**3GPP TSG-RAN WG1 Meeting #106bis-e R1-210xxxx**

**e-Meeting, October 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 resource, BWP, search space and L1 feedback. Besides, in new coming LS [R1-2108715](file:///C:\\Users\\Docs\\R1-2108715.zip)(R2-2109222), RAN2 has asked five questions for RA-SDT and CG-SDT, RAN1 will discuss these questions and reply to RAN2 by the end of this meeting.

This document contains the summary of remaining issues related to the physical layer aspects of small data transmission in RAN1#106bis-e meeting.

[106bis-e-NR-R17-SDT-01] Email discussions on remaining issues on NR SDT in INACTIVE state – Ziyang (ZTE)

* 1st check point: October 14
* Final check point: October 19

# SSB to PUSCH mapping details for CG-SDT

Agreements from the last meeting are copied as below. There are still some remaining details need to be discussed.

Agreement in 106-e:

* Each N of consecutive SSB indexes associated to one CG configuration are mapped to valid CG PUSCH resources
  + first, in increasing order of DMRS resource indexes, where a DMRS resource index is determined first in an ascending order of a DMRS port index and second in an ascending order of a DMRS sequence index
  + second, in increasing order of CG period indexes in the association period
* The mapping ratio N is explicitly signalled and the association period is implicitly derived
  + FFS candidate value set of mapping ratio, and whether it is configured per CG configuration or per cell
  + The SSB to CG PUSCH association period is the duration of multiple of CG periods depending the smallest time duration in the set determined by the CG period such that all SSBs associated with the CG configuration are mapped at least once to CG PUSCH resources.
  + An association pattern period includes one or more association periods and is determined so that a pattern between CG PUSCH occasions and SS/PBCH block indexes associated with the CG configuration repeats at most every 640 msec.
* Note: The mapping ordering and steps may be revisited if multiple CG PUSCH occasions in one CG period is supported

|  |
| --- |
| Agreement in 106-e  Support multiple DMRS resources per CG configuration when single layer PUSCH transmission is assumed, and each DMRS resource could be mapped to the same or different SSB(s)   * FFS if multi-layer PUSCH transmission is supported for CG-SDT * FFS any limitation on the DMRS configuration if multiple CG PUSCH occasions per CG period is supported |

Agreement in 106-e:

* 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
  + FFS if any validation rule following the CG-PUSCH in RRC connected state is applicable, and whether and how to handle the overlapping between CG-PUSCH occasions for CG-SDT and any valid PRACH occasion or MsgA PUSCH occasion.
  + FFS the rule for paired spectrum, and whether/how to support CG-SDT for UEs operating in Type-A HD-FDD.

## Mapping ratio and association period

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Spreadtrum [2] | ***Proposal 3: The mapping ratio N can configured per CG configuration.*** |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 1: the candidate value set of mapping ratio of SSB-to-PRACH occasion can be reused for the mapping ratio between SSB and CG PUSCH resource, e.g. {1/8, 1/4, 1/2, 1, 2, 4, 8, 16}**  **Proposal 2: mapping ratio of SSB-to-CG PUSCH can be defined per CG configuration.** |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 1: Reuse the mapping ratio value set of SSB to RO mapping for CG-SDT, and it should be per CG configuration.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 1: Reuse the similar mapping relationship between SSBs and ROs.** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 6**   * *For the association between SSBs and CG-PUSCH resources*   + *N 1 is supported.*   + *Do not support N < 1.*   + *Candidate values of N can be {1,2,4}* * *Multiple PUSCH occasions in a CG-PUSCH period are supported for a CG-PUSCH configuration.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. The mapping ratio between SSB and CG PUSCH can be similar to SSB to RO mapping ratio. 2. 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 if the CG period values for SDT are the same as those defined for CG Type 1 PUSCH. |
| [R1-2110012](file:///C:\\Users\\Docs\\R1-2110012.zip) Apple [13] | **Proposal 1: The SSB index to valid CG PUSCH resource mapping ratio is configured per CG configuration, the candidate value set of mapping ratio include {1, 2, 4, 8}.** |

### 2.1.1 First round discussion

For candidate value set of mapping ratio, 4 companies prefer to reuse the candidate value set of SSB to RO mapping, while 2 companies propose a different set of values respectively. The options of candidate value set are summarized as below:

* Option 1: Reuse the candidate value set of SSB to RO mapping ratio, i.e. {1/8,1/4,1/2,1,2,4,8,16} [3][4][5][9]
* Option 2: {1, 2, 4} [7]
* Option 3: {1, 2, 4, 8} [13]

4 companies[2][3][4][13] think that mapping ratio should be configured per CG configuration, no companies propose other options, so moderator would like to check if it’s agreeable.

One company[9] suggests to define the candidate value set of association period for SSB to CG PUSCH mapping, but according to previous agreement, the association period is implicitly derived based on the mapping ratio and CG period, and RAN1 has 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.

***Discussion point #2.1:***

* Mapping ratio of SSB to CG PUSCH is configured per CG configuration.
* Down-select one of the following options for candidate value set of SSB to CG PUSCH mapping ratio:
  + Option 1: Reuse the candidate value set of SSB to RO mapping ratio, i.e. {1/8,1/4,1/2,1,2,4,8,16}
  + Option 2: {1, 2, 4}
  + Option 3: {1, 2, 4, 8}
  + Option 4: Other values

Preference and comments on the above options?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We support option 1 |
| Nokia, NSB | We support option 1 |
| Samsung | We like to know the consequence for the first bullet.  If the mapping ratio is configured per CG configuration, does it imply that for one given SDT configuration containing multiple CG configuration, the different mapping ratio could be there. so as the number of CG-PUSCH, the periodicity, etc could also be different. does this mapping ratio be selected by gNB totally randomly or should there be some restrictions, e.g., targeting for same SSB-PUSCH association period, or association pattern period so something?  For the values, we think option 1 could be a good start. |
| Spreadtrum | Option 1 is fine for us |
| Intel | We support Option 2 and can compromise to Option 3. We do not think one to many mapping for SSB to CG-PUSCH resource is needed. |
| Apple | We support option 2 and option 3. We don’t see the motivation to support N<1, the PUSCH resources are reserved for the UE and could not be shared with other users. If N<1, it cuase the PUSCH resource waste. |
| Ericsson1 | Option 1. |
| Xiaomi | Option 1. |
| Huawei, HiSilicon | Agree with the first bullet.  For the second bullet, Option 1 is preferred. |
| ZTE, Sanechips | We support Option 1. Given that multiple DMRS resources are supported in a CG occasion, it’s fine to have mapping ratio N<1. |

### 2.1.2 Second round discussion

Proposal to be updated

## Multi-layer PUSCH transmission

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Proposal 1:*** *Multi-layer PUSCH transmission is not supported for CG-SDT.* |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Spreadtrum [2] | ***Proposal 4: Multi-layer PUSCH transmission is not supported for CG-SDT in R17.*** |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 3: multi-layer PUSCH transmission is not supported for CG-SDT.** |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 2: Multi-layer PUSCH transmission is not supported for CG-SDT.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 9: Support only a single layer for small data transmission.** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 7**   * *Multi-layer PUSCH transmission is not supported for CG-SDT.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. Only single layer is supported for CG SDT in RRC inactive state, and DMRS configuration can be independent from multiple CG PUSCH occasion configurations. |
| [R1-2110012](file:///C:\\Users\\Docs\\R1-2110012.zip) Apple [13] | **Proposal 2: Multi-layer PUSCH transmission is not supported for CG-SDT.** |

### 2.2.1 First round discussion

8 companies mentioned the issue of multi-layer PUSCH transmission for CG-SDT, and they share same view that multi-layer PUSCH transmission is not supported.

The other remaining issue is whether there is any limitation on the DMRS configuration if multiple CG PUSCH occasions per CG period is supported. Moderator thinks it can be discussed once we reach a consensus on section 2.5.

***Discussion point #2.2***:

* Multi-layer PUSCH transmission is not supported for CG-SDT.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We agree with the FL proposal. |
| Nokia, NSB | Agree with the FL proposal |
| Samsung | Fine. |
| Spreadtrum | Fine |
| Intel | We are fine with the proposal. |
| Apple | Agree with the FL proposal |
| Ericsson1 | Fine. |
| Xiaomi | Agree. |
| Huawei, HiSilicon | Agree with the FL proposal. |
| ZTE, Sanechips | Agree |

### 2.2.2 Second round discussion

Proposal to be updated

## Repetitions

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 3: For CG-SDT, the repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s).*** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Proposal 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.***  ***Observation 1: the repetition in CG-SDT is not motivated.***  ***Proposal 3: the repletion in CG-SDT is not supported.*** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 8**   * *Repetition of CG-PUSCH is supported.*    + *The repetitions are considered as a bundle of transmission occasions that are mapped to a same SSB.* |
| [R1-2110012](file:///C:\\Users\\Docs\\R1-2110012.zip) Apple [13] | **Proposal 4: Time domain repetition can be supported for CG-SDT.** |
| [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) Nokia [15] | **Observation 1: When SDT-CG-PUSCH configuration is associated to an SSB, there is no additional SSB mapping complication when repetitions are allowed.**  **Proposal 1: Allow using PUSCH repetition with SDT-CG-PUSCH without any spec changes.**  **Observation 2: There is no obvious use case for PUSCH repetition with SDT**  **Proposal 2: If it is difficult to agree on the PUSCH repetition support, rather than continue discussion, conclude that PUSCH repetition is not supported with SDT.** |
|  |  |

### 2.3.1 First round discussion

5 companies mentioned repetitions, 4 companies[4][7][13][15] among them support repetitions and consider the repetitions as a bundle of transmission occasions that are mapped to the same SSB(s), no additional specification rule is needed, while one company[6] prefers to re-interpret the configured repetitions as PUSCH transmission occasions within a CG period. One company[15] also thinks that if it is difficult to agree on the PUSCH repetition support, rather than continue discussion, conclude that PUSCH repetition is not supported with SDT. The situation is unchanged from the last meeting, the moderator would suggest to make decision in this meeting since it has RRC impact.

***Discussion point 2.3***:

Down-select between the following three options for the interpretation of PUSCH repetition:

* Option 1: Re-interpret the configured repetitions as TDMed transmission occasions within a CG period.[6]
* Option 2: The repetitions are considered as a bundle of transmission occasions that are mapped to the same SSB(s), no additional specification rule is needed. [4][7][13][15]
* Option 3: PUSCH repetition is not supported for CG-SDT. [6][15]

Any preference and comments on above options?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We prefer Option 2 |
| Nokia, NSB | We prefer option 2. If no agreement is reached, then option 3 is the end result and we would prefer option 3 to save time, if reaching an agreement is prolonged. |
| Samsung | Thx FL for the summary.  Yes, it is indeed discussed a lot in last meeting, regarding the motivation to have repetition or not, but still given the CG-SDT is a prior SDT to be used only above certain RSRP threshold, we are failing to see why the repetition is needed. And support the repetition as a buddle will be problematic if option 2 supported. Thus our position is NO to option 2.  Preference is option 1, can live with option 3. |
| Spreadtrum | We prefer Option 2 |
| Intel | We support Option 2. |
| Apple | We prefer Option 2. Repetition could relax the RSRP threshold, more users could get the benefits of the SDT. It’s network choice whether to setting repetition or not. |
| Ericsson1 | Option 2. |
| Xiaomi | We prefer Option 2. |
| Huawei, HiSilicon | Option 2. In RRC\_INACTIVE, UE’s TA may not be such accurate even though the TA is valid, so that the repetition is required to improve the PUSCH receiving performance. Also agree with Apple’s view. |
| ZTE, Sanechips | Option 2 |

### 2.3.2 Second round discussion

Proposal to be updated

## Validation of PUSCH occasion

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Observation 1:*** *PUSCH occasion validation for CG-SDT is not related to any RA procedure. The configuration may be overlapped while the UE would apply one procedure at a time.*  ***Proposal 2:***  *For unpaired spectrum, keep the existing agreements as CG-SDT PUSCH validation rules. For paired spectrum, all the CG-SDT PUSCH occasions are valid.* |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Spreadtrum [2] | ***Proposal 5: For the overlapping between PO and PRACH occasion or MsgA PO, PRACH occasion or MsgA PO has higher priority than SDT PO.*** |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 10: It is up to UE implementation to handle the overlapping between CG-PUSCH occasions for CG-SDT and any valid PRACH occasion or MsgA PUSCH occasion.** |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. A CG PUSCH occasion is not valid if it overlaps in time and frequency with any valid PRACH occasion associated with either a Type-1 random access procedure or a Type-2 random access procedurestate. 2. Further discuss in RAN1 on whether CG SDT can be allowed on flexible symbols when UE is in RRC inactive state. 3. If CG SDT is only allowed in uplink symbols, additional UE specific TDD uplink downlink configuration should be supported in RRC release message. 4. To support CG SDT in flexible symbols, *enableConfiguredUL* can be configured in RRC release message. 5. There’s no need to define validation rules for CG PUSCH for SDT for paried spectrum or for HD FDD. |

### 2.4.1 First round discussion

4 companies mentioned the remaining issues on validation rule of CG PUSCH occasion, companies’ views are split on how to handle the overlapping between CG PUSCH occasion and PRACH occasion or MsgA PUSCH occasion. For paired spectrum, 2 companies mentioned that there is no need to define validation rules.

***Discussion point #2.4***

* For paired spectrum or HD FDD, all the CG-SDT PUSCH occasions are valid.
* Down-select among the following 2 options:
  + Option 1: It is up to UE implementation to handle the overlapping between CG-PUSCH occasions for CG-SDT and any valid PRACH occasion or MsgA PUSCH occasion.
  + Option 2: A CG PUSCH occasion is not valid if it overlaps with any valid PRACH occasion or MsgA PUSCH occasion.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | For the first bullet,   * all the CG-SDT PUSCH occasions are valid for UE operating in FD-FDD. * for UE operating in HD-FDD, we can follow the decision/rule made in R17 RedCap WI (under discussion in RAN1#106b).   For the 2nd bullet, we are not sure when the UE needs to handle such “overlapping” after the type of SDT procedure is selected by UE. |
| Nokia, NSB | Agree on the 1st main bullet  Support option 2 for the 2nd main bullet to avoid CG-PUSCH collisions with PRACH transmissions of other UEs. |
| Samsung | First seems fine, as for the suggestion from Qualcom, we’d like to see what is the exactly decision or rules. Although we know HD-FDD might be discussed in Redcap, but sometimes, totally reuse should be carefully checked first.  Second one, does it still target for HD-FDD users? Our assumption is not.  Given 2step RACH is R16 feature, and for a UE supports 2step RACH, might not support SDT. So for BC purpose, we think option2 should be adopted, and one minor change is “valid MsgA PUSCH occasion”. |
| Spreadtrum | Share the similar view as QC |
| Intel | It seems first and second bullet are contradictory. If we agree with option 2 in the second bullet, we can not claim that all CG-SDT PUSCH occasions are valid.  Also for HD FDD, suggest to defer the discussion once decision is made in RedCap.  For the 2nd bullet, we prefer Option 2 as it follows MsgA PO validation rule. |
| Apple | For the first bullet, HD FDD can be checked further after the progress in RedCap.  For second bullet, Option 2 is preferred. |
| Ericsson1 | Fine for first main bullet, option 2 and fine with the updates from Samsung as well. |
| Xiaomi | Since there are common ROs for all UEs in the initial uplink BWP, there shouldn’t be conflict between the uplink CG-SDT transmission of one UE and the PRACH transmission of another UE. So, the collision between the RO and PO should be resolved and option 2 is preferred by us. |
| Huawei, HiSilicon | Agree with the first bullet.  For the second bullet, we support Option 1. |
| ZTE, Sanechips | Agree on the 1st main bullet and Option 2 of second main bullet. |

### 2.4.2 Second round discussion

Proposal to be updated

## Multiple CG occasions per CG period

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 4: For CG-SDT, multiple TDMed and/or FDMed CG PUSCH occasions in one CG period can be configured.** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 3: Support multiple POs configured in a configured grant period.** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Proposal 2: Configure the number of PUSCH transmission occasion (PO) in one CG-PUSCH period by re-interpreting the number of repetitions configured.*** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 6**   * *For the association between SSBs and CG-PUSCH resources*   + *N 1 is supported.*   + *Do not support N < 1.*   + *Candidate values of N can be {1,2,4}* * *Multiple PUSCH occasions in a CG-PUSCH period are supported for a CG-PUSCH configuration.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. Multiple CG PUSCH occasions in time and/or frequency domain can be configured per CG period for SDT in RRC inactive state. 2. Only single layer is supported for CG SDT in RRC inactive state, and DMRS configuration can be independent from multiple CG PUSCH occasion configurations. |
| [R1-2110012](file:///C:\\Users\\Docs\\R1-2110012.zip) Apple [13] | **Proposal 3: Multiple CG PUSCH occasions per CG period is not supported.** |

### 2.5.1 First round discussion

5 companies[3][5][6][7][9] support multiple CG PUSCH occasions per CG period, while 1 company[13] does not support multiple CG PUSCH occasions per CG period. Moderator encourages other companies to provide their views on whether to support multiple CG occasions per CG period.

As for how to support multiple CG occasions per CG period, one company[6] prefers to reinterpret repetitions as PUSCH transmission occasions, moderator would also like to ask other proponents to provide details on how to configure multiple CG occasions per CG period. Companies are also encouraged to clarify the corresponding spec impact, especially RRC impact because it’s better to make decision on the RRC related issues in this meeting.

***Discussion point#2.5***

* Whether and how to support multiple CG occasions per CG period.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK to study |
| Nokia, NSB | OK a discussion point, but quick convergence would be needed for this to still make it. |
| Samsung | Ideally, it can be studied.  But given the time left for SDT, we don’t see much hope for this.  On one hand, we do see it could be beneficial by having multiple PO in one period, this is like multiple RO in one RACH period. However, the proposals to use additional signaling is not acceptable to us.  Thus, we can live with no multiple CG occasions. |
| Spreadtrum | Fine |
| Intel | We support multiple CG occasions per CG period to allow more resources and reduce latency for CG-SDT operation.  Given that there is clearly the majority support, it is not clear to us why we cannot try to move forward to make proposal for this? |
| Apple | Considering the standard impacts, multiple POs per CG period are not supported. |
| Ericsson1 | Fine to support multiple CG PUSCH occasions when multiple time frequency resources are preferred than multiple DMRS resources in each CG period. RRC parameters needed may be number of POs FDMed and the number of POs TDMed on top of the configurations for time frequency resource allocation of the first PO. |
| Xiaomi | We support multiple CG occasions per CG period and share the same view as Ericsson that Both TDM and FDM can be applied. |
| Huawei, HiSilicon | If single PUSCH occasion with multiple DMRS is interpreted as multiple CG occasions, we support it. Otherwise we suggest to further study it, as multiple PUSCH occasion may introduce specification impact. |
| ZTE, Sanechips | Supporting multiple CG occasions per CG period may require additional signaling such as TDMed and FDMed number. Latency issue can be addressed by configuring multiple DMRS resource, so considering that there is only 1 meeting left in RAN1, we think multiple CG occasions per CG period is not necessary. |

### 2.5.2 Second round discussion

Proposal to be updated

## Other mapping issues

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. When multiple CG PUSCH configurations are configured, additional information from UE is required by the gNB to determine the SSB associated to the UL data received on an overlapping PUSCH resource configured by multiple CG configurations. 2. A UE specific TDRA list for CG PUSCH resource allocation in RRC inactive state should be configured in 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. |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Proposal 1: in case of the SSB set indication is absent, the UE determines the SSB(s) associated with the CG-PUSCH by one of the following***   1. ***Associating to all the indicated SSB in the SIB1*** 2. ***Determine the SSB according to the sequential order of CG-PUSCH configuration lists*** |
|  |  |

### 2.7.1 First round discussion

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

Issue 2.7-1 Default SSB subset if not indicated [6]

Issue 2.7-2 UE specific TDRA table in RRC inactive state [9]

Issue 2.7-3 SSB determination based on overlapped PUSCH resource in multiple CG configuration [9]

These issues are 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 |
| Nokia, NSB | 2.7-1: Default should be all SSBs  2.7-2: Not sure if this is necessary, but open to discuss  2.7-3: Not sure if there is a necessity to have any specific action specified. Fully overlapped in time and frequency would need a statement that one is selected in random. Partially overlapped should be a non-issue. |
| Samsung | We think all SSBs in SIB1 as default should be simple and effective. |
| Apple | 2.7-1: ok  2.7-2: *timeDomainAllocation* in *ConfiguredGrantConfig* seems enough.  2.7-3: according to our understanding, network configuration can avoid the issue. |
| Ericsson1 | One minor comment: this section should be 2.6.x instead.  -1: we also think that they should be all actually transmitted SSBs configured by SIB1.  -2: this is needed since this is in RRC inactive state and if only SIB1 configured TDRA table is used, it will be too restrictive for CG SDT. Note that dynamic repetition of CG PUSCH is only supported in dedicated TDRA list.  -3: when 2 POs from different CG configurations are fully overlapping, which CG configuration is used for actual transmission may be needed if the SSBs mapped to the 2 different CG configurations are different, otherwise gNB doesn’t know which SSB should be assumed. E.g. the rule can be introduced requiring that the CG configuration with lowest CG configuration index is always assumed to be used for this overlapping case. |
| Huawei, HiSilicon | With lower priority to discuss |

### 2.7.2 Second round discussion

Proposal to be updated

# SDT related procedures

## Search space

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Proposal 4:*** *RAN1 confirms the UE-specific search space is configured for UEs performing CG-SDT.* |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Spreadtrum [2] | ***Proposal 2: The CORESET associated to the search space set for monitoring the PDCCH addressed to the C-RNTI after successful completion of the RACH procedure during RA-SDT is a common CORESET.*** |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 8: RAN1 confirms the following working assumption, i.e. UE-specific search space is configured for UEs performing CG-SDT.** |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 5: Since a separate common search space for RA-SDT is supported, a new type should be defined in TS 38.213, such as Type4-PDCCH CSS set.***  ***Proposal 6: Confirm the RAN2 WA that UE-specific search space is configured for UEs performing CG-SDT.*** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 9**   * *RAN1 to confirm the working assumption that UE-specific search space is configured for UEs performing CG-SDT.* * *RAN1 to confirm that CG-SDT resource can be configured on either initial BWP or separate SDT BWP.* |
| [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Sony [10] | **Proposal 2: RAN1 to discuss whether CSS or USS is suitable for UEs performing CG-SDT.**  **Proposal 6: Confirm the RAN2 agreement as follows:**   * **The separate search space is common to the UEs performing RA-SDT.** * **If the separate SearchSpace is not configured, type-1 PDCCH CSS can be reused.**   **Proposal 7: A separate CORESET should be configured for the UEs performing RA-SDT and if the separate CORESET is not configured, CORESET#0 should be reused.** |
| [R1-2109911](file:///C:\\Users\\Docs\\R1-2109911.zip) Interdigital [11] | ***Proposal 1: Confirm working assumption that UE-specific search space is configured for UEs performing CG-SDT*** |
| [R1-2109960](file:///C:\\Users\\Docs\\R1-2109960.zip) LGE [12] | ***Proposal 3: UE-specific search space for UEs performing CG-SDT can be configured in the separate DL SDT BWP.*** |

### 3.1.1 First round discussion

6 companies[1][3][4][7][11][12] suggest to confirm the RAN2 working assumption that UE-specific search space is configured for UEs performing CG-SDT. One company[4] mentions that since a separate common search space for RA-SDT is supported, a new type should be defined in TS 38.213, such as Type4-PDCCH CSS set. One company[2] mentions that the CORESET for UE performing RA-SDT should be a common CORESET, another company[10] thinks a separate CORESET should be configured for RA-SDT, and it is noticed that there is an remaining FFS on whether it should be UE specific CORESET or common CORESET for RA-SDT in RAN1#104-e, so moderator would also to check companies’ views on this issue.

***Discussion point 3.1***:

* RAN1 confirms the working assumption in RAN2 that UE-specific search space is configured for UEs performing CG-SDT.
* A new type of common search space set should be defined in TS 38.213 for RA-SDT, such as Type4-PDCCH CSS set.
* CORESET for UE performing RA-SDT should be a common CORESET.
  + Whether to define separate CORESET for RA-SDT

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | * For UE performing CG-SDT in the initial BWP, both USS and CSS can be configured. * For RA-SDT, a new type of CSS associated with a common CORESET can be specified for the UE operating in initial BWP. |
| Nokia, NSB | RAN1 can confirm that UE specific SS can be configured for CG-SDT.  New CSS type for RA-SDT may be needed, but this would seem to require increase in # of search spaces the UE supporting SDT is required to be able to handle. |
| InterDigital | Support the bullets above. Please note the wording used by RAN2 is “UE-specific search space is configured”. |
| Samsung | First and third ones are fine.  Second one is not needed, from RAN1 discussion point of view, support a separate search space is enough, we don’t need to say whether it’s type 4 or sth. It should be upto the editor. |
| Spreadtrum | Fine |
| Intel | First bullet is fine.  We do not think second bullet is needed.  We support main bullet in the 3rd bullet and we do not think separate CORESET for RA-SDT is needed. |
| Apple | Ok to confirm the working assumption in RAN2.  clarify the third bullet that the common CORESET is CORESET#0 |
| Ericsson1 | Fine. |
| Huawei, HiSilicon | fine |
| ZTE, Sanechips | Fine |

### 3.1.2 Second round discussion

Proposal to be updated

## L1 feedback

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Observation 2:*** *Implicit ACK mechanism for CG-SDT suffers from the risk of degraded reliability due to inaccurate TA/channel state information in INACTIVE state, and the subsequent data transmission may be resumed after a relatively long time, which is against UE power saving motivation.*  ***Observation 3:*** *Explicit ACK helps UE’s power saving by reduced PDCCH monitoring.*  ***Proposal 3:*** *Support**explicit L1-ACK for CG-SDT considering both channel state achievement and UE’s power saving in RRC\_INACTIVE. The existing L1 feedback mechanism in LTE PUR and NR R15/16 CG specification can be referred to, including HARQ-ACK indication, TPC command and TA adjustment for subsequent CG-SDT.* |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 9: For CG-SDT, UL grant scheduling subsequent transmission can be used for the feedback response to CG-SDT transmission, i.e. Option 1B.** |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 7: From RAN1’s perspective, the existing DFI mechanism can be reused for the feedback of CG-SDT in subsequent transmission.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 6: Don’t support any additional explicit L1 feedback signaling for CG-SDT.** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 10**   * *RAN1 to confirm that existing L1 mechanism can be reused for feedback of CG-PUSCH transmission during CG-SDT.* |
| [R1-2109727](file:///C:\\Users\\Docs\\R1-2109727.zip) Sierra Wireless [8] | 1. L1 ACK is more spectrally efficient and lowers UE power consumption vs L2 ACK 2. L1 UL grant for retransmission is more spectrally efficient and lowers UE power consumption 3. L1 NACK lowers UE power consumption and reduces latency when a failure to detect occurs 4. When the CG-SDT is decoded, an explicit HARQ-ACK including TPC command and additional TA adjustments is supported as feedback 5. When the CG-SDT is not decoded, an explicit HARQ-NACK including TPC command and additional TA adjustments is supported as feedback 6. When the CG-SDT is detected but failed to be decoded, an UL grant is used to schedule retransmissions. 7. RAN1 confirms the support of L1 feedback (ACK/NACK/UL Grant) for CG-SDT to RAN2 |
| [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Sony [10] | **Proposal 3: RAN1 to discuss whether L1 feedback for CG-PUSCH is implicit based on *configuredGrantTimer* or explicit HARQ-ACK mechanism.**  **Proposal 4: RAN1 to discuss the following options for the resource of UL HARQ-ACK feedback:**   1. PUCCH resource is configured for the UE just before moving to Inactive state, that is RRC Release messge. 2. CG-PUSCH is used for carrying the HARQ-ACK for the DL SDT. |
| [R1-2109911](file:///C:\\Users\\Docs\\R1-2109911.zip) Interdigital [11] | ***Observation: RAN2 already agreed on retransmission by dynamic grant and CS-RNTI-based retransmission for CG-SDT.***  ***Proposal 3: Confirm RAN2 assumption that existing L1 mechanism (DFI) can be used for CG-SDT.*** |

### 3.2.1 First round discussion

8 companies[1][3][4][5][7][8][10][11] mentioned the L1 feedback issue, and companies’ views are quite split. The following options are copied from last meeting:

-        **Option 1**: Support explicit L1 feedback for CG-SDT.

   **Option 1A**: Reuse DFI based mechanism as introduced in Rel-16 NR-U [1][4][7][8][11]

  **Option 1B:** Use UL grant scheduling DG-PUSCH with same HARQ process ID as CG-SDT PUSCH[3]

-       **Option 2**: Explicit ACK is not supported for CG-SDT. Reuse Rel-15 CG re-transmission for CG-SDT[5]

One company[11] observes that retransmission based on dynamic grant has already been agreed in RAN2, and the only issue left is whether DFI mechanism can be used for CG-SDT.

***Discussion point #3.2***

* Confirm RAN2 assumption that existing L1 mechanism can be used for CG-SDT.
* Whether CG-DFI mechanism can be reused for CG-SDT retransmission.
  + Whether additional TA adjustments can be included

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK to discuss |
| Nokia, NSB | The meaning of “existing” seems somewhat debatable. Importing features specified for NR-U only cannot be considered as “existing” for licensed operation. RAN1 should confirm the RAN2 WA with the clarification that features existing to NR-U only are not considered existing in licensed operation context.  CG-DFI cannot be reused as it doesn’t “exist” for licensed operation. It would be possible to discuss introducing it, but we don’t see the need. |
| InterDigital | RAN2 already agreed on retransmission by dynamic grant. Clearly, RAN2 considers that “existing mechanism” includes DFI and is only asking RAN1 if there is any issue with their assumption that it can be reused for CG-SDT. So far, it does not look anyone in RAN1 identified a real issue. |
| Spreadtrum | Fine |
| Intel | We are fine to confirm RAN2 assumption that existing L1 mechanism can be used for CG-SDT  We are okay to support CG-DFT as HARQ-ACK feedback.  We also support to use UL grant scheduling DG-PUSCH with same HARQ process ID. |
| Ericsson1 | Existing HARQ feedback for CG Type 1 PUSCH for operation in licensed spectrum is enough. |
| Sierra Wireless | We are Ok to discuss. As mentioned above, RAN2 has already agreed to support retransmissions based on dynamic grant, now RAN1 can discuss introducing the CG-DFI to licensed operation. |
| Xiaomi | We don’t see the need to introduce additional explicit L1 feedback signaling for CG-SDT. |
| Huawei, HiSilicon | Fine with first bullet.  For the second bullet, CG-DFI mechanism can be reused and additional TA adjustments can be included. The CG-DFI mechanism should also be considered as an ‘existing’ mechanism although it is for NR-U for the CG in RRC\_CONNECTED. Companies who are not sure on this may check with RAN2. |
| ZTE, Sanechips | Agree to confirm RAN2 assumption that CG-DFI mechanism can be reused for CG-SDT. |

### 3.2.2 Second round discussion

Proposal to be updated

## Separate BWP

Q4: Do RAN1 have any concerns to support RA-SDT on the non-initial BWP?

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Proposal 5:*** *CG-SDT and RA-SDT resources can be configured on either separate UL BWP in FDD bands or initial UL BWP in TDD/FDD bands. In addition, the network can configure CG-SDT resource on separate UL BWP in TDD band according to UE’s bandwidth and RF capability report.* |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 7: RAN1 confirms that CG-SDT resources can be configured on non-initial BWP.**  **A4:** RAN1 don’t see the need to support RA-SDT on the non-initial BWP |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 8: From RAN1’s perspective, CG-SDT resource can be configured on a separate SDT BWP. For TDD mode, define a restriction that the separate BWP is linked to the DL BWP containing the SSB associated to the initial DL BWP.***  ***Proposal 9: From RAN1’s perspective, RA-SDT can be configured on non-initial BWP, and the RA-SDT related configuration on non-initial BWP is provided via system information.***  ***Proposal 10: When RA-SDT is configured on non-initial BWP, for TDD mode, similar to separate BWP for CG-SDT, define a restriction, i.e. the non-initial BWP is linked to the DL BWP containing the SSB associated to the initial DL BWP.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 4: Do NOT support configuring CG-SDT resource on separate SDT BWP** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Proposal 8: the support RA-SDT on the non-initial BWP is NOT confirmed.*** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 4**   * *For RA-SDT, non-initial UL BWP may not be needed.*   **Proposal 9**   * *RAN1 to confirm the working assumption that UE-specific search space is configured for UEs performing CG-SDT.* * *RAN1 to confirm that CG-SDT resource can be configured on either initial BWP or separate SDT BWP.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. It’s enough to use initial active BWP for both RA SDT and CG SDT, no optimization is necessary. |
| [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Sony [10] | **Proposal 1: Confirm the RAN2 agreement: CG-SDT resource can be configured on either initial BWP or separate SDT BWP.**  **Observation 1: The motivation to promote an additional “configurable” BWP for RA-SDT is to reduce the congestion of the initial BWP (both DL and UL) since there are several services that require to be received or transmitted when a UE in Inactive state such as Positioning and MBS in addition to SDT.**  **Proposal 5: BWP for RA-SDT can be configured to be either initial BWP or separate SDT BWP.**   * + - **Develop a common framework for RA-SDT and CG-SDT BWPs** |
| [R1-2109911](file:///C:\\Users\\Docs\\R1-2109911.zip) Interdigital [11] | ***Proposal 2: Confirm RAN2 agreement that CG-SDT resource can be configured on either initial BWP or separate SDT BWP.*** |
| [R1-2109960](file:///C:\\Users\\Docs\\R1-2109960.zip) LGE [12] | ***Observation 1: RAN2 agreed that CG-SDT resource can be configured on either initial BWP or separate SDT BWP and asked RAN1 to confirm this agreement.***  ***Proposal 1: RAN1 can confirm that CG-SDT resource can be configured on either initial BWP or separate SDT BWP.***  ***Proposal 2: The separate SDT BWP can be configured for both UL and DL.*** |
| [R1-2110164](file:///C:\\Users\\Docs\\R1-2110164.zip) Qualcomm [14] | ***Proposal 4: RA-SDT and CG-SDT are not supported on non-initial BWP of the RRC inactive UE performing SDT.*** |
| [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) Nokia [15] | Proposed A4: RAN1 has not identified any obvious need for supporting RA-SDT in non-initial BWP. |

### 3.3.1 First round discussion

In RAN1#106-e meeting, RAN1 has discussed whether CG-SDT can be configured on separate BWP, and in this meeting, RAN2 has asked a question on whether there is concern to support RA-SDT on separate BWP.

For CG-SDT, 7 companies[1][3][4][7][10][11][12] tend to confirm that CG-SDT can be configured on separate BWP while 3 companies[5][9][14] don’t agree on that.

For RA-SDT, 2 companies[4][10] think that RA-SDT can be configured on separate BWP, one company[1] thinks RA-SDT can be configured on separate BWP in FDD mode, 6 companies[3][6][7][9][14][15] don’t see the need to support that.

According to the majority’s views, moderator would like to check if companies can reach a consensus on whether CG-SDT and RA-SDT can be configured on separate BWP.

***Discussion point#3.3***

* Confirm RAN2 agreement that CG-SDT resource can be configured on separate SDT BWP.
  + In TDD mode, whether to restrict that the separate BWP is linked to the DL BWP containing the SSB associated to the initial DL BWP.
* From RAN1’s perspective, RA-SDT resource is not supported to be configured on non-initial BWP at least in TDD mode.
  + In FDD mode, whether RA-SDT resource can be configured on non-initial BWP.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | It is not necessary to define a separate SDT BWP for CG-SDT. CG-SDT UE can re-use the initial BWP (Configuration Option 1 or Option 2 for BWP#0 in TS 38.331), which includes SSB and CORESET#0. |
| Nokia, NSB | Agree with Qualcomm |
| InterDigital | We support confirming RAN2 agreement that CG-SDT resource can be configured on separate SDT BWP. This is useful to enable offloading for uplink resources. |
| Samsung | A separate SDT BWP is not needed for either CG-SDT or RA-SDT.  SDT is used in RRC inactive when UE may not need to switch to connected mode. It targets a quick and relatively short period transmission. And we think if a gNB decides to support SDT, it should configure a relative large bwp for better accommodation. |
| Spreadtrum | Agree with QC |
| Intel | We are fine to support separate SDT BWP for CG-SDT  For RA-SDT, we do not think non-initial BWP is necessary. |
| Ericsson1 | Initial BWP is enough at least for RA SDT unless RAN2 can provide reasonable justification of using separate BWP for SDT. |
| Xiaomi | Don’t support to define a separate BWP for both RA-SDT and CG-SDT. |
| Huawei, HiSilicon | We think separate SDT BWP can be configured for CG-SDT by RRCReleease message but not for RA-SDT. |

### 3.3.2 Second round discussion

Proposal to be updated

## PUCCH resource

Q1: For both RA-SDT and CG-SDT, RAN2 assumes that common PUCCH resources (i.e. those that are shared with non-SDT UEs) can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions. Can RAN1 confirm this?

Q2: For RA-SDT and CG-SDT, for Msg4 /MsgB and subsequent SDT transmissions, does RAN1 think there is a need for any other PUCCH resources than the above and if needed, can RAN1 define these?

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Proposal 6:*** *RAN1 confirms common PUCCH resources those shared with non-SDT Ues can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions, if in the initial UL BWP. For CG-SDT, the dedicated PUCCH resource can be also configured for DL feedback in non-initial UL BWP.* |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **A1:** RAN1 confirms that common PUCCH resources (i.e. those that are shared with non-SDT Ues) can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions.  **A2:** RAN1 thinks there is no need for any other PUCCH resources for Msg4 /MsgB and subsequent SDT transmissions. |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 11: RAN1 should confirm that the common PUCCH resources (i.e. those that are shared with non-SDT Ues) can also be used for HARQ-ACK feedback for Msg4/MsgB and subsequent SDT transmission.***  ***Proposal 12: SDT specific PUCCH resources can be considered for RA-SDT and CG-SDT if needed.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 7: Share the common PUCCH resources configured in the initial uplink BWP to the feedback of RA-SDT and CG-SDT.**  **Proposal 8: Configure one or more sets of additional common PUCCH resources for the feedback of SDT.** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Proposal 7: the PUCCH resource pool for msg4/B could be reused for RA-SDT and CG-SDT.***  **There is no need for new PUCCH resource unless serious issue found.** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 1**   * *RAN1 to confirm that cell specific PUCCH resource set, which is configured by pucch-ResourceCommon is used for HARQ-ACK feedback of Msg4/MsgB and subsequent data transmission.*   **Proposal 2**   * *UE specific PUCCH resource set is not needed for HARQ-ACK feedback of Msg4/MsgB and subsequent data transmissions during SDT.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. Common PUCCH resource is enough for HARQ feedback in SDT, there’s no need of separate PUCCH configuration specific for SDT in RRC inactive state. |
| [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Sony [10] | **Proposal 4: RAN1 to discuss the following options for the resource of UL HARQ-ACK feedback:**   1. PUCCH resource is configured for the UE just before moving to Inactive state, that is RRC Release messge. 2. CG-PUSCH is used for carrying the HARQ-ACK for the DL SDT.   **Proposal 9: The PUCCH resource for RA-SDT should be specified as follows:**   1. During initial access, the existing “common” PUCCH resources (i.e. those that are shared with non-SDT Ues) should be reused for HARQ-ACK feedback for Msg4 /MsgB. 2. During subsequent SDT DL messages (i.e., after initial access), a new separate PUCCH resource should be configured for HARQ-ACK feedbacks. |
| [R1-2110164](file:///C:\\Users\\Docs\\R1-2110164.zip) Qualcomm [14] | ***Proposal 1: In RA-SDT and CG-SDT, HARQ-ACK feedback to PDSCH is transmitted on pucch-ResourceCommon configured in the initial UL BWP of inactive UE.***  ***Proposal 2: For a non-RedCap SDT UE, PUCCH frequency hopping is enabled for HARQ-ACK transmission in the initial UL BWP, if* the UE is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon***.  ***Proposal 3: For a RedCap SDT UE configured with a separate initial UL BWP, PUCCH frequency hopping can be enabled/disabled by NW via SI or RRC signalling.*** |
| [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) Nokia [15] | Proposed A1: The use of common PUCCH resources for HARQ-ACK feedback for Msg4/MsgB is already the specified ehavior. Subsequent DL SDT transmissions can also use common PUCCH resources. Therefore, RAN1 does not see any issue with this.  Proposed A2: The only motivation to introduce dedicated SDT PUCCH resources would be to address capacity problems related to subsequent DL SDT. However, there is no clear evidence that this is a problem for SDT and there is few remaining time in the WI. Therefore, RAN1 sees no obvious need for additional PUCCH resource definitions, and would see defining such it problematic given the remaining time for the WI. |

### First round discussion

For Q1, all 10 companies agree to confirm that common PUCCH resources (i.e. those that are shared with non-SDT Ues) can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions.

For Q2, 4 companies[1][4][5][10] support to consider SDT specific PUCCH resource while 5 companies[3][6][7][9][15] think there is no need to consider that. Given the split views and limited meeting time in RAN1, it’s recommended to not consider other PUCCH resources in Rel-17.

One company[14] mentions the frequency hopping issue, it might be also related to RedCap, moderator suggests to down-prioritize this issue.

***Discussion point#3.4***

* RAN1 confirms that common PUCCH resources (i.e. those that are shared with non-SDT Ues) can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions.
* RAN1 thinks there is no need for any other PUCCH resources than common PUCCH resources shared with non-SDT Ues.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Agree with the FL proposal |
| Nokia, NSB | Agree with the FL proposal |
| InterDigital | Agree with the FL proposal |
| Samsung | ok |
| Spreadtrum | Fine |
| Intel | We are fine with the proposal |
| Apple | Agree with the FL proposal |
| Ericsson1 | Agree. |
| Xiaomi | OK |
| Huawei, HiSilicon | For RA-SDT, we are fine. But for CG-SDT, we think dedicated PUCCH resources for subsequent DL transmission can be provided by RRCReleaese message together with CG-SDT resources. |
| ZTE, Sanechips | Agree |

### 3.4.2 Second round discussion

Proposal to be updated

## BFD/BFR procedure

Q5: Does RAN1 think that BFD/BFR procedure is required for SDT and if needed, can RAN1 define the necessary procedure to support this?

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Huawei[1] | ***Proposal 7:*** *BFR/BFD can be introduced in the procedure of subsequent CG/RA-SDT, including CG-PUSCH based BFR in addition to PRACH-based.* |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **A5:** RAN1 don’t think BFD/BFR procedure is required for SDT. |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 13: BFD/BFR procedure for SDT is not required for Rel-17 and it can be considered in Rel-18.*** |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 5: Support to further study beam failure recovery procedure for SDT.** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***Observation 2: reuse similar manner as legacy BFD and BFR is possible but the introduced signalling overhead and power consumption (or complex) is considerable.***  ***Observation 3: RA-SDT can already support DL beam change during RACH procedure.***  ***Proposal 9: UCI piggybacked in PUSCH is supported to indicate the preferred DL beam (e.g., SSB index) for PUSCH after msg4 in RA-SDT and CG-SDT.***  ***Proposal 10: 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 11: for CG-SDT, the first UL transmission could be also up to UE implementation*** |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 5**   * *BFD/BFR procedure is not needed for SDT operation.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. BFR is not supported for SDT in RRC inactive state. |
| [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Sony [10] | **Proposal 8: RAN1 should discuss and specify BFD and BFR procedures during subsequent SDT transmissions.** |
| [R1-2110164](file:///C:\\Users\\Docs\\R1-2110164.zip) Qualcomm [14] | ***Observation 1: If suitable SSB beam cannot be found or the SSB-based TA validation fails, the RRC inactive UE configured with CG-SDT resources can switch to RA-SDT without triggering BFD/BFR, if RA-SDT is configured in the initial BWP of UE.***  ***Observation 2: If beam failure is detected by a RA-SDT UE, the RRC inactive UE can re-attempt RACH procedure in the initial BWP without triggering BFR.***  ***Proposal 5: The complexity/overhead impacts of BFD/BFR in SDT need to be studied and compared with the fallback procedure based on RA-SDT.*** |
| [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) Nokia [15] | Proposed A5: If the initial beam selection was incorrect, or the SDT transaction takes a longer time, there could be a benefit from BFD/BFR. |

### 3.5.1 First round discussion

3 companies[1][10][15] think that BFD/BFR procedure is beneficial for SDT, while 4 companies[3][4][7][9] think it’s not needed and 3 companies[5][6][14] think it should be further studied. Given the split views and the limited meeting time in RAN1, moderator suggests to down-prioritize this issue in Rel-17.

***Discussion point#3.5***

* BFD/BFR procedure is not required for SDT in Rel-17.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Agree with the FL proposal |
| Nokia, NSB | Even though we would be somewhat interested in supporting BFD/BFR for SDT, we can accept the FL proposal for quick progress. |
| InterDigital | Agree with the FL proposal |
| Samsung | As we discussed in the tdoc, a full legacy BFD/BFR may not be needed. But the feature to report the beam change to gNB should be discussed.  Thus ,we are fine with the main bullet, but suggest to add:   * BFD/BFR procedure is not required for SDT in Rel-17.   + FFS: support reporting the beam change to gNB. |
| Spreadtrum | Fine |
| Intel | We are fine with the proposal |
| Apple | Agree with the FL proposal |
| Ericsson1 | Agree. |
| Xiaomi | We are fine with the proposal for the sake of meeting progress, although we believe BFD/BFR procedure is worthy of being studied for SDT. |
| ZTE, Sanechips | Agree |

### 3.5.2 Second round discussion

Proposal to be updated

## Other L1 configuration

Q3: Is there any other L1 configuration needed for both RA-SDT and CG-SDT to support the subsequent data transmissions from RAN1 perspective?

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | For question 3, as discussed above, for RA-SDT, it seems sufficient. In addition, for CG-SDT, UE will be able to use the C-RNTI in previous connected mode as well as the CS-RNTI, as long as the CORESET/search space is determined, it seems sufficient as well. |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **A3:** From RAN1 perspective, no any other L1 configuration to support the subsequent data transmissions is needed for RA-SDT or CG-SDT. |
| [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Intel [7] | **Proposal 3**   * *Additional L1 configuration for subsequent data transmission during SDT may not be needed.* |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | For Q3, there seems no other configurations necessary for subsequent SDT given the search space configuration for scheduling subsequent data transmission is already agreed. |
| [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) Nokia [15] | Proposed A3: No. |

### 3.6.1 First round discussion

5 companies[3][6][7][9][15] think that there is no other L1 configuration to support subsequent data transmission, moderator would like to ask other companies to provide views on this Q3.

***Discussion point#3.6***

* From RAN1’s perspective, there is no other L1 configuration for RA-SDT and CG-SDT to support subsequent data transmission.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Agree with the FL proposal |
| Nokia, NSB | Agree with the FL proposal |
| InterDigital | Agree with the FL proposal |
| Spreadtrum | Fine |
| Intel | We are fine with the proposal |
| Apple | Agree with the FL proposal |
| Ericsson1 | Fine. |
| Xiaomi | Agree. |
| Huawei, HiSilicon | Fine |
| ZTE, Sanechips | Agree |

### 3.6.2 Second round discussion

Proposal to be updated

## HARQ process id determination

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 4: For CG-SDT in licensed band, if autonomous retransmission is supported, HARQ process id determination can reuse the mechanism in NR-U framework to reduce latency.*** |
|  |  |
|  |  |

### First round discussion

One company[4] mentioned that if autonomous retransmission is supported, according to the SSB to CG PUSCH mapping defined in RAN1, when UE selects a qualified SSB, it’s probably that the associated CG PUSCH may not have the same HARQ process id as previous new transmission, so it’s better that HARQ process id determination can reuse the mechanism in NR-U framework.

It is noticed that autonomous retransmission and HARQ process id determination are being discussed in RAN2 email discussion, it may have RAN1 impact but considering that there is only 1 meeting left in RAN1, it might be too late to wait for RAN2 LS to trigger the discussion, so moderator suggests companies to provide views on this issue in this meeting.

***Discussion point#3.7***

* If autonomous retransmission is supported, whether to reuse the mechanism in NR-U framework for HARQ process id determination.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Ok to discuss |
| Nokia, NSB | Don’t see the need to discuss this. |
| Intel | Not sure whether we need to discuss this. |
| Ericsson1 | Seems not necessary. |
| Huawei, HiSilicon | Fine for unlicensed spectrum. But for licensed spectrum, we think HARQ process id determination for URLLC can be reused for CG-SDT. |
| ZTE, Sanechips | If autonomous retransmission is supported in RAN2, it’s necessary to reuse NRU mechanism to report HARQ process id, otherwise, URLLC framework works fine. |

### 3.7.2 Second round discussion

Proposal to be updated

## Power control

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. For power control of CG PUSCH in SDT, the RS (reference signal) for pathloss estimation should be the DL RS associated with the CG PUSCH transmission. 2. RAN1 to discuss the UE specific power control parameters for CG SDT in RRC inactive state. |
| [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Xiaomi [5] | **Proposal 10: The pathloss for CG-SDT PUSCH power control can be determined by the measurement of the SSB associated with the selected PO.** |
|  |  |

### First round discussion

2 companies[5][9] propose that the pathloss for CG-SDT PUSCH power control can be determined by the measurement of SSB associated with the selected CG PUSCH. One company[9] suggests RAN1 to discuss UE specific power control parameters.

***Discussion point#3.8***

* The pathloss for CG-SDT PUSCH power control can be determined by the measurement of SSB associated with the selected CG PUSCH.

Companies are also encouraged to provide views on whether to introduce UE specific power control parameters since it has RRC impact.

Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | OK with the FL proposal |
| Nokia, NSB | Agree with the FL proposal |
| InterDigital | Agree with the FL proposal |
| Samsung | Wondering, does this need a specific RAN1 agreement? |
| Intel | We are fine with the proposal, although it is somehow implicitly agreed already. |
| Apple | OK with the FL proposal |
| Ericsson1 | Agree. |
| Xiaomi | Agree. |
| Huawei, HiSilicon | Fine |
| ZTE, Sanechip | Agree |

### 3.7.2 Second round discussion

Proposal to be updated

# Other physical layer issues

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

|  |  |
| --- | --- |
| Tdocs | Proposals |
| [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) vivo [3] | **Proposal 5: For RA-SDT, when PRACH occasions are separate between SDT and non-SDT, the following parameters can be configured specifically**   * + **Number of SSBs associated with a valid RO,**   + **Number of contention-based preambles per SSB per valid RO,**   **Proposal 6: For RA-SDT, when PRACH occasions are separate between SDT and non-SDT, the following parameters can be configured specifically**   * + **RO configuration related parameters, i.e. time and frequency resources of PRACH resources.**   + **Preamble related parameters, e.g. totalNumberofRA-Preambles, prach-RootSequenceIndex.** |
| [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Samsung [6] | ***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.*** |
| [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Ericsson [9] | 1. For shared RO case, mechanisms similar to what we’ve used for 2-step RACH can be reused for PRACH preamble grouping for indicating RA-SDT. Whether the preambles for indicating RA-SDT should be outside the total number of preambles configured for legacy RA in the shared RO should be discussed first. 2. For the separate RO case, PRACH configurations for SDT should be carefully designed to avoid RA-RNTI overlapping issues 3. The method to have ROs FDMed with common f\_id for RA-RNTI calculation, and that the f\_id is numbered together among all FDMed ROs for both Rel-15/16 and Rel-17 ROs introduced for RA SDT is used to avoid RA-RNTI overlapping issue. 4. RSRP change is the difference between RSRP calculated at the time when the UE receives the latest TAC from the network and the RSRP calculated at the time when UE determines TA validation for a CG PUSCH SDT. 5. Different RSRP variation thresholds and TAT configuations can be configured for different sets of SSBs configured within a set of SSBs configured per CG configuration 6. On top of the TA validation based on RSRP change, support TDOA based crieterial for TA validation in CG based SDT. 7. TA based on latest UL transmissions before RRC release message should be provided in the RRC release message as initial TA to be used by CG SDT in RRC inactive. 8. The TA for CG SDT should be relative to the subcarrier spacing of initial UL BWP or the separately configured for CG SDT. 9. TA offset is optionally configured in RRC release message for CG SDT and the default TA offset is used when absent. 10. SSB subset for the average RSRP calculation is within a set of SSBs per CG PUSCH configuration. |
| [R1-2109960](file:///C:\\Users\\Docs\\R1-2109960.zip) LGE [12] | ***Proposal 4: For CG-SDT, the UE can assume the PDCCH carrying the DCI has the same DM-RS antenna port quasi co-location properties as for a SSB associated to the CG PUSCH transmission e.g. for detection of retransmission DCI in response to a CG PUSCH transmission.*** |
| [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) ZTE [4] | ***Proposal 14: 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.*** |
| [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Spreadtrum [2] | ***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.*** |

## First round discussion

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

* 4.1 RO configuration[3][6][9]
* 4.2 TA validation[2][12]
* 4.3 CG-SDT for unlicensed band[4]
* 4.4 QCL relationship between PDCCH and SSB[12]

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.

TA validation is assumed to be finalized in RAN2, and there is no need for RAN1 to further discuss it.

CG-SDT for unlicensed band is being discussed in RAN2, moderator would like to check whether it requires RAN1 input.

QCL relationship between PDCCH and SSB is considered as low priority in the last meeting.

So the moderator suggests to first identify which issues are critical and need RAN1’s input, and for the low priority issues we can either treat them later or ask RAN2 to trigger the discussion if needed. Any comments?

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | 4.4 can be further discussed in RAN1 |
| Nokia, NSB | 4.2 and 4.4 can be further discussed in RAN1 |
| Samsung | 4.4, but it seems a very straightforward way, there is no other option basically. |
| Ericsson1 | 4.2, 4.4 need discussions in RAN1. |
| Sierra Wireless | 4.2 can be further discussed in RAN1 |
| Xiaomi | 4.4 can be further discussed in RAN1. |
| Huawei, HiSilicon | None is strictly necessary. |

## Second round discussion

Proposal to be updated

# Reply to LS R1-2108715

|  |
| --- |
| Q1: For both RA-SDT and CG-SDT, RAN2 assumes that common PUCCH resources (i.e. those that are shared with non-SDT UEs) can also be used for HARQ-ACK feedback for Msg4 /MsgB and subsequent SDT transmissions. Can RAN1 confirm this?  Q2: For RA-SDT and CG-SDT, for Msg4 /MsgB and subsequent SDT transmissions, does RAN1 think there is a need for any other PUCCH resources than the above and if needed, can RAN1 define these?  Q3: Is there any other L1 configuration needed for both RA-SDT and CG-SDT to support the subsequent data transmissions from RAN1 perspective?  Q4: Do RAN1 have any concerns to support RA-SDT on the non-initial BWP?  NOTE: It has already been agreed in RAN2 that *CG-SDT resource can be configured on either initial BWP or separate SDT BWP*, if confirmed by RAN1.  Q5: Does RAN1 think that BFD/BFR procedure is required for SDT and if needed, can RAN1 define the necessary procedure to support this? |

## First round discussion

The issues in these questions are separately discussed in different sections, the draft replies will be provided once we reach a consensus on section 3.3~3.6.

# Summary

The final proposals will be added later.

# References

1. [R1-2108752](file:///C:\\Users\\Docs\\R1-2108752.zip) Physical layer aspects of CG-SDT Huawei, HiSilicon
2. [R1-2108894](file:///C:\\Users\\Docs\\R1-2108894.zip) Discussion on physical layer aspects of small data transmission Spreadtrum Communications
3. [R1-2108950](file:///C:\\Users\\Docs\\R1-2108950.zip) Discussion on RAN1 impacts for small data transmission vivo
4. [R1-2109026](file:///C:\\Users\\Docs\\R1-2109026.zip) Discussion on remaining physical layer issues of small data transmission ZTE, Sanechips
5. [R1-2109377](file:///C:\\Users\\Docs\\R1-2109377.zip) Physical layer aspects for NR small data transmissions in INACTIVE state Xiaomi
6. [R1-2109465](file:///C:\\Users\\Docs\\R1-2109465.zip) Discussion on physical layer aspects for NR small data transmissions in INACTIVE state Samsung
7. [R1-2109590](file:///C:\\Users\\Docs\\R1-2109590.zip) Discussion on physical layer aspects of small data transmission Intel Corporation
8. [R1-2109727](file:///C:\\Users\\Docs\\R1-2109727.zip) Discussion on L1 feedback for CG-SDT Sierra Wireless. S.A.
9. [R1-2109762](file:///C:\\Users\\Docs\\R1-2109762.zip) Physical layer aspects for NR small data transmissions in INACTIVE state L.M. Ericsson Limited
10. [R1-2109771](file:///C:\\Users\\Docs\\R1-2109771.zip) Remaining issues of physical layer aspects for SDT Sony
11. [R1-2109911](file:///C:\\Users\\Docs\\R1-2109911.zip) Physical layer aspects of small data transmission InterDigital, Inc.
12. [R1-2109960](file:///C:\\Users\\Docs\\R1-2109960.zip) Discussion on physical layer aspects of small data transmission LG Electronics
13. [R1-2110012](file:///C:\\Users\\Docs\\R1-2110012.zip) Discussion on physical layer aspects of small data transmission Apple
14. [R1-2110164](file:///C:\\Users\\Docs\\R1-2110164.zip) Discussion on PHY Impacts of SDT Qualcomm Incorporated
15. [R1-2110297](file:///C:\\Users\\Docs\\R1-2110297.zip) On physical layer aspects of small data transmission Nokia, Nokia Shanghai Bell