**3GPP TSG-RAN WG1 Meeting #108-e R1-220xxxx**

**e-Meeting, February 21st - March 3rd, 2022**

**Agenda Item: 5.2**

**Source: Moderator (ZTE)**

**Title: Summary on the physical layer aspects of small data transmission**

**Document for: Discussion**

# Introduction

This document contains the summary of remaining issues related to the physical layer aspects of small data transmission in RAN1#108-e meeting.

[108-e-R17-SDT-01] Email discussions on remaining issues on NR SDT in INACTIVE state – Ziyang (ZTE)

* 1st check point: February 25
* Final check point: March 3

The discussions related to other working groups(e.g. RRC parameters) are prioritized and summarized in Section 2, per Chairman’s guidance, the corresponding outgoing LS shall be finalized by end of first week.

# RRC parameter related issues(High priority)

## Mapping ratio

Companies’ views from the submitted contributions are collected in the following table:

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 1: The candidate value set of mapping ratio of SSB-to-PRACH occasion {1/8,1/4,1/2} is supported.** |
| R1-2201400 ZTE [3] | ***Proposal 1: Support to introduce mapping ratio {1/8, 1/4, 1/2} for CG-SDT.*** |
| R1-2201533 Spreadtrum [4] | ***Proposal 1: Do not support the candidate values {1/8, 1/4, 1/2} for mapping ratio of SSB to CG PUSCH per CG configuration.*** |
| R1-2201680 Intel [7] | **Proposal 1**   * For the mapping ratio of SSB to CG PUSCH resource   + Do not support mapping ratio < 1. |
| R1-2201924 Xiaomi [8] | **Proposal 1: Support 1-to-N mapping ratio between SSBs and POs.**  **Proposal 2: Support only 1-to-1 mapping ratio between the SSB and the DMRS resource in a definite PO.** |
| R1-2201985 Samsung [9] | ***Observation 2: >1 mapping ratio will cause ambiguity for identifying the selected SSB by UE at gNB side.***  ***Proposal 2: {1/8,1/4,1/2} is supported.*** |

### 2.1.1 First round discussion

#### Issue 2.1-1

One remaining issue for candidate value set of mapping ratio is whether to introduce {1/8, 1/4, 1/2}, 3 companies[2][3][9] support to introduce N<1, the reason is that the mapping ratio of SSB to RO mapping can be directly reused, and the same resource can be allocated to different UEs, 2 companies[4][7] do not support N<1 since mapping ratio for CG-SDT is UE specific, there is no benefit to allow UE to randomly select CG PUSCH resource. It’s observed that the key controversial understanding is whether the PUSCH resource allocated to one UE is dedicated or not, if so, mapping ratio N<1 may cause resource waste, otherwise, N<1 could improve resource utilization efficiency because the PUSCH resource not used by one UE may be selected by other UEs. From Moderator’s understanding, it’s up to network implementation on whether to configure same or different PUSCH resource for different UEs, in RAN2#112-e meeting, RAN2 only agrees that “no contention resolution procedure” is defined, there is no relevant agreement to prohibit overlapped PUSCH resource for different UEs.

#### Issue 2.1-2

2 companies[8][9] observed that mapping ratio N>1 may cause ambiguity on gNB because more than one SSBs will be mapped to the same PUSCH resource(same DMRS port), gNB may rely on blind detection to differentiate different SSBs. However, {1, 2, 4, 8, 16} have already been agreed in previous meeting, Moderator would like to check whether there is strong motivation to revert previous agreement.

#### ***Proposal 2.1***

For CG-SDT, support mapping ratio {1/8, 1/4, 1/2} for SSB to CG PUSCH mapping.

Companies are encouraged to provide comments on ***Proposal 2.1***, and Moderator would also like to check companies’ views on the following questions to align the understanding:

Q1: On Issue 2.1-1, do you think it’s allowed to configure same or different PUSCH resources for different UEs? If so, do you agree that {1/8, 1/4, 1/2} will not cause resource waste and may be beneficial to improve resource utilization efficiency(e.g. when different UEs are configured on the same resource, UE may randomly select DMRS port)?

Q2: On Issue 2.1-2, do you think N>1 may cause ambiguity on gNB side to differentiate different SSBs mapped to the same PUSCH resource(same DMRS port)? If so, do you agree to revert previous agreement to prohibit mapping ratio{2, 4, 8, 16}?

Any other comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Support FL Proposal 2.1. |
| Samsung | Q1, we don’t this is resource waste; and we strongly think <1 ratio should be there, otherwise, gNB could never identify the beam selected by UE, or it could only reply on mapping ratio 1;  Q2, from our understanding, we don’t think >1 value is making much sense. But anyway, we should respect the agreement, and did not have to revert it. But only >1 values are not acceptable. |
| Intel | Q1: We do not see the need to configure more than one PUCCH resources associated with a single SSB as this is UE specific. If different UEs are configured with same PUSCH occasions, they can be configured with a single DMRS port to differentiate the PUSCH resource.  Q2: no. we do not think there is ambiguity on gNB side. |
| New H3C | We are fine with FL proposal l2.1 |
| ZTE | We support Proposal 2.1.  Q1: Although PUSCH resource configuration is UE specific, it doesn’t mean the PUSCH resource(DMRS resource) should be unique for each UE. The reason is that, among the UEs with SDT capability, there is very little possibility that more than 2 UEs trigger SDT procedure at the same time, so it’s more efficient to configure the overlapped resource to several UEs(similar as MsgA PUSCH), and mapping ratio N<1 could alleviate the potential possibility of contention to allow UE to randomly select resource; Otherwise, if gNB has to pre-configure unique resources for all UEs, this will cause huge resource waste since very few UEs will trigger SDT service at the same time.  Q2: Prefer to keep previous agreement. |
| LG Electronics | We are fine with FL proposal 2.1 and keeping the previous agreement. |
| vivo | Support FL proposal.  Q1: Yes. Yes. Yes.  Q2: No. No.  gNB will anyway have to try to detect/decode a PUSCH on all CG occasions. When multiple SSBs have same beam, they can be mapped to same CG PUSCH resource. When they have different beams, they can be mapped to different CG PUSCH occasions. |

## Repetitions

Companies’ views from the submitted contributions are collected in the following table:

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201400 ZTE [3] | ***Proposal 2: For CG-SDT, repetition is supported***   * ***Reuse repK, repK-RV, pusch-RepTypeIndicator-r16, frequencyHoppingPUSCH-RepTypeB-r16 for CG-SDT*** * ***The repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s).*** |
| R1-2201680 Intel [7] | **Proposal 2**   * Repetition of CG-PUSCH is supported.   + The repetitions are considered as a bundle of transmission occasions that are mapped to a same SSB. |
| R1-2201924 Xiaomi [8] | **Proposal 11: Support repetition of CG-SDT.**   * **Only the TO of the first repetition is associated with the SSB.** |
| R1-2201985 Samsung [9] | ***Observation 1: the repetition in CG-SDT is not motivated and no clear benefit could be identified.***  ***Proposal 1: the repetition in CG-SDT is not supported.*** |

### 2.2.1 First round discussion

4 companies mentioned repetitions, 3 companies[3][7][8] among them support repetitions, while one company[9] does not support repetitions and thinks that repetition has no clear benefit. Since this is the last meeting in Rel-17, and repetition has RRC impact, we have to make a decision in this meeting. Given that the situation has not changed for several meetings, it seems impossible for RAN1 to decide, so it’s better to leave it to RAN2 to check the necessity. As for the impact on mapping, it can be further discussed in RAN1 maintenance phase after RAN2 makes decision.

#### ***Proposal 2.2***

For CG-SDT, it’s up to RAN2 to decide on whether to support repetition or not and potential impact on existing RRC parameters:

* *repK*, *repK-RV*, *pusch-RepTypeIndicator-r16*, *frequencyHoppingPUSCH-RepTypeB-r16* in *ConfiguredGrantConfig*

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK with FL proposal to leave it to RAN2 to decide. |
| Samsung | To save time, and respect FL’s effort.  Although we are not supportive to have repetition, we can live with kicking the ball to RAN2. |
| Intel | We are okay to let RAN2 decide whether repetition is supported for CG-PUSCH.  However, our understanding is that RAN1 can decide whether “pusch-RepTypeIndicator-r16, frequencyHoppingPUSCH-RepTypeB-r16” are supported for CG-PUSCH. Our view is these two are not supported for CG-SDT operation, only PUSCH repetition type A is sufficient for CG-SDT operation.  We suggest to modify the proposal as: ***Proposal 2.2*** For CG-SDT, it’s up to RAN2 to decide on whether to support repetition or not and potential impact on existing RRC parameters:   * *repK*, *repK-RV*, *~~pusch-RepTypeIndicator-r16~~*~~,~~ *~~frequencyHoppingPUSCH-RepTypeB-r16~~* in *ConfiguredGrantConfig*   PUSCH repetition type B is not supported for CG-SDT. |
| New H3C | We are fine with FL proposal. |
| ZTE | Fine with Proposal 2.2.  Although we understand the intention of Intel’s suggestion, we slightly prefer to let RAN2 make decision on all these repetition related parameters. |
| LG Electronics | We are fine with FL proposal 2.2. |
| vivo | Fine. |

## Separate initial BWP for RedCap

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2200975 Huawei [1] | ***Observation 1:*** *For RA-SDT, it is feasible already to configure the* *PRACH and PUSCH occasions on separate initial UL BWP. The CORESET for RA purpose is also configurable/available already.*  ***Observation 2:*** *For CG-SDT, the CG PUSCH configuration can also be configured on the separate initial UL BWP.*  ***Proposal 1:*** *RAN1 confirms that the separate BWP in case of RedCap may still be considered as the initial BWP and SDT resources can hence be configured on this BWP for RedCap UEs.* |
| R1-2201058 vivo[14] | RAN1 has discussed this question and confirmed that SDT resources can be configured on the separate initial UL BWP for REDCAP UEs.  Specifically, following aspects are concluded in RAN1:   * To support RA-SDT for RedCap UEs in the separate initial UL BWP, separate PRACH resources for SDT should be configured in the separate initial UL BWP and RedCap UEs shall use only the separate initial UL BWP to perform RA-SDT. * To support CG-SDT for RedCap UEs in the separate initial UL BWP,   + CG PUSCH resources are configured in the separate initial UL BWP. The CD-SSBs in initial DL BWP are used for TA validation and for mapping to the CG PUSCH resources.   + In case a separate initial DL BWP is configured for RedCap UEs, the UE-specific search space *sdt-CG-SearchSpace* configured in RRC release message for SDT should have associated CORESET being configured in this separate initial DL BWP. |
| R1-2201400 ZTE [3] | ***Proposal 14: Confirm that the separate BWP in case of RedCap may still be considered as the initial BWP and SDT resources can hence be configured on this BWP for RedCap UEs.*** |
| R1-2201533 Spreadtrum [4] | ***Proposal 2: CG-SDT cannot be configured on non-initial BWP.***  ***Proposal 3: For an RRC-configured active DL BWP in inactive mode (if it does not include CD-SSB), a RedCap UE supporting mandatory FG 6-1 expects it to contain NCD-SSB for serving cell but not CORESET#0/SIB.***  ***Proposal 4: RA-SDT and CG-SDT is not optimized for RedCap also when RedCap UE is configured with the separate initial DL/UL BWP.*** |
| R1-2201651 InterDigital [5] | ***Proposal 1: Confirm to RAN2 that SDT resources can be configured on an initial BWP separately configured for RedCap UEs.*** |
| R1-2201667 Ericsson [6] | 1. RAN1 confirms that the separate initial UL/DL BWP for RedCap UEs may still be considered as the initial BWP and SDT resources can hence be configured on this BWP for RedCap UEs. 2. Send an LS to inform RAN2 and RAN4 that CG/RA-SDT can be configured on the RedCap-specific separate initial UL/DL BWP. |
| R1-2201924 Xiaomi [8] | **Proposal 5: If SDT is supported for Redcap UEs with separate initial uplink BWP, RA-SDT resources must be configured on this separate BWP.**  **Proposal 6: Inform RAN2 to consider the PRACH resources partitioning between SDT and non-SDT on the separate initial uplink BWP for Redcap UEs.**  **Proposal 7: consider whether to configure a separate CSS on a separate initial downlink BWP for Redcap UEs in TDD bands.**  **Proposal 9: Support to configure CG-SDT resources on the separate initial UL BWP for Redcap UEs.**  **Proposal 10: Support to configure CG-SDT resources on either the separate initial BWP or the non-Redcap UE’s initial BWP in the case of both of them no larger than Redcap UE’s bandwidth.** |
| R1-2201985 Samsung [9] | ***Proposal 7: RAN1 confirms the feasibility to support SDT for RedCap UE in separate initial BWP.*** |
| R1-2202111 Qualcomm [10] | For the above question, RAN1 would like to inform RAN2 that both RA-SDT and CG-SDT resources can be configured for RedCap UE in the initial BWP separately configured for RedCap UE [2]. More specifically,   1. For a cell that allows a RedCap UE to access, network can configure a separate initial DL/UL BWP for RedCap UE, wherein the supported BW for the separate initial DL/UL BWP can have any values up to the maximum UE BW, and this applies to both TDD and FDD (including FD-FDD and HD-FDD). 2. For both RA-SDT and CG-SDT, a RedCap UE with valid TA timer can transmit PRACH/PUSCH/PUCCH in an initial UL BWP separately configured for RedCap UE. 3. If SSB and CORESET#0 are included in the initial DL BWP separately configured for RedCap UE, SDT resources (including CSS and USS sets for CG-SDT, or CSS sets for RA-SDT) can be configured in the separate initial DL BWP of RedCap UE. 4. If SSB or the entire CORESET#0 are not included in the initial DL BWP separately configured for RedCap UE, SDT resources can still be configured in the separate initial DL BWP for RedCap UE based on UE capability.   If the separate initial DL BWP of RedCap UE is configured with CSS sets for RA-SDT but not for paging, the RedCap UE is not required to monitor paging PDCCH when performing RA-SDT in the separate initial DL BWP. |
| R1-2202334 LGE [11] | ***Observation 1: If a separate initial BWP is configured, RedCap UE could not perform RACH on the legacy initial BWP because the legacy initial UL BWP for non-RedCap UEs is wider than the maximum RedCap UE bandwidth.***  ***Proposal 1: For RedCap UEs supporting RA-SDT, RA-SDT can be configured in a separate initial BWP specific to RedCap.***  ***Proposal 2: For RedCap UEs supporting CG-SDT, CG-SDT can be configured in a separate initial BWP specific to RedCap.*** |
| R1-2201679 Intel [13] | **Proposal 1**   * RAN1 to confirm that separate BWP can be considered for RedCap UEs as the initial BWP and SDT resources can be configured on this BWP for RedCap UEs. * For TDD, center frequencies are assumed to be the same for the separate DL and UL BWPs used for RedCap UEs. |
| R1-2201378 CATT [15] | RAN1 confirms that the separate BWP in case of REDCAP may still be considered as the initial BWP and SDT resources can hence be configured on this BWP for REDCAP UEs. |

### 2.3.1 First round discussion

RAN2 has sent an LS in R1-2200881 to RAN1 to ask whether the separate BWP in case of RedCap may still be considered as the initial BWP and SDT resources can hence be configured on this BWP for RedCap UEs. 11 companies discussed this issue in their contribution and all these companies agree to confirm the RAN2’s question. Given this situation, the following proposal is proposed:

#### ***Proposal 2.3***

RAN1 confirms that the separate BWP in case of RedCap may still be considered as the initial BWP and SDT resources(both CG-SDT and RA-SDT) can hence be configured on this BWP for RedCap UEs.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Support FL proposal 2.3  If the RedCap-specific initial DL BWP does not include SSB or the entire CORESET#0, whether or not SDT resources can be configured for RedCap UE can depend on the capability of RedCap UE. |
| Samsung | Fine. |
| Intel | We are fine with the proposal. We also need to ensure that “For TDD, center frequencies are assumed to be the same for the separate DL and UL BWPs used for RedCap UEs. ” |
| ZTE | Agree with Proposal 2.3. |
| LG Electronics | OK. For RedCap UE supporting SDT, SDT resources can be configured on RedCap specific initial BWP. |
| Lenovo | Support the proposal. |
| vivo | Fine with proposal in principal.  However, since to support CG-SDT in separate initial UL BWP requires some clarifications as we provided in the contribution to make sure it works, we propose to have following updates: ***Proposal 2.3*** RAN1 confirms that the separate BWP in case of RedCap may still be considered as the initial BWP and SDT resources(both CG-SDT and RA-SDT) can hence be configured on this BWP for RedCap UEs, but with following conditions:   * For CG-SDT in the separate initial UL BWP. The CD-SSBs in initial DL BWP are used for TA validation and for mapping to the CG PUSCH resources. * In case a separate initial DL BWP is configured for RedCap UEs, the UE-specific search space sdt-CG-SearchSpace configured in RRC release message for CG-SDT should have associated CORESET being configured in this separate initial DL BWP. |

## Association period

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 2: Candidate value set of association period for SSB to CG PUSCH mapping can be based on legacy CG Type 1 period, similar to the definition of candidate value set of association period for SSB to RO mapping.**  **Proposal 3: For CG-SDT, the starting time of SSB to CG PUSCH association period is SFN0.** |
| R1-2201400 ZTE [3] | ***Proposal 12: For candidate value set of association period, adopt Table 2 in TS 38.213.***  **Table** 2 Mapping between CG configuration period and SS/PBCH block to CG occasion association period   |  |  | | --- | --- | | CG period(msec) | Association period(msec) | | ≦1 | {5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640} | | 2 | {8, 10, 16, 20, 32, 40, 80, 160, 320, 640} | | 4 | {8, 16, 20, 32, 40, 64, 80, 160, 320, 640} | | 5 | {5, 10, 20, 40, 80, 160, 320, 640} | | 8 | {8, 16, 32, 40, 64, 80, 128, 160, 320, 640} | | 10 | {10, 20, 40, 80, 160, 320, 640} | | 16 | {16, 32, 64, 80, 128, 160, 320, 640} | | 20 | {20, 40, 80, 160, 320, 640} | | 32 | {32, 64, 128, 160, 320, 640} | | 40 | {40, 80, 160, 320, 640} | | 64 | {64, 128, 320, 640} | | 80 | {80, 160, 320, 640} | | 128 | {128, 640} | | 160 | {160, 320, 640} | | 320 | {320, 640} | | 640 | {640} |   ***Proposal 11: For CG-SDT, the starting time of association period is SFN0.***   * ***Adopt TP #1 for TS 38.213*** |
| R1-2201667 Ericsson [6] | 1. Periodicites up to 20.48 seconds should be configurable for CG-SDT 2. RAN1 to send an LS to RAN2 capturing the allowed periodicities for CG-SDT and indicating that it is up to RAN2 to decide how to define the new periodicities.   Table 1: Mapping between CG period and SS/PBCH block to CG PUSCH resource association period   |  |  | | --- | --- | | CG period (msec) | Association period (number of CG periods except when CG period is less than 5 ms) | | <5 | FFS | | 5 | {1, 2, 4, 8,16, 32, 64, 128} | | 8 | {1, 2, 4, 5, 8, 10, 16, 20, 40, 80} | | 10 | {1, 2, 4, 8,16, 32, 64} | | 16 | {1, 2, 4, 5, 8,10,20,40} | | 20 | {1, 2, 4, 8,16, 32} | | 32 | {1, 2, 4, 5, 10, 20} | | 40 | {1, 2, 4, 8, 16} | | 64 | {1, 2, 5, 10} | | 80 | {1, 2, 4, 8} | | 128 | {1, 5} | | 160 | {1, 2, 4} | | 320 | {1, 2} | | 640 | {1} |  1. If the CG period values for SDT are the same as those defined for CG Type 1 PUSCH, the candidate values of SSB to CG PUSCH association period is defined similar to the candidate values of SSB to RO association period according to Table 1. However, if a longer CG period than 640 ms is agreed in RAN1/RAN2, there should be updates to the existing agreements for CG-SDT, as well to the different rows in Table 1. 2. RAN1 to design the SSB to CG PUSCH association period for CG-SDT based on the CG period values that will be agreed in RAN1/RAN2. |
| R1-2201985 Samsung [9] | ***Proposal 5: the SSB-PUSCH association period is based on symbol unit.*** |
|  |  |

### 2.4.1 First round discussion

In TS38.213 section 19.1, the association period of SSB to CG PUSCH mapping is defined as below:

|  |
| --- |
| An association period, starting from frame TBD, for mapping SS/PBCH block indexes, from the number of SS/PBCH block indexes, to valid PUSCH occasions and associated DM-RS resources is the smallest value in the set determined by the PUSCH configuration period such that SS/PBCH block indexes are mapped at least once to valid PUSCH occasions and associated DM-RS resources within the association period. |

As highlighted above, there are 2 remaining issues on association period, i.e. starting time and candidate value set.

#### Issue 2.4-1

For CG-SDT, 2 companies[2][3] think that the definition of association period between SSB and CG-PUSCH is similar as SSB to RO mapping, so it’s natural for SFN0 to be the starting time of association period of CG-SDT.

#### Issue 2.4-2

Regarding how to define the candidate value set of association period for CG-SDT, 4 companies[2][3][6][9] have discussed this issue, but the views are a bit split.

2 companies[3][6] think that the minimum value of association period should be ≧5ms, the reason is that the minimum SSB period is 5ms, and it’s necessary for the association period to cover the SSB period. For example in Figure 2.4-1, if mapping ratio is 1, SSB0 and SSB1 are configured in SSB subset, and CG period is 1ms with 2 DMRS ports, although 1ms association period could already satisfy the requirement that all SSBs in SSB subset are mapped at least once, it should be guaranteed that in each association period, the configured SSB subset should occur at least once, thus the association period in this example should be 5ms.



Figure 2.4-1 An example of association period

Among these 2 companies, Company[6] suggests to FFS the CG period values smaller than 5ms, and the following Table 2.4-1 is preferred. Furthermore, [6] suggests larger values for CG period, but Moderator thinks that CG period is within RAN2 scope, and RAN2 is discussing the potential values of CG period, RAN1 should wait for RAN2’s decision to avoid potential conflict between RAN1 and RAN2.

Company[3] suggests to define the value set of association period in ms unit, the benefit is that, when CG period values are smaller than 1ms, the corresponding value set of association period could be identical, thus the table of mapping between CG period and association period could be accomplished without FFS part. Table 2.4-2 is suggested by [3].

Company[2] suggests that the candidate value set of association period should be based on legacy CG Type 1 period.

Table 2.4-1: Mapping between CG period and SS/PBCH block to CG PUSCH resource association period

|  |  |
| --- | --- |
| CG period (msec) | Association period (number of CG periods except when CG period is less than 5 ms) |
| <5 | FFS |
| 5 | {1, 2, 4, 8,16, 32, 64, 128} |
| 8 | {1, 2, 4, 5, 8, 10, 16, 20, 40, 80} |
| 10 | {1, 2, 4, 8,16, 32, 64} |
| 16 | {1, 2, 4, 5, 8,10,20,40} |
| 20 | {1, 2, 4, 8,16, 32} |
| 32 | {1, 2, 4, 5, 10, 20} |
| 40 | {1, 2, 4, 8, 16} |
| 64 | {1, 2, 5, 10} |
| 80 | {1, 2, 4, 8} |
| 128 | {1, 5} |
| 160 | {1, 2, 4} |
| 320 | {1, 2} |
| 640 | {1} |

**Table** 2.4-2 Mapping between CG configuration period and SS/PBCH block to CG occasion association period

|  |  |
| --- | --- |
| CG period(msec) | Association period(msec) |
| ≦1 | {5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640} |
| 2 | {8, 10, 16, 20, 32, 40, 80, 160, 320, 640} |
| 4 | {8, 16, 20, 32, 40, 64, 80, 160, 320, 640} |
| 5 | {5, 10, 20, 40, 80, 160, 320, 640} |
| 8 | {8, 16, 32, 40, 64, 80, 128, 160, 320, 640} |
| 10 | {10, 20, 40, 80, 160, 320, 640} |
| 16 | {16, 32, 64, 80, 128, 160, 320, 640} |
| 20 | {20, 40, 80, 160, 320, 640} |
| 32 | {32, 64, 128, 160, 320, 640} |
| 40 | {40, 80, 160, 320, 640} |
| 64 | {64, 128, 320, 640} |
| 80 | {80, 160, 320, 640} |
| 128 | {128, 640} |
| 160 | {160, 320, 640} |
| 320 | {320, 640} |
| 640 | {640} |

Company[9] suggests that the time unit of CG period could be in symbol level since the minimum value of CG period is 2 symbols. However, in this way the table should be separately defined for each SCS, besides, it seems not necessary to precisely differentiate the small values of CG period, because the corresponding association period should be equal to or larger than 5ms.

#### ***Proposal 2.4***

* For CG-SDT, the starting time of association period is SFN0.
* Regarding the candidate value set of association period, define a table for mapping between CG period and association period similar as SSB to RO mapping, down-select from the following options:
  + Option 1: Adopt Table 2.4-1 and FFS CG period smaller than 5ms
  + Option 2: Adopt Table 2.4-2.
  + Option 3: Any other tables.
  + Note: The table will be updated if RAN2 introduces other CG period values.

Any comments and which option is preferred?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | It is fine to define SFN0 as the starting/reference time for association period configuration of CG-SDT.  Table 2.4-1 is preferred, if RAN1 has to do the down-selection in this meeting. |
| Samsung | Fine with first bullet;  For second bullet, we can decide after RAN2 introduced new value.  Not sure what kind of value will be introduced by RAN2, larger one, smaller one, SCS-dependent one? or anything else. |
| Intel | We are fine with the first main bullet. For the second bullet, we suggest to wait RAN2 conclusion on the support of CG periodicities. Or if needed, we can send an LS to ask for conclusion from RAN2 on the supported CG periodicity. |
| New H3C | We support the starting time of association period is SFN0 for SDT.  It is better to wait for RAN2’s decision on CG periodicity. |
| ZTE | We are fine with the first bullet.  For the second bullet, either Option 1 or Option 2 is fine.  As for additional CG period values, we don’t need to wait for RAN2’s input, because in reply LS, they clearly state that “With regards to the RAN1 question whether there is any restriction on the candidate values of CG period, RAN2 agreed that there is no restriction from RAN2 perspective”. RAN2 doesn’t mention anything about additional values in the reply LS, so there is no reason to postpone the RAN1 spec work, especially the association period is the essential design of RAN1.  If RAN2 introduces any other CG periods in the future, we can update the table correspondingly.  To Samsung: RAN2 is discussing larger values of CG period, e.g. up to 20.48s |
| vivo | Fine with FL proposal.  Option 1 is a bit preferred since number of CG periods is used similar to SSB to RO mapping period determination where number of PRACH configuration period is used.  It has already been agreed in RAN2 that CG type 1 CG periods will be reused for SDT, thus we should work based on this agreement.   |  | | --- | | With regards to the RAN1 question whether there is any restriction on the candidate values of CG period, RAN2 agreed that there is no restriction from RAN2 perspective. | |

## DMRS configuration

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201400 ZTE [3] | ***Proposal 3: Consider the following 2 options for DMRS configuration of CG-SDT:***   * ***Option 1: Introduce a new parameter e.g. sdt-DMRSports to configure the set of DMRS ports for SSB to PUSCH mapping and ignore existing parameter antennaPort.*** * ***Option 2: Re-interpret existing parameter antennaPort as the set of DMRS ports for SSB to PUSCH mapping.***   ***Proposal 4: Consider the following options for DMRS sequences of CG-SDT***   * ***Option 1: Do not support multiple DMRS sequences, and revise previous agreement by removing text related to DMRS sequence index.***   + ***The parameter dmrs-SeqInitialization can be reused.*** * ***Option 2: Support multiple DMRS sequences, the generation mechanism and configuration can reuse that of msgA PUSCH.***   + ***The parameter dmrs-SeqInitialization can be revised as present when single DMRS sequence is configured for CG-SDT.***   + ***Introduce a new parameter sdt-NrofDMRSsequence*** ***to configure 1 or 2 DMRS sequences.*** |
| R1-2201680 Intel [7] | |  | | --- | | **------------------------------ TP#3: TS 38.211-----------------------------------**  **< Unchanged text omitted >**  6.4.1.1.1.1 Sequence generation when transform precoding is disabled  **< Unchanged text omitted >**  The quantity is  - indicated by the DM-RS initialization field, if present, either in the DCI associated with the PUSCH transmission if DCI format 0\_1 or 0\_2, in [4, TS 38.212] is used;  - indicated by the higher layer parameter *dmrs-SeqInitialization*, if present, for a Type 1 PUSCH transmission with a configured grant;  - determined by the mapping between preamble(s) and a PUSCH occasion and the associated DMRS resource for a PUSCH transmission of Type-2 random access process in [5, TS 38.213];  - determined by the mapping between SS/PBCH block(s) and a PUSCH occasion and the associated DMRS resource for a PUSCH transmission with Type-1 configured grant in RRC\_INACTIVE state [5, TS 38.213];  - otherwise .  **< Unchanged text omitted >** |  |  | | --- | | **------------------------------ TP#4: TS 38.214-----------------------------------**  **< Unchanged text omitted >**  6.2.2 UE DM-RS transmission procedure  **< Unchanged text omitted >**  When transmitted PUSCH is scheduled by DCI format 0\_1 with CRC scrambled by C-RNTI, CS-RNTI, SP-CSI-RNTI or MCS-C-RNTI, or corresponding to a configured grant, or being a PUSCH for Type-2 random access procedure,  - for PUSCH corresponding to a configured grant in RRC\_INACTICVE state ~~absence of RRC connection~~, the UE is provided with a set of DM-RS port(s) by [*DMRS-UplinkConfig*s]~~,~~. ~~and the DM-RS resource index is determined as defined~~ The DMRS port for the PUSCH is determined by the mapping between SS/PBCH block(s) and a PUSCH occasion and the associated DMRS resource in Clause 19.1 of [6, TS 38.213].  - the UE may be configured with higher layer parameter *dmrs-Type* in *DMRS-UplinkConfig*, and the configured DM-RS configuration type is used for transmitting PUSCH in as defined in Clause 6.4.1.1 of [4, TS 38.211].  **< Unchanged text omitted >** |   **Proposal 5**   * A list of DMRS antenna ports and up to two DMRS sequences can be configured for CG-PUSCH configuration.   Agree on TP#3 and TP#4 for determination of DMRS sequence initialization and antenna port for CG-PUSCH transmission for CG-SDT, respectively. |

### 2.5.1 First round discussion

In RAN1#107-e meeting and associated post meeting email discussion, SDT related RRC parameters are discussed and the stable parameters have been sent to RAN2. While there are still several unstable parameters related to DMRS configuration, specifically on how to configure multiple DMRS ports and whether/how to configure multiple DMRS sequences.

#### Issue 2.5-1

Company[3] has provided 2 options to configure multiple DMRS ports, one is to introduce a new parameter, e.g. *sdt-DMRSports* to configure the set of DMRS ports for SSB to PUSCH mapping and ignore existing parameter *antennaPort*. The other option is to re-interpret existing parameter *antennaPort* as the set of DMRS ports for SSB to PUSCH mapping.

Among the 2 options, the first option will introduce a new parameter, but it also provides full flexibility on DMRS port configuration, up to 8/12 DMRS ports can be configured for DMRS Type 1/2. Option 2 re-interprets existing parameter, no new parameter is needed, however, the parameter *antennaPort* for normal CG is used to configure multiple DMRS ports for multi-layer transmission, so up to 4 DMRS ports can be configured, this option has limited flexibility.

#### Issue 2.5-2

Company[3] provides 2 options on whether to configure multiple DMRS sequences. Company[7] suggests that up to 2 DMRS sequences can be configured, similar as MsgA PUSCH.

Given that previous agreement on mapping order has already considered multiple DMRS sequences as below, it seems reasonable to support multiple DMRS sequences for CG-SDT similar as MsgA PUSCH.

|  |
| --- |
| **Agreement**   * Each N of consecutive SSB indexes associated to one CG configuration are mapped to valid CG PUSCH resources   + first, in increasing order of DMRS resource indexes, where a DMRS resource index *DMRSid* is determined first in an ascending order of a DMRS port index and second in an ascending order of a DMRS sequence index   + second, in increasing order of CG period indexes in the association period |

#### ***Proposal 2.5***

Introduce a new parameter e.g. *sdt-DMRSports* to configure the set of DMRS ports for SSB to PUSCH mapping and ignore existing parameter *antennaPort*.

Support up to 2 DMRS sequences for CG-SDT, the generation mechanism and configuration can reuse that of msgA PUSCH.

* The parameter *dmrs-SeqInitialization* can be revised as present when single DMRS sequence is configured for CG-SDT.
* Introduce a new parameter *sdt-NrofDMRS-Sequence*s to configure 1 or 2 DMRS sequences.

Moderator suggests to discuss the proposal above, so that the corresponding RRC parameters can be sent to RAN2 by end of first week, the relevant TPs can be discussed later.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | It is unclear to us if the dedicated DMRS configuration(s) in connected mode will be released when the UE transfers from connected mode to inactive mode. Therefore, it is preferred to introduce a new RRC parameter for the DMRS sequence configuration of CG-SDT. |
| Samsung | We are fine to keep upto 2 DMRS sequence similar as msgA;  But we are not seeing the necessity to have separate RRC parameter for DMRS port or sequence. |
| Intel | We are fine with the proposal in principle. We have some questions for clarification:   * For *sdt-DMRSports,* what does “ignore existing parameter *antennaPort*” mean? does this mean that UE is configured with *antennaPort*, but ignores this parameter for CG-SDT operation? Or UE is not configured with *antennaPort?* * The same question is also for dmrs-SeqInitialization. |
| New H3C | In principal we are fine with the intention of this proposal on introducing new parameter on DMRS. We can further discuss about how to define new RRC parameter. |
| ZTE | We are fine with the proposal. |
| vivo | One question which may be related to this issue is do we assume only single antenna port is used per CG PUSCH transmission in SDT?  Up to 2 DMRS sequences as indicated by Samsung is also fine to us, similar to MsgA PUSCH in 2-step RACH topic.  For DMRS port configuration, we can revisit this after agreeing on the TX scheme of CG PUSCH for SDT as being discussed in section 2.6. |

## Antenna ports and transmission scheme

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 8: RAN1 to discuss and conclude**   * **whether multiple antenna ports are supported for CG SDT transmissions, and if supported whether codebook based and nonCodebook based TX schemes are supported.** * **whether non-fallback DCI is supported for subsequent SDT.** |
| R1-2201400 ZTE [3] | ***Proposal 5: precodingAndNumberOfLayers in ConfiguredGrantConfig is always 1 for CG-SDT.***  ***Proposal 6 : srs-ResourceIndicator in ConfiguredGrantConfig is not applicable to CG-SDT.*** |

### 2.6.1 First round discussion

Company[2] suggests to discuss and conclude whether multiple antenna ports are supported for CG SDT transmissions, and if supported whether codebook based and nonCodebook based transmission schemes are supported.

Company[3] proposes that SRI is not applicable to CG-SDT, and the value of *precodingAndNumberOfLayers* is always 1. This implicitly implies that only single antenna port is supported for single layer transmission, because for normal CG, the number of antenna ports is the same as number of SRS ports configured by SRI. Another reason is that, if SRI is configured, it may cause confusion to UE on whether to use UL Tx beam based on selected SSB or SRI.

As mentioned by [2], if multiple antenna ports are supported, it requires further discussion on codebook based or non-codebook based transmission scheme, Moderator thinks that at the Rel-17 maintenance phase, it’s recommended to consider simpler solution, similar as msgA PUSCH, so the following proposal is suggested

#### ***Proposal 2.6***

Only single antenna port for single layer transmission is supported for CG-SDT

* *srs-ResourceIndicator* in *ConfiguredGrantConfig* is not applicable to CG-SDT.
* *precodingAndNumberOfLayers* in *ConfiguredGrantConfig* is always 1 for CG-SDT.

Moderator would like to ask companies the following questions:

Q1: Do you support multiple antenna ports for single layer CG-SDT transmission? If so, whether codebook based and nonCodebook based transmission schemes are supported?

Q2: If the answer of Q1 is no, do you agree on ***Proposal 2.6***?

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Proposal 2.6 is supported  Answer to Q1 is no. |
| Intel | Q1: no.  Q2: we are fine with the proposal 2.6. We are also fine that *precodingAndNumberOfLayers* is not applicable to CG-SDT |
| New H3C | We are fine with proposal 2.6, we don’t agree with multiple antenna ports for single layer CG-SDT transmission. |
| ZTE | We are fine with the proposal. Single antenna port for single layer transmission is enough. |
| vivo | We’re fine with the proposal though we’re also fine to support multiple antenna ports if DG can support multiple antenna ports in SDT. |

## BWP level RRC configuration

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201400 ZTE [3] | ***Proposal 9: UE specific CORESET is supported for CG-SDT.***  ***Proposal 10: For SDT dedicated RRC configuration in case of BWP level,***   * ***Remove pucch-Config-r17.*** * ***RAN1 to discuss whether pusch-Config-r17 and pdsch-Config-r17 are needed or not.*** |
| R1-2201063 vivo [2] | **Proposal 4: UE specific TDRA table is configured in RRC release message for scheduling a PUSCH for CG-SDT or subsequent SDT or retransmission of SDT.** |
| R1-2201667 Ericsson [6] | 1. A UE specific TDRA list for CG PUSCH resource allocation in RRC inactive state should be configured in the RRC release message. Which TDRA list or table to select for CG-SDT can be based on predetermined rules when multiple TDRA lists, or tables are available. |

### 2.7.1 First round discussion

Company[3] mentioned that in RAN2, most companies prefer to have a SDT dedicated RRC configuration in case of BWP level, thus the RRC configuration in RRC release message in running CR of TS 38.331 is copied below.



Although SDT only works on initial BWP, the RRC configuration may also be UE specific, it depends on the trade-off between flexibility and signaling overhead. For pucch-Config-r17, RAN1 has already agreed that only common PUCCH resource will be considered for CG-SDT, so this IE is not useful in the BWP level configuration. For pdcch-Config-r17, since UE specific search space is supported for CG-SDT, this IE is needed. For pusch-Config-r17 and pdsch-Config-r17, these UE specific configuration may be used for dynamic grant based re-transmission or subsequent transmission, it requires RAN1 to discuss whether these flexible scheduling is needed. For srs-Config, this IE considers the SRS configuration of Positioning in INACTIVE state, but it has already been covered in Positioning session and will be removed from SDT RRC structure in next version.

Company[3] also thinks that the CORESET for CG-SDT could be UE-specific, because it has already been agreed that UE specific search space is supported and pdcch-Config will be included in RRC release message.

2 companies[2][6] support UE specific TDRA table to be configured in RRC release message, but it also depends on whether pusch-Config-r17 is configured in RRC release message or not, if included, UE specific TDRA table has already been included in pusch-Config-r17.

Given limited input, it’s better to discuss the following discussion point first.

#### ***Discussion point 2.7***

For BWP level RRC configuration for SDT in RRC release message,

* RAN1 to discuss and conclude whether UE specific parameters pusch-Config-r17 and pdsch-Config-r17 are needed or not.
  + If pusch-Config-r17 is not configured, discuss whether UE specific TDRA table is needed or not.
* pucch-Config-r17 is not needed.
* In pdcch-Config-r17, whether UE specific CORESET is supported for CG-SDT.

Regarding the discussion point, Moderator would like to check companies’ view on the following questions:

Q1: Do you think UE specific parameters pusch-Config-r17 and pdsch-Config-r17 are needed? If not needed, do you think UE specific TDRA table is needed or not?

Q2: Do you agree that pucch-Config-r17 is not needed?

Q3: Do you support UE specific CORESET for CG-SDT?

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | UE-specific pusch-Config-r17 can be supported for CG-SDT.  We don’t see a strong motivation to support UE-specific CORESET, pucch-Config-r17 and pdsch-Config-r17. |
| Intel | Q1: it is not very clear to us the motivation to consider UE specific parameters pusch-Config-r17 and pdsch-Config-r17.  Q2: Yes. pucch-Config-r17 is not needed  Q3: it seems not very clear to us the need to support UE specific CORESET for CG-SDT |
| New H3C | We slightly prefer UE-specific CORESET for SDT.  We are fine with UE specific parameters pusch-Config-r17  We don’t think pucch-Config-r17 is needed. |
| ZTE | Q1:For pusch-Config-r17 and pdsch-Config-r17, we are fine with or without these parameters.  Q2: Yes, pucch-Config-r17 is not needed.  Q3: We prefer to have UE specific CORESET since we already agree on UE specific search space for CG-SDT.  For these parameters that RAN1 cannot reach consensus, we can simply conclude that they can be left to RAN2 to decide. |
| vivo | Q1: We do not see the need to copy all parameters from pusch-Config-r17 and pdsch-Config-r17 to RRC release since SDT only supports part of the functions compared to RRC connected mode. The IE names may be not called pusch-Config, or pdsch-Config, it should be up to RAN2 to discuss how to organize the necessary parameters agreed in RAN1.  Even if UE specific TDRA table is supported in SDT, it doesn’t have to be put in *pusch-Config* in RRC release message. Configuring a TDRA list in RRC release message is enough.  Q2: Agree.  Q3: UE specific CORESET for CG-SDT seems not necessary in our understanding. |

## Other RRC parameters

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201400 ZTE [3] | ***Proposal 7: uci-OnPUSCH in ConfiguredGrantConfig is reused for CG-SDT.***  ***Proposal 8: phy-PriorityIndex-r16 in ConfiguredGrantConfig is not applicable to CG-SDT.*** |

### 2.8.1 First round discussion

Company[3] discussed 2 remaining unstable parameters, i.e. *uci-OnPUSCH* and *phy-PriorityIndex-r16*, the proposals from [3] can be regarded as starting point for discussion.

Company[3] explains that for *uci-OnPUSCH*, in normal CG configuration, this parameter is used for multiplexing UCI and PUSCH. For CG-SDT, during subsequent data transmission, UE may also transmit HARQ-ACK information and CG PUSCH simultaneously, so this parameter may be useful sometime. Parameter phy-PriorityIndex-r16 indicates the physical layer priority of CG PUSCH at least for physical-layer collision handling. However, for CG-SDT transmission in RRC\_INACTIVE state, it’s not possible and reasonable to define different priority for different CG configurations, so this parameter is not applicable for CG-SDT.

Based on company’s input, the following proposal can be discussed as starting point,

#### ***Proposal 2.8***

*uci-OnPUSCH* in *ConfiguredGrantConfig* is reused for CG-SDT.

*phy-PriorityIndex-r16* in *ConfiguredGrantConfig* is not applicable to CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK with FL’s proposal |
| Intel | For CG-SDT operation, it is not clear to us why we need to support uci-OnPUSCH. It is expected not very frequent small data transmission for CG-SDT. We do not see the need to multiplex UCI on CG-PUSCH.  We are fine with “*phy-PriorityIndex-r16* in *ConfiguredGrantConfig* is not applicable to CG-SDT” |
| New H3C | We are fine with FL proposal. |
| ZTE | Fine with the proposal. |
| Lenovo | Fine with the proposal |
| vivo | Looks fine. |

# SDT related procedures(Medium priority)

## Spatial domain filter for PUCCH

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 9:** **When CG-SDT is selected, PUCCH transmission in RRC inactive state for SDT should have same spatial domain transmission filter as for a CG PUSCH transmission for CG-SDT.** |
| R1-2201680 Intel [7] | |  | | --- | | **------------------------------ TP#5: TS 38.213-----------------------------------**  **< Unchanged text omitted >**  19.1 Configured-grant based PUSCH transmission  **< Unchanged text omitted >**  A UE can be provided a USS set by *sdt-CG-SearchSpace*, or a CSS set by *sdt-SearchSpace*, to monitor PDCCH for detection of DCI format 0\_0 with CRC scrambled by C-RNTI or CS-RNTI for scheduling PUSCH transmission or of DCI format 1\_0 with CRC scrambled by C-RNTI for scheduling PDSCH receptions [12, TS 38.331]. The UE may assume that the DM-RS antenna port associated with the PDCCH receptions, the DM-RS antenna port associated with the PDSCH receptions, and the SS/PBCH block associated with the PUSCH transmission are quasi co-located with respect to average gain and quasi co-location 'typeA' or 'typeD' properties. The UE transmits a PUCCH with HARQ-ACK information associated with the PDSCH receptions as described in clause 9.2.1. The PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission.  **< Unchanged text omitted >** |   **Proposal 6**   * For CG-SDT, UE transmits the PUCCH carrying HARQ-ACK feedback in response to a PDSCH with a same spatial domain transmission filter as a last PUSCH transmission. * Agree on TP#5 for Tx beam for PUCCH carrying HARQ-ACK feedback in response to a PDSCH for CG-SDT. |

### 3.1.1 First round discussion

2 companies[2][7] have proposed the issue for PUCCH beam determination, they both suggest that the PUCCH transmission should have the same spatial domain transmission filter as a last CG PUSCH transmission.

This is in line with the spatial domain transmission filter determination for PUCCH transmission after Msg4 or MsgB, so the following proposal can be discussed:

#### ***Proposal 3.1***

For CG-SDT, UE transmits the PUCCH carrying HARQ-ACK feedback in response to a PDSCH with a same spatial domain transmission filter as a last CG PUSCH transmission.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK with FL’s proposal |
| Intel | We suggest to modify the proposal as follows as the last PUSCH transmission may not be CG-PUSCH. It could be DG-PUSCH retransmission, which is scheduled by the gNB. ***Proposal 3.1*** For CG-SDT, UE transmits the PUCCH carrying HARQ-ACK feedback in response to a PDSCH with a same spatial domain transmission filter as a last ~~CG~~ PUSCH transmission. |
| New H3C | We are fine with FL’s proposal with Intel’ s modfication |
| ZTE | Fine with the proposal and Intel’s modification. |
| Lenovo | Fine with the original FL proposal. For Intel's modification, there is a risk that the most recent DG-PUSCH grant is missed by the UE, and therefore the UE would apply a different spatial domain filter than what the gNB expects/desires. Tying the spatial domain filter to the most recent CG PUSCH seems more robust. |
| vivo | Fine with the FL proposal.  Since the beam of DG PUSCH (for retransmission of CG or subsequent SDT) would still follow last CG PUSCH, the modification by Intel seems not necessary. |

## Validation rule

Companies’ views from the submitted contributions are collected in the following table.

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 5: The collision handling mechanisms agreed in RedCap WI are reused for SDT of RedCap UEs, and the PO validation rule defined for CG-SDT of a FD-FDD UE can be re-used for a HD-FDD RedCap UE supporting CG-SDT.**  **Proposal 6:** **For a UE that supports both CG-SDT and 2-step RACH, CG PUSCH occasions for SDT are treated as invalid when overlapping with MsgA PUSCH occasion, i.e. MsgA PUSCH occasion should be prioritized.**  **Proposal 7:** **For a UE that supports CG-SDT but doesn’t support 2-step RACH, CG PUSCH occasions for SDT can be treated as valid when overlapping with MsgA PUSCH occasions.** |
| R1-2201400 ZTE [3] | ***Proposal 13: It’s up to UE implementation to handle the overlapping between CG PUSCH occasions and MsgA PUSCH occasions.*** |
| R1-2201667 Ericsson [6] | 1. A CG PUSCH occasion is not valid if it overlaps with MsgA PUSCH occasion at least for CBRA. |
| R1-2201680 Intel [7] | |  | | --- | | **------------------------------ TP#1: TS 38.213-----------------------------------**  **< Unchanged text omitted >**  19 PUSCH transmission in RRC\_INACTI~~C~~VE state  19.1 Configured-grant based PUSCH transmission  **< Unchanged text omitted >**  A PUSCH occasion is valid if it does not overlap with a valid PRACH occasion as described in clause 8.1 and a MsgA PUSCH occasion as described in clause 8.1A.  For unpaired spectrum and for SS/PBCH blocks with indexes provided by *ssb-PositionsInBurst* in *SIB1* or by *ServingCellConfigCommon*  - if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion  - does not precede a SS/PBCH block in the PUSCH slot, and  - starts at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2  - if a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion  - is within UL symbols  - starts at least symbols after a last downlink symbol, and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2  **< Unchanged text omitted >** |   **Proposal 3**   * A CG PUSCH occasion is not valid if it overlaps with any valid MsgA PUSCH occasion. * Agree on TP#1 for validation of CG PUSCH occasion for CG-SDT.   **Proposal 7**   * For a HD-FDD RedCap UE, validation rule for CG-PUSCH occasions defined for FDD is re-used for CG-SDT. * No TP is needed for validation rule for CG-PUSCH occasions for HD-FDD RedCap UEs. |
| R1-2201924 Xiaomi [8] | **Proposal 3: For the PUSCH occasion validation for HD-FDD Redcap UEs, reuse the same rules as ROs discussed in AI.8.6.1.3.**  **Proposal 4：For UEs with 2-step RACH feature, the CG-SDT POs are invalid if they are overlapping with msgA PUSCH resources.** |
| R1-2201985 Samsung [9] | ***Proposal 3: No new specific validation rules are introduced to CG PUSCH for RedCap UE when using CG-SDT.***  ***Proposal 4: It’s up to UE implementation to handle overlapping between CG PUSCH occasions and MsgA PUSCH occasions. Note: such overlapping happens to the UE supports both CG-SDT and 2step RACH.*** |

### First round discussion

In RAN1#107-e meeting, RAN1 discussed the validation rule but companies’ views cannot be converged. There are 2 remaining issues, i.e. whether and how to define validation rule for RedCap UE performing SDT, whether and how to define validation rule if CG PUSCH overlaps with MsgA PUSCH.

#### Issue 3.2-1

Regarding RedCap UE performing SDT, 3 companies[2][7][9] think that no specific rule should be introduced and existing validation rule defined for FD-FDD can be reused for HD-FDD.

Company[8] thinks the validation rule of RO defined in RedCap session can be reused for CG PUSCH when RedCap UEs perform SDT. But it seems the referred RO validation for HD-FDD is up to UE implementation.

#### Issue 3.2-2

If CG PUSCH overlaps with MsgA PUSCH, companies’ views are summarized as below:

* Option 1: A CG PUSCH occasion is not valid if it overlaps with valid MsgA PUSCH occasion.
  + Support: Ericsson[6](at least for CBRA), vivo[2](When UE supports both features), Intel[7], Xiaomi[8]
* Option 2: It’s up to UE implementation if CG PUSCH occasion overlaps with valid MsgA PUSCH occasion.
  + Support: ZTE[3], Samsung[9]

Considering majority’s view, Option 1 can be used for further discussion.

As for the restriction, Company[6] thinks the validation rule can be defined at least for CBRA, however, MsgA PUSCH for CFRA has even higher priority than CBRA, it seems not necessary to differentiate the RA type.

Company[2] considers UE capability restriction, if UE doesn’t support 2 step RACH, the UE may not be required to know the MsgA PUSCH configuration, so it seems reasonable to define the validation rule only for UEs supporting both SDT and 2 step RACH feature.

#### ***Proposal 3.2***

* The validation rule defined for CG-SDT in FD-FDD mode can be reused for RedCap UE performing CG-SDT in HD-FDD mode.
* For UEs supporting both CG-SDT and 2 step RACH, a CG PUSCH occasion is not valid if it overlaps with valid MsgA PUSCH occasion.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | For second bullet, despite 4 supporting company for it, but we did not find the reasoning to support this restriction on scheduling. Could proponent or FL clarify on the necessity and why the overlap cannot be allowed? There is no UE behavior ambiguity. |
| Intel | We are fine with the proposal. |
| New H3C | We are fine with FL’s proposal. |
| ZTE | Fine with the proposal. |
| vivo | Fine with the proposal. |

## Non-fallback DCI

Companies’ views from the submitted contributions are collected in the following table:

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201667 Ericsson [6] | 1. Discuss whether non-fallback DCI formats can be used to schedule retransmissions and subsequent transmissions for CG-SDT in an initial BWP. |
| R1-2201063 vivo [2] | **Proposal 8: RAN1 to discuss and conclude**   * **whether multiple antenna ports are supported for CG SDT transmissions, and if supported whether codebook based and nonCodebook based TX schemes are supported.** * **whether non-fallback DCI is supported for subsequent SDT.** |

### 3.3.1 First round discussion

2 companies[2][6] suggest to discuss whether non-fallback DCI can be supported for re-transmission or subsequent transmission on initial BWP.

For this issue, it depends on whether non-fallback DCI can be configured on initial BWP, the description of initial BWP configuration defined in TS 38.331 is copied below:

|  |
| --- |
| --------------------------------------TS 38.331-----------------------------------------------------  There are two possible ways to configure BWP#0 (i.e. the initial BWP) for a UE:  1) Configure *BWP-DownlinkCommon* and *BWP-UplinkCommon* in *ServingCellConfigCommon*, but do not configure dedicated configurations in *BWP-DownlinkDedicated* or *BWP-UplinkDedicated* in *ServingCellConfig*.  2) Configure both *BWP-DownlinkCommon* and *BWP-UplinkCommon* in *ServingCellConfigCommon* and configure dedicated configurations in at least one of *BWP-DownlinkDedicated* or *BWP-UplinkDedicated* in *ServingCellConfig*.  The same way of configuration is used for UL BWP#0 and DL BWP#0 if both are configured.  With the first option (illustrated by figure B2-1 below), the BWP#0 is not considered to be an RRC-configured BWP, i.e. UE only supporting one BWP can still be configured with BWP#1 in addition to BWP#0 when using this configuration. The BWP#0 can still be used even if it does not have the dedicated configuration, albeit in a more limited manner since only the SIB1-defined configurations are available. For example, only DCI format 1\_0 can be used with BWP#0 without dedicated configuration, so changing to another BWP requires RRCReconfiguration since DCI format 1\_0 doesn't support DCI-based switching.    Figure B2-1: BWP#0 configuration without dedicated configuration  With the second option (illustrated by figure B2-2 below), the BWP#0 is considered to be an RRC-configured BWP, i.e. UE only supporting one BWP cannot be configured with BWP#1 in addition to BWP#0 when using this configuration. However, UE supporting more than one BWP can still switch to and from BWP#0 e.g. via DCI normally, and there are no explicit limitations to using the BWP#0 (compared to the first option).    Figure B2-2: BWP#0 configuration with dedicated configuration |

It’s clear that based on RAN2 discussion on RRC configuration, Option 2 is adopted for dedicated configuration of SDT, meanwhile, when BWP-dedicated is configured, non-fallback DCI can be supported for normal UE. Moderator thinks that there is no reason to preclude non-fallback DCI for CG-SDT.

#### ***Proposal 3.3***

Non-fallback DCI can be supported for CG-SDT when dedicated BWP configuration is configured.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | For retransmission of CG-SDT or subsequent UL data transmission, fallback DCI (with CRC scrambled by C-RNTI or CS-RNTI) is sufficient. We don’t see a need to support non-fallback DCI in inactive mode of UE, which potentially increases UE’s PDCCH monitoring complexity and power consumption. |
| Intel | We do not see the need to support non-fallback DCI. If majority support, we can be okay for this. |
| New H3C | We are fine with FL’s proposal |
| LG Electronics | We prefer not to support non-fallback DCI for CG-SDT. |
| vivo | Fine to support. |

## Editorial corrections

The editorial issues are summarized in this section.

### 3.4.1 First round discussion

#### **TP 3.4-1**

For SSB to CG PUSCH mapping, the agreement is made similar as mapping between msgA preamble to msgA PUSCH, however, the preamble indexes are consecutive because the configuration of preambles would be simpler and there is no difference for each index of preambles. Unfortunately, the “consecutive” number is mistakenly copied for SSB to CG PUSCH mapping, for SSBs, each SSB index may represent a unique beam, it’s not reasonable to restrict the SSB indexes configured for mapping to be consecutive, so it’s proposed to remove the “consecutive” in TP#3.

|  |
| --- |
| **19.1 Configured-grant based PUSCH transmission**  < Start of text proposal>  Each ~~consecutive~~ number of SS/PBCH block indexes are mapped to valid PUSCH occasions and associated DMRS resources  - first, in increasing order of DMRS resource indexes within a PUSCH occasion, where a DMRS resource index is determined first in an ascending order of a DMRS port index and second in an ascending order of a DMRS sequence index [4, TS 38.211]  - second, in increasing order of PUSCH configuration period indexes  < End of text proposal> |

#### **TP 3.4-2**

In the section 10.1 of TS 38.213, the description for monitoring type1-PDCCH CSS set in case of SDT is as below.

*If the UE has not been provided sdt-SearchSpace for Type1A-PDCCH CSS set, the UE monitors PDCCH candidates for DCI format 0\_0 and DCI format 1\_0 with CRC scrambled by the C-RNTI in the Type1-PDCCH CSS set as described in clause 19.2.*

According to the description, only when Type1A-PDCCH CSS set is not provided, the UE monitors Type1-PDCCH CSS set. For SDT, other than *sdt-SearchSpace* for Type1A-PDCCH CSS set, UE specific search space *sdt-CG-SearchSpace* may also be configured. Hence, for the PDCCH monitoring condition, *sdt-CG-SearchSpace* should also be added, i.e. when *sdt-SearchSpace* for Type1A-PDCCH CSS set or *sdt-CG-SearchSpace* for a USS set are not provided, the UE monitors type 1-PDCCH CSS set. The following TP is proposed.

|  |
| --- |
| **10.1 UE procedure for determining physical downlink control channel assignment**  < Start of text proposal>  For a DL BWP, if a UE is not provided *ra-SearchSpace* for Type1-PDCCH CSS set, the UE does not monitor PDCCH for Type1-PDCCH CSS set on the DL BWP. If the UE has not been provided a Type3-PDCCH CSS set or a USS set and the UE has received a C-RNTI and has been provided a Type1-PDCCH CSS set, the UE monitors PDCCH candidates for DCI format 0\_0 and DCI format 1\_0 with CRC scrambled by the C-RNTI in the Type1-PDCCH CSS set. If the UE has not been provided *sdt-SearchSpace* for Type1A-PDCCH CSS set or *sdt-CG-SearchSpace* for a USS set, the UE monitors PDCCH candidates for DCI format 0\_0 and DCI format 1\_0 with CRC scrambled by the C-RNTI in the Type1-PDCCH CSS set as described in clause 19.2.  < End of text proposal> |

#### **TP 3.4-3**

At the RAN1#106-e meeting, it was agreed that each N of consecutive SSB indexes associated to one CG configuration are mapped to valid CG PUSCH resources. Further, the SSB to CG PUSCH association period is the duration of multiple of CG periods depending on the smallest time duration in the set determined by the CG period such that all SSBs associated with the CG configuration are mapped at least once to CG PUSCH resources.

Given the fact that for a CG configuration for CG-SDT operation, SSBs are associated with CG-PUSCH resource instead of CG-PUSCH occasions, current description on unused CG-PUSCH resources which are not associated with SSB, and association pattern period are not accurate.

The following TP is proposed for association pattern period for SSB and CG-PUSCH resources for CG-SDT in Section 19.1.

|  |
| --- |
| **< Unchanged text omitted >**  19.1 Configured-grant based PUSCH transmission  **< Unchanged text omitted >**  An association period, starting from frame TBD, for mapping SS/PBCH block indexes, from the number of SS/PBCH block indexes, to valid PUSCH occasions and associated DM-RS resources is the smallest value in the set determined by the PUSCH configuration period such that SS/PBCH block indexes are mapped at least once to valid PUSCH occasions and associated DM-RS resources within the association period. A UE is provided a number of SS/PBCH block indexes associated with a PUSCH occasion and a DM-RS resource by *sdt-SSB-perCG-PUSCH*. If after an integer number of SS/PBCH block indexes to PUSCH occasions and associated DMRS resources mapping cycles within the association period there is a set of PUSCH occasions and associated DMRS resources that are not mapped to SS/PBCH block indexes, no SS/PBCH block indexes are mapped to the set of PUSCH occasions and associated DMRS resources. An association pattern period includes one or more association periods and is determined so that a pattern between PUSCH occasions with associated DMRS resources and SS/PBCH block indexes repeats at most every 640 msec. PUSCH occasions and DMRS resources not associated with SS/PBCH block indexes after an integer number of association periods, if any, are not used for PUSCH transmissions.  **< Unchanged text omitted >** |

Any comments on these 3 TPs?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | The 3 TPs look fine to us |
| Intel | TP1: We understand the intention, but we think consecutive is needed as this is for the indicated subset of SSB indexes.  TP2: we are fine  TP3: we are fine |
| New H3C | We are fine with above 3 TPs. |
| ZTE | Fine with the 3 TPs.  For TP 3.4-1, if “consecutive” is there, we cannot indicate e.g. SSB0 and SSB2 in the SSB subset, I think this is not the intention, because from signaling perspective, the SSB subset is indicated using a bitmap, no need to restrict the SSB subset only includes “consecutive” SSB indices. |
| vivo | Fine for the 2nd and 3rd TP.  For the first TP, if “consecutive” means a configuration with non-consecutive SSB indexes e.g.{SSB0, SSB3, SSB5} is not allowed, then the TP is needed. However, SSBs should be still assumed to be in an increasing order of SSB indexes when they’re mapped to CG PUSCH resources, which should be captured in the spec. in this case on top of the removal of “consecutive”. |

# Other physical layer issues(Low priority)

Companies’ views from the submitted contributions are collected in the following table:

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2201063 vivo [2] | **Proposal 10:** **For CG-SDT, the agreement that the associated SSB is used to estimate the pathloss for CG PUSCH should be captured according to TP1 for section 7.1.1 of 38.213 v17.0.0.** |
| R1-2201667 Ericsson [6] | 1. P0 and alpha for CG-SDT. How to provide the semi-static updates (e.g., via MAC-CE) is up to RAN2. Introduce mechanism to allow semi-static updates of the power control parameters 2. When multiple CG PUSCH configurations are provided, additional information from the UE can be provided to the gNB to determine the SSB associated with the UL data received on an overlapping PUSCH resource associated with multiple CG configurations. 3. Multiple CG PUSCH occasions in time and/or frequency domain can be configured per CG period for CG-SDT in RRC inactive state. 4. DMRS configuration can be independent from the configurations of multiple CG PUSCH occasions. 5. Further discuss in RAN1 on whether CG-SDT in RRC inactive state is allowed on flexible symbols. 6. If CG-SDT is only allowed in uplink symbols, additional UE specific TDD uplink-downlink configuration should be supported in the RRC release message. 7. To support CG-SDT in flexible symbols, *enableConfiguredUL* can be configured in the RRC release message. 8. In addition to the RSRP and TAT based TA validation mechanisms, support TDOA based TA validation based on SFTD measurements for CG- SDT in RRC inactive state. 9. TA offset can be optionally configured in the RRC release message for CG-SDT. If the TA offset is configured, the UE applies this TA offset for CG PUSCH transmissions on this serving cell. If this field is absent, the UE applies the default value defined for the duplex mode and frequency range of this serving cell. |
| R1-2201985 Samsung [9] | ***Proposal 6: Support indicating a RA Type*** (4step RA, 2step RA, 4step RA-SDT) ***for subset RO sharing for SDT.*** |
| R1-2202411 Lenovo[12] | ***Proposal 1: A UE configured with SDT transmissions in inactive mode maintains its timing alignment. Adopt the provided TP for TS 38.133.***   |  | | --- | | **TP for TS38.133 v17.3.0**7.1.1 Introduction The UE shall have capability to follow the frame timing change of the reference cell in connected state. Additionally a UE configured with small data transmission shall have capability to follow the frame timing change of the reference cell in inactive state. The uplink frame transmission takes place  before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. For serving cell(s) in pTAG, UE shall use the SpCell as the reference cell for deriving the UE transmit timing for cells in the pTAG. For serving cell(s) in sTAG, UE shall use any of the activated SCells as the reference cell for deriving the UE transmit timing for the cells in the sTAG. UE initial transmit timing accuracy and gradual timing adjustment requirements are defined in the following requirements.  […] | |

## First round discussion

According to the submitted contributions, the following issues are considered as low priority issues:

* 4-1 RO configuration[9]
* 4-2 TA validation[6]
* 4-3 Capture pathloss reference RS in spec[2]
* 4-4 TA maintenance[12]
* 4-5 P0 and alpha update[6]
* 4-6 Multiple CG occasions per CG period[6]
* 4-7 UL symbol or flexible symbol[6]
* 4-8 SSB determination in multiple CG configurations[6]

Moderator’s initial observation for these issues is provided below:

Issue 4-1, shared RO mask has already been agreed in RAN1, RO configuration issue is being discussed in RAN2 feature combination, so moderator thinks that RAN2 will make the decision based on the general consideration of different WIs.

Issue 4-2, whether to support TDOA based TA validation is up to RAN4, so there is no need for RAN1 to further discuss it.

Issue 4-3, the relevant agreement has already been captured in TS 38.213 section 19.1, there is no need to capture it in section 7 again.

Issue 4-4, it seems this is purely RAN4 related issue, it’s suggested to discuss it in RAN4 directly.

Issue 4-5, closed loop power control has already been agreed, it seems not necessary to update the open loop parameters during SDT procedure. Besides, this is an optimization issue, it’s not recommended to be considered in maintenance phase.

Issue 4-6, it has been agreed in RAN2 #116bis-e meeting that multiple CG occasions per CG period is not supported, no need to discuss it any more.

Issue 4-7, validation rule of TDD mode has been agreed in RAN1, if UE is provided *tdd-UL-DL-ConfigurationCommon*, SDT can only be transmitted within UL symbol.

Issue 4-8, in last meeting, very few companies show interest in this issue, and such optimization is not preferred in maintenance phase.

So the moderator suggests to first identify which issues are critical and need RAN1’s input. Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Lenovo | Regarding Issue 4-4, we understand that it would be eventually covered in RAN4 specification, but we think the technical motivation of fixing the timing alignment in RRC\_Inactive is a RAN1 topic. So we think RAN1 should discuss and agree on the issue and then ask RAN4 to implement this. |
| vivo | Regarding issue 4-3, does the FL mean following text captured in section 19.1?   |  | | --- | | The UE may assume that the DM-RS antenna port associated with the PDCCH receptions, the DM-RS antenna port associated with the PDSCH receptions, and the SS/PBCH block associated with the PUSCH transmission are quasi co-located with respect to average gain and quasi co-location 'typeA' or 'typeD' properties. The UE transmits a PUCCH with HARQ-ACK information associated with the PDSCH receptions as described in clause 9.2.1. |   This is for the QCL assumption between PDCCH and SSBs associated to PUSCH, which has nothing to do with the pathloss estimation for CG PUSCH power control in SDT. Or do we miss any other text in that section?  If not, for the agreement below, as we proposed in our contribution, it should be captured in the section of power control for PUSCH in 38.213, which has been missed in current specification.   |  | | --- | | **Agreement**  The pathloss for CG-SDT PUSCH power control can be determined by the measurement of selected SSB associated with the CG PUSCH. | |
|  |  |
|  |  |

# Summary

The final proposals will be added later.

# References

1. [R1-2200975](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2200975.zip) Physical layer aspects of SDT Huawei, HiSilicon
2. [R1-2201063](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201063.zip) Remaining RAN1 related issues for NR small data transmissions in RRC INACTIVE state vivo
3. [R1-2201400](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201400.zip) Discussion on the remaining physical layer issues of small data transmission ZTE Corporation
4. [R1-2201533](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201533.zip) Discussion on physical layer aspects of small data transmission Spreadtrum Communications
5. [R1-2201651](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201651.zip) Physical layer aspects of small data transmission InterDigital, Inc.
6. [R1-2201667](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201667.zip) RAN1 aspects for NR small data transmissions in INACTIVE state Ericsson
7. [R1-2201680](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201680.zip) Remaining issues on physical layer aspects of small data transmission Intel Corporation
8. [R1-2201924](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201924.zip) Discussion on physical layer aspects of small data transmission xiaomi
9. [R1-2201985](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201985.zip) Discussion on PHY Aspects for NR small data transmissions in INACTIVE state Samsung
10. [R1-2202111](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2202111.zip) Draft reply LS to RAN2 on the SDT BWP configuration for RedCap UE Qualcomm Incorporated
11. [R1-2202334](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2202334.zip) Discussion on physical layer aspects of small data transmission LG Electronics
12. [R1-2202411](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2202411.zip) Physical layer aspects for small data transmissions Lenovo
13. [R1-2201679](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201679.zip) Discussion on reply LS for separate BWP for RedCap UEs supporting SDT Intel Corporation
14. [R1-2201058](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201058.zip) Draft reply LS on the L1 aspects of small data transmission vivo
15. [R1-2201378](file:///D:\Documents\3GPP%20documents\RAN1\TSGR1_108-e\Docs\R1-2201378.zip) Draft reply LS on the L1 aspects of small data transmission CATT