**3GPP TSG-RAN WG1 Meeting #104-eR1-210xxxx**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** **7.2.5**

**Source: Moderator (Apple Inc.)**

**Title: Summary of email discussion [104-e-NR-L1enh-URLLC-03] on PUSCH enhancements for NR eURLLC**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution provides a summary of the following email discussion:

[104-e-NR-L1enh-URLLC-03] Email discussion/approval on remaining issues on PUSCH enhancements – Sigen (Apple) by Feb 3

* Issue 1: New RRC parameter for TDRA indication to support up to 64 entries in a TDRA table for Type 1 configured grant with PUSCH repetition Type B
* Issue 2: Part 2 CSI dropping for UCI multiplexing on PUSCH repetition Type B

Section 2 and Section 3 capture the email discussions on Issue 1 and Issue 2, respectively. Section 4 provides the outcome of the email discussion.

# 2 Issue 1: New RRC parameter for TDRA indication to support up to 64 entries in a TDRA table for Type 1 configured grant with PUSCH repetition Type B

A draft CR was proposed in [1] to address the issue that *timeDomainAllocation* in *configuredGrantConfig* (applicable for Type 1 configured grant) has a value range of 0 to 15, while for PUSCH repetition Type B, there can be up to 64 entries in a TDRA table. It was proposed that a new RRC parameter is introduced, and TS 38.214 is modified accordingly.

Note that this involves a new RRC parameter, and it requires RAN2 to update TS 38.331 to reflect the proponent also submitted a companion CR for TS 38.331 in RAN2, which may be discussed in RAN2. If not, after RAN1 agrees on the TP, we can send an LS to RAN2 to request for corresponding changes.

Proposal 1 is basically the draft CR in [1], and it is used as the starting point for discussion.

### Proposal 1:

**Adopt the following TP for TS 38.214 Clause 6.1.2.3:**

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| 6.1.2.3 Resource allocation for uplink transmission with configured grant  When PUSCH resource allocation is semi-statically configured by higher layer parameter *configuredGrantConfig* in *BWP-UplinkDedicated* information element, and the PUSCH transmission corresponding to a configured grant, the following higher layer parameters are applied in the transmission:  - For Type 1 PUSCH transmissions with a configured grant, the following parameters are given in *configuredGrantConfig* unless mentioned otherwise:  - For the determination of the PUSCH repetition type, if the higher layer parameter *pusch-RepTypeIndicator* in *rrc-ConfiguredUplinkGrant* is configured and set to 'pusch-RepTypeB', PUSCH repetition type B is applied; otherwise, PUSCH repetition type A is applied;  - For PUSCH repetition type A, the selection of the time domain resource allocation table follows the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1.  - For PUSCH repetition type B, the selection of the time domain resource allocation table is as follows:  - If *pusch-RepTypeIndicatorDCI-0-1* in *pusch-Config* is configured and set to *'*pusch-RepTypeB*'*, *pusch-TimeDomainResourceAllocationListDCI-0-1* in *pusch-Config* is used;  - Otherwise, *pusch-TimeDomainResourceAllocationListDCI-0-2* in *pusch-Config* is used.  - It is not expected that *pusch-RepTypeIndicator* in *rrc-ConfiguredUplinkGrant* is configured with *'*pusch-RepTypeB*'* when none of *pusch-RepTypeIndicatorDCI-0-1* and *pusch-RepTypeIndicatorDCI-0-2* in *pusch-Config* is set to *'*pusch-RepTypeB*'*.  - The higher layer parameter *timeDomainAllocation or timeDomainAllocation-r16* value *m* provides a row index *m*+1 pointing to the determined time domain resource allocation table, where the start symbol, length and the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table) are determined following the procedure defined in Clause 6.1.2.1;  - Frequency domain resource allocation is determined by the *N* LSB bits in the higher layer parameter *frequencyDomainAllocation*, forming a bit sequence , where is the LSB, according to the procedure in Clause 6.1.2.2 and *N* is determined as the size of frequency domain resource assignment field in DCI format 0\_1 for a given resource allocation type indicated by *resourceAllocation,* except if *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* is configured, in which case uplink type 2 resource allocation is used wherein the UE interprets the LSB bits in the higher layer parameter *frequencyDomainAllocation* as for the frequency domain resource assignment field of DCI 0\_1 according to the procedure in Clause 6.1.2.2.3*;*  - The *IMCS* is provided by higher layer parameter *mcsAndTBS;*  - Number of DM-RS CDM groups, DM-RS ports, SRS resource indication and DM-RS sequence initialization are determined as in Clause 7.3.1.1.2 of [5, TS 38.212], and the antenna port value, the bit value for DM-RS sequence initialization, precoding information and number of layers, SRS resource indicator are provided by *antennaPort, dmrs-SeqInitialization, precodingAndNumberOfLayers*, and *srs-ResourceIndicator* respectively;  - When frequency hopping is enabled, the frequency offset between two frequency hops can be configured by higher layer parameter *frequencyHoppingOffset.*  - For Type 2 PUSCH transmissions with a configured grant: the resource allocation follows the higher layer configuration according to [10, TS 38.321], and UL grant received on the DCI.  - The PUSCH repetition type and the time domain resource allocation table are determined by the PUSCH repetition type and the time domain resource allocation table associated with the UL grant received on the DCI, respectively, as defined in Clause 6.1.2.1. |

**Companies please indicate if you support the intention of the TP.**

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| **Yes** | Apple, CATT, HW/HiSi, ZTE,vivo,OPPO |
| **No** | Intel, Ericsson, Qualcomm |

**Companies please provide detailed comments if any.**

If you do not agree with the intention of the TP, please explain why.

If you agree with the intention of the TP, please provide detailed comments on the TP if any.

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| **Company** | **Comments** |
| CATT | While we agree with the intention of the TP, we think the TP should be discussed after RAN2 agrees the new RRC parameter to avoid potential inconsistency between RAN1 and RAN2 specs. For example, the RRC parameter name proposed by the proponent in RAN2 is *timeDomainAllocation-v1640* instead of *timeDomainAllocation-r16*. If the latter is agreed in RAN2, we do not think *timeDomainAllocation-r16* needs to be added since *timeDomainAllocation* would include both RRC parameters with and without the suffix, similar as many other RRC parameters. |
| HW/HiSi | In our view according the two agreements from RAN1#99 below, the CG PUSCH repetition type B may share 64-entry TDRA table with DCI format 0\_2. If the repetition number is included in the new TDRA table, CG PUSCH will follow that. |
| ZTE | Regardless of RAN2’s discussion, we can first agree on the intention of this TP.  As for the final TP, we agree FL that, if it would not be discussed in RAN2, RAN1 can agree on the final TP and send an LS to RAN2 to request for corresponding changes. So, we are also ok to wait a bit for the final TP.  Regarding CATT’s comment on the parameter suffix, our original intention is the new parameter has different value ranges and may point to different time domain information (e.g., the number of repetitions), it may be better to make it explicitly. Note that, there are many places in the spec with presenting both legacy parameter and new parameter with Rel-16 suffix. But we would be open for this point. |
| Nokia, NSB | We agree with CATT, that we first would need to have an agreement on having a new RRC parameter for this and then do the TP later on (knowing the details of the RRC signaling).  One additional question now here is, that if there is a need for a new UE capability for having this new RRC parameter *timeDomainAllocation-r16XX* or not. Therefore, it maybe be good to e.g. have an LS to RAN2 first with the request on the new RRC parameter (incl. potential UE capability) and figure out the RAN1 / 38.214 details later on. |
| vivo | We agree with CATT’s view. |
| OPPO | We agree with Nokia/NSB’s view. |
| Intel | Considering very late stage of R16 maintenance, we think that this issue may not be essential and may not be corrected both in RAN1 and RAN2 due to the high bar for ASN.1 changes.  The fact that *timeDomainAllocation* has range of (0…15) does not break the system and even does not limit flexibility. The reason is that both the tables (*PUSCH-TimeDomainResourceAllocationList-ForDCIformat0\_1/PUSCH-TimeDomainResourceAllocationList-ForDCIformat0\_2*) and the *timeDomainAllocation* are provided semi-statically, therefore the first 16 entries of the tables could contain the target resource allocation configuration for CG type 1 (there could be up to 12 active configurations). When a change of *timeDomainAllocation* is required, then RRC can reconfigure it together with the tables. |
| Ericsson | Similar to CATT/Nokia/vivo/OPPO, we also observe the parallel activities in RAN2. It would be good to wait to know the final details of RRC parameter (if RAN2 makes agreement), then write the TP for 38.214.  Regarding Intel’s view that the change is not essential: we agree with this point as well. The system is expected to work fine using the first 16 entries of a larger TDRA table (with proper ordering), if a larger table is configured.  Regarding the TP sentence, we don’t agree to include “and the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table)”. Number of repetitions is not determined according to Clause 6.1.2.1 for CG. Instead, for CG there is already the sentence below in section 6.1.2.3 (right after the quoted section).  TS 38.214 V16.4.0 section 6.1.2.3:  “For PUSCH transmissions with a Type 1 or Type 2 configured grant, the number of (nominal) repetitions *K* to be applied to the transmitted transport block is provided by the indexed row in the time domain resource allocation table if *numberOfRepetitions* is present in the table; otherwise *K* is provided by the higher layer configured parameters *repK.*” |
| Qualcomm | We agree with Intel’s and Ericsson’s view that introducing a new RRC parameter is unnecessary.  As pointed out by HW, we already have the UE procedure in place to determine which TDRA table to follow for Type 1 CG, and in our view, the existing RRC parameter *timeDomainResourceAllocation* can be used to indicate a TDRA entry from a corresponding TDRA table (including the new TDRA table for Type B repetition).  At the maximum, one could enlarge the range of the existing RRC parameter *timeDomainResourceAllocation* from 15 to 63 to accommodate for the larger TDRA size for the *PUSCH-TimeDomainResourceAllocationList-ForDCIformat0\_1/PUSCH-TimeDomainResourceAllocationList-ForDCIformat0\_2*. But, in our view, this is a pure RAN2 issue, and may not need any RAN1 discussion.  Finally, on the CR related to repetition number, we agree with Ericsson that it is not needed. |

To summarize the comments from the companies that do not support the TP or the new RRC parameter, the main points include:

* Given that *timeDomainResourceAllocation* is semi-statically configured, the gNB can get around the issue by re-ordering the entries in the corresponding TDRA table, so that the index of the desired TDRA entry falls within the range of 0 to 15.
* The determination of the number of repetitions is covered by the text in Clause 6.1.2.3. Therefore, there is no need for the related change.

Taking into these comments, and also considering the fact that the change would require new RRC parameter and may involve capability signaling, the recommendation is to keep the current specification and let gNB handle the issue by implementation.

### Proposed conclusion:

**No additional specification change is introduced to address the issue that timeDomainAllocation in configuredGrantConfig (applicable for Type 1 configured grant) has a value range of 0 to 15, while for PUSCH repetition Type B, there can be up to 64 entries in a TDRA table.**

* **Note: this can be handled by proper configuration of the TDRA table via gNB implementation.**

**Companies please indicate if you support the proposed conclusion.**

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| **Yes** | Apple, Samsung, DOCOMO, CATT, Nokia/NSB |
| **No** | ZTE |

**Companies please provide detailed comments if any.**

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| **Company** | **Comments** |
| Samsung | We share similar views with Intel, Ericsson, Qualcomm and FL. This change provides full mapping to more entries, but the system can work without this change. As pointed out by Ericsson, with a proper ordering of TDRA table, there is no loss of flexibility either. |
| Nokia/NSB | Agree with the proposed conclusion. If seen more flexibility is needed, having 64 entries could be considered as a Rel-17 TEI or similar. |
| ZTE | We don’t agree with the proposed conclusion.  As the agreements cited by HW/HiSi, it’s clear that RAN1’s intention was to allow CG type 1 to share the 64 entries configured for DG PUSCH. Regarding the flexibility, without the CR, gNB has to keep re-configuring the whole TDRA table with proper re-ordering to satisfy the need of CG Type 1. This would not only introduce more complexity at gNB side for re-ordering, but also cause unnecessary signalling overhead. If gNB doesn’t update the re-configuration timely or during the unnecessary RRC re-configuration period, the flexibility would be lost.  As for the second change, we agree that the spec in other places has some definition on the number of repetitions for CG type 1. However, it would cause inconsistency in the spec if we don’t agree on the CR.  If companies’ concern is about introducing a new RRC parameter or UE capability, we would be fine to wait for RAN2’s decision first instead of making such conclusion in RAN1 now. |

# 3 Issue 2: Part 2 CSI dropping for UCI multiplexing on PUSCH repetition Type B

In RAN1#101-e email discussion [101-e-NR-L1enh-URLLC-PUSCH-03], we agreed on the following to determine the number of coded modulation symbols for UCI multiplexed on PUSCH repetition Type B.

***Agreement***

*For UCI multiplexed on PUSCH repetition Type B without UL-SCH, the number of coded modulation symbols per layer for HARQ-ACK, CSI part 1, and CSI part 2 is calculated based on the nominal repetition following Rel-15 principles*

*No TP is necessary for this agreement.*

***Agreement***

*For UCI multiplexed on PUSCH repetition Type B with UL-SCH, the number of coded modulation symbols per layer for HARQ-ACK, CSI part 1, and CSI part 2 is calculated by modifying the Rel-15 formula as follows:*

* ***Option 1a****: The calculation is based on the nominal repetition, with the additional limit that the total number of coded modulation symbols per layer for UCI is no more than the resources available in the actual repetition.*

A TP for TS 38.212 Clause 6.3.2 was agreed to capture the 2nd agreement, including the part related to CSI part 2 (please see the Annex A for the related TP). However, it was pointed out in [2] that for UCI multiplexing on PUSCH repetition Type B, there is some text on Part 2 CSI dropping in TS 38.214 Clause 5.2.3, which needs to be modified and was missed at the time when the related agreements were made.

The proposal below is basically the TP proposed in [2], and it is used as the starting point for discussion. Please note that some of the old equations are replaced by the new ones without tracking changes due to the figure format of the old equations, but the new equations are in red font.

### Proposal 2:

**Adopt the following TP for TS 38.214 Clause 5.2.3:**

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| 5.2.3 CSI reporting using PUSCH  <unchanged part omitted>  When the UE is scheduled to transmit a transport block on PUSCH not using repetition type B multiplexed with a CSI report(s), Part 2 CSI is omitted only when  is larger than , where parameters , , , , , , , , and are defined in Clause 6.3.2.4 of [5, TS 38.212].  Part 2 CSI is omitted level by level, beginning with the lowest priority level until the lowest priority level is reached which causes the  to be less than or equal to .  When the UE is scheduled to transmit a transport block on PUSCH using repetition type B multiplexed with a CSI report(s), Part 2 CSI is omitted only when  is larger than  ,  where parameters , , , , , , , , , , , and are defined in Clause 6.3.2.4 of [5, TS 38.212].  Part 2 CSI is omitted level by level, beginning with the lowest priority level until the lowest priority level is reached which causes  to be less than or equal to  .  When part 2 CSI is transmitted on PUSCH with no transport block, lower priority bits are omitted until Part 2 CSI code rate, which is given by where , , are given in clause 6.3.2.4 of [5, 38.212] before HARQ-ACK puncturing part 2 CSI if any, is below a threshold code rate lower than one, where    - is the CSI offset value from Table 9.3-2 of [6, TS 38.213]  - *R* is signaled code rate in DCI  <unchanged part omitted> |

**Companies please indicate if you support the intention of the TP.**

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| **Yes** | Apple, CATT, HW/HiSi, ZTE, Nokia/NSB,vivo,OPPO, Ericsson, Qualcomm,Samsung, DOCOMO |
| **No** |  |

**Companies please provide detailed comments if any.**

If you do not agree with the intention of the TP, please explain why.

If you agree with the intention of the TP, please provide detailed comments on the TP if any.

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| **Company** | **Comments** |
| CATT | We agree with the TP. |
| HW/HiSI | Agree with the TP |
| ZTE | Agree with the TP |
| Nokia/NSB | Agree with the TP |
| vivo | Agree with the TP |
| OPPO | Agree with the TP |
| Ericsson | Agree with the TP. |
| Qualcomm | Agree with the TP. |
| Samsung | Agree with the TP |
| DOCOMO | Agree with the TP |

# 3 Outcome of the email discussion

# References

1. R1-2100090, Draft CR on resource allocation for uplink transmission with configured grant, ZTE
2. R1-2101347, Remaining issues on UCI and PUSCH enhancements for eURLLC, Apple

# Annex A: Agreed TP for TS 38.212 on Rate Matching for UCI on PUSCH Repetition Type B

A TP was agreed to capture the 2nd agreement, and the part related to CSI part 2 is as follows:

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| TP for TS 38.212 Clause 6.3.2.4  6.3.2 Uplink control information on PUSCH  < Unchanged parts are omitted >  6.3.2.4 Rate matching  6.3.2.4.1 UCI encoded by Polar code  6.3.2.4.1.3 CSI part 2  <unrelated parts are omitted>  For CSI part 2 transmission on an actual repetition of a PUSCH with repetition Type B with UL-SCH, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as , is determined as follows:  where  - is the number of resource elements that can be used for transmission of UCI in OFDM symbol , for , in the PUSCH transmission assuming a nominal repetition without segmentation, and is the total number of OFDM symbols in a nominal repetition of the PUSCH, including all OFDM symbols used for DMRS;  - for any OFDM symbol that carries DMRS of the PUSCH assuming a nominal repetition without segmentation, ;  - for any OFDM symbol that does not carry DMRS of the PUSCH assuming a nominal repetition without segmentation, where is the number of subcarriers in OFDM symbol that carries PTRS, in the PUSCH transmission assuming a nominal repetition without segmentation;  - is the number of resource elements that can be used for transmission of UCI in OFDM symbol , for , in the actual repetition of the PUSCH transmission, and is the total number of OFDM symbols in the actual repetition of the PUSCH transmission, including all OFDM symbols used for DMRS;  - for any OFDM symbol that carries DMRS of the actual repetition of the PUSCH transmission, ;  - for any OFDM symbol that does not carry DMRS of the actual repetition of the PUSCH transmission, where is the number of subcarriers in OFDM symbol that carries PTRS, in the actual repetition of the PUSCH transmission;  - and all the other symbols in the formula are defined the same as for PUSCH with repetition Type A.  < Unchanged parts are omitted > |