

Agenda Item: 6.2.2.2

Source: OPPO

Title: Report of offline-403 - Remaining issues of consistent UL LBT failure

Document for: Discussion, Decision

1 Introduction

This contribution is to summarize the offline#304 of RAN2#108 meeting regarding the remaining issues on consistent uplink LBT failure for NR-U:

[R2-1914400](#) Remaining issues on consistent uplink LBT failure for NR-U OPPO discussion Rel-16 NR_unlic-Core

Proposal 2 Similar as BFR MAC CE, UE can trigger SR if there is no available UL resources for sending the MAC CE for SCell UL LBT problem.

- Convida thinks that we have to check the specs first as it may get complicated.
- Vivo agrees with the proposal
- Ericsson doesn't think this is a time critical thing so we don't need to trigger an SR. Mediatek also agrees. Interdigital explains that in the case of hidden node problem the delay can be quite large. Nokia also thinks that we should trigger the SR similar to the BFR framework. Qualcomm agrees as well.

Proposal 3 No need to have the limitation that the MAC CE should be transmitted on a different serving cell other than the SCell which has the UL LBT problem

- Vivo thinks that the UE should not transmit on the failed BWP as this can cause blockage.
- Nokia and Lenovo don't think it makes sense to transmit something on a cell that has failed.

Proposal 4 No need to re-trigger the MAC CE if there is already MAC CE triggered for consistent UL LBT failure for a SCell.

Proposal 5 The MAC CE format should support multiple entries to indicate all the SCells which have already declared consistent UL LBT failure.

- Ericsson thinks that we should only report a single MAC CE with a single SCell. Interdigital thinks we should report multiple. Qualcomm agrees.

Proposal 7 When consistent UL LBT failure is declared on SpCell, UE does not trigger MAC CE.

- Huawei thinks that we should trigger MAC CE to speed up the reporting. Oppo thinks that for PCell RLF will be triggered anyways for the cell.
- Nokia thinks this is important as we can have multiple different reasons why the BWP switching has happened. ZTE considers that it may be simpler for the MAC to generate it all the time.
- Ericsson thinks MAC CE should be sent. Mediatek would like to understand what the network will do with this information. Nokia explains that the network needs to distinguish.
- ZTE explains that BPW ID is not needed as the network should know which one was the active BWP.

Agreements:

1. UE can trigger SR if there is no available UL resources for sending the MAC CE for SCell UL LBT problem, using the same framework as BFR.

2. MAC CE for UL LBT problem has higher priority than data but lower priority than the BFR MAC CE.
3. The MAC CE should be transmitted on a different serving cell other than the SCell which has the UL LBT problem
4. The MAC CE can report multiple failed Cells. The MAC CE format should support multiple entries to indicate all the Cells which have already declared consistent UL LBT failure. UL LBT MAC CE includes Cell index(s) where UL LBT failure occurs. FFS if anything additional is needed for SpCell.
5. FFS on how to cancel MAC CE (at the point of assembly) [CB]
6. When consistent UL LBT failure is declared on SpCell, UE triggers MAC CE to indicate where failure happened. The MAC CE is sent on the BWP that the UE switched to during RA procedure [CB]
7. A new failure type for PSCell consistent UL LBT failure is added in the SCGFailureInformation.
8. No new re-establishment cause is introduced in the RRC re-establishment message. "Other" failure will be used

[CB - Offline discussion 403] Oppo

2 Discussion

2.1 LBT failure MAC CE format

Regarding the LBT failure MAC CE format, one left issue regarding the following agreement#4 and agreement#6:

4.The MAC CE can report multiple failed Cells. The MAC CE format should support multiple entries to indicate all the Cells which have already declared consistent UL LBT failure. UL LBT MAC CE includes Cell index(s) where UL LBT failure occurs. FFS if anything additional is needed for SpCell.

6.When consistent UL LBT failure is declared on SpCell, UE triggers MAC CE to indicate where failure happened. The MAC CE is sent on the BWP that the UE switched to during RA procedure [CB]

The FFS is that whether the LBT failure MAC CE can include additional information for SpCell besides what we have agreed, i.e., cell index(s) where UL LBT failure occurs.

Rapporteur understands this FFS is for the case when UE declares consistent LBT failure on the active UL BWP for SpCell, the UE will trigger BWP switching and switches to another UL BWP with RACH occasion. Then network may need to be aware of the UL BWPs on which the UE declares consistent LBT failure.

Thus, companies are asked to give the views on whether additional information is needed for the LBT failure MAC CE for SpCell, e.g., BWP information.

Question 1: Do you agree the LBT failure MAC CE should include additional information for SpCell? If yes, please indicate what additional information should be included for SpCell?

Companies	Yes/No	Comments
Samsung	No	-
vivo	Yes	The MAC CE should include all the BWP ID(s) which have consistent uplink LBT failure. The UE could switch its BWP several times. Before the successful RACH to the target BWP, the gNB is not able to know which BWP(s) or how many BWP(s) have the uplink LBT failure. Reporting all the failed BWP ID(s) can help the gNB to avoid switching the UE back to any of the failed BWP(s).
Nokia	No	Simpler to have some format as for SCell. Otherwise, it will make the format quite messy and require further discussions how to indicate e.g. multiple failed BWP etc.
LG	No	The BWP index does not need to be included. The network could be aware of the UL BWPs suffering from the consistent LBT failure problem

		since the NR-U cell operates as TDD. Moreover, considering the time-varying property of the channel congestion situation, it is not much informative for the network to report all the BWPs that have suffered the LBT failure problem long ago.
Lenovo	No	Would be better to have only one common format.
InterDigital	No → Yes?	Same MAC CE format can be used to report LBT failure on any cell, which can contain the cell and bwp information.
OPPO	No	We share the majority views to keep this simple
ZTE	No	We agree that this should be kept simple.
ITRI	No	We share the same view as LG and we also consider it would be better to keep simple.
Panasonic	No	
Asia Pacific Telecom (APT)	No	It's better to align the format of SCell and SpCell, or we may spend more time to discuss how and when to report the BWP(s). The purpose of LBT failure MAC CE for SpCell is to let gNB know that the SpCell suffers from the consistent LBT failure, with this information, gNB could keep the UE staying in the current active BWP (where RA is successful) for a period of time.
Ericsson	No	Agree with Nokia and LG and others.
Charter Communications	No	
MediaTek	No	Agree with Nokia

Rapporteur summary:

Majorities (2/14) agree that we should not include additional information besides cell index(s) information in the MAC CE for SpCell.

Proposal 1 LBT failure MAC CE only includes cell index(s) information even for SpCell.

Regarding the agreement#4:

4. The MAC CE can report multiple failed Cells. The MAC CE format should support multiple entries to indicate all the Cells which have already declared consistent UL LBT failure.

Rapporteur would like to collect views from companies that whether the multiple entries is in a form of bitmap or explicit serving cell index? The following options can be considered for discussion:

- Option 1: the LBT failure MAC CE can be a bitmap with the size, e.g., equal to the number of serving cells support by a CG, each corresponding field can indicate whether the corresponding serving cell has declared consistent LBT failure.
- Option 2: the LBT failure MAC CE can include the serving cell index for which the UE declares consistent LBT failure.
- Option 3: Alike the SCell activation/deactivation MAC CE, the LBT failure MAC CE include a bitmap of with 1 or 4 bytes to indicate the failure cell.

Question 2: Which options above do you prefer regarding the LBT MAC CE format?

Companies	Option	Comments
Samsung	Option 2	-
vivo	Option 3	We consider that we can try to reuse the bitmap as introduced for the

		Scell activation/deactivation MAC CE to indicate multiple failed cells.
Nokia	-	No strong opinion. Either bitmap or cell index works. Why does it depend on CG for option 1 since other UL transmissions are also monitored?
LG	Option 1	We prefer a bitmap to an individual serving cell index, similar to the Scell Activation/Deactivation MAC CE or the Scell BFR MAC CE format. Considering the size of the serving cell index is 5 bits, including a bitmap is more resource-efficient.
Lenovo	Option 1	
InterDigital	Option 2	It's probable that the MAC CE will report LBT failure for one cell most of the time (single entry), so bit map may be more overhead and overdesign.
OPPO	Option1	
ZTE	Option 1	
ITRI	Option1	
Panasonic	Option 2	
Asia Pacific Telecom (APT)	-	Before deciding the LBT MAC CE format, we may need to know how frequently the consistent LBT failure would occur on different serving cells simultaneously. If it is frequent that multiple serving cell would suffer from consistent LBT failure, bitmap is a better choice. Otherwise, serving cell index may be enough.
Ericsson	Option 2	Simpler to only have one MAC CE indicating the serving cell index.
Charter Communications	Option 2	
MediaTek	Option 2	

Rapporteur summary:

14 companies have input, in which 8 companies (1 company does not have strong view) prefer to have a bitmap format, the left prefer to contain serving cell index(s).

Proposal 2 As a baseline, the format of the LBT failure MAC CE is a bitmap to indicate if corresponding serving cell has declared consistent LBT failure.

If you answer to question 1 is "Yes", it means you want to include additional information related to SpCell. Thus, it would be good to indicate your views on what format the LBT failure MAC CE should include those information.

Question 3: If your answer to question 1 is "Yes", what's your view on the format of LBT failure MAC CE on including those additional information? For example, if BWP index should be included, does it included in the LBT failure MAC CE in a similar way as your answer to question 2?

Company	Comments
Samsung	Nothing is needed, as network is aware of the latest BWP index of the UE.
Vivo	The MAC CE can have additional byte to indicate the BWP ID for the failed cell. Or we can have two separate MAC CE(s), i.e. one for the Scell failure and one for the SpCell failure.
Nokia	Introducing multiple BWP index seems to be a bit messy for the format, enough for the NW to know the reason is UL LBT failure.

LG	Agree with Samsung.
Lenovo	Same view as Samsung
InterDigital	Cell index and BWP index are included. BWP index is needed after BWP switching and initiating RACH on the Pcell, to inform the network. BWP index is also needed after declaring LBT failure on Scell, given the BWP inactivity timer can expire after the declaration.
OPPO	Nothing additional is need besides the cell index information
ZTE	Nothing additional is needed as Samsung clarified.
ITRI	We share the same view as Samsung.
Asia Pacific Telecom (APT)	Share same view with Nokia.
Ericsson	Agree with Nokia.
Charter Communications	None
MediaTek	Agree with Nokia

Rapporteur summary:

Only 2 out of 14 companies want to have BWP index in the LBT failure MAC CE, so we will do thing, which has already been reflected in proposal 1.

2.2 LBT failure MAC CE cancellation

Regarding the agreement#5:

5.FFS on how to cancel MAC CE (at the point of assembly) [CB]

Rapporteur thinks the intention is to cancel the triggered MAC CE when LBT failure MAC CE is transmitted in a UL grant successfully. This is very similar to the case for SCell BFR, for which the Scell BFR MAC CE(s) will be cancelled when the BFR MAC CE indicting the corresponding serving cells is successfully transmitted.

However, there was another understanding, as captured in the FFS, that the MAC CE(s) is cancels at the point when the MAC PDU containing the MAC CE is assembled. This option is not well understood at least from rapporteur's perspective, because when UE assembles the MAC PDU containing the MAC CE, it does not mean the MAC CE will be transmitted successfully because UE may also have LBT problem on transmitting the MAC CE. If it's not transmitted, and UE cancels the MAC Ces, it may end up with the network not knowing the LBT failure of the serving cells.

Thus, companies are asked to give the views on which solution do you like, basically, it can be categorized:

- Option 1: triggered LBT failure MAC CE(s) for a serving cell is cancelled upon UE successfully transmit a LBT failure MAC CE indicating the serving cell;
- Option 2: triggered LBT failure MAC CE(s) for a serving cell is cancelled upon a MAC PDU is assembled, in which a MAC CE indicating the serving cell is included.

Question 4: Which option do your support?

Companies	Option	Comments
Samsung	Option 1	Can be captured similar to the BFR MAC CE case.
Vivo	Option 1	We think that all the failure information which are not successfully received by the gNB should be included in the MAC CE. This can be the same as the Scell BFR MAC CE.

Nokia	Option 1	The general principle should be the same MAC CE should not be included in multiple TBs between the time when it is assembled and transmitted regardless of how we model it.
LG	Option 1	This can be aligned with the Scell BFR MAC CE case.
Lenovo	Option 1	Should be specified similar to BFR MAC CE case
InterDigital	Option 1	Though “successfully” is not needed. It should be like BSR MAC CE cancellation, otherwise it can result in multiple reports for the same failure event. For BSR cancellation, the condition in the running CR is: All BSRs triggered prior to MAC PDU assembly shall be cancelled when a MAC PDU is transmitted, regardless of LBT failure indication from lower layers , and this PDU includes
OPPO	Option1	
ZTE	Option 1	
ITRI	Option1	
Panasonic	Option 1	
Asia Pacific Telecom (APT)	-	Based on our understanding, option 1 seems similar to the current BSR cancellation mechanism (i.e., triggered BSR is cancelled when the BSR MAC CE is transmitted). However, based on the running MAC CR for Scell BFR, R2-1915331, the condition to cancel the Scell BFR MAC CE is upon reception of an “ACK” from the network (i.e., UE cancels the Scell BFR MAC CE upon completion of the Scell BFR procedure). Thus, we would like to first clarify whether option 1 refers to the same cancellation condition as BSR or Scell BFR.
Ericsson	None, we have a different view	We think the terminology to use shall not be “triggered LBT failure MAC CE(s) for a serving cell is cancelled”, better would be to use something like what is now in the running MAC CR: consistent LBT is detected per BWP and is declared for an UL BWP. If the UE has declared consistent LBT failure in a BWP, then that BWP shall be considered to have consistent LBT failure until: • In SCell: until either RRC reconfiguration of that SCell, or MAC CE for activation/deactivation of that SCell, or BWP switch for that SCell is received. • In SpCell in a BWP after successful BWP switch: after successful contention resolution in new BWP in the SpCell. • In MCG after RLF: consistent LBT failure can be cleared at the same time a cell is cleared (MAC reset). • In SCG after SCG RLF: consistent LBT failure can be cleared at the same time a cell is cleared (MAC reset).
Charter Communications	Option 1, but ...	While MAC CE reporting should be done once, the status of consistent LBT failure should not be cleared until appropriate action has been taken.
MediaTek		Based on the discussion above, there are two points that need clarification: 1. What does MAC CE cancellation imply? Does it mean that SR is no longer triggered, or that the consistent LBT failure for the BWP is cancelled? 2. What does ‘successfully’ transmit mean? Is it that LBT is successful or an ACK is received? I’d like to reiterate IDC’s comment that BSR cancellation is not conditional on LBT success.

Rapporteur summary:

Majorities prefer to cancel the consistent LBT failure for a serving cell upon UE successfully transmit a LBT failure MAC CE indicating the serving cell.

But it seems there are still some issues which need to be further clarified, so the proposal is:

Proposal 3 Cancel the consistent LBT failure for a serving cell (or BWP(s)) upon UE successfully transmit a LBT failure MAC CE indicating the serving cell.

a. FFS on other conditions.

b. FFS on how to decide “UE successfully transmit a LBT failure MAC CE”.

One another clarification would be good to have regarding agreement #4:

4. The MAC CE can report multiple failed Cells. The MAC CE format should support multiple entries to indicate all the Cells which have already declared consistent UL LBT failure. UL LBT MAC CE includes Cell index(s) where UL LBT failure occurs. FFS if anything additional is needed for SpCell.

The above agreement says MAC CE format should indicate “all” the cells which have already declared consistent UL LBT failure, however, rapporteur thinks the intention was to just include those cells which has not yet been indicated previously. In other words, the cancelled LBT failure MAC CE(s) should not be indicated again in multiple entries of the LBT failure MAC CE.

Question 5: Do you agree the cancelled LBT failure MAC CE(s) should not be indicated again in multiple entries of the LBT failure MAC CE?

Companies	Yes/No	Comments
Samsung	Yes	Only the pending ones would be indicated, and then perhaps nothing needs to be captured as it is obvious?
Vivo	Yes	Not sure why we need to discuss this. It seems quite obvious that a cancelled MAC CE should be indicated again, according to the current MAC specification.
Nokia	-	The MAC CE should indicate the latest status of all the cells. Otherwise it might confuse the NW. Can be further discussed.
LG	Yes	
Lenovo	Yes	
InterDigital	Yes	As in BSR, UE doesn't report BSR again after it's cancelled, given BSR is cancelled upon transmission from a MAC perspective.
OPPO	Yes	
ZTE	Yes	If we go with option 1 for Q4, then, we think it is clear that network will receive the LBT failure indication (unless the MAC CE is lost – which is a case we don't really need to optimise for). So, with this, understanding, we think cancelled LBT failure MAC Ces need not be indicated again.
ITRI	Yes	
Panasonic	Yes	
Asia Pacific Telecom (APT)	Yes/No depends on the outcome of Q2	Depend on the outcome of Q2. From our perspective, in the case where a bitmap is used for an LBT failure MAC CE, indicating the latest status for all the cells that has been declared consistent UL LBT failures is acceptable, since the size of the LBT failure MAC CE is always the same. In contrast, in the case where the serving cell index(es) for which the UE declares consistent LBT failure is reported, indicating the failed cell(s) again could result in a larger LBT failure MAC CE and a waste of UL resource.
Ericsson	Yes	

Charter Communications	Yes	
MediaTek	Yes	

Rapporteur summary:

Majorities confirm that the LBT failure MAC CE only contains those serving cells which has declared consistent LBT failure but not successfully indicated before.

So, the proposal is:

Proposal 4 The LBT failure MAC CE only contains those serving cells which has declared consistent LBT failure but not successfully indicated before.

Another possible issue might be related is that, if there is any case that the UL grant can not accommodate the LBT failure MAC CE?

For example, for the SpCell, the LBT failure MAC CE is agreed to be transmitted during the RACH procedure. However, the UL grant from RAR may not be large enough, the UE would firstly multiplex MAC CE(s) with higher priority, e.g., C-RNTI MAC CE or BSR MAC CE etc., which means the LBT failure MAC CE may not be transmitted in msg3. On the other hand, for SCell cases, the received dynamic grant or configured grant might also not be large enough to accommodate the LBT failure MAC CE.

Question 6: In this case when UL grant can not accommodate the LBT failure MAC CE, do you agree the UE should not cancel the triggered LBT failure MAC CE(s)?

Companies	Yes/No	Comments
Samsung	Yes	Related to the Question 4.
vivo	Yes?	This depends on whether the MAC CE is fixed or not. For variable-size MAC CE, the pending LBT failure MAC CE should not be cancelled if the failure information for the pending LBT failure MAC CE is not included.
Nokia	Yes	
LG	Yes	
Lenovo	Yes	
InterDigital	Yes	It remains pending till cancelled.
OPPO	Yes	
ZTE	Yes	
ITRI	Yes	
Panasonic	Yes	
Asia Pacific Telecom (APT)	Yes	If the UL resource cannot accommodate the LBT failure MAC CE, it will not be generated, so it makes sense to not cancel it.
Ericsson	Yes	
Charter Communications	Yes	
MediaTek	Yes	This raises the question as to whether an SR is pending following the RACH procedure, as the LBT failure MAC CE has not been cancelled.

Rapporteur summary:

All companies confirm when UL grant can not accommodate the LBT failure MAC CE, the UE should not cancel the triggered LBT failure MAC CE(s).

So, the proposal is:

Proposal 5 If UL grant can not accommodate the LBT failure MAC CE, the UE should not cancel the triggered LBT failure MAC CE(s).

2.3 Others

There was an agreement from last meeting:

The UE switches to another BWP and initiates RACH upon declaration of consistent LBT failure on PCell or PSCell if there is another BWP with configured RACH resources.

Basically, when BWP is switched, according to the current behaviour, UE would (re-)initiate the suspended type 1 configured grant. However, it's not desired behaviour for the UE to transmit using type 1 configured grant since network is even not aware of the BWP switching due to consistent LBT failure on SpCell. Thus, rapporteur wants to confirm the understanding that when UE switches to another BWP and initiates RACH, it means ONLY RACH is initiated.

Question 7: When UE switches to another BWP and initiate RACH upon declaration of consistent LBT failure on SpCell, do you agree ONLY RACH is initiated?

Companies	Yes/No	Comments
Samsung	Yes, in principle.	-
vivo	Yes	Triggering RACH seems more aligned with previous RAN2 agreements.
Nokia	Yes	
LG	Yes	
Lenovo	Yes	
InterDigital	Yes	
OPPO	Yes	
ZTE	Yes	
ITRI	Yes	
Panasonic	Yes	
Asia Pacific Telecom (APT)	Yes	
Ericsson	Yes	
Charter Communications	Yes	
MediaTek	Yes	

Rapporteur summary:

All companies confirm when UE switches to another BWP and initiate RACH upon declaration of consistent LBT failure on SpCell, ONLY RACH is initiated.

So, the proposal is:

Proposal 6 When UE switches to another BWP and initiate RACH upon declaration of consistent LBT failure on SpCell, ONLY RACH is initiated

3 Conclusion

Based on the discussion in section 2 we propose the following:

- | | |
|-------------------|--|
| Proposal 1 | LBT failure MAC CE only includes cell index(s) information even for SpCell. |
| Proposal 2 | As a baseline, the format of the LBT failure MAC CE is a bitmap to indicate if corresponding serving cell has declared consistent LBT failure. |
| Proposal 3 | Cancel the consistent LBT failure for a serving cell (or BWP(s)) upon UE successfully transmit a LBT failure MAC CE indicating the serving cell.
a. FFS on other conditions.
b. FFS on how to decide “UE successfully transmit a LBT failure MAC CE”. |
| Proposal 4 | The LBT failure MAC CE only contains those serving cells which has declared consistent LBT failure but not successfully indicated before. |
| Proposal 5 | If UL grant can not accommodate the LBT failure MAC CE, the UE should not cancel the triggered LBT failure MAC CE(s). |
| Proposal 6 | When UE switches to another BWP and initiate RACH upon declaration of consistent LBT failure on SpCell, ONLY RACH is initiated |

4 Annex1 Text proposal

TBD.

5 Annex2

In RAN2#105bis meeting, RAN2 agreed to introduce a mechanism to handle UL LBT failure:

- ⇒ **Adopt a mechanism in MAC spec to handle the UL LBT failure, where “consistent” UL LBT failures (at least for UL transmissions of SR, RACH, PUSCH) are used for problem detection**

In RAN2#107 meeting, further agreements on the UL LBT failures have been agreed:

- ⇒ **L2 LBT failure mechanism take into account any LBT failure regardless UL transmission type.**
- ⇒ **The UL LBT failure mechanism will have the same recovery mechanism for all failures regardless UL transmission type**

Baseline Mechanism, further enhancements not precluded:

- ⇒ **A “threshold” for the maximum number of LBT failures which triggers the “consistent” LBT failure event will be used.**
- ⇒ **Both a timer and a counter are introduced, the counter is reset when timer expires and incremented when UL LBT failure happens**
- ⇒ **The timer is started/restarted when UL LBT failure occur.**

Chair summary on the baseline mechanism: The BFD inspired mechanism seems to be supported by many, but there is also some concerns. Agree it as a baseline mechanism to allow further review later, to understand whether further enhancements are needed.

- ⇒ **UL LBT failures are detected per BWP**
- ⇒ **The UE will report the occurrence of consistent UL LBT failures on PSCell and SCells. The assumption is to reuse SCell failure reporting for BF**

Then in RAN2#107bis meeting, we have the following agreements:

- ⇒ MAC relies on reception of a notification of UL LBT failure from the physical layer to detect a consistent UL LBT failure.
- ⇒ The UE switches to another BWP and initiates RACH upon declaration of consistent LBT failure on PCell or PSCell if there is another BWP with configured RACH resources.
- ⇒ The UE shall perform RLF recovery if the consistent UL LBT failure was detected on the PCell and UL LBT failure was detected on “N” possible BWP. “
- ⇒ When consistent uplink LBT failures are detected on the PSCell, the UE informs MN via the SCG failure information procedure after detecting a consistent UL LBT failure on “N” BWPs.
- ⇒ “N” is the number of configured BWPs with configured PRACH resources. If N is larger than one it is up to the UE implementation which BWP the UE selects.
- ⇒ When consistent uplink LBT failures are detected on an SCell, a new MAC CE to report this to the node where SCell belongs to is used. FFS whether the MAC CE can be used to report failure on PCell