**3GPP TSG RAN WG1#102-e R1-200xxxx**

**e-Meeting, August 17th – 28th, 2020**

**Agenda Item: 7.2.2.1.2**

**Source: Moderator (Lenovo)**

**Title: Email discussion [102-e-NR-unlic-NRU-DL\_Signals\_and\_Channels-04] on reply LS for R1-2005220**

**Document for: Discussion, Decision**

# Scope and discussion status from the preparation phase

According to the guidance by RAN1 (vice-)chairman, this email discussion to approve TPs is to be finalised by **20 August**.

Related contributions:

* R1-2005326 Draft reply on LS on Clarification on UE behavior after receiving the MAC CE deactivation command for semi-persistent CSI reporting in NR-U vivo
* R1-2006759 Discussion of the LS about cancelled ACK for MAC deactivation Qualcomm Incorporated
* R1-2006940 Discussion on UE behavior after receiving the MAC CE deactivation command for semi-persistent CSI reporting in NR-U Huawei, HiSilicon
* R1-2006093 DL signals and channels for NR-U (Section 4) Samsung

[102-e-NR-unlic-NRU-DL\_Signals\_and\_Channels-04] Email discussion/approval of reply LS for R1-2005220 by 08/20 – Alex (Lenovo)

# Summary of Discussion and Suggestions

During the discussion, companies showed support for the following solutions:

**Option 1** (Supported by: Nokia, NSB, LG, ZTE, Sanechips, Huawei, HiSilicon)
If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK

**Option 1bis** (Supported by: vivo)
If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, however it is up to UE implementation whether it continues measure and report L1-RSRP or report stale L1-RSRP until it successfully transmits HARQ-ACK

**Option 4** (Supported by: Qualcomm, Ericsson, MediaTek, CATT)
For semi-persistent CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failure, the UE performs deactivation at the original MAC action time.

In addition, a timeline issue has been brought up, regarding how soon a UE is able of stopping PUCCH transmissions for the L1-RSRP after transmitting the deactivation acknowledgement, i.e. if 3 ms is too ambitious considering reacting to the LBT status for the transmission of the deactivation acknowledgement.

FL suggestion: Consider the following UE behaviour for further discussion to relieve the UE of measurements while keeping the reporting:

|  |
| --- |
| If a UE cannot transmit HARQ-ACK for a MAC-CE deactivation of SP-CSI reports with L1-RSRP due to UL CCA failure,* the UE stops measuring and computing L1-RSRP; and
* the UE transmits L1-RSRP SP-CSI reports with a NOT\_VALID value until [3] ms after it successfully transmits HARQ-ACK for the deactivation
 |

# Discussion

From R1-2005220:

|  |
| --- |
| RAN4 is currently discussing NR-U RRM requirements. During RAN4 #95 it was agreed to clarify the UE behaviour in case of receiving the MAC-CE deactivation command for semi-persistent CSI reporting, in case of UL LBT failure for sending the HARQ-ACK.The following options have been discussed in RAN4 #95e:• **Option 1**: If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK• **Option 2**: For semi-persistent CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failures, UE continues the L1-RSRP measurements but delay the L1-RSRP reporting. If UE does not receive deactivation command during the delay period, UE restarts to transmit L1-RSRP reporting. • **Option 3**: Delay the L1-RSRP reporting when the HARQ feedback cannot be transmitted after receiving the MAC CE deactivation command. A time limit shall be defined when the L1-RSRP reporting is delayed. When exceeding the time limits, UE shall abandon the stored measurement results, where the time limit is FFS. The UE shall also abandon the measurement results when the HARQ feedback is retransmitted for the deactivation commandRAN4 respectfully asks RAN1 to clarify the UE behaviour, with respect to semi-persistent CSI reporting, in case there is UL LBT failure for sending the HARQ-ACK for the MAC-CE deactivation command.**To RAN1:**RAN4 respectfully asks RAN1 to:* Clarify the UE behaviour, with respect to semi-persistent CSI reporting, in case there is UL LBT failure for sending the HARQ-ACK for the MAC-CE deactivation command.
 |

Qualcomm is suggesting a fourth option:

**Option 4**: For semi-persistent CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failure, the UE performs deactivation at the original MAC action time.

|  |
| --- |
| **Based on submissions to this meeting, it seems Option 1 with a potential modification suggested by vivo is favoured.** **Therefore please consider whether Option 1 with or without vivo's modification is acceptable as a reply from RAN1.****Option 1:** If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK**Option 1bis (vivo):** If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, however it is up to UE implementation whether it continues measure and report L1-RSRP or report stale L1-RSRP until it successfully transmits HARQ-ACK |
| **Company** | **Comment** |
| **Nokia, NSB** | **Option 1 is our preference.** |
| **Qualcomm** | **We prefer Option 4. The other options require tight phy and MAC integration that MAC behavior will need to keep checking phy events. We believe it is important to have a simple interface between MAC and phy. So far, we are not aware of any other MAC mechanism that relies on phy layer A/N is delivered or not. We don’t believe we should introduce this now.** **More detail can be found in our paper R1-2006759, quoted in 4.2 below.** |
| **Ericsson** | **We also prefer Option 4 – it is simple and clean. Option 1 or 1bis does not make sense – why would the UE continue measuring and reporting if it has received the MAC-CE deactivation?****Consider licensed operation – the HARQ-ACK from the UE can always be missed by the gNB which is a similar situation as the UE not being able to transmit the HARQ-ACK due to LBT failure. From a gNB perspective, since it has deactivated the reporting, the UE should definitely not continue measuring and reporting.****So, licensed and unlicensed, can and should be treated in the same way – the measurement/reporting procedure should not depend on LBT outcome corresponding to the HARQ ACK transmission. This general principle is assumed in many other places in the spec.** |
| **MediaTek** | **Option 4 is preferred due to no implementation and spec impact** |
| **LG** | **Option 1 is preferred to avoid potential ambiguity between UE and gNB in terms of UCI multiplexing.****In case with Option 4, since the reason of not detecting ACK (whether UE missed DCI to schedule MAC PDSCH or UE detected DCI but failed to acquire channel by LBT) is uncertain in the gNB side, whether SP-CSI PUCCH is transmitted and whether SP-CSI is multiplexed with other UCI on new PUCCH would be ambiguous between UE and gNB.** |
| **ZTE, Sanechips** | **We prefer Option 1 due to it will not cause mismatch between gNB and UE side.****For Option 4, we has the following comments: how can the gNB know whether the UE has performed deactivation operation, or gNB does not know whether UE has received the deactivation indication or UE cannot transmit HARQ-ACK due to LBT failure. Based on this, we don’t think option 4 is a good candidate.** |
| **Huawei, HiSilicon** | **Option 1 is our preference. It aligns with the traditional rules that UE keep previous state when ACK is not sent. In unlicensed band, the chances of gNB failing to detect HARQ-ACK feedback would be higher due to LBT failure at UE side. gNB will continue to transmit CSI-RS and reserve UL resource for feedback before correctly received ACK. option 1 can make full use of the gNB’s transmission and keep the measurement up to date instead of just wasting the measurement opportunities in vain.**  |
| **CATT** | **Option 4 is our preference. Given the network intends not to receive semi-persistent CSI any further, UE can simply terminate CSI measurement/reporting as instructed by the MAC-CE.**  |
| **vivo** | **Option1bis is our preference, this is somehow a compromise solution between option1 and option4. In the case of UE not being able to transmit HARQ-ACK due to LBT failure, even though gNB continues to transmit CSI-RS, UE is not able to transmit SP-CSI report due to LBT failure as well thus it is only the one SP-CSI report that is concerned. With option1bis the UE also terminate, the difference the UCI payload when UE can successfully transmit HARQ-ACK.**  |

# Related contributions

## R1-2005326 Draft reply on LS on Clarification on UE behavior after receiving the MAC CE deactivation command for semi-persistent CSI reporting in NR-U vivo

RAN1 would like to thank RAN4 for the LS R4-2008576 on Clarification of UE behavior after receiving the MAC CE deactivation command for semi-persistent CSI reporting in NR-U. From RAN1 perspective all three options can work, however different options will introduce different UE behaviors and will have different level of spec impact. From gNB perspective, there is no difference in UL CCA failure or unsuccessful detection of HARQ-ACK transmitted from an UE. In the case of UL CCA failure, UE continues to be in previous state however it is up to UE implementation whether it continues measurement or report stale L1-RSRP until it successfully transmits HARQ-ACK. Since gNB deactivated semi-persistent CSI reporting, it doesn’t expect UE to report up to date L1-RSRP and UE can save power by ceasing measurement. When the UE reports stale L1-RSRP after successful UL CCA, the UE can successfully transmit HARQ-ACK as well, that means the UE will transmit stale L1-RSRP at most once. RAN1 agreed to slightly modified Option1’ as below.

Option 1’: If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, however it is up to UE implementation whether it continues measure and report L1-RSRP or report stale L1-RSRP until it successfully transmits HARQ-ACK

## R1-2006759 Discussion of the LS about cancelled ACK for MAC deactivation Qualcomm Incorporated

In general, the standard defined multiple inter-connected requirements that define UE behavior for certain events that often have causal relationship with other events. Some of these describe events that take place due to an uplink transmission or a request for uplink transmission. In general, it is not always clear what the UE is required to do when the UL transmission, though requested, does not take place. Here we list scenarios that result in cancellation/dropping of UL transmissions.

An UL transmission may be partially or fully dropped or cancelled due to

* Prioritization (Rel-16 only)
* UL skipping (Rel-16 only)
* Cancellation (CI) (Rel-16 only)
* Overlap with DL
* Power limitation
* Measurement gap
* Conflict with SL (Rel-16 only)
* Etc.

In the following, we list a number of UE requirements that a current UL transmission has an effect on:

* TPC accumulation
	+ The PC command in the grant is included in the TPC accumulation
* Power scaling on other CCs
	+ The transmit power on other CCs is scaled in case of power limitation due to the current transmission
* MPR on other CCs (e.g. intra-band)
	+ The MPR on other CCs is changed by the presence of the current transmission
* Half duplex handling
	+ The Rel-16 TEI on enhanced half-duplex conflict resolution takes into account the current transmission (What happens when the current transmission would be prioritized over DL Rx but that the current transmission is cancelled/dropped?)
* NDI interpretation
	+ The NDI of the next grant is taken relative to the current transmission’s NDI
* UCI multiplexing
	+ The current PUCCH/PUSCH transmission has UCI multiplexed that would be transported in other channels without the current transmission. (Will the UCI be moved to a different channel if the current transmission is cancelled/dropped?)
* Supported max data rate
	+ The maximum number of info bits a UE can transmit is limited by the scaling factor signaled in the UE capability. (Does a cancelled transmission count in the total number of transmitted bits in a slot when comparing to the UE capability?)
* CPU determination
	+ CSI Processing unit occupancy is reset due to the current PUCCH/PUSCH transmission when it carries the CSI report. (Will the CPU reset if the current transmission carrying the CSI is cancelled/dropped?)
* Counting of active CSI resources
	+ Active CSI resource occupancy is counted until the current PUCCH/PUSCH transmission when it carries the CSI report. (Will the CPU reset if the current transmission carrying the CSI is cancelled/dropped?)
* PHR in re-Tx
	+ When a PUSCH carrying PHR is retransmitted, the UE includes the same PHR in the retransmission as in the original transmission. (Should the UE include the original PHR when the original transmission was cancelled/dropped, or should it include a new PHR?)
* HARQ out-of-order
	+ The current transmission may violate HARQ out-of-order rules, creating an error case. (What happens if the current UL transmission gets cancelled/dropped? Does the error case remain, or is the UE required to perform operation as normal?)
* CA-based SRS switching preemption
	+ In CA-based SRS switching, the target SRS is dropped if the source CC would have higher priority transmission, such as PUCCH or PUSCH with UCI (What happens when the transmission on the source CC is cancelled/dropped?)
* SL procedures (due to dropped SL)
	+ SL transmission may be dropped due to a current SL transmission.
* SRS for codebook based
	+ The TPMI refers to the current (latest) transmitted instance of the SRS resource. (Does the TPMI refer to a cancelled/dropped transmission, or to the previous one?)
* SRS for non-codebook based UL MIMO
	+ The SRI refers to the current (latest) transmitted instance of the SRS resource. (Does the SRI refer to a cancelled/dropped transmission, or to the previous one?)
* Interpretation of reserved MCS
	+ The TBS corresponding to the reserved MCS values (MCS=29, 30 31) refers to the previous transmission. (Should a cancelled/dropped transmission count as the previous transmission?)
* UL Tx switching state
	+ The current transmission is taken into account in the Case 1 vs. Case 2 determination for Rel-16 UL Tx switching.
* Determination of duplex direction
	+ The current transmission is taken into account in the Rel-15 duplex direction determination. (What will be the duplex direction when the current semi-static or dynamic UL transmission (semi-static or dynamic) would change a symbol from X to U but that UL transmission is cancelled/dropped?)
* **MAC CE action time**
	+ **The MAC command action time is 3 ms after the ACK is sent for the PDSCH carrying the MAC CE. (Should the MAC command take effect at the action time if the ACK is cancelled/dropped?)**
* BWP inactivity timer
	+ The current transmission resets the timer used to determine when to switch back to the default UL BWP. (Should a cancelled/dropped transmission reset the BWP inactivity timer?)
* DRX inactivity timer
	+ Defined by MAC. (Should a cancelled/dropped transmission reset the DRX inactivity timer?)
* Data inactivity timer
	+ Defined by MAC. (Should a cancelled/dropped transmission reset the data inactivity timer?)
* SCell deactivation timer
	+ Defined by MAC. (Should a cancelled/dropped transmission reset the SCell deactivation timer?)
* RTT timer
	+ Defined by MAC. (Should a cancelled/dropped transmission start the RTT timer?)
* HARQ attempt count
	+ Defined by MAC. (Should a cancelled/dropped transmission be counted as a HARQ attempt?)
* BSR
	+ The current transmission is counted in the buffer status. (Should a cancelled/dropped transmission be counted?)
* PHR calculation
	+ The current transmission impacts the PHR calculation, i.e. the power on other CCs may be changed due to MPR, or the current transmission changes the actual vs. virtual PHR decision. (Should the PHR be calculated after cancellation/dropping?)

Before describing our understanding of the UE requirements, we would like to discuss the notation we used.

We distinguish ‘Fast Cancellation’ and ‘Slow Cancellation’ defined as follows, respectively:

**Fast cancellation:**

* **The trigger for cancellation of an UL transmission is received later than *T*proc before the start of the first symbol of the UL transmission**
	+ **May result in a partial cancellation**

**Slow cancellation:**

* **The trigger for cancellation of an UL transmission is received earlier than *T*proc before the start of the first symbol of the UL transmission**
	+ **Results in full cancellation**

Fast cancellation and slow cancellation are illustrated in Figure 1 below.



**Figure 1. Illustration of fast cancellation and slow cancellation**

The UE requirements are denoted as either ‘T’, ‘N’ or ‘X’, which are defined as follows.

**Procedure ‘T’:**

* **The effect is the same as if cancellation did not occur, i.e. the transmission is considered to have taken place**

**Procedure ‘N’:**

* **The effect is the same as if the transmission has not been requested, i.e. the transmission is considered have not been taking place**

**Procedure ‘X’:**

* **The UE may follow either ‘T’ or ‘N’ based on UE implementation**

Next, we summarize our understanding of the categorization of the UE procedures for each of the requirements listed before

|  |  |  |  |
| --- | --- | --- | --- |
| **Procedure** | **Fast cancel**  | **Slow cancel** | **Notes** |
| TPC accumulation | T | T | In case of group TPC (after deadline), it is ‘X’ |
| Power scaling on other CCs | T | N |  |
| MPR on other CCs (e.g. intra-band) | T | N |  |
| Half duplex handling | T | N |  |
| NDI interpretation | T | T |  |
| UCI multiplexing | T | T | Already specified in Rel-16, it is undefined in Rel-15 |
| Supported max data rate | T | N | Already specified |
| CPU determination | T | T | Already specified |
| Counting of active CSI resources | T | T |  |
| PHR in re-Tx | T | T |  |
| HARQ out-of-order | T | T |  |
| CA-based SRS switching preemption | T | N |  |
| SL procedures (due to dropped SL) | - | - | Already specified |
| SRS for codebook based | N | N |  |
| SRS for non-codebook based | N | N |  |
| Interpretation of reserved MCS | T | T |  |
| UL Tx switching state | T | N |  |
| Determination of duplex direction | T | N |  |
| **MAC CE action time** | **T** | **T** | **Related to RAN4 LS** |
| BWP inactivity timer | T | N | Proposed specification change |
| DRX inactivity timer | T | N | Proposed specification change |
| Data inactivity timer | T | N | Proposed specification change |
| SCell deactivation timer | T | N | Proposed specification change |
| RTT timer | N | N |  |
| HARQ attempt count | T | N |  |
| BSR | T | N | Proposed specification change |
| PHR calculation | T | N |  |

As it can be seen in the table above, for the case of MAC CE action time, the UE consider the HARQ-ACK having been transmitted, therefore the UE stops transmitting the semi-persistent CSI on PUCCH upon deactivation 3 ms after the HARQ-Ack opportunity, irrespective of whether ACK was not sent due to LBT failure. The reason for this behavior is that the UE has already started the deactivation procedure in order to meet the 3 ms timeline, even before the LBT check. Therefore, we make the following proposals:

**Proposal 1: Send a response to the RAN4 LS [1] recommending a new option instead of Options 1 through 3:**

* **Option 4: For semi-persistent CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failure, the UE performs deactivation at the original MAC action time.**

**Proposal 2: Discuss the other requirement cases for cancelled/dropped UL transmission described in this contribution.**

**Proposal 3: Change the specification, so that when the processing time requirements are met, a cancelled transmission is not taken into account in the determination of the following:**

* **BWP inactivity timer**
* **DRX inactivity timer**
* **Data inactivity timer**
* **SCell deactivation timer**
* **RTT timer**
* **HARQ attempt count**
* **BSR**

**Send an LS to RAN2 regarding the above.**

## R1-2006940 Discussion on UE behavior after receiving the MAC CE deactivation command for semi-persistent CSI reporting in NR-U Huawei, HiSilicon

In NR Rel-15, for a UE configured with CSI resource setting(s) where the higher layer parameter ***resourceType*** set to ***'semiPersistent'***, following behavior is defined when the UE receives a deactivation command.

|  |
| --- |
| **Section 5.2.1.5.2 in TS 38.214**when a UE receives a deactivation command, as described in clause 6.1.3.12 of [10, TS 38.321], for activated CSI-RS/CSI-IM resource set(s) associated with configured CSI resource setting(s), and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the deactivation command, the corresponding actions in [10, TS 38.321] and UE assumption on cessation of CSI-RS/CSI-IM transmission corresponding to the deactivated CSI-RS/CSI-IM resource set(s) shall apply starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. |

For operation with shared spectrum, UE might suffer LBT failure and cannot transmit HARQ-ACK on the scheduled PUCCH resource. There are following three options provided by RAN4 to align the behavior between UE and gNB.

|  |
| --- |
| • Option 1: If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK• Option 2: For semi-persistent CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failures, UE continues the L1-RSRP measurements but delay the L1-RSRP reporting. If UE does not receive deactivation command during the delay period, UE restarts to transmit L1-RSRP reporting. • Option 3: Delay the L1-RSRP reporting when the HARQ feedback cannot be transmitted after receiving the MAC CE deactivation command. A time limit shall be defined when the L1-RSRP reporting is delayed. When exceeding the time limits, UE shall abandon the stored measurement results, where the time limit is FFS. The UE shall also abandon the measurement results when the HARQ feedback is retransmitted for the deactivation command |

It can be observed that UE continues measurement on CSI-RS in all of the three options and only difference is whether and how UE should reporting the measurement. From the gNB perspective, it is impossible to identify whether the detection failure of PUCCH is due to LBT failure or low SINR. Generally, the DTX will be treated as NACK and gNB will assume UE maintain in previous state and continue to transmit CSI-RS and receiving measurement report on the pre-configured uplink resource from UE until retransmit the deactivation MAC CE. Option 1 allows UE to make full use of CSI-RS and allocated uplink resource to keep the CSI-RS-based measurement up-to-date. Option 1 also has the least standard impact from Rel-15 behavior. For option 2 and 3, the preconfigured CSI-RS and uplink resource for feedback might be wasted while energy for measurement and reporting at UE side could be saved.

***Observation: All three options provided by RAN4 can solve the ambiguity issue between gNB and UE on the CSI-RS-based measurement and reporting. Option 1 has least standard impact from Rel-15.***

## R1-2006093 DL signals and channels for NR-U (Section 4) Samsung

During RAN4 #95-e meeting, it was discussed the UE behavior in case of receiving the MAC CE deactivation command for SP-CSI reporting, especially when UL LBT for sending the HARQ-ACK is failed.

Following three options were discussed in RAN4,

* Option 1: If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK
* Option 2: For SP-CSI reporting with PUCCH, if UE cannot transmit HARQ-ACK on the MAC CE deactivation due to the UL LBT failures, UE continues the L1-RSRP measurements but delay the L1-RSRP reporting. If UE does not receive deactivation command during the delay period, UE restarts to transmit L1-RSRP reporting
* Option 3: Delay the L1-RSRP reporting when the HARQ feedback cannot be transmitted after receiving the MAC CE deactivation command. A time limit shall be defined when the L1-RSRP reporting is delayed. When exceeding the time limits, UE shall abandon the stored measurement results, where the time limit is FFS. The UE shall also abandon the measurement results when the HARQ feedback is retransmitted for the deactivation command

When gNB does not receive HARQ-ACK for MAC CE deactivation command, gNB can assume one of the followings 1) UE fails to access channel for sending the HARQ-ACK, or 2) UE does not receive MAC CE deactivation command. Since the gNB cannot distinguish 1) or 2), gNB would send MAC CE deactivation command again until it receives HARQ-ACK for MAC CE deactivation command with the assumption that UE is assumed it is activated. Therefore, to be consistent operation between gNB and UE, Option 1 is more preferable.

**Proposal 3: If UE cannot transmit HARQ-ACK on MAC-CE deactivation due to UL CCA failure, UE continues to be in its previous state, i.e., it should measure and report L1-RSRP until it successfully transmits HARQ-ACK (Option 1)**