3GPP TSG RAN WG2 Meeting #115-e R2-21XXXXX

e-Meeting, 9th – 27th August, 2021

**Agenda item: 6.1.3.1**

**Source: Samsung**

**Title: Report of Offline 020: MAC II**

**Document for: Discussion and Decision**

# 1 Introduction

This document is a discussion report of the following offline discussion:

* [AT115-e][020][NR16] MAC II (Samsung)

Scope: Take on-line outcome into account, Treat remaining aspects, determine agreeable parts and agree CRs Treat R2-2108257, R2-2107197, R2-2107610, R2-2108094, R2-2108095, R2-2108787, R2-2107735, R2-2107200, R2-2108283, R2-2108284, R2-2108285,

Intended outcome: Report, Agreed CRs.

Deadline: On-line first, Schedule 1

R2-2108257 Clarification of PUCCH resource in LCH-based Prioritization    Samsung    CR    Rel-16    38.321    16.5.0    1141    -    F    NR\_IIOT-Core

R2-2107197 Overlapping UCI and PUSCH    CATT    discussion    NR\_IIOT-Core

R2-2107610 UCI multiplexing and overlapped SR/PUSCH    Apple    CR    Rel-16    38.321    16.5.0    1132    -    F    NR\_newRAT-Core

[R2-2108094](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108094.zip) Corrections to retransmission of configured grant with empty buffer    Ericsson, MediaTek Inc.    discussion

R2-2108095 Corrections to retransmission of configured grant with empty buffer    Ericsson, MediaTek Inc.    CR    Rel-16    38.321    16.5.0    1136    -    F    NR\_IIOT-Core

[R2-2108787](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108787.zip) UCI on retransmission uplink grant    LG Electronics UK    discussion    TEI16

R2-2107735 Ignoring the retransmission grant overlapped with UCI    OPPO    discussion    Rel-16    TEI16

R2-2107200 Handling of pending empty PDUs after UCI multiplexing    CATT    discussion    NR\_IIOT-Core

[R2-2108283](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108283.zip) Autonomous Transmission of MAC PDU with only Padding or Periodic BSR    Nokia, Nokia Shanghai Bell    discussion    Rel-16    NR\_IIOT-Core

[R2-2108284](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108284.zip) Avoiding autonomous transmission of MAC PDU with only Padding BSR or unuseful Periodic BSR – Option 1    Nokia, Nokia Shanghai Bell    CR    Rel-16    38.321    16.5.0    1146    -    F    NR\_IIOT-Core

[R2-2108285](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108285.zip) Avoiding autonomous transmission of MAC PDU with only Padding BSR or unuseful Periodic BSR – Option 2    Nokia, Nokia Shanghai Bell    CR    Rel-16    38.321    16.5.0    1147    -    F    NR\_IIOT-Core

# 2 Contact Information

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# 3 Phase 1 Discussion

## 3.1 Issue #1: NOTE for the final PUCCH resource

R2-2108257 Clarification of PUCCH resource in LCH-based Prioritization    Samsung    CR    Rel-16    38.321    16.5.0    1141    -    F    NR\_IIOT-Core

R2-2107197 Overlapping UCI and PUSCH    CATT    discussion    NR\_IIOT-Core

R2-2107610 UCI multiplexing and overlapped SR/PUSCH    Apple    CR    Rel-16    38.321    16.5.0    1132    -    F    NR\_newRAT-Core

The contributions above propose to capture the last meeting’s RAN2 agreement as follows:

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| * We go with Understanding 1: MAC does not use knowledge of UCI multiplexing when MAC executes LCH based prioritization and deciding when to transmit SR (i.e. in the context of the cases listed in R2-2105781) * [016] MAC CR is postponed (until R1 has made more progress). |

For careful checking for better TP, MAC CR has been postponed in the last meeting. In this meeting, three companies provided CRs, which all propose to have a NOTE in MAC specification.

R2-2108257 (Samsung)

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| 5.4.1 and 5.4.4 (Same NOTE)  NOTE Y: If the MAC entity is configured with *lch-basedPrioritization,* the MAC entity does not consider UCI multiplexing in the physical layer when determining whether the PUSCH duration of an uplink grant overlaps with the PUCCH resource for the SR transmission. |

R2-2107197 (CATT)

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| 5.4.1  NOTE X: If the MAC entity is configured with *lch-basedPrioritization*, the MAC entity does not take the UCI multiplexing in the physical layer into account when determining whether the PUSCH duration of an uplink grant overlaps with the PUCCH resource for an SR transmission.  5.4.4  NOTE Y: If the MAC entity is configured with *lch-basedPrioritization*, the MAC entity does not take the UCI multiplexing in the physical layer into account when determining whether the PUCCH resource for the SR transmission occasion overlaps with the PUSCH duration of an uplink grant and whether the physical layer can signal the SR on one valid PUCCH resource for SR. |

R2-2107610 (Apple)

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| 5.4.1  NOTE 8: If the MAC entity is configured with *lch-basedPrioritization* and the PUCCH resource with an SR transmission overlaps with other UCI(s) according to the procedure specified in TS 38.213 [6] clause 9.2.5, the MAC entity determines a prioritized SR transmission for the PUCCH resource with an SR transmission that is configured by RRC.  5.4.4  NOTE 5: If the MAC entity is configured with *lch-basedPrioritization* and the PUCCH resource for the SR transmission occasion for the pending SR overlaps with other UCI(s) according to the procedure specified in TS 38.213 [6] clause 9.2.5, the MAC entity determines a prioritized SR transmission for the valid PUCCH resource for SR that is configured by RRC. |

Since only detail of TP is different and there was no objection to have a NOTE during the RAN#114-e offline discussion, the rapporteur would suggest to agree to have NOTEs for 5.4.1 and 5.4.4, as proposed by those CRs. The rapporteur would start the discussion with compromise TP considering all three CRs.

**Q1) Do companies agree to have the following NOTE for subclause 5.4.1 UL Grand Reception?**

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| NOTE X: If the MAC entity is configured with *lch-basedPrioritization*, the MAC entity does not take the UCI multiplexing according to the procedure specified in TS 38.213 [6] into account when determining whether the PUSCH duration of an uplink grant overlaps with the PUCCH resource for an SR transmission. | | |
| **Company** | **Yes/No** | **Comment (or any suggestion)** |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| MediaTek | Yes | Minor wording suggestion to remove ‘the’, as below:  *…the MAC entity does not take ~~the~~ UCI multiplexing according to the procedure specified in TS 38.213…* |
| Lenovo | Yes | Agree with MTK’s improved wording |
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**Q2) Do companies agree to have the following NOTE for subclause 5.4.4 Scheduling Request?**

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| NOTE Y: If the MAC entity is configured with *lch-basedPrioritization*, the MAC entity does not take the UCI multiplexing according to the procedure specified in TS 38.213 [6] into account when determining whether the PUCCH resource for the valid SR transmission occasion overlaps with the PUSCH duration of an uplink grant. | | |
| **Company** | **Yes/No** | **Comment (or any suggestion)** |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| MediaTek | Yes | Same wording suggestion as Q1 |
| Lenovo | Yes |  |
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## 3.2 Issue #2: Retransmission resource for a skipped CG

[R2-2108094](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108094.zip) Corrections to retransmission of configured grant with empty buffer    Ericsson, MediaTek Inc.    discussion

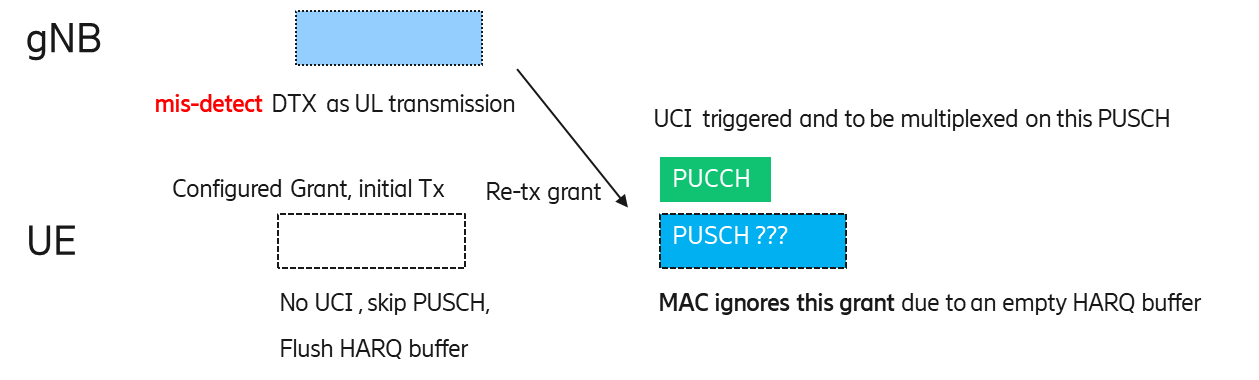
R2-2108095 Corrections to retransmission of configured grant with empty buffer    Ericsson, MediaTek Inc.    CR    Rel-16    38.321    16.5.0    1136    -    F    NR\_IIOT-Core

[R2-2108787](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108787.zip) UCI on retransmission uplink grant    LG Electronics UK    discussion    TEI16

R2-2107735 Ignoring the retransmission grant overlapped with UCI    OPPO    discussion    Rel-16    TEI16

[R2-2108094, R2-2108095] points out that MAC specification does not follow a RAN1 agreement on UL skipping. As shown in the figure below, a problematic scenario is

* CG is skipped due to the absence of pending data and UCI. HARQ buffer is flushed.
* gNB mis-detects the skipped CG. (i.e. false alarm/false positive)
* gNB allocates a retransmission grant by CS-RNTI for the skipped CG. The PUSCH duration of the retransmission grant overlaps with UCI. This UCI should be multiplexed in the PUSCH. However, the current MAC specification ignores the retransmission grant.



[R2-2108094, R2-2108095 (Ericsson, MediaTek)] propose to allow the initial transmission for UL grant addressed to CS-RNTI, if the HARQ buffer is empty, as follows. This is also to align the operations between the dynamic grant and the configured grant. For retransmission of a dynamic grant, the same problem due to the gNB false positive occurs, but the MAC spec treats it as a new transmission.

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| For each uplink grant, the HARQ entity shall:  1> identify the HARQ process associated with this grant, and for each identified HARQ process:  2> if the received grant was not addressed to a Temporary C-RNTI on PDCCH, and the NDI provided in the associated HARQ information has been toggled compared to the value in the previous transmission of this TB of this HARQ process; or  2> if the uplink grant was received on PDCCH for the C-RNTI and the HARQ buffer of the identified process is empty; or  2> if the uplink grant received on PDCCH was addressed to CS-RNTI and if the HARQ buffer of the identified process is empty; or  … (omitted)  2> if the uplink grant is part of a bundle of the configured uplink grant, and may be used for initial transmission according to clause 6.1.2.3 of TS 38.214 [7], and if no MAC PDU has been obtained for this bundle:  … (omitted)  3> else if the MAC entity is not configured with *lch-basedPrioritization*; or  3> if this uplink grant is a prioritized uplink grant:  4> obtain the MAC PDU to transmit from the Multiplexing and assembly entity, if any;  3> if a MAC PDU to transmit has been obtained:  4> if the uplink grant is not a configured grant configured with *autonomousTx*; or  4> if the uplink grant is a prioritized uplink grant:  5> deliver the MAC PDU and the uplink grant and the HARQ information of the TB to the identified HARQ process;  5> instruct the identified HARQ process to trigger a new transmission;  …  2> else (i.e. retransmission):  3> if the uplink grant received on PDCCH was addressed to CS-RNTI and if the HARQ buffer of the identified process is empty; or  3> if the uplink grant is part of a bundle and if no MAC PDU has been obtained for this bundle; or  3> if the uplink grant is part of a bundle of the configured uplink grant, and the PUSCH duration of the uplink grant overlaps with an uplink grant received in a Random Access Response (i.e. MAC RAR or fallbackRAR) or an uplink grant determined as specified in clause 5.1.2a for MSGA payload for this Serving Cell; or:  3> if the MAC entity is not configured with *lch-basedPrioritization* and this uplink grant is part of a bundle of the configured uplink grant, and the PUSCH duration of the uplink grant overlaps with a PUSCH duration of another uplink grant received on the PDCCH; or:  3> if the MAC entity is configured with *lch-basedPrioritization* and this uplink grant is not a prioritized uplink grant:  4> ignore the uplink grant.  3> else:  4> deliver the uplink grant and the HARQ information (redundancy version) of the TB to the identified HARQ process;  4> instruct the identified HARQ process to trigger a retransmission;  … |

On the other hand, [R2-2108787] and [R2-2107735] propose to keep the current text.

R2-2108787 (LG Electronics)

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| **Proposal 1.** The dynamic uplink grant received for retransmission of skipped initial transmission shall be ignored as today, i.e., it is not to be used for UCI transmission even though UCI is overlapped with this invalid retransmission uplink grant. |

R2-2107735 (OPPO)

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| Proposal 2 RAN2 agrees to keep the current spec, i.e. ignore the retransmission grant whose PUSCH is overlapped with UCI if no MAC PDU has already been obtained for the corresponding HARQ process when Rel-16 LCH based prioritization is not configured and Rel-16 PUSCH skipping is enabled. |

**Q3) Do companies agree to allow the initial transmission for UL grant addressed to CS-RNTI, if the HARQ buffer is empty?**

* **Yes, the MAC entity shall treat the retransmission grant as the initial transmission.**
* **No, the MAC entity shall ignore the retransmission grant as today.**

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| **Company** | **Yes/No** | **Comments (optional)** |
| Ericsson | Yes | We would like to point out that the operation of configured grant was copied from the LTE spec, which would make sense in the case of non-adaptive retransmission with PHICH but not anymore in NR.  In addition to what the rapporteur has summarized, this is to align the operation in the case of a retransmission of the dynamic grant. We have added this with change marks in the above. |
| Nokia | No | UL grant addressed to CS-RNTI has only been designed for retransmission rather than initial transmission or UCI multiplexing. Receiving such an UL grant when there is no data in the buffer is obviously an error case. If the NW intends to schedule new transmission, it would have used UL grant addressed to C-RNTI. |
| MediaTek | Yes | Agree with Ericsson.  As highlighted in R2-2108094, false alarm/false positive cannot be considered as a corner case. If we keep the current text, we do not fulfil the expected UE behaviour that RAN1 asked us to implement. |
| Lenovo | Yes | We have same view as Ericsson/Mediatek. We think that the proposed behaviour is inline with what RAN1 had in mind. |
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## 3.3 Issue #3: Retransmission of Padding BSR-only MAC PDU

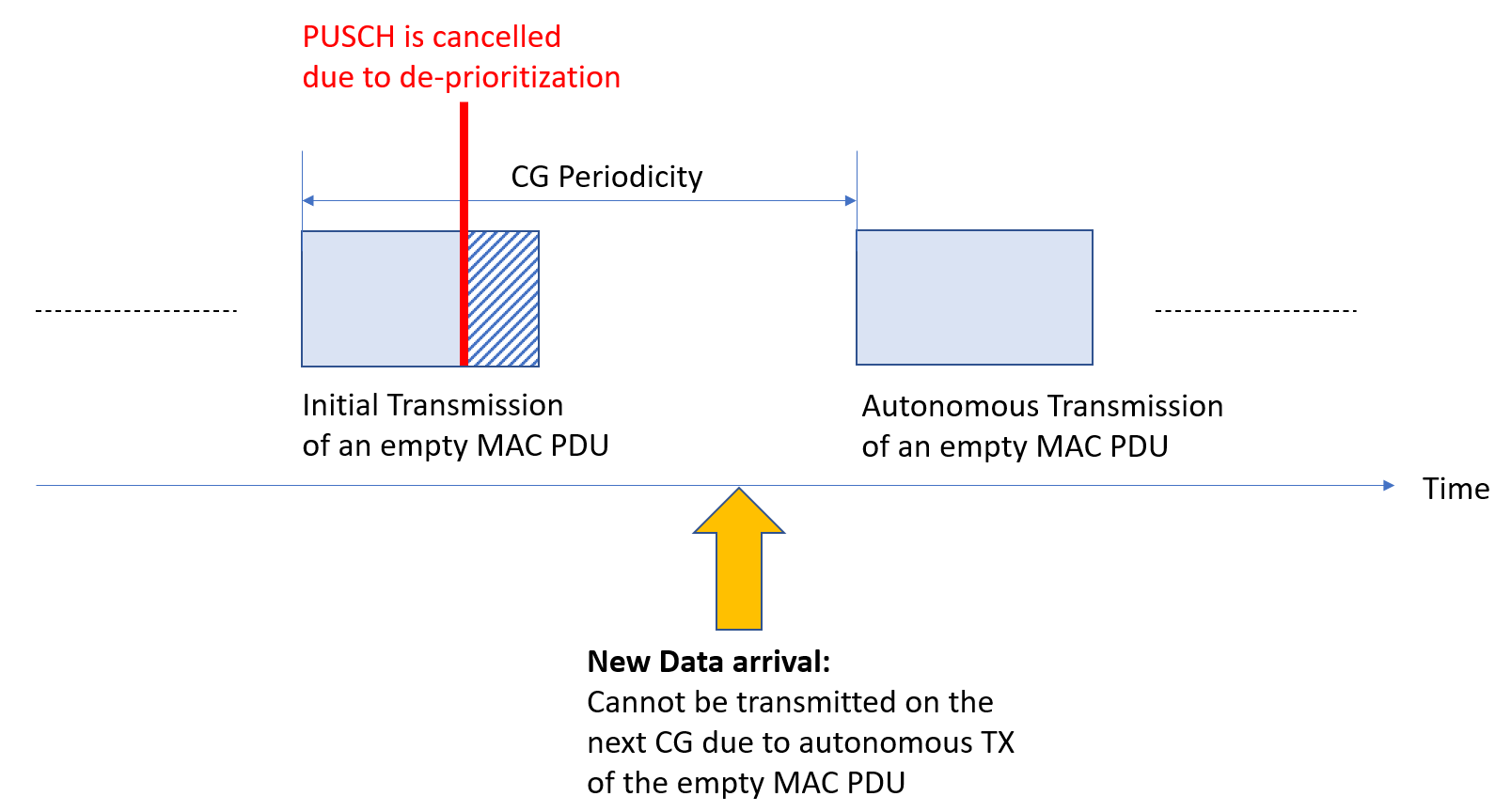
R2-2107200 Handling of pending empty PDUs after UCI multiplexing    CATT    discussion    NR\_IIOT-Core

[R2-2108283](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108283.zip) Autonomous Transmission of MAC PDU with only Padding or Periodic BSR    Nokia, Nokia Shanghai Bell    discussion    Rel-16    NR\_IIOT-Core

[R2-2108284](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108284.zip) Avoiding autonomous transmission of MAC PDU with only Padding BSR or unuseful Periodic BSR – Option 1    Nokia, Nokia Shanghai Bell    CR    Rel-16    38.321    16.5.0    1146    -    F    NR\_IIOT-Core

[R2-2108285](file:///C:\3GPP%20meetings\RAN2\2021\TSGR2_115-e\docs\R2-2108285.zip) Avoiding autonomous transmission of MAC PDU with only Padding BSR or unuseful Periodic BSR – Option 2    Nokia, Nokia Shanghai Bell    CR    Rel-16    38.321    16.5.0    1147    -    F    NR\_IIOT-Core

[R2-2107200] and [R2-2108283] point out that MAC may generate a MAC PDU carrying UCI-only TB (or with BSR) for a configured grant, if there is no UL transmission for the CG and CG overlaps with one PUCCH carrying UCI. In case that *AutonomousTx* is configured (potentially CGRT is configured and potentially LBT failure occurs), padding-only MAC PDU (or BSR-only MAC PDU) may be retransmitted in the next CG occasion. It would negatively impact the latency performance. Moreover, the delayed BSR may be outdated.



[R2-2107200] and [R2-2108283] propose to have a mechanism to avoid autonomous transmission of padding-only MAC PDU. Also, there were some proposals for the similar issue in Relase-17 IIOT WI, i.e. [R2-2107896, R2-2108810]. The rapporteur would like to ask if companies would agree to resolve the issue.

**Q4) Do companies agree to have a mechanism to avoid autonomous transmission of a MAC PDU that includes only padding BSR or periodic BSR indicating no data, in Rel-16?**

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| **Company** | **Yes/No** | **Comments (optional)** |
| Ericsson | No | This is an optimization, and we don’t consider this correction as essential in Rel-16, in particular this late phase.   * The feature of autonomous transmission was introduced in Rel-16 in the case that the network may not always send a re-transmission grant for the de-prioritized CG which may contain data. The motivation is not to “facilitate low latency transmission by recovering deprioritized MAC PDU that could be relatively delay-sensitive.”, but to recover the data. The data transmitted on CG is de-prioritized and thus it is assumed that it is for the best effort eMBB data but not the URLLC data. * In Rel-16, even without the latest LS from RAN1 on UCI-multiplexing, the uplink grant may contain paddings due to aperiodic CSI request. |
| Nokia | Yes | We disagree with Ericsson that the intention of autonomous transmission is only for gNB to recover eMBB data. In fact, in IIoT use cases the UE may have to handle multiple URLLC traffic flows simultaneously (with some differences in their urgency level which can be reflected to LCH priorities), so **the CG configured with AutoTX can be delay-sensitive** even though it may not be the most urgent data the UE has to handle. For such cases, AutoTX provides some benefits of latency reduction as the MAC PDU can be transmitted autonomously without waiting for retransmission grant. For eMBB we can simply rely on SR/BSR procedures and dynamic grants, not necessarily CG with AutoTX. And even if the MAC PDU is for aperiodic CSI, the PHY can always convey the A-CSI on some other TBs once the original MAC PDU is deprioritized. What has been stored in the HARQ buffer by MAC does not include anything useful really.  Therefore, we do not think it makes sense at all to transmit such MAC PDU autonomously and block new data that has much more value. Furthermore, the paddind/periodic BSR conveyed by this empty MAC PDU can be outdated and the gNB may erroneously treat this as the latest buffer information (because the gNB does not know exactly when this BSR is prepared), and the UE may also miss out the opportunity to update the BSR. This is especially undesirable for IIoT/URLLC use cases. |
| MediaTek | No | We do not see this as an essential correction for Rel-16. Also agree with Ericsson that this was already the case for aperiodic CSI requests. |
| Lenovo | Yes | We agree with Nokia, that such UCI-only TBs shall not delay other high priority new data, i.e. this is in particular unacceptable if the new data is some URLLC data or if there are some critical MAC CEs that need to be sent immediately. UCI contents multiplexed in this UCI-only TB may be no longer useful/valuable for the gNB, since the corresponding information such as HARQ-ACK or CSI may be already outdated or superseded. |
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Assuming that companies agree to resolve the issue, RAN2 needs to decide the option. (Note that if companies disagree, then none of the solutions is needed.) Anyway, the following solutions were proposed:

R2-2108283, R2-2108284, R2-2108285 (Nokia)

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| **Proposal: RAN2 should discuss how to avoid autonomous transmission of a MAC PDU that includes only padding BSR or periodic BSR indicating no data, based on the following options:**   1. **Flush this MAC PDU when it is deprioritized, so it will not be fetched for autonomous TX in the subsequent CG, if it only has padding or periodic BSR indicating no data (CR: R2-2108284)** 2. **Do not consider this MAC PDU as obtained for autonomous transmission in HARQ entity procedure, if it only has padding or periodic BSR indicating no data (CR: R2-2108285)** |

R2-2107200 (CATT)

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| **Proposal 1: MAC flushes the corresponding HARQ process after an empty MAC PDU aimed for an UCI-only TB has been delivered to PHY.** |

R2-2107896 (Lenovo)

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| **Proposal 4: UE flushes the HARQ buffer after the initial transmission (attempt) of an empty MAC PDU.** |

R2-2108810 (LG Electronics)

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| **Proposal.** If retransmission of UCI-only MAC PDU needs to be de-prioritized, RAN2 discuss an option of *not starting configuredGrantTimer* and *cg-RetransmissionTimer* upon transmission of UCI-only MAC PDU. |

**Q5) Assuming that RAN2 introduce a mechanism to avoid autonomous transmission of a MAC PDU that includes only padding BSR or periodic BSR indicating no data in Rel-16, which option is preferred?**

* **Option 1. Flush this MAC PDU when it is deprioritized, so it will not be fetched for autonomous TX in the subsequent CG, if it only has padding or periodic BSR indicating no data [R2-2108284].**
* **Option 2. Do not consider this MAC PDU as obtained for autonomous transmission in HARQ entity procedure, if it only has padding or periodic BSR indicating no data [R2-2108285].**
* **Option 3. MAC flushes the corresponding HARQ process after an empty MAC PDU aimed for an UCI-only TB has been delivered to PHY [R2-2107200].**
* **Option 4. UE flushes the HARQ buffer after the initial transmission (attempt) of an empty MAC PDU [R2-2107896].**
* **Option 5. If retransmission of UCI-only MAC PDU needs to be de-prioritized, the MAC entity does not start *configuredGrantTimer* and *cg-RetransmissionTimer* upon transmission of UCI-only MAC PDU [R2-2108810].**

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| **Company** | **Option** | **Comments (optional)** |
| Nokia | 1, (4), (5) | Option 1 is beneficial in term of complexity, because MAC anyway needs to check the MAC PDU content before deciding if it should be deprioritized. So the MAC can decide directly if this MAC PDU should be flushed upon its de-prioritization.  We understand that Option 3 is more generic, but we generally think this problem is more undesirable for autoTX or autoReTX mechanisms where gNB may not be able to detect the MAC PDU, and the subsequent resources may be used by autoTX/ReTX that potentially blocks new data. So, we prefer to limit the special handling to these autonomous mechanisms only.  Option 4 and Option 5 make sense when CG retransmission timer is configured in NR-U. |
| Lenovo | 4,5 |  |
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# 4 Phase-1 Conclusion