**3GPP TSG RAN WG2 Meeting #116bis-e R2-220**

**Electronic meeting, 17st – 25th Jan, 2022**

**Source: Huawei, HiSilicon**

**Title: [Post116-e][509][SDT]CG open issues (Huawei)**

**Agenda item: 8.11.5**

**Document for:** **Discussion and Decision**

# Introduction

The following email discussion has been planned during RAN2#115 for the issues with integrity assistance data.

* [Post116-e][509][SDT] CG open issues (Huawei)

 Scope: Discuss the remaining CG stage 2 open issues and take into account RAN1 agreements including no L1 feedback

 Deadline: Long

This questionnaire intends to address the remaining issues on CG-SDT.

# Contact Information

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# Discussion

TA aspects for CG-SDT

### RSRP-based TA validation

In the previous R2 meetings, we have agreed that RSRP-based TA validation shall be applied for CG-SDT. However, it is still not clear whether this criterion for TA validation is applicable for both initial transmission and subsequent transmissions, including subsequent transmission on CG, DG for new transmission and retransmission and PUCCH transmission.

During the last R2 meeting, we have also agreed that retransmission on CG should at least supported for initial transmission.

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| * At least for initial transmission we will have a mechanism to allow the UE to transmit the message again. FFS for retransmission for subsequent.
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The understanding from the moderator is that after initial transmission, since the network and UE are already able to establish transmission, the TA validation can be totally took over by the network, e.g., by sending TAC MAC CE. Then, there is no need for the UE-side RSRP-based TA validation anymore.

The moderator would like to ask the following question on whether TA validation is needed for subsequent transmission on CG.

###### Question1: Do companies agree that RSRP-based TA validation should only be applicable for initial SDT transmission and its retransmission?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | We think TA validation is performed only for initial transmission (i.e. not for its retransmission). |

###### Question1 Summary:

***TBD***

In the legacy spec, for the cell measurement consolidated from SSB, the following is specified, take SSB for an example:

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| 1> for each cell measurement quantity to be derived based on SS/PBCH block:2> if *nrofSS-BlocksToAverage* is not configured in the associated *measObject* in RRC\_CONNECTED or in the associated entry in *measIdleCarrierListNR* within *VarMeasIdleConfig* in RRC\_IDLE/RRC\_INACTIVE; or2> if *absThreshSS-BlocksConsolidation* is not configured in the associated *measObject* in RRC\_CONNECTED or in the associated entry in *measIdleCarrierListNR* within *VarMeasIdleConfig* in RRC\_IDLE/RRC\_INACTIVE; or2> if the highest beam measurement quantity value is below or equal to *absThreshSS-BlocksConsolidation*:3> derive each cell measurement quantity based on SS/PBCH block as the highest beam measurement quantity value, where each beam measurement quantity is described in TS 38.215 [9];2> else:3> derive each cell measurement quantity based on SS/PBCH block as the linear power scale average of the highest beam measurement quantity values above *absThreshSS-BlocksConsolidation* where the total number of averaged beams shall not exceed *nrofSS-BlocksToAverage*, and where each beam measurement quantity is described in TS 38.215 [9]; |

It can be seen from the part highlighted in yellow that the case when none of the SSB is above the threshold is considered. When the highest beam is below the configured threshold, the beam with the highest measurement quantity value is taken as the cell measurement.

For SSB-based TA validation, we need to ask the same question for the subset of beams for TA validation

###### Question2: Do companies agree that when the highest beam measurement is below the configured threshold, the beam with the highest beam measurement value is used for TA validation?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | If none of the SSB is above the threshold, the TA validation is failed for CG-SDT, and the UE should not perform CG-SDT procedure. |

###### Question2 Summary:

***TBD***

### Relationship between CG-TAT and legacy TAT

In the following, we discuss the remaining issues for how the CG-TAT and legacy TAT should be handled when there is CG-SDT.

It is possible that RA can be triggered during CG-SDT, e.g., no uplink grant or no SSB above the RSRP threshold. When RACH is triggered, agreements during the last meeting show that legacy TAT should be reused for the TA received during the RACH procedure.

* The legacy TAT (i.e. timeAlignmentTimerCommon in SIB) is used for UL timing maintenance during RA-SDT procedure. (21/23)
* The legacy TAT (i.e. timeAlignmentTimerCommon in SIB) starts/restarts when RAR TAC or TAC MAC CE is received, regardless of SDT procedure. No spec change is needed. (23/23)
* CG-SDT resource is not released even if the legacy TAT expires. (23/23)

Then, at this time, the CG-SDT-TAT may also be running. Also, the received uplink timing advance by RACH procedure may not be the same as the TA for CG-SDT, since it is more updated. The moderator would like to ask the question below on the NTA maintenance for CG-SDT.

###### Question3: Do comapanies agree that the UE should maintain a CG-SDT-N\_TA for CG-SDT, which can be different from the legacy N\_TA?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | Why N\_TA values are different for legacy TAT and CG-SDT-TAT? We think a single N\_TA is used for both legacy TAT and CG-SDT-TAT. |

###### Question3 Summary:

***TBD***

During RAN2#116, the following proposal has been made by the email discussion during the meeting [1]:

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| **Proposal 24: Postpone the issue to the next meeting: whether and when to start/restart TAT-SDT if RAR TAC is received during legacy RA procedure.** |

Then, at successful RACH completion , it should be discussed whether the CG-SDT-NTA should be updated to the value of NTA if it has been confirmed that the UE is the intended UE at successful RACH completion. The moderator would like to ask the following question.

###### Question4: Do companies agree that the UE should apply the N\_TA maintained for legacy RACH to CG-SDT-N\_TA and stop maintaining N\_TA at successful RACH completion?

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| **Company** | **Yes/No** | **Comments** |
| LG | Comments | We think N\_TA is common for both legacy TAT and CG-SDT-TAT. In addition, we are wondering why the UE stops maintaining N\_TA at successful RACH completion. We think the UE should maintain N\_TA at successful RACH completion because UE may be moved to RRC\_CONNECTED. |

###### Question4 Summary:

***TBD***

Another issue is how should we handle the CG-SDT-TAT and legacy TAT at successful RACH completion. Since a new value for the NTA is applied and the TA is updated, it seems to be reasonable to restart the timer at this time. For legacy TAT, the moderator thinks that it is reasonable to stop the timer since we have already got the ongoing CG-SDT-TAT. Similar UE behaviour has also been seen in on-demand SI request in RRC\_IDLE/INACTIVE. When contention resolution is successful for odSIB, legacy TAT is stopped, since it is no longer needed.

###### Question5: Do companies agree that the CG-SDT-TAT should be restarted and the legacy TAT can be stopped at successful RACH completion ?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | CG-SDT-TAT: restart the CG-SDT-TAT at successful RACH completion.Legacy TAT: does not stop at successful RACH completion, same as legacy. |

###### Question5 Summary:

***TBD***

### UE procedure at the expiry of CG-SDT-TAT

Another issue we think that should be discussed is what the behavior is after expiry of CG-SDT-TAT. In previous meeting RAN2 agreed to release CG configuration upon expiry of CG-SDT-TAT but for other behavior like those for *timeAlignmentTimer* as mentioned below which is still unclear.

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| 1> when a *timeAlignmentTimer* expires:2> if the *timeAlignmentTimer* is associated with the PTAG:3> flush all HARQ buffers for all Serving Cells;3> notify RRC to release PUCCH for all Serving Cells, if configured;3> notify RRC to release SRS for all Serving Cells, if configured;3> clear any configured downlink assignments and configured uplink grants;3> clear any PUSCH resource for semi-persistent CSI reporting;3> consider all running *timeAlignmentTimer*s as expired;3> maintain NTA (defined in TS 38.211 [8]) of all TAGs. |

The moderator upon expiry of CG-SDT-TAT, the MAC entity shall clear configured grant for SDT, flush HARQ buffers. Since at this time, the configuration for CG-SDT has already be released, including the CG-TAT configuration, there is no point anymore to still maintain the NTA for CG-SDT.

###### Question6: Do companies agree that UE should (a) clears all SDT configured grant, (b) flushe HARQ buffer and (c) stop maintaining CG-SDT-NTA upon expiry of CG-SDT-TAT?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | We agree with (a) and (b). However, for (c), we think NTA should be maintained, as in legacy. |

###### Question6 Summary:

***TBD***

## CG retransmission

During R2#116e, the following agreement has been made on L1-ACK:

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| [R2-2111219](file:///C%3A%5CUsers%5Cpanidx%5COneDrive%20-%20InterDigital%20Communications%2C%20Inc%5CDocuments%5C3GPP%20RAN%5CTSGR2_116-e%5CDocs%5CR2-2111219.zip) Reply LS on the physical layer aspects of small data transmission (R1-2110661; contact: ZTE) RAN1 LS in Rel-17 NR\_SmallData\_INACTIVE-Core To:RAN2=> Assumption that we won’t have L1 feedback as a functionality. Discuss subsequent and autonomous CG transmissions with email discussion.  |

Then, during RAN1#107, the issue has been discussed in R1 again and R1 couldn’t reach consensus on this again.

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| R1-2112782 Reply LS on the physical layer aspects of small data transmissionRAN1 still cannot reach consensus on separate non-initial BWP and explicit L1 ACK feedback for CG-SDT. |

During the last R2 meeting, it was also agreed that a confirmation is needed at least for initial transmisison.

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| 9. The UE is allowed to initiate subsequent UL data transmission only after the reception of confirmation of initial transmission from the gNB |

The above means that some acknowledgement is needed, different than L1-ACK as this could not be agreed in R1.

During RAN2#116, discussion has also taken place on this and the main options that were mentioned were by using a MAC CE or by network issuing a DG. It should be noted that a MAC CE as an acknowledgement is not new and this has been used for RACH-less handover in LTE by sending a MAC CE with C-RNTI to the UE.

While another option is by DG scheduling a new transmission for the same HARQ process, some companies think that DG is already enough; and other thinks that if subsequent transmission on CG is supported, it enhances efficient usage of CG-SDT by not wasting the resource. Note that previously we have already agreed on using CG-SDT for subsequent new trnamission.

###### Question7: Do companies think which option can be adopted for subsequent new transmission on CG-SDT?

* ***OptionA: Revert the previous agreement: subsequent new transmission on CG-SDT is not supported.***
* ***OptionB: Stick to the previous agreement: subsequent new transmission on CG-SDT is supported. For the acknowledgement in subsequent CG-SDT, downselect from the following options:***
	+ ***OptionB1: Imlicit ACK by dynamic scheduling of uplink new transmission (no spec change is needed)***
	+ ***OptionB2: MAC CE for acknowledgement***

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| --- | --- | --- |
| **Company** | **Options** | **Comments** |
| LG | B2 | Subsequent transmission can be performed by either DG or CG. If the network wants to rely on CG for subsequent transmission, the network can just send MAC CE without any UL grant. Else, if the network wants to rely on DG for subsequent transmission, the network can provide dynamic UL grant after sending MAC CE.  |

###### Question7 Summary:

***TBD***

During R2#116, R2 has made an agreement that we shall at least support retransmission on CG-SDT for initial transmission. Similarly as specified for URLLC, the HARQ process ID is determined by the time domain characteristics of the CG occasion and the UE uses the same HARQ process for retransmission. However, an open question that has to be answered is whether the same retransmission scheme can be reused for CG transmissions during subsequent data pahse of SDT.

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| * 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 uses/selects the same HARQ process for retransmission
 |

The discussion has been briefly taken on this during online discussion. Some companies thought that the UE behaviour between initial transmission and subsequent transmission should be aligned and that this creates no additional specification complexity. On the other hand, some other companies indicated the retransmissions are only needed for initial transmission since the initial transmission is more important in order for the gNB to detect the UE in the first place.

###### Question8: Do companies agree that we need to support retransmission on CG-SDT resource for subsequent CG-SDT transmission?

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| **Company** | **Yes/No** | **Comments** |
| LG | Yes | We prefer the same behavior for both initial transmission and subsequent transmission. |

###### Question8 Summary:

***TBD***

Another mechanism to enable the acknowledgement is by subsequent downlink transmission. In the previous meetings, we have agreed on multiple HARQ process for CG-SDT and subsequent uplink data trnamission should only happen after the reception of confirmation for initial transmission. Then, it should be investigated, whether for initial transmission, any downlink transmission after the initial trnamission can serve as an implicit ACK. The moderator thinks that the subsequent DL transmission after initial CG-SDT can serve as implicit ACK, since there is only one ongoing HARQ process; while this does not hold for subsequent uplink transmission, since there might be multiple HARQ process.

###### Question9: Do companies think that subsequent downlink transmission can serve as an implicit acknowledgement for initial CG-SDT but not for subsequent CG-SDT?

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| **Company** | **options** | **Comments** |
| LG | No | We don’t want to associate DL with UL. In addition, the downlink transmission cannot be served as an acknowledgement for subsequent CG-SDT because multiple HARQ processes can be used for subsequent transmission. We want to have same behavior for both initial transmission and subsequent transmission. |

###### Question9 Summary:

***TBD***

Another question is on the usage of configured grant timer. In Release-15, when configured grant timer expires, new uplink transmission using a configured grant is possible on the same HARQ process, while when the timer is running, new transmissions via configured grant cannot use this HARQ process. In R16 NRU, CG retransmission timer (CGRT) was introduced whose duration is shorter than that of CGT, so that multiple CG retransmssions controlled by the CGRT can take place within the duration of the CGT.

For CG-SDT, we would like to ask the question that whether CGT can be reused for preventing new uplink transmissions from using the same HARQ process.

###### Question10: Do companies agree that configuredGrantTimer is reused for CG-SDT for prohibiting the HARQ process for new uplink transmissions?

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| **Company** | **options** | **Comments** |
| LG | Not sure | We don’t think the legacy CGT is needed for CG-SDT. The retransmission of CG-SDT is controlled by a new CG-SDT timer, and retransmission can be stopped by acknowledgement. We think the only reason to keep CGT for CG-SDT is easy implementation in the specification, but we are wondering whether it is that critical. |

###### Question10 Summary:

***TBD***

### Considerations on CG-SDT timer

During RAN2#116e, the following agreements have been reached for the CG-SDT timer.

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| * 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
* The “CG-SDT timer” can be started/restarted during for initial and subsequent transmissions
* The UE restarts the “CG-SDT timer” at least:
	+ upon the PUSCH retransmission indicated by the CS-RNTI PDCCH
	+ after each CG-SDT transmission
* The “CG-SDT timer” stops at least:
	+ When the UE receives RRC feedback messages (e.g. RRCResume, RRCSetup, RRCRelease and RRCReject)
 |

With the agreements above, it is useful to determine how the UE should handle the CG-SDT timer when C-RNTI is received, since we have already agreed previously that subsequent CG-SDT can be based on dynamic grant. Note that the above agreement is for the UE to restart the timer **when PUSCH is transmitted**. Also note that for legacy releases, CGRT is restarted when PDCCH addressed to C-RNTI is received. Another aspect is how to handle the timer when CS-RNTI is received for CG retransmission. In legacy, the CGRT is restarted when PDCCH addressed to CS-RNTI is received. With the stopping of the timer, the UE does not need to monitor PDCCH for a certain HARQ process thus power can be saved.

###### Question11: Do companies agree that the CG-SDT timer should be stopped when PDCCH addressed to C-RNTI and CS-RNTI is received?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | As replied to Q7, we prefer to have MAC CE as an acknowledgement. Then, the CG-SDT Timer should be stopped when the acknowledgement MAC CE is received. |

###### Question11 Summary:

***TBD***

### SSB selection for CG-SDT

During the previous R2 meetings, we agreed that UE shall perform SSB selection for initial transmission, while leaving that for subsequent transmission for CG-SDT as FFS:

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| 3. For initial CG transmission, UE does not select any SSB if none of the SSBs’ RSRP is above the RSRP threshold. FFS if re-evaluation for every CG transmission is necessary |

Furthermore, as mentioned above, at least for initial transmission, retransmission can happen on CG-SDT resources. However, we have also agreed in the last meeting that CG retransmission should have the same HARQ process id as the new transmission in order to enable soft combining in the network side.

Then, if we allow for SSB reselection for subsequent uplink transmission, it is also possible that the CG configuration and CG occasion associated with the SSB is also changed. Since we have also agreed that HARQ process id is determined by the time domain characteristics of the CG occasion. Then, question arises on whether the UE can use the same HARQ process when SSB is reselected.

Based on the understanding of the moderator, when multiple CG configurations are configured, it is up to the network’s judgement to configure the range of the HARQ process id for each CG configuration. Then, by network implementation, different CG configurations can be configured with the same range of HARQ process ids. Then, even if SSB reselected and the mapped CG configuration/occasion is changed, the UE is still able to find the CG occasion with the same HARQ process id. This is allowed by NRU with the following note in R16, but not allowed for URLLC



###### Question12: Do companies agree that HARQ process id can be shared between different CG configurations such that when SSB is reselected, the HARQ process id can be the same for retransmission as initial CG-SDT transmission?

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| **Company** | **Yes/No** | **Comments** |
| LG | Comments | First, we don’t think SSB re-evaluation for every CG transmission is needed, because the time gap between initial transmission and retransmission is not that large and the RSRP would not change much during the short time gap. Note that we already agreed that “During the subsequent new CG transmission phase, for the purpose of CG resource selection, UE re-evaluates the SSB for subsequent CG transmission.”. We think SSB re-evaluation for every initial transmission is enough.Secondly, regardless of SSB re-evaluation, we think the HARQ process ID should be same for retransmission as initial transmission. |

###### Question12 Summary:

***TBD***

Then, based on the discussion above, the moderator would like to ask the following question on whether SSB reselection should be performed for retransmission on initial CG-SDT message.

###### Question13: Do companies agree that SSB can be reselected for the retransmission for initial message over CG-SDT resource under the condition that the corresponding CG configuration allows transmission using the same HARQ process ID?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | See our reply to Q12. |

###### Question13 Summary:

***TBD***

CG-SDT fallback

During the previous RAN2 meetings, we have made the following agreement regarding the fallback/switching from CG-SDT to legacy RACH or RA-SDT

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| * 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.
	+ 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
* 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
 |

Based on the above, we have agreed that for subsequent CG-SDT transmission, the UE can trigger legacy RA when there is no SSB above the RSRP threshold. It should be further investigated whether RA-SDT resource can be used when there are no SSB available for subsequent new transmission.

###### Question14: Do companies think that the UE should use RA-SDT resources when there are no SSB available for subsequent new transmission?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | We already agreed that if there is no SSB available during subsequent transmission, the UE relies on legacy RA procedure. We think this would not happen frequently, and don’t want to introduce another mechanism.  |
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###### Question14 Summary:

***TBD***

CS-RNTI

During RAN2#115, the following agreement was made:

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| * CS-RNTI based dynamic retransmission mechanism can be reused for CG-SDT. FFS whether CS-RNTI is the same one as the one previously configured in RRC\_CONNECTED or a new CS-RNTI one is provided to the UE
 |

It should be noted that UE is not always configured with CS-RNTI while it is in RRC Connected mode. Therefore, it seems that CS-RNTI configuration in RRCRelease message is necessary.

###### Question15: Do companies agree that CS-RNTI for CG-SDT is provided to the UE in RRCRelease message?

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| **Company** | **Yes/No** | **Comments** |
| LG | Yes | If the UE is not configured with CG in CONNECTED, then the UE may not have CS-RNTI. In this case, the CS-RNTI should be provided to the UE in RRCRelease message. But the provision of CS-RNTI is not mandatory (i.e. the UE can keep the CS-RNTI used in CONNECTED), and we want to change the text as “CS-RNTI **can be** provided”. |

###### Question15 Summary:

***TBD***

UL carrier selection

For legacy RACH in R15, UL carrier selection is performed for each RACH transmission and its retransmissions. For subsequent transmission on CG-SDT, we need to confirm on whether UL carrier reselection is needed in this phase, in addition to the initial CG-SDT transmission.

###### Question16: Do companies think the UE should perform UL carrier reselection for subsequent CG-SDT transmission over CG-SDT resources?

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| **Company** | **Yes/No** | **Comments** |
| LG | No | We think UL carrier selection is performed before SDT procedure is initiated, as discussed in common session. |

###### Question16 Summary:

***TBD***

For legacy RACH in R15, once UL carrier is selected, the UE continues RACH on that specific UL carrier and does not perform UL carrier selection again during the same RACH procedure. The moderator would like to confirm with companies whether the same should be applied for CG-SDT transmission.

Note that the question below is dependent on the question for whether to allow autonomous transmission for subsequent CG transmission. If retransmission for CG-SDT is performed by dynamic grant, this question does not apply.

###### Question17: Do companies agree that once a UL carrier is selected for a specific CG-SDT transmission (including both initial and subsequent CG-SDT transmission), the UE should perform autonomous retransmission on the same uplink carrier?

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| **Company** | **Yes/No** | **Comments** |
| LG | Yes |  |

###### Question17 Summary:

***TBD***

CG-SDT configurations

In the LS from R1, the following question has been asked by R1 twice in the LSs

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| R1-2112782 Reply LS on the physical layer aspects of small data transmissionRAN1 would like to ask RAN2 for feedback on whether there is restriction on candidate values of CG period. |

Therefore, companies are invited to answer the following question:

###### Question18: Do companies think there is any restriction on the candidate values of CG period?

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| **Company** | **Yes/No** | **Comments** |
| LG | No |  |

###### Question18 Summary:

***TBD***

In the R1 LS, the following has also been indicated:

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| Multiple CG occasions per CG period* RAN1 cannot reach consensus on whether to support multiple CG occasions per CG period
* Note that the CG PUSCH with multiple DMRS is considered as one CG occasion.
 |

Thus, we would like also to ask the following question;

###### Question19: Do companies think that multiple CG occasions can be configured per CG period?

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| **Company** | **Yes/No** | **Comments** |
| LG | No |  |

###### Question19 Summary:

***TBD***

Any other issues

For the following open question, companies are invited to input any other issues relating to CG-SDT. We may consider to address these issues in the future meetings by contribution.

###### Question20: Do companies think there are other issues relating to CG-SDT?

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| **Company** | **Comments** |
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###### Question20 Summary:

***TBD***

# Conclusions

***TBD***

# References

1. R2-2111519 [AT116-e][503][SData] UP SDT open issues (LG) LG
2. R1-2112782 Reply LS on the physical layer aspects of small data transmission