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

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

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| *CR-Form-v12.2* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  | **38.214** | **CR** | **-** | **Rev** | **-** | **Current version:** | **18.3.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Rel-18 editorial corrections for TS 38.214 | | | | | | |
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| ***Source to WG:*** | Nokia | | | | | | |
| ***Source to TSG:*** |  | | | | | | |
|  |  | | | | | | |
| ***Work item code:*** | NR\_MIMO\_evo\_DL\_UL, NR\_MC\_enh-Core, NR\_pos\_enh2-Core, NR\_NTN\_enh-Core, NR\_MBS\_enh-Core | | |  | ***Date:*** | | 2024-08-30 |
|  |  | |  | |  | |  |
| ***Category:*** | **F** |  | | | ***Release:*** | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | **NR\_MIMO\_evo\_DL\_UL**  **Unified TCI framework extension for multi-TRP**  In clause 5.1.5, align TCI state terminology and missing citations.  In clauses 5.1.5 and 5.2.1.5.1, there are still some UE capability parameters and DCI field labelled with bracket.  1. Two UE capability parameters on supporting of default beam in Rel-18 unified TCI framework are not clear (i.e., [two default beams for S-DCI based MTRP] and [default beam per coresetPoolIndex for M-DCI based MTRP]). While, in 38.306, it is already specified that the Rel-16 UE capability parameters (i.e., *defaultQCL-TwoTCI-r16* and *defaultQCL-PerCORESETPoolIndex-r16*) are reused for Rel-18 unified TCI framework.  **38.306 18.2.0**  ***tci-JointTCI-UpdateSingleActiveTCI-PerCC-r18***  …  NOTE: *defaultQCL-TwoTCI-r16* can be used to indicate support of two default beams.  ***tci-JointTCI-UpdateSingleActiveTCI-PerCC-PerCORESET-r18***  …  NOTE 2: defaultQCL-PerCORESETPoolIndex-r16 can be used to indicate support of two default beams.  2. The time duration used to determine apply of default beam is still with bracket ([*timeDurationForQCL*]). Considering that there is no dedicated Rel-18 UE capability parameters for this funcionality, we suggest reuse *timeDurationForQCL* in Rel-18, i.e., remove the bracket.  3. The name of DCI field for TCI selection is also not clear (i.e., [TCI selection field]). While, in 38.212, it is already specified as ‘TCI selection’.  **Increased number of orthogonal DMRS ports**  In clauses 5.3 and 6.1.3, TS 38.214 introduced brackets around various open parameter and capability names. These parameter names have now been set.  In clause 6.2.3.1, the PT-RS coherence conditions for 8 Tx codebook based operation were corrected in R1-2405594. At that time, “and non-codebook based” was inadvertently deleted from Table 6.2.3.1-3A, which leaves the PUSCH to PT-RS power ratio for >4 layer non-codebook based operation undefined. For reference, we note that the PUSCH to PTRS power ratio for non-codebook and other PUSCH configurations was agreed in RAN1#112bis.  **SRI/TPMI enhancement for enabling 8 TX UL transmission**  In clause 6.1.1.1, fixed some typo  **NR\_MC\_enh-Core**  In cluses 6.1.1.2, 6.1.2.1 and 6.1.7:  1. Unclear mapping of PUSCH scheduled by DCI format 0\_3 and antenna ports as the SRS port(s) indicated by SRI for non-codebook based UL transmission.  2. m-TRP and multi-cell scheduled cannot be configured simultaneously, so there is up to one SRS resource set.  3. It was agreed DMRS bundling is supported for PUSCH scheduled by DCI format 0\_3 and the TP of adding DCI format 0\_3 for DMRS bundling was agreed according to the following agreement in RAN1#116. However, one place is missing for DCI format 0\_3.   |  | | --- | | **Agreement**  TP1 in section 8 of [R1-2401589](https://lenovobeijing-my.sharepoint.com/personal/leihp1_lenovo_com/Documents/R1-2401589.zip) is agreed for TS38.214. |   In clause 5.1.5, editorial change needed to add plural to PDSCHs.  **NR\_pos\_enh2-Core**  In clause 5.1.6.5.2: according to the latest TS 37.355, nr-PRU-RSCP-MeasInfo, which only contains DL RSCP measurement, does not include the RSTD measurement. Thus, it doesn’t match the current description “which contains DL RSCP/RSCPD measurements together with DL RSTD, DL PRS-RSRP, and/or DL PRS-RSRPP measurement(s)”. A similar problem occurs with parameter ‘nr-PRU-DL-TDOA-MeasInfo’.  Clauses 5.1.6.5.3 and 6.2.1.4: for bandwidth aggregation, the linked DL PRS resource sets are expected to share the same configuration on some parameters, the mentioned parameters are not described in the same format, i.e., some of them apply the IE name, while others apply the definition. The parameters description should be aligned.  Clause 6.2.1.4.1:   * *SRS-PeriodicityAndOffset* can only represent the starting slot offset for periodic and semi-persistent SRS of the first hop. *slotOffset* for aperiodic SRS should also be added. * The parameter names *SRS-PeriodicityAndOffset* and *slotOffset* can be shared by both the first hop and remaining hops, it is necessary to distinguish them by *resourceType* in the first hop and *SlotOffsetForRemainingHops* for remaining hops.   Clause 8.1: there are brackets for the name of the field *Embedded SCI format payload.* Since the field name of *Embedded SCI format payload* in SCI format 2-D has been confirmed in TS 38.212 v18.3.0 as follows, the brackets should be removed.   |  | | --- | | TS 38.212 v18.3.0  8.4.1.4 SCI format 2-D  **<<<** UNRELATED PARTS OMITTED**>>>**  **Embedded SCI format payload** - number of bits determined according to Table 8.4.1.4-1. This field is set to the associated payload of the embedded SCI format indicated by the ‘Embedded SCI format’ field as defined in Table 8.4.1.4-1.  **<<<** UNRELATED PARTS OMITTED**>>>** |   Clause 8.2.4.2:   * In clause 8.2.4.2 of TS 38.214, the names of several higher layer parameters for SL PRS resource selection in a dedicated SL PRS resource pool are pending confirmation and currently, they do not align with those in TS 38.331. And the description on the parameter *sl-SelectionWindowListDedicatedSL-PRS-RP* is also pending confirmation. * In SL PRS resource allocation mode 2, the sensing unit is a candidate SL PRS resource, but currently in TS 38.214, the definition of candidate SL PRS resource is wrongly written as candidate “single slot resource”, wherein the candidate single slot resource is only used for SL data.   Clause 8.4.4:   * The parameter description of SL-TimeStamp for DFN is not aligned with that of SFN. The number and names of parameters for SL AOA as well as its uncertainty are not correct. * The parameter names for sidelink time stamps, ARP location info are not aligned with TS 38.331.   **NR\_NTN\_enh-Core**  In clause 6.1, after RAN#104, it is observed that the RRC parameter *nrofHARQ-ProcessesForPUSCH* used to indicate the number of HARQ processes for supporting 32 HARQ processes is duplicated. It is also noted that the similar issue was fixed in the latest TS38.214 v17.10.0 after RAN#104 by removing the duplicated parameter name, but the change to TS38.214 v18.3.0 section 6.1 is missing.  **NR\_MBS\_enh-Core**  In clause 5.1, FG 57-2 about intra-slot TDM-ed unicast PDSCH and group-common PDSCH for multicast reception in RRC\_INACTIVE mode is introduced in RAN1 UE features list, but the corresponding description of intra-slot PDSCHs reception is missed.  In clauses 5.1, 5.1.3.1, 5.1.3.2, 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. The dedicated PDSCH config includes PDSCH resource allocation, rate matching pattern configuration, xoverhead, and MCS table configuration. The same configuration is transplanted into multicast reception in RRC\_INACTIVE. Therefore, the application of the configuration should also be reused in multicast reception in RRC\_INACTIVE.  In clause 5.1.4.2, when the UE is configured to receive broadcast, REs indicated by *RateMatchPatternLTE-CRS* are not available for broadcast reception. For multicast reception in RRC\_INACTIVE\_state, the same scheme should be reused. But in current specification, it is not clear whehter REs indicated by *RateMatchPatternLTE-CRS* are available or not for multicast reception in RRC\_INACTIVE\_state. | | | | | |
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| ***Summary of change:*** | | **NR\_MIMO\_evo\_DL\_UL**  **Unified TCI framework extension for multi-TRP**  In clause 5.1.5, align TCI state terminology and missing citations.  In clauses 5.1.5 and 5.2.1.5.1, updated the name of the UE capability parameters and DCI field to align 38.214 with 38.306 and 38.212.  **Increased number of orthogonal DMRS ports**  In clauses 5.3 and 6.1.3, removed brackets and corrected parameter and capability names.  In clause 6.2.3.1, the text “and non-codebook based” is restored in Table 6.2.3.1-3A.  **UL precoding indication for multi-panel transmission**  In clauses 5.2.5 and 6.1,  **SRI/TPMI enhancement for enabling 8 TX UL transmission**  In clause 6.1.1.1, fixed some typo  **NR\_MC\_enh-Core**  In cluses 6.1.1.2, 6.1.2.1 and 6.1.7:  1. PUSCH scheduled by DCI format 0\_3 use the same antenna ports as the SRS ports(s) indicated by SRI in the DCI for non-codebook based UL transmission.  2. Remove the case of two SRS resource sets are configured when a PUSCH is scheduled by DCI format 0\_3.  3. Adding back PUSCH repetition type A scheduled by DCI format 0\_3 to DMRS bundling  In clause 5.1.5, added plural to PDSCH as: “to ~~the~~ one or more PDSCHs scheduled”  **NR\_pos\_enh2-Core**  In clause 5.1.6.5.2:   * Replaced current higher layer parameters with *NR-PRU-DL-Info* which includes *nr-PRU-RSCP-MeasInfo* and *nr-PRU-DL-TDOA-MeasInfo*. * Added a comma after “and/or DL PRS-RSRPP measurement(s) associated with the RSCP/RSCPD measurements performed by a positioning reference unit (PRU) [20, TS 38.305]”.   In clauses 5.1.6.5.3 and 6.2.1.4: corrected the description for the parameters that share the same values in the linked DL PRS resource sets.  In clause 6.2.1.4.1: distinguished the separate periodicity and offset for the first hop and the remaining hops.  In clause 8.1: removed the brackets for the name of field *Embedded SCI format payload*.  In clause 8.2.4.2:   * Aligned the names of the affected higher layer parameters for SL PRS resource selection in a dedicated SL PRS resource pool to those in TS 38.331. * Confirmed the description for the parameter *sl-SelectionWindowListDedicatedSL-PRS-RP* by removing brackets. * Editorial: correct “mse” to “msec”. * Corrected the description for UE procedure in SL PRS resource allocation mode 2.   In clause 8.4.4: corrected the description of time stamp and parameters for SL AOA.   * Aligned parameter names for timestamps and ARP location info as in TS 38.331.   **NR\_NTN\_enh-Core**  In clause 6.1, deleted one of *nrofHARQ-ProcessesForPUSCH* to align with TS38.214 v17.10.0.  **NR\_MBS\_enh-Core**  In clause 5.1, FG 57-2 about intra-slot TDM-ed unicast PDSCH and group-common PDSCH for multicast reception in RRC\_INACTIVE mode is introduced according to previous decisions.  In clauses 5.1, 5.1.3.1, 5.1.3.2, corrected the rate matching pattern configuration, xoverhead, and MCS table configuration for PDSCH reception for multicast in RRC\_INACTIVE  In clause 5.1.4.2, clarified that REs indicated by *RateMatchPatternLTE-CRS* are not available for multicast reception in RRC\_INACTIVE\_state.c | | | | | |
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| ***Consequences if not approved:*** | Incomplete and unclear specification. | | | |
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| ***Clauses affected:*** | 5.1, 5.1.3.1, 5.1.3.2, 5.1.4.2, 5.1.5, 5.1.6.5.2, 5.1.6.5.3, 5.2.1.5.1, 5.3, 6.1, 6.1.1.1, 6.1.1.2, 6.1.2.1, 6.1.3, 6.1.7, 6.2.3.1, 6.2.1.4.1, 6.2.1.4.2, 8.1, 8.2.4.2, 8.4.4 | | | |
|  |  | | | |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  | Other core specifications | ... |
| ***affected:*** |  | **X** | Test specifications | ... |
| ***(show related CRs)*** |  | **X** | O&M Specifications | ... |
|  |  | | | |
| ***Other comments:*** |  | | | |
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| ***This CR's revision history:*** |  | | | |

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## 5.1 UE procedure for receiving the physical downlink shared channel

For downlink, a maximum of 16 HARQ processes per cell are supported by the UE, or subject to UE capability, a maximum of 32 HARQ processes per cell as defined in [13, TS 38.306]. The number of processes the UE may assume will at most be used for the downlink is configured to the UE for each cell separately by higher layer parameter *nrofHARQ-ProcessesForPDSCH* or *nrofHARQ-ProcessesForPDSCH-v1700*, and when no configuration is provided the UE may assume a default number of 8 processes.

A UE shall upon detection of a PDCCH with a configured DCI format 1\_0, 1\_1, 1\_2, 1\_3, 4\_0, 4\_1, or 4\_2 decode the corresponding PDSCHs as indicated by that DCI. When the UE is scheduled with multiple PDSCHs on a serving cell by a DCI, HARQ process ID indicated by this DCI applies to the first PDSCH not overlapping with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, HARQ process ID is then incremented by 1 for each subsequent PDSCH(s) in the scheduled order, with modulo operation of *nrofHARQ-ProcessesForPDSCH* applied if *nrofHARQ-ProcessesForPDSCH* is provided, or with modulo operation of *nrofHARQ-ProcessesForPDSCH-v1700* applied if or *nrofHARQ-ProcessesForPDSCH-v1700* is provided, or with modulo operation of 8 applied, otherwise. HARQ process ID is not incremented for PDSCH(s) not received if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided. When a UE is configured by the higher layer parameter *repetitionScheme* set to 'tdmSchemeA', the PDSCH includes two PDSCH transmission occasions. For each PDSCH, if either PDSCH occasion overlaps with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, the PDSCH is not received and HARQ process ID is not increment for the PDSCH. For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to receive a PDSCH that overlaps in time with another PDSCH if the UE is not capable of receiving FDMed unicast and multicast PDSCH per slot per carrier. When HARQ feedback for the HARQ process ID is not disabled, or for the HARQ process associated with the first SPS PDSCH when *HARQ-feedbackEnablingforSPSactive* is provided and enabled, the UE is not expected to receive another PDSCH for a given HARQ process until after the end of the expected transmission of HARQ-ACK for that HARQ process, where the timing is given by Clause 9.2.3 of [6, TS 38.213]. For HARQ-ACK subject to HARQ-ACK deferral described in Clause 9.2.5.4 of [6 TS 38.213], the expected transmission of HARQ-ACK corresponds to the expected transmission HARQ-ACK in a first slot. When HARQ feedback for the HARQ process ID is disabled, the UE is not expected to receive another PDCCH carrying a DCI scheduling a PDSCH or set of slot-aggregated PDSCH scheduled for the given HARQ process or to receive another PDSCH without corresponding PDCCH for the given HARQ process that starts until Tproc,1 after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process. Except for the case when a UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet* and PDCCHs that schedule two PDSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex* and the UE reports its capability of *outOfOrderOperationDL-r16,* in a given scheduled cell, the UE is not expected to receive a first PDSCH and a second PDSCH, starting later than the first PDSCH, with its corresponding HARQ-ACK assigned to be transmitted on a resource ending before the start of a different resource for the HARQ-ACK assigned to be transmitted for the first PDSCH, where the two resources are in different slots for the associated HARQ-ACK transmissions, each slot is composed of symbols [4] or a number of symbols indicated by *subslotLengthForPUCCH* if provided, and the HARQ-ACK for the two PDSCHs are associated with the HARQ-ACK codebook of the same priority. Except for the case when a UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet* and PDCCHs that schedule two PDSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex* and the UE reports its capability of *outOfOrderOperationDL-r16,* in a given scheduled cell, the UE is not expected to receive a first PDSCH and a second PDSCH, starting later than the first PDSCH, with its corresponding HARQ-ACK assigned to be transmitted on a resource ending before the start of a different resource for the HARQ-ACK assigned to be transmitted for the first PDSCH if the HARQ-ACK for the two PDSCHs are associated with HARQ-ACK codebooks of different priorities. For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol *j* by a PDCCH ending in symbol *i* on a scheduling cell, the UE is not expected to be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH that ends later than symbol *i* of a scheduling cell,. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], the PDCCH ending in symbol *i* is determined based on the PDCCH candidate that ends later in time. In a given scheduled cell, for any PDSCH corresponding to SI-RNTI, the UE is not expected to decode a re-transmission of an earlier PDSCH with a starting symbol less than *N* symbols after the last symbol of that PDSCH, where the value of *N* depends on the PDSCH subcarrier spacing configuration *μ,* with *N*=13 for *μ*=0, *N*=13 for *μ*=1, *N*=20 for *μ*=2, *N*=24 for *μ*=3, *N*=96 for *m*=5, and *N*=192 for *m*=6.

When receiving PDSCH scheduled with SI-RNTI, P-RNTI, MCCH-RNTI, G-RNTI for broadcast, or Multicast MCCH-RNTI, G-RNTI for multicast in RRC\_INACTIVE state, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the associated SS/PBCH block with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.

When receiving PDSCH scheduled with RA-RNTI, or MSGB-RNTI, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the SS/PBCH block or the CSI-RS resource the UE used for RACH association as applicable, and transmission with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable. When receiving a PDSCH scheduled with RA-RNTI in response to a random access procedure triggered by a PDCCH order which triggers contention-free random access procedure for the SpCell [10, TS 38.321], the UE may assume that the DM-RS port of the received PDCCH order and the DM-RS ports of the corresponding PDSCH scheduled with RA-RNTI are quasi co-located with the same SS/PBCH block or CSI-RS with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable. If a UE is configured with *SSB-MTC-AddtionalPCI* and with *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, and if the UE is configured with [*twoTAGs*]for the SpCell, if the UE attempts to detect the DCI format 1\_0 with CRC scrambled by the corresponding RA-RNTI or when receiving a PDSCH scheduled with RA-RNTI in response to a random access procedure triggered by a PDCCH order which triggers contention-free random access procedure for the SpCell [10, TS 38.321], and if the CORESET used for the PDCCH order transmission is not associated with the serving cell physical cell ID, the UE may assume that the DM-RS ports of the received PDSCH are quasi co-located with the DM-RS antenna port associated with PDCCH receptions in the CORESET for Type1-PDCCH CSS set with respect to Doppler shift, Doppler spread, average delay, delay spread, and spatial RX parameters when applicable.

When receiving PDSCH in response to a PUSCH transmission scheduled by a RAR UL grant or corresponding PUSCH retransmission, or when receiving PDSCH in response to a PUSCH for Type-2 random access procedure, or a PUSCH scheduled by a fallbackRAR UL grant or corresponding PUSCH retransmission, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the SS/PBCH block the UE selected for RACH association and transmission with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.

If the UE is not configured for PUSCH/PUCCH transmission for at least one serving cell configured with slot formats comprised of DL and UL symbols, and if the UE is not capable of simultaneous reception and transmission on serving cell *c1*and serving cell *c2*, the UE is not expected to receive PDSCH on serving cell *c1* if the PDSCH overlaps in time with SRS transmission (including any interruption due to uplink or downlink RF retuning time [10]) on serving cell *c2* not configured for PUSCH/PUCCH transmission.

The UE is not expected to decode a PDSCH in a serving cell scheduled by a PDCCH with C-RNTI, CS-RNTI, MCS-C-RNTI, G-RNTI, G-CS-RNTI or MCCH-RNTI and one or multiple PDSCH(s) required to be received according to this Clause in the same serving cell without a corresponding PDCCH transmission if the PDSCHs partially or fully overlap in time except if the PDCCH scheduling the PDSCH ends at least 14 symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, where *m* and the symbol duration are based on the smallest numerology between the scheduling PDCCH and the PDSCH, in which case the UE shall decode the PDSCH scheduled by the PDCCH. When the PDCCH reception incudes two PDCCH candidates from two respective search space sets, as described in clause 10 of [6, TS 38.213], for the purpose of determining the PDCCH with C-RNTI, CS-RNTI or MCS-C-RNTI scheduling the PDSCH ends at least 14 symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, the PDCCH candidate that ends later in time is used.

The UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, Multicast MCCH-RNTI, G-CS-RNTI or CS-RNTI if another PDSCH in the same cell scheduled with RA-RNTI or MSGB-RNTI partially or fully overlap in time.

If cell DTX is activated for the serving cell, the UE is not expected to decode a PDSCH scheduled without corresponding PDCCH transmission using SPS-Config that overlap in time with any non-active periods of cell DTX for the serving cell.

Furthermore, a UE indicating *supportOfERedCap* capability but not indicating *eRedCapNotReducedBB-BW* is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, Multicast MCCH-RNTI, G-CS-RNTI or CS-RNTI in the same or next slot if another PDSCH in the same cell is scheduled with RA-RNTI or MSGB-RNTI, when the PDSCH scheduled with RA-RNTI or MSGB-RNTI is allocated more than 25 PRBs when configured with SCS m = 0 or more than 12 PRBs when configured with SCS m = 1.

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 or TC-RNTI, where the PDSCH scheduled with TC-RNTI for a reduced capability UE that indicates *supportOfERedCap* is allocated no more than 25 PRBs when configured with SCS m = 0 or no more than 12 PRBs when configured with SCS m = 1, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs.

The UE:

- is expected to decode PDSCH scheduled with MCCH-RNTI or Multicast MCCH-RNTI, and PBCH in PCell that partially or fully overlaps in time in non-overlapping PRBs in PCell.

- is not expected to decode PDSCH scheduled with G-RNTI for broadcast and PBCH in PCell that partially or fully overlaps in time in non-overlapping PRBs in PCell.

- is not expected to decode PDSCH scheduled with G-RNTI for multicast and PBCH in PCell that partially or fully overlaps in time in non-overlapping PRBs in PCell.

On a frequency range 1 cell, the UE shall be able to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI and, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI that partially or fully overlap in time in non-overlapping PRBs, unless the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI requires Capability 2 processing time according to clause 5.3 in which case the UE may skip decoding of the scheduled PDSCH with C-RNTI, MCS-C-RNTI, or CS-RNTI.

On a frequency range 2 cell, the UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI if in the same cell, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI partially or fully overlap in time.

A UE that indicates *supportOfERedCap* capability but does not indicate *eRedCapNotReducedBB-BW*, during a process of P-RNTI triggered SI acquisition, when the total number of PRBs for the PDSCH scheduled with SI-RNTI and the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI scheduled in the slot is larger than 25 PRBs if configured with SCS µ = 0 or larger than 12 PRBs if configured with SCS µ = 1, the UE may skip decoding of the scheduled PDSCH with C-RNTI, MCS-C-RNTI, or CS-RNTI.

The UE is expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI during a process of autonomous SI acquisition.

In RRC\_CONNECTED state, the maximum number of PDSCHs scheduled per slot per component carrier with C-RNTI/CS-RNTI and G-RNTI/G-CS-RNTI/MCCH-RNTI that the UE shall be able to decode is the same as the indicated UE capability for the number of unicast PDSCHs per slot per component carrier. In RRC\_INACTIVE state, if the UE is capable of receiving TDMed unicast and multicast per slot per component carrier, the UE shall be able to decode one PDSCH scheduled with C-RNTI and one PDSCH scheduled with G-RNTI/Multicast MCCH-RNTI per slot per component carrier. If the UE is capable of receiving FDMed unicast and multicast PDSCH per slot per carrier, the UE shall be able to decode a PDSCH scheduled by a DCI format with C-RNTI or a PDSCH scheduled for a retransmission of a TB by a DCI format with CS-RNTI and a PDSCH scheduled by a DCI format with G-RNTI for multicast or a PDSCH scheduled for a retransmission of a TB by a DCI format with G-CS-RNTI that partially or fully overlap in time in non-overlapping PRBs. If the UE is capable of receiving FDMed unicast and broadcast PDSCH per slot per carrier, the UE shall be able to decode a PDSCH scheduled by a DCI format with C-RNTI or a PDSCH scheduled for a retransmission of a TB by a DCI format with CS-RNTI and a PDSCH scheduled with G-RNTI for broadcast/MCCH-RNTI that partially or fully overlap in time in non-overlapping PRBs. For a reduced capability UE that indicates *supportOfERedCap* but not indicating *eRedCapNotReducedBB-BW*, if the UE is capable of receiving FDMed unicast and multicast/broadcast PDSCH per slot, the UE can decode the two PDSCHs, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs,

- if the total number of PRBs allocated is no more than 25 PRBs when configured with SCS m = 0 or no more than 12 PRBs when configured with SCS m = 1,

- otherwise, the UE may skip decoding one of the two PDSCHs.

If the UE is configured by higher layers to decode a PDCCH with its CRC scrambled by a CS-RNTI or G-CS-RNTI, the UE shall receive PDSCH transmissions without corresponding PDCCH transmissions using the higher-layer-provided PDSCH configuration for those PDSCHs.

The UE is not expected to support reception of:

- FDMed broadcast MCCH PDSCH and broadcast MTCH PDSCH in PCell or SCell, or

- FDMed multiple broadcast MTCH PDSCHs in PCell or SCell, or

- FDMed broadcast MCCH/broadcast MTCH/multicast PDSCH and SIB PDSCH in PCell, or

- FDMed multicast PDSCHs in PCell or SCell, or

- FDMed multicast PDSCH and MCCH/broadcast MTCH PDSCH in PCell or SCell, or

- FDMed broadcast MCCH/broadcast MTCH/multicast PDSCH and paging PDSCH.

The UE in RRC\_INACTIVE state is not expected to support reception of:

- FDMed multicast MCCH PDSCH and multicast MTCH PDSCH in Pcell, or

- FDMed multiple multicast MTCH PDSCHs in Pcell, or

- FDMed broadcast MCCH/broadcast MTCH/multicast MCCH/multicast MTCH and SIB PDSCH in Pcell, or

- FDMed multicast MCCH/multicast MTCH and broadcast MCCH/broadcast MTCH in Pcell, or

- FDMed multicast MCCH/multicast MTCH and paging PDSCH in Pcell.

If a UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, the UE may expect to receive multiple PDCCHs scheduling fully/partially/non-overlapped PDSCHs in time and frequency domain. The UE may expect the reception of full/partially-overlapped PDSCHs in time, only when PDCCHs that schedule two PDSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex*. For a *ControlResourceSet* without *coresetPoolIndex*, the UE may assume that the *ControlResourceSet* is assigned with *coresetPoolIndex* as 0. When the UE is configured with *SSB-MTC-AdditionalPCI*, *ControlResourceSets* corresponding to different *coresetPoolIndex* values may be associated with different physical cell IDs via activated TCI states of the *ControlResourceSets*, where *ControlResourceSets* corresponding to one *coresetPoolIndex* is associated with the serving cell physical cell ID and *ControlResourceSets* corresponding to another *coresetPoolIndex* can be associated with another physical cell ID. When the UE is scheduled with full/partially/non-overlapped PDSCHs in time and frequency domain, the full scheduling information for receiving a PDSCH is indicated and carried only by the corresponding PDCCH, the UE is expected to be scheduled with the same active BWP and the same SCS. When the UE is scheduled with full/partially-overlapped PDSCHs in time and frequency domain, the UE can be scheduled with at most two codewords simultaneously. When PDCCHs that schedule two PDSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex* and the UE reports its capability of *outOfOrderOperationDL-r16,* the following operations are allowed:

- For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol *j* by a PDCCH associated with a value of *coresetPoolIndex* ending in symbol *i*, the UE can be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH associated with a different value of *coresetPoolIndex* that ends later than symbol *i*.

- In a given scheduled cell, the UE can receive a first PDSCH in slot *i*, with the corresponding HARQ-ACK assigned to be transmitted in slot *j*, and a second PDSCH associated with a value of *coresetPoolIndex* different from that of the first PDSCH starting later than the first PDSCH with its corresponding HARQ-ACK assigned to be transmitted in a slot before slot *j*.

If PDCCHs that schedule corresponding PDSCHs are associated to the same or different *ControlResourceSets* having the same value of *coresetPoolIndex*, the UE procedure for receiving the PDSCH upon detection of a PDCCH follows Clause 5.1.

A UE does not expect to be configured with *repetitionScheme* if the UE is configured with higher layer parameter *repetitionNumber* for the same PDSCH.

When a UE is configured by higher layer parameter *repetitionScheme* set to one of 'fdmSchemeA*'*, 'fdmSchemeB*'*, 'tdmSchemeA*'*, if the UE not configured with *dl-OrJointTCI-StateList* is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* or if the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH and the UE is indicated with DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)'*.

- When the UE is set to 'fdmSchemeA*',* the UE shall receive a single PDSCH transmission occasion of the TB with each TCI state associated to a non-overlapping frequency domain resource allocation as described in Clause 5.1.2.3.

- When the UE is set to 'fdmSchemeB*'*, the UE shall receive two PDSCH transmission occasions of the same TB with each TCI state associated to a PDSCH transmission occasion which has non-overlapping frequency domain resource allocation with respect to the other PDSCH transmission occasion as described in Clause 5.1.2.3.

- When the UE is set to 'tdmSchemeA*'*, the UE shall receive two PDSCH transmission occasions of the same TB with each TCI state associated to a PDSCH transmission occasion which has non-overlapping time domain resource allocation with respect to the other PDSCH transmission occasion and both PDSCH transmission occasions shall be received within a given slot as described in Clause 5.1.2.1.

When a UE is configured by the higher layer parameter *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation*, the UE not configured with *dl-OrJointTCI-StateList* may expect to be indicated with one or two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* or when the UE configured with *dl-OrJointTCI-StateList* may expect to apply one or two indicated TCI states to the PDSCH, together with the DCI field '*Time domain resource assignment*' indicating an entry which contains *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation* and DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)'*.

- When two TCI states are indicated in a DCI with '*Transmission Configuration Indication*' field for the UE not configured with *dl-OrJointTCI-StateList*, or when the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with two TCI states used across multiple PDSCH transmission occasions in the *repetitionNumber* consecutive slots as defined in Clause 5.1.2.1.

- When one TCI state is indicated in a DCI with '*Transmission Configuration Indication*' field for the UE not configured with *dl-OrJointTCI-StateList*, or when the UE configured with *dl-OrJointTCI-StateList* is having one indicated TCI states to be applied to PDSCH, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with one TCI state used across multiple PDSCH transmission occasions in the *repetitionNumber* consecutive slots as defined in Clause 5.1.2.1.

When a UE is not indicated with a DCI that DCI field '*Time domain resource assignment*' indicating an entry which contains *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation*, and it is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* for the UE not configured with *dl-OrJointTCI-StateList*, or when the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH, and is indicated with DM-RS port(s) within two CDM groups in the DCI field '*Antenna Port(s)'* and it is not configured with higher layer parameter *sfnSchemePDSCH*, the UE may expect to receive a single PDSCH where the association between the DM-RS ports and the TCI states are as defined in Clause 5.1.6.2.

When a UE is not indicated with a DCI that DCI field '*Time domain resource assignment*' indicating an entry which contains *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation*, and it is not configured with *dl-OrJointTCI-StateList* and is indicated with one TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* or it is configured with *dl-OrJointTCI-StateList* and is expected to apply one indicated TCI states to PDSCH, the UE procedure for receiving the PDSCH upon detection of a PDCCH follows Clause 5.1.

When a UE is configured with higher layer parameter *sfnSchemePDSCH* set to either *'*sfnSchemeA*'* or *'*sfnSchemeB*'* and

- if the UE reports its capability of *sfn-SchemeA-DynamicSwitching* or *sfn-SchemeB-DynamicSwitching*, the UE not configured with *dl-OrJointTCI-StateList* is indicated with one or two TCI state(s) in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, or the UE configured with *dl-OrJointTCI-StateList* is having one or two indicated TCI States to be applied to PDSCH

- otherwise, the UE not configured with *dl-OrJointTCI-StateList* is not expected to be indicated with one TCI state per any of TCI codepoint by MAC CE, and the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, or the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH

the UE procedure for receiving the PDSCH upon detection of a PDCCH follows clause 5.1 and the QCL assumption for the PDSCH as defined in clause 5.1.5.

When a UE is configured with both *sfnSchemePDSCH* and *sfnSchemePDCCH*, the UE shall expect that *sfnSchemePDSCH* and *sfnSchemePDCCH* are set to the same scheme, either *'*sfnSchemeA*'* or *'*sfnSchemeB*'*.

If a UE not configured with *dl-OrJointTCI-StateList* is configured with *sfnSchemePDCCH* set to 'sfnSchemeA' and activated with two TCI states by MAC CE, and the UE does not report its capability of *sfn-SchemeA-PDCCH-only*, the UE is expected to be configured with *sfnSchemePDSCH* set to *'sfnSchemeA'* and indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* if the PDSCH is scheduled by DCI format 1\_1/1\_2.

If a UE configured with *dl-OrJointTCI-StateList* and having two indicated TCI-States is configured with *sfnSchemePdcch* set to 'sfnSchemeA' for a DL BWP and signaled by the higher layer parameter *applyIndicatedTCI-State* to apply both indicated TCI-States to a PDCCH on a CORESET, and the UE does not report its capability of *sfn-SchemeA-PDCCH-only*, the UE is expected to be configured with *sfnSchemePdsch* set to *'sfnSchemeA'* and both indicated TCI-States are applicable to PDSCH, if the PDSCH is scheduled by DCI format 1\_1/1\_2 on the PDCCH.

If a UE not configured with *dl-OrJointTCI-StateList* is configured with *sfnSchemePDCCH* set to 'sfnSchemeB' and activated with two TCI states by MAC CE, the UE is expected to be configured with *sfnSchemePDSCH* set to *'sfnSchemeB'* and indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* if the PDSCH is scheduled by DCI format 1\_1/1\_2.

If a UE configured with *dl-OrJointTCI-StateList* and having two indicated TCI-States is configured with *sfnSchemePdcch* set to 'sfnSchemeB' for a DL BWP, and signaled by the higher layer parameter *applyIndicatedTCI-State* to apply both indicated TCI-States to a PDCCH on a CORESET, the UE is expected to be configured with *sfnSchemePdsch* set to *'sfnSchemeB'* and both indicated TCI-States are applicable to PDSCH*,* if the PDSCH is scheduled by DCI format 1\_1/1\_2 on the PDCCH.

When a UE is configured with *sfnSchemePDSCH* and/or *sfnSchemePDCCH*, the UE shall expect that the *sfnSchemePDSCH* and/or *sfnSchemePDCCH* configuration are the same within a CC, and the UE shall expect that the *sfnSchemePDSCH* and/or *sfnSchemePDCCH* configuration are the same in all CCs in a same frequency band if the UE is configured with CA, where the UE does not expect to be configured with *sfnSchemePDSCH* and/or *sfnSchemePDCCH* in initial BWP in each CC.

For the PDSCH scheduled by PDCCH with DCI format 4\_0 with CRC scrambled by Multicast MCCH-RNTI, the parameter *pdsch-TimeDomainAllocationList,* *mcs-Table*, *xOverhead*, *rateMatchPatternToAddModList* and *RateMatchPatternLTE-CRS* are provided by pdsch-ConfigMCCH for MBS multicast. For the PDSCH scheduled by PDCCH with DCI format 4\_1 with CRC scrambled by G-RNTI for multicast in RRC\_INACTIVE, the parameter *pdsch-TimeDomainAllocationList,* *mcs-Table*, *xOverhead*, *rateMatchPatternToAddModList* and *RateMatchPatternLTE-CRS* are provided by *pdsch-ConfigMTCH-r18* if configured; or by pdsch-ConfigMCCH for MBS multicast, otherwise.

If more than one PDSCH on a serving cell each without a corresponding PDCCH transmission are in a slot, after resolving overlapping with symbols in the slot indicated as uplink by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*, or determined as non-active periods of cell DTX, if the serving cell is activated with cell DTX, based on [10, TS 38.321], a UE receives one or more PDSCHs without corresponding PDCCH transmissions in the slot as specified below.

‒ Step 0: set *j=0*, where *j* is thenumber of selected PDSCH(s) for decoding. *Q* is the set of activated PDSCHs without corresponding PDCCH transmissions within the slot

‒ Step 1: A UE receives one PDSCH with the lowest configured *sps-ConfigIndex* within *Q*, set *j=j+1*. Designate the received PDSCH as survivor PDSCH.

‒ Step 2: The survivor PDSCH in step 1 and any other PDSCH(s) overlapping (even partially) with the survivor PDSCH in step 1 are excluded from *Q*.

‒ Step 3: Repeat step 1 and 2 until *Q* is empty or *j* is equal to the number of unicast/multicast PDSCHs in a slot supported by the UE.

For a cell detected in cell search procedure with synchronization raster defined in Table 5.4.3.1-2 or Table 5.4.3.1-3 of [8, TS 38.101-1], the size of CORESET 0 for the cell in this clause refers to the size of punctured CORESET 0 as defined in clause 7.3.2.2 of [4, TS 38.211] if any.

<omitted text>

#### 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 1\_3, 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, Multicast MCCH-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 or 1\_3 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 or 1\_3 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* and *pdsch-ConfigMTCH* for MBS broadcast is set to 'qam256', and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI or 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-ConfigMCCH* or *pdsch-ConfigMTCH* for MBS multicast is set to ‘qam256’, and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by Multicast MCCH-RNTI or by a PDCCH with DCI format 4\_1 with CRC scrambled by G-RNTI for multicast in RRC\_INACTIVE

- the UE shall use *IMCS* and Table 5.1.3.1-2 to determine the modulation order (*Qm*) and Target code rate I 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* and *pdsch-ConfigMTCH* for broadcast is set to 'qam64LowSE', and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by MCCH-RNTI or 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-ConfigMCCH* or *pdsch-ConfigMTCH* for MBS multicast is set to ‘qam64LowSE’, and the PDSCH is scheduled by a PDCCH with DCI format 4\_0 with CRC scrambled by Multicast MCCH-RNTI or by a PDCCH with DCI format 4\_1 with CRC scrambled by G-RNTI for multicast in RRC\_INACTIVE

- 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

For a UE configured with the higher layer parameter *repetitionScheme* set to 'fdmSchemeB', and when the UE not configured with *dl-OrJointTCI-StateList* is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* or when the UE configured with *dl-OrJointTCI-StateList* and having two indicated TCI States to be applied to PDSCH, and the UE is indicated with DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)*', the determined modulation order of PDSCH transmission occasion associated with the first TCI state is applied to the PDSCH transmission occasion associated with the second TCI state.

<omitted text>

#### 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 or 1\_3 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, 1\_2, 1\_3, 4\_0, 4\_1, or 4\_2 with CRC scrambled by C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI, G-RNTI, G-CS-RNTI, MCCH-RNTI, Multicast 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 or 1\_3, 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, 1\_2 or 1\_3 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 G-RNTI for broadcast or MCCH-RNTI, is the overhead configured by higher layer parameter *xOverhead* in *pdsch-ConfigBroadcast*. If the *xOverhead* in *pdsch- ConfigBroadcast* is not configured, the is set to 0.

- For the PDSCH scheduled by PDCCH with a CRC scrambled by Multicast MCCH-RNTI, is the overhead configured by higher layer parameter *xOverhead* in *pdsch-ConfigMCCH* for MBS multicast. If the *xOverhead* in *pdsch-ConfigMCCH* for MBS multicast is not configured, the is set to 0.

- For the PDSCH scheduled by PDCCH with a CRC scrambled by G-RNTI for multicast in RRC\_INACTIVE, is the overhead configured by higher layer parameter *xOverhead* in *pdsch-ConfigMTCH-r18* if configured; or *pdsch-ConfigMCCH* for MBS multicast otherwise.

- A UE determines the total number of REs allocated for PDSCH () by , where *nPRB* is the total number of allocated PRBs for the UE.

2) Unquantized intermediate variable (*Ninfo*) is obtained by .

If 

Use step 3 as the next step of the TBS determination

else

Use step 4 as the next step of the TBS determination

end if

3) When , TBS is determined as follows

- quantized intermediate number of information bits , where .

- use Table 5.1.3.2-1 find the closest TBS that is not less than .

Table 5.1.3.2-1: TBS for 

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Index | TBS | Index | TBS | Index | TBS | Index | TBS |
| 1 | 24 | 31 | 336 | 61 | 1288 | 91 | 3624 |
| 2 | 32 | 32 | 352 | 62 | 1320 | 92 | 3752 |
| 3 | 40 | 33 | 368 | 63 | 1352 | 93 | 3824 |
| 4 | 48 | 34 | 384 | 64 | 1416 |  |  |
| 5 | 56 | 35 | 408 | 65 | 1480 |  |  |
| 6 | 64 | 36 | 432 | 66 | 1544 |  |  |
| 7 | 72 | 37 | 456 | 67 | 1608 |  |  |
| 8 | 80 | 38 | 480 | 68 | 1672 |  |  |
| 9 | 88 | 39 | 504 | 69 | 1736 |  |  |
| 10 | 96 | 40 | 528 | 70 | 1800 |  |  |
| 11 | 104 | 41 | 552 | 71 | 1864 |  |  |
| 12 | 112 | 42 | 576 | 72 | 1928 |  |  |
| 13 | 120 | 43 | 608 | 73 | 2024 |  |  |
| 14 | 128 | 44 | 640 | 74 | 2088 |  |  |
| 15 | 136 | 45 | 672 | 75 | 2152 |  |  |
| 16 | 144 | 46 | 704 | 76 | 2216 |  |  |
| 17 | 152 | 47 | 736 | 77 | 2280 |  |  |
| 18 | 160 | 48 | 768 | 78 | 2408 |  |  |
| 19 | 168 | 49 | 808 | 79 | 2472 |  |  |
| 20 | 176 | 50 | 848 | 80 | 2536 |  |  |
| 21 | 184 | 51 | 888 | 81 | 2600 |  |  |
| 22 | 192 | 52 | 928 | 82 | 2664 |  |  |
| 23 | 208 | 53 | 984 | 83 | 2728 |  |  |
| 24 | 224 | 54 | 1032 | 84 | 2792 |  |  |
| 25 | 240 | 55 | 1064 | 85 | 2856 |  |  |
| 26 | 256 | 56 | 1128 | 86 | 2976 |  |  |
| 27 | 272 | 57 | 1160 | 87 | 3104 |  |  |
| 28 | 288 | 58 | 1192 | 88 | 3240 |  |  |
| 29 | 304 | 59 | 1224 | 89 | 3368 |  |  |
| 30 | 320 | 60 | 1256 | 90 | 3496 |  |  |

4) When , TBS is determined as follows.

- quantized intermediate number of information bits , where and ties in the round function are broken towards the next largest integer.

- if 

, where 

else

if 

, where 

else



end if

end if

else if Table 5.1.3.1-2 is used and *,*

- the TBS is assumed to be as determined from the DCI transported in the latest PDCCH for the same transport block using . If there is no PDCCH for the same transport block using , and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH.

else if Table 5.1.3.1-4 is used and *,*

- the TBS is assumed to be as determined from the DCI transported in the latest PDCCH for the same transport block using . If there is no PDCCH for the same transport block using , and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH.

else

- the TBS is assumed to be as determined from the DCI transported in the latest PDCCH for the same transport block using . If there is no PDCCH for the same transport block using, and if the initial PDSCH for the same transport block is semi-persistently scheduled, the TBS shall be determined from the most recent semi-persistent scheduling assignment PDCCH.

The UE is not expected to receive a PDSCH assigned by a PDCCH with CRC scrambled by SI-RNTI with a TBS exceeding 2976 bits.

For a UE configured with the higher layer parameter *repetitionScheme* set to 'fdmSchemeB',and when the UE not configured with *dl-OrJointTCI-StateList* is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* or when the UE configured with *dl-OrJointTCI-StateList* and having two indicated TCI States to be applied to PDSCH, and the UE is indicated with DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)*', the TBS determination follows the steps 1-4 with the following modification in step 1: a UE determines the total number of REs allocated for PDSCH () by , where *nPRB* is the total number of allocated PRBs corresponding to the first TCI state, and the determined TBS of PDSCH transmission occasion associated with the first TCI state is also applied to the PDSCH transmission occasion associated with the second TCI state. For a UE configured with the higher layer parameter *repetitionScheme* set to 'tdmSchemeA'and indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* for the UE not configured with *dl-OrJointTCI-StateList* or for the UE configured with *dl-OrJointTCI-StateList* and having two indicated TCI States to be applied to PDSCH and indicated with DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)*', the TBS determination follows the steps 1-4 with the following modification in step 1: a UE determines the number of REs allocated for PDSCH within a PRB () by , where  is the number of symbols of the PDSCH allocation within the slot corresponding to the first TCI state, and the determined TBS of PDSCH transmission occasion associated with the first TCI state is also applied to the PDSCH transmission occasion associated with the second TCI state.

For the PDSCH assigned by a PDCCH with DCI format 1\_0 with CRC scrambled by P-RNTI, or RA-RNTI, MsgB-RNTI, TBS determination follows the steps 1-4 with the following modification in step 2: a scaling  is applied in the calculation of *Ninfo*, where the scaling factor is determined based on the *TB scaling* field in the DCI as in Table 5.1.3.2-2.

Table 5.1.3.2-2: Scaling factor of *Ninfo* for P-RNTI, RA-RNTI and MSGB-RNTI

|  |  |
| --- | --- |
| TB scaling field | Scaling factor S |
| 00 | 1 |
| 01 | 0.5 |
| 10 | 0.25 |
| 11 |  |

The NDI and HARQ process ID, as signalled on PDCCH, and the TBS, as determined above, shall be reported to higher layers.

<omitted text>

#### 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\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_3.

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* or *lte-CRS-PatternList3-r18* 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 or multicast reception in RRC\_INACTIVE\_state, 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 or multicast PDSCH reception in RRC\_INACTIVE\_state. The total number of *RateMatchPatternLTE-CRS* for broadcast reception or multicast reception in RRC\_INACTIVE\_state that a UE can be configured with is the same as for unicast in Rel-15.

- 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*.

- If the UE is not configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet*, and if the UE is configured by higher layer parameter *lte-CRS-PatternList3-r18* and *lte-CRS-PatternList4-r18* in *ServingCellConfig*, REs indicated by *lte-CRS-PatternList3-r18* and *lte-CRS-PatternList4-r18* are declared as not available for PDSCH.

- 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-PatternList3-r18* and *lte-CRS-PatternList4-r18* 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-PatternList3-r18* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList4-r18* if PDSCH is associated with *coresetPoolIndex* set to '1';

- otherwise, REs indicated by *lte-CRS-PatternList3-r18* and *lte-CRS-PatternList4-r18,* in *ServingCellConfig*.

- Within a BWP, the UE can be configured with one or more ZP CSI-RS resource set configuration(s) for aperiodic, semi-persistent and periodic time-domain behaviours (higher layer parameters *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList,*  *sp-ZP-CSI-RS-ResourceSetsToAddModList* and *p-ZP-CSI-RS-ResourceSet* respectively comprised in *PDSCH-Config*), with each ZP CSI-RS resource set consisting of at most 16 ZP CSI-RS resources (higher layer parameter *ZP-CSI-RS-Resource*) in numerology of the BWP. The REs indicated by *p-ZP-CSI-RS-ResourceSet* are declared as not available for PDSCH. The REs indicated by *sp-ZP-CSI-RS-ResourceSetsToAddModList* and aperiodic-ZP-CSI-RS-ResourceSetsToAddModList are declared as not available for PDSCH when their triggering and activation are applied, respectively. The following parameters are configured via higher layer signaling for each ZP CSI-RS resource configuration:

- *zp-CSI-RS-ResourceId* in *ZP-CSI-RS-Resource* determines ZP CSI-RS resource configuration identity.

- *nrofPorts* in *CSI-RS-ResourceMapping* defines the number of CSI-RS ports, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *cdm-Type* in *CSI-RS-ResourceMapping* defines CDM values and pattern, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *resourceMapping* in *ZP-CSI-RS-Resource* defines the OFDM symbol and subcarrier occupancy of the ZP CSI-RS resource within a slot that are given in Clause 7.4.1.5 of [4, TS 38.211].

- *periodicityAndOffset* in*ZP-CSI-RS-Resource* defines the ZP-CSI-RS periodicity and slot offset for periodic/semi-persistent ZP CSI-RS.

- For the UE in RRC\_CONNECTED mode for multicast reception, *p-ZP-CSI-RS-ResourceSet* can be configuredin *pdsch-ConfigMulticast* for GC-PDSCH rate matching, subject to UE capability. The REs indicated by *p-ZP-CSI-RS-ResourceSet* are declared as not available for GC-PDSCH. The REs indicated by *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config* for unicast do not apply for GC-PDSCH and the REs indicated by *p-ZP-CSI-RS-ResourceSet* configured in *pdsch-ConfigMulticast* for multicast do not apply for unicast PDSCH. The total number of periodic *ZP-CSI-RS-Resources* that a UE can be configured with is the same as for unicast in Rel-16. If *p-ZP-CSI-RS-ResourceSet* is configured in both *PDSCH-Config* and *pdsch-ConfigMulticast*, it is subject to UE capability whether the *p-ZP-CSI-RS-ResourceSet* configured in *pdsch-ConfigMulticast* can be different from the *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config*.

- For the UE in RRC\_CONNECTED mode for multicast reception, s*p-ZP-CSI-RS-ResourceSet* can be configuredin *pdsch-ConfigMulticast* for GC-PDSCH rate matching, subject to UE capability. The REs indicated by s*p-ZP-CSI-RS-ResourceSet* are declared as not available for GC-PDSCH when their triggering and activation delivered by unicast PDSCH are applied. The REs indicated by s*p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config* for unicast do not apply for GC-PDSCH and the REs indicated by s*p-ZP-CSI-RS-ResourceSet* configured in *pdsch-ConfigMulticast* for multicast do not apply for unicast PDSCH. The total number of semi-persistent *ZP-CSI-RS-Resources* that a UE can be configured with is the same as for unicast.

The UE may be configured with a DCI field for triggering the aperiodic ZP CSI-RS. A list of *ZP-CSI-RS-ResourceSet(s)*, provided by higher layer parameter *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* in*PDSCH-Config*, is configured for aperiodic triggering. The maximum number of aperiodic *ZP-CSI-RS-ResourceSet(s)* configured per BWP is 3. The bit-length of DCI field *ZP CSI-RS trigger* depends on the number of aperiodic *ZP-CSI-RS-ResourceSet(s)*configured (up to 2 bits). Each non-zero codepoint of '*ZP CSI-RS' trigger* in DCI format 1\_1 triggers one aperiodic 'ZP-CSI-RS-ResourceSet' in the list *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* by indicating the aperiodic ZP CSI-RS resource set ID. The DCI codepoint '01' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '1', the DCI codepoint '10' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '2', and the DCI codepoint '11' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '3'. Codepoint '00' is reserved for not triggering aperiodic ZP CSI-RS. When receiving PDSCH scheduled by DCI format 1\_0 or PDSCHs with SPS activated by DCI format 1\_0, the REs corresponding to configured resources in *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* or in *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* are available for PDSCH.

When the UE is configured with multi-slot and single-slot PDSCH scheduling or *pdsch-TimeDomainAllocationListForMultiPDSCH*, the triggered aperiodic ZP CSI-RS is applied to all the slot(s) of the PDSCH(s) scheduled or the PDSCHs with SPS activated by the PDCCH containing the trigger.

For a UE configured with a list of semi-persistent *ZP-CSI-RS-ResourceSet(s)* provided by higher layer parameter *sp-ZP-CSI-RS-ResourceSetsToAddModList*:

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, as described in clause 6.1.3.19 of [10, TS 38.321], for ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on the PDSCH RE mapping corresponding to the activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1 and for FR2-NTN, and is provided by *K-Mac* or if *K-Mac* is not provided.

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the deactivation command, as described in clause 6.1.3.19 of [10, TS 38.321], for activated ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on cessation of the PDSCH RE mapping corresponding to the de-activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1 and for FR2-NTN, and is provided by *K-Mac* or if *K-Mac* is not provided.

### 5.1.5 Antenna ports quasi co-location

The UE can be configured with a list of up to *M* *TCI-State* configurations within the higher layer parameter *PDSCH-Config* to decode PDSCH according to a detected PDCCH with DCI intended for the UE and the given serving cell, where M depends on the UE capability *maxNumberConfiguredTCIstatesPerCC*. Each *TCI-State* contains parameters for configuring a quasi co-location relationship between one or two downlink reference signals and the DM-RS ports of the PDSCH, the DM-RS port of PDCCH or the CSI-RS port(s) of a CSI-RS resource. The quasi co-location relationship is configured by the higher layer parameter *qcl-Type1* for the first DL RS, and *qcl-Type2* for the second DL RS(if configured). For the case of two DL RSs, the QCL types shall not be the same, regardless of whether the references are to the same DL RS or different DL RSs. The quasi co-location types corresponding to each DL RS are given by the higher layer parameter *qcl-Type* in *QCL-Info* and may take one of the following values:

- 'typeA': {Doppler shift, Doppler spread, average delay, delay spread}

- 'typeB': {Doppler shift, Doppler spread}

- 'typeC': {Doppler shift, average delay}

- 'typeD': {Spatial Rx parameter}

The UE can be configured with a list of up to *128* *TCI-State* configurations, within the higher layer parameter *dl-OrJointTCI-StateList* in *PDSCH-Config* for providing a reference signal for the quasi co-location for DM-RS of PDSCH and DM-RS of PDCCH in a BWP/CC, for CSI-RS, and to provide a reference signal with *qcl-Type* set to 'typeD', if applicable, for determining UL TX spatial filter for dynamic-grant and configured-grant based PUSCH and PUCCH resource in a BWP/CC, and SRS.

If the *TCI-State* or *TCI-UL-State* configurations are absent in a BWP of the CC, the UE can apply the *TCI-State* or *TCI-UL-State* configurations from a reference BWP of a reference CC configured by *unifiedTCI-StateRef*. The UE is not expected to be configured with *tci-StatesToAddModList*, *SpatialRelationInfo* or *PUCCH-SpatialRelationInfo*, except *SpatialRelationInfoPos* in a CC in a band, if the UE is configured with *dl-OrJointTCI-StateList* or *ul-TCI-StateList* in any CC in the same band. The UE can assume that when the UE is configured with *tci-StatesToAddModList* in any CC in the CC list configured by *simultaneousTCI-UpdateList1-r16, simultaneousTCI-UpdateList2-r16,* *simultaneousSpatial-UpdatedList1-r16, or simultaneousSpatial-UpdatedList2-r16,* the UE is not configured with *dl-OrJointTCI-StateList* or *ul-TCI-StateList* in any CC within the same band in the CC list.

The UE receives an activation command, as described in clause 6.1.3.14 of [10, TS 38.321], or 6.1.3.47 of [10, TS 38.321], used to map up to 8 TCI states and/or pairs of TCI states, with one TCI state for DL channels/signals and/or one TCI state for UL channels/signals to the codepoints of the DCI field *'Transmission Configuration Indication'* for one or for a set of CCs/DL BWPs, [and/] or up to 8 sets of TCI states, where each set is comprised of up to two TCI state(s) for DL and UL signals/channels, or up to two TCI state(s) for DL channels/signals and up to two TCI state(s) for UL channels/signals to the codepoints of the DCI field *'Transmission Configuration Indication'* for one or for a set of CCs/DL BWPs, and if applicable, for one or for a set of CCs/UL BWPs. When a set of TCI state IDs are activated for a set of CCs/DL BWPs and if applicable, for a set of CCs/UL BWPs, where the applicable list of CCs is determined by the indicated CC in the activation command, the same set of TCI state IDs are applied for all DL and/or UL BWPs in the indicated CCs. If the activation command maps *TCI-State(s)* and/or *TCI-UL-State(s)* to only one TCI codepoint, the UE shall apply the indicated *TCI-State(s)* and/or *TCI-UL-State(s)* to one or to a set of CCs /DL BWPs, and if applicable, to one or to a set of CCs /UL BWPs once the indicated mapping for the one single TCI codepoint is applied as described in [11, TS 38.133].

When the *bwp-id* or *cell* for QCL-TypeA/D source RS in a QCL-Info of the TCI state is not configured, the UE assumes that QCL-TypeA/D source RS is configured in the CC/DL BWP where TCI state applies.

When *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, a UE configured with *dl-OrJointTCI-StateList* with activated *TCI-State* or *ul-TCI-StateList* with activated *TCI-UL-State* receives DCI format 1\_1/1\_2/1\_3 providing indicated *TCI-State(s)* and/or *TCI-UL-State(s)* for a CC or all CCs in the same CC list configured by *simultaneousU-TCI-UpdateList1-r17, simultaneousU-TCI-UpdateList2-r17, simultaneousU-TCI-UpdateList3-r17, simultaneousU-TCI-UpdateList4-r17*. The DCI format 1\_3 provides indicated *TCI state(s)* and/or*TCI-UL-State(s)* for the CC(s) in a *scheduledCellListDCI-1-3* if the UE is scheduled by the DCI format 1\_3 to receive PDSCH at least on one serving cell in the *scheduledCellListDCI-1-3*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2 is without DL assignment, the UE can assume the following:

- CS-RNTI is used to scramble the CRC for the DCI

- The values of the following DCI fields are set as follows:

- RV = all '1's

- MCS = all '1's

- NDI = 0

- Set to all '0's for FDRA Type 0, or all '1's for FDRA Type 1, or all '0's for dynamicSwitch (same as in Table 10.2-4 of [6, TS 38.213]).

After a UE receives an initial higher layer configuration of *dl-OrJointTCI-StateList* where more than one *TCI-State* can be used as an indicated TCI state and before application of an indicated TCI state from the configured TCI states:

- The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH that are not received during the RACH procedure, and the CSI-RS applying the indicated TCI state are quasi co-located with the reference signal(s) in the *CandidateTCI-State* indicated in the LTM Cell Switch Command MAC CE [10, 38.321] if applicable, otherwise.

- The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block the UE identified during the initial access procedure

After a UE receives an initial higher layer configuration of *dl-OrJointTCI-StateList* where more than one *TCI-State* can be used as an indicated TCI state or an initial higher layer configuration of *ul-TCI-StateList* where more than one *TCI-UL-State* can be used as an indicated TCI state and before application of an indicated TCI state from the configured TCI states:

- The UE determines the UL TX spatial filter, if applicable, for dynamic-grant based PUSCH that is not transmitted during the RACH procedure and configured-grant based PUSCH and PUCCH that are not transmitted during the RACH procedure, and for SRS applying the indicated TCI state, from the *CandidateTCI-State* or *CandidateTCI-UL-State* indicated in the LTM Cell Switch Command MAC CE [10, 38.321] if applicable, otherwise.

- The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH, and for SRS applying the indicated TCI state, is the same as that for a PUSCH transmission scheduled by a RAR UL grant or a MsgA PUSCH transmission during the initial access procedure

After a UE receives a higher layer configuration of *dl-OrJointTCI-StateList* where more than one *TCI-State* can be used as an indicated TCI stateas part of a Reconfiguration with sync procedure as described in [12, TS 38.331]and before applying an indicated TCI state from the configured TCI states:

- The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH, and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block or the CSI-RS resource the UE identified during the random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331].

After a UE receives a higher layer configuration of *dl-OrJointTCI-StateList* where more than one *TCI-State* can be used as an indicated TCI state or a higher layer configuration of *ul-TCI-StateList* where more than one *TCI-UL-State* can be used as an indicated TCI state as part of a Reconfiguration with sync procedure as described in [12, TS 38.331] and before applying an indicated TCI state from the configured TCI states:

- The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH, and for SRS applying the indicated TCI state, is the same as that for a PUSCH transmission scheduled by a RAR UL grant or a MsgA PUSCH transmission during random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331].

If a UE receives a higher layer configuration of *dl-OrJointTCI-StateList* where only one TCI-State can be used as an indicated TCI state, the UE obtains the QCL assumptions from that TCI state for DM-RS of PDSCH and DM-RS of PDCCH, and the CSI -RS applying the indicated TCI state.

If a UE receives a higher layer configuration of *dl-OrJointTCI-StateList* where only one TCI-State can be used as an indicated TCI state or a higher layer configuration of *ul-TCI-StateList* where only one *TCI-UL-State* can be used as an indicated TCI state, the UE determines an UL TX spatial filter, if applicable, from that TCI state for dynamic-grant and configured-grant based PUSCH and PUCCH, and SRS applying the indicated TCI state.

When a UE configured with *dl-OrJointTCI-StateList* would transmit a PUCCH with positive HARQ-ACK or a PUSCH with positive HARQ-ACK corresponding to the DCI carrying the TCI State indication and without DL assignment, or corresponding to one or more PDSCHs scheduled by the DCI carrying the TCI State indication, and if the indicated TCI State(s) is/are different from the previously indicated one(s), the indicatedTCI-State(s) and/or *TCI-UL-State*(s)should be applied starting from the first slot that is at least symbols after the last symbol of the PUCCH or the PUSCH, and if the UE receives more than one indicated TCI state for a CC/BWP to be applied starting from the first slot that is at least symbols after the last symbol of the PUCCH or the PUSCH, the indicated TCI state carried in the latest DCI, for the corresponding *coresetPoolIndex* value when applicable, in time corresponding to positive HARQ-ACK value is applied. The first slot and the symbols are both determined on the active BWP with the smallest SCS among the BWP(s) from the CCs applying the indicated *TCI-State*(s) or *TCI-UL-State*(s) that are active at the end of the PUCCH or the PUSCH carrying the positive HARQ-ACK.

When a UE is configured with *dl-OrJointTCI-StateList* and is having one indicated *TCI-state*, and if the UE is configured with *unifiedTCI-StateType* is set as ‘separate’, and if the UE receives a TCI codepoint mapped with either of {TCI-State, *TCI-UL-State*}, the UE shall update the one indicated {TCI-State, *TCI-UL-State*} and maintain the other {TCI-State, *TCI-UL-State*} that is not updated by the received TCI codepoint.

When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated *TCI-states*, if the UE receives a TCI codepoint mapped with a sub-set of first and second *TCI-State(s)* and/or a sub-set offirst and second *TCI-UL-State(s)*, the UE shall update the first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* mapped to the TCI codepoint, when applicable, and keep the previously indicated first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* that is/are not updated by the TCI codepoint.

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* in which one or more rows contain multiple *SLIV*s for PDSCH on a DL BWP of a serving cell, and the UE is receiving a DCI carrying the *TCI-State* indication and without DL assignment, the UE does not expect that the number of indicated *SLIV*s in the row of the *pdsch-TimeDomainAllocationListForMultiPDSCH* by the DCI is more than one.

If the UE is configured with *SSB-MTC-AddtionalPCI* and with *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, the UE receives an activation command associated with each *coresetPoolIndex*, as described in clause 6.1.3.14 of [10, TS 38.321] or 6.1.3.47 of [10, TS 38.321], used to map up to 8 TCI states and/or pairs of TCI states, with one TCI state for DL channels/signals and/or one TCI state for UL channels/signals to the codepoints of the DCI field *'Transmission Configuration Indication'* in one CC/DL BWP. When a set of TCI state IDs are activated for a *coresetPoolIndex*, the activated TCI states corresponding to one *coresetPoolIndex* is associated with the serving cell physical cell ID and activated TCI states corresponding to another *coresetPoolIndex* can be associated with another physical cell ID.

When a UE supports two TCI states in a codepoint of the DCI field '*Transmission Configuration Indication'* the UE may receive an activation command, as described in clause 6.1.3.24 of [10, TS 38.321], the activation command is used to map up to 8 combinations of one or two TCI states to the codepoints of the DCI field *'Transmission Configuration Indication'*. The UE is not expected to receive more than 8 TCI states in the activation command.

When the DCI field *'Transmission Configuration Indication'* is present in DCI format 1\_2 and when the number of codepoints S in the DCI field *'Transmission Configuration Indication'* of DCI format 1\_2 is smaller than the number of TCI codepoints that are activated by the activation command, as described in clause 6.1.3.14, 6.1.3.24, 6.1.3.47, 6.1.3.70 and 6.1.3.71 of [10, TS38.321], only the first S activated codepoints are applied for DCI format 1\_2.

When the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, the indicated mapping between TCI states and codepoints of the DCI field *'Transmission Configuration Indication'* should be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1 and for FR2-NTN, and is provided by *K-Mac* or if *K-Mac* is not provided. If *tci-PresentInDCI* is set to 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET scheduling the PDSCH, and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than *timeDurationForQCL* if applicable, after a UE receives an initial higher layer configuration of TCI states and before reception of the activation command,

- the UE assumes that DM-RS of ports of PDSCH of a serving cell are quasi co-located with the reference signal(s) in the *CandidateTCI-State* indicated in the LTM Cell Switch Command MAC CE [10, 38.321], except during RACH procedure for RACH-based LTM, if applicable, otherwise

- the UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the SS/PBCH block determined in the initial access procedure with respect to *qcl-Type* set to 'typeA', and when applicable, also with respect to *qcl-Type* set to 'typeD'.

If a UE is configured with the higher layer parameter *tci-PresentInDCI* that is set as 'enabled'for the CORESET scheduling a PDSCH, the UE assumes that the TCI field is present in the DCI format 1\_1 or format 1\_3 of the PDCCH transmitted on the CORESET. If a UE is configured with the higher layer parameter *tci-PresentDCI-1-2* for the CORESET scheduling the PDSCH, the UE assumes that the TCI field with a DCI field size indicated by *tci-PresentDCI-1-2* is present in the DCI format 1\_2 of the PDCCH transmitted on the CORESET. If a UE is configured with the higher layer parameter *tci-PresentInDCI* that is set as 'enabled'for the CORESET scheduling the multicast PDSCH, the UE assumes that the TCI field is present in the DCI format 4\_2 of the PDCCH transmitted on the CORESET. If the PDSCH is scheduled by a DCI format not having the TCI field present, and the time offset between the reception of the DL DCI and the corresponding PDSCH of a serving cell is equal to or greater than a threshold *timeDurationForQCL* if applicable, where the threshold is based on reported UE capability [13, TS 38.306], for determining PDSCH antenna port quasi co-location, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the TCI state or QCL assumption whichever is applied for the CORESET used for the PDCCH transmission within the active BWP of the serving cell.

When a UE is configured with both *sfnSchemePDCCH* and *sfnSchemePDSCH* scheduled by DCI format 1\_0 or by DCI format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH of a serving cell is equal to or greater than a threshold *timeDurationForQCL* if applicable:

- if the UE supports *sfn-DefaultDL-BeamSetup-r17* for DCI scheduling without TCI field, the UE assumes that the TCI state(s) or the QCL assumption(s) for the PDSCH is identical to the TCI state(s) or QCL assumption(s) whichever is applied for the CORESET used for the reception of the DL DCI within the active BWP of the serving cell regardless of the number of active TCI states of the CORESET. If the UE does not support *sfn-SchemeA-DynamicSwitching-r17* or *sfn-SchemeB-DynamicSwitching-r17*, the UE should be activated with the CORESET with two TCI states.

- else if the UE does not support *sfn-DefaultDL-BeamSetup-r17* for DCI scheduling without TCI field, the UE shall expect TCI field present when scheduled by DCI format 1\_1/1\_2.

When a UE is configured with *sfnSchemePDSCH* and *sfnSchemePDCCH* is not configured, when scheduled by DCI format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH of a serving cell is equal to or greater than a threshold *timeDurationForQCL* if applicable, the UE shall expect TCI field present.

For PDSCH scheduled by DCI format 1\_0, 1\_1, 1\_2, when a UE is configured with *sfnSchemePDCCH* set to 'sfnSchemeA' and *sfnSchemePDSCH* is not configured, and there is no TCI codepoint with two TCI states in the activation command, and if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* if applicable and the CORESET which schedules the PDSCH is indicated with two TCI states, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the first TCI state or QCL assumption which is applied for the CORESET used for the PDCCH transmission within the active BWP of the serving cell.

If a UE is not provided *dl-OrJointTCI-StateList-r17*, and if a PDSCH is scheduled by a DCI format having the TCI field present, the TCI field in DCI in the scheduling component carrier points to the activated TCI states in the scheduled component carrier or DL BWP, the UE shall use the *TCI-State* according to the value of the '*Transmission Configuration Indication*' field in the detected PDCCH with DCI for determining PDSCH antenna port quasi co-location. The UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the RS(s) in the TCI state with respect to the QCL type parameter(s) given by the indicated TCI state if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a threshold *timeDurationForQCL*, where the threshold is based on reported UE capability [13, TS 38.306]. For a single slot PDSCH, the indicated TCI state(s) should be based on the activated TCI states in the slot with the scheduled PDSCH. For a multi-slot PDSCH or the UE is configured with higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, the indicated TCI state(s) should be based on the activated TCI states in the first slot with the scheduled PDSCH(s), and UE shall expect the activated TCI states are the same across the slots with the scheduled PDSCH(s). When the UE is configured with CORESET associated with a search space set for cross-carrier scheduling and the UE is not configured with *enableDefaultBeamForCCS*, the UE expects *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, and if one or more of the TCI states configured for the serving cell scheduled by the search space set contains *qcl-Type* set to 'typeD', the UE expects the time offset between the reception of the detected PDCCH in the search space set and a corresponding PDSCH is larger than or equal to the threshold *timeDurationForQCL.*

Independent of the configuration of *tci-PresentInDCI* and *tci-PresentDCI-1-2* in RRC connected mode, if the UE is not provided *dl-OrJointTCI-StateList-r17*, and if the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL* and at least one configured TCI state for the serving cell of scheduled PDSCH contains *qcl-Type* set to 'typeD',

- the UE may assume that the DM-RS ports of PDSCH(s) of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE. In this case, if the *qcl-Type* is set to 'typeD' of the PDSCH DM-RS is different from that of the PDCCH DM-RS with which they overlap in at least one symbol, the UE is expected to prioritize the reception of PDCCH associated with that CORESET. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers).

- If a UE is configured with *enableDefaultTCI-StatePerCoresetPoolIndex* and the UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in different *ControlResourceSets,*

- the UE may assume that the DM-RS ports of PDSCH associated with a value of *coresetPoolIndex* of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* among CORESETs, which are configured with the same value of *coresetPoolIndex* as the PDCCH scheduling that PDSCH, in the latest slot in which one or more CORESETs associated with the same value of *coresetPoolIndex* as the PDCCH scheduling that PDSCH within the active BWP of the serving cell are monitored by the UE. In this case, if the 'QCL-TypeD' of the PDSCH DM-RS is different from that of the PDCCH DM-RS with which they overlap in at least one symbol and they are associated with same value of *coresetPoolIndex*, the UE is expected to prioritize the reception of PDCCH associated with that CORESET. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers).

- If a UE is configured with *enableTwoDefaultTCI-States*, and at least one TCI codepoint indicates two TCI states, the UE may assume that the DM-RS ports of PDSCH or PDSCH transmission occasions of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states. When the UE is configured by higher layer parameter *repetitionScheme* set to 'tdmSchemeA' or is configured with higher layer parameter *repetitionNumber*, and the offset between the reception of the DL DCI and the first PDSCH transmission occasion is less than the threshold *timeDurationForQCL,* the mapping of the TCI states to PDSCH transmission occasions is determined according to clause 5.1.2.1 by replacing the indicated TCI states with the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states based on the activated TCI states in the slot with the first PDSCH transmission occasion. In this case, if the 'QCL-TypeD' in both of the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states is different from that of the PDCCH DM-RS with which they overlap in at least one symbol, the UE is expected to prioritize the reception of PDCCH associated with that CORESET. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers)

- If a UE is not configured with *sfnSchemePDSCH*, and the UE is configured with *sfnSchemePDCCH* set to 'sfnSchemeA' and there is no TCI codepoint with two TCI states in the activation command and the CORESET with the lowest ID in the latest slot is indicated with two TCI states, the UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the first TCI state of two TCI states indicated for the CORESET. In this case, if the *qcl-Type* is set to 'typeD' of the PDSCH DM-RS is different from that of the PDCCH DM-RS with which they overlap in at least one symbol, the UE is expected to prioritize the reception of PDCCH associated with that CORESET with single active TCI state. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers).

- In all cases above, if none of configured TCI states for the serving cell of scheduled PDSCH is configured with *qcl-Type* set to 'typeD', the UE shall obtain the other QCL assumptions from the indicated TCI state(s) for its scheduled PDSCH irrespective of the time offset between the reception of the DL DCI and the corresponding PDSCH.

Independent of the configuration of *tci-PresentInDCI* and *tci-PresentDCI-1-2* in RRC connected mode, if the UE is provided *dl-OrJointTCI-StateList-r17*, and if the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL* and at least one configured TCI state for the serving cell of scheduled PDSCH contains *qcl-Type* set to 'typeD', regardless of configuration of *followUnifiedTCI-State*,

- if the indicated TCI state is associated with the PCI of the serving cell, the indicated TCI state is applied to PDSCH reception.

- if the indicated TCI state is associated with a PCI different from the serving cell, the UE may assume that the DM-RS ports of PDSCH(s) of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE. In the CA case, if the 'QCL-TypeD' of the PDSCH DM-RSs from respective CCs in a band are different in a slot, the QCL-TypeD assumption of the PDSCH DM-RS in the CC with lowest CC ID in the band is applied to all the PDSCH DM-RSs in the CCs in the band. In this case, if the *qcl-Type* is set to 'typeD' of the PDSCH DM-RS is different from that of the PDCCH DM-RS with which they overlap in at least one symbol, the UE is expected to prioritize the reception of PDCCH associated with that CORESET. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers).

If the PDCCH carrying the scheduling DCI is received on one component carrier, and a PDSCH scheduled by that DCI is on another component carrier:

- The *timeDurationForQCL* is determined based on the subcarrier spacing of the scheduled PDSCH. If µPDCCH < µPDSCH an additional timing delay is added to the *timeDurationForQCL*, where *d* is defined in 5.2.1.5.1a-1, otherwise *d* is zero;

- When the UE is configured with *enableDefaultBeamForCCS*, if the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL,* or if the DL DCI does not have the TCI field present, the UE obtains its QCL assumption for the scheduled PDSCH from the activated TCI state with the lowest ID applicable to PDSCH in the active BWP of the scheduled cell.

A UE that has indicated a capability *beamCorrespondenceWithoutUL-BeamSweeping* set to 'supported', as described in [13, TS 38.306], can determine a spatial domain filter to be used while performing the applicable channel access procedures described in [16, TS 37.213] prior to a UL transmission on the channel as follows:

- if UE is indicated with an SRI corresponding to the UL transmission, the UE may use a spatial domain filter that is same as the spatial domain transmission filter associated with the indicated SRI,

- if UE is configured with *SRS-spatialRelationInfo* for the UL transmission, the UE may use a spatial domain filter that is same as the spatial domain filter associated with *referenceSignal* in the corresponding *SRS-spatialRelationInfo*,

- if UE is configured with *TCI-State* in *dl-OrJointTCI-StateList* or *TCI-UL-State* in *ul-TCI-StateList*, the UE may use a spatial domain filter that is same as the spatial domain receive filter the UE may use to receive the DL reference signal associated with the indicated TCI state.

When the PDCCH reception includes two PDCCH from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the time offset between the reception of the DL DCI and the corresponding PDSCH, the PDCCH candidate that ends later in time is used. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the configuration of *tci-PresentInDCI* or *tci-PresentDCI-1-2*, the UE expects the same configuration in the first and second CORESETs associated with the two PDCCH candidates; and if the PDSCH is scheduled by a DCI format not having the TCI field present and if the scheduling offset is equal to or larger than *timeDurationForQCL,* if applicable, PDSCH QCL assumption is based on the CORESET with lower ID among the first and second CORESETs associated with the two PDCCH candidates.

For a periodic CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):

- 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block where SS/PBCH block may have a PCI different from the PCI of the serving cell. The UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell, or

- 'typeC' with an SS/PBCH block and, when applicable,'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition,* where SS/PBCH block may have a PCI different from the PCI of the serving cell. The UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell.

For periodic/semi-persistent CSI-RS, if the UE is configured with *dl-OrJointTCI-StateList,* the UE can assume that the indicated *TCI-State* is not applied.

For an aperiodic CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info,* the UE shall expect that a *TCI-State* indicates *qcl-Type* set to 'typeA' with a periodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, *qcl-Type* set to 'typeD' with the same periodic CSI-RS resource.

For a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured without higher layer parameter *trs-Info* and without the higher layer parameter *repetition*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with an SS/PBCH block, where SS/PBCH block may have a PCI different from the PCI of the serving cell. The UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or

- 'typeB' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* when 'typeD' is not applicable.

For a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition,* the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or

- 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block, the reference RS may additionally be an SS/PBCH block having a PCI different from the PCI of the serving cell. The UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell.

For the DM-RS of PDCCH, if the UE is not configured with *dl-OrJointTCI-StateList,* the UE shall expect that a *TCI-State* indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured without higher layer parameter trs-Info and without higher layer parameter *repetition* and,when applicable, 'typeD' with the same CSI-RS resource.

When a UE is configured with *sfnSchemePdcch* set to 'sfnSchemeA', and CORESET is activated with two TCI states or is configured with *applyIndicatedTCI-State* set to 'both', the UE shall assume that the DM-RS port(s)of the PDCCH in the CORESET is quasi co-located with the DL-RSs of the two TCI states. When a UE is configured with *sfnSchemePdcch* set to 'sfnSchemeB', and a CORESET is activated with two TCI states or is configured with *applyIndicatedTCI-State* set to 'both', the UE shall assume that the DM-RS port(s)of the PDCCH is quasi co-located with the DL-RSs of the two TCI states except for quasi co-location parameters {Doppler shift, Doppler spread} of the second indicated TCI state.

When a UE is configured by higher layer parameter *cjtSchemePDSCH* and *dl-OrJointTCI-StateList* and is indicated with two TCI-States applied for PDSCH reception and reports *twoTCI-StatePDSCH-CJT-TxScheme*:

- if the UE is configured with *cjtSchemeA*, the UE assumes that PDSCH DM-RS port(s) are QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA.

- if the UE is configured with *cjtSchemeB*, the UE assumes that PDSCH DM-RS port(s) are QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state.

For the DM-RS of PDSCH, if the UE is not configured with *dl-OrJointTCI-StateList,* the UE shall expect that a *TCI-State* indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource*,* or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*,or

- typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured without higher layer parameter *trs-Info* and without higher layer parameter *repetition* and, when applicable, 'typeD' with the same CSI-RS resource.

For the DM-RS of PDCCH, if the UE is configured with *dl-OrJointTCI-StateList,* the UE shall expect that an indicated *TCI-State* indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition.*

For the DM-RS of PDSCH, if the UE is configured with *dl-OrJointTCI-StateList,* the UE shall expect that an indicated *TCI-State* indicates one of the following quasi co-location type(s):

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource*,* or

- 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition.*

When a UE is configured with *sfnSchemePDSCH* set to 'sfnSchemeA', and the UE not configured with *dl-OrJointTCI-StateList* is indicated with two TCI states in a codepoint of the DCI field 'Transmission Configuration Indication' in a DCI scheduling a PDSCH or the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH, the UE shall assume that the DM-RS port(s)of the PDSCH is quasi co-located with the DL-RSs of the two TCI states. When a UE is configured with *sfnSchemePDSCH* set to 'sfnSchemeB', and the UE not configured with *dl-OrJointTCI-StateList* is indicated with two TCI states in a codepoint of the DCI field 'Transmission Configuration Indication' in a DCI scheduling a PDSCH or the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI States to be applied to PDSCH, the UE shall assume that the DM-RS port(s)of the PDSCH is quasi co-located with the DL-RSs of the two TCI states except for quasi co-location parameters {Doppler shift, Doppler spread} of the second indicated TCI state.

When a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and is configured by higher layer parameter *PDCCH-Config* that contains two different values of coresetPoolIndex in *ControlResourceSet*, an indicated TCI state is specific to a coresetPoolIndex value, when it is indicated by the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2 associated with the coresetPoolIndex value.

When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated TCI-states, if the UE does not report its capability of *defaultQCL-TwoTCI* in frequency range 2 and when the offset between the reception of the scheduling/activation DCI format 1\_0/1\_1/1\_2 and the scheduled or activated PDSCH reception is less than *timeDurationForQCL* in frequency range 2, the UE shall apply the first indicated TCI-State to the scheduled or activated PDSCH reception.

When a UE is configured with *dl-OrJointTCI-StateList*, is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, if the UE does not report its capability of *defaultQCL-PerCORESETPoolIndex* in frequency range 2

- when the offset between the reception of the scheduling/activation DCI format 1\_0/1\_1/1\_2 in a CORESET associated with *coresetPoolIndex* value 0 and the scheduled or activated PDSCH reception is less than *timeDurationForQCL* in frequency range 2, the UE shall apply the indicated joint/DL TCI state specific to *coresetPoolIndex* value 0 to the scheduled or activated PDSCH reception.

- the UE does not expect that the offset between reception of the scheduling/activation DCI format 1\_0/1\_1/1\_2 in a CORESET associated with *coresetPoolIndex* value 1 and scheduled or activated PDSCH reception is less than *timeDurationForQCL* in frequency range 2.

When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated TCI-states:

- Regardless of the offset between the reception of the scheduling DCI format 1\_0/1\_1/1\_2 and the scheduled/activated PDSCH reception, if the UE is in frequency range 1, or the UE reports its capability of *defaultQCL-TwoTCI* in frequency range 2, or

- If the UE does not report its capability of *defaultQCL-TwoTCI* in frequency range 2 and if the scheduling offset between the reception of the scheduling DCI format 1\_0/1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than *timeDurationForQCL*

- The UE can be configured by higher layer parameter *applyIndicatedTCI-StateDCI-1-0* to indicate whether the first, the second, or both of the indicated TCI-state(s) is/are applied to PDSCH reception scheduled or activated by DCI format 1\_0. The UE can be configured with *applyIndicatedTCI-StateDCI-1-0* with value *both* only when the UE is configured with *cjt-Scheme-PDSCH* and the UE reports *twoTCI-StatePDSCH-CJT-TxScheme* or the UE is configured with *sfnSchemePdsch*. In that case, the UE shall apply both indicated TCI-states to PDSCH reception scheduled or activated by DCI format 1\_0 on a search space other than Type0/0A/2 CSS on CORESET#0.

- If the UE is not configured with *applyIndicatedTCI-StateDCI-1-0*, the first indicated TCI-state is applied to PDSCH reception scheduled or activated by DCI format 1\_0.

- When the UE is configured with *tciSelection-PresentInDCI* jointly for both DCI formats 1\_1 and 1\_2 in the same DL BWP,and when the UE receives a DCI format 1\_1/1\_2 that schedules or activates PDSCH reception, the UE shall determine the indicated joint/DL TCI state(s) for the PDSCH reception according to the following:

- If the DCI format 1\_1/1\_2 indicates codepoint "00" for the DCI field ‘TCI selection’, the UE shall apply the first one of two indicated joint/DL TCI states to all PDSCH DM-RS port(s) of corresponding PDSCH transmission occasion(s) scheduled or activated by the DCI format 1\_1/1\_2.

- If the DCI format 1\_1/1\_2 indicates codepoint "01" for the DCI field ‘TCI selection’, the UE shall apply the second one of two indicated joint/DL TCI states to all PDSCH DM-RS port(s) of corresponding PDSCH transmission occasion(s) scheduled or activated by the DCI format 1\_1/1\_2.

- If the DCI format 1\_1/1\_2 indicates codepoint "10" for the DCI field ‘TCI selection’, the UE shall apply both indicated joint/DL TCI states to the PDSCH reception scheduled or activated by the DCI format 1\_1/1\_2.

- If the UE is not configured with *tciSelection-PresentInDCI* and when the UE receives a DCI format 1\_1/1\_2 that schedules/activates PDSCH reception, the UE shall apply both indicated TCI-States to the scheduled or activated PDSCH reception

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##### 5.1.6.5.2 PRS for carrier phase positioning

For DL UE positioning measurement reporting in higher layer parameter *NR-DL-TDOA-SignalMeasurementInformation,* the UE may be configured to report the DL Reference Signal Carrier Phase Difference (RSCPD) [7, TS 38.215] measurement along with the DL RSTD measurement. When the UE reports RSCPD measurements, the reference *nr-DL-PRS-ReferenceInfo* is the same as the one reported, for the RSTD measurements. For DL UE positioning measurement reporting in higher layer parameter *NR-Multi-RTT-SignalMeasurementInformation*, the UE may be configured to report the DL Reference Signal Carrier Phase (RSCP) measurement [7, TS 38,215] along with the UE Rx-Tx time difference measurement. When the UE reports DL RSCPD measurement(s) along with DL RSTD measurement(s) or DL RSCP measurement(s) along with UE Rx-Tx time difference measurement(s), the DL RSCPD and/or DL RSCP measurement(s) should be measured from a single DL PRS positioning frequency layer. For a UE in RRC\_CONNECTED state, DL RSCP/RSCPD measurements are measured within the configured measurement gap.

The UE is expected to obtain each DL RSCP or DL RSCPD measurement with as defined in [11, TS 38.133]. If the UE reports a DL RSTD measurement with = 2 or 4 samples as defined in [11, TS 38.133], up to DL RSCPD measurements can be reported associated with the DL RSTD measurement. If the UE reports a UE Rx-Tx time difference measurement with = 2 or 4 samples as defined in [11, TS 38.133], up to DL RSCP measurements can be reported associated with the UE Rx-Tx time difference measurement. Each DL RSCP or DL RSCPD measurement has its own timestamp.

When the UE reports a timestamp associated with a DL RSCP measurement or a DL RSCPD measurement, subject to UE capability, it may include a symbol index in the timestamp.

If the UE reports LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-Indicator* along with a measurement report containing DL RSCP or DL RSCPD the LoS/NLoS indicator(s) are assumed to also apply to the DL RSCP or DL RSCPD measurements.

The UE may be provided with *NR-PRU-DL-Info* which contains DL RSCP/RSCPD measurements together with DL RSTD, DL PRS-RSRP, and/or DL PRS-RSRPP measurement(s) associated with the RSCP/RSCPD measurements performed by a positioning reference unit (PRU) [20, TS 38.305], the timestamps associated with the measurements, and the location information of the PRU.

The UE may be configured to report quality metrics *NR-PhaseQuality* corresponding to the DL RSCP and RSCPD measurements which include the following fields [17, TS 37.355]:

*- phaseQualityValue* which provides the uncertainty of the measurement

*- phaseQualityResolution* which specifies the resolution levels used in the *phaseQualityValue* field.

The UE in RRC\_INACTIVE or RRC\_IDLE mode is expected to perform the DL RSCP or DL RSCPD measurement from the bandwidth of a DL PRS resource including outside of the initial downlink bandwidth part.

##### 5.1.6.5.3 PRS bandwidth aggregation for positioning measurements

When the UE is expected to perform aggregated measurements for bandwidth aggregation across DL PRS positioning frequency layers, the UE expects to be configured with linkage information, via higher layer parameter *nr-DL-PRS-AggregationInfo*, between DL PRS resource sets across DL PRS positioning frequency layers. For the linked DL PRS resource sets, the UE is expected to be configured with the same values of *dl-PRS-QCL-Info*, *dl-PRS-Periodicity-and-ResourceSetSlotOffset, dl-PRS-NumSymbols*,*dl-PRS-ResourceTimeGap, dl-PRS-ResourceRepetitionFactor, dl-PRS-ResourceSymbolOffset,* *dl-PRS-MutingBitRepetitionFactor,* *dl-PRS-SubcarrierSpacing, dl-PRS-CyclicPrefix*, *dl-PRS-CombSizeN*, *dl-PRS-ResourcePower*, *NR-MutingPattern*, and *NR-DL-PRS-SFN0-Offset,* and the UE is expected to be configured with DL PRS resources that maintain uniformly spaced DL PRS RE pattern within a symbol across aggregated DL PRS positioning frequency layers. The UE assumes that DL PRS resources across the linked DL PRS resource sets which satisfy the above conditions are linked for bandwidth aggregation, and the UE may assume phase continuity on the DL PRS resources on same symbol(s); otherwise, the UE does not assume that PRS resources from the linked DL PRS resource sets are linked for bandwidth aggregation.

The UE may be indicated by the network that aggregated DL PRS resource set(s) can be used as the reference for the aggregated DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, and UE Rx-Tx time difference measurements.

The UE may be configured to measure and report, subject to UE capability, up to 4 aggregated DL RSTD measurement(s) per pair of *dl-PRS-ID,* from a different pair of aggregated DL PRS resources across two or three DL PRS positioning frequency layers*.* The UE may report up to 4 RSTD measurements associated with different aggregated DL PRS resources per UE Rx TEG per *dl-PRS-ID*.

The UE may be configured to measure and report, subject to UE capability, up to 4 aggregated UE Rx-Tx time difference measurement(s) from aggregated DL PRS resources across two or three DL PRS positioning frequency layers. The UE may report up to 4 UE Rx-Tx time difference measurements associated with different aggregated DL PRS resources per UE RxTx TEG per *dl-PRS-ID*.

The UE may be requested via higher layer parameter *nr-DL-PRS-JointMeasurementRequestedPFL-List* to perform the aggregated DL RSTD measurement(s) or the aggregated UE Rx-Tx time difference measurement(s) across two or three DL PRS positioning frequency layers.

The UE may report via higher layer parameter *nr-RSTD-BasedOnAggregatedResources* or *nr-UE-RxTxTimeDiffBasedOnAggregatedResources* in a measurement report whether the aggregated DL RSTD measurement(s) or the aggregated UE Rx-Tx time difference measurement(s) is performed. If any aggregated measurement is performed, the two or three DL PRS positioning frequency layers to be used may also be reported by reporting PRS resource set IDs.

If the UE reports a DL PRS-RSRP or a DL PRS-RSRPP with aggregated DL RSTD measurement(s) or aggregated UE Rx-Tx time difference measurement(s), the DL PRS-RSRP or the DL PRS-RSRPP correspond to the aggregated DL PRS resources across two or three DL PRS positioning frequency layers.

For PRS resources on multiple DL PRS positioning frequency layers (PFLs) linked for aggregation, the channel over which a symbol on one PFL for PRS transmission is conveyed can be inferred from the channel over which the same symbol of another PFL or the aggregated PFL is conveyed.

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##### 5.2.1.5.1 Aperiodic CSI Reporting/Aperiodic CSI-RS when the triggering PDCCH and the CSI-RS have the same numerology

For CSI-RS resource sets associated with Resource Settings configured with the higher layer parameter *resourceType* set to 'aperiodic', 'periodic', or 'semi-persistent', trigger states for Reporting Setting(s) (configured with the higher layer parameter *reportConfigType* set to 'aperiodic') and/or Resource Setting for channel and/or interference measurement on one or more component carriers are configured using the higher layer parameter *CSI-AperiodicTriggerStateList*. For a reporting setting for which the *CSI-ReportConfig* contains a list of sub-configurations provided by the higher layer parameter *csi-ReportSubConfigToAddModList*, one or more trigger states can be configured with each indicating one or more of the sub-configurations. For aperiodic CSI report triggering, a single set of CSI triggering states are higher layer configured, wherein the CSI triggering states can be associated with any candidate DL BWP. A UE is not expected to receive more than one DCI with non-zero *CSI request* field per slot per cell. A UE is not expected to receive DCI with non-zero *CSI request* field within a cell group in a slot overlapping with any slot receiving DCI with non-zero *CSI request* field in the same cell group. A UE is not expected to be configured with different *TCI-StateId*'s for the same aperiodic CSI-RS resource ID configured in multiple aperiodic CSI-RS resource sets with the same triggering offset in the same aperiodic trigger state. A UE is not expected to receive more than one aperiodic CSI report request for transmission in a given slot per cell. A UE is not expected to receive an aperiodic CSI report request for transmission in a slot overlapping with any slot having an aperiodic CSI report transmission in the same cell group. If a UE does not indicate its capability of *csi-TriggerStateNon-ActiveBWP* the UE is not expected to be triggered with a CSI report for a non-active DL BWP. Otherwise, when a UE is triggered with a CSI report for a DL BWP that is non-active when expecting to receive the most recent occasion, no later than the CSI reference resource, of the associated NZP CSI-RS, the UE is not expected to report the CSI for the non-active DL BWP and the CSI report associated with that BWP is omitted. When a UE is triggered with aperiodic NZP CSI-RS in a DL BWP that is non-active when expecting to receive the NZP CSI-RS, the UE is not expected to measure the aperiodic CSI-RS. In the carrier of the serving cell expecting to receive that associated NZP CSI-RS, if the active DL BWP when receiving the NZP CSI-RS is different from the active DL BWP when receiving the triggering DCI,

- the last symbol of the PDCCH span of the DCI carrying the BWP switching shall be no later than the last symbol of the PDCCH span of the DCI carrying the CSI trigger, irrespective of whether they are in the same carrier of a serving cell or not and irrespective of whether they are in the same SCS or not;

- the UE is not expected to have any other BWP switching in that carrier after the last symbol of the PDCCH span covering the DCI carrying the CSI trigger and before the first symbol of the triggered NZP CSI-RS or CSI-IM.

- when the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], the span that involves the PDCCH candidate that ends later in time is used.

A trigger state is initiated using the *CSI request* field in DCI.

- When all the bits of *CSI request* field in DCI are set to zero, no CSI is requested.

- When the number of configured CSI triggering states in *CSI-AperiodicTriggerStateList* is greater than , where  is the number of bits in the DCI *CSI request* field, the UE receives a subselection indication, as described in clause 6.1.3.13 of [10, TS 38.321], used to map up to  trigger states to the codepoints of the *CSI request* field in DCI.  is configured by the higher layer parameter *reportTriggerSize* where . When the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the subselection indication, the corresponding action in [10, TS 38.321] and UE assumption on the mapping of the selected CSI trigger state(s) to the codepoint(s) of DCI CSI request field shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1 and for FR2-NTN, and is provided by *K-Mac* or if *K-Mac* is not provided..

- When the number of CSI triggering states in *CSI-AperiodicTriggerStateList* is less than or equal to , the *CSI request* field in DCI directly indicates the triggering state.

- For each aperiodic CSI-RS resource in a CSI-RS resource set associated with each CSI triggering state, the UE is indicated the quasi co-location configuration of quasi co-location RS source(s) and quasi co-location type(s), as described in clause 5.1.5, through higher layer signaling of *qcl-info* which contains a list of references to *TCI-State's* for the aperiodic CSI-RS resources associated with the CSI triggering state. If a *State* referred toin the list is configured with a reference to an RS configured with *qcl-Type* set to 'typeD', that RS may be an SS/PBCH block located in the same or different CC/DL BWP or a CSI-RS resource configured as periodic or semi-persistent located in the same or different CC/DL BWP.

- If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in a *NZP-CSI-RS-ResourceSet* configured without higher layer parameter *trs-Info* is smaller than the UE reported threshold *beamSwitchTiming,* as defined in [13, TS 38.306], when the reported value is one of the values of {14, 28, 48} and *enableBeamSwitchTiming* is not provided, or is smaller than 48 when the UE provides *beamSwitchTiming-r16*, *enableBeamSwitchTiming* is provided and the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameter *repetition,* or is smaller than the UE reported threshold *beamSwitchTiming-r16,* when *enableBeamSwitchTiming* is provided and the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *repetition* set to 'on'.

- If a UE is configured with *enableDefaultTCI-StatePerCoresetPoolIndex* and the UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*

- if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled by a PDCCH associated with the same *coresetPoolIndex* as the PDCCH triggering the aperiodic CSI-RS and scheduled with offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], aperiodic CSI-RS triggered by a PDCCH associated with the same *coresetPoolIndex* as the PDCCH triggering the aperiodic CSI-RS and scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and *enableBeamSwitchTiming* is not provided, aperiodic CSI-RS triggered by a PDCCH associated with the same *coresetPoolIndex* as the PDCCH triggering the aperiodic CSI-RS and scheduled with offset larger than or equal to 48 when the reported value of *beamSwitchTiming-r16* is one of the values {224, 336} and *enableBeamSwitchTiming* is provided, periodic CSI-RS, semi-persistent CSI-RS;

- else, the UE applies the QCL parameter(s) of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* among CORESETs, which are configured with the same value of *coresetPoolIndex* as the PDCCH triggering that aperiodic CSI-RS, in the latest slot in which one or more CORESETs are associated with the same value of *coresetPoolIndex* as the PDCCH triggering that aperiodic CSI-RS

- else if a UE is configured with *enableTwoDefaultTCI-States* and at least one TCI codepoint is mapped to two TCI states

- if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], aperiodic CSI-RS scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and *enableBeamSwitchTiming* is not provided, aperiodic CSI-RS scheduled with offset larger than or equal to 48 when the reported value of *beamSwitchTiming-r16* is one of the values {224, 336} and *enableBeamSwitchTiming* is provided, periodic CSI-RS, semi-persistent CSI-RS. If there is a PDSCH indicated with two TCI states in the same symbols as the CSI-RS, the UE applies the first TCI state of the two TCI states when receiving the aperiodic CSI-RS.

- else, the UE applies the first one of two TCI states corresponding to the lowest TCI codepoint among those mapped to two TCI states and applicable to the PDSCH within the active BWP of the cell in which the CSI-RS is to be received when receiving the aperiodic CSI-RS.

- else if a UE is configured with *sfnSchemePdcch* set to *'*sfnSchemeA' or 'sfnSchemeB', it is not configured with *enableTwoDefaultTCI-States,* and the two TCI states are activated for the CORESET by the activation command as described in clause 6.1.3.44 of [10, TS 38.321]

- if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with an offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], periodic CSI-RS, semi-persistent CSI-RS, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and when *enableBeamSwitchTiming* is not provided or the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *trs-Info* , aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters *repetition* and *trs-Info* scheduled with offset larger than or equal to 48 when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'on' scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided;

- else, the UE applies the first one of TCI states indicated for the CORESET with the lowest CORESET ID in the latest slot within the active BWP of the cell in which the CSI-RS is to be received when receiving the aperiodic CSI-RS, if two TCI states are activated for the CORESET. Otherwise, the UE applies the single activated TCI state of the CORESET with the lowest CORESET ID in the latest slot within the active BWP of the cell in which the CSI-RS is to be received, when receiving the aperiodic CSI-RS

- else if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], periodic CSI-RS, semi-persistent CSI-RS, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and when *enableBeamSwitchTiming* is not provided or the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *trs-Info* , aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters *repetition* and *trs-Info* scheduled with offset larger than or equal to 48 when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'on' scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided;

- else if the UE is not provided *dl-OrJointTCI-StateList*, and if at least one CORESET is configured for the BWP in which the aperiodic CSI-RS is received, when receiving the aperiodic CSI-RS, the UE applies the QCL assumption used for the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs within the active BWP of the serving cell are monitored;

- else if the UE is provided *dl-OrJointTCI-StateList* and if the indicated TCI state is associated with a PCI different from the serving cell, regardless of configuration of *followUnifiedTCI-State*, and if at least one CORESET is configured for the BWP in which the aperiodic CSI-RS is received, when receiving the aperiodic CSI-RS, the UE applies the QCL assumption used for the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs within the active BWP of the serving cell are monitored. In the CA case, if the 'QCL-TypeD' of the aperiodic CSI-RSs from respective CCs in a band are different in a slot, the QCL-TypeD assumption of the CSI-RS in the CC with lowest CC ID in the band is applied to all the aperiodic CSI-RSs in the CCs in the band;

- else if the UE is provided *dl-OrJointTCI-StateList* and the indicated TCI state is associated with the PCI of the serving cell, regardless of configuration of *followUnifiedTCI-State*, the indicated TCI state is applied to the aperiodic CSI-RS;

- else if the UE is configured with *enableDefaultBeamForCCS* and when receiving the aperiodic CSI-RS, the UE applies the QCL assumption of the lowest-ID activated TCI state applicable to the PDSCH within the active BWP of the cell in which the CSI-RS is to be received.

- If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in a *NZP-CSI-RS-ResourceSet* is equal to or greater than the UE reported threshold *beamSwitchTiming* when the reported value is one of the values of {14,28,48} and *enableBeamSwitchTiming* is not provided and the *NZP-CSI-RS-ResourceSet* is not configured with higher layer parameter *trs-Info*, or is equal to or greater than the UE reported threshold *beamSwitchTiming* when the reported value is one of the values of {14,28,48} and the *NZP-CSI-RS-ResourceSet* is configured with higher layer parameter *trs-Info*, or is equal to or greater than 48 when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided and the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters *repetition* and *trs-Info*, or is equal to or greater than the UE reported threshold *beamSwitchTiming-r16,* when *enableBeamSwitchTiming* is provided and the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *repetition* set to 'on', the UE is expected to apply the QCL assumptions in the indicated TCI states for the aperiodic CSI-RS resources in the CSI triggering state indicated by the CSI trigger field in DCI.

- The UE is not expected to receive aperiodic CSI-RS and PDSCH/aperiodic CSI-RS associated with different values of *coresetPoolIndex* in overlapped symbol(s). The UE is not expected to receive aperiodic CSI-RS and semi-persistent/periodic CSI-RS with different 'QCL-type D' in overlapped symbol(s).

- If *dl-OrJointTCI-StateList-r17* is provided, the UE may assume that a CSI-RS resource in an aperiodic CSI-RS resource set configured without *trs-Info* is quasi co-located with the RS(s) in the indicated TCI state.

- A non-zero codepoint of the CSI request field in the DCI is mapped to a CSI triggering state according to the order of the associated positions of the up to trigger states in *CSI-AperiodicTriggerStateList* with codepoint '1' mapped to the triggering state in the first position.

For a UE configured with the higher layer parameter *CSI-AperiodicTriggerStateList*, if a Resource Setting linked to a *CSI-ReportConfig* has multiple aperiodic resource sets, only one of the aperiodic CSI-RS resource sets from the Resource Setting is associated with the trigger state, and the UE is higher layer configured per trigger state per Resource Setting to select the one CSI-IM/NZP CSI-RS resource set from the Resource Setting.

When aperiodic CSI-RS is used with aperiodic reporting, the CSI-RS offset is configured per resource set by the higher layer parameter *aperiodicTriggeringOffset* or *aperiodicTriggeringOffset-r16* or *aperiodicTriggeringOffset-r17*. The CSI-RS triggering offset has the values of {0, 1, 2, 3, 4, 5, 6, …, 15, 16, 24} slots for or {0, 4, 8, 12, …, 60, 64, 96} slots for and , where is the subcarrier spacing configurations for CSI-RS. If the UE is not configured with *minimumSchedulingOffsetK0* for any DL BWP and *minimumSchedulingOffsetK2* for any UL BWP and if all the associated trigger states do not have the higher layer parameter *qcl-Type* set to 'typeD' in the corresponding TCI states, the CSI-RS triggering offset is fixed to zero. The aperiodic triggering offset of the CSI-IM follows offset of the associated NZP CSI-RS for channel measurement. The aperiodic CSI-RS is transmitted in a slot , , if UE is configured with ca-SlotOffset for at least one of the triggered and triggering cell, and in slot , otherwise, and where

*- n* is the slot containing the triggering DCI, *X* is the CSI-RS triggering offset according to the higher layer parameter *aperiodicTriggeringOffset* or *aperiodicTriggeringOffset-r16* or *aperiodicTriggeringOffset-r17*,

*-* and are the and the  which are determined by higher-layer configured *ca-SlotOffset* for the cell receiving the PDCCH, and are the and the  which are determined by higher-layer configured *ca-SlotOffset* for the cell transmitting the CSI-RS respectively, as defined in [4, TS 38.211] clause 4.5.

The UE does not expect that aperiodic CSI-RS is transmitted before the OFDM symbol(s) carrying its triggering DCI. When the minimum scheduling offset restriction is applied, UE is not expected to be triggered by CSI triggering state indicated by the CSI request field in DCI in which CSI-RS triggering offset is smaller than the currently applicable minimum scheduling offset restriction *K*0min.

If interference measurement is performed on aperiodic NZP CSI-RS, a UE is not expected to be configured with a different aperiodic triggering offset of the NZP CSI-RS for interference measurement from the associated NZP CSI-RS for channel measurement.

If the UE is configured with a single carrier for uplink, the UE is not expected to transmit more than one aperiodic CSI report triggered by different DCIs on overlapping OFDM symbols.

When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources, the PDCCH candidate that ends later in time is used, and the UE does not expect that the aperiodic CSI-RS is transmitted before the first symbol of the PDCCH candidate that starts later in time.

When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated TCI states, a higher layer configuration can be provided to an aperiodic CSI-RS resource set or a CSI-RS resource in an aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated TCI-State to the aperiodic CSI-RS resource set or to the CSI-RS resource in the aperiodic CSI-RS resource set, if the higher layer configuration is provided and if the offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in the aperiodic CSI-RS resource set is equal to or larger than a threshold.

-If the UE is configured by higher layer parameter PDCCH-Config that contains two different values of CORESETPoolIndex in different ControlResourceSets, the first and the second indicated TCI-States correspond to the indicated TCI-States specific to coresetPoolIndex value 0 and value 1, respectively.

When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated TCI states and if the offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in the aperiodic CSI-RS resource set is smaller than a threshold:

-If there is no DL signal in the same symbols as the aperiodic CSI-RS

-if the UE is in frequency range 1, or the UE reports its capability of *defaultQCL-TwoTCI* in frequency range 2, the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or to the aperiodic CSI-RS resource set

-otherwise, the UE shall apply the first indicated joint/DL TCI state to the aperiodic CSI-RS

-else if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with offset larger than or equal to the threshold *timeDurationForQCL*, as defined in [13, TS 38.306], periodic CSI-RS, semi-persistent CSI-RS, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48}∙2max(0,μCSIRS-3) and when *enableBeamSwitchTiming* is not provided or the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *trs-Info*, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters *repetition* and *trs-Info* scheduled with offset larger than or equal to 48∙2max(0,μCSIRS-3) when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *repetition* set to 'on' scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided. If there is a PDSCH applying two indicated joint/DL TCI states in the same symbols as the AP CSI-RS, the UE applies the first or the second indicated joint/DL TCI state to the AP CSI-RS according to the higher layer configuration(s) provided to the AP CSI-RS resource or to the aperiodic CSI-RS resource set.

When a UE is configured with *dl-OrJointTCI-StateList*, is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in different *ControlResourceSets,* is having two indicated TCI states where the first and the second indicated TCI states correspond to the indicated TCI states specific to *coresetPoolIndex* value 0 and value 1 and if the offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in the aperiodic CSI-RS resource set is smaller than a threshold:

-If there is no other DL signal in the same symbols as the aperiodic CSI-RS

-if the UE is in frequency range 1, or the UE reports its capability of *defaultQCL-PerCORESETPoolIndex* in frequency range 2, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set

-otherwise, the UE shall apply the indicated TCI state specific to *coresetPoolIndex* value 0 to the aperiodic CSI-RS resource set

-else if there is any other DL signal with an indicated TCI state in the same symbols as the aperiodidc CSI-RS,

- if the UE is in frequency range 1, or the UE reports its capability of *defaultQCL-PerCORESETPoolIndex* in frequency range 2, and there are two other DL signals applying the first and the second indicated TCI states, respectively, in the same symbols as the aperiodic CSI-RS, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set

- otherwise, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with offset larger than or equal to the threshold *timeDurationForQCL*, as defined in [13, TS 38.306], periodic CSI-RS, semi-persistent CSI-RS, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48}∙2max(0,μCSIRS-3) and when *enableBeamSwitchTiming* is not provided or the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *trs-Info*, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters repetition and *trs-Info* scheduled with offset larger than or equal to 48∙2max(0,μCSIRS-3) when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *repetition* set to 'on' scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided.

<omitted text>

## 5.3 UE PDSCH processing procedure time

If the first uplink symbol of the PUCCH which carries the HARQ-ACK information, as defined by the assigned HARQ-ACK timing *K1* and Koffset, if configured, 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. For a PDSCH with disabled HARQ-ACK feedback,.

*- 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 assumed to be transmitted for PDSCH with or without disabled HARQ-ACK feedback, and κ is defined in clause 4.1 of [4, TS 38.211].

*-* For UE processing capability 2,

*-* if the UE is not indicating *simulDMRS-PDSCH*, the UE is not expected to be simultaneously configured with higher layer parameter *processingType2Enabled* set to 'enable' and higher layer parameter *dmrs-TypeEnh*, and the additional processing delay *d3* is 0.

- if the UE is indicating *simulDMRS-PDSCH*,

*-* if the UE is configured with higher layer parameter *dmrs-TypeEnh,* the additional processing delay *d3* is indicated by *simulDMRS-PDSCH*,

*-* otherwise *d3* =0.

*-* For operation with shared spectrum channel access in FR1, is calculated according to [4, TS 38.211], otherwise =0.

*-* 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*

- If a PUCCH of a larger priority index would overlap with a PUCCH of a smaller priority index, or with a PUSCH of a smaller priority index and the PUCCH of a larger priority index and the PUSCH of a smaller priority index are not simultaneously transmitted and the UE is not provided *uci-MuxWithDiffPrio* for theprimary PUCCH group or *uci-MuxWithDiffPrioSecondaryPUCCHgroup* for the secondary PUCCH group, *d2* for the PUCCH of a larger priority is set as reported by the UE; otherwise *d2 = 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 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'.

- PDSCH processing capability 2 is not applied to PDSCH scheduled by PDCCH with DCI format 4\_0, 4\_1, or 4\_2.

- 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.

- UE is not expected to be scheduled totransmit PUCCH carrying the HARQ-ACK information for PDSCH scheduled by a PDCCH if uplink switching gap is triggered for the PUCCH as defined in clause 6.1.6 and the first uplink symbol of the PUCCH starts earlier than the duration of { + } from the last symbol of the PDCCH, where equals to the switching gap duration.

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.

For a PDSCH that consists of two PDSCH transmission occasions in time domain in one slot, *d1,1* is calculated based on the first PDSCH transmission occasion in the slot, and as described above.

For PDSCH with mapping Type B, if PDSCH is scheduled by a PDCCH reception that includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], *d1,1* for PDSCH processing time is determined by considering the PDCCH candidate that results in larger d1,1 value.

Table 5.3-1: PDSCH processing time for PDSCH processing capability 1

|  |  |  |
| --- | --- | --- |
|  | PDSCH decoding time *N1* [symbols] | |
| *dmrs-AdditionalPosition* = 'pos0' in  *DMRS-DownlinkConfig* in *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB* if either higher layer parameter is configured, and in *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2* if either higher layer parameter is configured | *dmrs-AdditionalPosition* ≠ 'pos0' in  *DMRS-DownlinkConfig* in any of  *dmrs-DownlinkForPDSCH-MappingTypeA*, *dmrs-DownlinkForPDSCH-MappingTypeB, dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2, dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2,*  or if none of the higher layer parameters is configured |
| 0 | 8 | *N1,0* |
| 1 | 10 | 13 |
| 2 | 17 | 20 |
| 3 | 20 | 24 |
| 5 | 80 | 96 |
| 6 | 160 | 192 |

Table 5.3-2: PDSCH processing time for PDSCH processing capability 2

|  |  |
| --- | --- |
|  | PDSCH decoding time *N1* [symbols] |
| *dmrs-AdditionalPosition* = 'pos0' in  *DMRS-DownlinkConfig* in  *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB* if either higher layer parameter is configured, and in *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2* if either higher layer parameter is configured |
| 0 | 3 |
| 1 | 4.5 |
| 2 | 9 for frequency range 1 |

<omitted text>

## 6.1 UE procedure for transmitting the physical uplink shared channel

PUSCH transmission(s) can be dynamically scheduled by an UL grant in a DCI, or the transmission can correspond to a configured grant Type 1 or Type 2. The configured grant Type 1 PUSCH transmission is semi-statically configured to operate upon the reception of higher layer parameter of *configuredGrantConfig* including *rrc-ConfiguredUplinkGrant* without the detection of an UL grant in a DCI. The configured grant Type 2 PUSCH transmission is semi-persistently scheduled by an UL grant in a valid activation DCI according to clause 10.2 of [6, TS 38.213] after the reception of higher layer parameter *configuredGrantConfig* not including *rrc-ConfiguredUplinkGrant*. If *configuredGrantConfigToAddModList* is configured, more than one configured grant configuration of configured grant Type 1 and/or configured grant Type 2 may be active at the same time on an active BWP of a serving cell.

The UE can be configured with a list of up to 64 *TCI-UL-State* configurations within the higher layer parameter *BWP-UplinkDedicated.* Each *TCI-UL-State* configuration contains a parameter for configuring one reference signal, if applicable, for determining UL TX spatial filter for dynamic-grant and configured-grant based PUSCH and PUCCH resource in a CC, and SRS.

If a UE is configured by higher layer parameter *PDCCH-Config* that contains *ControlResourceSets* with two different values of *coresetPoolIndex* for the active BWP of a serving cell, or if a UE is configured with *SSB-MTC-AddtionalPCI* and with *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, and if the UE is configured with [*twoTAGs*] and is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* for a serving cell, each *TCI-State* or *TCI-UL-State* is associated with a [*TAG-ID*]for determining timing adjustment for a corresponding UL transmission as described in Clause 4.2 of [6, TS 38.213]. The UE does not expect that *TCI-states* or *TCI-UL-States* associated with one *coresetPoolIndex* to correspond to two TAGs.

For the PUSCH transmission corresponding to a Type 1 configured grant or a Type 2 configured grant activated by DCI format 0\_0 or 0\_1, the parameters applied for the transmission are provided by *configuredGrantConfig* except for *dataScramblingIdentityPUSCH*, *txConfig*, *codebookSubset*, *maxRank*, *scaling* of *UCI-OnPUSCH,* which are provided by *pusch-Config*. A configured grant PUSCH can be transmitted with at most 4 layers. For the PUSCH transmission corresponding to a Type 2 configured grant activated by DCI format 0\_2, the parameters applied for the transmission are provided by *configuredGrantConfig* except for *dataScramblingIdentityPUSCH*, *txConfig*, *codebookSubsetDCI-0-2*, *maxRankDCI-0-2*, *scaling* of *UCI-OnPUSCH*, *resourceAllocationType1GranularityDCI-0-2* provided by *pusch-Config*.If the UE is provided with *transformPrecoder* in *configuredGrantConfig*, the UE applies the higher layer parameter *tp-pi2BPSK*, if provided in *pusch-Config*, according to the procedure described in clause 6.1.4 for the PUSCH transmission corresponding to a configured grant.

When the UE is configured *dl-OrJointTCI-StateList* or *ul-TCI-StateList*, the UE shall perform PUSCH transmission corresponding to a Type 1 configured grant or a Type 2 configured grant or a dynamic grant according to the spatial relation, if applicable, with a reference to the RS for determining UL Tx spatial filter. The RS is determined based on an RS configured with *qcl-Type* set to 'typeD' of the indicated *TCI-State* or an RS in the indicated *TCI-UL-State*. The reference RS in the indicated *TCI-State* can be a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info.* The reference RS in the indicated *TCI-UL-State* can be a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, an SRS resource in an SRS resource set with the higher layer parameter *usage* set to 'beamManagement', or SS/PBCH block associated with the same or different PCI from the PCI of the serving cell. When *nrofSlotsInCG-Period* is configured for Type 1 configured grant or Type 2 configured grant, HARQ process ID for the first configured PUSCH grant and each subsequent valid configured PUSCH grant within a *periodicity* of the configuration is determined as in clause 5.4.1 of [10, TS 38.321], where a valid configured PUSCH grant is the one not colliding with the DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, and not colliding with a symbol(s) of an SS/PBCH block with index provided by *ssb-PositionsInBurst* as described in clause 11.1 of [6, TS 38.213].

When a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and is having two indicated TCI-States or TCI-UL-States,

- a UE having a PUSCH transmission scheduled or activated by DCI format 0\_0 should apply the first indicated TCI state to the PUSCH transmission,

- a UE configured with a PUSCH transmission corresponding to a Type 1 configured grant is expected to be configured with the higher layer parameter *applyIndicatedTCI-State* indicating the *first*, the *second* or *both* of the indicated TCI states to be applied for the PUSCH transmission. If 'both' TCI states are indicated, the UE should apply the first indicated TCI state to the PUSCH transmission occasion(s) or the PUSCH antenna port(s) associated with the first SRS resource set for CB/NCB transmission, and the second indicated TCI state to the PUSCH transmission occasion(s) or the PUSCH antenna port(s) associated with the second SRS resource set for CB/NCB transmission; otherwise the UE should apply either the 'first' or 'second' indicated TCI state to all PUSCH transmission occasions.

- If the UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in different *ControlResourceSets* in the active DL BWP, the first and the second indicated TCI states correspond to the indicated TCI-States or TCI-UL-States specific to coresetPoolIndex value 0 and value 1, respectively, and *applyIndicatedTCI-State* does not indicate *both* of the indicated TCI states to be applied for the PUSCH transmission.

For the PUSCH retransmission scheduled by a PDCCH with CRC scrambled by CS-RNTI with NDI=1, the parameters in *pusch-Config* are applied for the PUSCH transmission except for *p0-NominalWithoutGrant, p0-PUSCH-Alpha, powerControlLoopToUse,* *pathlossReferenceIndex* described in clause 7.1 of [6, TS 38.213], *mcs-Table, mcs-TableTransformPrecoder* described in clause 6.1.4.1 and *transformPrecoder* described in clause 6.1.3.

For a UE configured with two uplinks in a serving cell, PUSCH retransmission for a TB on the serving cell is not expected to be on a different uplink than the uplink used for the PUSCH initial transmission of that TB.

A UE shall upon detection of a PDCCH with a configured DCI format 0\_0, 0\_1, 0\_2 or 0\_3 transmit the corresponding PUSCH as indicated by that DCI unless the UE does not generate a transport block as described in [10, TS38.321]. Upon detection of a DCI format 0\_1 or 0\_2 with '*UL-SCH indicator*' set to '0' and with a non-zero '*CSI request*' where the associated *reportQuantity* in *CSI-ReportConfig* set to '*none*' for all CSI report(s) triggered by '*CSI request*' in this DCI format 0\_1 or 0\_2, the UE ignores all fields in this DCI except the '*CSI request*' and the UE shall not transmit the corresponding PUSCH as indicated by this DCI format 0\_1 or 0\_2. Upon detection of a DCI format 0\_3 with '*UL-SCH indicator*' set to '0' and with a non-zero '*CSI request*' where the associated *reportQuantity* in *CSI-ReportConfig* set to '*none*' for all CSI report(s) triggered by '*CSI request*' in this DCI format 0\_3, the UE ignores all fields for the scheduled cell with the smallest serving cell index in this DCI except the '*CSI request*' and the UE shall not transmit the corresponding PUSCH on the serving cell with the smallest serving cell index as indicated by this DCI format 0\_3.

When the UE is scheduled with multiple PUSCHs on a serving cell by a DCI, HARQ process ID indicated by this DCI applies to the first PUSCH not overlapping with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*, HARQ process ID is then incremented by 1 for each subsequent PUSCH(s) in the scheduled order, with modulo operation of *nrofHARQ-ProcessesForPUSCH* applied if *nrofHARQ-ProcessesForPUSCH* is provided, or with modulo operation of 16 applied, otherwise. HARQ process ID is not incremented for PUSCH(s) not transmitted if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*. For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to transmit a PUSCH that overlaps in time with another PUSCH. Except for the case when a UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet* for the active BWP of a serving cell and PDCCHs that schedule two PUSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex,* for any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol *j* by a PDCCH ending in symbol *i* on a scheduling cell,, the UE is not expected to be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH that ends later than symbol *i* of the scheduling cell. When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the PDCCH ending in symbol *i*, the PDCCH candidate that ends later in time is used. The UE is not expected to be scheduled to transmit another PUSCH by a DCI format 0\_0 with CRC scrambled by TC-RNTI, for a given HARQ process with the DCI received before the end of the expected transmission of the last PUSCH for that HARQ process if the latter is scheduled by a DCI format 0\_0 with CRC scrambled by TC-RNTI or by an UL grant in RA Response. The UE is not expected to be scheduled to transmit another PUSCH by DCI format 0\_0, 0\_1, 0\_2 or 0\_3 scrambled by C-RNTI, CS-RNTI or MCS-C-RNTI for a given HARQ process with the DCI received before the end of the expected transmission of the last PUSCH for that HARQ process if the latter is scheduled by a DCI with CRC scrambled by C-RNTI, CS-RNTI or MCS-C-RNTI.

If a UE is configured by higher layer parameter *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet* for the active BWP of a serving cell and PDCCHs that schedule two PUSCHs are associated to different *ControlResourceSets* having different values of *coresetPoolIndex,* for any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol *j* by a PDCCH associated with a value of *coresetPoolIndex* ending in symbol *i*, the UE can be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH associated with a different value of *coresetPoolIndex* that ends later than symbol *i*.

When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'nonCodebook' and higher layer parameter *enableSTx2PofmDCI* is configured and *PDCCH-Config* contains two different values of *coresetPoolIndex* in *ControlResourceSet* for the active DL BWP of a serving cell,

- two PUSCHs that are fully/partially overlapping in time domain and are fully/partially/non-overlapping in frequency domain can be dynamically scheduled by UL grant(s) in DCI(s) and/or scheduled by configured grant(s) Type 1 or Type 2,

- if dynamically scheduled by UL grant(s) in DCI(s) or activated by DCI(s) for configured grant Type 2, the DCI field *SRS Resource Set Indicator* is not present in each of PDCCH

- two PUSCHs are associated to different values of *coresetPoolIndex* where for configured grant Type 1, the association is based on higher layer parameter *srs-ResourceSetId* in *rrc-ConfiguredUplinkGrant* that indicates either the first or the second SRS resource set with usage 'codebook' or 'nonCodeBook' in *srs-ResourceSetToAddModList*

- the UE is not expected to be configured with different number of SRS resources in the two SRS resource sets

- the UE expects *maxNrofPorts* in *PTRS-UplinkConfig* to be configured as one if UL PT-RS is configured.

When a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', and the higher layer parameter *multiPanelSchemeSDM* or *multiPanelSchemeSFN* is configured, and the higher layer parameter *rrc-ConfiguredUplinkGrant* does not contain *srs-ResourceIndicator2* or *precodingAndNumberOfLayers2*, the PUSCH transmission occasion(s) is associated with the first SRS resource set if the first indicated *TCI-States* or *TCI-UL-States* applies and is associated with the second SRS resource set if the second indicated *TCI-States* or *TCI-UL-States* applies.

When a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and is having two indicated TCI states, and only one SRS resource set is configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', the PUSCH transmission occasion(s) scheduled or activated by DCI format 0\_1 or 0\_2 is associated with the first indicated *TCI-States* or *TCI-UL-States* if applies or is associated with the second indicated *TCI-States* or *TCI-UL-States* if applies, as indicated by the higher layer parameter *applyIndicatedTCI-State* configured by *PUSCH-Config.*

When a UE is configured with higher layer parameter *sTx-2Panel* and *PDCCH-Config* contains two different values of *coresetPoolIndex* in *ControlResourceSet* for the active DL BWP of a serving cell,

- the UE is expected to be configured with two SRS resource sets with usage 'codebook' or 'nonCodeBook' in *srs-ResourceSetToAddModList*

- if the UE is configured to monitor DCI format 0\_2 and there is only one SRS resource set~~s~~ configured by *srs-ResourceSetToAddModListDCI-0-2* and associated with usage 'codebook' or 'nonCodeBook', the UE monitors only CORESETs associated with *coresetPoolIndex* value 0*.*

A UE is not expected to be scheduled by a PDCCH ending in symbol to transmit a PUSCH on a given serving cell overlapping in time with a transmission occasion, where the UE is allowed to transmit a PUSCH with configured grant according to [10, TS38.321], starting in a symbol on the same serving cell if the end of symbol is not at least symbols before the beginning of symbol , if

- the UE is not provided *prioLowDG-HighCG* or *prioHighDG-LowCG*, or the UE is provided *prioLowDG-HighCG* or *prioHighDG-LowCG* and the two PUSCHs have the same priority index as described in Clause 9 of [6, TS 38.213] and

- the UE is not provided *enableSTx2PofmDCI,* or is provided *enableSTx2PofmDCI* and the two PUSCHs are associated with the same *coresetPoolIndex* value.

The value in symbols is determined according to the UE processing capability defined in Clause 6.4, and and the symbol duration are based on the minimum of the subcarrier spacing corresponding to the PUSCH with configured grant and the subcarrier spacing of the PDCCH scheduling the PUSCH.

If a UE receives an ACK for a given HARQ process in CG-DFI in a PDCCH ending in symbol *i* to terminate a transport block repetition in a PUSCH transmission with a configured grant on a given serving cell with the same HARQ process after symbol *i*, the UE is expected to terminate the repetition of the transport block in a PUSCH transmission starting from a symbol *j* if the gap between the end of PDCCH of symbol *i* and the start of the PUSCH transmission in symbol *j* is equal to or more than *N2* symbols. The value *N2* in symbols is determined according to the UE processing capability defined in Clause 6.4, and *N2* and the symbol duration are based on the minimum of the subcarrier spacing corresponding to the PUSCH and the subcarrier spacing of the PDCCH indicating CG-DFI. A UE is not expected to be scheduled by a PDCCH ending in symbol to transmit a PUSCH on a given serving cell for a given HARQ process, if there is a transmission occasion where the UE is allowed to transmit a PUSCH with configured grant according to [10, TS38.321] with the same HARQ process on the same serving cell starting in a symbol after symbol , and if the gap between the end of PDCCH and the beginning of symbol is less than symbols. The value in symbols is determined according to the UE processing capability defined in clause 6.4, and and the symbol duration are based on the minimum of the subcarrier spacing corresponding to the PUSCH with configured grant and the subcarrier spacing of the PDCCH scheduling the PUSCH.

For PUSCH scheduled by DCI format 0\_0 on a cell, the UE shall transmit PUSCH according to the spatial relation, if applicable, corresponding to the dedicated PUCCH resource with the lowest ID within the active UL BWP of the cell, as described in Clause 9.2.1 of [6, TS 38.213]. If the dedicated PUCCH resource with the lowest ID within the active UL BWP of the cell corresponds to two spatial relations, the UE shall transmit the PUSCH according to the spatial relation with the lower ID.

For PUSCH scheduled by DCI format 0\_0 on a cell and if the higher layer parameter *enableDefaultBeamPL-ForPUSCH0-0* is set 'enabled', the UE is not configured with PUCCH resources on the active UL BWP and the UE is in RRC connected mode, the UE shall transmit PUSCH according to the spatial relation, if applicable, with a reference to the RS configured with *qcl-Type* set to 'typeD' corresponding to the QCL assumption of the CORESET with the lowest ID on the active DL BWP of the cell. If the CORESET is indicated with two TCI states, *sfnSchemePdcch* is configured and the UE supports *sfn-DefaultUL-BeamSetup-r17*, the UE shall use the first TCI state as the QCL assumption.

For PUSCH scheduled by DCI format 0\_0 on a cell and if the higher layer parameter *enableDefaultBeamPL-ForPUSCH0-0* is set 'enabled', the UE is configured with PUCCH resources on the active UL BWP where all the PUCCH resource(s) are not configured with any spatial relation and the UE is in RRC connected mode, the UE shall transmit PUSCH according to the spatial relation, if applicable, with a reference to the RS configured with *qcl-Type* set to 'typeD' corresponding to the QCL assumption of the CORESET with the lowest ID on the active DL BWP of the cell in case CORESET(s) are configured on the cell. If the CORESET is indicated with two TCI states, *sfnSchemePdcch* is configured and the UE supports *sfn-DefaultUL-BeamSetup-r17*, the UE shall use the first TCI state as the QCL assumption.

For uplink, 16 HARQ processes per cell are supported by the UE, or subject to UE capability, a maximum of 32 HARQ processes per cell as defined in [13, TS 38.306]. The number of processes the UE may assume will at most be used for the uplink is configured to the UE for each cell separately by higher layer parameter *nrofHARQ-ProcessesForPUSCH*, and when no configuration is provided the UE may assume a default number of 16 processes.

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#### 6.1.1.1 Codebook based UL transmission

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When higher layer parameter *ul-FullPowerTransmission* is set to 'fullpowerMode2*'* and the higher layer parameter *CodebookTypeUL* is set to *'*codebook2' or *'*codebook3', and the *SRS-resourceSet* with *usage* set to 'codebook' includes one SRS resource with 8 ports, and at least one SRS resource with 2 ports or 4 ports, subject to UE capability,

- when *CodebookTypeUL* is set to *'*codebook2', the *codebookSubset* associated with the 2-port SRS resource is 'nonCoherent'.

- when *CodebookTypeUL* is set to *'*codebook2', the *codebookSubset* associated with the 4-port SRS resource can be configured as 'partialAndNonCoherent' or 'nonCoherent', subject to UE capability.

- when *CodebookTypeUL* is set to *'*codebook3', the *codebookSubset* associated with the 4-port SRS resources is 'nonCoherent'.

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#### 6.1.1.2 Non-Codebook based UL transmission

For non-codebook based transmission, PUSCH can be scheduled by DCI format 0\_0, DCI format 0\_1, DCI format 0\_2, DCI format 0\_3 or semi-statically configured to operate according to Clause 6.1.2.3. If this PUSCH is scheduled by DCI format 0\_1, DCI format 0\_2, DCI format 0\_3 or semi-statically configured to operate according to Clause 6.1.2.3, the UE can determine its PUSCH precoder(s) and transmission rank based on the SRI(s) when multiple SRS resources are configured, where the SRI(s) is given by one or two SRS resource indicator(s) in DCI according to clause 7.3.1.1.2 and 7.3.1.1.3 of [5, 38.212] for DCI format 0\_1 and DCI format 0\_2, or the SRI is given by one SRS resource indicator in DCI according to clause 7.3.1.1.4 of [5, 38.212] for DCI format 0\_3, or the SRI is given by *srs-ResourceIndicator* according to clause 6.1.2.3, or SRIs given by *srs-ResourceIndicator* and *srs-ResourceIndicator2* according to clause 6.1.2.3.. The *SRS-ResourceSet(s)* applicable for PUSCH scheduled by DCI format 0\_1 and DCI format 0\_2 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2* in *SRS-config*, respectively. The UE shall use one or multiple SRS resources for SRS transmission, where, in a SRS resource set, the maximum number of SRS resources which can be configured to the UE for simultaneous transmission in the same symbol and the maximum number of SRS resources are UE capabilities. The SRS resources transmitted simultaneously occupy the same RBs. For a given CC, multiple SRS resources in a set with usage “nonCodebook” are not expected to be partially overlapped in time. Only one SRS port for each SRS resource is configured. Only one or two SRS resource sets can be configured in *srs-ResourceSetToAddModList* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook', and only one or two SRS resource sets can be configured in *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook'. When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook', SRIs are given by the DCI fields of two SRS resource indicators in clauses 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212] for DCI format 0\_1 and 0\_2 and the UE applies the indicated SRI(s) to one or more PUSCH repetitions according to the associated SRS resource set of a PUSCH repetition according to clause 6.1.2.1. A UE does not expect two SRS resource sets are configured in *srs-ResourceSetToAddModList* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook' for a serving cell, when the serving cell is included in *schedulingCellListDCI-0-3-r18* for a set of serving cells provided by *mc-DCI-SetOfCellsToAddModList-r18*. The maximum number of SRS resources per SRS resource set that can be configured for non-codebook based uplink transmission is 1, 2, 4 or 8 depending on UE capability. Each of the indicated SRIs in slot *n* is associated with the most recent transmission of SRS resource(s) of associated SRS resource set identified by the SRI, where the SRS transmission is prior to the PDCCH carrying the SRI. When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook', the UE is not expected to be configured with different number of SRS resources in the two SRS resource sets.

When the higher layer parameter *multipanelScheme* is set to 'SDMScheme' and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook', SRIs are given by the DCI fields of two SRS resource indicators in clause 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212] for DCI format 0\_1 and 0\_2 or given by *srs-ResourceIndicator, srs-ResourceIndicator2* in *configuredGrantConfig*:

- When codepoint "10" of *SRS Resource Set* *indicator* is indicated*,* or when *srs-ResourceIndicator2* is provided, the first SRI is used to indicate resource(s) to be associated with layer(s) {0…v1-1}, where v1 being the number of layers indicated by the first SRI, and the second SRI is used to indicate resource(s) to be associated with layer(s) {v1…. v2+v1-1}, where v2 being the number of layers indicated by the second SRI, v1 ≤ *Lmax* andv2 ≤ *Lmax* where *Lmax* is defined inclauses 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212]. The UE shall expect that SRS resource(s) indicated by the first SRI and SRS resource(s) indicated by the second SRI are corresponding to different PUSCH antenna ports.

- When codepoint "00" or "01" of *SRS Resource Set* *indicator* is indicated*,* the second SRI is reserved, the first SRI is used to indicate resource(s) to be associated with layers {0…v-1}, v ≤ *Lmax*.

- Codepoint "11" of *SRS Resource Set indicator* is reserved.

When the higher layer parameter *multipanelScheme* is set to 'SFNscheme' and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook', two SRI(s) are given by the DCI fields of two SRS resource indicators in clause 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212] for DCI format 0\_1 and 0\_2 or given by *srs-ResourceIndicator and srs-ResourceIndicator2* in *configuredGrantConfig*:

- When codepoint "10" of *SRS Resource Set* *indicator* is indicated*,* or when *srs-ResourceIndicator2* is provided, the first SRI is used to indicate resource(s) to be associated with layer(s) {0…v-1} and the second SRI is used to indicate resource(s) to be associated with layer(s) {0…v-1}, where v ≤ *Lmax* and where *Lmax* is defined in clauses 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212]. The UE shall expect that SRS resource(s) indicated by the first SRI and SRS resource(s) indicated by the second SRI are corresponding to different PUSCH antenna ports.

- When codepoint "00" or "01" of *SRS Resource Set* *indicator* is indicated*,* the second SRI is reserved, the first SRI is used to indicate resources(s) to be associated with layers {0…v-1}, where v ≤ *Lmax*. When two SRIs are indicated, the UE shall expect that the number of SRS antenna ports associated with two indicated SRIs to be the same.

- Codepoint "11" of *SRS Resource Set indicator* is reserved.

When the UE is configured with the higher layer parameter *txConfig* set to 'Noncodebook', the UE is configured with at least one SRS resource. Each of the indicated one or two SRI(s) in slot *n* is associated with the most recent transmission of SRS resource of associated SRS resource set identified by the SRI, where the SRS resource is prior to the PDCCH carrying the SRI. When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'Noncodebook', the UE is not expected to be configured with different number of SRS resources in the two SRS resource sets.

When the PDCCH reception includes two PDCCH candidates from two respective search space sets, as described in clause 10.1 of [6, TS 38.213], for the purpose of determining the most recent transmission of SRS resource(s) identified by the SRI, the PDCCH candidate that starts earlier in time is used.

For non-codebook based transmission, the UE can calculate the precoder used for the transmission of SRS based on measurement of an associated NZP CSI-RS resource. A UE can be configured with only one NZP CSI-RS resource for each of the SRS resource set(s) with higher layer parameter usage in *SRS-ResourceSet* set to 'nonCodebook' if configured.

- If aperiodic SRS resource set is configured, the associated NZP-CSI-RS is indicated via SRS request field in DCI format 0\_1 and 1\_1, DCI format 0\_2 (if SRS request field is present) and DCI format 1\_2 (if SRS request field is present), as well as DCI format 0\_3 and 1\_3, where *AperiodicSRS-ResourceTrigger* and *AperiodicSRS-ResourceTriggerList* (indicating the association between aperiodic SRS triggering state(s) and SRS resource sets), triggered SRS resource(s) *srs-ResourceSetId*, *csi-RS* (indicating the associated *NZP-CSI-RS-ResourceId*) are higher layer configured in *SRS-ResourceSet*. The *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_1, 0\_3, 1\_1 and 1\_3 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* and the *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_2 and 1\_2 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModListDCI-0-2*. A UE is not expected to update the SRS precoding information if the gap from the last symbol of the reception of the aperiodic NZP-CSI-RS resource and the first symbol of the aperiodic SRS transmission is less than 42 OFDM symbols, where the SCS configuration *μ* is the smallest SCS configuration between the NZP-CSI-RS resource and the SRS transmission.

- If the UE configured with aperiodic SRS associated with aperiodic NZP CSI-RS resource, the presence of the associated CSI-RS is indicated by the SRS request field if the value of the SRS request field is not '00' as in Table 7.3.1.1.2-24 of [5, TS 38.212] and if the scheduling DCI is not used for cross carrier or cross bandwidth part scheduling. If UE is configured with *minimumSchedulingOffsetK0* in the active DL BWP and the currently applicable minimum scheduling offset restriction *K0,min* is larger than 0, the UE does not expected to receive the scheduling DCI with the SRS request field value other than '00'. The CSI-RS is located in the same slot as the SRS request field. If the UE configured with aperiodic SRS associated with aperiodic NZP CSI-RS resource, any of the TCI states configured in the scheduled CC shall not be configured with *qcl-Type* set to 'typeD'.

- If periodic or semi-persistent SRS resource set is configured, the *NZP-CSI-RS-ResourceId* for measurement is indicated via higher layer parameter *associatedCSI-RS* in *SRS-ResourceSet*.

The UE shall perform one-to-one mapping from the indicated SRI(s) to the indicated DM-RS ports(s) and their corresponding PUSCH layers {0 … ν-1} given by DCI format 0\_1, 0\_2 or 0\_3 or by *configuredGrantConfig* according to clause 6.1.2.3 in increasing order.

The UE shall transmit PUSCH using the same antenna ports as the SRS port(s) in the SRS resource(s) indicated by SRI(s) given by DCI format 0\_1, 0\_2 or 0\_3, or by *configuredGrantConfig* according to clause 6.1.2.3, where the SRS port in (*i*+1)-th SRS resource in the SRS resource set is indexed as .

The DM-RS antenna ports  in Clause 6.4.1.1.3 of [4, TS 38.211] are determined according to the ordering of DM-RS port(s) given by Tables 7.3.1.1.2-6 to 7.3.1.1.2-23 in Clause 7.3.1.1.2 of [5, TS 38.212].

For non-codebook based transmission, the UE does not expect to be configured with both *spatialRelationInfo* for SRS resource and *associatedCSI-RS* in *SRS-ResourceSet* for SRS resource set.

For non-codebook based transmission, the UE can be scheduled with DCI format 0\_1, 0\_2 or 0\_3 when at least one SRS resource is configured in *SRS-ResourceSet* with *usage* set to 'nonCodebook'.

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#### 6.1.2.1 Resource allocation in time domain

When the UE is scheduled to transmit a transport block and no CSI report by a DCI or by a RAR UL grant or fallbackRAR UL grant, or the UE is scheduled to transmit a transport block and a CSI report(s) on PUSCH by a DCI, the '*Time domain resource assignment'* field value *m* for the scheduled PUSCH on the serving cell of the DCI or the *PUSCH time resource allocation* field value *m* of the RAR UL grant or of the fallbackRAR UL grant provides a row index *m* + 1to a resource allocation table. The determination of the used resource allocation table is defined in Clause 6.1.2.1.1. The indexed row defines the slot offset *K2*, the start and length indicator *SLIV*, or directly the start symbol *S* and the allocation length *L*, the PUSCH mapping type, the number of slots used for TBS determination (if *numberOfSlotsTBoMS* is present in the resource allocation table), and the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table) to be applied in the PUSCH transmission.

When the UE is scheduled to transmit a PUSCH with no transport block and with a CSI report(s) by a '*CSI request'* field on a DCI, the '*Time domain resource assignment'* field value *m* of the DCI provides a row index *m* + 1to the allocated table as defined in Clause 6.1.2.1.1. The indexed row defines the start and length indicator SLIV, or directly the start symbol *S* and the allocation length *L*, and the PUSCH mapping type to be applied in the PUSCH transmission and the *K2* value is determined as , where  are the corresponding list entries of the higher layer parameter

- reportSlotOffsetListDCI-0-2or *reportSlotOffsetListDCI-0-2-r17*, if PUSCH is scheduled by DCI format 0\_2 and reportSlotOffsetListDCI-0-2 or *reportSlotOffsetListDCI-0-2-r17* is configured;

- *reportSlotOffsetListDCI-0-1* or *reportSlotOffsetListDCI-0-1-r17*, if PUSCH is scheduled by DCI format 0\_1 or 0\_3 and *reportSlotOffsetListDCI-0-1* or *reportSlotOffsetListDCI-0-1-r17* is configured;

- *reportSlotOffsetList* or *reportSlotOffsetList-r17*, otherwise;

in *CSI-ReportConfig* for the  triggered CSI Reporting Settings and  is the *(m+1)*th entry of  including the omitted CSI Reporting Settings triggered for non-active DL BWPs, where the UE does not expect that *(m+1)* is larger than 16.

- The slot *Ks* where the UE shall transmit the PUSCH is determined by *K2* as *Ks* =, if UE is configured with ca-SlotOffset for at least one of the scheduled and scheduling cell, , otherwise, where is a parameter configured by higher layer as specified in clause 4.2 of [6 TS 38.213], and where is the subcarrier spacing configuration for with a value of 0 for frequency range 1 and for FR2-NTN, *n* is the slot with the scheduling DCI, K*2* is based on the numerology of PUSCH,  and  are the subcarrier spacing configurations for PUSCH and PDCCH, respectively, and the scheduling DCI is other than DCI format 0\_0 with CRC scrambled by TC-RNTI.

- and are the and the, respectively, which are determined by higher-layer configured ca-SlotOffsetfor the cell receiving the PDCCH, and are the and the,respectively, which are determined by higher-layer configured ca-SlotOffset for the cell transmitting the PUSCH, as defined in clause 4.5 of [4, TS 38.211], and

- for PUSCH scheduled by DCI format 0\_1, if *pusch-RepTypeIndicatorDCI-0-1* is set to 'pusch-RepTypeB', the UE applies PUSCH repetition Type B procedure when determining the time domain resource allocation. For PUSCH scheduled by DCI format 0\_2, if *pusch-RepTypeIndicatorDCI-0-2* is set to 'pusch-RepTypeB', the UE applies PUSCH repetition Type B procedure when determining the time domain resource allocation. Otherwise, the UE applies PUSCH repetition Type A procedure when determining the time domain resource allocation for PUSCH scheduled by PDCCH, by RAR UL grant, or by fallbackRAR UL grant.

- for PUSCH scheduled by DCI format 0\_1, 0\_2 or 0\_3, if *numberOfSlotsTBoMS* is present and larger than 1, the UE applies TB processing over multiple slots procedure when determining the time domain resource allocation.

- For PUSCH repetition Type A and TB processing over multiple slots, the starting symbol *S* relative to the start of the slot, and the number of consecutive symbols *L* counting from the symbol *S* allocated for the PUSCH are determined from the start and length indicator *SLIV* of the indexed row:

if  then



else



where, and

- For PUSCH repetition Type B, the starting symbol *S* relative to the start of the slot, and the number of consecutive symbols *L* counting from the symbol *S* allocated for the PUSCH are provided by *startSymbol* and *length* of the indexed row of the resource allocation table, respectively.

- For PUSCH repetition Type A and TB processing over multiple slots, the PUSCH mapping type is set to Type A or Type B as defined in Clause 6.4.1.1.3 of [4, TS 38.211] as given by the indexed row.

- For PUSCH repetition Type B, the PUSCH mapping type is set to Type B.

The UE shall consider the *S* and *L* combinations defined in table 6.1.2.1-1 as valid PUSCH allocations

Table 6.1.2.1-1: Valid *S* and *L* combinations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PUSCH mapping type | Normal cyclic prefix | | | Extended cyclic prefix | | |
| *S* | *L* | *S+L* | *S* | *L* | *S+L* |
| Type A (repetition Type A only) | 0 | {4,…,14} | {4,…,14} | 0 | {4,…,12} | {4,…,12} |
| Type B | {0,…,13} | {1,…,14} | {1,…,14} for repetition Type A, {1,…,27} for repetition Type B | {0,…, 11} | {1,…,12} | {1,…,12} for repetition Type A, {1,…,23} for repetition Type B |

For TB processing over multiple slots, when transmitting PUSCH scheduled by DCI format 0\_1, 0\_2 or 0\_3 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1,

- the number of slots used for TBS determination *N* is indicated by *numberOfSlotsTBoMS.*

- the number of repetitions *K* of the number of slots *N* used for TBS determination is determined as

- if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions *K* is equal to *numberOfRepetitions*;

- otherwise, *K=1*.

- when the UE supports repetition of TB processing over multiple slots, the UE does not expect that is larger than 32.

When configured with m= 5 or 6 the UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs, where multiple DCIs are not associated with CORESETs having different *coresetpoolIndex*.

For PUSCH repetition Type A, when transmitting PUSCH scheduled by DCI format 0\_1, 0\_2 or 0\_3 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or scheduled by DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled CS-RNTI with NDI=1, the number of repetitions *K* is determined as

- if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions K is equal to *numberOfRepetitions*;

- elseif the UE is configured with *pusch-AggregationFactor*, the number of repetitions *K* is equal to *pusch-AggregationFactor*;

- otherwise *K=1*.

- the number of slots used for TBS determination *N* is equal to 1.

For PUSCH repetition type A, when transmitting PUSCH scheduled by RAR UL grant, the 2 MSBs of the MCS information field of the RAR UL grant provide a codepoint to determine the number of repetitions *K* according to Table 6.1.2.1-1A, based on whether or not the higher layer parameter *numberOfMsg3-RepetitionsList* is configured. The number of slots used for TBS determination N is equal to 1.

For PUSCH repetition type A, when transmitting PUSCH scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, the 2 MSBs of the MCS information field of the DCI format 0\_0 with CRC scrambled by TC-RNTI provide a codepoint to determine the number of repetitions *K* according to Table 6.1.2.1-1A, based on whether or not the higher layer parameter *numberOfMsg3-RepetitionsList* is configured. The number of slots used for TBS determination N is equal to 1.

Table 6.1.2.1-1A: Number of repetition *K* as a function of 2 MSBs of MCS information field

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *numberOfMsg3-RepetitionsList is configured* | |  | *numberOfMsg3-RepetitionsList is not configured* | |
| *Codepoint* | *K* |  | Codepoint | *K* |
| 00 | First value of *numberOfMsg3-RepetitionsList* |  | 00 | 1 |
| 01 | Second value of *numberOfMsg3-RepetitionsList* |  | 01 | 2 |
| 10 | Third value of *numberOfMsg3-RepetitionsList* |  | 10 | 3 |
| 11 | Fourth value of *numberOfMsg3-RepetitionsList* |  | 11 | 4 |

If a UE is configured with higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH*, the UE does not expect to be configured with *pusch-AggregationFactor*.

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple SLIVs for PUSCH on a UL BWP of a serving cell, the UE does not apply *pusch-AggregationFactor,* if configured, to DCI format 0\_1 on the UL BWP of the serving cell and the UE does not expect to be configured with *numberOfRepetitions* in *pusch-TimeDomainAllocationListForMultiPUSCH*.

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple *SLIV*s for PUSCH on a UL BWP of a serving cell, when any two UL DCIs end in the same symbol and at least one of the DCIs scheduling multiple PUSCHs, the UE does not expect that the any scheduled multiple PUSCHs have overlapping spans, where the span associated with a DCI is defined from the beginning of the first scheduled PUSCH till the end of the last scheduled PUSCH.

For unpaired spectrum:

- When *AvailableSlotCounting* is enabled, and in case *K>1,* the UE determines slots for a PUSCH transmission of a PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, based on *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* *and ssb-PositionsInBurst*, and the TDRA information field value in the DCI format 0\_1, 0\_2 or 0\_3.

- A slot is not counted in the number of slots for PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3 if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

- Otherwise, the UE determines consecutive slots for a PUSCH transmission of a PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, based on the TDRA information field value in the DCI format 0\_1, 0\_2 or 0\_3.

- The UE determines slots for a PUSCH transmission of TB processing over multiple slots scheduled by DCI format 0\_1, 0\_2 or 0\_3, based on *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* and *ssb-PositionsInBurst*, and the TDRA information field value in the DCI format 0\_1, 0\_2 or 0\_3.

- A slot is not counted in the number of slots for a PUSCH transmission of TB processing over multiple slots if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

- The UE determines slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by RAR UL grant, based on *tdd-UL-DL-ConfigurationCommon* and *ssb-PositionsInBurst,* and the TDRA information field value in the RAR UL grant.

- A slot is not counted in the number of slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by RAR UL grant, if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

- The UE determines slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, based on *tdd-UL-DL-ConfigurationCommon* and *ssb-PositionsInBurst* and the TDRA information field value in the DCI scheduling the PUSCH.

- A slot is not counted in the number of slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_0 scrambled by TC-RNTI, if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

For paired spectrum and SUL band:

- The UE determines consecutive slots for a PUSCH transmission of a PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or 0\_3 for paired spectrum only, or for a PUSCH transmission of TB processing over multiple slots scheduled by DCI format 0\_1 or 0\_2, or 0\_3 for paired spectrum only, based on the TDRA information field value in the DCI format 0\_1, 0\_2 or 0\_3.

- For the case of a reduced capability half-duplex UE, the UE determines slots for a PUSCH transmission of a PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3 when *AvailableSlotCounting* is enabled and K>1, or for a PUSCH transmission of TB processing over multiple slots scheduled by DCI format 0\_1, 0\_2 or 0\_3, based on the TDRA information field value in the DCI format 0\_1, 0\_2 or 0\_3. A slot is not counted in the number of slots if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot does not start or end at least or , respectively, from the last or first symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

- The UE determines consecutive slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by RAR UL grant, based on the TDRA information field value in the RAR UL grant.

- The UE determines consecutive slots for a PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, based on the TDRA information field value in the DCI scheduling the PUSCH.

If a UE would transmit a PUSCH of PUSCH repetition Type A when *AvailableSlotCounting* is enabled and K>1 or a TB processing over multiple slots over slots, and the UE does not transmit the PUSCH of a TB processing over multiple slots or the PUSCH repetition Type A in a slot from the slots, according to Clause 9, Clause 11.1, Clause 11.2A, Clause 15 and Clause 17.2 of [6, TS 38.213], and Clause 5.34.3 of [10, TS 38.321], the UE counts the slots in the number of slots.

For PUSCH repetition Type A, in case *K>1*,

- If the PUSCH is scheduled by DCI format 0\_1, 0\_2 or 0\_3

- if *AvailableSlotCounting* is enabled, the same symbol allocation is applied across the slots determined for the PUSCH transmission and the PUSCH is limited to a single transmission layer. The UE shall repeat the TB across the slots determined for the PUSCH transmission, applying the same symbol allocation in each slot.

- Otherwise, the same symbol allocation is applied across the consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall repeat the TB across the consecutive slots applying the same symbol allocation in each slot.

- Else if the PUSCH is scheduled by RAR UL grant or by DCI format 0\_0 with CRC scrambled by TC-RNTI, the same symbol allocation is applied across the slots determined for the PUSCH transmission and the PUSCH is limited to a single transmission layer. The UE shall repeat the TB across the slots determined for the PUSCH transmission, applying the same symbol allocation in each slot.

For PUSCH repetition Type B:

- If *pusch-DMRS-Bundling* is enabled, the PUSCH is limited to a single transmission layer.

For TB processing over multiple slots:

- For unpaired spectrum, the same symbol allocation is applied across the slots determined for the PUSCH transmission and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the slots determined for the PUSCH transmission, applying the same symbol allocation in each slot.

- For paired spectrum or supplementary uplink band, the same symbol allocation is applied across the consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the consecutive slots applying the same symbol allocation in each slot.

- For the case of reduced capability half-duplex UE, the same symbol allocation is applied across the slots determined for the PUSCH transmission and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the slots determined for the PUSCH transmission, applying the same symbol allocation in each slot.

For a PUSCH transmission scheduled by DCI format 0\_1, 0\_2 or 0\_3, or 0\_0 with CRC scrambled by TC-RNTI, the redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, …-1, is determined according to table 6.1.2.1-2.

For a PUSCH transmission of a PUSCH repetition Type A scheduled by RAR UL grant, the redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, …-1, is determined according to the first row of Table 6.1.2.1-2.

Table 6.1.2.1-2: Redundancy version for PUSCH transmission

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *rvid* indicated by the DCI scheduling the PUSCH | *rvid* to be applied to *n*th transmission occasion (repetition Type A) or TB processing over multiple slots) or *n*th actual repetition (repetition Type B) | | | |
| *((n-(n mod N))/N)* mod 4 = 0 | *((n-(n mod N))/N)* mod 4 = 1 | *((n-(n mod N))/N)* mod 4 = 2 | *((n-(n mod N))/N)* mod 4 = 3 |
| 0 | 0 | 2 | 3 | 1 |
| 2 | 2 | 3 | 1 | 0 |
| 3 | 3 | 1 | 0 | 2 |
| 1 | 1 | 0 | 2 | 3 |

When transmitting MsgA PUSCH on a non-initial UL BWP, if the UE is configured with *startSymbolAndLengthMsgA-PO*, the UE shall determine the *S* and *L* from *startSymbolAndLengthMsgA-PO*.

When transmitting MsgA PUSCH, if the UE is not configured with *startSymbolAndLengthMsgA-PO*, and if the TDRA list *PUSCH-TimeDomainResourceAllocationList* is provided in *PUSCH-ConfigCommon*, the UE shall use *msgA-PUSCH-TimeDomainAllocation* to indicate which values are used in the list. If *PUSCH-TimeDomainResourceAllocationList* is not provided in *PUSCH-ConfigCommon*, the UE shall use parameters *S* and *L* from table 6.1.2.1.1-2 or table 6.1.2.1.1-3 where *msgA-PUSCH-TimeDomainAllocation* indicates which values are used in the list. The time offset for PUSCH transmission is described in [6, TS 38.213].

For PUSCH repetition Type A and TB processing over multiple slots, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1, Clause 11.2A, Clause 15 and Clause 17.2 of [6, TS 38.213], and Clause 5.34.3 of [10, TS 38.321].

For PUSCH repetition Type B, except for PUSCH transmitting CSI report(s) with no transport block, the number of nominal repetitions is given by *numberOfRepetitions*. For the *n*-th nominal repetition, *n* = *0*, …, *numberOfRepetitions* - 1,

- The slot where the nominal repetition starts is given by , and the starting symbol relative to the start of the slot is given by .

- The slot where the nominal repetition ends is given by , and the ending symbol relative to the start of the slot is given by .

Here is the slot where the PUSCH transmission starts, and is the number of symbols per slot as defined in Clause 4.3.2 of [4, TS38.211].

For PUSCH repetition Type B, the UE determines invalid symbol(s) for PUSCH repetition Type B transmission as follows:

- A symbol that is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* is considered as an invalid symbol for PUSCH repetition Type B transmission.

- For operation in unpaired spectrum, symbols indicated by *ssb-PositionsInBurst* in SIB1 or *ssb-PositionsInBurst* in *ServingCellConfigCommon* for reception of SS/PBCH blocks are considered as invalid symbols for PUSCH repetition Type B transmission.

- For a reduced capability half-duplex UE in paired spectrum, symbols that do not start or end at least or , respectively, from the last or first symbol of an SS/PBCH block with index indicated by *ssb-PositionsInBurst* in SIB1 or by *ssb-PositionsInBurst* in *ServingCellConfigCommon* or by *NonCellDefiningSSB*, or by *ssb-PositionsInBurst* in *SSB-MTC-AdditionalPCI* associated to physical cell ID with active TCI states for PDCCH or PDSCH, or for a set of symbols of a slot corresponding to SS/PBCH blocks configured for L1 beam measurement/reporting for reception of SS/PBCH blocks are considered as invalid symbols for PUSCH repetition Type B transmission.

- For operation in unpaired spectrum, symbol(s) indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set are considered as invalid symbol(s) for PUSCH repetition Type B transmission.

- For operation in unpaired spectrum, if *numberOfInvalidSymbolsForDL-UL-Switching* is configured, *numberOfInvalidSymbolsForDL-UL-Switching* symbol(s) after the last symbol that is indicated as downlink in each consecutive set of all symbols that are indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* are considered as invalid symbol(s) for PUSCH repetition Type B transmission. The symbol(s) given by *numberOfInvalidSymbolsForDL-UL-Switching* are defined using the reference SCS configuration *referenceSubcarrierSpacing* provided in *tdd-UL-DL-ConfigurationCommon*.

- For operation with shared spectrum channel access with semi-static channel occupancy, symbols in an idle duration associated with a periodic channel occupancy as described in Clause 4.3.1.1 of [16, 37.213], or in an idle duration in a period associated with an initiated channel occupancy as described in Clause 4.3.2. of [16, TS 37.213] are considered as invalid symbol(s) for PUSCH repetition Type B transmission.

- The UE may be configured with the higher layer parameter *invalidSymbolPattern*, which provides a symbol level bitmap spanning one or two slots (higher layer parameter *symbols* given by *invalidSymbolPattern*). A bit value equal to 1 in the symbol level bitmap *symbols* indicates that the corresponding symbol is an invalid symbol for PUSCH repetition Type B transmission. The UE may be additionally configured with a time-domain pattern (higher layer parameter *periodicityAndPattern* given by *invalidSymbolPattern*), where each bit of *periodicityAndPattern* corresponds to a unit equal to a duration of the symbol level bitmap *symbols*, and a bit value equal to 1 indicates that the symbol level bitmap *symbols* is present in the unit. The *periodicityAndPattern* can be {1, 2, 4, 5, 8, 10, 20 or 40} units long, but maximum of 40 msec. The first symbol of *periodicityAndPattern* every 40 msec/P periods is a first symbol in frame 𝑛𝑓 mod 4 = 0, where P is the duration of *periodicityAndPattern-r16* in units of msec. When *periodicityAndPattern* is not configured, for a symbol level bitmap spanning two slots, the bits of the first and second slots correspond respectively to even and odd slots of a radio frame, and for a symbol level bitmap spanning one slot, the bits of the slot correspond to every slot of a radio frame. If *invalidSymbolPattern* is configured, when the UE applies the invalid symbol pattern is determined as follows:

- if the PUSCH is scheduled by DCI format 0\_1, or corresponds to a Type 2 configured grant activated by DCI format 0\_1, and if *invalidSymbolPatternIndicatorDCI-0-1* is configured,

- if invalid symbol pattern indicator field is set 1, the UE applies the invalid symbol pattern;

- otherwise, the UE does not apply the invalid symbol pattern;

- if the PUSCH is scheduled by DCI format 0\_2, or corresponds to a Type 2 configured grant activated by DCI format 0\_2, and if *invalidSymbolPatternIndicatorDCI-0-2* is configured,

- if invalid symbol pattern indicator field is set 1, the UE applies the invalid symbol pattern;

- otherwise, the UE does not apply the invalid symbol pattern;

- otherwise, the UE applies the invalid symbol pattern.

- If the UE

- is configured with multiple serving cells within a cell group and is provided with *directionalCollisionHandling-r16* = 'enabled' for a set of serving cell(s) among the multiple serving cells, and

- indicates support of *half-DuplexTDD-CA-SameSCS-r16* capability, and

- is not configured to monitor PDCCH for detection of DCI format 2-0 on any of the multiple serving cells,

- a symbol indicated to the UE for reception of SS/PBCH blocks in a first cell of the multiple serving cells by *ssb-PositionsInBurst* in *SIB1,* or by *ssb-PositionsInBurst* in *ServingCellConfigCommon,* or by *NonCellDefiningSSB*, or by *ssb-PositionsInBurst* in *SSB-MTC-AdditionalPCI* associated to physical cell ID with active TCI states for PDCCH or PDSCH, or for a set of symbols of a slot corresponding to SS/PBCH blocks configured for L1 beam measurement/reporting is considered as an invalid symbol for PUSCH repetition Type B transmission in

- any of the multiple serving cells if the UE is not capable of simultaneous transmission and reception as indicated by *simultaneousRxTxInterBandCA* among the multiple serving cells, and

- any one of the cells corresponding to the same band as the first cell, irrespective of any capability indicated by *simultaneousRxTxInterBandCA*

and

- a symbol is considered as an invalid symbol in another cell among the set of serving cell(s) provided with *directionalCollisionHandling-r16* for PUSCH repetition Type B transmission with Type 1 or Type 2 configured grant except for the first Type 2 PUSCH transmission (including all repetitions) after activation if the symbol is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* on the reference cell as defined in Clause 11.1 of [6, TS 38.213], or the UE is configured by higher layers to receive PDCCH, PDSCH, or CSI-RS on the reference cell in the symbol.

For PUSCH repetition Type B, after determining the invalid symbol(s) for PUSCH repetition type B transmission for each of the *K* nominal repetitions, the remaining symbols are considered as potentially valid symbols for PUSCH repetition Type B transmission. If the number of potentially valid symbols for PUSCH repetition type B transmission is greater than zero for a nominal repetition, the nominal repetition consists of one or more actual repetitions, where each actual repetition consists of a consecutive set of all potentially valid symbols that can be used for PUSCH repetition Type B transmission within a slot. An actual repetition with a single symbol is omitted except for the case of *L*=1. An actual repetition is omitted according to the conditions in Clause 9, Clause 11.1, Clause 11.2A, Clause 15 and Clause 17.2 of [6, TS 38.213], and Clause 5.34.3 of [10, TS 38.321]. The UE shall repeat the TB across actual repetitions. The redundancy version to be applied on the *n*th actual repetition (with the counting including the actual repetitions that are omitted) is determined according to table 6.1.2.1-2, where *N*=1.

For PUSCH repetition Type B, when a UE receives a DCI that schedules aperiodic CSI report(s) or activates semi-persistent CSI report(s) on PUSCH with no transport block by a '*CSI request'* field on a DCI, the number of nominal repetitions is always assumed to be 1, regardless of the value of *numberOfRepetitions*. When the UE is scheduled to transmit a PUSCH repetition Type B with no transport block and with aperiodic or semi-persistent CSI report(s) by a '*CSI request'* field on a DCI, the first nominal repetition is expected to be the same as the first actual repetition. For PUSCH repetition Type B carrying semi-persistent CSI report(s) without a corresponding PDCCH after being activated on PUSCH by a '*CSI request'* field on a DCI, if the first nominal repetition is not the same as the first actual repetition, the first nominal repetition is omitted; otherwise, the first nominal repetition is omitted according to the conditions in Clause 9, Clause 11.1, Clause 11.2A, Clause 15 and Clause 17.2 of [6, TS 38.213], and Clause 5.34.3 of [10, TS 38.321].

For PUSCH repetition Type B, when a UE is scheduled to transmit a transport block and aperiodic CSI report(s) on PUSCH by a '*CSI request'* field on a DCI, the CSI report(s) is multiplexed only on the first actual repetition. The UE does not expect that the first actual repetition has a single symbol duration.

For *pusch-TimeDomainAllocationListForMultiPUSCH* in *pusch-Config*, if a row indicates resource allocation for two to eight contiguous PUSCHs and *extendedK2* is not configured, *K2* given by *k2-r16* indicates the slot where UE shall transmit the first PUSCH of the multiple PUSCHs. Each PUSCH has a separate SLIV and mapping type. The number of scheduled PUSCHs is signalled by the number of indicated valid SLIVs in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* signalled in DCI format 0\_1.

For *pusch-TimeDomainAllocationListForMultiPUSCH* in *pusch-Config,* if a row indicates resource allocation of more than one PUSCH and *extendedK2* is configured, each PUSCH has a separate SLIV, mapping type and *K2* given by *extendedK2*. If a row indicates resource allocation of a single PUSCH, the PUSCH has a single SLIV, mapping type, and *K2*, where *K2* is given by *extendedK2*, if configured, otherwise *K2* is given by *k2-r16*. The number of scheduled PUSCHs is signalled by the number of indicated SLIVs in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* signalled in DCI format 0\_1.

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple *SLIV*s for PUSCH on a UL BWP of a serving cell, and the UE is indicated re-transmission of PUSCH by DCI format 0\_1, where the PUSCH is correspond to a configured grant Type 1 or Type 2, the UE does not expect that the number of indicated *SLIV*s in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* by the DCI is more than one.

If a UE is configured with *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple *SLIV*s for PUSCH on a UL BWP of a serving cell, the UE does not expect to be scheduled with one or multiple PUSCH transmissions by a single DCI format 0\_1, where each PUSCH transmission overlaps with a DL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, or a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

When the UE is configured with *minimumSchedulingOffsetK2* in an active UL BWP it applies a minimum scheduling offset restriction indicated by the '*Minimum applicable scheduling offset indicator*' field in DCI format 0\_1, 0\_3, 1\_1 or 1\_3 if the same field is available. When the UE is configured with *minimumSchedulingOffsetK2* in an active UL BWP and it has not received '*Minimum applicable scheduling offset indicator*' field in DCI format 0\_1, 0\_3, 1\_1 or 1\_3, the UE shall apply a minimum scheduling offset restriction indicated based on '*Minimum applicable scheduling offset indicator*' value '0'. When the minimum scheduling offset restriction is applied the UE is not expected to be scheduled with a DCI in slot *n* to transmit a PUSCH scheduled with C-RNTI, CS-RNTI, MCS-C-RNTI or SP-CSI-RNTI with *K*2 smaller than, where *K*2min and are the applied minimum scheduling offset restriction and the numerology of the active UL BWP of the scheduled cell when receiving the DCI in slot *n*, respectively, and is the numerology of the new active UL BWP in case of active UL BWP change in the scheduled cell and is equal to , otherwise. The minimum scheduling offset restriction is not applied when PUSCH transmission is scheduled by RAR UL grant or fallbackRAR UL grant for RACH procedure, or when PUSCH is scheduled with TC-RNTI. The application delay of the change of the minimum scheduling offset restriction is determined in Clause 5.3.1.

When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', for PUSCH repetition Type A, in case *K>1,* the same symbol allocation is applied across the *K* consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall repeat the TB across the *K* consecutive slots applying the same symbol allocation in each slot, and the association of the first and second SRS resource set in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* toeach slot is determined as follows:

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint "00" for the *SRS resource set indicator*, the first SRS resource set is associated with all K consecutive slots,

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint "01" for the *SRS resource set indicator*, the second SRS resource set is associated with all K consecutive slots,

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint "10" for the *SRS resource set indicator*, the first and second SRS resource set association to K consecutive slots is determined as follows:

- When K = 2, the first and second SRS resource sets are applied to the first and second slot of 2 consecutive slots, respectively.

- When K > 2 and *cyclicMapping* in *PUSCH-Config* is enabled, the first and second SRS resource sets are applied to the first and second slot of K consecutive slots, respectively, and the same SRS resource set mapping pattern continues to the remaining slots of K consecutive slots.

- When K > 2 and *sequentialMapping* in *PUSCH-Config* is enabled, first SRS resource set is applied to the first and second slots of K consecutive slots, and the second SRS resource set is applied to the third and fourth slot of K consecutive slots, and the same SRS resource set mapping pattern continues to the remaining slots of K consecutive slots.

- Otherwise, a DCI format 0\_1 or DCI format 0\_2 indicates codepoint "11" for the *SRS resource set indicator*, and the first and second SRS resource set association to K consecutive slots is determined as follows,

- When K = 2, the second and first SRS resource set are applied to the first and second slot of 2 consecutive slots, respectively.

- When K > 2 and *cyclicMapping* in *PUSCH-Config* is enabled, the second and first SRS resource sets are applied to the first and second slot of K consecutive slots, respectively, and the same SRS resource set mapping pattern continues to the remaining slots of the K consecutive slots.

- When K > 2 and *sequentialMapping* in *PUSCH-Config* is enabled, the second SRS resource set is applied to the first and second slot of K consecutive slots, and the first SRS resource set is applied to the third and fourth slot of K consecutive slots, and the same SRS resource set mapping pattern continues to the remaining slots of the K consecutive slots.

For PUSCH repetition Type B, when two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', the SRS resource set association to nominal PUSCH repetitions follows the same method as SRS resource set association to slots in PUSCH Type A repetition by considering nominal repetitions instead of slots.

When a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and is having two indicated TCI-States or TCI-UL-States, and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', for PUSCH repetition Type A or Type B as described above, or for PUSCH transmission when the higher layer parameter *multipanelScheme* is set to 'SDMscheme' or 'SFNscheme', the association of the first and second indicated joint/UL TCI states to PUSCH transmission occasions or to corresponding PUSCH antenna ports is determined as follows:

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint “00” or “01” for the *SRS resource set indicator*, the first or second indicated joint/UL TCI state is applied to all PUSCH transmission occasions, respectively.

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint “10” or “11” for the *SRS resource set indicator*, and the *multipanelScheme* is not configured,

- the first indicated joint/UL TCI state is applied to the PUSCH transmission occasion(s) associated with the first SRS resource set and the second indicated joint/UL TCI state is applied to the PUSCH transmission occasion(s) associated with the second SRS resource set, where the association of PUSCH transmission occasions to SRS resource sets is determined for K = 2 and K > 2, and depending on whether *cyclicMapping* or *sequentialMapping* in *PUSCH-Config* is enabled, based on the above description in this Clause.

- if a DCI format 0\_1 or DCI format 0\_2 indicates codepoint “10” for the *SRS resource set indicator* and the higher layer parameters *multipanelScheme* is configured and set to 'SDMscheme' or 'SFNscheme',

- the first indicated TCI state is applied to the PUSCH antenna port(s), of corresponding PUSCH transmission occasion, associated with the first SRS resource set, and the second indicated TCI state is applied to the PUSCH antenna port(s), of corresponding PUSCH transmission occasion, associated with the second SRS resource set, where the association of PUSCH antenna ports to SRS resource sets is determined according to Clauses 6.1.1.1 and 6.1.1.2.

For both PUSCH repetition Type A and PUSCH repetition Type B, when a DCI format 0\_1 or DCI format 0\_2 indicates codepoint "10" or "11" for the *SRS resource set indicator*, the redundancy version to be applied on the *n*th transmission occasion (for PUSCH repetition Type A) of the TB, where n = 0, 1, … *K*-1, or *n*th actual repetition (for PUSCH repetition Type B, with the counting including the actual repetitions that are omitted) is determined according to Table 6.1.2.1-2 and Table 6.1.2.1-3. For all PUSCH repetitions associated with the SRS resource set of the first transmission occasion or actual repetition, the redundancy version to be applied is derived according to Table 6.1.2.1-2, where n is counted only considering PUSCH transmission occasions or actual repetitions associated with the same SRS resource set as the first transmission occasion or actual repetition. The redundancy version for PUSCH transmission occasions or actual repetitions that are associated with an SRS resource set other than the SRS resource set of the first transmission occasion or actual repetition is derived according to Table 6.1.2.1-3, where additional shifting operation for each redundancy version is configured by higher layer parameter *sequenceOffsetforRV* in *PUSCH-Config* and is counted only considering PUSCH transmission occasions or actual repetitions that are not associated with the SRS resource set of the first transmission occasion or actual repetition.

Table 6.1.2.1-3: Applied redundancy version for the other SRS resource set (SRS resource set not associated with the first transmission occasion or actual repetition) when *sequenceOffsetforRV* is present

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *rvid* indicated by the DCI scheduling the PUSCH | *rvid* to be applied to *n*th transmission occasion (repetition Type A) or *n*th actual repetition (repetition Type B) | | | |
| *n* mod 4 = 0 | *n* mod 4 = 1 | *n* mod 4 = 2 | *n* mod 4 = 3 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

For PUSCH repetition Type A, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and schedule aperiodic CSI report(s) on PUSCH with transport block by a '*CSI request'* field on a DCI, the CSI report(s) multiplexing is determined as follows

- if higher layer parameter *ap-CSI-MultiplexingMode* in *CSI-AperiodicTriggerState* is enabled and UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is transmitted separately only on the first transmission occasion associated with the first SRS resource set and the first transmission occasion associated with the second SRS resource set.

- otherwise, the CSI report(s) is transmitted only on the first transmission occasion.

For PUSCH transmissions of TB processing over multiple slots, when a DCI format 0\_1, 0\_2 or 0\_3 schedule aperiodic CSI report(s) on PUSCH with transport block by a 'CSI request' field on a DCI, the CSI report(s) is transmitted only on the first slot of the 𝑁 ∙ 𝐾 slots determined for the PUSCH transmission.

For PUSCH repetition Type B, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and schedule aperiodic CSI report(s) on PUSCH with transport block by a '*CSI request'* field on a DCI, CSI report(s) multiplexing is determined as follows

- if higher layer parameter *ap-CSI-MultiplexingMode* in *CSI-AperiodicTriggerState* is enabled and the first actual repetition associated with the first SRS resource set and the first actual repetition associated with the second SRS resource set have the same number of symbols and UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is multiplexed separately only on the first actual repetition associated with the first SRS resource set and first actual repetition associated with the second SRS resource set.

- otherwise, the CSI report(s) is multiplexed only on the first actual repetition.

The UE does not expect a different number of actual PT-RS ports for the two actual repetitions when the CSI report(s) is transmitted separately on two actual repetitions.

For PUSCH repetition Type A, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and schedule aperiodic CSI report(s) on PUSCH with no transport block by a '*CSI request'* field on a DCI, the number of repetitions is assumed to be 2 regardless of the value of *numberOfRepetitions* or *pusch-AggregationFactor* (if *numberOfRepetitions* is not present in the time domain resource allocation table), and transmission of CSI report(s) is determined as follows

- if higher layer parameter *ap-CSI-MultiplexingMode* in *CSI-AperiodicTriggerState* is enabled and UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is transmitted separately on the first transmission occasion and the second transmission occasion

- otherwise, the CSI report(s) is transmitted only on the first transmission occasion.

For PUSCH repetition Type B, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and schedule aperiodic CSI report(s) or activates semi-persistent CSI report(s) on PUSCH with no transport block by a '*CSI request'* field on a DCI, the number of nominal repetitions is always assumed to be 2 regardless of the value of *numberOfRepetitions*, and the first and second nominal repetitions are expected to be the same as the first and second actual repetitions, and transmission of CSI report(s) is determined as follows:

- if higher layer parameter *ap-CSI-MultiplexingMode* in *CSI-AperiodicTriggerState* is enabled for aperiodic CSI report(s) or higher layer paremeter *SP-CSI-MultiplexingMode* in *CSI-SemiPersistentOnPUSCH-TriggerState* is enabled for semi-persistent CSI report(s) and UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is transmitted separately on the first actual repetition and the second actual repetition

- otherwise, the CSI report(s) is transmitted only on the first actual repetition.

The UE does not expect a different number of actual PT-RS ports for the two actual repetitions when the CSI report(s) is transmitted separately on two actual repetitions.

For PUSCH repetition Type A, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and activate semi-persistent CSI report(s) on PUSCH with no transport block by a '*CSI request'* field on a DCI, or indicate the PUSCH repetition Type A carrying semi-persistent CSI report(s) without a corresponding PDCCH after being activated on PUSCH by a 'CSI request' field on a DCI, the number of repetitions is always assumed to be 2 regardless of the value of *numberOfRepetitions* or *pusch-AggregationFactor* (if *numberOfRepetitions* is not present in the time domain resource allocation table), and transmission of CSI report(s) is determined as follows

- if higher layer parameter *SP-CSI-MultiplexingMode* in *CSI-SemiPersistentOnPUSCH-TriggerState* is enabled and UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is transmitted separately on the first transmission occasion and the second transmission occasion

- otherwise, the CSI report(s) is transmitted only on the first transmission occasion.

For PUSCH repetition Type B, when higher layer parameter *multipanelScheme* is not provided and a DCI format 0\_1 and DCI format 0\_2 indicate codepoint "10" or "11" for the *SRS resource set indicator* and the PUSCH repetition Type B carrying semi-persistent CSI report(s) without a corresponding PDCCH after being activated on PUSCH by a '*CSI request'* field on a DCI, the number of nominal repetitions is always assumed to be 2 regardless of the value of *numberOfRepetitions*, and transmission of CSI report(s) is determined as follows

- if higher layer parameter *SP-CSI-MultiplexingMode* in *CSI-SemiPersistentOnPUSCH-TriggerState* is enabled and one of the first or second nominal repetition is the same as corresponding first or second actual repetition, the nominal repetition that is not having same actual repetition is omitted and the CSI report(s) is transmitted on the actual repetition that is not omitted.

- if higher layer parameter *SP-CSI-MultiplexingMode* in *CSI-SemiPersistentOnPUSCH-TriggerState* is enabled and the first and second nominal repetitions are the same as the first and second actual repetitions and the UCI other than CSI report(s) are not multiplexed on PUSCH, the CSI report(s) is transmitted separately on the first actual repetition and the second actual repetition

- otherwise, the CSI report(s) is transmitted only on the first actual repetition.

<omitted text>

### 6.1.3 UE procedure for applying transform precoding on PUSCH

For a PUSCH scheduled by RAR UL grant, or for a PUSCH scheduled by fallbackRAR UL grant, or for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, the UE shall consider the transform precoding either 'enabled' or 'disabled' according to the higher layer configured parameter *msg3-transformPrecoder.*

For a MsgA PUSCH, the UE shall consider the transform precoding either 'enabled' or 'disabled' according to the higher layer configured parameter *msgA-TransformPrecoder.* If higher layer parameter *msgA-TransformPrecoder* is not configured, the UE shall consider the transform precoding either 'enabled' or 'disabled' according to the higher layer configured parameter *msg3-transformPrecoder.*

For PUSCH transmission scheduled by a PDCCH with CRC scrambled by CS-RNTI with NDI=1, C-RNTI, or MCS-C-RNTI or SP-CSI-RNTI:

- If the DCI with the scheduling grant was received with DCI format 0\_0, the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to the higher layer configured parameter *msg3-transformPrecoder*.

- If the DCI with the scheduling grant was not received with DCI format 0\_0

- If the DCI with the scheduling grant was received with DCI format 0\_1 or 0\_2 with CRC scrambled by C-RNTI, MCS-RNTI, or CS-RNTI with NDI=1 and if the UE is configured with a higher layer parameter *dynamicTransformPrecoderFieldPresenceDCI-0-1* in *pusch-Config* for DCI format 0\_1 or *dynamicTransformPrecoderFieldPresenceDCI-0-2* in *pusch-Config* for DCI format 0\_2 and the higher layer parameter is set to 'enabled',

- the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to the Transform precoder indicator field in the DCI with the scheduling grant.

- For *pusch-TimeDomainAllocationListForMultiPUSCH* in *pusch-Config,* the UE shall, for all PUSCH transmissions, consider the transform precoding either enabled or disabled according to Transform precoder indicator field in the DCI format 0\_1 with the scheduling grant.

- If r*esourceAllocation* in *pusch-Config* for DCI format 0\_1 or *resourceAllocationDCI-0-2* in *pusch-Config* for DCI format 0\_2 is set to *resourceAllocationType0*, or if the resource allocation is set to resource allocation type 0 according to the DCI configuration as described in clauses 7.3.1.1.2 and 7.3.1.1.3 of [6, TS 38.212], or if *dmrs-Type* in *DMRS-UplinkConfig* is set to ‘type 2’ for this PUSCH transmission, the UE does not expect that the Transform precoder indicator field in the DCI with the scheduling grant indicates that transform precoding is enabled.

- If the UE is configured with the higher layer parameter *dmrs-TypeEnh* in *DMRS-UplinkConfig*, and if the scheduling grant indicates that transform precoding is enabled for the scheduled PUSCH transmission, the UE ignores the higher layer parameters *dmrs-TypeEnh* in *DMRS-UplinkConfig*, if configured, for the DM-RS transmission of the scheduled PUSCH transmission.

- Otherwise,

- If the UE is configured with the higher layer parameter *transformPrecoder* in *pusch-Config*, the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to this parameter.

- If the UE is not configured with the higher layer parameter *transformPrecoder* in *pusch-Config*, the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to the higher layer configured parameter *msg3-transformPrecoder*.

For PUSCH transmission with a configured grant

- If the UE is configured with the higher layer parameter *transformPrecoder* in *configuredGrantConfig*, the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to this parameter.

- If the UE is not configured with the higher layer parameter *transformPrecoder* in *configuredGrantConfig*, the UE shall, for this PUSCH transmission, consider the transform precoding either enabled or disabled according to the higher layer configured parameter *msg3-transformPrecoder*.

<omitted text>

### 6.1.7 UE procedure for determining time domain windows for bundling DM-RS

For PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, when *pusch-DMRS-Bundling* is enabled, and for PUCCH transmissions of PUCCH repetition, when *PUCCH-DMRS-Bundling* is enabled, the UE determines one or multiple nominal TDWs, as follows:

- For PUSCH transmissions of repetition Type A, PUSCH repetition Type B and TB processing over multiple slots, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:

- Given by *pusch-TimeDomainWindowLength*, if configured.

- Computed as min (*maxDurationDMRS-Bundling*, M), if *pusch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots of PUSCH transmissions, and where:

- For PUSCH transmissions of PUSCH repetition Type A, N=1 and K is the number of repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.

- For PUSCH transmissions of PUSCH repetition Type B, N=1 and K is the number of nominal repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.

- For PUSCH transmissions of TB processing over multiple slots, N is the number of slots used for TBS determination and K is the number of repetitions of the number of slots N used for TBS determination, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.

- For PUCCH transmissions of PUCCH repetition, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:

- Given by *pucch-TimeDomainWindowLength*, if configured.

- Computed as min (*maxDurationDMRS-Bundling*, M), if *pucch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots from the first slot determined for PUCCH transmissions of PUCCH repetition to the last slot determined for PUCCH transmissions of PUCCH repetition according to clause 9.2.6 of [6, TS 38.213].

- For PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3 and PUSCH repetition Type A with a configured grant, when *AvailableSlotCounting* is enabled, and for TB processing over multiple slots:

- The start of the first nominal TDW is the first slot determined for the first PUSCH transmission.

- The end of the last nominal TDW is the last slot determined for the last PUSCH transmission.

- The start of any other nominal TDWs is the first slot determined for PUSCH transmission after the last slot determined for PUSCH transmission of a previous nominal TDW.

- For PUSCH transmissions of a PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3 and PUSCH repetition Type A with a configured grant, when the UE is not configured with *AvailableSlotCounting* and for PUSCH repetition type B:

- The start of the first nominal TDW is the first slot for the first PUSCH transmission.

- The end of the last nominal TDW is the last slot for the last PUSCH transmission.

- The start of any other nominal TDWs is the first slot after the last slot of a previous nominal TDW.

- For PUCCH transmissions of a PUCCH repetition:

- The start of the first nominal TDW is the first slot determined for the first PUCCH transmission.

- The end of the last nominal TDW is the last slot determined for the last PUCCH transmission.

- The start of any other nominal TDWs is the first slot determined for PUCCH transmission after the last slot determined for PUCCH transmission of a previous nominal TDW.

For PUSCH transmissions of a PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, a nominal TDW consists of one or multiple actual TDWs. The UE determines the actual TDWs as follows:

- The start of the first actual TDW is the first symbol of the first PUSCH transmission in a slot for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW.

- The end of an actual TDW is

- The last symbol of the last PUSCH transmission in a slot for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW, if the actual TDW reaches the end of the last PUSCH transmission within the nominal TDW.

- The last symbol of a PUSCH transmission before the event, if an event occurs which causes power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW, and the PUSCH transmission is in a slot for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots.

- When *pusch-WindowRestart* is enabled, the start of a new actual TDW is the first symbol of the PUSCH transmission after the event which causes power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW, and the PUSCH transmission is in a slot for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots.

For PUCCH transmissions of PUCCH repetition, a nominal TDW consists of one or multiple actual TDWs. The UE determines the actual TDWs as follows:

- The start of the first actual TDW is the first symbol of the first PUCCH transmission in a slot determined for PUCCH transmission within the nominal TDW.

- The end of an actual TDW is

- The last symbol of the last PUCCH transmission in a slot determined for transmission of the PUCCH within the nominal TDW, if the actual TDW reaches the end of the last PUCCH transmission within the nominal TDW.

- The last symbol of a PUCCH transmission before the event, if an event occurs which causes power consistency and phase continuity not be maintained across PUCCH transmissions of PUCCH repetition within the nominal TDW, and the PUCCH transmission is in a slot determined for transmission of the PUCCH.

- When *pucch-WindowRestart* is enabled, the start of a new actual TDW is the first symbol of the PUCCH transmission after the event which causes power consistency and phase continuity not to be maintained across PUCCH transmissions of PUCCH repetition within the nominal TDW, and the PUCCH transmission is in a slot determined for transmission of the PUCCH.

Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:

- A downlink slot or downlink reception or downlink monitoring based on *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* for unpaired spectrum.

- For the UE indicating the capability *dmrs-BundlingNonBackToBackTX* or *dmrs-BundlingNonBackToBackTX-PerBC* in [13, TS 38.306], the gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, exceeds 13 symbols for normal cyclic prefix or exceeds 11 symbols for extended cyclic prefix.

- For the UE not indicating either of the capabilities *dmrs-BundlingNonBackToBackTX* or *dmrs-BundlingNonBackToBackTX-PerBC* in [13, TS 38.306], a non-zero symbol gap is scheduled between any two consecutive PUSCH transmissions or between any two consecutive PUCCH transmissions.

- The gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, does not exceed 13 symbols but other uplink transmissions are scheduled between the two consecutive PUSCH transmissions or the two consecutive PUCCH transmissions.

- For PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B or TB processing over multiple slots, a dropping or cancellation of a PUSCH transmission according to clause 9, clause 11.1 and clause 11.2A of [6, TS 38.213] or due to cell DRX operation.

- For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9, clause 9.2.6 and clause 11.1 of [6, TS 38.213] or due to cell DRX operation.

- For any two consecutive PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, and when two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook', a different SRS resource set association is used for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, according to Clause 6.1.2.1.

- For any two consecutive PUCCH transmissions of PUCCH repetition, and when a PUCCH resource used for repetitions of a PUCCH transmission by a UE includes first and second spatial relations or first and second sets of power control parameters, as described in [10, TS 38.321] and in clause 7.2.1 of [6, TS 38.213], different spatial relations or different power control parameters are used for the two PUCCH transmissions of PUCCH repetition, according to Clause 9.2.6 of [6, TS 38.213].

- Uplink timing adjustment in response to a timing advance command according to clause 4.2 of [6, TS 38.213].

- Frequency hopping.

- For reduced capability half-duplex UEs,

- a dropping or cancellation of a PUSCH or PUCCH transmission according to clause 17.2 of [6, TS 38.213] or

- an overlapping of the gap between two consecutive PUSCH or two consecutive PUCCH transmissions and any symbol of downlink reception or downlink monitoring

The UE shall maintain power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to frequency hopping, or in response to the use of a different SRS resource set association for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, or in response to the use of different spatial relations or different power control parameters for the two PUCCH transmissions of PUCCH repetition, or in response to any event not triggered by DCI or MAC-CE. The UE maintains power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to an event triggered by DCI other than frequency hopping or the use of a different SRS resource set association for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, or the use of different spatial relations or different power control parameters for the two PUCCH transmissions of PUCCH repetition, or in response to an event triggered by MAC-CE, subject to UE capability. of *dmrs-BundlingRestart* [13, TS 38.306] and when *pusch-WindowRestart* or *pucch-WindowRestart* is enabled.

<omitted text>

##### 6.2.1.4.1 SRS frequency hopping for positioning

The reduced capability UE may be configured via *SRS-PosTx-Hopping*, subject to UE capability, to perform transmit frequency hopping separate from the UL BWP configuration and outside of the UL BWP, where the UE may be configured with subcarrier spacing, CP and bandwidth that are different from the UL active BWP. The reduced capability UE transmit frequency hopping is configured within one SRS resource for positioning, that may be configured with a bandwidth larger than the maximum bandwidth of the reduced capability UE, in RRC\_CONNECTED or RRC\_INACTIVE mode. The reduced capability UE transmit frequency hopping, may be configured with overlapping or non-overlapping frequency hops in the frequency domain. When the reduced capability UE is configured to perform transmit frequency hopping:

- it expects to be configured with the following parameters:

- starting PRB of the first hop in time domain in *freqDomainShift*

- starting slot offset for the first hop in *periodicityAndOffset* for periodic and semi-persistent SRS and *slotOffset* for aperiodic SRS, starting slot offset for each hop following the first hop in *periodicityAndOffset* for periodic and semi-persistent SRS and *slotOffset* for aperiodic SRS in *SlotOffsetForRemainingHops,* and starting symbol for each hop in *startPosition*

- number of symbols in each hop in *nrofSymbols*

- hop bandwidth in *c-SRS*

- number of overlapping resource block(s) between hops, if present, in *overlapValue*

- number of hops in *numberOfHops*.

- it does not expect to be configured with the sum of *startPosition* and *nrofSymbol*s for a hop that exceeds a slot duration.

- it expects to be configured with the same periodicity of each hop of an SRS resource with the transmit frequency hopping.

The reduced capability UE may be configured, via *srs-PosUplinkTransmissionWindowConfig*, subject to UE capability, with an UL time window where the UE is not expected to transmit other signals/channels and is only expected to transmit the SRS for positioning using frequency hopping. The UE is not expected to be configured with one [cycle] of the transmit frequency hopping, including the switching time from/to active BWP required ahead of the first hop and after the last hop, that is partially overlapped with the time window.

For aperiodic positioning SRS with Tx frequency hopping, the minimal time interval between the last symbol of the PDCCH triggering the aperiodic SRS transmission and the first symbol of SRS resource is *N2* symbols and an additional time duration corresponding to the switching time from the active uplink BWP.

The reduced capability UE is expected to switch back to the active BWP if the time between two consecutive hops exceeds twice the switching time from/to the active BWP.

In RRC\_CONNECTED mode, for a transmission of a hop for an SRS resource for positioning with frequency hopping starting in symbol and a colliding PUSCH or PUCCH transmissionstarting in symbol , the UE shall apply the dropping rules taking into account:

- DCI(s) for which the time interval between the last symbol of PDCCH and the SRS symbol is at least symbols and additional time duration , where is the switching time to/from the active BWP.

- DCI(s) for which the time interval between the last symbol of PDCCH and the colliding PUSCH/PUCCH symbol is at least  symbols, where calculation of is based on the smallest SCS between the SCS configured for positioning SRS with the frequency hopping, the SCS of the PUSCH/PUCCH, and the SCS of the PDCCH.

- semi-persistent CSI reports or SRS considered active at least symbols and an additional time duration before , and considered active at least symbols before .

If the SRS symbol(s), including the switching time to and from the active bandwidth part, of the transmit frequency hopping collides with PUSCH or PUCCH, and if the UE determines the SRS to be dropped, the colliding SRS symbol(s) are dropped.

When the reduced capability UE is configured by the higher layer parameter *SRS-PosTx-Hopping*, including a switching time to and from the active bandwidth part, the UE shall use the same priority rules as defined in Clause 6.2.1.

For operation in the same carrier, the reduced capability UE is not expected to be configured on overlapping symbols with an SRS resource of the transmit frequency hopping configured by the higher layer parameter *SRS-PosTx-Hopping* including the switching time to or from the active bandwidth part and an SRS resource with *resourceType* of both SRS resources as 'periodic'.

For operation in the same carrier, the reduced capability UE is not expected to be activated or triggered to transmit SRS on overlapping symbols with a SRS resource of the transmit frequency hopping configured by the higher layer parameter *SRS-PosTx-Hopping* including the switching time to or from the active bandwidth part and a SRS resource with *resourceType* of both SRS resources as 'semi-persistent' or 'aperiodic'.

##### 6.2.1.4.2 SRS bandwidth aggregation for positioning measurements

The UE is expected to be configured with linkage information *SRS-PosResourceSetLinkedForAggBWList* on SRS resource sets for positioning across two or three CCs which are linked for bandwidth aggregation. For the linked SRS resource sets, the UE is expected to be configured with the same values of *startPosition, nrofSymbols,* *periodicityAndOffset, slotOffset, alpha, p0,* *spatialRelationInfoPos, resourceType*, *subcarrierSpacing*, *cyclicPrefix*, and *transmissionComb*, and the UE is expected to maintain phase continuity for the SRS transmission on the same symbol(s). The UE assumes that SRS resources across the linked SRS resource sets which satisfy the above conditions are linked for bandwidth aggregation, otherwise, the UE does not assume that SRS resources of the linked SRS resource sets are linked for bandwidth aggregation.

If the UE is configured with *dci-TriggeringPosResourceSetLink*, and if the UE receives a DCI 0\_1, 0\_2, 1\_1, or 1\_2 triggering an aperiodic SRS resource set for positioning linked for bandwidth aggregation in a CC, subject to UE capability, UE transmits SRS of the linked SRS resource sets across all CCs.

A UE in RRC\_INACTIVE mode is expected to be configured with frequency information via *freqInfo* in *SRS-PosResourceSetLinkedForAggBW* for additional component carrier(s) with respective SRS configuration(s) for bandwidth aggregation.

When an SRS resource configured in a CC without PUSCH or PUCCH is linked for bandwidth aggregation with an SRS resource configured in an active UL BWP of another CC in the same band, there is a guard period during which the UE is not expected to transmit or receive other signals or channels in this band, or any other affected band(s), subject to UE capability.

For the linked SRS resource sets for bandwidth aggregation across CCs in RRC\_CONNECTED state, if an SRS configured by the higher layer parameter *SRS-PosResource*, along with the guard period when applicable, collides with other signals or channels on a symbol and if the SRS in that symbol is dropped, SRS transmission of the linked SRS resource sets across all CCs is dropped on that symbol.

For the linked SRS resource sets for bandwidth aggregation in RRC\_INACTIVE state, if an SRS configured by the higher layer parameter *SRS-PosResource*, along with the guard period when applicable, collides with other signals or channels on a symbol, SRS transmission of all linked SRS resource sets is dropped on that symbol.

If the UE receives an activation or deactivation command of semi-persistent SRS resource set(s) for positioning in up to three aggregated carriers or SRS resource set(s) for positioning in up to two aggregated carriers as specified in [10, TS 38.321] and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation or deactivation command, the corresponding actions in [10, TS 38.321] and the UE assumptions on SRS transmission or cessation corresponding to the SRS resource set(s) shall be applied starting from the first slot that is after slot where µ is the SCS configuration for the PUCCH.

For positioning SRS resources on multiple carriers linked for aggregation, the channel over which a symbol on one carrier for SRS transmission is conveyed can be inferred from the channel over which the same symbol of another carrier or the aggregated carrier is conveyed.

<omitted text>

#### 6.2.3.1 UE PT-RS transmission procedure when transform precoding is not enabled

When transform precoding is not enabled and if a UE is configured with the higher layer parameter *phaseTrackingRS* in *DMRS-UplinkConfig,*

- the higher layer parameters *timeDensity* and *frequencyDensity* in *PTRS-UplinkConfig* indicate the threshold values *ptrs-MCSi*, *i*=1,2,3 and *NRB,i* , *i*=0,1, as shown in Table 6.2.3.1-1 and Table 6.2.3.1-2, respectively.

- if either or both higher layer parameters *timeDensity* and/or *frequencyDensity* in *PTRS-UplinkConfig* are configured, the UE shall assume the PT-RS antenna ports' presence and pattern are a function of the corresponding scheduled MCS of the codeword associated with the PT-RS and scheduled bandwidth in a corresponding bandwidth part as shown in Table 6.2.3.1-1 and Table 6.2.3.1-2, respectively,

- if the higher layer parameter *timeDensity* is not configured, the UE shall assume *LPT-RS* = 1.

- if the higher layer parameter *frequencyDensity* is not configured, the UE shall assume *KPT-RS* = 2.

- if a UE is configured with the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* set to 'n2' and scheduled with two codewords, the PT-RS time-density for both PT-RS ports is determined based on the higher MCSs of two codewords associated with the initial transmission.

- if none of the higher layer parameters *timeDensity* and *frequencyDensity* in *PTRS-UplinkConfig* are configured, the UE shall assume *LPT-RS* = 1 and *KPT-RS* = 2.

Table 6.2.3.1-1: Time density of PT-RS as a function of scheduled MCS

|  |  |
| --- | --- |
| Scheduled MCS | Time density() |
| IMCS < ptrs-MCS1 | PT-RS is not present |
| ptrs-MCS1  IMCS < ptrs-MCS2 | 4 |
| ptrs-MCS2  IMCS < ptrs-MCS3 | 2 |
| ptrs-MCS3  IMCS < ptrs-MCS4 | 1 |

Table 6.2.3.1-2: Frequency density of PT-RS as a function of scheduled bandwidth

|  |  |
| --- | --- |
| Scheduled bandwidth | Frequency density () |
| NRB < NRB0 | PT-RS is not present |
| NRB0  NRB < NRB1 | 2 |
| NRB1  NRB | 4 |

The higher layer parameter *PTRS-UplinkConfig* provides the parameters *ptrs-MCSi*, *i*=1,2,3 andwith values in 0-29 when MCS Table 5.1.3.1-1 or Table 5.1.3.1-3 is used and 0-28 when MCS Table 5.1.3.1-2 is used, respectively. *ptrs-MCS4* is not explicitly configured by higher layers but assumed 29 when MCS Table 5.1.3.1-1 or Table 5.1.3.1-3 is used and 28 when MCS Table 5.1.3.1-2 is used. The higher layer parameter *PTRS-UplinkConfig* provides the parameters *NRBi**i*=0,1with values in range 1-276.

If the higher layer parameter *PTRS-UplinkConfig* indicates that the time density thresholds *ptrs-MCSi* = *ptrs-MCSi+1*, then the time density *LPTRS* of the associated row where both these thresholds appear in Table 6.2.3.1-1 is disabled. If the higher layer parameter *frequencyDensity* in *PTRS-UplinkConfig* indicates that the frequency density thresholds *NRB,i* = *NRB,i+1*, then the frequency density *KPTRS* of the associated row where both these thresholds appear in Table 6.2.3.1-2 is disabled.

If either or both of the parameters PT-RS time density (*LPT-RS*) and PT-RS frequency density (*KPT-RS*), shown in Table 6.2.3.1-1 and Table 6.2.3.1-2, indicates that are configured as 'PT-RS not present', the UE shall assume that PT-RS is not present.

When a UE is scheduled to transmit PUSCH with allocation duration of 2 symbols or less, and if *LPT-RS* is set to 2 or 4, the UE shall not transmit PT-RS. When a UE is scheduled to transmit PUSCH with allocation duration of 4 symbols or less, and if *LPT-RS* is set to 4, the UE shall not transmit PT-RS.

When a UE is scheduled to transmit PUSCH for retransmission, if the UE is scheduled with *IMCS* > *V*, where *V* = 28 for MCS Table 5.1.3.1-1 and MCS Table 5.1.3.1-3 and *V* = 27 for MCS Table 5.1.3.1-2, respectively, the MCS for PT-RS time-density determination is obtained from the DCI for the same transport block in the initial transmission, which is smaller than or equal to V.

The maximum number of configured PT-RS ports is given by the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig.* The UE is not expected to be configured with a larger number of UL PT-RS ports than it has reported need for.

If a UE has reported the capability of supporting full-coherent UL transmission with 2 or 4 antenna ports or the capability of *codebook1-8TxPUSCH-r18* with 8 antenna ports, the UE shall expect *maxNrofPorts* in *PTRS-UplinkConfig* to be configured as one if UL PT-RS is configured. If a UE has reported the capability of supporting full-coherent UL transmission and when the higher layer parameter *multipanelScheme* is set to 'sdmscheme', subject to UE capability, the UE can be configured with *maxNrofPortsforSDM* in *PTRS-UplinkConfig* set to n2, where at most one PT-RS port is associated with each SRS resource set with higher layer parameter *usage* set to 'codebook'/'nonCodebook'.

For codebook or non-codebook based UL transmission, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1, 0\_2 and 0\_3. For a PUSCH corresponding to a configured grant Type 1 transmission, the UE may assume the association between UL PT-RS port(s) and DM-RS port(s) defined by value 0 in Table 7.3.1.1.2-25, or value "00" in Table 7.3.1.1.1.2-26 or value "00" in Table 7.3.1.1.1.2-25a described in Clause 7.3.1 of [5, TS38.212].

For PUSCH scheduled by DCI format 0\_0 or by activation DCI format 0\_0, the UL PT-RS port is associated to DM-RS port 0.

For non-codebook based UL transmission, the actual number of UL PT-RS port(s) to transmit is determined based on SRI(s) in DCI format 0\_1, 0\_2 or 0\_3 or higher layer parameter *sri-ResourceIndicator* in *rrc-ConfiguredUplinkGrant*. When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'noncodebook', the actual number of UL PT-RS port(s) to transmit corresponding to each SRS resource set is determined based on SRI(s) corresponding to the associated SRS resource set or higher layer parameter *sri-ResourceIndicator or sri-ResourceIndicator2* corresponding to the associated SRS resource set in *rrc-ConfiguredUplinkGrant*. A UE is configured with the PT-RS port index for each configured SRS resource by the higher layer parameter *ptrs-PortIndex* configured by *SRS-Config* if the UE is configured with the higher layer parameter *phaseTrackingRS in DMRS-UplinkConfig*. If the PT-RS port index associated with different SRIs are the same, the corresponding UL DM-RS ports are associated to the one UL PT-RS port.

When the higher layer parameter *multipanelScheme* is set to 'sdmscheme' and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/'nonCodebook' and higher layer parameter *maxNrofPortsforSDM* in *PTRS-UplinkConfig* set to n2, the actual number of UL PT-RS port(s) to transmit corresponding to SRS resource sets is *2*.

When the higher layer parameter *multipanelScheme* is set to 'SFNscheme' and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/'nonCodebook' and the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* is set to *n2*, the actual number of UL PT-RS port(s) to transmit corresponding to each SRS resource set is determined based on 1st TPMI codepoint field for 'codebook' or 1st SRI(s) codepoint field for 'nonCodebook'.

For partial-coherent and non-coherent codebook-based UL transmission with 2 or 4 antenna ports or when the higher layer parameter *CodebookTypeUL* is set to ‘codebook2’, ‘codebook3’, or ‘codebook4’ with 8 antenna ports, the actual number of UL PT-RS port(s) is determined based on TPMI(s) and/or number of layers which are indicated by '*Precoding information and number of layers'* field(s) in DCI format 0\_1, 0\_2 or 0\_3 or configured by higher layer parameter *precodingAndNumberOfLayers*:

- if the UE is configured with the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* set to 'n2', the actual UL PT-RS port(s) and the associated transmission layer(s) are derived from indicated TPMI(s) as:

- for PUSCH transmission with 2 or 4 ports, PUSCH antenna port 1000 and 1002 in indicated TPMI(s) share PT-RS port 0, and PUSCH antenna port 1001 and 1003 in indicated TPMI(s) share PT-RS port 1.

- UL PT-RS port 0 is associated with the UL layer 'x' of layers which are transmitted with PUSCH antenna port 1000 and PUSCH antenna port 1002 in indicated TPMI(s), and UL PT-RS port 1 is associated with the UL layer 'y' of layers which are transmitted with PUSCH antenna port 1001 and PUSCH antenna port 1003 in indicated TPMI(s), where 'x' and/or 'y' are given by DCI parameter '*PTRS-DMRS association'* as shown in DCI format 0\_1, 0\_2 and 0\_3 described in Clause 7.3.1 of [5, TS38.212].

- for PUSCH transmission with 8 ports, PUSCH antenna port 1000, 1001, 1004 and 1005 in indicated TPMI(s) share PT-RS port 0, and PUSCH antenna port 1002, 1003, 1006 and 1007 in indicated TPMI(s) share PT-RS port 1.

- UL PT-RS port 0 is associated with the UL layer 'x' of layers which are transmitted with one or more of PUSCH antenna port 1000, 1001, 1004 and 1005 in indicated TPMI(s), and UL PT-RS port 1 is associated with the UL layer 'y' of layers which are transmitted with one or more of PUSCH antenna port 1002, 1003, 1006 and 1007 in indicated TPMI(s), where 'x' and/or 'y' are given by DCI parameter '*PTRS-DMRS association*' as shown in DCI format 0\_1 and DCI format 0\_2 described in Clause 7.3.1 of [5, TS38.212].

If a UE is scheduled with two codewords,

- if the UE is configured with the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* set to 'n1', the PT-RS port is associated with the one of DM-RS ports indicated by DCI field *PTRS-DMRS association* for the codeword with the higher MCS. If the MCS indices of the two codewords are the same, the PT-RS antenna port is associated with codeword 0. When a codeword is scheduled to transmit PUSCH for retransmission, the MCS for determining PT-RS association to codeword is obtained from the DCI for the same transport block in the initial transmission.

When the UE is scheduled with *Qp*={1,2} PT-RS port(s) in uplink and the number of scheduled layers is ,

- If the UE is configured with higher layer parameter *ptrs-Power*, the PUSCH to PT-RS power ratio per layer per RE  is given by , where  is shown in the Table 6.2.3.1-3, Table 6.2.3.1-3A and Table 6.2.3.1-3B according to the higher layer parameter *ptrs-Power*, the PT-RS scaling factor  specified in clause 6.4.1.2.2.1 of [4, TS 38.211] is given by and also on the '*Precoding Information and Number of Layers'* field in DCI.

- The UE shall assume *ptrs-Power* in *PTRS-UplinkConfig* is set to state "00" in Table 6.2.3.1-3, Table 6.2.3.1-3A, and Table 6.2.3.1-3B if not configured or in case of non-codebook based PUSCH.

- When the higher layer parameter *CodebookTypeUL* is set to ‘codebook2’or ‘codebook3’ for 8 antenna port transmission, *Lx* is the number of PUSCH layers in the antenna port group which are precoded coherently with the PUSCH layer/DM-RS port that PT-RS port x is associated with, and *Qp* is the number of PT-RS ports scheduled to the UE.

- When the higher layer parameter *multipanelScheme* is set to ‘sdmscheme’ and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/’nonCodebook’, and codepoint "10" of *SRS Resource Set* *indicator* is indicated, for each PT-RS port is based on Table 6.2.3.1-3B, where *Qp* is the total number of PT-RS ports for the PUSCH.

Table 6.2.3.1-3: Factor related to PUSCH to PT-RS power ratio per layer per RE  other than 8TX PUSCH transmission and other than SDM PUSCH

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *UL-PTRS-power /* |  | The number of PUSCH layers ( ) | | | | | | |
| 1 | 2 | | 3 | | 4 | | |
| All cases | Full coherent | Partial and non- coherent and non-codebook based | Full coherent | Partial and non- coherent and non-codebook based | Full coherent | Partial coherent | Non-coherent and non-codebook based |
| 00 | 0 | 3 | 3*Qp*-3 | 4.77 | 3*Qp*-3 | 6 | 3*Qp* | 3*Qp*-3 |
| 01 | 0 | 3 | 3 | 4.77 | 4.77 | 6 | 6 | 6 |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

Table 6.2.3.1-3A: Factor related to PUSCH to PT-RS power ratio per layer per RE  for 8TX PUSCH transmission

|  |  |  |  |
| --- | --- | --- | --- |
| ***UL-PTRS-power /*** | **The number of PUSCH layers ()** | | |
| **1-8** | | |
| *CodebookTypeUL* =‘codebook1’ | *CodebookTypeUL* =‘codebook2’ or ‘codebook3’ | *CodebookTypeUL* =‘codebook4’ and non-codebook based |
| 00 |  |  |  |
| 01 |  |  |  |
| 10 | Reserved | | |
| 11 | Reserved | | |

Table 6.2.3.1-3B: Factor related to PUSCH to PT-RS power ratio per layer per RE for SDM PUSCH

|  |  |  |  |
| --- | --- | --- | --- |
| ***UL-PTRS-power /*** | **The number of PUSCH layers associated with the same SRS resource set as the PT-RS port** | | |
| **1** | **2** | |
| All cases | Full coherent | Partial and non- coherent and non-codebook based |
| 00 | 3*Qp*-3 | 3*Qp* | 3*Qp*-3 |
| 01 | 3*Qp*-3 | 3*Qp* | 3*Qp* |
| 10 | Reserved | | |
| 11 | Reserved | | |

<omitted text>

## 8.1 UE procedure for transmitting the physical sidelink shared channel

Each PSSCH transmission is associated with an PSCCH transmission.

That PSCCH transmission carries the 1st stage of the SCI associated with the PSSCH transmission; the 2nd stage of the associated SCI is carried within the resource of the PSSCH.

If the UE transmits SCI format 1-A on PSCCH according to a PSCCH resource configuration in slot *n* and PSCCH resource *m*, then for the associated PSSCH transmission in the same slot

- one transport block is transmitted with up to two layers;

- The number of layers (ʋ) is determined according to the '*Number of DMRS port'* field in the SCI;

- The set of consecutive symbols within the slot for transmission of the PSSCH is determined according to clause 8.1.2.1;

- The set of contiguous or interlaced resource blocks for transmission of the PSSCH is determined according to clause 8.1.2.2;

Transform precoding is not supported for PSSCH transmission.

Only wideband precoding is supported for PSSCH transmission.

The DM-RS antenna ports cid:image011.png@01D5F222.20AEBCB0 in Clause 8.4.1.1.2 of [4, TS38.211] are determined according to the ordering of DM-RS port(s) given by Tables 8.3.1.1-3 in Clause 8.3.1.1 of [5, TS 38.212].

The UE shall set the contents of the SCI format 2-A as follows:

- the UE shall set value of the *'HARQ process number'* field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*Cast type indicator*' field as indicated by higher layers.

- the UE shall set value of the '*CSI request*' field as indicated by higher layers.

- the UE shall set value of the '*CAPC*' field, if present, as indicated by higher layers.

- the UE shall set value of the '*COT sharing cast type*' field, if present, as indicated by higher layers.

- the UE shall set value of the '*COT sharing Additional ID'* field, if present, as indicated by higher layers.

- the UE shall set value of the '*Remaining COT duration'* field, if present, as indicated by higher layers.

The UE shall set the contents of the SCI formats 2-B as follows:

- the UE shall set value of the '*HARQ process number*' field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*Zone ID*' field as indicated by higher layers.

- the UE shall set the '*Communication range requirement*' field as indicated by higher layers.

The UE shall set the contents of the SCI format 2-C as follows:

- the UE shall set value of the *'HARQ process number'* field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*CSI request*' field as indicated by higher layers.

- the UE shall set value of '*Providing/Requesting indicator*' field as indicated by higher layers.

- if '*Providing/Requesting indicator*' indicates SCI format 2-C is used to convey an explicit request for inter-UE coordination information:

- the UE shall set value of the '*Priority*' field as indicated by higher layers.

- the UE shall set value of the '*Number of subchannels*' field as indicated by higher layers.

- the UE shall set value of the '*Number of RB sets*' field as indicated by higher layers if the higher layer parameter *sl-TransmissionStructureForPSCCHandPSSCH* in *SL-BWP-Config* is configured to 'interlaceRB'.

- the UE shall set value of the '*Resource reservation period*' field as indicated by higher layers.

- the UE shall set value of the '*Resource selection window location*' field as indicated by higher layers.

- the UE shall set value of the '*Resource set type*' field as indicated by higher layers if higher layer parameter *sl-DetermineResourceType* is configured to 'UE-B's request'; otherwise this field is omitted.

- if '*Providing/Requesting indicator*' indicates SCI format 2-C is used to convey inter-UE coordination information:

- the UE shall set value of the '*Resource set type*' field as indicated by higher layers.

- the UE shall set value of the '*Resource combination(s)*' field (clause 8.1.5A) as indicated by higher layers.

- the UE shall set value of the *'Lowest subchannel indices'* as indicated by higher layers

- the UE shall set value of the *'Lowest RB set indices'* as indicated by higher layers if the higher layer parameter *sl-TransmissionStructureForPSCCHandPSSCH* in *SL-BWP-Config* is configured to 'interlaceRB'.

- the UE shall set value of the '*First resource location*' as indicated by higher layers

- the UE shall set value of the '*Reference slot location*' as indicated by higher layers

The UE shall set the contents of the SCI format 2-D as follows:

- the UE shall set value of the *'SL PRS resource ID'* field as indicated by higher layers.

- the UE shall set value of the *'SL PRS request'* field as indicated by higher layers.

- the UE shall set value of the *'Embedded SCI format'* field as indicated by higher layers.

- if *'Embedded SCI format'* indicates that SCI format 2-A is embedded within this SCI format 2-D then the UE shall include in the *'Embedded SCI format payload'* field the fields of SCI format 2-A, set as specified above.

- if *'Embedded SCI format'* indicates that SCI format 2-B is embedded within this SCI format 2-D then the UE shall include in the *'Embedded SCI format payload'* field the fields of SCI format 2-B, set as specified above.

<omitted text>

#### 8.2.4.2 UE procedure for determining the subset of resources to be reported to higher layers in SL PRS resource selection in a dedicated SL PRS resource pool in sidelink resource allocation mode 2

In resource allocation mode 2 in a dedicated SL PRS resource pool, the higher layer can request the UE to determine a subset of resources from which the higher layer will select resources for SL PRS/PSCCH transmission. To trigger this procedure, in slot *n,* the higher layer provides the following parameters for this SL PRS/PSCCH transmission:

- the resource pool from which the resources are to be reported;

- L1 priority, ;

- the remaining SL PRS delay budget;

- Set of SL-PRS resource ID(s);

- optionally, the resource reservation interval, , in units of msec.

- if the higher layer requests the UE to determine a subset of resources from which the higher layer will select resources for SL PRS/PSCCH transmission as part of re-evaluation or pre-emption procedure, the higher layer provides a set of resources which may be subject to re-evaluation and a set of resources which may be subject to pre-emption.

- it is up to UE implementation to determine the subset of resources as requested by higher layers before or after the slot - , where is the slot with the smallest slot index among and , and is equal to , whereis defined in slots in Table 8.1.4-2 whereis the SCS configuration of the SL BWP.

The following higher layer parameters affect this procedure:

*- sl-SelectionWindowListDedicatedSL-PRS-RP t*:internal parameter is set to the corresponding value from higher layer parameter *sl-SelectionWindowListDedicatedSL-PRS-RP* for the given value of .

*- sl-Thres-RSRP-ListDedicatedSL-PRS-RP*: this higher layer parameter provides an RSRP threshold for each combination , where is the value of the priority field in a received SCI format 1-B and is the priority of the transmission of the UE selecting resources; for a given invocation of this procedure, .

*- sl-PRS-ResourceReservePeriodList:* the resource reservation interval, , is set to the corresponding value from higher layer parameter in units of msec

*- sl-SensingWindowDedicatedSL-PRS-RP*: internal parameter is defined as the number of slots corresponding to *sl-SensingWindowDedicatedSL-PRS-RP* msec

*- sl-TxPercentageDedicatedSL-PRS-RP-List*: internal parameter for a given is defined as *sl-TxPercentageDedicatedSL-PRS-RP-List ()* converted from percentage to ratio

- *sl-PreemptionEnableDedicatedSL-PRS-RP*: if *sl-PreemptionEnableDedicatedSL-PRS-RP* is provided, and if it is not equal to 'enabled', internal parameter is set to the higher layer provided parameter *sl-PreemptionEnableDedicatedSL-PRS-RP.*

The UE shall perform this procedure according to clause 8.1.4, with the following modifications:

- "packet delay budget" is replaced by "SL PRS delay budget",

- partial sensing is not applicable in a dedicated SL PRS resource pool,

- "candidate single-slot resource" is replaced by "candidate SL PRS resource",

- a candidate SL PRS resource for transmission is defined as the SL PRS resource with index within the Set of SL-PRS resource ID(s) provided by the higher layer and in slot ,

- "SCI format 1-A" is replaced by "SCI format 1-B",

- in step 5, the second condition is modified as follows: for any periodicity value allowed by the higher layer parameter *sl-PRS-ResourceReservePeriodList* and any SL PRS resource ID in the set of SL PRS resource ID(s) provided by the higher layer, and a hypothetical SCI format 1-B received in slot with '*Resource reservation period*' field set to that periodicity value and indicating that SL-PRS resource ID, condition c in step 6 would be met,

- In condition b of step 6, the RSRP measurement is the PSCCH-RSRP over the DM-RS resource elements of the PSCCH;

- In condition c of step 6 "determines according to clause 8.1.5 the set of resource blocks and slots" is replaced by "determines according to clause 8.2.4.2A the set of SL PRS resources and slots ".

<omitted text>

### 8.4.4 SL PRS reception procedure

The UE may be configured to measure and report one or more of the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL PRS-RSRPP, for the first detected path and up to 8 additional detected paths, and SL PRS-RSRP measurements. The UE may be configured to measure and report one or more of the SL AoA, SL PRS-RSRPP for the first path and up to 2 additional detected paths, and SL PRS-RSRP measurement.

The UE may report an ARP ID associated with the reported measurements. The UE may provide the ARP location information via *ARP-LocationInfo*.

The UE uses the same ARP for both the transmission and reception of sidelink positioning reference signals while performing an SL Rx-Tx time difference measurement.

The UE may include SL PRS resource ID(s) when it reports one or more of the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements.

For the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements, the UE reports an associated SL PRS reception timestamp via higher layer parameter *sl-TimeStamp*. For SL Rx-Tx time difference, the UE may report an associated SL PRS transmission timestamp via higher layer parameter *tx-TimeInfo* and the UE may be configured to report a SL PRS transmission timestamp via *associatedSL-PRS-TxTimeStampRequest*. The timestamp includes the SFN, slot number, and optionally *nr-PhysCellID*, *nr-ARFCN*, *nr-CellGlobalID*, or the timestamp includes DFN, slot number, and optionally *syncSourceType*.

The UE may be configured to report up to N Rx-Tx time difference measurements for the same SL PRS transmission associated with N different SL PRS receptions for the same pair of UE(s). The UE may be configured to report up to N Rx-Tx time difference measurements for the same SL PRS reception associated with N different SL PRS transmissions for the same pair of UE(s).

The UE may report, LoS/NLoS indicator(s) via *los-NLOS-Indicator* associated with each SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements.

The UE may report synchronization source type via *syncSourceType* and/or relative time difference with the associated quality metric, via *sl-RTD-Info*. If reported *syncSourceType* is *gNB-eNB*, the UE may report cell identity information.

The UE may be provided with synchronization source type of a UE and/or the relative time difference with the associated quality metric, via *syncSourceType* and *sl-RTD-Info, respectively*.

For the SL RSTD measurement, the UE may report a reference UE information.

For SL RTOA measurement, SFN or DFN initialization time may be provided to the UE by a UE or the network.

The UE may be provided with the location information of other UEs via *anchorUE-LocationInformation*. The UE may report the location information of the UE to the network.

The UE may be provided with expected SL AoA and uncertainty range of the expected SL AoA via *expectedSL-AzimuthAoA, expectedSL-ElevationAoA, expectedSL-AzimuthAoA-Uncertainty,* and *expectedSL-ElevationAoA-Uncertainty*.

The UE may report quality metric *sl-TimingQuality* corresponding to the SL RSTD, SL RTOA or SL Rx-Tx time difference measurements. The UE may report quality metric *sl-AngleQuality* corresponding to the SL AoA measurement.

If the *'SL PRS request'* field in the SCI associated with the received SL PRS is set to 1 then this request for SL PRS transmission is reported to higher layers.

<omitted text>