3GPP TSG-RAN WG2 Meeting #128 draft R2-2410952

**Orlando, USA, Nov 18th – 22nd, 2024**

**Agenda item: 7.0.2.13**

**Source: ASUSTeK, ZTE**

**Title: Report of [AT127bis][202][MIMOevo] Discuss on the modelling and review the MAC CR for 8Tx 2TB if the modelling is agreeable (ASUSTeK, ZTE)**

**WID/SID: NR\_MIMO\_evo\_DL\_UL-Core**

**Document for: Discussion and Decision**

# Introduction

This document records inputs and outcome for the following offline discussion.

* [AT128][202][MIMOevo] Discuss on the modelling and review the MAC CR for 8Tx 2TB if the modelling is agreeable (ASUSTeK, ZTE)

Scope: Discuss the modelling, and if there is an agreeable modelling, prepare and review the MAC CR. Can also check if any change to RRC is needed.

 Intended outcome: Summary in R2-2410952 and agreeable CR in R2-24xxxxx.

 Deadline: Before CB

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| **Company** | **Name** | **Contact** |
| LGE | Hanul Lee | hanul.lee@lge.com |
| Huawei, HiSilicon | Chong Lou | louchong@huawei.com |
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# Discussion

## 2.1 Discussing possible MAC changes for modelling method #2

In RAN2#128 online MIMO session, modeling methods for supporting 8Tx in MAC specification is discussed and the following assumption was made based on modeling method #2:

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| ?? For 8Tx 2TB transmission, we assume the following from MAC point of view: two uplink grants for two HARQ processes, one HARQ process ID, 2 HARQ buffer. Detailed changes to MAC will be discussed in offline.  |

Based on the modeling method #2, several changes were proposed to be made based on proposals in [1][2]. In this email discussion, we discuss whether modeling method #2 is agreeable by discussing whether each of the proposed changes is needed to support 8Tx, and then discussing whether any of the changes imposes RRC impact. We merged and listed the proposed changes in [1] and [2] for checking companies’ view.

**[intended offline conclusion]**

??Based on the discussion, is the following modeling agreeable to support 8Tx in MAC, and a draft CR can be prepared accordingly?

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| For 8Tx 2TB transmission, we assume the following from MAC point of view: two uplink grants for two HARQ processes, one HARQ process ID, 2 HARQ buffer.  |

[Discussion]

[CATT] think we should discuss RRC impact and PHY impact first, and think one-HARQ process method modeling has less PHY and RRC impact. Think we can send an LS

[QC] think there are two modeling: one or two HARQ process, think two UL grant two HARQ process is straightforward from RAN2, but from RAN1 perspective, it is to use one HARQ process for scheduled two TBs; think it’s good to check with RAN1.

[ZTE] in LTE, same issue has occurred but not asked. We can ask this in NR.

[Ericsson] prefer not changing number of HARQ process. Support sending LS w/ options and RAN2 analysis on the impact.

[HW] wonder the outcome of the LS. [ZTE] suggest to provide the options on the table and ask RAN1 their preference. (including impact analysis on MAC) [CATT] good to check with RAN1 about HARQ process and HARQ process id association.

[QC] include RAN2 impact

[HW] prefer to ask whether there’s further RAN1 impact on method#2

[Xiaomi] suggest to send preference that was discussed online.

[ASUSTeK] can ask 2TB generation to RAN1 in the same LS [ZTE, Samsung, Ericsson ] Agree to send this question as well.

[LG] wonder if UL HARQ mode should be asked as well. [ZTE, Samsung] Prefer to discuss after this LS.

Conclusion

Send an LS to RAN1 including:

Tell them we discussed two options for 8Tx modeling (one HARQ or 2 HARQ processes)

Send them this↓

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| For 8Tx 2TB transmission, we assume the following from MAC point of view: two uplink grants for two HARQ processes, one HARQ process ID, 2 HARQ buffer.  |

And inform them that we selected that↑because of less RAN2 impact)

Ask RAN1 about their view (whether there’s RAN1 concern on this option)

Whether to ensure 2-TB generation (Q2.1.4)

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| Below not discussed in online F2F |

### UL grant reception and number of HARQ processes

In order to support modeling method in 8Tx, corresponding description should be captured in UL grant reception and the previous change on one HARQ process supporting two TBs should be reverted.

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| 5.4. UL Grant receptionUplink grant is either received dynamically on the PDCCH, in a Random Access Response, configured semi-persistently by RRC or determined to be associated with the PUSCH resource of MSGA as specified in clause 5.1.2a. The MAC entity shall have an uplink grant to transmit on the UL-SCH. To perform the requested transmissions, the MAC layer receives HARQ information from lower layers. For uplink spatial multiplexing, the MAC layer can receive up to two uplink grants for two TBs via one PDCCH from lower layers. An uplink grant addressed to CS-RNTI with NDI = 0 is considered as a configured uplink grant. An uplink grant addressed to CS-RNTI with NDI = 1 is considered as a dynamic uplink grant.…5.4.2 HARQ operation5.4.2.1 HARQ Entity…Each HARQ process supports one TB. |

Suggested wording by Samsung:

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| 5.4. UL Grant receptionUplink grant is either received dynamically on the PDCCH, in a Random Access Response, configured semi-persistently by RRC or determined to be associated with the PUSCH resource of MSGA as specified in clause 5.1.2a. The MAC entity shall have an uplink grant to transmit on the UL-SCH. For uplink spatial multiplexing, the MAC entity considers two uplink grants are received on the PDCCH that schedules two TBs. To perform the requested transmissions, the MAC layer receives HARQ information from lower layers. An uplink grant addressed to CS-RNTI with NDI = 0 is considered as a configured uplink grant. An uplink grant addressed to CS-RNTI with NDI = 1 is considered as a dynamic uplink grant.… |

Suggested wording by LG:

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| 5.4. UL Grant receptionUplink grant is either received dynamically on the PDCCH, in a Random Access Response, configured semi-persistently by RRC or determined to be associated with the PUSCH resource of MSGA as specified in clause 5.1.2a. The MAC entity shall have an uplink grant to transmit on the UL-SCH. To perform the requested transmissions, the MAC layer receives HARQ information from lower layers. For uplink spatial multiplexing, the MAC layer can receive up to two uplink grants for two TBs on the PDCCH from lower layers. An uplink grant addressed to CS-RNTI with NDI = 0 is considered as a configured uplink grant. An uplink grant addressed to CS-RNTI with NDI = 1 is considered as a dynamic uplink grant.… |

**Q1: To support UL 8Tx in MAC specification, do you agree with above changes in UL grant reception and HARQ entity?**

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| **Company** | **Y/N** | **Reason/Comment** |
| Samsung | Y with comment | Polish wording:For uplink spatial multiplexing, the MAC entity considers two uplink grants are received on the PDCCH that schedules two TBs.Prefer to move this sentence forward, make it immediately follow “The MAC entity shall have an uplink grant to transmit on the UL-SCH.”. |
| LGE | Y | We prefer the original sentence with some editorial because the original sentence is more aligned with LTE text.For uplink spatial multiplexing, the MAC layer can receive up to two uplink grants for two TBs on the PDCCH from lower layers |
| Huawei, HiSilicon | Y | Prefer the revisions from LGE |
|  |  |  |

**[Discussion 1]**

??Conclusion 1: The part of the modeling method#2 where one PDCCH schedules two uplink grants for two TBs can be agreed?

### HARQ process ID for the HARQ processes

Based on observation in [2], for the modelling method #2, a DCI schedules two uplink grants on two HARQ processes with one HARQ process Id for two TB transmission, and corresponding description is captured below:

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| 5.4.2.1 HARQ Entity…Each HARQ process is associated with a HARQ process identifier. For two UL grants received from one PDCCH that schedules two TBs for uplink spatial multiplexing, two associated HARQ processes share one HARQ process identifier.  |

**Suggested by Samsung**

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| 5.4.2.1 HARQ Entity…Each HARQ process is associated with a HARQ process identifier. For uplink spatial multiplexing, the HARQ entity considers two HARQ processes for two TBs are associated with one HARQ process identifier. |

**Suggested by LG**

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| 5.4.2.1 HARQ Entity…For uplink spatial multiplexing, two associated HARQ processes share one HARQ process identifier. Otherwise, each HARQ process is associated with a HARQ process identifier. |

**Q2: To support UL 8Tx in MAC specification, do you agree with above changes for HARQ process ID?**

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| **Company** | **Y/N** | **Reason/Comment** |
| Samsung | Y with comment | Polish wording:Each HARQ process is associated with a HARQ process identifier. For UL transmission with UL grant in RA Response or for UL transmission for MSGA payload, HARQ process identifier 0 is used. For uplink spatial multiplexing, the HARQ entity considers two HARQ processes for two TBs are associated with one HARQ process identifier. |
| LGE | Y with comment | We prefer to align with LTE text, i.e. Two uplink spatial multiplexing case is first, then legacy case with otherwise.For uplink spatial multiplexing, two associated HARQ processes share one HARQ process identifier. Otherwise, each HARQ process is associated with a HARQ process identifier. For UL transmission with UL grant in RA Response or for UL transmission for MSGA payload, HARQ process identifier 0 is used. |
| Huawei, HiSilicon | Y with comment | Prefer the revisions from LGE |

**[Discussion 2]**

??Conclusion 2: the part of the modeling method#2 where two HARQ processes, one HARQ process ID, 2 HARQ buffer can be agreed?

### Intra-UE multiplexing

As indicated in [2], for modelling method #2, extra handling for the two UL grants are needed for intra-UE multiplexing based on the following observations:

**Observation 16: Regarding the coexistence of intra-UE multiplexing and 8Tx, the Uplink grants received from a PDCCH that schedules two TBs with two codewords is not considered as conflict with each other.**

**Observation 17: Regarding the coexistence of intra-UE multiplexing and 8Tx, the uplink grants received from a PDCCH that schedules two TBs with two different codewords shall be prioritized or deprioritized together.**

**Observation 18: Regarding the intra-UE multiplexing and 8Tx, the priority level of uplink grants received from a PDCCH that schedules two TBs with two different codewords are determined by the highest priority among prioirties of the logical channels that are multiplexed or have data available that can be multiplexed in two MAC PDUs, according to the mapping restriction as described in clause 5.4.3.1.2.**

And corresponding changes are quoted below:

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| 5.4.1 UL Grant reception…For two uplink grants received from one PDCCH that schedules two TBs, the MAC entity does not consider those two uplink grant are overlapping in time domain.**…**For the MAC entity configured with *lch-basedPrioritization*, priority of an uplink grant is determined by the highest priority among priorities of the logical channels that are multiplexed (i.e. the MAC PDU to transmit is already stored in the HARQ buffer) or have data available that can be multiplexed (i.e. the MAC PDU to transmit is not stored in the HARQ buffer) in the MAC PDU, according to the mapping restrictions as described in clause 5.4.3.1.2. The priority of two uplink grants received from one PDCCH that schedules two TBs are determined by the highest priority among priorities of the logical channels that are multiplexed or have data available that can be multiplexed in two MAC PDUs, according to the mapping restriction as described in clause 5.4.3.1.2. The priority of an uplink grant for which no data for logical channels is multiplexed or can be multiplexed in the MAC PDU is lower than either the priority of an uplink grant for which data for any logical channels is multiplexed or can be multiplexed in the MAC PDU or the priority of the logical channel triggering an SR.…NOTE x: If the MAC entity is configured with *lch-basedPrioritization,* the MAC entity consider the two uplink grants are prioritized or deprioritized together if the two uplink grants are received from one PDCCH that schedules two TBs. |

**Q3: To support UL 8Tx in MAC specification, do you agree with above changes for Intra-UE multiplexing?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, HiSilicon | N | We haven’t thoroughly discussed how 8Tx work with intra-UE multiplexing, e.g. how it works for auto-retx for deprioritized data, so we need more time to think and this part can be deprioritized.Actually, we fail to see a valid case for combining URLLC with 8TX which is used to UL enhancement in CPE scenario and thus not targeted at URLLC, an alternative WF is to not consider intra-UE multiplexing and 8Tx simultaneously. Since intra-UE multiplexing in RAN2 feature, we can discuss and decide in RAN2.  |

**[Discussion 3]**

??Conclusion 3: changes on intra-UE multiplexing for modeling method#2 can be agreed?

### Ensuring 2-TB generation

As indicated in [1], in LTE, is that PHY is unable to perform corresponding transmission properly with only one TB when two TB transmission is scheduled by DCI and two TBs are expected by eNB for UL spatial multiplexing. The corresponding changes for NR 8Tx proposed in [1] is modified based on modeling method #2 shown below:

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| 5.4.2.1 HARQ Entity…NOTE 1a: If at least one MAC PDU is to be generated or to be retransmitted for a PDCCH that schedules two TBs, the MAC entity generates MAC PDUs corresponding to all UL grants indicated by the PDCCH. |

**Q4: To support UL 8Tx in MAC specification, do you agree with above changes for ensuring 2-TB generation?**

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y, but | In our understanding, as long as two TBs are scheduled in a single DCI, the physical layer uses two codewords and two TBs should be transmitted. However, companies have different understanding, so we think RAN1 confirm is needed. |
| Huawei, HiSilicon | N | We understand in this case, the lower layer will delivery two UL grant with two UL information so no need to have any clarification in MAC spec.  |

[Discussion 4]

??Conclusion 4: changes on ensuring 2-TB generation for modeling method#2 can be agreed?

### Other changes

**Q5: To support UL 8Tx in MAC specification, are there any additional changes needed besides the changes mentioned above?**

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y | According to 38.331, uplinkHARQ-Mode is configured per HARQ process ID, but in 38.321, it is specified per UL HARQ process. In our view, it is not clear how to set HARQ mode in the uplink spatial uplink case. We think there are two option.* Option 1. Introduce a restriction in RRC, e.g., NTN and uplink spatial multiplexing are not used simultaneously.
* Option 2. Clarify how to set HARQ mode in MAC, e.g., For uplink spatial multiplexing, two associated HARQ processes that share one HARQ process ID are set the same uplink HARQ mode.
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| Huawei, HiSilicon | Y | See comments in Q3, also share similar view with LGE that any other impacted features can be excluded for now. |

**[Discussion 5]**

??Conclusion 5: Are other changes to support UL 8Tx in MAC acceptable?

## 2.2 Discussing possible RRC impact for modelling method #2

In the online discussion, some companies raised concern regarding RRC impact responsive to changes caused by following modeling method #2. In this section, companies are welcomed to provide comments regarding possible RRC impacts for discussion.

**Q6: To support UL 8Tx in MAC specification, do you foresee any RRC impact?**

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| **Company** | **yes/no** | **Reason/Comment** |
| Samsung | No |  |
| LGE | Y | Comment in Q5 |
| Huawei, HiSilicon | Y | See comments in Q3 and Q5 |

**[Discussion 6]**

??Conclusion 6: Are there no / editorial/ acceptable/ not-acceptable / RRC impact to support UL 8Tx using modeling method#2?

**[offline conclusion]**

??Based on the discussion above, is the following modeling agreeable to support 8Tx in MAC, and a draft CR can be prepared accordingly?

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| For 8Tx 2TB transmission, we assume the following from MAC point of view: two uplink grants for two HARQ processes, one HARQ process ID, 2 HARQ buffer.  |

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| Above not discussed in online F2F |

# Conclusion

Proposal: Send an LS asking RAN1’s view regarding the following:

* Modelling method for supporting NR 8Tx:
	+ Regarding modelling method for supporting NR 8Tx, the following two options were considered by RAN2
		- **Modelling method#1: One uplink grant and One HARQ process with two HARQ buffers for 2TB transmission**
		- **Modelling method#2: Two uplink grants and Two HARQ processes with two HARQ buffers (one HARQ buffer each) with one HARQ process Id for 2TB transmission.**
	+ RAN2 has carefully analyzed impacts on both options (e.g., R2-2411076, R2-2410952). Option 1 changes the current modelling (which is one UL grant is provided to generate one MAC PDU, and the corresponding TB is transmitted in one HARQ process with one HARQ buffer). Option 2 implies that two HARQ processes for the two TBs is associated with one ID.
	+ And RAN2 made assumption for selecting modelling method#2 for less MAC specification impact:

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| ?? For 8Tx 2TB transmission, we assume the following from MAC point of view: two uplink grants for two HARQ processes, one HARQ process ID, 2 HARQ buffer. Detailed changes to MAC will be discussed in offline. |

* + Ask RAN1 whether there’s concern on modelling method#2
* Whether ensuring a 2-TB generation is needed in NR 8Tx

# Reference

[1] R2-2408352 Discussion on supporting 8Tx in MAC specification ASUSTeK discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core

[2] R2-2411076 Harmonization of 8Tx in MAC specification ZTE Corporation discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core