3GPP TSG RAN WG1 #102 R1-200xxxx

e-Meeting, August 17th – 28th, 2020

Source: Moderator (OPPO)

Title: Discussion in Email Thread #4

Agenda Item: 7.2.6

Document for: Discussion and Decision

1. Introduction

Rel-16 enhancement on MIMO WID includes objectives of enhancing multi-TRP/Panel transmission with ideal and non-ideal backhaul. During the work of rel-16, designs for multiple-PDCCH based and single-PDCCH based multi-TRP/Panel transmission were discussed and specified. This document provides the discussion eMIMO email thread#4:

* [102-e-NR-eMIMO-04] Email thread#4 Processing time for URLLC scheme 3:

# Processing Time for URLLC scheme 3

Huawei [1] and Qualcomm [2] discussed issues related with processing time for URLLC scheme 3. Apple and MediaTek suggested to further relaxation of UE processing time for URLLC scheme 3 if some clarification is agreeable and Lenovo/MOT commented to support clarification on PDSCH processing time for scheme3 during the email discussion [3].

Huawei [1] explained that current spec may cause different UE/gNB behavior due to a potential ambiguity. Based on the current spec, the processing time is counted starting from the end of the last PDSCH occasion for scheme 3, but we actually have two interpretations of d1,1:

* Alt-1: The number of allocated PDSCH symbols and overlapping symbols between PDCCH and PDSCH only take into count one of the two PDSCH transmission occasions, i.e. the first PDSCH occasion.
* Alt-2: The number of allocated PDSCH symbols and overlapping symbols between PDCCH and PDSCH take into count the two PDSCH transmission occasions.

Those two alts can give rise to different values of *d1,1*  in both cases a and b explained in the figure below

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Huawei explained that especially for case a with Alt 1, a delay can be larger than an 8-symbol PDSCH in R15 and HARQ-ACK message can be postponed into next slot in Rel-16. Similar observation can be seen for case b. Huawei proposed to go with the understanding of Alt2 and a TP is proposed.

Qualcomm [2] explained that In scheme 3 (‘TDMSchemeA’), there are two repetitions in one slot and it is not clear in current spec that how PDSCH allocation length for the purpose of determining , and the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH are determined. They noted that represents “additional delay” for PDSCH processing time with respect to , and due to soft combining in scheme 3, if the processing for the first repetition is delayed, processing of the second repetition should be also delayed. Qualcomm [2] suggested that should be calculated separately for the two repetitions, and the maximum value should be considered. If there is a gap between first repetition and second repetition, StartingSymbolOffsetK can be subtracted from for the first repetition. Denoting and the values calculated for the first and second repetitions, respectively, and the value of StartingSymbolOffsetK, is calculated as .

Apple commented in phase 1 email discussion [3] that:

* based on the current specification, it is based on the first PDSCH occasion. This is the similar issue as scheme 4. The specification is not broken.
* If we discuss the issue, we need to ensure two things
	+ There is no discussion for CAP#2, since there is no related capability
	+ The outcome needs to be further relaxation of UE processing compared to the current specification instead of tightening the requirement

MediaTek [3] inputted the same view as Apple and they commented that not tightening of processing time.

Based on the comments/explanation inputted by the companies, we have 4 different understanding/proposals on the PDSCH processing time of URLLC scheme 3: no need for clarification and the time is based on the first PDSCH occasion and three different proposals on how to further clarify the PDSCH processing time.

Draft Proposal: About the PDSCH processing time of URLLC scheme 3, down-select one from the following 4 Alts

* **Alt1: no further clarification for URLLC scheme 3 in the Spec is needed, and the PDSCH processing time is based on the first PDSCH occasion in URLLC scheme 3.**
* **Alt-2: The number of allocated PDSCH symbols and overlapping symbols between PDCCH and PDSCH take into count the two PDSCH transmission occasions (proposed by Huawei). The following TP draft proposed by Huawei is sued as starting point.**

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| < Start of the text proposal >5.3 UE PDSCH processing procedure timeIf the first uplink symbol of the PUCCH which carries the HARQ-ACK information, as defined by the assigned HARQ-ACK timing *K1* and the PUCCH resource to be used and including the effect of the timing advance, starts no earlier than at symbol *L1*, where *L1* is defined as the next uplink symbol with its CP starting after after the end of the last symbol of the PDSCH carrying the TB being acknowledged, then the UE shall provide a valid HARQ-ACK message. *- N1* is based on *µ* of table 5.3-1 and table 5.3-2 for UE processing capability 1 and 2 respectively, where *µ* corresponds to the one of (*µPDCCH*, *µPDSCH*, *µUL*) resulting with the largest *Tproc,1*, where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH scheduling the PDSCH, the *µPDSCH* corresponds to the subcarrier spacing of the scheduled PDSCH, and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the HARQ-ACK is to be transmitted, and κ is defined in clause 4.1 of [4, TS 38.211]. *-* If the PDSCH DM-RS position for the additional DM-RS in Table 7.4.1.1.2-3 in clause 7.4.1.1.2 of [4, TS 38.211] is then *N1,0=14* inTable 5.3-1*,* otherwise *N1,0=13.*- If the UE is configured with multiple active component carriers, the first uplink symbol which carries the HARQ-ACK information further includes the effect of timing difference between the component carriers as given in [11, TS 38.133].- For the PDSCH mapping type A as given in clause 7.4.1.1 of [4, TS 38.211]: if the last symbol of PDSCH is on the *i-*th symbol of the slot where *i* < 7, then *d1,1 = 7 - i*, otherwise *d1,1 = 0*- The number of PDSCH symbols allocated is 2ⅹL to determine *d1,1* when a UE is configured by higher layer parameter *RepSchemeEnabler* set to *'TDMSchemeA'*, and the UE is indicated with two TCI states in a codepoint of the DCI field '*Transmission Configuration Indication*' and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)*".- For UE processing capability 1: If the PDSCH is mapping type B as given in clause 7.4.1.1 of [4, TS 38.211], and- if the number of PDSCH symbols allocated is *L* ≥ 7, then *d1,1* = 0,- if the number of PDSCH symbols allocated is *L* ≥ 4 and *L* ≤ 6, then *d1,1* = 7- *L.*- if the number of PDSCH symbols allocated is *L* = *3* then *d1,1 = 3 +* min *(d,1)*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- if the number of PDSCH symbols allocated is 2, then *d1,1* = 3*+d*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.< End of the text proposal > |

* **Alt-3: is calculated separately for the two repetitions, and the maximum value is used. If there is a gap between first repetition and second repetition, *StartingSymbolOffsetK* is subtracted from for the first repetition (proposed by Qualcomm [2]). The following TP draft proposed by Qualcomm is used as the starting point.**

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| ============TP for 38.214 Section 5.3====================================If the first uplink symbol of the PUCCH which carries the HARQ-ACK information, as defined by the assigned HARQ-ACK timing *K1* and the PUCCH resource to be used and including the effect of the timing advance, starts no earlier than at symbol *L1*, where *L1* is defined as the next uplink symbol with its CP starting after  after the end of the last symbol of the PDSCH carrying the TB being acknowledged, then the UE shall provide a valid HARQ-ACK message. *- N1* is based on *µ* of table 5.3-1 and table 5.3-2 for UE processing capability 1 and 2 respectively, where *µ* corresponds to the one of (*µPDCCH*, *µPDSCH*, *µUL*) resulting with the largest *Tproc,1*, where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH scheduling the PDSCH, the *µPDSCH* corresponds to the subcarrier spacing of the scheduled PDSCH, and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the HARQ-ACK is to be transmitted, and κ is defined in clause 4.1 of [4, TS 38.211]. *-* If the PDSCH DM-RS position for the additional DM-RS in Table 7.4.1.1.2-3 in clause 7.4.1.1.2 of [4, TS 38.211] is then *N1,0=14* inTable 5.3-1*,* otherwise *N1,0=13.*- If the UE is configured with multiple active component carriers, the first uplink symbol which carries the HARQ-ACK information further includes the effect of timing difference between the component carriers as given in [11, TS 38.133].- For the PDSCH mapping type A as given in clause 7.4.1.1 of [4, TS 38.211]: if the last symbol of PDSCH is on the *i-*th symbol of the slot where *i* < 7, then *d1,1 = 7 - i*, otherwise *d1,1 = 0*- For UE processing capability 1: If the PDSCH is mapping type B as given in clause 7.4.1.1 of [4, TS 38.211], and- if the number of PDSCH symbols allocated is *L* ≥ 7, then *d1,1* = 0,- if the number of PDSCH symbols allocated is *L* ≥ 4 and *L* ≤ 6, then *d1,1* = 7- *L.*- if the number of PDSCH symbols allocated is *L* = *3* then *d1,1 = 3 +* min *(d,1)*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- if the number of PDSCH symbols allocated is 2, then *d1,1* = 3*+d*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- For UE processing capability 2: If the PDSCH is mapping type B as given in clause 7.4.1.1 of [4, TS 38.211], - if the number of PDSCH symbols allocated is *L* ≥ 7, then *d1,1* = 0,- if the number of PDSCH symbols allocated is *L* ≥ 3 and *L* ≤ 6, then *d1,1* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH,- if the number of PDSCH symbols allocated is 2,- if the scheduling PDCCH was in a 3-symbol CORESET and the CORESET and the PDSCH had the same starting symbol, then *d1,1* = 3,- otherwise *d1,1* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- For a PDSCH that consists of two PDSCH transmission occasions in one slot, , where- is determined by considering the first PDSCH transmission occasion in the slot, and as described above.- is determined by considering the second PDSCH transmission occasion in the slot, and as described above.- is the higher layer parameter *StartingSymbolOffsetK,* if configured; else = 0.- For UE processing capability 2 with scheduling limitation when *µPDSCH* = 1, if the scheduled RB allocation exceeds 136 RBs, the UE defaults to capability 1 processing time. The UE may skip decoding a number of PDSCHs with last symbol within 10 symbols before the start of a PDSCH that is scheduled to follow Capability 2, if any of those PDSCHs are scheduled with more than 136 RBs with 30kHz SCS and following Capability 1 processing time. - For a UE that supports capability 2 on a given cell, the processing time according to UE processing capability 2 is applied if the high layer parameter *processingType2Enabled* in *PDSCH-ServingCellConfig* is configured for the cell and set to *enable*.- If this PUCCH resource is overlapping with another PUCCH or PUSCH resource, then HARQ-ACK is multiplexed following the procedure in clause 9.2.5 of [6, TS 38.213], otherwise the HARQ-ACK message is transmitted on PUCCH.Otherwise the UE may not provide a valid HARQ-ACK corresponding to the scheduled PDSCH. The value of *Tproc,1* is used both in the case of normal and extended cyclic prefix.--Unchanged part omitted------------------------ |

* **Alt-4: Further relax the PDSCH processing time for URLLC scheme 3 (proposed by Apple). The following TP draft proposed by Apple is the starting point:**

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| ============================ 38.214 Section 5.3 ============================5.3 UE PDSCH processing procedure time< Unchanged parts are omitted >If the first uplink symbol of the PUCCH which carries the HARQ-ACK information, as defined by the assigned HARQ-ACK timing *K1* and the PUCCH resource to be used and including the effect of the timing advance, starts no earlier than at symbol *L1*, where *L1* is defined as the next uplink symbol with its CP starting after  after the end of the last symbol of the PDSCH carrying the TB being acknowledged, then the UE shall provide a valid HARQ-ACK message. *- N1* is based on *µ* of table 5.3-1 and table 5.3-2 for UE processing capability 1 and 2 respectively, where *µ* corresponds to the one of (*µPDCCH*, *µPDSCH*, *µUL*) resulting with the largest *Tproc,1*, where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH scheduling the PDSCH, the *µPDSCH* corresponds to the subcarrier spacing of the scheduled PDSCH, and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the HARQ-ACK is to be transmitted, and κ is defined in clause 4.1 of [4, TS 38.211]. *-* If the PDSCH DM-RS position for the additional DM-RS in Table 7.4.1.1.2-3 in clause 7.4.1.1.2 of [4, TS 38.211] is then *N1,0=14* inTable 5.3-1*,* otherwise *N1,0=13.*- If the UE is configured with multiple active component carriers, the first uplink symbol which carries the HARQ-ACK information further includes the effect of timing difference between the component carriers as given in [11, TS 38.133].- For the PDSCH mapping type A as given in clause 7.4.1.1 of [4, TS 38.211]: For a PDSCH that does not consist of two PDSCH transmission occasions in one slot, if the last symbol of PDSCH is on the *i-*th symbol of the slot where *i* < 7, then *d1,1 = 7 - i*, otherwise *d1,1 = 0*- For UE processing capability 1: For a PDSCH that does not consist of two PDSCH transmission occasions in one slot, if the PDSCH is mapping type B as given in clause 7.4.1.1 of [4, TS 38.211], and- if the number of PDSCH symbols allocated is *L* ≥ 7, then *d1,1* = 0,- if the number of PDSCH symbols allocated is *L* ≥ 4 and *L* ≤ 6, then *d1,1* = 7- *L.*- if the number of PDSCH symbols allocated is *L* = *3* then *d1,1 = 3 +* min *(d,1)*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- if the number of PDSCH symbols allocated is 2, then *d1,1* = 3*+d*, where *d* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- For UE processing capability 2: For a PDSCH that does not consist of two PDSCH transmission occasions in one slot, if the PDSCH is mapping type B as given in clause 7.4.1.1 of [4, TS 38.211], - if the number of PDSCH symbols allocated is *L* ≥ 7, then *d1,1* = 0,- if the number of PDSCH symbols allocated is *L* ≥ 3 and *L* ≤ 6, then *d1,1* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH,- if the number of PDSCH symbols allocated is 2,- if the scheduling PDCCH was in a 3-symbol CORESET and the CORESET and the PDSCH had the same starting symbol, then *d1,1* = 3,- otherwise *d1,1* is the number of overlapping symbols of the scheduling PDCCH and the scheduled PDSCH.- For a PDSCH that consists of two PDSCH transmission occasions in one slot, , where- *N1* is based on *µ* of table 5.3-1, where *µ* corresponds to the one of (*µPDCCH*, *µPDSCH*, *µUL*) resulting with the largest *Tproc,1*, where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH scheduling the PDSCH, the *µPDSCH* corresponds to the subcarrier spacing of the scheduled PDSCH, and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the HARQ-ACK is to be transmitted. - is determined by considering the first PDSCH transmission occasion in the slot, and as described above for UE processing capability 1.- is determined by considering the second PDSCH transmission occasion in the slot, and as described above for UE processing capability 1.- is the higher layer parameter *StartingSymbolOffsetK-r16,* if configured; else = 0.- For UE processing capability 2 with scheduling limitation when *µPDSCH* = 1, if the scheduled RB allocation exceeds 136 RBs, the UE defaults to capability 1 processing time. The UE may skip decoding a number of PDSCHs with last symbol within 10 symbols before the start of a PDSCH that is scheduled to follow Capability 2, if any of those PDSCHs are scheduled with more than 136 RBs with 30kHz SCS and following Capability 1 processing time. < Unchanged parts are omitted > |

Please input your views and comments on these four alternatives:

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| Company | Views and comments |
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1. Reference
2. [R1-2006395](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_102%5CDocs%5CR1-2006395.zip) Remaining issues for Multi-TRP in Rel-16 Huawei, HiSilicon
3. [R1-2006781](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_102%5CDocs%5CR1-2006781.zip) Multi-TRP Enhancements Qualcomm Incorporated
4. R1-2006979 Summary#2 for Rel.16 NR eMIMO maintenance Moderator (Samsung)