**3GPP TSG RAN WG1 #118 R1-240xxxx**

**Maastricht, NL, August 19th – 23rd, 2024**

**Source: Moderator (ZTE)**

**Title: FL summary of PDSCH reception for MBS**

**Agenda item: 7.1**

**Document for:** **Discussion and Decision**

# Introduction

This document provides the summary of PDSCH reception for MBS proposed by [1].

R1-2406113 Draft CR on PDSCH reception for MBS ZTE Corporation, Sanechips

# Discussion

For broadcast reception, it was agreed that the dedicated PDSCH-config can be configured for MTCH, and if it is not configured, PDSCH-config for MCCH configured by SIB can be used.

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| **Agreement**  For broadcast reception with RRC\_IDLE/RRC\_INACTIVE UEs:   * The CFR frequency resources used for MCCH and MTCH are configured by SIBx; * PDCCH-config/PDSCH-config for broadcast reception with GC-PDCCH/PDSCH carrying MCCH is configured by SIBx * PDCCH-config/PDSCH-config for broadcast reception with GC-PDCCH/PDSCH carrying MTCH is configured by MCCH. If the PDCCH-config/PDSCH-config for MTCH is not configured, the PDCCH-config/PDSCH-config for GC-PDCCH/PDSCH carrying MCCH configured by SIBx is reused for GC-PDCCH/PDSCH carrying MTCH. |

This agreement has been captured in the TS 38.331 as shown below.

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| ***pdsch-ConfigMTCH***  Provides parameters for acquiring the PDSCH for MTCH. When this field is absent, the UE shall use parameters in *pdsch-ConfigMCCH* to acquire the PDSCH for MTCH. |

The dedicated PDSCH config includes rate matching pattern configuration, xoverhead, and MCS table configuration. The above agreement is not captured in the TS 38.214 correctly. The draft CR is provided as below.

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| 5.1.3.1 Modulation order and target code rate determination For the PDSCH scheduled by a PDCCH with DCI format 1\_0, format 1\_1, format 1\_2, format 4\_0, format 4\_1 or format 4\_2 with CRC scrambled by C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI, SI-RNTI, RA-RNTI, MSGB-RNTI, G-RNTI, G-CS-RNTI, MCCH-RNTI or P-RNTI, or for the PDSCH scheduled without corresponding PDCCH transmissions using the higher-layer-provided PDSCH configuration *SPS-Config*,  if the higher layer parameter *mcs-Table-r17* given by *PDSCH-Config* is set to 'qam1024', and the PDSCH is scheduled by a PDCCH with DCI format 1\_1 with CRC scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-4 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif *mcs-TableDCI-1-2-r17* given by *PDSCH-Config* is set to 'qam1024', and the PDSCH is scheduled by a PDCCH with DCI format 1\_2 with CRC scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-4 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-TableDCI-1-2* given by *PDSCH-Config* is set to 'qam256', and the PDSCH is scheduled by a PDCCH with DCI format 1\_2 with CRC scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with MCS-C-RNTI, the higher layer parameter *mcs-TableDCI-1-2* given by *PDSCH-Config* is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with DCI format 1\_2 scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *PDSCH-Config* is set to 'qam256', and the PDSCH is scheduled by a PDCCH with DCI format 1\_1 with CRC scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMulticast* is set to 'qam256', and the PDSCH is scheduled by a PDCCH with DCI format 4\_1 or 4\_2 with CRC scrambled by G-RNTI for multicast  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMCCH* is set to 'qam256',  - if the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI or  - if the higher layer parameter *mcs-Table* is not provided in *pdsch-ConfigMTCH* and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by G-RNTI for broadcast  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMulticast* is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with DCI format 4\_1 or 4\_2 with CRC scrambled by G-RNTI for multicast  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMCCH* is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI  - if the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI or  - if the higher layer parameter *mcs-Table* is not provided in *pdsch-ConfigMTCH* and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by G-RNTI for broadcast  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMTCH* is set to 'qam256', and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by G-RNTI for broadcast  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the higher layer parameter *mcs-Table* given by *pdsch-ConfigMTCH* is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by G-RNTI for broadcast  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with MCS-C-RNTI, the higher layer parameter *mcs-Table* given by *PDSCH-Config* is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with a DCI format other than DCI format 1\_2 in a UE-specific search space with CRC scrambled by C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is configured with MCS-C-RNTI, and the PDSCH is scheduled by a PDCCH with CRC scrambled by MCS-C-RNTI  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with the higher layer parameter *mcs-Table* given by *SPS-config*, and the higher layer parameter *mcs-Table-r17* given by *PDSCH-Config* is set to 'qam1024',  - if the PDSCH is scheduled by a PDCCH with DCI format 1\_1 with CRC scrambled by CS-RNTI or  - if the PDSCH with SPS activated by DCI format 1\_1 is scheduled without corresponding PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-4 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with the higher layer parameter *mcs-Table* given by *SPS-config*, and the higher layer parameter *mcs-TableDCI-1-2-r17* given by *PDSCH-Config* is set to 'qam1024',  - if the PDSCH is scheduled by a PDCCH with DCI format 1\_2 with CRC scrambled by CS-RNTI or  - if the PDSCH with SPS activated by DCI format 1\_2 is scheduled without corresponding PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-4 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with the higher layer parameter *mcs-Table* given by *SPS-config*, and the higher layer parameter *mcs-TableDCI-1-2* given by *PDSCH-Config* is set to 'qam256',  - if the PDSCH is scheduled by a PDCCH with DCI format 1\_2 with CRC scrambled by CS-RNTI or  - if the PDSCH with SPS activated by DCI format 1\_2 is scheduled without corresponding PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is not configured with the higher layer parameter *mcs-Table* given by *SPS-Config*, and the higher layer parameter *mcs-Table* given by *PDSCH-Config* is set to 'qam256',  - if the PDSCH is scheduled by a PDCCH with DCI format 1\_1 with CRC scrambled by CS-RNTI or  - if the PDSCH with SPS activated by DCI format 1\_1 is scheduled without corresponding PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is configured with the higher layer parameter *mcs-Table* given by *SPS-Config* set to 'qam64LowSE'  - if the PDSCH is scheduled by a PDCCH with CRC scrambled by CS-RNTI or  - if the PDSCH is scheduled without corresponding PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  elseif the UE is configured with the higher layer parameter *mcs-Table* given by *SPS-Config* or *mcs-Table* of *pdsch-ConfigMulticast* in the same *CFR-ConfigMulticast* set to 'qam64LowSE'  - if the GC-PDSCH is scheduled by a GC-PDCCH with CRC scrambled by G-CS-RNTI or  - if the GC-PDSCH is scheduled without corresponding GC-PDCCH transmission using *SPS-Config*,  - the UE shall use *IMCS* and Table 5.1.3.1-3 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  else  - the UE shall use *IMCS* and Table 5.1.3.1-1 to determine the modulation order (*Qm*) and Target code rate (*R*) used in the physical downlink shared channel.  end  The UE is not expected to decode a PDSCH scheduled with P-RNTI, RA-RNTI, SI-RNTI and *Qm* > 2  **<Unchanged parts are omitted>** 5.1.3.2 Transport block size determination In case the higher layer parameter *maxNrofCodeWordsScheduledByDCI* in *PDSCH-config* indicates that two codeword transmission is enabled, then one of the two transport blocks is disabled by DCI format 1\_1 if *IMCS* = 26 and if *rvid* = 1 for the corresponding transport block. In case the higher layer parameter *maxNrofCodeWordsScheduledByDCI* in *pdsch-ConfigMulticast* indicates that two codeword transmission is enabled, then one of the two transport blocks is disabled by DCI format 4\_2 if *IMCS* = 26 and if *rvid* = 1 for the corresponding transport block. When the UE is configured with higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, either the first or the second transport block of all scheduled PDSCHs is disabled by the DCI format 1\_1 if *IMCS* = 26 and if *rvid* = 2 for the corresponding transport block of all scheduled PDSCHs. If both transport blocks are enabled, transport block 1 and 2 are mapped to codeword 0 and 1 respectively. If only one transport block is enabled, then the enabled transport block is always mapped to the first codeword.  For the PDSCH assigned by a PDCCH with DCI format 1\_0, 1\_1, 4\_0, 4\_1, 4\_2 or 1\_2 with CRC scrambled by C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI, G-RNTI, G-CS-RNTI, MCCH-RNTI or SI-RNTI, if Table 5.1.3.1-2 is used and *,* else if Table 5.1.3.1-4 is used and or a table other than Table 5.1.3.1-2 and Table 5.1.3.1-4 is usedand *,* the UE shall, except if the transport block is disabled in DCI format 1\_1, first determine the TBS as specified below:  1) The UE shall first determine the number of REs (*NRE*) within the slot.  - A UE first determines the number of REs allocated for PDSCH within a PRB () by , where is the number of subcarriers in a physical resource block,  is the number of symbols of the PDSCH allocation within the slot,  is the number of REs for DM-RS per PRB in the scheduled duration including the overhead of the DM-RS CDM groups without data, as indicated by DCI format 1\_1 or format 1\_2 or as described for format 1\_0 in Clause 5.1.6.2, and  is the overhead configured by higher layer parameter *xOverhead* in *PDSCH-ServingCellConfig*. If the *xOverhead* in *PDSCH-ServingCellconfig* is not configured (a value from 6, 12, or 18), the  is set to 0. If the PDSCH is scheduled by PDCCH with a CRC scrambled by SI-RNTI, RA-RNTI, MSGB-RNTI or P-RNTI, is assumed to be 0. If the PDSCH is scheduled by PDCCH with a CRC scrambled by G-RNTI for multicast or G-CS-RNTI or PDSCH without PDCCH is activated by PDCCH with a CRC scrambled by G-CS-RNTI, is the overhead configured by higher layer parameter *xOverhead-Multicast* in *pdsch-ConfigMulticast*. If the *xOverhead-Multicast* in *pdsch-ConfigMulticast* is not configured, the is set to 0. If the PDSCH is scheduled by PDCCH with a CRC scrambled by MCCH-RNTI, or G-RNTI for broadcast and *xOverhead* is not provided in *pdsch-ConfigMTCH*, is the overhead configured by higher layer parameter *xOverhead* in *pdsch-ConfigMCCH*. If the *xOverhead* in *pdsch-ConfigMCCH* is not configured, the is set to 0. If the PDSCH is scheduled by PDCCH with a CRC scrambled by G-RNTI for broadcast, is the overhead configured by higher layer parameter *xOverhead*, if provided, in *pdsch-ConfigMTCH*.  - A UE determines the total number of REs allocated for PDSCH () by , where *nPRB* is the total number of allocated PRBs for the UE.  **<Unchanged parts are omitted>** 5.1.4.1 PDSCH resource mapping with RB symbol level granularity The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying only the parameters of *rateMatchPatternGroup1DCI-1-2*, *rateMatchPatternGroup2DCI-1-2* instead of *rateMatchPatternGroup1* and *rateMatchPatternGroup2*. The procedures for PDSCH scheduled by PDCCH with DCI format 1\_0 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI, or G-RNTI for broadcast when *rateMatchPatternToAddModList* is not provided in *pdsch-ConfigMTCH*, by applying only the parameters of *rateMatchPatternToAddModList* configured in *pdsch-ConfigMCCH*. The procedures for PDSCH scheduled by PDCCH with DCI format 1\_0 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_0 with G-RNTI for broadcast, by applying only the parameters of *rateMatchPatternToAddModList* configured in *pdsch-ConfigMTCH*.  The procedures for PDSCH scheduled by PDCCH with DCI format 1\_0 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_1, and the procedures for PDSCH scheduled by DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_2 by applying only the parameters of *rateMatchPatternToAddModList, rateMatchPatternGroup1* and *rateMatchPatternGroup2* configured in *pdsch-ConfigMulticast*.  **<Unchanged parts are omitted>** 5.1.4.2 PDSCH resource mapping with RE level granularity The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList*.  The procedures for PDSCH scheduled by PDCCH with DCI format 1\_0 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_1 and the procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModList in pdsch-ConfigMulticast* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList in PDSCH-Config*.  A UE may be configured with any of the following higher layer parameters:  *-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  *-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  - For the UE for broadcast reception, REs indicated by *'RateMatchPatternLTE-CRS'* in *pdsch-ConfigMCCH* or *pdsch-ConfigMTCH* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for broadcast PDSCH. The total number of *RateMatchPatternLTE-CRS* for broadcast reception that a UE can be configured with is the same as for unicast in Rel-15. REs indicated by *'RateMatchPatternLTE-CRS'* in *pdsch-ConfigMCCH* for MBS broadcast apply to PDSCH scheduled by PDCCH with DCI format 4\_0 with CRC scrambled by CRC scrambled by MCCH-RNTI, or G-RNTI for broadcast when *lte-CRS-ToMatchAround* is not included in *pdsch-ConfigMTCH*. REs indicated by *'RateMatchPatternLTE-CRS'* in *pdsch-ConfigMTCH* for MBS broadcast apply to PDSCH scheduled by PDCCH with DCI format 4\_0 with CRC scrambled by CRC scrambled G-RNTI for broadcast.  - Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.  - If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.  **<Unchanged parts are omitted>** |

**Question 1:**

Companies are invited to provide their views on the proposed CR in the following table.

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| **Company** | **Comments** |
| Nokia | In general we are OK with the CR.  There seems to be an issue with the xOverhead logic due to the fact that all the if-sentences are in sequence in a single paragraph and thus it is lost that which conditions are hierarchical and which are in parallel. Adding tabulation below emphasizes the issue that was created by adding the MBS xOverhead conditions directly in the same paragraph with the earlier xOverhead definitions. Because of this xOverhead is first set for all cases, then for MBS case, and then set to zero for all cases if some of the RRC configrations were not present.  - A UE first determines the number of REs allocated for PDSCH within a PRB () by , where is the number of subcarriers in a physical resource block,  is the number of symbols of the PDSCH allocation within the slot,  is the number of REs for DM-RS per PRB in the scheduled duration including the overhead of the DM-RS CDM groups without data, as indicated by DCI format 1\_1 or format 1\_2 or as described for format 1\_0 in Clause 5.1.6.2, and  -  is the overhead configured by higher layer parameter *xOverhead* in *PDSCH-ServingCellConfig*. This condition is not tied to how the PDSCH was scheduled.  - If the *xOverhead* in *PDSCH-ServingCellconfig* is not configured (a value from 6, 12, or 18), the  is set to 0. This condition is not tied to how the PDSCH was scheduled.  - If the PDSCH is scheduled by PDCCH with a CRC scrambled by SI-RNTI, RA-RNTI, MSGB-RNTI or P-RNTI, is assumed to be 0.  - If the PDSCH is scheduled by PDCCH with a CRC scrambled by G-RNTI for multicast or G-CS-RNTI or PDSCH without PDCCH is activated by PDCCH with a CRC scrambled by G-CS-RNTI, is the overhead configured by higher layer parameter *xOverhead-Multicast* in *pdsch-ConfigMulticast*.  - If the *xOverhead-Multicast* in *pdsch-ConfigMulticast* is not configured, the is set to 0. This condition is not tied to how the PDSCH was scheduled and should be a sub-case of the sentence above, but it isn’t!  - If the PDSCH is scheduled by PDCCH with a CRC scrambled by MCCH-RNTI, or G-RNTI for broadcast and *xOverhead* is not provided in *pdsch-ConfigMTCH*, is the overhead configured by higher layer parameter *xOverhead* in *pdsch-ConfigMCCH*.  - If the *xOverhead* in *pdsch-ConfigMCCH* is not configured, the is set to 0. This condition is not tied to how the PDSCH was scheduled!  - If the PDSCH is scheduled by PDCCH with a CRC scrambled by G-RNTI for broadcast, is the overhead configured by higher layer parameter *xOverhead*, if provided, in *pdsch-ConfigMTCH*. |
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# Conclusion

# References

1. R1-2406113 Draft CR on PDSCH reception for MBS ZTE Corporation, Sanechips