**3GPP TSG-RAN WG1 Meeting #107-e R1-211xxxx**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 5.2**

**Source: Moderator (ZTE)**

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

**Document for: Discussion**

# Introduction

In this meeting, it is necessary to continue the discussion on the remaining physical layer issues, i.e. mapping details of SSB to PUSCH mapping details and some other SDT related procedures.

This document contains the summary of remaining issues related to the physical layer aspects of small data transmission in RAN1#107-e meeting.

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

* 1st check point: November 15
* Final check point: November 19

# SSB to PUSCH mapping details for CG-SDT

## Mapping ratio and association period

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. For the candidate value set of SSB to CG PUSCH mapping ratio, support the values {1/8,1/4,1/2} 2. Allow different SSB to CG PUSCH mapping ratio for different CG-SDT configurations. 3. 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. 4. RAN1 to send LS to RAN2 asking RAN2 to provide feedback regarding whether or not the period values for CG-SDT are the same as those defined for CG Type 1 PUSCH. RAN1 to design the SSB to CG PUSCH association period for SDT based on the feedback from RAN2. |
| R1-2110812 Huawei [2] | ***Proposal 2:*** *Mapping ratio of SSB to CG PUSCH is configured per CG configuration. No restriction on the value across the CG configuration.* |
| R1-2110973 vivo [3] | **Proposal 1: It is not necessary for CG-SDT to restrict the same value for all CG configurations.**  **Proposal 2: The candidate value set of mapping ratio of SSB-to-PRACH occasion {1/8,1/4,1/2} is supported.** |
| R1-2111083 Spreadtrum [4] | ***Proposal 2: Do not restrict the same value for all CG configurations.***  ***Proposal 3: Do not support the candidate values {1/8, 1/4, 1/2} for mapping ratio of SSB to CG PUSCH per CG configuration.*** |
| R1-2111356 ZTE [5] | ***Proposal 1: There is no need to restrict the same value of mapping ratio for all CG configurations.***  ***Proposal 2: Do not introduce mapping ratio N<1 for CG-SDT.*** |
| R1-2111473 Intel [7] | **Proposal 1**   * *For the mapping ratio of SSB to CG PUSCH resource*   + *Different mapping ratios can be configured for different CG configurations.*   + *Do not support mapping ratio < 1.* |
| R1-2111539 Xiaomi [8] | **Proposal 1: Reuse the similar mapping relationship between SSBs and ROs.**  **Proposal 4: Support only 1-to-1 mapping ratio between the SSB and the DMRS resource in a definite PO.** |
| R1-2111711 Samsung [9] | ***Observation 2: if one SSB could only be in one CG-PUSCH configuration, the benefit to configure different mapping ratio is unclear;***  ***Observation 3: if one SSB could be in multiple CG-PUSCH configurations, the benefits of having different mapping ratios may or may not exist depending on whether the subset and all indicated SSBs are in multiple CG-PUSCH configurations, respectively.***  ***Proposal 3: different mapping ratio is not supported.*** |
| R1-2111844 Apple [10] | **Proposal 1: One SSB mapping to multiple CG PUSCH resources is not supported.** |

### 2.1.1 First round discussion

One remaining issue for candidate value set of mapping ratio is whether to introduce {1/8, 1/4, 1/2}, 2 companies[1] [3] support to introduce N<1, the reason is that the mapping ratio of SSB to RO mapping can be directly reused, 5 companies[4][5][7][8][10] 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. One company[8] even only supports N=1, however, {1, 2, 4, 8, 16} have already been agreed in last meeting, there is no strong motivation to revert previous agreement.

Another issue is whether to restrict same mapping ratio for all CG configurations and/or allow different values for different CG configurations, 6 companies[1][2][3][4][5][7] think there is no need to restrict same value for all CG configurations, while one company[9] still believes there is no benefit to allow different values for different CG configurations.

One company[1] suggests to define the candidate value set of association period for SSB to CG PUSCH mapping, it’s noted that RAN1 has already asked RAN2 about whether to restrict CG period value set, so moderator suggests to wait for RAN2’s decision on CG period and then come back to association period if needed.

***Conclusion #2.1:***

* No need to restrict the same value of mapping ratio for all CG configurations.
* Do not introduce mapping ratio N<1 for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Question to FL, sorry from the summary I did not see the benefits to having different mapping ratio for different CG-PUSCH configuration for a single given UE. I see you mentioned 6 companies thinks there is no need to restrict, but could you clarify what’s the main purpose and use cases? Thank you. |
| Spreadtrum | CG configuration is beam set specific. Different CG configuration can have different beam set. |
| Ericsson | We are fine with first bullet.  We are NOT fine with the second bullet. The N<1 values are anyway configurable by the NW. We also would like to check with the FL if N<1 is not supported, would this have impact on configuration of repetitions for CG PUSCH? |
| Intel | We are fine with the conclusion.  Different CG-PUSCH configurations may have different DMRS resources/CG-PUSCH periodicity/MCS/amounts of resources/number of associated SSBs, it is not reasonable to assume same mapping ratios between SSB and CG-PUSCH resources in different configurations.  As CG-PUSCH configuration is configured in RRC release message and is UE specific, transmission of CG-PUSCH would be contention free. Our view is that it is not necessary to allow UE to randomly select one CG-PUSCH resource. In this case, N < 1 is not justified. |
| Apple | We are fine with the conclusion.  For the second bullet, RAN2 already agreed that “*Configuration is only type 1 CG with no contention resolution procedure for CG*”.” If mapping ratio N<1, it violates the RAN2 agreement, and we don’t see any benefits to have such configuration. |
| Qualcomm | We are fine with the first bullet. For the second bullet, we think N<1 can be configured by NW and it is not against RAN2’s agreement, wherein contention refers to different UEs choose the same DMRS/PUSCH resources. |
| HW, HiSi | We are fine with the proposal. |
| ZTE, Sanechips | We are fine with the conclusion. For the 2nd bullet, although N<1 does not violate RAN2 agreement, it seems not beneficial to allow UE to randomly select from multiple PUSCH resource. Since CG configuration is UE specific, it means the PUSCH resources allocated to one UE cannot be used by other UEs to avoid contention resolution, it may cause resource waste. |
| Xiaomi | We are fine with the first bullet.  For the second bullet, N<1 is beneficial for the case that SSB shave a long periodicity but the CG has a short periodicity. |
| vivo1 | Fine with the first bullet.  Do not support 2nd bullet, supporting N<1 means that one SSB can be mapped to multiple CG PUSCH occasions/DMRS resources which could be used by more static UEs in our understanding, i.e. when the beam change is not that fast while multiple SSB beams are configured in one CG configuration. |
| Moderator | @Samsung Thanks for your question. SSB subset, number of DMRS ports, CG periodicity and many other parameters are configured per CG configuration, different combinations of these parameters can be used for different scenarios. For example, in CG1, SSB0 and SSB1 are configured, in CG2, SSB2~SSB17 are configured, if the same mapping ratio is restricted, e.g. 1, CG2 may require a quite long association period to map all these SSBs. Anyway, per CG configuration means mapping ratio is under ConfiguredGrantConfig IE, it’s up to gNB to configure same or different mapping ratios for multiple CG configurations.  @Ericsson Thanks for your question. If N<1 is not supported, it has nothing to do with repetitions. If repetition is supported, these repetitions are considered as a bundle mapped to the same SSB. N<1 means one SSB can be mapped to multiple CG PUSCH resources, e.g. SSB0 will be mapped to DMRS port 0~3, and UE will randomly select one DMRS port from these resources. However, the CG configuration is UE specific, there is no collision among UEs and these DMRS port 0~3 cannot be used by other UEs, so it may cause resource waste as mentioned by other companies. |

### 2.1.2 Second round discussion

For the first bullet, it seems all companies except Samsung are fine with it, so Moderator would like to check whether Samsung could accept this given the explanation from Moderator and other companies.

For the 2nd bullet, companies’ views are divergent and summarized below:

For mapping ratio N<1

* Support: Ericsson, Qualcomm, Xiaomi, vivo
  + Reason: Mapping ratio N is anyway configurable by gNB, N<1 is beneficial for the case that SSB shave a long periodicity but the CG has a short periodicity, may be beneficial for more static UEs?
* Not support: Intel, Apple, ZTE, Huawei
  + Reason: N<1 will allow UE to randomly select PUSCH resources, it may cause resource waste.

Considering this is the last RAN1 meeting, Moderator suggests we go with majority’s view on the first bullet.

***Conclusion #2.1:***

* No need to restrict the same value of mapping ratio for all CG configurations.

As for the mapping ratio N<1, companies’ views are quite divergent, companies are encouraged to further discuss the pros and cons, let’s see whether the reasons listed above can be accepted by each side.

Any comments?

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| --- | --- |
| Company | Comment |
| Samsung | Thx FL’s for the explanation. But our question is not answered. We asked about the “use cases and main purpose”. What has been described in the reply is that there could be configuration with CG1 having 2 SSBs and CG2 has 16 SSBs, which are fine though non-common. And as you said, the PUSCH resources and DMRS could be different from CG1 and CG2, so if gNB configures only 2 SSBs in CG1 but 16 SSBs in CG2, don’t think CG2 should have much more PUSCH resources than CG1? That’s all fine if the PUSCH resource is different, my point is why gNB need or should configure like this, given gNB did not know which SSB UE is going to select?  *@Samsung Thanks for your question. SSB subset, number of DMRS ports, CG periodicity and many other parameters are configured per CG configuration, different combinations of these parameters can be used for different scenarios. For example, in CG1, SSB0 and SSB1 are configured, in CG2, SSB2~SSB17 are configured, if the same mapping ratio is restricted, e.g. 1, CG2 may require a quite long association period to map all these SSBs. Anyway, per CG configuration means mapping ratio is under ConfiguredGrantConfig IE, it’s up to gNB to configure same or different mapping ratios for multiple CG configurations.*  Overall, we are still not denying the “flexibility”, we still seek the answers for main purpose and meaningful use cases. We really feel pity this goes circle, could it once for all, just directly answer our question, what is the meaningful use cases? |
| Moderator | @ Samsung For example, CG1 corresponds to a static case, when a UE does not move frequently, the UE could select CG1 with mapping ratio 1, and CG2 means a dynamic case, when a UE moves around, the UE could select CG2 with mapping ratio 8. With different mapping ratios, the UE could have similar latency for both cases. Is it meaningful? |
| Qualcomm | Fine with the conclusion |
| Intel | We are fine with the conclusion.  For N < 1, our understanding is that if RAN1 cannot reach consensus, we can simply mention that “RAN1 cannot reach consensus on the support of N < 1” |
| H3C | We are fine with this conclusion. |
| Apple | Fine with the conclusion. For N<1, we share the views as Intel if no consensus can be reached. |
| vivo2 | Fine with the conclusion.  For N<1, we do not understand why resource overhead is related to such mapping ratio configuration, the CG PUSCH resource configuration is independent from the N configuration, N<1 only means the SSB to PO mapping period is extended as one SSB will be mapped to multiple CG PUSCH resources which may be necessary when the SSB beam change is not that faster, the CG resources configured in a fixed time duration depends on the CG PUSCH configuration itself (e.g. CG period, number of POs per CG period, number of DMRS ports/sequences per PO). From gNB point of view, it will try to decode PUSCH on all CG PUSCH resources no matter whether the mapping ratio is >1 or <1.  Whether N>1 or N<1 is configured for different scenarios is still up to gNB configuration. |
| Xiaomi | Fine with the conclusion. |
| HW, HiSi | Fine with the conclusion |
| Ericsson | Fine with the conclusion.  As mentioned by Vivo, whether to configure N<1 is still up to gNB. So there is no need to exclude this configuration. |

### 2.1.3 Final round discussion

Conclusion 2.1 is supported by all companies except Samsung, can Samsung accept it?

As for N<1, vivo and Ericsson think it’s up to gNB configuration, but Intel and Apple still want to preclude that, given there is no consensus, we may have to conclude that

***Conclusion 2.1a***

RAN1 cannot reach consensus on whether to support mapping ratio N<1.

Any comments?

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| --- | --- |
| Company | Comment |
| Intel | We are fine with the conclusion. |
| HW, HiSi | Fine with the conclusion |
| Xiaomi | We suggest to tell RAN2 the discussion in RAN1, and ask them to make the decision. |
| Qualcomm | We can live with the conclusion above |
| Apple | Fine with this conclusion |
| vivo3 | No conclusion is needed if no consensus can be made. RAN1 just inform the detailed discussions in RAN1 and the status in an LS to RAN2 so that they can discuss in GTW discussions to make a decision. |

## Repetitions

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. Support repetition of a TB across multiple slots for CG-SDT. |
| R1-2110812 Huawei [2] | ***Proposal 1:*** *The repetition mechanism in CG configuration in licensed band is reused for CG-SDT.* |
| R1-2111356 ZTE [5] | ***Proposal 5: For CG-SDT, the repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s).*** |
| R1-2111473 Intel [7] | **Proposal 3**   * *Repetition of CG-PUSCH is supported.*    + *The repetitions are considered as a bundle of transmission occasions that are mapped to a same SSB.* |
| R1-2111711 Samsung [9] | ***Observation 1: the repetition in CG-SDT is not motivated and no clear benefit could be identified.***  ***Proposal 2: the repletion in CG-SDT is not supported.*** |
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### 2.2.1 First round discussion

5 companies mentioned repetitions, 4 companies[1][2][5][7] among them support repetitions and consider the repetitions as a bundle of transmission occasions that are mapped to the same SSB(s), while one company[9] does not support repetitions and think the 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.

***Proposal #2.2***:

* For CG-SDT, the repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s), no additional specification rule is needed.

In addition to the proposal above, Moderator would like to make sure all companies understand the concern from the objecting company, so companies are also encouraged to provide comments on the following questions.

Q1: Do you think repetition is beneficial for CG-SDT? If so, what is the benefit of repetition?

Q2: If some of the repetitions are invalid, it may result in different number of repetitions mapped to different SSBs, e.g. repK is configured as 4, SSB1 is associated with 4 repetitions while SSB2 is associated with 2 repetitions(2 other repetitions are invalid), do you think it will cause problems for the unequal number of repetitions associated with different SSBs?

Any comments on the proposal and questions?

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| --- | --- |
| Company | Comment |
| Samsung | To save sometime, we want to ask the direct/basic question since the above 2 questions might still get us to repeat each other and the way how it is asked is questionable. We are not in the CR phase; causing problem is NOT the criteria, whether having justification and benefits should be. So instead, we want to ask the proponents for supporting repetition, especially when the same number of repetition cannot be guaranteed, for which we can compromise to same number of repetition cases.  Q: which use case is beneficial when the number of repetitions are not equal (e.g., one SSB with 4 repetitions and another SSB without repetition), given the fact that gNB has no idea on which SSB this UE will select? |
| Spreadtrum | Q1: beneficial for coverage  Q2: up to gNB implementation |
| Ericsson | Fine with proposal.  Q1: Yes. It may be beneficial for coverage reasons. Also, the repetitions are anyway configurable by the NW.  Q2: No. The gNB can also rely on retransmissions if there are coverage issues due to unequal repetitions. |
| Intel | Q1: this is beneficial as commented multiple times.  Q2: this will not lead to issue for the unbalanced number of repetitions for different SSBs. This can also happen for normal PUSCH repetitions, e.g., due to collision with DL symbols, higher priority transmission, etc.  If there is really concern for this, our suggestion is to invalidate all the repetitions for a CG PUSCH occasion if one repetition is invalidated. This can help avoid unbalanced mapping and meanwhile guarantee the performance. |
| Apple | Q1: it’s beneficial for the coverage  Q2: don’t see the issue for unbalanced repetitions. gNB has the flexibility to configure repetition or not, and the repetition number. |
| Qualcomm | Q1: repetitions can improve coverage/reliability.  Q2: no. |
| Huawei, HiSilicon | Q1: The repetition is benefit for improving the receiving performance of PUSCH. We gives an example of use case in our tdoc [2]. In RRC\_INACTIVE, The RSRP threshold for CG-SDT cannot always guarantee the gNB’s receiving performance of CG PUSCH because this is a cell-level RSRP calculated by averaging the RSRP of several SSBs such as SSB0~7, which is not for specific SSB, e.g. SSB1. However, the gNB shall probably receive the PUSCH according to the beam of SSB1 if UE chooses the PUSCH occasion associated to SSB1. In this case, the receiving performance cannot be guaranteed and the repetition can help to improve the receiving performance.  Q2: We do not see any problem from the unequal number of repetitions associated with different SSBs. |
| ZTE, Sanechips | Q1: Repetitions are beneficial for coverage, it will allow more UEs to transmit SDT.  Q2: We also don’t see the issue with unequal number of repetitions.  Q from Samsung: Although gNB has no idea on which SSB this UE will select, it’s most probably that the actual repetition number of selected SSB is not 1, it still has benefit compared with no repetitions. |
| LG Electronics | Q1: It’s beneficial for the coverage.  Q2: We don’t see the issue. |
| Xiaomi | Q1: Benefit to improve the coverage.  Q2: Don’t see the problem of the unequal number of repetitions associated with different SSBs. |
| vivo1 | Q1: Repetitions are of course beneficial for coverage, which is an important feature being further enhanced in URLLC topic in Rel-16 and coverage enhancement topic in Rel-17.  Q2: No. The number of actual repetitions for each transmission can be different even in legacy PUSCH repetitions. We can not understand why we need to introduce such restrictions in PUSCH repetitions in SDT topic, which is quite strange to the majority companies as we’ve repeated many times. |

### 2.2.2 Second round discussion

The situation has not changed from several meetings ago, Samsung is still the only company objecting the proposal.

***Proposal #2.2***:

* For CG-SDT, the repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s), no additional specification rule is needed.

As for the 2 questions asked by Moderator for companies to understand Samsung’s concern, the situation is summarized below:

Q1: Do you think repetition is beneficial for CG-SDT? If so, what is the benefit of repetition?

* This is associating with Samsung’s concern on motivation to have repetition for CG-SDT.
* Yes: Spreadtrum, Ericsson, Intel, Apple, Qualcomm, Huawei, LGE, ZTE, Xiaomi, vivo, H3C
* Benefit: Coverage

Q2: If some of the repetitions are invalid, it may result in different number of repetitions mapped to different SSBs, e.g. repK is configured as 4, SSB1 is associated with 4 repetitions while SSB2 is associated with 2 repetitions(2 other repetitions are invalid), do you think it will cause problems for the unequal number of repetitions associated with different SSBs?

* This is to associating with Samsung’s concern on unequal number of actual repetitions for each SSB
* No: Spreadtrum, Ericsson, Intel, Apple, Qualcomm, Huawei, LGE, ZTE, Xiaomi, vivo, H3C

In last meeting, Mr. Chairman has decided to check the situation of this issue in 1st check point, so instead of continuing the discussion in 2nd round, Moderator would summarize the situation and ask Mr.Chairman to make decision.

Huawei suggests to send an LS to RAN2 to ask them to make the decision.

Intel thinks we can try the compromised proposal, maybe we can use the following proposal as a starting point.

***Proposal #2.2a***:

* The K>1 repetitions are supported and considered as a bundle of transmission occasions that are mapped to the same SSB(s), when a consistent number of valid repetitions across different CG periods can be guaranteed for each associated SSB.

Do you agree with the above 2 suggestions? Any comments?

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| --- | --- |
| Company | Comment |
| Xiaomi | Fine with the proposal, but there may be sufficient number of valid repetitions during a CG period, which depends on the conclusion of ***Proposal #2.4.*** |
| HW, HiSi | The Proposal 2.2a comes back to the situation several meetings ago. Since RAN1 cannot reach consensus on repetition, we suggest to send LS to RAN2, tell them the discussion in RAN1, and ask them to make the decision. |
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### 2.2.3 Final round discussion

Now the most updated proposal is as below, please companies share your views on whether it can be acceptable or not, if not, based on Chairman’s guidance in last meeting, we may drop the discussion and conclude no repetition can be supported.

***Updated Proposal #2.2 from Intel:***

For CG-SDT, the repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s).

* The bundle of transmission occasions are invalid if any of these repetitions are invalid.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | Support. |
| Qualcomm | The invalidation rule appears too strong to us.  However, we can live with this proposal if that is the majority view in RAN1. |
| Apple | Same view as Qualcomm. |
| vivo3 | As we commented earlier in the email directly, it’s strange that we need to drop all repetitions when only part of the repetitions are dropped due to e.g. overlapping with DL symbols in TDD configuration or overlapping with SSB transmissions.  We’re fine to send an LS to RAN2 on the situation so that they can use their TU for online discussions. |
|  |  |

## Validation of PUSCH occasion

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

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| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. A CG PUSCH occasion is not valid if it overlaps with MsgA PUSCH occasion at least for CBRA. 2. Further discuss in RAN1 on whether CG-SDT in RRC inactive state is allowed on flexible symbols. 3. If CG-SDT is only allowed in uplink symbols, additional UE specific TDD uplink-downlink configuration should be supported in the RRC release message. 4. To support CG-SDT in flexible symbols, *enableConfiguredUL* can be configured in the RRC release message. 5. There is no need to define validation rules for CG PUSCH for paired spectrum for RedCap UEs operating in Type-A HD FDD mode. |
| R1-2110812 Huawei [2] | ***Proposal 3:*** *A CG PUSCH occasion is valid if it overlaps with MsgA PUSCH occasion.* |
| R1-2110973 vivo [3] | **Proposal 4: No need to define UL/DL pattern type of validation rule specific for paired spectrum for RedCap UEs. The collision handling mechanisms agreed in RedCap WI are reused for SDT for RedCap UEs.**  **Proposal 5: It is up to UE implementation to handle the overlapping between CG-PUSCH occasions for CG-SDT and any valid MsgA PUSCH occasion.** |
| R1-2111356 ZTE [5] | ***Proposal 3: It’s up to UE implementation to handle the overlapping between CG PUSCH occasions and MsgA PUSCH occasions.*** |
| R1-2111539 Xiaomi [8] | **Proposal 8: For the PUSCH occasion validation for HD-FDD Redcap UEs, reuse the same rules as ROs discussed in AI.8.6.1.3.**  **Proposal 9：For UEs with 2-step RACH feature, the CG-SDT POs are invalid if they are overlapping with msgA POs mapping to the preamble of valid ROs.** |
| R1-2111844 Apple [10] | **Proposal 2: No new validation rule is defined for CG PUSCH occasion. It’s up to gNB implementation to avoid the overlap between CG PUSCH occasion and MsgA PUSCH occasion.** |
| R1-2112189 Qualcomm [12] | ***If a UE is configured with both CG-SDT and 2-step RACH resources in RRC inactive state, it is not expected to handle overlap between CG-PUSCH occasions and msgA PUSCH occasions configured by higher layers.*** |

### 2.3.1 First round discussion

3 companies[1][3][8] think that there is no need to define validation rule for CG PUSCH for RedCap UEs. the collision handling mechanisms defined in RedCap WI can be reused.

As for the overlapping between CG PUSCH occasions and MsgA PUSCH occasions, 2 companies[1][8] think the CG PUSCH occasion is invalid if it overlaps with MsgA PUSCH occasions, while 5 companies[2][3][5][10][12] think that there is no need to define validation rule to handle the overlapping between CG PUSCH occasions and MsgA PUSCH occasions because they are all optional features.

Considering that majority companies prefer to not define additional validation rule other than already agreed, Moderator suggests to go with the following conclusion.

***Conclusion #2.3***

* No need to define validation rule for CG PUSCH for RedCap UEs.
* No need to define validation rule to handle overlapping between CG PUSCH occasions and MsgA PUSCH occasions.

Any comments?

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| --- | --- |
| Company | Comment |
| Samsung | Seems ok.  For second bullet, one question to ask, does 2step RACH is a mandated feature for supporting SDT? If not, then some UE may not even see the msgA PUSCH occasions. |
| Ericsson | Fine with the first bullet. However, it could be clarified that the proposal concerns RedCap UEs operating in HD-FDD Type A mode.  NOT fine with the second bullet. In our view, CG PUSCH occasion is not valid if it overlaps with MsgA PUSCH at least for CBRA of 2-step RA type. In our understanding, even if a CG-SDT UE doesn’t support 2-step RACH, it can know where the MsgA PUSCH occasions when it reads the configuration in SIB1. |
| Intel | Regarding validation rule for CG PUSCH for RedCap UEs, our understanding is that they can simply follow what was defined for FDD, i.e., when CG PUSCH overlaps with ROs, it is invalid. We are open to consider for SSB symbols to validate the CG PUSCH for RedCap UEs.  Regarding overlapping between CG PUSCH occasions and MsgA PUSCH occasion, we share similar view as Ericsson that CG PUSCH occasion is not valid if it overlaps with MsgA PUSCH. The design is similar to the MsgA PUSCH validation when colliding with ROs for 4-step and 2-step RACH. |
| Apple | Ok with the conclusions.  For the second bullet, SDT UE will not response any 2-step RACH related signalings if it doesn’t support 2-step RACH feature. |
| Qualcomm | The wording of the first bullet is a bit confusing to us. Does it actually mean R17 SDT will not define *RedCap-specific* validation rules for CG PUSCH occasions ? If so, we propose to revise it as:  *If a R17 RedCap UE supports CG-SDT, the RedCap UE is expected to re-use the CG PUSCH occasion validation rules specified for non-RedCap UE in both TDD and FDD.* |
| Huawei, HiSilicon | Fine with the conclusion |
| ZTE, Sanechips | Fine with the conclusion. |
| LG Electronics | Fine with the conclusion. |
| Xiaomi | Fine with the first bullet.  For the second bullet, we think at least for UEs with 2-step RACH feature, the CG PUSCH occasion is not valid if it is overlapping with Msg.A PUSCH occasions, in case of influencing other UEs’ RACH procedure. |
| vivo1 | Fine. |

### 2.3.2 Second round discussion

According to the comments, for the 1st bullet, some companies think the wording is a bit confusing, but the general ideas seems fine for everyone, so let’s try Qualcomm’s suggestion on the wording.

For the 2nd bullet, the situation is summarized as follows:

* No need to define validation rule to handle overlapping between CG PUSCH occasions and MsgA PUSCH occasions.
  + Supported by: Samsung, Apple, Qualcomm, Huawei, ZTE, vivo
  + Reason: SDT UE will not response any 2-step RACH related signalings if it doesn’t support 2-step RACH feature.
* CG PUSCH occasion is not valid if it overlaps with MsgA PUSCH occasions.
  + Supported by: Ericsson, Intel, Xiaomi(at least for UEs with 2-step RACH feature)
  + Reason: Even if a CG-SDT UE doesn’t support 2-step RACH, it can know where the MsgA PUSCH occasions when it reads the configuration in SIB1. The design is similar to the MsgA PUSCH validation when colliding with ROs for 4-step and 2-step RACH.

Going through these comments in 1st round, it seems one major controversial point is, if a SDT UE does not support 2-step RACH feature, will it know the MsgA PUSCH occasion?

***Conclusion #2.3***

* If a Rel-17 RedCap UE supports CG-SDT, the RedCap UE is expected to re-use the CG PUSCH occasion validation rules specified for non-RedCap UE in both TDD and FDD.
* It’s up to UE implementation to handle overlapping between CG PUSCH occasions and MsgA PUSCH occasions.

Companies are encouraged to check the reasons provided by each side and check which understanding is correct. Minor updates are made on the 2nd bullet, please check if it’s acceptable.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Although the proposal itself seems no difference from previous one, which is ok. but one of following is reason is not correct.   * + Reason: Even if a CG-SDT UE doesn’t support 2-step RACH, it can know where the MsgA PUSCH occasions when it reads the configuration in SIB1. The design is similar to the MsgA PUSCH validation when colliding with ROs for 4-step and 2-step RACH.   It is not similar, 4step RACH is a mandated feature, so any UE supporting 2step RACH will see the 4step RACH configuration; but 2step RACH is R16 optional feature, CG-SDT UE may or may not support, if it did not support, we cannot require a UE mandated to read it’s configuration.  So one note:   * 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. |
| Qualcomm | Fine with the conlcusions |
| Intel | It is not clear to us the first bullet. RedCap supports HD-FDD and we should clearly define the CG-PUSCH validation rule for HD-FDD.  For the second bullet, we do not think it is good for UE implementation to handle this. We still believe a clear behavior should be defined. If this cannot be acceptable, we suggest to make a conclusion:  “UE is not expected overlapping between CG PUSCH occasions and MsgA PUSCH occasions” |
| H3C | We are fine with 1st bullet.  For 2nd bullet, from our perspective, CG-SDT transmission shouldn’t affect RACH procedure related to 4-step and 2-step RACH. So we don’t support 2nd bullet. |
| Apple | **For the first bullet**, we can just re-use existing agreements as much as possible for HD-FDD UE. If companies would like to see details, the followings can be starting point for HD-FDD UE PO validation rules for CG-SDT.   * The following PUSCH occasion validation rule is applied for HD-FDD UE supporting CG-SDT   + ~~for unpaired spectrum and~~ for SS/PBCH blocks with indexes provided by ssb-PositionsInBurst in SIB1 or by ServingCellConfigCommon     - ~~if a UE is provided tdd-UL-DL-ConfigurationCommon,~~ the valid PO is the PO in UL part in a slot, or at least Ngap symbols after the end of the DL part in a slot or after the end of the SSB in a slot     - ~~if a UE is not provided tdd-UL-DL-ConfigurationCommon,~~ the valid PO does not precede a SS/PBCH block in the PUSCH slot, starts at least *Ngap* symbols after a last SS/PBCH block symbol     - *Ngap* is provided in Table 8.1-2 in TS 38.213   + A CG PUSCH occasion is not valid if it overlaps with any valid PRACH occasion   **Agreement**   * The following PUSCH occasion validation rule is applied for CG-SDT   + for unpaired spectrum and for SS/PBCH blocks with indexes provided by ssb-PositionsInBurst in SIB1 or by ServingCellConfigCommon     - if a UE is provided tdd-UL-DL-ConfigurationCommon, the valid PO is the PO in UL part in a slot, or at least Ngap symbols after the end of the DL part in a slot or after the end of the SSB in a slot     - if a UE is not provided tdd-UL-DL-ConfigurationCommon, the valid PO does not precede a SS/PBCH block in the PUSCH slot, starts at least *Ngap* symbols after a last SS/PBCH block symbol     - *Ngap* is provided in Table 8.1-2 in TS 38.213   **Agreement**  A CG PUSCH occasion is not valid if it overlaps with any valid PRACH occasion.  **For the second bullet,** we are ok with this conclusion and ok with Samsung’s note. Intel’s proposal is fine as well, the difference is Intel’s proposal puts restrictions on gNB scheduling to avoid the collision. |
| vivo2 | We’re generally fine with the FL proposal and the note updated by Samsung as a UE not supporting 2-step RACH will not be required to read the MsgA configurations configured in SIB1. |
| Xiaomi | We are fine with the 1st bullet.  For the 2nd bullet, we are fine with the version given by Intel. |
| HW, HiSi | Fine with Moderator’s conclusions |
| Ericsson | 1st bullet: Is this also applicable to HD-FDD Type A? That is, a RedCap UE operating in HD-FDD Type A mode reuse non-RedCap validation rules in FDD?  2nd bullet: Not OK with this bullet. Does the version from Intel imply that it is up to gNB configuration to avoid overlapping CG PUSCH occasions and MsgA PUSCH occasions? |

### 2.3.3 Final round discussion

For the 1st bullet, several companies think that if CG-SDT is supported by a RedCap UE, validation rule should be defined for HD-FDD, and Apple proposes a suggested text for starting point, let’s check if it’s agreeable.

For the 2nd bullet, at least 3 companies think that it can not be based on UE implementation to handle the overlapping, Intel proposes an alternative proposal to avoid such overlapping from gNB scheduling perspective, can we accept it?

***Proposal #2.3a from Apple***

The following PUSCH occasion validation rule is applied for HD-FDD UE supporting CG-SDT

* ~~for unpaired spectrum and~~ for SS/PBCH blocks with indexes provided by ssb-PositionsInBurst in SIB1 or by ServingCellConfigCommon
  + ~~if a UE is provided tdd-UL-DL-ConfigurationCommon,~~ the valid PO is the PO in UL part in a slot, or at least Ngap symbols after the end of the DL part in a slot or after the end of the SSB in a slot
  + ~~if a UE is not provided tdd-UL-DL-ConfigurationCommon,~~ the valid PO does not precede a SS/PBCH block in the PUSCH slot, starts at least *Ngap* symbols after a last SS/PBCH block symbol
    - *Ngap* is provided in Table 8.1-2 in TS 38.213
* A CG PUSCH occasion is not valid if it overlaps with any valid PRACH occasion

***Proposal #2.3b from Intel***

UE is not expected to be configured with a CG PUSCH occasion overlapping with valid MsgA PUSCH occasion.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine with both proposals. |
| HW, HiSi | Neither.  There were no clear reason given why it cannot be handled by UE implementation and why it affects each other. As we proposed in [2], first, the procedure of CG-SDT and RA-SDT are not overlapped, i.e. UE will not transmit CG PUSCH and MsgA PUSCH at the same time. Second, gNB can configure some CG PUSCH occasion overlapped with MsgA PUSCH occasion to save the resource. So we still prefer to the Conclusion #2.3.  ***Conclusion #2.3***  • It’s up to UE implementation to handle overlapping between CG PUSCH occasions and MsgA PUSCH occasions. |
| Xiaomi | Support. |
| Qualcomm | We support Proposal #2.3b.  For Proposal #2.3a, we can live with it. A simpler conclusion below is preferred, in the same spirit of the RAN1 agreements made for msgA PO of HD-FDD RedCap UE:  Alternative for Proposal #2.3a   * For a HD-FDD RedCap UE supporting CG-SDT, the PO validation rule defined for CG-SDT of a FD-FDD UE can be re-used.   So far, RAN1 has made the following agreements for R17 HD-FDD RedCap UE**:**  **RAN1#106b Agreement**   * The same validation rules of MsgA PUSCH occasions and RO/Preamble-to-PRU mapping rules for FDD can be reused for HD-FDD   **RAN1#107 Agreement**   * For MsgA PUSCH occasion overlapping with dynamic or semi-static DL reception, leave it to UE implementation to prioritize the DL reception or MsgA PUSCH transmission |
| Apple | We are fine with both proposals. |
| vivo3 | Neither.  We do not see the need to introduce new rules for HD-FDD compared to FD-FDD either, as pointed out by Qualcomm. And support the updated proposal #2.3a by Qualcomm:  Alternative for Proposal #2.3a  For a HD-FDD RedCap UE supporting CG-SDT, the PO validation rule defined for CG-SDT of a FD-FDD UE can be re-used. |

## Multiple CG occasions per CG period

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. Multiple CG PUSCH occasions in time and/or frequency domain can be configured per CG period for CG-SDT in RRC inactive state. 2. DMRS configuration can be independent from the configurations of multiple CG PUSCH occasions. |
| R1-2110973 vivo [3] | **Proposal 3: For CG-SDT, multiple TDMed and/or FDMed CG PUSCH occasions in one CG period can be configured.** |
| R1-2111356 ZTE [5] | ***Proposal 4: Multiple CG occasions per CG period is not supported.*** |
| R1-2111473 Intel [7] | **Proposal 2**   * *Multiple PUSCH occasions in a CG-PUSCH period are supported for a CG-PUSCH configuration.* |
| R1-2111539 Xiaomi [8] | **Proposal 3: Support multiple POs configured in a configured grant period.** |
| R1-2111711 Samsung [9] | ***Proposal 1: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.*** |

### 2.4.1 First round discussion

6 companies[1][3][5][7][8][9] have mentioned multiple CG PUSCH occasions per CG period, companies’ views are summarized as below:

* Option 1: Configure multiple TDMed and/or FDMed CG PUSCH occasions in one CG period, similar as multiple MsgA PUSCH occasions[1][3][7][8]
* Option 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.[9]
* Option 3: Multiple CG occasions per CG period is not supported[5]

***Proposal #2.4***

Down-select among the following options in RAN1#107e:

* Option 1: Configure multiple TDMed and/or FDMed CG PUSCH occasions in one CG period, similar as multiple MsgA PUSCH occasions.
* Option 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.
* Option 3: Multiple CG occasions per CG period is not supported.

Any preference on the above options?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Option 2 or 3; |
| Ericsson | Option 1 |
| Intel | We support Option 1.  In our view, multiple CG-PUSCH occasions in a CG-PUSCH period for a CG-PUSCH configuration can be helpful to reduce the latency for CG-SDT operation, especially when number of DMRS resources is relatively small. The design can simply reuse what was defined for MsgA PUSCH configuration |
| Apple | We don’t see strong motivation to support TDMed /FDMed CG PUSCH occasion. It will have large impacts on current CG configuration. We already agreed the SSB to CG PUSCH association period and association pattern period, there are enough space to mapping the SSB to CG-PUSCH resource.  Option 3 is preferred. |
| Qualcomm | Option 1 |
| HW, HiSi | Our understanding is Option 3 includes the case of multiple DMRSs and Option 1 require changes on the previous agreements about SSB index mapping with CG configuration, wherein only DMRS indexes, CG period indexes is considered.  So Option 3 is preferred. |
| ZTE, Sanechips | Option 3 |
| Xiaomi | Option 1. |
| vivo1 | Fine with FL proposal.  Option 1 is slightly preferred (compared to option 3) by us considering more POs may be needed when a smaller number of DMRS resources is configured. We can not see how option 1 reverts any earlier agreements made in RAN1 so far.  We do not think option 2 is necessary, repetition should be independent from SSB to CG PUSCH resource mapping and all repetitions should have same mapping as the first repetitions. In addition, multiple PUSCH resources and repetitions could be separate discussion. |

### 2.4.2 Second round discussion

Companies’ views are summarized as follows:

* Option 1: Configure multiple TDMed and/or FDMed CG PUSCH occasions in one CG period, similar as multiple MsgA PUSCH occasions.
  + Supported by: Ericsson, Intel, Qualcomm, vivo, Xiaomi
  + Reason: Reduce latency, the design can reuse MsgA PUSCH occasions
* Option 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.
  + Supported by: Samsung
* Option 3: Multiple CG occasions per CG period is not supported.
  + Supported by: Samsung, Apple, Huawei, ZTE
  + Reason: It may require to revisit agreed mapping order, DMRS index, the spec impact is quite large

Companies’ views are quite divergent, Moderator understands there is benefit to introduce multiple CG occasions per CG period, i.e. reduce the latency, however, the spec impact is quite large as some companies mentioned, and some agreements may need to be revisited as well, e.g. mapping order doesn’t consider the impact of multiple CG occasions. Considering this is the last RAN1 meeting, Moderator suggests we focus on Option 1 and Option 3, the proponents of Option1 could try to address the concern of Option 3, and further discuss in 2nd round discussion.

***Proposal #2.4***

Down-select among the following options in RAN1#107e:

* Option 1: Configure multiple TDMed and/or FDMed CG PUSCH occasions in one CG period, similar as multiple MsgA PUSCH occasions.
* Option 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.
* Option 3: Multiple CG occasions per CG period is not supported.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Option2 seems not interested.  We are ok with option3 |
| Qualcomm | OK to support Option 1 |
| Intel | We support Option 1. |
| H3C | We support Option 3. |
| Apple | We support Option 3. We don’t think reduce latency is the argument, the CG periodicity could be from 2symobl to 5120 slots, the periodicity granularity is not the issue. |
| vivo2 | Support option 1 which covers option 3 where gNB configures single PO per CG period which is a special case of option 1. |
| Xiaomi | We support option 1. |
| HW, HiSi | Support Option 3, but it should be clear the CG PUSCH with multiple DMRS is considered as one CG occasion, otherwise this option is conflict with the existing agreements on multiple DMRS.  *Option 3: Multiple CG occasions per CG period is not supported. The CG PUSCH with multiple DMRS is considered as one CG occasion.* |
| Ericsson | We support Option 1. We would also like to clarify whether this TDMed and/or FDMed CG PUSCH occasions are mapped to same or different SSB. |
| Moderator | @ Huawei I share same understanding with you, from the agreed mapping order, it can be inferred that in one CG period there is only one CG occasion with multiple DMRS.  @Ericsson Here whether the TDMed/FDMed CG PUSCH occasions are mapped to same or different SSBs depends on the mapping ratio, but at least these CG occasions are independently mapped to SSBs. |

### 2.4.3 Final round discussion

The situation is not changed, there are still 4 companies supporting Option 3 and 5 companies supporting Option 1. Given the situation, maybe the only we can do is to conclude that there is no consensus. Or companies want to discuss it further?

***Conclusion #2.4***

RAN1 cannot reach consensus on whether to support multiple CG occasions per CG period.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | Although we still prefer to support multiple CG occasions per CG period, given the remaining time, we are fine with the conclusion. |
| HW, HiSi | Conclusion #2.4 can be a compromise according to the situation. If we send this conclusion to RAN2, we still suggest to clearly tell them *the CG PUSCH with multiple DMRS is considered as one CG occasion* in LS, to avoid confusion . |
| Xiaomi | Fine with the conclusion for the progress of the meeting. |
| Qualcomm | We can live with the conclusion, if it is the majority view in RAN1. We are ok with the update of Huawei as above. |
| Apple | We are fine with this conclusion. Ok with HW’s proposal to RAN2 LS. |
| vivo3 | Fine with the conclusion, but it’s up to RAN2 to decide whether multiple CG PUSCH occasions per CG period should be supported or not. |

## Other mapping issues

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. 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. 2. 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. |
|  |  |
|  |  |

### 2.5.1 First round discussion

The following mapping related issues are summarized based on the submitted contributions:

Issue 2.5-1 UE specific TDRA table in RRC inactive state [1]

Issue 2.5-2 SSB determination based on overlapped PUSCH resource in multiple CG configuration [1]

These issues are resubmitted and proposed by single company, so moderator would suggest companies to provide views on these issues to identify which one is critical. Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | 1. One more issue to raise that the SSB-PUSCH association period determination, previously in RACH, since the RACH period is 10ms based, and SSB-RACH association is also 10ms based; but now the CG-PUSCH period has different value as well as symbol-level periodicity and candidate value set is dependent on the SCS. We think this issue should be resolved.  2. another one is similar to SSB-RACH, there should be a starting time for SSB-PUSCH association as well, e.g., SFN0 as in SSB-RACH association. |
| Ericsson | In our view, both issues are critical and needs to be addressed.  With regards to Issue 2.5-2, the details on what additional information from the UE can be provided to the gNB can be FFS or can be decided in RAN2. |
| HW, HiSi | We don’t see strong motivation to have extra efforts towards these issues (not meaning they are not issues while they seem to be able to be addressed automatically by reusing current mechanisms and gNB configuration). |
| vivo1 | For 2.5-1, RAN1 needs to conclude whether UE specific TDRA table is needed or not, if not whether legacy SIB1 configured TDRA table is used or not.  For issue 2.5-2, to avoid blind decoding of PUSCH configured by different CG configurations, it might be enough to require UE to transmit PUSCH configured by the first CG configuration in this case. |

### 2.5.2 Second round discussion

On Issue 2.5-1, 2 companies think it should be addressed, i.e. whether to configure UE-specific TDRA table. As for the TDRA configured in SIB1, Moderator thinks anyway it can be used is no UE specific TDRA table. So Moderator suggests to discuss the following proposal:

***Proposal #2.5-1***

UE specific TDRA table can be configured for CG-SDT.

There are 2 other issues raised by Samsung about the association period of CG-SDT:

Issue 2.5-3 Candidate value set of association period

Issue 2.5-4 Starting time of association period

On Issue 2.5-3, Ericsson also raises this issue in their contribution, Moderator’s initial consideration is to wait for RAN2’s reply on whether there is restriction on CG period, so that the association period can be determined accordingly. However, if companies are willing to discuss it, it’s fine to discuss the candidate value set based on the assumption that there is no restriction on the value set of CG period. I copied the table from Ericsson[1] below:

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} |

On Issue 2.5-4, Moderator thinks it makes sense and it’s natural to assume the starting time of association period is SFN0, so the following proposal is provided, companies are also encouraged to provide views on it.

***Proposal #2.5-4***

For CG-SDT, the starting time of association period is SFN0.

Any comments on Issue 2.5-3, 2.5-4 and Proposal 2.5-1, Proposal 2.5-4?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | For 2.5.1,  For 2.5.3, about the association period, we think the first thing we need to identify is, whether we should follow the PRACH using “ms” as the unit or not; since PRACH configuration period is 10ms-based; but CG-configuration period is symbol-based like following:  ***periodicity***  Periodicity for UL transmission without UL grant for type 1 and type 2 (see TS 38.321 [3], clause 5.8.2).  The following periodicities are supported depending on the configured subcarrier spacing [symbols]:  15 kHz: 2, 7, n\*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640}  30 kHz: 2, 7, n\*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 640, 1280}  60 kHz with normal CP 2, 7, n\*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560}  60 kHz with ECP: 2, 6, n\*12, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560}  120 kHz: 2, 7, n\*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1024, 1280, 2560, 5120} |
| Apple | Proposal 2.5-1: before we agree to introduce new TDRA table, any issue or restrictions are there if we reuse the default TDRA table? |
| vivo2 | 2.5-1: Seems fine considering more flexible TDRA for SDT.  2.5-3: Candidate value set seems fine but this depends on whether RAN2 will revise the candidate CG period values. Small CG periods (<5ms, the minimum SSB period) in legacy seems not useful for CG SDT. The maximum CG period is already agreed to be 640 which should be taken into account.  2.5-4: In current spec. SSB to RO association period starts from frame 0, which seems natural to be reused for the start time of SSB to CG PUSCH association period.   |  | | --- | | An association period, starting from frame 0, for mapping SS/PBCH block indexes to PRACH occasions is the smallest value in the set determined by the PRACH configuration period according Table 8.1-1 such that  SS/PBCH block indexes are mapped at least once to the PRACH occasions within the association period, where a UE obtains  from the value of *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*. | |
| Ericsson | Proposal #2.5-1: Fine  Issue 2.5-3 and Proposal 2.5-4: We prefer to discuss this after RAN2 agrees on the candidate CG period values. |
| Moderator | @Apple The default TDRA table may not be flexible considering the CG-SDT is UE specific. If UE specific TDRA table can be supported, it can be included in RRC release message. Of course it can work without it. |

### 2.5.3 Final round discussion

There is quite limited input on these proposals, Moderator suggests to continue the discussion on the following proposals. The candidate value set of association period can be decided after RAN2 gives some feedback.

***Proposal #2.5-1***

UE specific TDRA table can be configured for CG-SDT.

***Proposal #2.5-4***

For CG-SDT, the starting time of association period is SFN0.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | For proposal #2.5-1, it is not clear to us whether UE specific TDRA table is needed. In our view, default table should be flexible enough.  We are fine with Proposal #2.5-4. |
| Xiaomi | Fine with these two proposals. For proposal#2.5-1, the UE specific TDRA table can include one column of number of repetitions for CG-SDT transmission. |
| Qualcomm | FFS the necessity for Proposal #2.5-1  Fine with Proposal #2.5-4 |
| Apple | Fine with proposal 2.5-4. |
| vivo3 | Fine with both proposals. |

# SDT related procedures

## Beam related

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2111356 ZTE [5] | ***Proposal 6: Consider to report preferred DL beam by UCI included in PUSCH transmission to gNB.*** |
| R1-2111379 Sony [6] | **Proposal 1: After beam failure for the subsequent RA-SDT, a UE triggers RACH procedure for reporting the beam change to gNB.**  **Proposal 2: After a UE has transmitted a contention-based PRACH preamble, a UE monitors any DCI addressed to C-RNTI on the “new SSB” within a widow of time. If the UE receives a DCI addressed to C-RNTI on the common search space and common CORESET that are configured for SDT in the cell, then the UE assumes the beam change is successful.** |
| R1-2111473 Intel [7] | **Proposal 4**   * *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.* |
| R1-2111539 Xiaomi [8] | **Proposal 6: Don’t support any additional explicit or implicit way to report the beam change.** |
| R1-2111711 Samsung [9] | ***Observation 4: RA-SDT can already support DL beam change during RACH procedure.***  ***Proposal 7: UCI piggybacked in PUSCH can be supported to indicate the preferred DL beam (e.g., SSB index) for PUSCH after msg4 in RA-SDT and CG-SDT.***  ***Proposal 8: for RA-SDT, the UL tx beam for PUSCH after msg4/B could be same as that one for last msg3 transmission, or last PUCCH transmission.***  ***Proposal 9: for CG-SDT, the first UL transmission could be also up to UE implementation*** |
|  |  |
|  |  |
|  |  |

### 3.1.1 First round discussion

4 companies[5][6][8][9] has mentioned the beam change related issues, regarding whether and how to report the beam change to gNB, companies’ views are summarized as below:

* Option 1: Report preferred DL beam by UCI piggybacked in PUSCH for RA-SDT and CG-SDT.[5][9]
* Option 2: For subsequent RA-SDT, report beam change through RACH procedure.[6]
* Option 3: No need to report beam change to gNB.[8]

One company[7] mentions that the beam used for PUCCH transmission for CG-SDT should be same as last PUSCH transmission. Another company[9] thinks for RA-SDT, the UL tx beam for PUSCH after msg4/B could be same as that one for last msg3 transmission, or last PUCCH transmission.

***Discussion point #3.1***:

* Down-select among the following options on beam change during subsequent data transmission in RAN1#107e:
  + Option 1: Report preferred DL beam by UCI piggybacked in PUSCH for RA-SDT and CG-SDT.
  + Option 2: For subsequent RA-SDT, report beam change through RACH procedure.
  + Option 3: No need to report beam change to gNB.
* 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.
* For RA-SDT, the UL tx beam for PUSCH after msg4/B could be same as that one for last msg3 transmission, or last PUCCH transmission.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | For 2nd bullet, what is the CG-SDT PUSCH beam determination? It could be changed by UE automatically? |
| Spreadtrum | Option 3. As TA validation is per cell in some companies’ view, there should be none of beam operation in CG-SDT procedure. It is very strange that mobility-caused TA change is per cell, but mobility-caused location change is per beam. |
| Ericsson | 1st main bullet: OK. Our preference is Option 3. But open to further discuss.  2nd main bullet: In our understanding, this issue also depends on whether L1/L2/L3 ACK supported for CG-SDT PUSCH transmission. For example, there may be possibility to unform the UE of the new spatial relation for PUCCH in the PDSCH transmission associated with the ACK (or associated with other PDSCH transmissions). Therefore, this can be FFS.  3rd main bullet: The intention of this bullet is not clear to us. |
| Intel | We do not think beam report is needed. If there is an issue, UE may trigger CG-PUSCH transmission which corresponds to different SSB for uplink transmission, or even fall-back to RA-SDT and conventional RACH procedure for subsequent data transmission. We support Option 3.  We are fine with 2nd bullet.  We may need further discussion on 3rd bullet. |
| Qualcomm | For the first bullet, we are ok with Option 3 (No need to report beam change to gNB).  For the second bullet, we are wondering if there is a “last PUSCH” before the PUCCH. In other words, PUCCH transmission may happen before CG PUSCH transmission starts in the initial UL BWP. |
| Huawei, HiSilicon | Fine with the discussion point 3.1.  For the first main bullet, RAN2 has agreed that UE can initiate legacy RACH when no qualified SSB, so Option 1 may not be necessary and Option 2 is already supported.  For the second and third main bullet, we think these will help to improve the transmission performance and both of them should be supported. |
| ZTE, Sanechips | For the first bullet, we prefer Option 1 and can accept Option 3 if this is majority’s view. |
| LG Electronics | For the first bullet, we prefer Option 1 or Option 2. For Option 2, we also think that UE can initiate RACH when no qualified SSB. |
| Xiaomi | For the first bullet, we prefer Option 3.  For the second and third bullet, just as the Msg.3 uplink transmission beam is determined based on UE’s implementation, we think there is no need to specify the beams for the uplink transmission in inactive state. |
| vivo1 | No need to introduce beam report, subsequent SDT can be assumed to have same beam as the initial SDT considering the time gap between initial and subsequent SDT should be that large.  For the HARQ feedback on PUCCH in RRC inactive state for SDT, the beam should be assumed to be same as the last CG PUSCH transmission for SDT in our understanding.  For RA-SDT, following text in current spec. in section 9.2.1 of 38.213 seems enough when dedicated PUCCH resource is not provided:   |  | | --- | | The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in clause 8.3. | |
| Sony | For the first bullet, we are ok with Option 3. If solution is necessary we can accept Option 2. |
|  |  |

### 3.1.2 Second round discussion

For the 1st bullet, about the beam change report, companies’ views are summarized as:

* Option 1: Report preferred DL beam by UCI piggybacked in PUSCH for RA-SDT and CG-SDT.
  + Supported by: ZTE(1st preference), LGE
* Option 2: For subsequent RA-SDT, report beam change through RACH procedure.
  + Supported by: Sony(can accept), LGE
* Option 3: No need to report beam change to gNB.
  + Supported by: Spreadtrum, Ericsson, Intel, Qualcomm, Huawei, ZTE(2nd preference), vivo, Sony, Xiaomi

It seems Option 3 has obvious majority’s support, so Moderator suggests to go with Option 3 to move forward.

For the 2nd bullet, Ericsson mentioned that this may depend on whether L1/L2/L3 ACK is supported, if so, the new spatial filter may be informed to UE, Qualcomm has the concern that PUCCH transmission may happen before CG PUSCH transmission, Xiaomi thinks there is no need to specify the UL beams similar as Msg3. Given the split view, this may need further discussion.

For the 3rd bullet, Ericsson thinks the intention is not clear, Intel thinks it may need further discussion, vivo thinks the existing spec is enough. Moderator suggests the proponent company could clarify a bit on this bullet if they want to further discuss this issue.

***Conclusion #3.1***:

During subsequent data transmission, no need to report beam to gNB.

Any comments on Conclusion #3.1 and any suggestion on the 2nd and 3rd bullet?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Just trying to understand the consequence, so if the original beam becomes bad, and even there is a candidate beam to use, the UE still has to drop the transmission entirely? |
| Qualcomm | Ok with the conclusion. |
| Intel | We are fine with the conclusion.  For the original 2nd bullet, our understanding is that this is for HARQ-ACK response of subsequent DL transmission, which is already supported and existing mechanism is reused.  It is similar to what was defined for Tx beam for PUCCH carrying HARQ-ACK response for MsgB PDSCH, which follows Tx beam of last PUSCH in Section 8.2A in 213.   |  | | --- | | - the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission | |
| H3C | We are fine with this conclusion. |
| Apple | Fine with this conclusion |
| Moderator | @Samsung I think beam change may still happen, it only says no need to report the change to gNB, the required DL beam may rely on the association of SSB to CG PUSCH and SSB to PRACH. |
| vivo2 | Fine. |
| Xiaomi | We are fine with this conclusion. |
| HW, HiSi | With further review, this conclusion seems conflict with RAN2’s agreements that the new SSB can be selected and reported through RACH or CG during subsequent data transmission, which are as following:  [RAN2’s agreements]  36. During subsequent CG transmission phase (i.e. after the UE has received response from NW) UE can initiate at least legacy RACH procedure (e.g. trigger due to no UL resources). No MAC PDU rebuilding is required. FFS if the RA-SDT RA resources can be used for subsequent data.  a. At least the following conditions are agreed: (1) no qualified SSB when the evaluation is performed; (2) when TA is invalid; (3) when SR is triggered due to lack of UL resource  40. During the subsequent new CG transmission phase, for the purpose of CG resource selection, UE re-evaluates the SSB for subsequent CG transmission. FFS what happens if no SSBs are valid or if no sample is available |
| Ericsson | Fine with the conclusion. |

### 3.1.3 Final round discussion

Most companies agree with this conclusion, as for Huawei’s concern, the question is similar as Samsung’s, Moderator’s understanding is, this conclusion means no need to explicitly report the beam change, e.g. through the UCI, it’s not intended to revert RAN2 agreement. UE could still re-evaluate SSB for subsequent CG transmission, and the corresponding SSB can be obtained by gNB though implicit mapping between SSB and CG PUSCH/PRACH. To avoid confusion, can we consider the following conclusion?

***Conclusion #3.1***:

During subsequent data transmission, no need to explicitly report beam to gNB.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine with the conclusion. |
| HW, HiSi | Fine with Moderator’s understanding, suggest to add a sub-bullet to clarify this issue.  ***Updated Conclusion #3.1***:  During subsequent data transmission, no need to explicitly report beam to gNB.   * The selected new SSB can be obtained by gNB though implicit mapping between SSB and CG PUSCH/PRACH |
| Xiaomi | We are fine with the conclusion and Huawei’s version is also OK. |
| Qualcomm | Support the conclusion |
| Apple | OK with this conclusion |
| vivo3 | Fine.  The update from Huawei seems not necessary and it should also be noted that for subsequent SDT on DG PUSCH, there’s no SSB associated, it can be up to UE to use which beam. |

## Power control

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. If the SSB beam selected for CG-SDT PUSCH resource selection is changed, the TPC accumulation for the power control of CG PUSCH should be suspended. 2. RAN1 to discuss whether TPC command can be received in DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI for CG-SDT in inactive state. 3. RAN1 to discuss the UE-specific power control parameters for CG-SDT in RRC inactive state. |
| R1-2111356 ZTE [5] | ***Proposal 10: Align the understanding of RAN1 and RAN2 on power control parameters for RA-SDT.***  ***Proposal 11: Reuse power control mechanism in PUR, i.e. P0 and alpha should be configured for CG-SDT.*** |
|  |  |

### First round discussion

2 companies[1][5] propose to discuss UE specific power control parameters for CG-SDT, one company[5] thinks power control mechanism in PUR can be reused for CG-SDT, i.e. P0 and alpha. The reason is that, in inactive state, the existing power control parameter in CG configuration cannot be obtained. One company[1] considers the TPC accumulation for the power control of CG PUSCH should be suspended if SSB beam is changed. This company also suggests RAN1 to discuss whether TPC command can be received in DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI for CG-SDT in inactive state.

|  |
| --- |
| Agreement from RAN1:   * For RA-SDT in shared ROs and separate ROs with non-SDT, the power control parameters follow those for non-SDT,   - i.e. preambleReceivedTargetPower and power ramping setting follow those for non-SDT.  Agreement from RAN2  At least the following parameters can be RA-SDT specific.   * SSB selection related parameters, i.e., rsrp-ThresholdSSB, msgA-RSRP-ThresholdSSB. * Power control related parameters, i.e., preambleReceivedTargetPower/gA-PreambleReceivedTargetPower, powerRampingStep/msgA-PreamblePowerRampingStep, msg3-DeltaPreamble/msgA-DeltaPreamble. |

Another issue mentioned by [5] is that, RAN1 and RAN2’s agreements on power control parameters for RA-SDT is controversial, the understanding of RAN1 and RAN2 may need to be aligned.

***Discussion point #3.2***

* Reuse power control mechanism in PUR, i.e. P0 and alpha should be configured for CG-SDT.
* If the SSB beam selected for CG-SDT PUSCH resource selection is changed, the TPC accumulation for the power control of CG PUSCH should be suspended.
* Whether TPC command can be received in DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI for CG-SDT in inactive state.
* Down-select among the following options on power control parameters for RA-SDT:
  + Option 1: For RA-SDT, confirm RAN2’s agreement that the power control parameters can be RA-SDT specific.
  + Option 2: For RA-SDT, the power control parameters should follow that for non-SDT and ask RAN2 to revert their agreements.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | For 1st bullet, what is exactly power control mechanism in PUR?  For 2nd bullet, what is legacy behavior in current spec if beam changed during CG-PUSCH in RRC connected mode?  For 3rd bullet, may not be needed, open to discuss.  For 4th bullet, RAN2 agreement is fine. |
| Ericsson | * 1st main bullet: OK. In our understanding, PUR also supports open-loop power control mechanism. However, CG-SDT should support closed-loop power control mechanism. The FL could clarify this aspect to avoid misunderstanding. * 2nd main bullet: OK * 3rd main bullet: We don’t see a strong reason to support DCI format 2\_2 in inactive state * 4th main bullet: Option 1 |
| Intel | 1. What is PUR? Or it is intended for SDT?  2. is this simply to follow legacy behavior?  3. we do not see the need.  4. We support Option 1. |
| Apple | First bullet, we are open to discuss it, as there is subsequent transmission, the closed loop power control could be helpful.  Second bullet, this seems related to the third bullet, the TPC command accumulation need to support group common power control.  Third bullet, according to our understanding, small data transmission is infrequent transmissions in short time, no need to support group common power control.  Fourth bullet, Option1 is ok. |
| Qualcomm | Agree with the comments of Ericsson. |
| Huawei, HiSilicon | On the third bullet, whether DCI format 2\_2 should be detected in RRC\_INACTIVE is not clear, we do not see strong motivation to send TPC command through DCI format 2\_2.  On the fourth bullet, prefer Option 1 to confirm RAN2’s agreement. |
| ZTE, Sanechips | 1st bullet, this proposal is simply to say we may need to introduce P0 and alpha, if companies have concern on PUR mechanism, it can be removed. As for the existing power control parameter P0-PUSCH-AlphaSetId, it may not be used if UE specific power control is not configured.  2nd bullet, we thinks it’s not the legacy behavior, it would be better if proponent could clarify.  3rd bullet, we share similar view as Ericsson.  4th bullet, Option 1. |
| Xiaomi | 2nd bullet: OK  4th bullet: Option 1. |
| vivo1 | 1st bullet, it seems fine since this is the CG SDT in RRC inactive state.  2nd bullet, OK.  3rd bullet, group common TPC command may be not needed for SDT.  4th bullet, this depends on whether separate ROs or separate preambles in shared RO are used for differentiating SDT RA and non-SDT RA.  For shared RO, option 2 should be supported considering potential impact to legacy RA performance when different power control parameters are configured for different preambles in one RO; for separate RO, option 1 can be supported to allow more flexible power control configurations for SDT RA and non-SDT RA. |

### 3.2.2 Second round discussion

For the 1st bullet, some companies have concern on the exact PUR mechanism, the proponent has explained that this is to introduce P0 and alpha for CG-SDT, the existing parameter P0-PUSCH-AlphaSetId may not be obtained in inactive state. So it may need to be clarified that the existing closed loop power control mechanism can be used for CG-SDT.

For the 2nd bullet, some companies have the concern that whether it’s the legacy behavior in connected state. From Moderator’s understanding, beam change may not cause the TPC accumulation suspended. It would be better if proponent company could explain a bit if they still want to support it.

For the 3rd bullet, all companies think DCI 2\_2 may not need to be detected in inactive state.

For the 4th bullet, most companies agree with Option 1, i.e. confirm RAN2’s agreement that the power control parameters can be RA-SDT specific. But vivo has raised a very good issue that it may depend on separate ROs or shared ROs. For shared ROs, SDT UEs and non-SDT UEs are using different preambles on the same RO, it seems natural to use same power control parameters for SDT and non-SDT UEs.

|  |
| --- |
| Agreements in RAN1#98:  For shared ROs with 4-step RACH and 2-step RACH,   * The *powerRampingStep* and *preambleReceivedTargetPower* for 2-step RACH are indicated by those for the 4-step RACH. |

After checking previous agreements in 2 step RACH, it seems for shared ROs, the power control parameters also follow that for 4-step RACH, so I guess we may follow this criteria of 2-step RACH as vivo suggested.

***Proposal #3.2:***

* UE specific power control parameters P0 and alpha should be configured initial UL transmission for CG-SDT
  + Existing closed loop power control mechanism can be reused for re-transmission and subsequent data transmission.
* For RA-SDT power control parameters preambleReceivedTargetPower and powerRampingStep:
  + For separate ROs, the power control parameters can be RA-SDT specific
  + For shared ROs, the power control parameters follow those for non-SDT

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Fine. |
| Qualcomm | Support the FL proposal |
| Intel | We are fine with the proposal. |
| H3C | We support FL proposal. |
| Apple | Fine with this Proposal |
| vivo2 | Fine. |
| Xiaomi | We are fine with the proposal. |
| HW, HiSi | Fine |
| Ericsson | We are OK to support the proposal. However, can the FL please clarify the following:   * What happens for next CG period, i.e., is TPC from the previous CG period (if there is no beam change) still valid for the “initial” transmission in the next CG period? * What is the need for the power control parameters to be RA-SDT specific? |
| Moderator | @Ericsson Thanks for the questions.  Q1: I guess Ericsson may refer to the TPC behavior for 1st triggered CG-SDT and 2nd triggered CG-SDT. During the 1st CG-SDT, it first includes initial transmission, after that, there might be subsequent transmission or re-transmission, and UE will receive TPC from gNB and perform TPC accumulation during that. Then after UE finishes the 1st CG-SDT transmission, my understanding the TPC accumulation should be reset, and during the initial transmission of 2nd CG-SDT, UE will use P0 and alpha and no TPC can be referred to, and during the subsequent transmission and re-transmission, UE will receive a new TPC for closed loop power control. That is my understanding.  Q2: The main reason that RAN2 wants RA-SDT specific power control is that, the TB size for SDT may not be the same as msg3/msgA PUSCH for normal RACH procedure, so the required power may be different. |

### 3.2.3 Final round discussion

It seems all companies agree with this proposal #3.2, so Moderator will ask for email approval.

Any comments?

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| --- | --- |
| Company | Comment |
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|  |  |

## SDT for RedCap UE

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2112044 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: Clarify whether RedCap UE can support RA-SDT in Rel-17.***  ***Proposal 2: Discuss whether RA-SDT can be supported in a separate initial UL BWP for RedCap UEs.***  ***Proposal 3: Clarify whether RedCap UE can support CG-SDT in Rel-17.***  ***Proposal 4: Discuss whether CG-SDT can be supported in a separate initial UL BWP for RedCap UEs.*** |
| R1-2112189 Qualcomm [12] | ***Both RA-SDT and CG-SDT are supported by Rel-17 RedCap UEs***   * ***The RA-SDT and CG-SDT resources of a RedCap UE are configured in the initial UL BWP of the RedCap UEs*** * ***For a cell that supports SDT of RedCap UEs, the specification impacts of paging reception, UE power saving and S777DT can be minimized, if SSB and CORESET/CSS for paging and SDT are configured in the initial DL BWP of RedCap UE.*** * ***For both RA-SDT and CG-SDT, intra-slot frequency hopping of PUCCH can be enabled/disabled for RedCap UEs by SIB.*** |
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### 3.3.1 First round discussion

2 companies[11][12] would like to discuss whether CG-SDT and RA-SDT can be supported for RedCap UEs, if so, another issue is whether SDT can be configured on separate initial BWP configured for RedCap UEs and whether intra-slot frequency hopping of PUCCH can be enabled/disabled for RedCap UEs by SIB.

***Discussion point #3.3***:

* Whether RA-SDT and CG-SDT can be supported for RedCap UEs.
  + Whether RA-SDT and CG-SDT can be configured on separate initial BWP configured for RedCap UEs.
  + Whether intra-slot frequency hopping of PUCCH can be enabled/disabled for RedCap UEs by SIB.

Moderator would like to ask companies whether this joint discussion on SDT and RedCap should be discussed here, if so, companies are encouraged to provide comments on the following discussion point.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | We tends to design the SDT without considering specific optimization for Redcap, if need, they can adjust their Redcap feature for this. |
| Spreadtrum | SDT CSS for the separate initial BWP was mentioned in RedCap discussion. RA-SDT and CD-SDT should be supported by the separate initial BWP for RedCap UEs. |
| Ericsson | 1st sub-bullet: OK for RA-SDT. Wait for progress in the RedCap WI for CG-SDT.  2nd sub-bullet: OK |
| Intel | We are fine with the main bullet.  For the sub-bullets, we suggest to defer the discussions once all the details are clear for the support of separate initial BWP and frequency hopping for PUCCH in RedCap, in order to avoid duplicated discussions. |
| Apple | This is the last meeting for Rel-17. Before answer the question, we need to know how many aspects need to be considered for support RedCap UE, how much the specification impacts. After that, decision can be made. |
| Qualcomm | We think RA-SDT and CG-SDT can be supported for RedCap UE as optional UE features. The details of initial BWP configurations and intra-slot PUCCH FH can be discussed later. |
| Huawei, HiSi | We think the discussion is not needed - can be part of UE feature discussion. |
| ZTE, Sanechips | We think SDT can be supported for RedCap UE if no specific changes is needed for SDT. |
| LG Electronics | 1st sub-bullet: If gNB configures a separate initial BWP configured for RedCap UEs by SIB for a cell, RA-SDT and CG-SDT can be configured on separate initial BWP configured for RedCap UEs for the cell, e.g. depending on UE capability.  In this case, RedCap UEs may not support the legacy initial BWP at the cell. If so, RedCap UEs would not expect configuring/using RA-SDT and CG-SDT on the legacy initial BWP, if any, for the cell.  2nd sub-bullet: OK |
| Xiaomi | Share the same view as Intel and fine with the main bullet. |
| vivo1 | For the main bullet, we think RA-SDT and CG-SDT can be optionally supported for RedCap UEs, it can be discussed in UE feature agenda.  For the two sub-bullets, those can be discussed later depending on the progress in RedCap WI. |

### 3.3.2 Second round discussion

This joint discussion may be better to be discussed in UE feature discussion, however, SDT UE features will not be discussed in RAN1, so Moderator is not sure whether this can be discussed there. According to the companies’ comments, for the main bullet, it seems companies are fine with it if no specific optimization for RedCap is needed, and the sub-bullets can be discussed further after relevant discussion in RedCap session is finished. So Moderators suggests the following proposal:

***Proposal #3.3***:

* RA-SDT and CG-SDT can be supported for RedCap UEs if no specific optimization for RedCap is needed.
  + FFS whether RA-SDT and CG-SDT can be configured on separate initial BWP configured for RedCap UEs.
  + FFS whether intra-slot frequency hopping of PUCCH can be enabled/disabled for RedCap UEs by SIB.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | We suggest one conclusion in our SDT agenda saying:  *Conclusion:*  *RA-SDT and CG-SDT can be supported for RedCap UEs without considering specific optimization for Redcap.*  With this, if Redcap discussion want to reuse our any agreement and design, it’s up to them. |
| Moderator | @All Companies are also encouraged to check if Samsung’s conclusion is OK. |
| Qualcomm | To exclude unnecessary optimization and spec impacts of R17 SDT, we suggest the following changes for the FL proposals:  **RA-SDT and CG-SDT can be supported for R17 RedCap UEs as optional features, when the initial DL/UL BWP of RedCap UE is used for SDT.**   * **A RedCap UE is expected to re-use the procedures specified for non-RedCap UE in R17 SDT without further optimization, to minimize the spec impacts of R17 SDT.** |
| Intel | We are fine with the update from Samsung. |
| H3C | We are fine with QC’s modification in order to avoid introducing unnecessary optimization and spec impacts of R17 SDT for R17 RedCap UEs. |
| Apple | Fine with Samsung’s update. |
| Moderator | From my perspective, Samsung and Qualcomm’s modification have the same intention, as for the use of initial BWP of RedCap UE, it can be discussed later. So Let’s check whether we can agree on the following conclusion:  ***Conclusion #3.3:***  RA-SDT and CG-SDT can be supported for RedCap UEs without considering specific optimization for Redcap. |
| vivo2 | Regarding QC’s proposal, we have one question for clarification. Does “**the initial DL/UL BWP of RedCap UE**” mean the initial BWP shared with legacy non-RedCap UEs? Or is it the “separate initial BWP specific for RedCap UE”?  As we know SDT is mainly intended for power saving and signaling overhead reduction, if we support SDT in separate RedCap specific initial BWP, UE may need to retune the RF to the initial BWP for non-RedCap UEs so as to monitor the SSBs, paging and SDT related PDCCH associated with CORESET0 which will cause more power consumption. Thus, SDT in the separate RedCap specific initial BWP may be not useful.  According to above and to leave it open for RedCap group to further discuss SDT in the separate initial BWP specific for RedCap UEs, we propose following update:   |  | | --- | | ***Proposal #3.3***:   * RA-SDT and CG-SDT can be supported for RedCap UEs ~~if no specific optimization for RedCap is needed.~~ at least when RedCap UE share both the initial DL BWP and initial UL BWP with non-RedCap UEs.   + FFS whether RA-SDT and CG-SDT can be configured on separate initial BWP configured for RedCap UEs.   + FFS whether intra-slot frequency hopping of PUCCH can be enabled/disabled for RedCap UEs by SIB. | |
| Xiaomi | We are fine with the update from QC. |
| Nokia, NSB | Support the Samsung conclusion. Obviously the SDT is optional feature, for any UE type, including RedCap. There is no need to go overboard and start to go to the level Qualcomm is suggesting.  It is also OK not to do anything, as that will lead to the same outcome |
| HW, HiSi | Fine with Moderator’s update |
| Ericsson | The wording “if no specific optimization for RedCap is needed” is unclear. We support Vivo’s update to Proposal #3.3. |

### 3.3.3 Final round discussion

Moderator thinks the insight of this proposal or conclusion is to support SDT for RedCap without follow-up effort in SDT agenda, and all the details can be discussed later. It seems Samsung’s conclusion can clearly reflect what we want, i.e. no optimization from SDT’s perspective, so can we agree on the following conclusion?

***Conclusion #3.3:***

RA-SDT and CG-SDT can be supported for RedCap UEs without considering specific optimization for Redcap.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine with the conclusion. |
| HW, HiSi | Fine with the conclusion. |
| Xiaomi | Fine with the conclusion. |
| Qualcomm | OK |
| Apple | Fine with the conclusion. |
| vivo3 | As we commented earlier, we’re not sure whether SDT can be supported when separate BWP is used for a RedCap UE. So we propose the update below and fine to FFS other cases later which can be up to RedCap discussions as well:  ***Conclusion #3.3:***  RA-SDT and CG-SDT can be supported for RedCap UEs without considering specific optimization for Redcap, at least when RedCap UE share both the initial DL BWP and initial UL BWP with non-RedCap UEs. |

## Search space

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2111356 ZTE [5] | ***Proposal 8: Separate common search space for RA-SDT can also be used for CG-SDT.*** |
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### 3.4.1 First round discussion

1 company[5] has noticed that in last meeting RAN1 has confirmed RAN2 working assumption that USS can be configured for CG-SDT, and it does not exclude CSS for CG-SDT. But it’s not clear which type of CSS can be used for CG-SDT, so this company suggests that the separate common search space defined for RA-SDT can also be used for CG-SDT.

***Discussion point #3.4***:

* Separate common search space for RA-SDT can also be used for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | Fine |
| Intel | It is good to clarify what is the separate common search space for RA-SDT? Is this a new type CSS or existing type? |
| Qualcomm | We are ok with the proposal, if both RA-SDT and CG-SDT share the SSB/CORESET/CSS configurations of initial DL BWP. |
| HW, HiSi | Agree with Intel |
| ZTE, Sanechips | Fine with the proposal. We think the separate common search space for RA-SDT means a new type of CSS, that is what “separate” means, and it has already been agreed in RAN2. For CG-SDT, it’s natural to use the CSS defined for RA-SDT rather than existing CSS for other uses. |
| Xiaomi | Fine. |
| vivo1 | Fine with the intention of the proposal.  However, it would be also good to clarify whether such CSS could be the SS0, RA search space, RA search space for RA SDT etc., as configured in PDCCH-configCommon:   |  | | --- | | PDCCH-ConfigCommon ::= SEQUENCE {  controlResourceSetZero ControlResourceSetZero OPTIONAL, -- Cond InitialBWP-Only  commonControlResourceSet ControlResourceSet OPTIONAL, -- Need R  searchSpaceZero SearchSpaceZero OPTIONAL, -- Cond InitialBWP-Only  commonSearchSpaceList SEQUENCE (SIZE(1..4)) OF SearchSpace OPTIONAL, -- Need R  searchSpaceSIB1 SearchSpaceId OPTIONAL, -- Need S  searchSpaceOtherSystemInformation SearchSpaceId OPTIONAL, -- Need S  pagingSearchSpace SearchSpaceId OPTIONAL, -- Need S  ra-SearchSpace SearchSpaceId OPTIONAL, -- Need S | |

### 3.4.2 Second round discussion

Moderator understands separate common search space means a new CSS type, e.g. Type4-PDCCH CSS set in addition to the existing CSS as defined in TS38.213 below, it is RA-SDT specific CSS, now what we are discussing about is whether this RA-SDT specific CSS can be used for CG-SDT. If not, we may need to discuss which one of other CSS can be used for CG-SDT.

*A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets*

*- a Type0-PDCCH CSS* set *configured by pdcch-ConfigSIB1 in MIB or by searchSpaceSIB1 in PDCCH-ConfigCommon or by searchSpaceZero in PDCCH-ConfigCommon for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG*

*- a Type0A-PDCCH CSS set configured by searchSpaceOtherSystemInformation in PDCCH-ConfigCommon for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG*

*- a Type1-PDCCH CSS set configured by ra-SearchSpace in PDCCH-ConfigCommon for a DCI format with CRC scrambled by a RA-RNTI, a MsgB-RNTI, or a TC-RNTI on the primary cell*

*- a Type2-PDCCH CSS set configured by pagingSearchSpace in PDCCH-ConfigCommon for a DCI format with CRC scrambled by a P-RNTI on the primary cell of the MCG*

*- a Type3-PDCCH CSS set configured by SearchSpace in PDCCH-Config with searchSpaceType = common for DCI formats with CRC scrambled by INT-RNTI, SFI-RNTI, TPC-PUSCH-RNTI, TPC-PUCCH-RNTI, TPC-SRS-RNTI, or CI-RNTI and, only for the primary cell, C-RNTI, MCS-C-RNTI, CS-RNTI(s), or PS-RNTI and*

*- a USS set configured by SearchSpace in PDCCH-Config with searchSpaceType = ue-Specific for DCI formats with CRC scrambled by C-RNTI, MCS-C-RNTI, SP-CSI-RNTI, CS-RNTI(s), SL-RNTI, SL-CS-RNTI, or SL Semi-Persistent Scheduling V-RNTI.*

The previous agreement on separate common search space of RA-SDT from RAN2 is copied below, anyway we have a separate CSS for RA-SDT already.

|  |
| --- |
| **Agreement:**   1. The separate search space is common to the UEs performing RA-SDT. Inform RAN1 of this agreement |

As for the question from vivo, Moderator understands if we can agree on the following, in PDCCH-ConfigCommon, there would be a new parameter such as sdt-SearchSpace that can be used by CG-SDT and RA-SDT. If not, the new parameter can only be used by RA-SDT, and we can further discuss which CSS can be used by CG-SDT.

***Proposal #3.4***:

* Separate common search space for RA-SDT can also be used for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Ok to support, if both RA-SDT and CG-SDT use the initial DL BWP for SDT. Otherwise, the proposal is problematic. For clarity, suggest to revise the FL proposal as below:  ***Separate common search space configured for RA-SDT within the initial DL BWP can also be used for CG-SDT.*** |
| Intel | We are fine with the proposal, but our understanding is that existing CSS type, e.g., Type3-CSS can be reused for RA-SDT/CG-SDT. Otherwise there could be significant spec change. We suggest to leave this to editor. |
| H3C | We want to clarify which purpose for supporting separate common search space configured for RA-SDT. |
| Moderator | @ Intel @H3C  Honestly, the separate search space for RA-SDT is discussed and agreed in the first RAN1 meeting for SDT, the relevant agreement is copied below. RAN1 is only not sure whether it should be CSS or USS, and after confirmation from RAN2, it should be clear that for RA-SDT, we will have a new CSS type that is different from the existing CSS. Now this proposal is just to say whether the new CSS can be used by CG-SDT as well, if not, we need to consider which one of these existing CSS types can be used by CG-SDT. Hope this clarifies the situation.  Agreement:   * From RAN1 perspective, at least a separate SearchSpace that is different from the existing common SearchSpace should be supported for monitoring the PDCCH addressed to the C-RNTI after successful completion of the RACH procedure during RA-SDT   + It is up to RAN2 decision if the separate SearchSpace is UE-specific or common to the UEs performing RA-SDT * If the separate SearchSpace is not configured, type-1 PDCCH CSS can be reused. * FFS UE-specific CORESET or common CORESET   @All I think Qualcomm’s revision is reasonable, please check if it’s OK  ***Updated Proposal #3.4***:  Separate common search space configured for RA-SDT within the initial DL BWP can also be used for CG-SDT. |
| vivo2 | We’re generally fine with the proposal.  In our understanding, the separate common SS for RA-SDT may be optional, and the RA-SDT itself may also be optional meaning that only CG-SDT may be configured. In both cases the CSS specific for RA SDT may be not configured and the legacy CSS may have to be used. It would be good if companies can share the understandings on this as well. |
| HW, HiSi | Fine with Moderator ’s updated proposal |
| Ericsson | It would be good to have clarification on the following question (similar to the question from Vivo):   * Would the separate CSS be always the same for RA-SDT and CG-SDT, i.e., can non-overlapping CSS be configured for RA-SDT and CG-SDT? * If RA-SDT is not configured (but only CG-SDT), can CG-SDT be configured with the “Separate common search space”? |

### 3.4.3 Final round discussion

The intention of this proposal seems acceptable to companies, vivo and Ericsson have raised good questions, from Moderator’s understanding, if RA-SDT is not configured, CG-SDT can also be configured with the “Separate common search space”, and the CSS would be the same for both RA-SDT and CG-SDT if both of them are configured, so the current wording may need some revision like the following:

***Updated Proposal #3.4***:

Separate common search space that can be configured for RA-SDT within the initial DL BWP can also be used for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine with the proposal in principle.  As mentioned earlier, this does not mean a new type of CSS for RA-SDT. Also, it would be good to clarify this is a CSS for RA-SDT. |
| HW, HiSi | Fine with the updated proposal |
| Xiaomi | Fine. |
| Qualcomm | Support |
| vivo3 | We would like to understand why UE needs to do PDCCH monitoring in so many SSs for CG-SDT, which seems not aligned with the intention of SDT feature for saving power.  According to FL clarification, this separate common search space is a common search space configured for SDT which can be RA-SDT and/or CG-SDT. So, for CG-SDT, there will be then 2 **separate** search spaces (1 CSS, 1 USS) additionally configured. Will the C-RNTI (for potential subsequent CG SDT) be also monitored in RA search space (C-RNTI monitoring is supported in legacy) during CG SDT？if yes, then UE needs to monitor, RA CSS, separate CSS, separate USS, CSS for paging monitoring, SS0 for system information reception.  If all other companies think UE needs so many SSs for simple CG SDT, we can also live with this proposal. |

# Other physical layer issues

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| R1-2110774 Ericsson [1] | 1. SSB subset for RSRP based TA validation is within a set of SSBs per CG PUSCH configuration. 2. RSRP change can calculated as the difference between RSRP calculated at the time instant when the UE receives the latest TAC from the network and the RSRP calculated at the time instant when UE determines TA validation for CG-SDT. 3. 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. 4. The TA based on the latest UL transmissions in the RRC connected state should be provided in the RRC release message as the initial TA to be used for CG PUSCH transmission in RRC inactive state. 5. The TA for CG-SDT should be relative to the subcarrier spacing of the initial UL BWP for CG-SDT. 6. 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. |
| R1-2111083 Spreadtrum [4] | ***Proposal 1: The SSB subset for RSRP based TA validation is determined at least based on a configured absolute RSRP threshold, where the subset of SSBs is a set of SSBs configured per CG configuration.*** |
| R1-2111356 ZTE [5] | ***Proposal 7: From RAN1’s perspective, if CG-SDT is supported for unlicensed band, the solutions for mapping can be reused for unlicensed band CG-SDT, and the CG configuration in unlicensed band can also be reused for unlicensed band CG-SDT.***  ***Proposal 9: The following options can be considered for configuration of CG-SDT:***   * ***Option 1: Reuse existing BWP dedicated configuration (i.e. BWP-DownlinkDedicated and BWP-UplinkDedicated) for CG-SDT and clarify in RAN1 which parameters (e.g. pucch-Config, beamFailureRecoveryConfig) are applicable to CONNECTED mode only and should be ignored in CG-SDT operation.*** * ***Option 2: Define/use a new BWP dedicated (i.e. BWP-DownlinkDedicatedSDT and BWP-UplinkDedicatedSDT )configuration for SDT instead of the legacy one. RAN1 needs to identify the parameter list for the new SDT specific BWP dedicated configuration, and ask RAN2 to formulate the details of the IE structure.***   ***Proposal 12: srs-ResourceIndicator in ConfiguredGrantConfig is not applicable to CG-SDT.*** |
| R1-2111539 Xiaomi [8] | **Proposal 2: Support FDM between the different ROs.**  **Proposal 5: Do NOT support configuring CG-SDT resource on separate SDT BWP**  **Proposal 7: Don’t support any additional explicit L1 feedback signaling for CG-SDT.** |
| R1-2111711 Samsung [9] | ***Proposal 4: a PRACH mask index is supported for subset RO sharing for SDT purpose.***  ***Proposal 5: a RA Type (***4step RA, 2step RA,4step RA-SDT***) is supported to be indicated for subset RO sharing for SDT purpose.***  ***Proposal 6: only number of preamble for SDT in one RO for a SSB is necessary to be indicated. These preambles are counting from the end of the total preambles for one SSB in one RO.*** |
| R1-2112189 Qualcomm [12] | ***For an inactive UE performing CG-SDT or RA-SDT, the initial DL BWP is configured with at least SSB, CORESET/CSS for paging and SDT.***  ***In RA-SDT or CG-SDT, PUCCH can be transmitted by an inactive UE with valid TA***   * ***FFS if TA validation procedure of CG-SDT PUSCH can be applied to PUCCH transmission configured by higher layer during CG-SDT.*** * ***FFS if UCI multiplexing is supported by CG-SDT when PUCCH overlaps with CG PUSCH.*** |

## First round discussion

According to the submitted contributions, the following issues may have RAN1 impact:

* 4.1 RO configuration[9]
* 4.2 TA validation[1][4]
* 4.3 CG-SDT for unlicensed band[5]
* 4.4 BWP level configuration for CG-SDT[5]
* 4.5 *srs-ResourceIndicator* in CG configuration[5]
* 4.6 Restriction on PUCCH transmission[12]

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.

Subset of SSBs for TA validation will be decided in RAN2, other methods for TA accuracy are up to RAN4, so there is no need for RAN1 to further discuss it.

CG-SDT for unlicensed band has been discussed in RAN2, moderator would like to check whether it requires RAN1’s input.

BWP level configuration is about RRC parameters, if Option 1 is adopted, RAN1 may need to add restriction on some of the existing parameters in *BWP-DownlinkDedicated* and *BWP-UplinkDedicated*, and if Option 2 is adopted, RAN1 may need to tell RAN2 about which parameters can be included in the SDT specific BWP level configuration. This can also be discussed in RRC parameter related email discussion.

The parameter *srs-ResourceIndicator* in CG configuration is used for UL beam indication, but this may not needed in CG-SDT since gNB cannot obtain the beam measurement results in inactive state. This can also be discussed in RRC parameter related email discussion.

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

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | TDOA based TA validation is critical for a reliable CG SDT feature. This needs to be discussed. |
| Huawei, HiSilicon | Fine with moderator’s view on these issues. |
|  |  |
|  |  |

## Second round discussion

Given the limited comments on this section, Moderator suggests we discuss these issues later.

# Reply LS(R1-2112630) related issues

The content of RAN2’s reply LS can be found in Appendix, in action part RAN2 asks RAN1 to inform them whether there is consensus on separate BWP for SDT. Among the agreements provided by RAN2, some are based on the assumption that L1 feedback is not supported, so RAN2 still expects RAN1’s response on whether there is consensus on L1 feedback. Another agreement is to inform RAN1 about RAN2’s decision on the 4 options of SSB subset determination for TA validation, Moderator would like to check if there is any other follow-up issues on this.

## Separate BWP for CG-SDT

### 5.1.1 Second round discussion

-------------------------------- From RAN2 LS ------------------------------------------------------------------

Agreements for RA-SDT and CG-SDT

|  |
| --- |
| => RAN2 changes the agreements and as a baseline we will focus on initial BWP for RA and CG SDT. FFS if further work on CG SDT for non-initial BWP will be needed, based on RAN1 consensus. |

For the configuration of CG-SDT resources on non-initial BWP, some companies supported this as this is assumed to reduce the congestion on UL initial BWP by providing larger bandwidth for SDT data and flexibility of CG resource allocation, whilst others expressed concerns on the complexity and SSB/paging/system information monitoring associated with non-initial BWP for SDT in case the non-initial SDT BWP could not contain initial BWP.

To RAN1

ACTION: RAN2 respectfully asks RAN1 to take the above information into account in their specification work and inform RAN2 if there is consensus on separate SDT BWP for CG-SDT.

-------------------------------- From RAN2 LS ------------------------------------------------------------------

RAN2 has explained their thoughts on separate BWP for CG-SDT and asked RAN1 to inform RAN2 if there is consensus on separate SDT BWP for CG-SDT. In order to not block RAN2’s progress, let’s check whether RAN1 could reach consensus on this issue so that we could inform RAN2 about RAN1’s decision.

Given the explanation from RAN2, can we accept the following proposal?

***Proposal #5.1***

CG-SDT can be configured on separate BWP.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We don’t support the proposal on configuring a separate BWP for CG-SDT.  Based on the RAN2 LS, there is no consensus in RAN2 to support a separate UL BWP configuration for CG-SDT, since companies did have “***concerns on the complexity and SSB/paging/system information monitoring associated with non-initial BWP for SDT*** ***in case the non-initial SDT BWP could not contain initial BWP .”***  In our view, the initial DL and UL BWPs are sufficient to support CG-SDT with minimum spec impacts in RAN1 and RAN2. Some additional comments on the UL and DL BWP configurations for CG-SDT are summarized as follows:  **UL BWP used for CG-SDT**   * Different from the initial DL BWP, the initial UL BWP configuration needs to span a wide BW (up to the entire carrier), to improve the frequency diversity of UL transmissions and mitigate the potential UL resource fragmentation incurred by intra-slot FG of PUCCH (based on 213 spec, PUCCH FH is mandatory for NR R15/16 legacy UEs). * Due to the small data volume of CG-SDT, UL congestion should not be a concern for the initial UL BWP.   **DL BWP used for CG-SDT**   * It is essential to include SSB in the DL BWP for SDT, since most procedures of CG-SDT require UE to measure SSB regularly, such as TA validation, power control, CG PUSCH validation and etc. Besides, RAN2 has agreed a CG-SDT UE needs to monitor paging at least for SI update and PWS notification after initiating CG-SDT. * If a non-initial DL BWP for SDT is narrow than the initial DL BWP, the non-initial DL BWP may not include CD-SSB and the entire CORESET#0. * If a non-initial DL BWP for SDT is wider than the initial DL BWP, the power saving benefits of SDT is diminished, since the inactive UE needs consume more power in DL reception. |
| Apple | We don’t want to discuss this issue again, as RAN1 already had conclusion.  **Conclusion**   * RAN1 cannot reach a consensus on whether to confirm RAN2 agreement that CG-SDT resource can be configured on separate SDT BWP. * Capture the following in the LS: the concern is on the necessity. |
| Moderator | @Apple Yes, we have already had conclusion. But it seems RAN2 still expects RAN1 to give a confirmed yes or no, and the Action part also would like RAN1 to inform them the result, that’s why I trigger the discussion.  @All It seems at least 2 companies can not agree to Proposal 5.1, let me try the opposite way, can we make a conclusion below? If not, we may still say no consensus in the reply LS to RAN2.  ***Conclusion #5.1***  CG-SDT cannot be configured on separate BWP |
| vivo2 | Share similar view as Qualcomm and Apple, there’s no need to discuss this again given the concerns raised by companies earlier in RAN1.  CG SDT in RRC inactive state is different from CG Type 1 transmissions in RRC connected state. In CG SDT, UE is required to measure SSBs all the time to determine the good enough SSB so that a corresponding CG PUSCH resource can be determined for SDT in RRC inactive state. On top of that, UE is also required to measure SSBs to determine whether RSRP change is smaller enough so that TA can be assumed to be valid for CG-SDT. Both require frequent measurement on SSBs which should be within the active BWP to avoid RF retuning to initial DL BWP for SSB monitoring. |
| Xiaomi | Share the same view as QC and don’t support this proposal. |
| Nokia, NSB | Share the same view as Qualcomm and Apple, the response should be no. |
| HW, HiSi | Although RAN1 does not make consensus in last meeting, RAN2 sent this issue again and tell RAN1 the motivation of separate BWP: to reduce the congestion on UL initial BWP by providing larger bandwidth for SDT data and flexibility of CG resource allocation. RAN2’s concern is not the motivation but when the non-initial SDT BWP could not contain initial BWP, there may be some complexity introduced by RF retuning. So we suggest RAN1 discuss this issue seriously to echo RAN2’s requirement, instead of just ignoring it.  Noted that in NR Positioning Enh. topic, it is agreed that SRS can be configured on the separate BWP.  Agreement:   * For RRC\_INACTIVE UEs, SRS for positioning bandwidth, SCS and CP type are configured by RRC and can be different from that of initial UL BWP configured by the system information   If CG-SDT resource must be configured on initial BWP, the UE has to perform BWP switching when it sends both SRS and CG-SDT in RRC\_INACTIVE. Therefore, we support the moderator’s original Proposal #5.1 and add the sub bullet to address some companies’ concern from RAN2.  ***Updated Proposal #5.1***  CG-SDT can be configured on separate BWP.   * Whether the separate BWP contains initial BWP is according to UE’s bandwidth and RF capability report. |
| Ericsson | We are fine with moderator’s updated conclusion #5.1. |

### 5.1.2 Final round discussion

Although RAN2 triggers the discussion again and explains what RAN2 thinks about, unfortunately six companies say no and most of them don’t want to discuss it again, one company still wants to support CG-SDT on separate BWP. Given this situation, it seems no chance to reach consensus in RAN1 on this issue, Moderator suggests we still say no consensus in the reply LS to RAN2, companies could directly revise the wording in the draft LS.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine that “RAN1 could not reach consensus on the support of separate BWP for CG-SDT”. |
| Qualcomm | We support the previous conclusion that RAN1 could not reach consensus to support separate/non-initial BWP for CG-SDT. |
| vivo3 | Same comment as in last round. |
|  |  |
|  |  |

## L1 feedback

### 5.2.1 Second round discussion

Agreements for CG-SDT

|  |
| --- |
| * Assumption that we won’t have L1 feedback as a functionality. Discuss subsequent and autonomous CG transmissions with email discussion. * The “CG-SDT timer” starts at the first “valid” PDCCH occasion from the end of the CG-SDT PUSCH transmission. The first “valid” PDCCH occasion is defined in RAN1 * At least for initial transmission we will have a mechanism to allow the UE to transmit the message again. FFS for retransmission for subsequent. * The UE is allowed to initiate subsequent UL data transmission only after the reception of confirmation of initial transmission from the gNB |

According to the agreements above, it seems RAN2 assumes no L1 feedback as a functionality, and it would be better if RAN1 could reach consensus on whether L1 feedback can be supported or not.

From RAN2’s discussion, if there is no L1 feedback from gNB to indicate successful reception, during subsequent data transmission, even if gNB has received successfully, when the new defined CG-SDT timer expires, UE would assume it’s a NACK and always re-transmit. It is different from legacy CG based transmission, CG-SDT can not be regarded as successful if no indication has received. To avoid such retransmission all the time, RAN2 has discussed the following options:

* Option 1: No CG based subsequent data transmission
* Option 2: gNB provides overlapping dynamic grant for subsequent CG resources
* Option 3: Mac level feedback

Although these are discussed in RAN2, they are all based on the assumption that L1 feedback is not supported. So Moderator would like to check if there is any consensus on L1 feedback, considering DG based NACK indication has already been supported, we can discuss whether some L1 ACK feedback can be supported or not.

***Proposal #5.2***

L1 ACK feedback can be supported for CG-SDT.

|  |  |
| --- | --- |
| Company | Comment |
| Intel | Our view is that L1 ACK feedback is by default already supported. gNB simply schedules a DG-PUSCH with same HPN and toggled NDI. This can be considered as L1 ACK feedback. |
| H3C | We are the similar with Intel |
| Moderator | @Intel Yes, I agree. But if for each CG UL transmission, a DG is used for ACK feedback, I think it might be better to directly use DG for subsequent data transmission, i.e. the Option 1 mentioned above.  Anyway, if Intel’s view is the common understanding, I guess we can try the following conclusion:  ***Conclusion #5.2***  For CG-SDT, L1 ACK feedback has already been supported by scheduling the same HPN with toggled NDI. |
| vivo2 | Our understanding is that RAN2 assumes no **explicit** HARQ feedback is needed. For the implicit HARQ feedback via NDI, there’s no need to discuss it here. It’s up to RAN2 to decide whether additional SDT response message is needed or not. |
| Xiaomi | Don’t support to add an explicit HARQ-ACK feedback for CG-SDT. |
| Nokia, NSB | Don’t support adding explicit HARQ-ACK for CG-SDT. We can clearly respond this. |
| Ericsson | We don’t see a need for explicit L1 ACK. There is no need to discuss about implicit feedback via NDI here. |

Any comments?

### 5.2.2 Final round discussion

It seems at least 6 companies don’t support explicit HARQ-ACK feedback for CG-SDT, and no other views have been received so far. So Moderator suggests the following conclusion, if this can not be agreed, we can directly say no consensus in the draft reply LS.

***Conclusion #5.2***

From RAN1’s perspective, no explicit HARQ-ACK feedback is needed for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We are fine with the proposal.  We would also like to add “implicit L1 ACK feedback has already been supported by scheduling the same HPN with toggled NDI.” |
| HW, HiSi | We are glad to see RAN2’s view that when CG-SDT timer expires, UE would assume it’s a NACK. On top of this, the explicit ACK should be supported to give the feedback to UE. If no explicit HARQ-ACK feedback, how can UE know ACK if gNB does not want to dynamically schedule the subsequent transmission?  Scheduling the same HPN with toggled NDI by C-RNTI is an indirect way of explicit ACK in RRC\_CONNECTED, and that means subsequent new transmission must be DG-based, which we think is not a good solution for CG-based subsequent transmission. Therefore, we prefer original Proposal #5.2.  If we still cannot reach consensus, fine to directly say no consensus in the draft reply LS. |
| Xiaomi | Support. |
| Qualcomm | OK with the conclusion |
| vivo3 | Fine with FL conclusion. |
|  |  |

## TA validation

### 5.3.1 Second round discussion

Agreements for CG-SDT

|  |
| --- |
| * Highest N SSBs of all SSBs actually transmitted as indicated in SIB1 is used for RSRP based TA validation |

Moderator thinks this agreement may have impact on RRC parameters, e.g. according to the agreement, it may mean the RSRP threshold should be cell specific, and we need to add a new parameter N to the list as well, is it the common understanding? Is there any other RAN1 related issues with the agreement?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | N can be configured. |
| H3C | We agree with FL’s observation. |
| vivo2 | N can be configured similar to *nrofSS-BlocksToAverage* configured in SIB2. |
| Xiaomi | Agree. |
| Nokia, NSB | Agree |
| Ericsson | Is N UE-specific or cell-specific? |

### 5.3.2 Final round discussion

The related parameters have been reflected in the parameter list in another email thread, as for Ericsson’s question, Moderator thinks N should be cell-specific as well.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We slightly prefer UE specific as this can be configured as part of CG PUSCH configuration, together with SSB set. |
| HW, HiSi | Share similar view with Intel. |
| Xiaomi | May be a cell-specific value is sufficient. Don’t understand why different UEs need different values, One issue needs to be clarified: highest N SSBs of all SSBs actually transmitted as indicated in SIB1, but not highest N SSBs of all SSBs in the SSB set configured by RRCRelease, is used for TA validation. |
| Qualcomm | No strong preference |
| vivo3 | Should be UE specific in our view.  According to the RAN1 agreements for SSB to CG PUSCH mapping, different UEs are even configured with different subset of SSBs per CG PUSCH configuration. Some UEs may not have to monitor too many SSBs while some UEs may need to monitor more. |
|  |  |

# Summary

The final proposals will be added later.

# References

1. R1-2110774 RAN1 aspects for NR small data transmissions in INACTIVE state Ericsson
2. R1-2110812 Physical layer aspects of CG-SDT Huawei, HiSilicon
3. R1-2110973 Remaining RAN1 impacts for small data transmission vivo
4. R1-2111083 Discussion on physical layer aspects of small data transmission Spreadtrum Communications
5. R1-2111356 Discussion on the remaining physical layer issues of small data transmission ZTE, Sanechips
6. R1-2111379 Remaining issues of physical layer aspects for SDT Sony
7. R1-2111473 Discussion on physical layer aspects of small data transmission Intel Corporation
8. R1-2111539 Physical layer aspects for NR small data transmissions in INACTIVE state Xiaomi
9. R1-2111711 Discussion on physical layer aspects for NR small data transmissions in INACTIVE state Samsung
10. R1-2111844 Discussion on physical layer aspects of small data transmission Apple
11. R1-2112044 Discussion on physical layer aspects of small data transmission LG Electronics
12. R1-2112189 Draft reply LS on the physical layer aspects of small data transmission Qualcomm Incorporated

# Appendix-content of RAN2 reply LS

1. **Overall description**

RAN2 would like to thank RAN1 for the LS on the physical layer aspects of small data transmission in R2-2111219.

RAN2 has made the following agreements for SDT at RAN2#116-e.

Agreements for RA-SDT and CG-SDT

|  |
| --- |
| => RAN2 changes the agreements and as a baseline we will focus on initial BWP for RA and CG SDT. FFS if further work on CG SDT for non-initial BWP will be needed, based on RAN1 consensus. |

For the configuration of CG-SDT resources on non-initial BWP, some companies supported this as this is assumed to reduce the congestion on UL initial BWP by providing larger bandwidth for SDT data and flexibility of CG resource allocation, whilst others expressed concerns on the complexity and SSB/paging/system information monitoring associated with non-initial BWP for SDT in case the non-initial SDT BWP could not contain initial BWP.

Agreements for CG-SDT

|  |
| --- |
| * Assumption that we won’t have L1 feedback as a functionality. Discuss subsequent and autonomous CG transmissions with email discussion. * The “CG-SDT timer” starts at the first “valid” PDCCH occasion from the end of the CG-SDT PUSCH transmission. The first “valid” PDCCH occasion is defined in RAN1 * Highest N SSBs of all SSBs actually transmitted as indicated in SIB1 is used for RSRP based TA validation * At least for initial transmission we will have a mechanism to allow the UE to transmit the message again. FFS for retransmission for subsequent. * The UE is allowed to initiate subsequent UL data transmission only after the reception of confirmation of initial transmission from the gNB |

1. **Actions**

To RAN1

ACTION: RAN2 respectfully asks RAN1 to take the above information into account in their specification work and inform RAN2 if there is consensus on separate SDT BWP for CG-SDT.