
| Qualcomm | 1 | If bitmap based format is agreed, we think Option 1 is a simpler and cleaner solution for the purpose. If explicit cell ID based format is agreed, we think UE can simply include SpCell’s cell index in the MAC CE. |
| Samsung | 2 | SSB ID is already indicated by Msg1. |
| SHARP | 2 | As commented in Q13, a separate BFR MAC CE for Spcell will make spec easy. And msg1 has already provide the necessary information about best candidate beam. |
| Nokia, Nokia Shanghai Bell | Option 1 | This allows to indicate the SCell that have beam failure at the same time. |
| APT | 2 | Beam information for SpCell is different from SCell case |
| ZTE | Option 2 or others | If we want to support the BFR MAC CE for PCell which can be sent by Msg.3, given that the container of Msg.3 only have 52 bits, and only 28 bits are remaining for accommodate the BFR MAC CE for SpCell since the other 24 bits shall be for accommodating the C-RNTI MAC CE. Thus we can accept all possible structures of BFR MAC CE for SpCell whose payload plus its subheader can be less than 28 bits. |
| MediaTek | 1 | Share same view with Nokia. |

# References

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3. R2-2001652, "BFR MAC CE for SpCell", Ericsson, Nokia, Nokia Shanghai Bell, Apple
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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
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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
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