**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. |

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). |
| Samsung | No | RSRP-based TA validation is not needed for retransmission. |
| ZTE | Yes | We agree with moderator’s explanation that after initial UL transmission TA maintanence is up to network.  However, whether to use CG for subsequent transmission or not depends on the outcome of Q7 below.  In addition, if this is the case (i.e. RSRP-based TA is only used for initial UL transmission), then the RSRP-based TA can be stopped when ever normal TAT is started (and it can be restarted upon receiving RRCRelease with CG-SDT config), and we don’t need to maintain the RSRP-based TA during SDT, in which case we can avoid to maintain two TA timer simultaneously. |
| Sharp | No | RSRP-based TA validation is enough for initial transmission but not for its retransmission.  If the TA is no longer valid within the retransmission, we think it could depend on T319-like timer expiry to terminate the procedure. |
| OPPO | No | If RSRP change is the only TA validation criteria configured for CG-SDT (i.e., SDT-TAT is not configured), we think this RSRP-based TA validation shall be applied for all the transmissions at least before UE receives response from network with TAC. |
| CATT | No | RSRP-based TA validation is applied for initial transmission and not applied to retransmission of the initial transmission to keep the procedure simple. |
| Lenovo | No | Agree with others |

###### 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; or  2> 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; or  2> 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. |
| Samsung | No | We can simply use the average of N best SSBs for RSRP based TA avalidation. |
| ZTE | Yes | But in this case the TA is invalid anyway, so, it seems no further checks are needed. |
| Sharp | No | Regarding to the case, the CG-SDT should not be initiated. |
| OPPO | No | The RSRP of highest N SSBs can still be used. |
| CATT | No | when the highest beam measurement is below the configured threshold, it means none of the SSB’s RSRP is above the configured threshiold. And in RAN2#115e-meeting, it was agreed that: |
| Lenovo | No | For the RSRP-based TA validation it was agreed in RAN2#116 that the highest N SSBs of all SSBs actually transmitted as indicated in SIB1 is used for RSRP based TA validation. Therefore we can simply follow this agreement and don’t need any other RSRP reference definition |

###### 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.  [Rapp]  The NTA can be different for RACH procedure triggered during CG-SDT. For example, SSB below the threshold or SR. During the RACH procedure, should the UE use the NTA previously maintained for CG-SDT for msg3, or the TA received in the RAR? If the answer is the TA received in RAR, obviously, we need to maintain another NTA for the RACH procedure, which can be the legacy NTA in the spec. |
| Samsung | No | single N\_TA is used for both legacy TAT and CG-SDT-TAT |
| ZTE | No | The actual timing advance would be independent of whether CG-SDT is used or not. So, it seems we don’t really need to maintain two separate N\_TAs.  In general, the TA timer can be different (since it is used for different purposes) but the N\_TA should be the same (since it is used for calculating the timing advance which is the same). |
| Sharp | No | We think there is only a common N\_TA for either legacy RA or CG-SDT. It is weird to allow different N\_TA value for legacy RA and CG-SDT in the same cell.  According to TS38.133, *N*TA for PRACH is defined as 0. So the maintained N\_TA will not impact the initiation of RA. |
| OPPO | Comments | In this case, NTA received in RAR shall be maintained by UE, but we think CG-TAT-NTA shall also be stored before the contention is resolved for RACH. Similar issue has been addressed in LTE PUR transmission by introducing temporary NTA in case that RACH procedure is not completed successfully. Section 5.4.7.2 of TS 36.321 can be referred to:  - upon considering a Random Access procedure successfully completed:  - start or restart the *pur-TimeAlignmentTimer*, if configured;  - indicate to upper layers that the Timing Advance value has been adjusted;  - if a temporary NTA has been stored, delete the stored temporary NTA.  - upon considering a Random Access procedure unsuccessfully completed, if a temporary NTA has been stored:  - set the NTA to the stored temporary NTA;  - delete the stored temporary NTA. |
| CATT | No | We don’t see that is not necessary. |
| Lenovo | No | When UE initiates the CG-SDT procedure it uses the N\_TA value which was maintained from RRC\_CONNECTED state. In the legacy when performing a RACH procedure whether N\_TA is determined based on RAR TAC depends on whether TAT is running or not. Hence if we follow this procedure, UE would only apply the TAC received in RAR when TAT-SDT is not running. Otherwise UE keeps the N\_TA used for the CG-SDT. In general we think that UE only needs to maintain a single N\_TA value. The only issue is how this N\_TA is updated. |

###### 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. |
| Samsung | Comments | single N\_TA is used for both legacy TAT and CG-SDT-TAT  The N\_TA is as per the latest TA command. |
| ZTE | Not needed | We don’t think we need two different N\_TAs.  When the UE goes to INACTIVE with CG-SDT configuration (i.e. upon receiving RRCRelease), then the UE shall save the current N\_TA value (in the UE stored configuration) and use it for the CG-SDT session. If RACH procedure is initiated during SDT, then the N\_TA will be initialiesed during the RACH procedure and will be used accordingly. |
| Sharp | Comments | As commented in Q3, there is one common N\_TA maintained for either legacy RACH or CG-SDT.  After successful RACH completion, the N\_TA could have been updated and should be maintained and applied to the CG-SDT. |
| OPPO | Comments | Only one NTA can be maintained by UE. After RACH is completed successfully, UE shall maintain the NTA received in RAR and retart SDT-TAT. |
| CATT | No | We think single N\_TA value is used for both RA procedure and CG-SDT procedure. |
| Lenovo |  | See Question 3. We assume that UE only maintains a single N\_TA value. Question should be whether UE applies the TA command received in RAR or not. In the legacy UE ignores the TAC in RAR (CBRA) for cases that TAT is running. So the question is whether UE should update the N\_TA while CG-SDT-TAT is running. |

###### 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. |
| Samsung |  | For CG-SDT procedure   * Agree to restart the CG-SDT-TAT at successful RACH completion * Agree to not stop legacy TAT as in legacy |
| ZTE | It depends  (on whether CG-SDT is allowed for subsequent data) | Firstly we want to clarify per our comment above that the question is mainly about what happens when the TAC is received from the network (this may happen with or without a RACH procedure – so we should decouple this discussion from RACH completion).  If CG-SDT is only used for initial UL message (i.e. not for subsequent transmission), then the overall procedure is simpler (and is similar to LTE-PUR). In this case, the CG-SDT-TAT can simply be stopped after the successful acknowledgement of the first UL message.  On the otherhand, if CG-SDT is also used for subsequent data phase, then we need to decide how to handle the CG-SDT-TAT and legacy TAT.  The point is that when TAC is received, the TAT timer would be restarted. The issue is that the initial value of CG-SDT-TAT and legacy TAT can potentially be different. Also, the actions upon expiry of each of these timers is also different. Then it seems that we may need to maintain both timers if we allow CG-SDT to be used for subsequent data transmission as well. This seems to complicate the overall procedure a bit. |
| Sharp | Yes with comments | Regarding to the CG-SDT-TAT, it should be restarted upon the TA COMMAND is received in an successfully completed RA procedure in the cell where the CG-SDT is received.  Regarding to the legacy TAT, if the the RA is initiated within a CG-SDT procedure, we think it could be stopped when the RA is successfully completed to avoid the unnecessary behaviour of legacy TAT expiry, e.g. “flush all HARQ buffers for all Serving Cells;”. Otherwise, the TAT is not stopped as legacy. |
| OPPO | Yes | It is redundant to use two timers to maintain TA. |
| CATT | comments | There are 2 different cases:  Case 1: the UE performs RA during CG-SDT and remains in RRC\_INACTIVE:  The CG-SDT-TAT should be resrated when RAR is received as legacy TAT. And legacy TAT should also be started.  Case 2: the network indicates the UE go to RRC\_CONNECTED when RA at successful RACH completion:  In this case, we agree to stop CG-SDT-TAT and keep legacy TAT running. |
| Lenovo | Yes with comments | We think that there should be only one TA timer used at a time, i.e. either CG-SDT-TAT or legacy TAT. Hence when RACH procedure is performed during CG-SDT, legacy TAT is started upon reception of TAC in RAR (this was already agreed). We agree with the moderator that CG-SDT-TAT is restarted at successful reception of the RACH procedure. We also think that legacy TAT can be stopped. Otherwise UE would need to maintain two different TAT(s) and the UE behaviour would need to be defined for all the different cases based on the status of such two timers. |

###### 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. |
| Samsung | No | Agree with a) and b) |
| ZTE | Also depends | If the CG-SDT timer is only used in initial UL transmission phase, we think the expiry of CG-SDT-TAT after initial UL transmission and before the acknowledgement is received for the first UL message is a real corner case.  Hence, if this happens, we think the UE can just declare SDT failure.  The alternative is to fallback to RA-SDT, but this may be even more complex since this needs interaction with RRC layer and may also have impacts to common RACH procedure which seems not nice! |
| Sharp | Yes for (a) and (b)  No for (c) | For N\_TA, it could be maintained, as legacy. |
| OPPO | Partially yes | We agree with a).  For c), we also support to follow legacy, i.e., maintain NTA.  For b) and c), a case is observed that network may want to schedule retransmission for the first UL while CG-SDT-TAT expires. If NTA is maintained and the buffer where the MAC PDU of the first UL data is stored is not flushed, it is still possible for network to provide a TAC MAC CE to start/restart a timer for TA maintainance and then indicate the retransmission. |
| CATT | No | Same view as LG and Samsung. |
| Lenovo | No | We agree with a) and b). For c) the reason why we maintain N\_TA even when TAT is expired in legacy, is that NW could start the TAT by sending TAC MAC CE |

###### 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:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\TSGR2_116-e\Docs\R2-2111219.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 transmission  RAN1 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. |
|  |  | Reagrding the following agreement: The UE is allowed to initiate subsequent UL data transmission only after the reception of confirmation of initial transmission from the gNB.   * For the acknowledgment/confirmation of initial UL transmission during SDT, PDCCH addressed to SDT-RNTI is sufficient.   For subsequent UL data transmission using CG-SDT, Option B1 is sufficient. |
| ZTE | Option A | Considering the current status in RAN1, we think without L1 feedback it is a bit cumborsume to support CG-SDT for subsequent transmission.  Further, as noted above, the maintanece of TAT and CG-SDT-TAT and the interaction between these two gets complicated if we allow CG-SDT for subsequent new transmissions.  The main issue as explained above by the moderator is as follows:   * UE transmits a new transmission in subsequent CG resource. The network successfully receives it but there is no L1 feedback. Since there is no way for the UE to know the successful reception, the UE will retransmit. The only way to suppress such continuous retransmissions is:   + Either to support some MAC CE based ACK or   + Provide a new DG to suppress the retransmission (even if there is nothing to send UL, such DG will be needed)   We think defining a new MAC CE just for this ACK case is overly complex and comes with too much overhead.  If DG is necessary to supress retransmission, then it seems DG can be used for the the transmissions in the first place anyway. It is also unclear how the DG will interact with the configuredGrantTimer in this case (i.e. will the configuredGrantTimer be stopped when receiving this DG or something else??). So, it is not clear why we need CG for subsequent + DG just to provide ACK (when DG could simply have been used in the first place).  Based on the above analysis, and given the current situation with lack of L1 feedback, we think the best way forward is to simply use option A and this seems to significantly simplify the overall CG-SDT procedure. |
| Sharp | B2 |  |
| OPPO | Option B1 |  |
| CATT | B1 | We think defining one new MAC CE will introduce too much specification impacts and want to keep the spec simple. |
| Lenovo | B1 | We should stick to the earlier agreement that CG PUSCH or DG PUSCH can be used for subsequent UL transmissions. NW can implicitly ACK a previous transmission by sending a initial DG for the same HARQ process. |

###### 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. |
| Samsung | Yes |  |
| ZTE | Yes,  if we go with option B1 or B2 for Q7 | Assuming we allow CG-SDT for subsequent transmissions, we think allowing retransmissions for failure case is not a problem since in this case there will be NACK via CS-RNTI.  However, the problem is with supressing these retransmissions for the successful case as explained above since there is no ACK in this case. |
| Sharp | No | We think the retransmission for subsequent transmission could rely on dynamic grant. |
| OPPO | No | Considering that the calculation on the HARQ process ID for liscensed band is reused for CG-SDT, it may not be efficient to perform retransmission since the CG resource with same HARQ process ID appears in periodicity. |
| CATT | comments | Our question is how to trigger retransmission for CG-SDT. Unlike IIoT in Rel-16, the UE can’t find that the transmission has failed. So the mechanism to trigger autonomous retransmission is based on timer, like Rel-16 NR-U. if NR-U mechanism is reused to trigger retransmission on CG-SDT resource, some mechanism is needed to stop the timer. So we think the same mechanism as licensed band in RRC\_CONNECTED is used for subsequent CG-SDT transmission, i.e. network based retransmssion. |
| Lenovo |  | No strong opinion. However if there are no issues found with supporting (autonomous) retransmission for subsequent UL data, then we should have one common UE behaviour rather than supporting some functionality only for the initial SDT 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. |
| Samsung | See comments | Reagrding the following agreement: The UE is allowed to initiate subsequent UL data transmission only after the reception of confirmation of initial transmission from the gNB.   * For the acknowledgment/confirmation of initial UL transmission during SDT, PDCCH addressed to SDT-RNTI is sufficient. |
| ZTE | Yes | For initial transmission there can be no response from the network unless the network successfully receives the initial UL message from the UE. Hence any network response can be treated as an implicit ACK for the first UL message and until the UE receives such ACK it can restransmit (e.g. based on a timer).  For subsequent transmissions such assumption cannot be made because the network can always sechedule the UE (both in UL and DL) and such scheduling cannot be assumed as ACK for the CG-SDT transmission in subsequent resource. This is the problem with lack of L1 ack for subsequent transmissions. |
| Sharp | No | We prefer a explicit ACK as discussed in Q7. |
| OPPO | Yes |  |
| CATT | Yes | This question is related to Q7. We think this is simple. |
| Lenovo |  | Agree with Samsung |

###### 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?

|  |  |  |
| --- | --- | --- |
| **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. |
| Samsung | Yes |  |
| ZTE | No | For the initial UL message we can rely on CG-SDT timer and when this timer expires, the UE can retransmit autonomously on the same HARQ process.  If we don’t allow subsequent CG-SDT, then it seems we don’t need to use this timer anymore and the overall procedure is simplified again. If we do use CG-SDT for subsequent transmission phase, then we need discussion on how to indicate successful reception of UL CG transmission first. |
| Sharp | Yes | It could be reused as legacy. |
| OPPO | Comments | We think the function of CGT is necessary for subsequent new transmissions on CG. But we are wondering whether CGT and CG-SDT timer can be combined to one timer. |
| CATT | Yes | We think after the initial transmission of CG-SDT, the transmission between the network and the UE has been setup, the network is aware of the UE. Then, the same mechanism as that in RRC\_CONNECTED can be reused. |
| Lenovo | Yes |  |

###### Question10 Summary:

***TBD***

### Considerations on CG-SDT timer

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

|  |
| --- |
| * 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?

|  |  |  |
| --- | --- | --- |
| **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. |
| Samsung | yes |  |
| ZTE | Yes |  |
| Sharp | No | CG-SDT timer could keep running and be restarted. It is not clear for us the benefit to stop the CG-SDT except for the RRC feedback messages. |
| OPPO | No | In our understanding, CG-SDT timer is configured per HARQ process. If the PDCCH addressed to C-RNTI/CS-RNTI is used to indicate a successful transmission of the corresponding HARQ process, the timer can be stopped, otherwise, it shall keep running. |
| CATT | Yes | We think the function of the CG-SDT is to trigger autonomous retransmission, which is similar to CGRT. And CGRT will be stopped when PDCCH addressed to C-RNTI and CS-RNTI is received. |
| Lenovo | Yes |  |

###### 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:

|  |
| --- |
| 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

C:\Users\y00397895\AppData\Roaming\eSpace_Desktop\UserData\y00397895\imagefiles\9137B8C2-7B3C-460C-AFA5-2DA82BB5FB08.png

###### 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?

|  |  |  |
| --- | --- | --- |
| **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. |
| Samsung | Comments | Agree that re-evaluation of initial transmission is enough. Not needed to retransmission. |
| ZTE | No | We need to first discuss whether we allow UE to select retransmission resource from different CG configuration. We think this is is not needed.  For the case where there are many SSB within the cell, then the CG-SSB period will be quite long if there is only one CG occasion per CG period. To address this issue, we have 3 alternatives:  Alt1：have multiple CG occasion per CG period  Alt2：have a shorter CG period,  Alt3：have multiple CG configuration interleaving on time domain associated to different SSB.  For the three alternatives above, alt2 seems the simplest one (i.e. by NW implementation). If alt2 is not sufficient based on the majority view, then we can take one from alt1 and alt 3. Alt 1 has less impact on RAN2 but have some impact on RAN1; Alt3 has impact on RAN2 only (HARQ process derivation).  Based on the above, we prefer alt2. Then, it is up to network configuration to allow sufficient CG resources within one CG configuration to indicate the selected SSB.  If there is no consensus on this issue, the consequence could be that the UE may need to wait for multiple CG period for the CG occasion associated to the SSB selected (although this is a bit restrictive, it may still work for CG-SDT which aim to support the stationary UE without requirement on latency). |
| Sharp | - | We think the HARQ process ID should be same for retransmission as initial transmission, but we don’t see SSB re-evaluation is necessary for retransmission. So the question here is not existing. |
| OPPO | No |  |
| CATT | No | We think the HARQ process ID should be the same between retransmission and initial transmission. But since the HARQ process ID is calculated by timing for SDT, we think the HARQ process ID is not shared between different CG configrautions like IIoT in Rel-16. |
| Lenovo |  | We agree with LG/Samsung that evaluation is sufficient for initial CG transmissions. HARQ process ID should be always same for initial transmission and associated retransmissions. |

###### 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?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LG | No | See our reply to Q12. |
| Samsung | No |  |
| ZTE | Yes |  |
| Sharp | No |  |
| OPPO | No |  |
| CATT | No | The time between new transmission and retransmission might not be too long. So the channel condtion will be stable. Then, the benefits of reselction of SSB for retransmission are marginal. |
| Lenovo | No | We don’t see a need for this. |

###### 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

R2#115

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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?

|  |  |  |
| --- | --- | --- |
| **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. |
| Samsung | No | Legacy RA procedure using non SDT RA resources is applied |
| ZTE | Yes  (if CG is used for subsequent transmissions) | Depends on outcome of Q7 see above. |
| Sharp | No | Legacy RA procedure is enough. |
| OPPO | No | In our understanding, there is no technical issue to use RA-SDT resources. But considering the complexity to select among different RACH resources, it is suggested to restrict to legacy RACH resources. |
| CATT | No | Legacy RA procedure can be used. |
| Lenovo | No | In principle it would be also possible to use RACH-SDT for cases that there is no SSB above the configured threshold. However we don’t see much benefit compared to legacy RA procedure for this case. Therefore for simplicitly, we think that UE use trigger legacy RA procedure. |

###### 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?

|  |  |  |
| --- | --- | --- |
| **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”. |
| Samsung | Yes | Simple approach would be to always configure CS-RNTI in RRC Release. |
| ZTE | Yes |  |
| Sharp | Yes |  |
| OPPO | Yes |  |
| CATT | Yes | Otherwise, the UE can’t figure out new transmission and retransmission via NDI bit. |
| Lenovo | Yes | Needs to be anyway supported. |

###### 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?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LG | No | We think UL carrier selection is performed before SDT procedure is initiated, as discussed in common session. |
| Samsung | No | For legacy RACH, UL carrier is performed only when RA procedure is initiated. It is not performed for every RA attempt during the RA procedure.  UL carrier selection at the beginning of SDT procedure as agreed earlier is enough, |
| ZTE | No | Once the initial UL message is received, the UE shall not switch to different UL carrier. |
| Sharp | No |  |
| OPPO | No |  |
| CATT | No | To keep it simple, it is not necessary to perform UL carrier reselection for subsequent CG-SDT transmission over CG-SDT resources. |
| Lenovo | No | UE should do UL carrier selection for the initial SDT message. |

###### 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?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LG | Yes |  |
| Samsung | Yes |  |
| ZTE | Yes |  |
| Sharp | Yes |  |
| OPPO | Yes |  |
| CATT | Yes | It is not necessary to reselect carrier for autonomous retransmission. |
| Lenovo | 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 transmission  RAN1 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?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LG | No |  |
| Samsung | No |  |
| ZTE | No | We don’t see any restriction from RAN2 perspective. |
| Sharp | No |  |
| OPPO | No |  |
| CATT | No |  |
| Lenovo | No |  |

###### Question18 Summary:

***TBD***

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

|  |
| --- |
| 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?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| LG | No |  |
| ZTE | No | We think a short period can be used instead (as explained in Q 12) |
| Sharp | No |  |
| OPPO | No | If it refers to one CG configurations, the answer is no. |
| CATT | No | We have supported multiple CG configurations for SDT, so there is no necessity to support multiple CG occasions per CG period. |
| Lenovo | Yes | If the intention is to support multiple CG occasions per CG period in order to allow subsequent UL data transmission on CG resources we think that the answer should be yes. |

###### 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?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We think there are no other issues, but if we want to allow CG-SDT to also for subsequent transmissions, it seems we may have to discuss a few open issues further as noted above. In the interest of time, we think we should make such simplification to ensure that the CG-SDT feature is stabilized quickly at the next meeting. |
| Lenovo | 1. RAN2 should discuss whether UE in RRC\_INACTIVE configured with CG-SDT is required to maintain its uplink timing alignment as in RRC\_CONNECTED, i.e. UE in RRC\_INACTIVE (gradually) adjusts its uplink timing when there is a DL timing difference observed by the UE. This is somehow related to Question 6.  As seen from TS 38.133, up to and including NR Rel-16, a UE is required to maintain timing alignment for its UL transmission when it is in connected state, i.e. in RRC\_CONNECTED state; however UE is not required to maintain its uplink timing alignment in the inactive state (RRC\_INACTIVE). Up to Rel-17 it makes sense since UE is not performing any uplink transmission except PRACH. However, with the introduction of SDT, it actually makes also sense that UE maintains its uplink timing alignment in RRC\_INACTIVE, in particular for the case of CG-SDT. Since UE performs UL transmission, e.g. CG PUSCH, in RRC\_INACTIVE without a prior random access, it is beneficial for the timing accuracy if UE maintains its uplink timing alignment also in RRC\_INACTIVE when being configured with CG-SDT resources and a TAT timer. Maintaining uplink timing alignment means that UE in RRC\_INACTIVE (gradually) adjusts its uplink timing when there is a DL timing difference observed by the UE, e.g. UE autonomously adjusts its uplink timing in order to follow the DL timing reference. It is assumed that a UE in RRC\_INACTIVE (configured for CG-SDT) has a NTA value, e.g. last or most-recent NTA value used in RRC\_CONNECTED before being released to RRC\_INACTIVE. The UE would store and maintain NTA when being released to RRC\_INACTIVE. If the UE for example moves further towards the cell edge, the received downlink timing arrives at a certain amount of time later than the previous reference downlink timing. The UE may change the NTA to a NTA,adjusted accordingly based on the new downlink timing.  2. The pre-configured CG resources can be considered as dedicated resources. And the small data transmission is configured per DRB. It means there are allocated resources for SDT if the arrival data corresponds to the configured DRB which is allowed to perform SDT. If the legacy UAC is performed and the UE is barred for the SDT, the dedicated resources are wasted. Therefore, it is better to consider the access attempt as allowed if the pre-configured CG resources are configured for SDT and the arrival data corresponds to the configured DRB which is allowed to perform SDT. |

###### 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