**3GPP TSG-RAN WG1 Meeting #112bis-e R1-23xxxxx**

**E-meeting, April 16th – 27th, 2023**

**Agenda Item: 7.2**

**Source: Moderator (ZTE)**

**Title: Summary on Rel-17 SDT**

**Document for: Discussion**

# Introduction

This document contains the summary of remaining issues identified in RAN1#112bis-e meeting. The following email thread is used:

[112bis-e-R17-SDT-01] Email discussion on Rel-17 SDT maintenance by April 21 – Ziyang (ZTE)

# Remaining issues on SDT

## Issue#1 Redundancy version for CG-SDT

### First round discussion

In previous meetings, the following agreements have been made in RAN1 and RAN2 for redundancy version of CG-SDT:

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| RAN2#117e agreement  => For autonomous re-tx, fix the RV to be 0 for both the initial and retransmission of initial CG-SDT transmission.  RAN1#112 agreement  Agreement  For initial transmission or autonomous retransmission of initial PUSCH transmission for CG-SDT, the RV is determined by repK-RV if repK-RV is configured. |

In R1-2303291, ZTE, vivo, Samsung and Intel propose that according to above agreements, for initial transmission or autonomous retransmission of initial PUSCH transmission for CG-SDT, current description for RV of PUSCH transmission for CG-SDT in section 19.1 in TS 38.213 should be revised so that it will be applied only if *repK-RV* is not configured. The content of the draft CR is shown in section 5.1.

**FL suggestion:**

Adopt the draft CR R1-2303291 for TS 38.213.

Companies are encouraged to provide comment and and suggested priority (Low/Medium/High).

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| Company | Priority | Comment |
| NewH3C | High |  |
| vivo | High |  |
| Huawei | High | For companies to consider whether there could be an issue since the parameter (for RV) may not be configured while repetitions could still be configured. |
| Samsung | high | Ok with suggestion. |
| Intel | High |  |
| Xiaomi | High | Fine with TP#1 |
| LG Electronics | High |  |
| Ericsson | High | Fine with FL’s suggestion |

### Second round discussion

All companies think this is high priority, and there is no objection on FL suggestion, so the following proposal is provided:

**Proposal 2.1**

Adopt the draft CR R1-2303291 for TS 38.213.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Xiaomi | Support |
| New H3C | Fine |
| Huawei | For the case that repetition is configured but repRV is not configured, we are a bit not sure if the draftCR is still good enough. We had some offline discussion with the co-sourced companies, but apologize for not identifying this potential issue earlier. |
| Apple | Ok with the proposal. if repetition is configured, it can be discussed separately whether current spec is enough. |
| Intel | Support. We can further check the case that Huawei mentioned. |
| Ericsson | Fine |
| Qualcomm | OK |

## Issue#2 Alignment on CG-SDT-CS-RNTI

### First round discussion

In R1-2302742, Ericsson mentions that RAN2 has introduced the CG-SDT-CS-RNTI for CG-SDT retransmissions, which is equivalent to that of CS-RNTI when there is an CG-SDT procedure ongoing, but only CS-RNTI is mentioned in 38.211. The content of the draft CR is shown in section 5.1.

After checking RAN2 spec on the CG-SDT-CS-RNTI, this new RNTI is introduced with the following changes in RNTI usage table with a note:

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| --- | --- | --- | --- | --- |
| TS 38.321  **7.1 RNTI values**  Table 7.1-2: RNTI usage.   |  |  |  |  | | --- | --- | --- | --- | | CG-SDT-CS-RNTI | Dynamically scheduled unicast transmission  (retransmission) | UL-SCH | CCCH, DCCH, DTCH |   NOTE 3: The usage of CG-SDT-CS-RNTI is equivalent to that of CS-RNTI when there is an CG-SDT procedure ongoing. |

However, in the main text of TS 38.321, CG-SDT-CS-RNTI does not appear anywhere, even in section 5.27.1 dedicated for SDT, the RNTI to schedule SDT re-transmission is still CS-RNTI:

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| --- |
| TS 38.321  **5.4 UL-SCH data transfer**  If the MAC entity has a C-RNTI, a Temporary C-RNTI, or CS-RNTI, the MAC entity shall for each PDCCH occasion and for each Serving Cell belonging to a TAG that has a running *timeAlignmentTimer* or a running *cg-SDT-TimeAlignmentTimer* and for each grant received for this PDCCH occasion:  **5.27 Small Data Transmission**  If CG-SDT is selected above and after the initial transmission for CG-SDT is performed, the UE monitors PDCCH addressed to C-RNTI as stored in UE Inactive AS context as specified in TS 38.331 [5] and CS-RNTI until the CG-SDT procedure is terminated. |

**FL observation:**

RAN2 assumes that when there is an CG-SDT procedure ongoing, “CS-RNTI” in RAN2 spec refers to “CG-SDT-CS-RNTI”, they didn’t add “CG-SDT-CS-RNTI” in all places in which this RNTI may be used.

**FL suggestion:**

Companies are encouraged to check the following potential options to handle this issue:

- Option 1: Identify all positions in RAN1 spec in which CG-SDT-CS-RNTI may be used and add the RNTI name.

- Note: If this option is adopted, draft CR in R1-2302742 can be starting point for discussion by considering that CG-SDT-CS-RNTI is only used to schedule **UL re-transmission for CG-SDT**.

- Option 2: Add a similar note in RAN1 spec, e.g. “CG-SDT-CS-RNTI is used equivalent to that of CS-RNTI when there is an CG-SDT procedure ongoing”

- Option 3: Assume that the Note 3 in Table 7.1-2 in TS 38.321 also applies to RAN1 spec. No spec change in RAN1 is required.

Any comment on FL observation/suggestion and suggested priority (Low/Medium/High)?

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| --- | --- | --- |
| Company | Priority | Comment |
| NewH3C | High | Slightly prefer option 3. |
| Vivo | High | Option 3 is a bit preferred. |
| Huawei | High |  |
| Samsung | M | Option 3, following RAN2 logic. |
| Intel | High | We prefer Option 3. |
| Xiaomi | High | Down-select between Option 2 and Option 3. |
| Ericsson |  | Option 3 is the simplest way to address the issue. |
| LG Electronics | High | We slightly prefer option 3. |

### Second round discussion

Most companies suggest this as high priority and prefer Option 3, i.e. assuming that the Note 3 in Table 7.1-2 in TS 38.321 also applies to RAN1 spec. With this, FL suggests to make a conclusion to reflect the RAN1 understanding.

**Conclusion 2.2:**

It’s RAN1’s common understanding that the usage of CG-SDT-CS-RNTI is equivalent to that of CS-RNTI in RAN1 spec when there is an CG-SDT procedure ongoing.

- No need to introduce CG-SDT-CS-RNTI in RAN1 spec.

Any comments?

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| --- | --- |
| Company | Comment |
| Xiaomi | Fine with the conclusion. |
| NewH3C | OK |
| Huawei | It is better to allow more time for companies to check whether they are indeed equivalent. |
| Apple | OK with the conclusion. |
| Intel | Support the conclusion |
| Ericsson | Fine with the conclusion. |
| Qualcomm | OK |

## Issue#3 Simultaneous reception of SDT and other channels

### First round discussion

In R1-2302957, Xiaomi mentions that in Rel-15, the UE shall be able to decode two broadcast/unicast downlink channels simultaneously during the RRC\_INACTIVE state, including PBCH, SIB1, OSI, paging, Msg2/B and Msg4. The physical downlink channel of SDT is the same as physical downlink channels of Msg3/4, which can be regarded as a kind of unicast channel in the inactive state, so SDT should have a similar situation to Msg3/4. That is, the UE shall be able to simultaneously receive the PDCCH/PDSCH of SDT and one of other multiple broadcast/unicast physical downlink channels during the inactive state. The TPs for TS 38.214 and TS 38.202 are shown in section 5.3 and 5.4 respectively.

FL thinks that TP#3 is reasonable since C-RNTI scheduled PDSCH is possible during SDT in inactive state, it can be added along with other RNTIs. As for TP#4, it’s not clear whether it’s really needed, if so, it may need some revisions, e.g. the reception type combinations A + (B and/or (C1 or Q) and/or D0 and/or D1) + F0+F1 can be added in a new row namely “UEs supporting SDT” instead of “All UEs”. In addition, whether CG-SDT-CS-RNTI should be added can wait for the discussion of section 2.2.

#### Revised TP#4

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| 6.2 Downlink  **<Unchanged parts omitted>**  **Table 6.2-2: Downlink “Reception Type” combinations**   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Supported Combinations** | | | | | **Comment** | | | **Pcell** | **PSCell** | | **Scell** | | | 2. RRC\_INACTIVE | | | | | | | | 2.1 All UEs | | | | | | | | A + (B and/or (C1 or Q) and/or D0) + F0 |  | |  | | Note 1 | | | 2.2 UEs supporting MBS broadcast reception | | | | | | | | A+D5 | |  | |  | |  | | 2.3 UEs supporting SDT | | | | | | | | A + (B and/or (C1 or Q) and/or D0 and/or D1) + F0+F1 | |  | |  | |  | | Note 1: UE is not required to decode more than two PDSCH simultaneously, and decoding prioritization when more than two are received is up to UE implementation. | | | | | | |   **<Unchanged parts omitted>** |

In addition, Xiaomi also proposes to consider whether to support the simultaneous reception of MBS and SDT during the inactive state.

**FL suggestion:**

1. Adopt TP#3 in section 5.3 for TS 38.214.
2. Companies are encouraged to check whether TP#4 for TS 38.202 is needed, if so, whether TP#4 needs to be revised?
3. Companies are encouraged to check whether to support the simultaneous reception of MBS and SDT during the inactive state.

Any comment on TP#3, 4 and suggested priority (Low/Medium/High)?

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| Company | Priority | Comment |
| New H3C | High |  |
| vivo | High | **For section 5.1 of 38.214:**  Basically, this is about the overlapping between C-RNTI scheduling and SI-RNTI scheduling during SDT procedure. In our view, the C-RNTI scheduling in SDT, i.e. the subsequent transmission should have lower priority than SI (i.e. the UE does not need to decode two PDSCH transmissions). Therefore, no change is needed.  It should also be noted that P-RNTI/RA-RTNI/TC-RNTI scheduling overlapping with C-RTNI is impossible for SDT. And C-RNTI is not used for IDLE either.  **For 38.202 CR:**  It is needed. However, the proposed CR is not correct as current type can not be simply reused and the relationship between existing type D/F and SDT specific type D/F should be “or”.  For RRC inactive state, for SDT, we should define D7= C-RNTI for PDCCH+PDSCH; F2= CG-SDT-CS-RNTI+C-RNTI for PDCCH scheduling UL-SCH.  And for all UEs in RRC inactive state: A + (B and/or (C1 or Q) and/or (D0 or D7)) + (F0 or F2) |
| Qualcomm | High |  |
| Huawei | High |  |
| Samsung | M | First of all, if nothing is being modified in spec, we think the UE behavior is still clear, after all the simultaneous reception over 2 PDSCH will left to UE implementation. I see no issue that if UE handles any one involving SDT PDSCH;  Second of all, from strictly correct specification point of view, TP3 is acceptable, and TP4 the first part is not needed (e.g., no need to add the CG-SDT-CS-RNTI), as discussed in issue#2, it acts same as CS-RNTI without putting its name everywhere. The second part is needed, and we think D1 and F1 should be ok, instead of the vivo’s introduction of new D7 and F2 , which is covered by D1 and F1. |
| Intel | High |  |
| Xiaomi | High | From UE implementation perspective, the UE has the capability to decode one unicast PDSCH and one broadcast PDSCH at the same time, since the capability has already been implemented during connected state for the simultaneous reception of OSI and unicast PDSCH. So, we think the same requirement can be reused for DL reception during SDT procedure in indicative state.  We are fine with Samsung’s suggestion on the first part of TP4 that not introducing CG-SDT-CG-RNTI as discussed in Issue#2 |
| Ericsson | High | TP#3 is fine with us.  For TP#4 and simultaneous reception of MBS and SDT, we will check further and provide our views in the next round. |
| LG Electronics | High |  |

### Second round discussion

Most companies suggest that this issue should be high priority, but companies have different views on the exact TP.

For TP#3, vivo thinks this TP is not needed since UE does not need to simultaneously receive 2 PDSCHs in which one of them is C-RNTI scheduled PDSCH in SDT, but Samsung, Ericsson and Xiaomi support TP#3 with the understanding that UE already has the capability to decode 2 PDSCHs in inactive state, the requirement also applies to PDSCH scheduled during SDT procedure. From FL’s perspective, it’s reasonable to add C-RNTI as one of the possible RNTIs for scheduling PDSCH in inactive state, it does not change the capability of UE.

Then the following proposal is provided:

**Proposal 2.3:**

Adopt the following TP in TS 38.214 as alignment CR for editors.

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| 5.1 UE procedure for receiving the physical downlink shared channel  **<Unchanged parts omitted>**  The UE in RRC\_IDLE and RRC\_INACTIVE modes shall be able to decode two PDSCHs each scheduled with SI-RNTI, P-RNTI, RA-RNTI, C-RNTI or TC-RNTI, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs.  **<Unchanged parts omitted>** |

Any comments?

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| --- | --- |
| Company | Comment |
| Xiaomi | Support |
| Vivo | Do not support.  We didn’t discuss such UE behavior in normative SDT work item, and at such maintenance stage, it would be preferred to just keep it as it is. |
| NewH3C | Proposed text mentioned the UE in RRC\_IDLE and RRC\_INACTIVE can decode PDSCH with C-RNTI. First of all, STD doesn’t work in idle mode not in inactive mode. This potentially extended SDT work scope from inactive mode to idle mode. In addition, this motivation of proposal isn’t clear to us and why UE can decode PDSCH with C-RNTI in inactive mode.  In the end, current proposed text isn’t required. |
| Apple | Current TP is not correct, it extends to decode PDSCH address by C-RNTI to RRC idle mode. |
| Intel | We share similar concern as Vivo. For SDT in RRC inactive mode, it is expected that the traffic is sporadic, which indicates the PDSCH transmission with C-RNTI should not be frequently scheduled. gNB scheduler or UE implementation can handle such overlapping.  In addition, as mentioned by other companies, this does not apply for RRC idle mode.  We do not support this CR. |
| Ericsson | We would be fine if it is clarified that C-RNTI in the TP applies only to RRC\_INACTIVE. |
| Qualcomm | Same view as Ericsson |

For TP#4, vivo prefers to define D7= C-RNTI for PDCCH+PDSCH; F2= CG-SDT-CS-RNTI+C-RNTI for PDCCH scheduling UL-SCH, while Samsung thinks D1 and F1 can be reused since D7 and F2 can be covered by D1 and F1. In addition, in the discussion of Issue#2, most companies prefer to not introduce CG-SDT-CS-RNTI in RAN1 spec, so the same logic can be followed in this section.

FL thinks TP is needed but it’s better to align companies’ understanding on the following questions before making further revisions on the TP.

Q1: Do you prefer to define new reception types for SDT, i.e. D7= C-RNTI for PDCCH+PDSCH; F2= CS-RNTI+C-RNTI for PDCCH scheduling UL-SCH, or reuse existing reception types for SDT, i.e. D1=C-RNTI, CS-RNTI, MCS-C-RNTI for PDCCH+PDSCH; F1=C-RNTI, CS-RNTI, MCS-C-RNTI for PDCCH scheduling UL-SCH?

Q2: For supported combinations in Table 6.2-2, do you prefer to directly modify 2.1 All UEs or add a new row 2.3 UEs supporting SDT?

Any comments on Q1, Q2 and anything else?

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| --- | --- |
| Company | Comment |
| Xiaomi | For Q1, if “,” in “C-RNTI, CS-RNTI, MCS-C-RNTI” denotes “and”, a new D7= C-RNTI for PDCCH+PDSCH, and a new F2= CS-RNTI+C-RNTI for PDCCH scheduling UL-SCH can be introduced; else if it denotes “or”, then the D1 can be reused.  For Q2, both ways summarized by FL are OK for us. |
| Vivo | For Q1, in our understanding, it is obvious that *CS-RNTI* and *MCS-C-RNTI* (for PDCCH+PDSCH) are not supported in RRC inactive state, which means D1 can not be simply reused and a separate definition of D7 is needed. Similarly, MCS-C-RNTI (for PDCCH+ULSCH) is not supported in RRC inactive state either, thus a definition of F2 would be needed. Maybe Samsung can clarify a bit more on the different understanding in last round as is also pointed out by Xiaomi?  For Q2, modify 2.1 for all UEs as we commented in last round should be enough at least according to our understanding. |
| Intel | Q1: it seems a new D7 and F2 are needed given that MCS-C-RNTI is not supported for SDT, but we would like to hear more views from companies.  Q2: it may be good to separate SDT operation from all UEs. |
| Ericsson | Q1: Our preference would be to add new reception types for SDT.  Q2: Our preference would be to add a new row for UEs supporting SDT. |

# Summary

The final proposals will be added later.

# References

1. R1-2302742 Alignment of terminology Ericsson LM
2. R1-2302957 Corrections on simultaneous reception during SDT procedure xiaomi
3. R1-2303291 Correction on redundancy version for CG-SDT in TS 38.213 ZTE, vivo, Samsung, Intel

# Appendix

## TP#1 for TS 38.213 in R1-2303291, ZTE, vivo, Samsung, Intel

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| **Reason for change:**  In RAN1#112, the following is agreed for redundancy version of PUSCH transmission for CG-SDT.  Agreement  For initial transmission or autonomous retransmission of initial PUSCH transmission for CG-SDT, the RV is determined by repK-RV if repK-RV is configured.  With this agreement, current description for RV of PUSCH transmission for CG-SDT in section 19.1 in TS 38.213 should be revised so that it will be applied only if *repK-RV* is not configured.  **Summary of change:**  In section 19.1, “if the UE is not provided *repK-RV*” is added after the description “For initial transmission or autonomous retransmission of an initial transport block provided for the PUSCH transmission as described in clause 18.0 in [19, TS 38.300], the UE encodes the transport block using redundancy version number 0 ”.  **Consequences if not approved:**  The RV determination is not clear for PUSCH transmission during CG-SDT when *repK-RV* is configured.  **< Unchanged text omitted >** 19.1 Configured-grant based PUSCH transmission A UE determines a power of a PUSCH transmission as described in clause 7.1.1, where the UE obtains using a RS resource from an SS/PBCH block with index associated with the PUSCH transmission.  A UE can be provided a USS set by *SearchSpace*, or a CSS set by *sdt-SearchSpace*, to monitor PDCCH for detection of DCI format 0\_0 with CRC scrambled by C-RNTI or CS-RNTI for scheduling PUSCH transmission or of DCI format 1\_0 with CRC scrambled by C-RNTI for scheduling PDSCH receptions [12, TS 38.331]. The UE may assume that the DM-RS antenna port associated with the PDCCH receptions, the DM-RS antenna port associated with the PDSCH receptions, and the SS/PBCH block associated with the PUSCH transmission are quasi co-located with respect to average gain and quasi co-location 'typeA' or 'typeD' properties. The UE transmits a PUCCH with HARQ-ACK information associated with the PDSCH receptions as described in clause 9.2.1 using a same spatial domain transmission filter as for the last PUSCH transmission.  For initial transmission or autonomous retransmission of an initial transport block provided for the PUSCH transmission as described in clause 18.0 in [19, TS 38.300], the UE encodes the transport block using redundancy version number 0 if the UE is not provided *repK-RV*.  **< Unchanged text omitted >** |

## TP#2 for TS 38.211 in R1-2302742, Ericsson

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| **Reason for change:**  RAN2 has introduced the CG-SDT-CS-RNTI for CG-SDT retransmissions, which is equivalent to that of CS-RNTI when there is an CG-SDT procedure ongoing, but only CS-RNTI is mentioned in 38.211  **Summary of change:**  Adding CG-SDT-CS-RNTI  **Consequences if not approved:**  Misalignment between RAN1 and RAN2 specifications  **< Unchanged text omitted >**  **6.3.1.1 Scrambling**  For the single codeword, the block of bits , where is the number of bits in codeword transmitted on the physical channel, shall be scrambled prior to modulation, resulting in a block of scrambled bits according to the following pseudo code  Set *i* = 0  while  if  // UCI placeholder bits    else  if  // UCI placeholder bits    else    end if  end if  *i* = *i* + 1  end while  where x and y are tags defined in [4, TS 38.212] and where the scrambling sequence is given by clause 5.2.1. The scrambling sequence generator shall be initialized with  where  -  equals the higher-layer parameter *dataScramblingIdentityPUSCH* if configured and the RNTI equals the C-RNTI, MCS-C-RNTI, SP-CSI-RNTI, CG-SDT-CS-RNTI or CS-RNTI, and the transmission is not scheduled using DCI format 0\_0 in a common search space;  - equals the higher-layer parameter *msgA-DataScramblingIndex* if configured and the PUSCH transmission is triggered by a Type-2 random access procedure as described in clause 8.1A of [5, TS 38.213];  -  otherwise  - is the index of the random-access preamble transmitted for msgA as described in clause 5.1.3A of [11, TS 38.321]  and where  equals the RA-RNTI for msgA and otherwise corresponds to the RNTI associated with the PUSCH transmission as described in clause 6.1 of [6, TS 38.214] and clause 8.3 of [5, TS 38.213].  **6.4.1.1.1.1 Sequence generation when transform precoding is disabled**  If transform precoding for PUSCH is not enabled, the sequence  shall be generated according to  .  where the pseudo-random sequence  is defined in clause 5.2.1. The pseudo-random sequence generator shall be initialized with  where  is the OFDM symbol number within the slot, is the slot number within a frame, and  - are given by the higher-layer parameters *scramblingID0* and *scramblingID1*, respectively, in the *DMRS-UplinkConfig* IE if provided and the PUSCH is scheduled by DCI format 0\_1 or 0\_2, or by a PUSCH transmission with a configured grant;  - is given by the higher-layer parameter *scramblingID0* in the *DMRS-UplinkConfig* IE if provided and the PUSCH is scheduled by DCI format 0\_0 with the CRC scrambled by C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI or CS-RNTI;  - are, for each msgA PUSCH configuration, given by the higher-layer parameters *msgA-ScramblingID0* and *msgA-ScramblingID1*, respectively, in the *msgA-DMRS-Config* IE if provided and the PUSCH transmission is triggered by a Type-2 random access procedure as described in clause 8.1A of [5, TS 38.213];  - otherwise;  - and are given by  - if the higher-layer parameter *dmrs-Uplink* in the *DMRS-UplinkConfig* IE is provided  where is the CDM group defined in clause 6.4.1.1.3.  - otherwise  The quantity is  - indicated by the DM-RS initialization field, if present, either in the DCI associated with the PUSCH transmission if DCI format 0\_1 or 0\_2, in [4, TS 38.212] is used;  - indicated by the higher layer parameter *dmrs-SeqInitialization*, if present, for a Type 1 PUSCH transmission with a configured grant;  - determined by the mapping between preamble(s) and a PUSCH occasion and the associated DMRS resource for a PUSCH transmission of Type-2 random access process in [5, TS 38.213];  - determined by the mapping between SS/PBCH block(s) and a PUSCH occasion and the associated DMRS resource for a configured-grant based PUSCH transmission in RRC\_INACTIVE state [5, TS 38.213];  - otherwise .  **6.4.1.1.1.2 Sequence generation when transform precoding is enabled**  If transform precoding for PUSCH is enabled, the reference-signal sequence  shall be generated according to    where with depends on the configuration:  - if the higher-layer parameter *dmrs-UplinkTransformPrecoding* is configured, π/2-BPSK modulation is used for PUSCH, and the PUSCH transmission is not a msg3 transmission, and the transmission is not scheduled using DCI format 0\_0 in a common search space, is given by clause 5.2.3 with given by  where unless given by the DCI according to clause 7.3.1.1.2 in [4, TS38.212] for a transmission scheduled by DCI format 0\_1, or given by the DCI according to clause 7.3.1.1.3 in [4, TS38.212] for a transmission scheduled by DCI format 0\_2 if the antenna ports field in the DCI format 0\_2 is not 0 bit, or given by the higher-layer parameter *antennaPort* for a PUSCH transmission scheduled by a type-1 configured grant; and  - are given by the higher-layer parameters *pi2BPSK-ScramblingID0* and *pi2BPSK-ScramblingID1*, respectively, in the *DMRS-UplinkConfig* IE if provided and the PUSCH is scheduled by DCI format 0\_1, or by DCI format 0\_2 if the antenna ports field in the DCI format 0\_2 is not 0 bit, or by a PUSCH transmission with a configured grant;  - is given by the higher-layer parameter *pi2BPSK-ScramblingID0* in the *DMRS-UplinkConfig* IE if provided and the PUSCH is scheduled by DCI format 0\_0 with the CRC scrambled by C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, or CS-RNTI, or by DCI format 0\_2 if the antenna ports field in the DCI format 0\_2 is 0 bit;  - otherwise;  - otherwise, is given by clause 5.2.2 with .  The sequence group , where is given by  - if is configured by the higher-layer parameter *nPUSCH-Identity* in the *DMRS-UplinkConfig* IE, and  - the higher-layer parameter *dmrs-UplinkTransformPrecoding* is not configured or the higher-layer parameter *dmrs-UplinkTransformPrecoding* is configured and π/2-BPSK modulation is not used for PUSCH, and  - the PUSCH is neither scheduled by RAR UL grant nor scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI according to clause 8.3 in [5, TS 38.213];  - if the higher-layer parameter *dmrs-UplinkTransformPrecoding* is configured, π/2-BPSK modulation is used for PUSCH, the PUSCH transmission is not a msg3 transmission, and the transmission is not scheduled using DCI format 0\_0 in a common search space;  - otherwise  where  and the sequence number are given by:  - if neither group, nor sequence hopping is enabled    - if group hopping is enabled and sequence hopping is disabled    where the pseudo-random sequence  is defined by clause 5.2.1 and shall be initialized with  at the beginning of each radio frame  - if sequence hopping is enabled and group hopping is disabled    where the pseudo-random sequence  is defined by clause 5.2.1 and shall be initialized with  at the beginning of each radio frame.  The hopping mode is controlled by higher-layer parameters:  - for PUSCH transmission scheduled by RAR UL grant or by DCI format 0\_0 with CRC scrambled by TC-RNTI, sequence hopping is disabled and group hopping is enabled or disabled by the higher-layer parameter *groupHoppingEnabledTransformPrecoding;*  - for all other transmissions, sequence hopping and group hopping are enabled or disabled by the respective higher-layer parameters *sequenceHopping* and *sequenceGroupHopping* if these parameters are provided, otherwise, the same hopping mode as for Msg3 shall be used.  The UE is not expected to handle the case of combined sequence hopping and group hopping.  The quantity above is the OFDM symbol number in the slot except for the case of double-symbol DMRS in which case is the OFDM symbol number in the slot of the first symbol of the double-symbol DMRS.  **6.4.1.2.2.1 Precoding and mapping to physical resources if transform precoding is not enabled**  The UE shall transmit phase-tracking reference signals only in the resource blocks used for the PUSCH, and only if the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are being used.  The PUSCH PT-RS shall be mapped to resource elements according to    when all the following conditions are fulfilled  -  is within the OFDM symbols allocated for the PUSCH transmission  - resource element  is not used for DM-RS  -  and correspond to  The quantities and are given by Tables 6.4.1.1.3-1 and 6.4.1.1.3-2, the configuration type is given by the higher-layer parameter *dmrs-Type* in the *DMRS-UplinkConfig* IE, and the precoding matrix is given by clause 6.3.1.5*.* The quantity  is an amplitude scaling factor to conform with the transmit power specified in clause 6.2.2 of [6, TS 38.214].  The set of time indices  defined relative to the start of the PUSCH allocation is defined by  1. set and  2. if any symbol in the interval overlaps with a symbol used for DM-RS according to clause 6.4.1.1.3  - set  - set  to the symbol index of the DM-RS symbol in case of a single-symbol DM-RS or to the symbol index of the second DM-RS symbol in case of a double-symbol DM-RS  - repeat from step 2 as long as  is inside the PUSCH allocation  3. add  to the set of time indices for PT-RS  4. increment  by one  5. repeat from step 2 above as long as  is inside the PUSCH allocation  where  is defined in Table 6.2.3.1-1 of [6, TS 38.214].  For the purpose of PT-RS mapping, the resource blocks allocated for PUSCH transmission are numbered from 0 to  from the lowest scheduled resource block to the highest. The corresponding subcarriers in this set of resource blocks are numbered in increasing order starting from the lowest frequency from 0 to . The subcarriers to which the PT-RS shall be mapped are given by    where  -  -  is given by Table 6.4.1.2.2.1-1 for the DM-RS port associated with the PT-RS port according to clause 6.2.3 in [6, TS 38.214]. If the higher-layer parameter *resourceElementOffset* in *PTRS-UplinkConfig* is not configured, the column corresponding to 'offset00' shall be used.  - is the RNTI associated with the DCI scheduling the transmission using C-RNTI, CS-RNTI, MCS-C-RNTI, SP-CSI-RNTI, or is the CG-SDT-CS-RNTI or CS-RNTI in case of configured grant  -  is the number of resource blocks scheduled  - is given by [6, TS 38.214].  Table 6.4.1.2.2.1-1: The parameter  .   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | DM-RS antenna port |  | | | | | | | | | DM-RS Configuration type 1 | | | | DM-RS Configuration type 2 | | | | | *resourceElementOffset* | | | | *resourceElementOffset* | | | | | offset00 | offset01 | offset10 | offset11 | offset00 | offset01 | offset10 | offset11 | | 0 | 0 | 2 | 6 | 8 | 0 | 1 | 6 | 7 | | 1 | 2 | 4 | 8 | 10 | 1 | 6 | 7 | 0 | | 2 | 1 | 3 | 7 | 9 | 2 | 3 | 8 | 9 | | 3 | 3 | 5 | 9 | 11 | 3 | 8 | 9 | 2 | | 4 | - | - | - | - | 4 | 5 | 10 | 11 | | 5 | - | - | - | - | 5 | 10 | 11 | 4 |     **7.3.1.1 Scrambling**  Up to two codewords  can be transmitted. In case of single-codeword transmission, .  For each codeword , the UE shall assume the block of bits , where is the number of bits in codeword  transmitted on the physical channel, are scrambled prior to modulation, resulting in a block of scrambled bits according to    where the scrambling sequence is given by clause 5.2.1. The scrambling sequence generator shall be initialized with  where  -  equals the higher-layer parameter *dataScramblingIdentityPDSCH* if configured and the RNTI equals the C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, or CS-RNTI, and the transmission is not scheduled using DCI format 1\_0 in a common search space;  - equals the higher-layer parameter *dataScramblingIdentityPDSCH* if configured in a common MBS frequency resource and the RNTI equals the G-RNTI, G-CS-RNTI, or MCCH-RNTI, and the transmission is scheduled using DCI in a common search space configured in the common MBS frequency resource;  - equals  - the higher-layer parameter *dataScramblingIdentityPDSCH* if the codeword is scheduled using a CORESET with *CORESETPoolIndex* equal to 0;  - the higher-layer parameter *dataScramblingIdentityPDSCH2* if the codeword is scheduled using a CORESET with *CORESETPoolIndex* equal to 1;  if the higher-layer parameters *dataScramblingIdentityPDSCH* and *dataScramblingIdentityPDSCH2* are configured together with the higher-layer parameter *CORESETPoolIndex* containing two different values, and the RNTI equals the C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, or CS-RNTI, and the transmission is not scheduled using DCI format 1\_0 in a common search space;  - otherwise  and where  corresponds to the RNTI associated with the PDSCH transmission as described in clause 5.1 of [6, TS 38.214].    **7.3.1.5 Mapping to virtual resource blocks**  The UE shall, for each of the antenna ports used for transmission of the physical channel, assume the block of complex-valued symbols conform to the downlink power allocation specified in [6, TS 38.214] and are mapped in sequence starting with to resource elements in the virtual resource blocks assigned for transmission which meet all of the following criteria:  - they are in the virtual resource blocks assigned for transmission;  - the corresponding physical resource blocks are declared as available for PDSCH according to clause 5.1.4 of [6, TS 38.214];  - the corresponding resource elements in the corresponding physical resource blocks are  - not used for transmission of the associated DM-RS or DM-RS intended for other co-scheduled UEs as described in clause 7.4.1.1.2;  - not used for non-zero-power CSI-RS, which is according to clause 7.4.1.5 and not configured by *TRS-ResourceSet* IE, if the corresponding physical resource blocks are for a PDSCH scheduled by a PDCCH with the CRC scrambled by C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, CS-RNTI, G-RNTI for multicast, G-CS-RNTI, or a PDSCH with SPS, except if the non-zero-power CSI-RS is a CSI-RS configured by the higher-layer parameter *CSI-RS-Resource-Mobility* in the *MeasObjectNR* IE or except if the non-zero-power CSI-RS is an aperiodic non-zero-power CSI-RS resource;  - not used for PT-RS according to clause 7.4.1.2;  - not declared as 'not available for PDSCH according to clause 5.1.4 of [6, TS 38.214].  The mapping to resource elements allocated for PDSCH according to [6, TS 38.214] and not reserved for other purposes shall be in increasing order of first the index over the assigned virtual resource blocks, where is the first subcarrier in the lowest-numbered virtual resource block assigned for transmission, and then the index .  **7.4.1.1.1 Sequence generation**  The UE shall assume the sequence is defined by  .  where the pseudo-random sequence is defined in clause 5.2.1. The pseudo-random sequence generator shall be initialized with  where is the OFDM symbol number within the slot, is the slot number within a frame, and  - are given by the higher-layer parameters *scramblingID0* and *scramblingID1*, respectively, in the *DMRS-DownlinkConfig* IE if provided and the PDSCH is scheduled by PDCCH using DCI format 1\_1 or 1\_2 with the CRC scrambled by C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, or CS-RNTI;  - is given by the higher-layer parameter *scramblingID0* in the *DMRS-DownlinkConfig* IE if provided and the PDSCH is scheduled by PDCCH using DCI format 1\_0 with the CRC scrambled by C-RNTI, MCS-C-RNTI, CG-SDT-CS-RNTI, or CS-RNTI;  - are given by the higher-layer parameters *scramblingID0* and *scramblingID1*, respectively, in the *DMRS-DownlinkConfig* IE if provided in a common MBS frequency resource for multicast and the PDSCH is scheduled by PDCCH using DCI format 4\_2 with the CRC scrambled by G-RNTI or G-CS-RNTI;  - is given by the higher-layer parameter *scramblingID0* in the *DMRS-DownlinkConfig* IE if provided in a common MBS frequency resource and the PDSCH is scheduled by PDCCH with the CRC scrambled by G-RNTI, G-CS-RNTI, or MCCH-RNTI;  - otherwise;  - given by  - if the higher-layer parameter *dmrs-Downlink* in the *DMRS-DownlinkConfig* IE is provided  where λ is the CDM group defined in clause 7.4.1.1.2.  - otherwise by  The quantity is given by the DM-RS sequence initialization field, if present, in the DCI associated with the PDSCH transmission if DCI format 1\_1, 1\_2, or 4\_2 in [4, TS 38.212] is used, otherwise .  **< Unchanged text omitted >** |

## TP#3 for TS 38.214 in R1-2302957, Xiaomi

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| 5.1 UE procedure for receiving the physical downlink shared channel  **<Unchanged parts omitted>**  The UE in RRC\_IDLE and RRC\_INACTIVE modes shall be able to decode two PDSCHs each scheduled with SI-RNTI, P-RNTI, RA-RNTI, C-RNTI or TC-RNTI, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs.  **<Unchanged parts omitted>** |

## TP#4 for TS 38.202 in R1-2302957, Xiaomi

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 6.2 Downlink  **<Unchanged parts omitted>**  **Table 6.2-1: Downlink "Reception Types"**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **"Reception Type"** | **Physical Channel(s)** | | **Monitored RNTI** | | **Associated Transport Channel** | | | **Comment** | | **<Unchanged rows omitted>** | | | | | | | | | | D1 | | PDCCH+PDSCH | | C-RNTI, CS-RNTI, MCS-C-RNTI | | DL-SCH |  | | | D2 | | PDCCH | | C-RNTI, CS-RNTI, MCS-C-RNTI | | DL-SCH |  | | | D3 | | PDCCH+PDSCH | | G-RNTI, G-CS-RNTI | | DL-SCH | Note 6 | | | D4 | | PDCCH | | G-CS-RNTI | | N/A | Note 7 | | | D5 | | PDCCH+PDSCH | | MCCH-RNTI | | DL-SCH | Note 8 | | | D6 | | PDCCH+PDSCH | | G-RNTI | | DL-SCH | Note 9 | | | E | | PDCCH | | C-RNTI | | N/A | Note 4 | | | F0 | | PDCCH | | Temporary C-RNTI | | UL-SCH | Note 3 | | | F1 | | PDCCH | | C-RNTI, CS-RNTI, MCS-C-RNTI or CG-SDT-CS-RNTI | | UL-SCH |  | | | G | | PDCCH | | SFI-RNTI | | N/A |  | | | **<Unchanged rows omitted>** | | | | | | | | | | Note 1: These are received from PCell only.  Note 2: In some cases UE is only required to monitor the short message within the DCI for P-RNTI.  Note 3: These are received from PCell or PSCell.  Note 4: This corresponds to PDCCH-ordered PRACH.  Note 5: This corresponds to PDCCH scheduling LTE PC5.  Note 6: This is for multicast in RRC connected state.  Note 7: This corresponds to DL Semi-Persistent Scheduling release for multicast in RRC connected state.  Note 8: This is for broadcast MCCH.  Note 9: This is for broadcast MTCH. UE is not required to decode more than one PDSCH for MTCH simultaneously. | | | | | | | | |   **Table 6.2-2: Downlink "Reception Type" combinations**   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Supported Combinations** | | | | | **Comment** | | | **PCell** | **PSCell** | | **SCell** | | | 2. RRC\_INACTIVE | | | | | | | | 2.1 All UEs | | | | | | | | A + (B and/or (C1 or Q) and/or D0 and/or D1) + F0+F1 |  | |  | | Note 1 | | | 2.2 UEs supporting MBS broadcast reception | | | | | | | | A+D5 | |  | |  | |  | | Note 1: UE is not required to decode more than two PDSCH simultaneously, and decoding prioritization when more than two are received is up to UE implementation. | | | | | | |   **<Unchanged parts omitted>** |