**3GPP T****SG-RAN WG2 Meeting #115-e R2-210xxxx**

**Online, August 16 - 27, 2021**

**Agenda item: 8.6.5**

**Source: Qualcomm Incorporated**

**Title: Report of [Post114-e][508][SData] Open issues for CG-SDT**

**WID/SID:** **NR\_SmallData\_INACTIVE-Core – Release 17**

**Document for: Discussion and Decision**

# Introduction

This document is for the report of the discussion and summary of the following email discussion:

* [Post114-e][508][SData] Open issues for CG-SDT (Qualcomm)

**Scope:**

a) Is switching to RA-SDT allowed after initial CG-SDT transmission (i.e. the FFS if re-evaluation for every CG transmission is necessary for SSB selection if none of the SSBs is above the RSRP threshold)

b) Details of the window started of CG/DG transmission for CG-SDT (i.e. the FFS whether to design a new timer or to reuse an existing timer)

c) Any other FFSs for CG-SDT

d) Stage 3 details of CG configuration (identify the detailed parameters needed for CG type 1 configuration that could be reused and identify any new parameters needed. Can also have discussion on parameter range etc, identify if any feedback from RAN1 is needed)

**Intended outcome:** Report with agreeable proposals

**Deadline:** Long

The specific deadline for companies’ input is August 4th, 0900 UTC.

# Discussion

## Switching between RA-SDT and CG-SDT

In RAN2 #113bis-e meeting, the following agreements related to switching between RA-SDT and CG-SDT were agreed. Whether switching from CG-SDT to RA-SDT is allowed or not is FFS, highlighted in yellow.

|  |
| --- |
| RAN2 #113bis-e agreements   * Switching from SDT to non-SDT is supported. * FFS Switching from CG-SDT to RA-SDT is not allowed * UE switches from SDT to non-SDT in following cases:   + Case 1 (27/0): UE receive indication from network to switch to non-SDT procedure.     - Network can send RRCResume. FFS whether network can send indication in RAR/fallbackRAR/DCI to switch to non-SDT procedure.   + FFS Case 2 (18/9): Initial UL transmission (in msgA/Msg3/CG resources) fails configured number of times |

RAN2 #114e meeting made the following agreement related to the criteria for initiation of CG transmission.

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| --- |
| RAN2 #114e agreement  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 |

In the SDT initiation stage, if none of SSB is qualified to be selected for CG transmission, it seems that UE is not allowed to transmit any small data on the CG resource. If CG-SDT criteria are not met, UE should further check the RA-SDT criteria to evaluate whether the criteria of RA-SDT could be met or not. Therefore, the rapporteur think it is straightforward for UE to evaluate and select RA-SDT if none of SSB is qualified in CG criteria in the initial CG transmission phase [12], [20], [26], [28], [34].

Companies are invited to answer the following questions.

### **Question 1: Do companies agree UE should select RA-SDT if none of the SSBs’ RSRP is above the RSRP threshold of CG-SDT criteria in the initial CG transmission phase.**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes | As the agreement above, for initial CG transmission, UE does not select any SSB if none of the SSBs’ RSRP is above the RSRP threshold. Then if none of the SSBs’ RSRP is above threshold, it is considered that the criteria of CG-SDT are not met. |
| ZTE | Yes | However, we think this is already agreed (please see the following agreements:  The general procedure agreed is as follows (R2#113bis-e):  *If CG-SDT criteria is met: UE selects CG-SDT. UE initiate SDT procedure*  *Else if RA-SDT criteria is met: UE selects RA-SDT. UE initiate SDT procedure*  *Else: UE initiate non SDT procedure.*  On top of this we also agreed that “*For initial CG transmission, UE does not select any SSB if none of the SSBs’ RSRP is above the RSRP threshold*”  Based on the above, our understanding is that this is already agreed (for initial CG transmission phase). |
| Samsung | See comments | In this case, UE should assume that CG-SDT criteria is not met. Whether UE uses RA-SDT or not depends on whether RA-SDT criteria is met or not. |
| Fujitsu | Yes | Same view with rapporteur that switching between RA-SDT and CG-SDT would be permitted. |
| Google | Yes | As agreed by RAN2, if RSRP is not above a threshold, UE selects RA-SDT. |
| LG | See comments | This is the case when the CG-SDT criteria is not met. In this case, we agree with Samsung that Whether to use RA-SDT or not depends on whether RA-SDT criteria is met or not. |
| OPPO | Yes | We also agree that UE shall turn to the check of RA-SDT if none of the SSBs’ RSRP is above the RSRP threshold for CG-SDT validation. But we think it might be not proper to use ‘in the initial CG transmission phase’ since this description can lead to another understanding that CG-SDT has be selected while UE needs to fallback RA-SDT due to no qualified SSB. So we suggest to modify the wording to ‘in the SDT type selection phase’. |
| Sharp | See comments | We share the same view with Samsung. If none of the SSBs’ RSRP is above the RSRP threshold of CG-SDT criteria, the CG-SDT criteria is not met and it should be indicated to RRC. Whether RA-SDT is applied later depends on the evaluation of RA-SDT criteria. |
| Lenovo | Yes | We think that UE applies the general CG/SDT selection procedure with the consideration that the CG-SDT criteria are not met. Hence as mentioned by Samsung, UE further checks whether criteria for RACH-SDT are met. |
| FGI, APT | Yes, with comments | Same view as Samsung. If none of the SSBs’ RSRP is above the RSRP threshold of CG-SDT criteria in the initial CG transmission phase, the UE should check the RA-SDT criteria. For example, whether the RA-SDT resource is configured on the selected UL carrier. If so, the UE can select RA-SDT. Otherwise, the UE should initiate the RA procedure for legacy RRC resume request. |
| Intel | Yes | If any of the CG-SDT specific conditions are not met/valid (i.e. TAT is not running or TA validation criteria of the RSRP delta threshold is not met), UE should be allowed to fallback to RA-SDT (which would be still considered the 1st UL attempt). However, rebuilding of the MAC PDU should not be a concern (as rebuilding is not needed). |
| Apple | See comments | When CG-SDT criteria is not met, we agree with Samsung that whether to use RA-SDT or not depends on whether RA-SDT criteria is met or not. |
| CATT | Yes | We share the same view that if none of the SSB’s RSRP is above the threshold of CG-SDT, it means the criteria of CG-SDT are not met. |
| InterDigital | Yes | UE attempts RA-based SDT if conditions for selecting CG-based SDT are not met. |
| vivo | Comments | We can follow the FFS below as the baseline.   * *FFS on the order and missing pieces (e.g. failure, fallback) of the high level procedure. .* * A. Upon arrival of data only for DRB/SRB(s) for which SDT is enabled, the high level procedure for selection between SDT and non SDT procedure is as follows:   + If CG-SDT criteria is met: UE selects CG-SDT. UE initiate SDT procedure   + Else if RA-SDT criteria is met: UE selects RA-SDT. UE initiate SDT procedure   + Else: UE initiate non SDT procedure. |
| Huawei, HiSilicon | Y | But, this has already been implied by the current agreement and discussed during RAN2#114e. During the online discussion, the previous FFS was removed |
| ITRI | Yes | When none of the SSBs’ RSRP is above the RSRP threshold of CG-SDT criteria, UE could select RA-SDT. However, whether the UE could perform RA-SDT should depend on the RA-SDT criteria. |
| Ericsson | Y | UE behaviour should be specified. Should be a rare case though: If CG-SDT selected (using a cell RSRP threshold) then there shouldn’t be a case where no individual SS-RSRP is not above SS-RSRP threshold. |
| Nokia | See comments | Agree with Samsung RA-SDT criteria is then checked if CG-SDT criteria is not met. |

In the online discussion of RAN2 #114e meeting, another issue is that whether it is necessary for UE to reevaluate the SSB for every CG transmission. Current RAN2 conclusion is that the SSB selection and RSRP evaluation is only for the initial CG transmission stage. However, CG resource may exist on multiple SSBs. So, we need to understand if UE can select (potentially a different) SSB for subsequent CG transmissions.

Companies are invited to answer the following questions.

### **Question 2: During the subsequent CG transmission phase, for the purpose of CG resource selection, do companies think it is necessary to re-evaluate the SSB for every CG transmission?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes | Since the radio condition of SSB for pervious transmission may change from time to time, the UE could re-evaluate the SSB for every CG transmission and select an appropriate beam. |
| ZTE | Yes  (for CG resource selection) | Seems the question is about CG resource selection and in this case, since CG resource may be configured on multiple SSBs, we think during the subsequent transmission phase, it is possible for the UE to select the CG resource associated with a different SSB (if configured). |
| Samsung | Yes | UE should select SSB for CG resource selection |
| Fujitsu | Yes | Otherwise, SDT on CG may be performed without meeting the required radio condition for CG, which should be avoided. |
| Google | Yes | UE should reevaluate SSBs to select a good SSB. |
| LG | No | We think RSRP evaluation at CG-SDT initiation is enough considering that the SDT procedure would not last long. If beam quality becomes worse during subsequent transmission, SDT failure handling procedure can be applied. |
| OPPO | Yes | If the CG-SDT resources are configured on multiple SSBs, it is beneficial to transmit the data on resources with better radio link quality. |
| Sharp | Yes |  |
| Lenovo | Yes | Linkage between SSB and CG resources should be also considered during subsequent data transmission phase |
| FGI, APT | Yes | Since there is no beam failure detection mechanism and beam reporting in RRC\_INACTIVE, it’s beneficial to update the selected SSB information to NW to reflect the timely DL channel condition. |
| Intel | Yes | We think similar behavior in case of RACH procedure, i.e. UE re-evaluating the SSB for each transmission should be used. |
| Apple | Yes | Since UE’s radio quality may be changed, UE should re-evaluate the SSB for each CG transmission. |
| CATT | Yes | If BFR is not agreed to be used in SDT, we think evaluating SSB for every CG transmission is necessary which can make sure the selected SSB is good enough to provide qualified channel condition. |
| InterDigital | Yes | Per SSB-radio conditions change from one CG occasion to the next. |
| vivo | Yes | We think this is straight-forward, which is similar to the SSB selection for every RACH attempt. This is because the suitable beam might be changed due to the time-varying characteristic of radio channel. |
| Huawei, HiSilicon | Yes | It is important that, with the mobility of the UE, that it re- evaluates the SSB and indicates the suitable SSB to the network for CG transmission. Actually, the issue of SSB selection is a potential issue for RA-SDT, for which the subsequent UL transmission is only based on DG, an issue which we may need to address. |
| ITRI | No | Same view with LG that this case should be considered as SDT failure case and the SDT failure handling procedure can be applied. |
| Ericsson | Yes | Solutions to lower gNB blind detection should be considered I necessary. |
| Nokia | Comments | After initial transmission and success reception of NW response, in principle the UE should not change serving beam by itself. While before NW response, the UE could select other beams if the previous one fails since the UE is not visible to the NW yet.  For subsequent transmissions after NW response, how beam management works should be discussed separately, and it should be common for RA-SDT and CG-SDT. |

After UE has selected CG resource to perform CG-SDT, it is possible that UE may not receive any downlink response during the monitoring window (timer window will be discussed in section 2.2) due to the link degradation [23]. In some cases, TA may become invalid at next CG occasion in the subsequent CG transmission phase [16], [30], and UE may not be allowed to continue transmitting data in CG resource, and UE should perform RACH to regain the synchronization. In some other cases, the best serving beam may also have to be changed during subsequent CG-SDT phase [30], and current beam may not be suitable. Some companies [26] also analyze that it can be useful to switch to RACH based SDT to retransmit the TB after a configured number of consecutive failures.

Therefore, one possible solution is that UE is allowed to switch to initiate RACH procedure if CG SDT is failure due to certain reasons, which may help UE to finish the data transfer in short latency. The condition to allow UE performing switching from CG-SDT to performing RACH may be based on the reason of no qualified beam when (re)evaluation or invalid TA or a configured number of consecutive failures or other reasons.

However, some companies express that switching from CG-SDT to RA-SDT is not needed [34], because the switching to RA-SDT is fundamentally related to reliability and the HARQ retransmission is sufficient for SDT reliability. Moreover, the switching brings complexity to SDT such as MAC PDU rebuilding [34].

Companies are invited to answer the following questions.

### **Question 3: Do companies agree that UE can initiate RACH procedure during subsequent CG transmission phase?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes | If the SSBs are not qualified for CG transmission, the UE should initiate RACH procedure. |
| Samsung | Yes, but comments | This does not mean that UE switches to RA-SDT. UE can initiate RACH if SR is triggered or none of SSBs are suitable |
| Fujitsu | Yes | We have the similar view pointed out in [26,30] as rapporteur pointed out above. |
| Google | Yes | The conditions to initiate the RACH procedure should be discussed. |
| LG | Comments | If CG-SDT transmission fails due to some reasons, it would be enough to apply SDT failure handling procedure. We don’t want to mix-up the CG-SDT procedure and RA-SDT procedure. The UE can initiate RACH procedure during subsequent CG transmission phase, but this RACH procedure should be a normal RRCResume procedure (i.e. not RA-SDT procedure). |
| OPPO | Yes | RACH procedure can be triggered during the subsequent CG transmission, i.e., when BSR is triggered while SR resource is not available, as we have agreed. Other events that can trigger RACH needs to be further discussed. |
| Sharp | Yes | A SR could trigger a RA procedure. |
| Lenovo | Yes | Similar to other responses we also think that UE should initiate RACH procedure in certain conditions, i.e. no SSB above threshold, UL timing becomes invalid etc. |
| FGI, APT | Yes | It’s also worth discussing that the UE should initiate RA-SDT (via SDT preamble) or legacy RA procedure (via non-SDT preamble) during CG-SDT procedure in this case.  On the other hand, in our understanding, it seems the SR could not trigger RA procedure in this case. Based on current spec, if the UE is configured with CG resource, the UE will consider there is available UL-SCH resource, so the UE does not trigger SR by BSR. Then the UE will not trigger RA by SR. |
| Intel | See Comments | Firstly, we understand that there might be two scenarios to consider here:   1. If the UE has still not gotten successful ACK of the 1st UL SDT including RRCResumeRequest, we assume that the UE can still initiate the RA procedure. 2. If “subsequent CG transmission phase” here means that the UE has received some ACK from the NW for the first UL CG message already, then the need for switching to RACH afterwards during the ongoing SDT session is not clear to us. This is because we assume that the UE reevaluates the SSB criterion and is thus likely to find a suitable SSB, so it is preferred to continue using CG. Moreover, assuming a SDT session is sufficiently short in duration, the need of switching to RACH during an ongoing CG-SDT session is not pressing. Finally, as observed in [34], this can also create complexity with respect to MAC PDU rebuilding. |
| Apple | Yes | During the subsequent transmission phase, if the criteria of the SDT-CG is not met, UE can fallback to RA-SDT procedure if the RA-SDT criteria is met, otherwise, UE should trigger the legacy resume procedure. |
| CATT | Comments | We think Question 3 is not clear. There are two understandings.  Understanding 1:FFS Switching from CG-SDT to RA-SDT is not allowed  Our answer to this FFS is no. Because failure recovery in CG-SDT been a long time that there is no necessity to switch to RA-SDT.  Understanding 2: When data arrives but there is no UL grant, whether it is allowed to trigger RA.  Our answer to this question is yes. Since SR is not supported in SDT, only RA procedure can be used to indicate the network the arrival of new data. |
| InterDigital | Yes | Beam alignment cannot be guaranteed to be maintained during the subsequent transmission phase and in some cases no SSB can be found as suitable/above the RSRP threshold. |
| vivo | Comments | If the radio link quality is too poor, we think the UE should be allowed to autonomously fallback to the legacy resume procedure. And then, the UE can trigger RA procedure for legacy resume procedure. |
| Huawei, HiSilicon | Y, but only in certain situations | The exact reason/trigger need to be specified. For example the UE can initiate normal RACH if SR is triggered or if none of the associated SSBs are above the minimum SSB threshold during the subsequent CG transmission phase |
| ITRI | Yes | Same view with OPPO that BSR may be one of RA trigger event during subsequent CG transmission phase. |
| Ericsson | Comment | The different cases need to be discussed. In general, failiure should not mean or allow switching, rather reinitiating a SDT procedure. Otherwise new grants can be used and sufficient for subsequent data. Only exception to use RA is if restrictions prevent use of CG-SDT (subsequent procedure). RA for re-tx would probably also require MAC rebuilding. |
| Nokia | Comments | “Subsequent CG transmission phase” is a bit ambiguous in the question as it usually refers to the phase after the initial transmission has been successful.  The question should cover several cases:   1. If RA-SDT is allowed if initial transmission does not go throught; 2. If RA is allowed if CG resource becomes invalid for subsequent transmissions after initial transmission is responded.   If case 1 is allowed, rebuilding might be needed.  While case 2 does not seem to introduce extra complexity as normal RA can be used as SR with C-RNTI MAC CE in MSG3 since the UE is already known to the NW. However, with CG, unlikely we need to trigger SR/RA. |

Companies are invited to select the preferred option below and provide comments.

### **Question 4: If during CG-SDT UE is allowed to initiate RACH procedure per Question 3 above, on what condition(s) UE is allowed to initiate RACH?**

* **Option 1: no qualified SSB when the evaluation is performed**
* **Option 2: TA is invalid**
* **Option 3: after a configured number of consecutive failures**
* **Option 4: others (RACH based SR is triggered due to lack of UL resource)**

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| --- | --- | --- |
| Company | Reply (Option 1/2/3/4) | Detailed comments |
| ASUSTeK | Option 1, 2, 3, 4 | Option 4: As agreement in RAN2#113bis, since SR resource is not configured for SDT, the UE triggers RA procedure when the BSR is triggered by SDT data. |
| ZTE | Option 2, Option 4 (when SR is triggered due to lack of UL grant) | If there is no qualified SSB when the valuation is performed, UE can choose any SSB (same as RACH).  We also don’t think that fallback after configured number of consecutive failures is needed. |
| Samsung | 1, 2 and 4 |  |
| Fujitsu | At least Option 1, 2 | Option 1 aligns with Q1.  Option 2 aligns with existing principle that UE can only send RACH when TA is invalid.  Option 3 needs further discussion since email discussion [507] is discussing SDT failure. Consecutive failure may be considered as SDT failure and may not be good to carry on SDT. |
| Google | 1, 2 and 4 | If BSR is triggered, UE should initiate a RACH procedure and if BFR is supported, UE should also initiate RA procedure if beam failure happens. |
| LG | None | If CG-SDT transmission fails due to some reasons, it would be enough to apply SDT failure handling procedure. We think switching from CG-SDT to RA-SDT is not needed. |
| OPPO | Option1 with comments, Option 4 | For Option1, we understand the intention to trigger RACH is to inform the network of the best SSB which is not configured with CG resources. The benefit is to continue the data transmission instead of waiting for the failure. This can be a solution if there is not any other beam management mechanism supported, which we need to further check with RAN1.  For Option2, we are not sure whether it is a valid case. In our understanding, once the SDT is triggered and the first UL transmission is completed, the network can update the TA to guarantee that the TA is valid before the procedure is terminated.  For Option3, consecutive failures may happen in either MAC or RLC. Regarding the retransmission of TB in MAC, it is under the control of network, thus, we do not need to introduce any maximum transmission threshold. For the RLC failure detection, i.e., maximum retransmission of AM data is reached, we need further discuss whether it is supported since no consensus was made during last meeting. If it is supported, we think some procedures shall be triggered by higher layer to handle this case instead of RACH. |
| Sharp | Option 1, 2 and 4 |  |
| Lenovo | 1,2,4 |  |
| FGI, APT | Option 1, 2, 3 | For option 2, we would like to clarify whether TA invalid includes both cases of TAT expires and RSRP change?  For option 4, we think this may not happen in current spec. If the UE is configured with CG resource, the UE will consider there is available UL-SCH resource, so the UE does not trigger SR by BSR. Then the UE will not trigger RA by SR. |
| Intel | At least 1,2 | In case of the first scenario we mentioned in our comment on Q3 above, options 1 and 2 are straightforward conditions for triggering RACH. The need for option 3 is not clear, mainly because we assume the SDT failure detection timer already serves a similar purpose |
| Apple | Option 1,2,3,4 | Option 1 and Option 2 are the case that the CG-SDT criteria can not be met. As discussed in the previous questions, UE should fallback to RA-SDT if the RA-SDT criteria is met.  Option 3 is about the condition to justify the CG-SDT procedure failure. If the CG-SDT transmission failure reaches a configured number, it should be regarded as the CG-SDT failure, UE should fallback to RA-SDT or legacy resume procedure.  Option 4 is about the RA-SR triggering during the CG-SDT transmission phase, which has been agreed in last RAN2 meeting. |
| CATT | 1,2,4 | Option 2: without valid TA, UE can only acquire UL synchronization by RA;  Option 4: SR is not agreed in SDT, so only RA procedure can be used to obtain UL grant.  We also think non-SDT data can only be transmitted using RA-based method. |
| InterDigital | 1, 2, 3, 4 | Channel conditions, beam misalignment and synchronization can change during subsequent transmission phase, which can cause a repeated failure to transmit the TB. |
| vivo | 2,3 | In our understanding, CG-SDT is not intended for latency-sensitive service. In this sense, if no qualified SSB could be selected, then the UE can increment the failure counter and wait for the following subsequent CG-SDT. If the failure counter has reached the threshold, then the UE should autonomously fallback to the legacy resume procedure. |
| Huawei, HiSilicon | 1, 2 | From our understanding, Option 2 is already supported based on the current agreement, i.e. :  “SR resource is not configured for SDT. When the is triggered by SDT data, the UE will trigger RA because SR resource is not available, same as legacy”  Option 3 is relevant for initial CG\_SDT transmission, but not during subsequent data phase. |
| ITRI | 4 | Option 1~3 should be handled by the SDT failure handling procedure. |
| Ericsson | 2,4 | If TA is invalid (at least if TAT expires), CG should be released. Then UE initiates RA-SDT. Option 4 after CG procedure termination. |
| Nokia | 1, 2 |  |

Some companies [28] mention that the rebuilding of MAC PDU may be required when UE switches from CG-SDT to RA-SDT, and other solutions may be better than the switching mechanism.

If rebuilding of MAC PDU is needed, whether the details of rebuilding mechanism should be specified or should be left to UE implementation needs further discussion [23], [26], [30].

Companies are invited to answer the following questions.

### **Question 5: If RACH procedure is initiated per Question 3 above and MAC PDU rebuilding is required, do companies agree the MAC PDU rebuilding can be left to UE implementation?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes |  |
| ZTE | Yes |  |
| Samsung | yes |  |
| Fujitsu | Yes | We assume that SDT is infrequent and processing requirement is not strict. The rebuild is considered to be not burden of UE. |
| Google | Yes | As in LTE, PDU rebuilding can be left to UE implementation |
| LG | Yes | But we don’t think the UE can switch from CG-SDT to RA-SDT. |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes |  |
| Intel | Yes | For the first scenario we mentioned in Q3, MAC PDU rebuilding can be handled by UE implementation. |
| Apple | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| vivo | Yes |  |
| Huawei, HiSilicon | Yes, but | Should be discussed together with the other failure cases and strive for more systematic treatement |
| ITRI | Yes |  |
| Ericsson | Yes | Although, we think the status in general agreements are still that no rebuilding or switching is supported. |
| Nokia |  | Should avoid rebuilding or it cannot be left to UE implementation. |

## Monitoring window for CG-SDT

RAN2 #113bis-e meeting made the following agreement, i.e. UE should start a window after CG/DG transmission for CG-SDT. Whether introduce a new timer or reuse an existing timer is FFS.

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| RAN2 #113bis-e agreement  UE start a window after CG/DG transmission for CG-SDT. FFS whether to design a new timer or to reuse an existing timer. |

In the email discussion [6], the PDCCH monitoring timer after CG transmission was discussed and the new timer similar to the *pur-ResponseWindowTimer* specified in LTE PUR [36.321] was also briefly introduced. The behavior of the new timer for CG-SDT could be assumed to be similar with the *pur-ResponseWindowTimer*.

Meanwhile, during the email discussion [6], some companies also mentioned the existing timer may be reused. Some companies [18] proposes that the *drx-InactivityTimer* may control the PDCCH monitoring since SDT targets short and infrequent data traffic and may not fail many times due to lots of criteria to decide whether to perform SDT. However, in RAN2 #113bis-e, RAN2 has agreed that ‘*connected mode DRX is not supported for SDT*’ [2]. Whether the *drx-InactivityTimer* related to DRX mechanism can be used in this case needs further discussion. Some companies [20] mentioned the *cg-RetransmissionTimer* specified in Rel-16 can be reused for UE monitors the reception of the gNB response and other UE behaviors regarding the *cg-RetransmissionTimer* can be kept as the Rel-16. There are also some other companies think the new T319 timer (SDT failure detection timer) can be considered.

From the rapporteur’s understanding, the timer (either new or existing timer) served for PDCCH monitoring after CG/DG transmission for CG-SDT should be a MAC layer timer. Within the timer window, UE should monitor PDCCH to check any feedback from network on the status of latest transmission. According to the feedback, UE can decide to perform a new transmission or retransmission. The intention of this timer can be similar to a MAC layer retransmission timer. While for the SDT failure detection timer, i.e. new T319 timer, it should be a RRC layer timer serving for failure detection of CG-SDT, and RAN2 #113bis-e meeting has agreed the stop conditions of legacy T319 should apply to SDT failure detection timer [2]. It seems to be a little different from the intention of the MAC timer for PDCCH monitoring.

Companies are invited to answer whether a new timer or the existing timer is preferred for PDCCH monitoring in the following questions.

### **Question 6: Regarding the timer for UE to monitor PDCCH after CG/DG transmission for CG-SDT, what timer do companies prefer, a new timer or reuse the existing timer? Companies are encouraged to provide the reasons.**

1. **New timer**
2. **The existing timer**

|  |  |  |
| --- | --- | --- |
| Company | Reply (a/b) | Detailed comments |
| ASUSTeK | b | We could reuse an existing DRX timer rather than reuse the “connected mode DRX”. |
| ZTE | b | The actual use of the timer should be clarified a bit.   * Is it for failure detection or, * Is it for controlling the retransmission of the first UL message?   Assuming this timer is to control the retransmission of the initial UL message, we think a timer similar to the existing CG-retransmission timer can be used. Some more details are provided in our answer to Q10 below. |
| Samsung | a/b | Prefer a new timer |
| Fujitsu | a | Reusing existing timer may not be good since SDT is new mechanism. It seems good to introduce a new timer for new mechanism SDT. The introduction of a new timer may also ease ASN.1 coding. |
| Google | a | Using a new timer has less impact on existing timer. |
| LG | a | As RAN2 agreed that connected mode DRX is not supported to SDT, we cannot use the existing timer. |
| OPPO | a | We suggest to use a new timer for the PDCCH monitoring after CG/DG transmission in CG-SDT. For the existing timers, we think none of them can be reused if we have a right understanding of these exiting timers.   1. cg-RetransmissionTimer/ *configuredGrantTimer* is used to determine whether UE can use the CG sources with the same HARQ process for retransmission/new new transmission. These timers are not used to control the monitoring of PDCCH. 2. *drx-InactivityTimer* defines a duration that UE monitors PDCCH after a new UL or DL is received.This timer will not be restarted for retransmission scheduling. Threrefore, there is a risk that UE does not monitor PDCCH any more when drx-InactivityTimer expires while network still needs to schedule retransmission. In this case, functions like *drx-RetransmissionTimerUL* might be necessary.   In addtion, it is still not clear whether the timer we want to have for SDT is configured per UE or per HARQ process. |
| Sharp | a | We prefer a new timer to avoid any possible impact on existing timer. |
| Lenovo | a | Slight preference for a new timer |
| FGI, APT | Comments | Before choosing which timer is feasible, we should clarify what’ s the intention of this timer first.  If the UE behavior is only to monitor PDCCH, some DRX timers can be reused, e.g., drx-RetransmisiontimerUL.  However, if there are other UE behaviors on the timer. For instance, the UE should do something when the timer expires, a new timer is more favorable, so that we can define the specific UE behaviors on this new timer and not influence the legacy. |
| Intel | b | We think that the functionality for the CG-SDT timer, i.e. monitoring of PDCCH after CG transmission for either a A/N or a DG/CG for subsequent transmission is quite similar to what the new T319 timer seeks to accomplish, i.e. SDT failure handling in case the UE does not receive any response form the network. Therefore, we prefer to use the same (newly defined) T319 timer to have a uniform failure handling design for CG-SDT and RA-SDT. |
| Apple | a | CG-SDT is a new mechanism and requires a new configuration. Therefore, a new timer should be introduced and configured with the CG-SDT configuration. |
| CATT | a/b | If BFR is not supported, we think a timer for failure detection is useful. |
| InterDigital | a | It was agreed that “connected mode DRX is not supported for SDT” in RAN2#103-bis-e, so the drx timers cannot be re-purposed for this monitoring |
| vivo | a | In LTE PUR, a new timer PUR response window is introduced, we think it is a spontaneous logic to introduce a new timer for CG-SDT, which helps to make the spec clear. |
| Huawei, HiSIlicon | A | We have agreed not to reuse DRX for small data transmission. A new timer needs to be defined. |
| Ericsson | a | New timer. |
| Nokia | a | Seems to be simplest to define new timer for initial CG transmission before NW response, if any UE retry is to be supported.  For subsequent CG after NW response, no further timer needed. We do not assume there is auto retransmission for subsequent CG which has only been supported for NR-U. |

Regarding more details on the existing timer, there are options based on the pervious email discussions and contributions. Companies are invited to answer the following question. The proponents are encouraged to provide detailed time behavior.

### **Question 7: If companies select to reuse the existing timer per Question 6 above, which following options do companies prefer?**

* **Option 1: similar to drx-InactivityTimer**
* **Option 2: cg-RetransmissionTimer**
* **Option 3: new T319 timer (SDT failure detection timer)**
* **Option 4: other**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Option ½/3/4) | Detailed comments |
| ASUSTeK | Option 4 | Similar to drx-RetransmissionTimerUL. |
| ZTE | Option 2 | Assuming the timer under discussion is to control the retransmission of the first UL message. |
| Samsung | Option 4 | New timer which starts from the first PDCCH monitoring occasion after the end of PUSCH transmission |
| LG | Option 1, 2, 4 | RAN2 agreed in RAN2#113bis that “UE start a window after CG/DG transmission for CG-SDT”. It doesn’t matter which existing timer behavior should be followed by a new timer. |
| OPPO | Option 4 | A new timer similar to drx-RetransmissionTimerUL. It can be further discussed whether we introduce ConfiguredGrant timer to control the new transmission on the CG with same HARQ process or combine the function of CGT to this new timer. |
| Lenovo | Option 4 | Some new timer similar to drx-retransmissionTimerUL |
| FGI, APT | Option 4 | For Option 1, if DRX timer is acceptable, we think drx-RetransmissionTimerUL is better than drx-InactivityTimer. Because drx-InactivityTimer is performed per MAC entity while drx-RetransmissiontimerUL is performed per HARQ process. If the intention of the timer is to monitor the feedback for a UL transmission, per HARQ process-based timer is more feasible.  For Option 2, we think this is not very appropriate since the UE does not monitor PDCCH while the cg-RetransmissionTimer is running. However, the UE should monitor PDCCH to receive the feedback or retransmission scheduling while the timer is running. In PUR, we also defined that the UE should monitor PDCCH while the PUR response window is running.  For Option 3, we prefer to have a MAC timer instead of a RRC timer (if option 3 is a RRC timer) since the UE behaviors on the timer are specified in MAC spec. |
| Intel | Option 3 | Same comments as in Q7. |
| Apple | Option 4 | We prefer a new timer similar as drx-RetransmissionTimerUL. |
| CATT | Option 2, 4 | Option 1:  Since subsequent transmission is agreed in SDT, and there are potential DL transmissions during subsequent transmission, it is strange that UE does not monitor PDCCH if timer like drx-InactivityTimer does not running.  Option 2:  We think cg-RetransmissionTimer can be used to trigger autonomous retransmission and we can define one maximum number of retransmission to trigger failure detection.  Option 3:  Timer like new T319 timer is useful in RRC, but it is not efficient in MAC.  Option 4:  Similar to pur-ResponseWindowTimer.  Pur-ResponseWindowTimer.like timer is useful especially when BFR is not supported. It can be started for each new UL transmission when it is not running. When this timer expires, UE can trigger one RA attempt. |
| Huawei, HiSIlicon | Option4 | A new timer should be designed |
| Ericsson | Option 2, 4 |  |
| Nokia | 4 | New timer. |

Regarding the new timer for PDCCH monitoring in CG-SDT, the behavior of new timer could be similar to the *PUR-ResponseWindowTimer* specified in LTE PUR [36.321]. UE monitors PDCCH when the timer *PUR-ResponseWindowTimer* is running in LTE PUR. Regarding the behaviour of new timer, the start/stop/timer expiry condition seems to be similar with that of the timer *PUR-ResponseWindowTimer*. The details should be further discussed.

Companies are invited to answer the following questions related to the behavior of new timer. The proponent of the new timer is encouraged to explain the expected behavior in the detailed comments.

### **Question 8: If companies prefer to have a new timer for PDCCH monitoring after CG/DG (re)transmission in CG-SDT per Question 6 above, do companies agree the new timer should start after each transmission scheduled by CG or DG?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ZTE | Yes | In fact even if a new timer is defined, its functionality will be very similar to the CG-retransmission timer. |
| Samsung | Yes | Timer can be started from the first PDCCH monitoring occasion from the end of PUSCH transmission |
| Fujitsu | Yes | It seems to align with the previous agreement in RAN2 #113bis-e. |
| Google | Yes | UE should restart the timer to detect a possible uplink grant. |
| LG | Yes |  |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes |  |
| Intel | See comment | While we do not prefer to have (yet) another timer as per our comments above, if a new one is defined, it should start/restart with each CG/DG transmission during a given SDT session. |
| Apple | Yes |  |
| CATT | Comments | For cg-RetranmissionTimer like timer, the timer can be restarted  For PUR-ResponseWindowTimer like timer, it can started when it is not running. Otherwise, failure can’t be detected. |
| InterDigital | Yes |  |
| vivo | Yes | The operation behavior that is similar to PUR respone timer can be taken as the baseline. |
| Huawei, HiSilicon | Y |  |
| Ericsson | Yes |  |
| Nokia | No | For subsequent transmissions, no need to duplicate the functionality for T319-like timer.  We have not decided to have CG retx yet which was only supported for NR-U in Rel-16. Should just reply on NW dynamic grant after the UE is known to the NW. |

In RAN2 #114e meeting, RAN2 agreed that some feedback may be beneficial in case CG is used for the subsequent transmission and assumed the existing mechanism can be used [1].

|  |
| --- |
| RAN2 #114-e agreement  RAN2 thinks that some feedback may be beneficial in case CG is used for subsequent transmission. RAN2 assumes that existing mechanism can be used. |

Please note that RAN2 has sent LS [10] to RAN1 to ask the detailed feedback from the existing mechanism. Thus, the following question will not focus on the feedback itself, instead, it is only related to the discussion on whether the stop condition is related to the feedback. Companies are invited to answer or comment.

### **Question 9: If companies prefer to have a new timer for PDCCH monitoring after CG/DG (re)transmission in CG-SDT per Question 6 above, do company agree the timer should stop if UE receives ‘some feedback’?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ZTE | Yes | Again, same as CG-retransmission timer handling |
| Samsung | Yes |  |
| Fujitsu | No | It is an optimization. The new timer can keep running but the UE need not to monitor the feedback, which is similar to Msg2 window. |
| Google | Yes | As in LTE, UE stops a timer if it receives feedback. |
| LG | Yes |  |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes | The timer should be stopped when receiving (explicit/implicit) ACK to avoid expiring. Also, some UE behaviors could be introduced while the timer is not running, e.g., if the UE autonomous CG retransmission is allowed. |
| Intel | See comment | While we do not prefer to have (yet) another timer as per our comments above, if a new one is defined, we still need to wait for RAN1 input on the details of what this feedback is, but the timer behavior should be clear. |
| Apple | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| vivo | Yes | Feedback is supposed to be introduced as an early termination indication for UE power saving. |
| Huawei, HiSilicon | Y, But | The UE does not need to monitor for PDCCH anymore if ACK is received for this HARQ process. This would also mean that the network choose CG for subsequent uplink transmission that the UE does not need to monitor PDCCH for DG  If there are multiple HARQ processes, the UE still may need to monitor PDCCH for the other HARQ processes |
| Ericsson | Yes - comment | UE needs still to monitor for DL assignments/other processes, hence timer should not be stopped in all instances. |
| Nokia | See comment | Stop the timer only means the initial transmission is successful received by the NW. it does not stop PDCCH monitoring for subsequent transmisssions. |

The next question is related to the behaviour of new timer expiry.

### **Question 10: If companies prefer a new timer for PDCCH monitoring after CG/DG (re)transmission in CG-SDT per Question 6 above, do company agree UE at least could indicate the CG transmission failure to upper layer when the new timer expires?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ZTE | Comments | In our view, there will be 2 timers that are needed.   1. A timer to trigger HARQ retransmission (similar to CG-retransmission timer) 2. A timer to trigger error handling and terminate the SDT procedure (similar to T 319 but slightly longer)   **For the initial UL message:**  After the initial UL message, the UE shall start the failure detection timer (as already agreed) – the handling of this timer should be same for RA-SDT and CG-SDT (and this timer will be handled in RRC layer – same as the T319 today).  If the initial UL message has not be acknowledged, then the UE shall retry the transmission of the first UL message (and a timer similar to CG-Retransmission timer can control the retransmissions) and if the failure detection timer expires, then CG-SDT failure is declared.  The question is whether the UE is allowed to send other UL messages whilst the initial UL message (containing the RRCResumeReq) is not yet acknowledged.  If the UE is not allowed to transmit new transmissions before acknowledgement of the first UL message is received, then some mechanism is needed to control the new transmissions.  If the UE is allowed to transmit new transmissions whilst the acknowledgement for the first UL message is pending, then the network has to buffer all the new transmissions until the first UL message (with RRCResumeReq) is successfully verified. We need to decide whether we allow the new transmissions whilst the first UL message is pending or not.  **For the subsequent UL messages:**  The retransmission of the subsequent UL messages on CG resource shall be controlled by the timer similar to CG-Retransmission timer. There is no other mechanism needed to control retransmissions  For failure handling, we think this is all controlled by the extended T319 like timer. So, if the RRC response (e.g. RRCRelease or RRCResume etc) is not received before the extended T319 like timer, then SDT failure shall be indicated to the upper layers and the common error handling can be invoked. |
| Samsung | Comments | UE should perform retransmission upon timer expiry |
| Fujitsu | TBD | The CG-SDT failure handling is also discussed in email discussion [507]. Consecutive failure may be considered as SDT failure and may be good to indicate it to upper layer. |
| Google | Comments | RAN2 should first discuss whether this new timer is similar to the CG retransmission timer or the pur-ResponseWindowTimer. |
| LG | Maybe Yes | But we have to discuss first what UE shall do after CG-SDT failure. |
| OPPO | No | The behavior of the new timer expiry may not be the same as *pur-ResponseWindowTimer.* Only one HARQ process is supported in PUR, when the pur-ResponseWindowTimer expires, the UE will not monitor PDCCH anymore. In this case, UE can inform the upper layer of the PUR transmission failure instead of waiting for the expiry of T300, which is beneficial to end the procedure earlier. While in SDT, multiple HARQ process can be configured, the function of the new timer cannot be used for failure detection. |
| Sharp | Comments | Upon timer expiry, a retransmission is performed. And the failure management could be controlled by the failure timer. |
| Lenovo |  | Same view as Samsung |
| FGI, APT | Yes | The MAC layer can indicate the CG-SDT failure inter-layer indication to upper layer by further considering the cases as Q4, i.e.,  Option 1: no qualified SSB when the evaluation is performed  Option 2: TA is invalid  Option 3: after a configured number of consecutive failures |
| Intel | See comment | While we do not prefer to have (yet) another timer as per our comments above, if a new one is defined, we assume that upon its expiration, the UE shall trigger SDT failure, i.e. transition to IDLE as in the case of expiry of the T319 timer and potentially attempt RRC connection setup |
| Apple | See comments | UE should perform retransmission upon the timer expiry. |
| CATT | Comments | If the timer is cg-Retransmission like timer, the UE will perform retransmission after expiration of the timer. And a maximum number should be defined. Otherwise, UE will continue retransmission again and again until T319’ expires. We think this is low efficiency.  If pur-ResponseWindowTimer like timer is defined, we think that UE can indicate to upper layers, at least for initial transmission. And the timer can be started at each UL transmission when it is not running. |
| InterDigital | No | UE can perform a retransmission upon timer expiry. Notifications to upper layers can be handled separately by SDT failure timer. |
| vivo | Comments | In our understanding, similar to the expiry of RA response timer, when this timer for CG-SDT expires, the UE can reselect SSB and prepare the retransmission at the next available CG-SDT occasion and increment the transmission counter. Only when the counter has reached the threshold, indicating fallback to the upper layer is needed. |
| Huawei, HiSilicon | See commetns. | It needs to be clarified first why the UE should indicate to the upper layer for failure in reception of L1-ACK. The reason could be that the higher layer can release CG resource of the UE if PDCCH monitoring fails. If we do not support NRU-like CG retransmission, the UE has to release the CG resoruce and fallback to RACH. In this case, the UE should perform RACH as fallback solution, either RA-SDT, or legacy resume procedure.  Another possibility, as mentioned by companies above, is to perform retransmission on the CG resource, which requires to requse NRU mechanism or design new mechanisms. IN this case, there is no need to indicate the PDCCH monitoring failure to the upper layer. |
| Ericsson | Comment | The intention of the timer is to save energy, not monitor for acks. If we don’t support L1 feedback there will be no feedback after successful tx (pending discussion in RAN1) |
| Nokia | Comments | What’s the difference from the T319-like timer then if it indicates to higher layer on the failure? |

## Other FFS for CG-SDT

According to the email discussion scoping, this session focuses on the remaining issues (FFS) from the previous CG-SDT discussions.

## CG resource handling at cell reselection

In RAN2 #112e meeting, it has been agreed that the configuration of CG-SDT resource for UE small data transmission is valid only in the same serving cell. In RAN2 #113e meeting, how to specify this agreement in stage 3 details is FFS.

|  |
| --- |
| RAN2 #112e agreement  The configuration of configured grant resource for UE small data transmission is valid only in the same serving cell. FFS for other CG validity criteria (e.g. timer, UL/SUL aspect, etc)  RAN2 #113e agreement  FFS Discuss further in stage 3 how to specify the agreement that CG-SDT resources are only valid in one cell (i.e. cell in which RRCRelease is received) |

During the email discussion [5], some companies comment that UE should release the CG-SDT resources when it moves to a new cell, while some other companies think network is not aware of the cell reselection in UE and there is no need for UE to release the resource by itself.

Please noted that in legacy PUR release behavior, it has been specified that UE should release PUR configuration when it initiates RRC connection resume on another cell [36.331] (i.e. different from the cell in which RRCRelease is received)

|  |
| --- |
| TS 36.331 v16.4.0  5.3.3.2 Initiation  <omit>   1. if the UE is establishing or resuming an RRC connection from a suspended RRC connection:   2> if the UE has a stored *pur-Config* and the cell is different from the cell where *pur-Config* was provided:  3> if *pur-TimeAlignmentTimer* is configured, indicate to lower layers that *pur-TimeAlignmentTimer* is released;  3> release *pur-Config*;  3> discard previously stored *pur-Config*;  <omit> |

Companies are invited to answer the following question.

### **Question 11: Do companies agree that UE should release CG-SDT resource (if stored) when UE initiates RRC resume procedure from another cell which is different from the cell in which the RRCRelease is received?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes | As legacy in LTE. |
| ZTE | Yes |  |
| Samsung | Yes |  |
| Fujitsu | Yes | We assume that CG resource is only valid to the serving cell the UE is connecting. |
| Google | Yes | As in LTE, UE should release CG resources if it initiates a RRC resume procedure on other cell. |
| LG | Yes | But the UE should keep CG-SDT resource even if the UE moves to another cell if the UE does not initiate RRCResume procedure to another cell. |
| OPPO | Yes | Follow the procedure as in PUR transmission. |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes | The CG-SDT resource configured on the previous cell is not needed anymore. If the UE goes back to the previous cell, the cell can configure CG-SDT again. |
| Intel | Yes | We support that the UE can reselect to a different cell and keep the CG-SDT resource/configuration until UE initiates a resume procedure (based on legacy or for SDT). Therefore, upon UE initiating RRC resume procedure in a different cell, the UE should release any stored CG-SDT configuration. |
| Apple | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes | Releasing the CG resource autonomously by the UE on its own upon mobility can cause issues, as the network is still blind decoding on the CG. The UE can release it upon initiating RRC Resume Request on another cell. |
| vivo | Yes | We agree with the above companies. |
| Huawei, HiSilicon | Y | This has already been discussed during the previous meeting, while at that time, the agreement was that this issue shall be resolved when drafting the stage3 spec. |
| ITRI | Yes |  |
| Ericsson | Yes | Config is only valid in same cell, if UE moves out of cell and comes back, timing may be off and position different etc, e.g. configured beams may not be useful or usable. |
| Nokia | Yes |  |

## CG-SDT criteria

In RAN2 #113bis-e meeting, the general CG-SDT and RA-SDT selection procedure was discussed, and the high-level procedure was agreed for information. There was one FFS about the CG-SDT criteria that are whether should consider the CG-SDT resources are configured on the selected UL carrier and are valid, highlighted in yellow.

|  |
| --- |
| RAN2 #113bis-e agreement  *FFS on the order and missing pieces (e.g. failure, fallback) of the high level procedure. The details of the procedures are left for stage 3. FFS on the procedure below, but copied for information.*  A. Upon arrival of data only for DRB/SRB(s) for which SDT is enabled, the high level procedure for selection between SDT and non SDT procedure is as follows:  If CG-SDT criteria is met: UE selects CG-SDT. UE initiate SDT procedure  Else if RA-SDT criteria is met: UE selects RA-SDT. UE initiate SDT procedure  Else: UE initiate non SDT procedure.  B. CG-SDT criteria is considered met, if all of the following conditions are met,  1) available data volume <= data volume threshold  2) RSRP is greater than or equal to a configured threshold  FFS 3) CG-SDT resources are configured on the selected UL carrier and are valid  C. RA-SDT criteria is considered met, if all of the following conditions are met,  1) available data volume <= data volume threshold  2) RSRP is greater than or equal to a configured threshold  3) 4 step RA-SDT resources are configured on the selected UL carrier and criteria to select 4 step RA SDT is met; or 2 step RA-SDT resources are configured on the selected UL carrier and criteria to select 2 step RA SDT is met |

In RAN2 #113e meeting, there is one FFS related to the CG-SDT criteria.

|  |
| --- |
| RAN2 #113e agreement  FFS If both carriers can be selected and CG resources are available on one carrier only, does the UE select the carrier with CG? |

When UE checks the CG-SDT criteria, if the RSRP threshold for carrier selection is above the threshold, UE selects the NUL; otherwise UE may select the SUL. After UL carrier is selected, one of the CG-SDT criterion might be that whether there are valid and configured CG resource on the selected UL carrier.

Some companies [11] assumes one scenario that is network may configure CG resources only on SUL in a cell supporting SUL. In this case, if RSRP of the downlink pathloss reference is not less than the configured threshold*,* UE will not use CG resources for SDT. However, in this scenario, the SUL can be used as SUL typically has more UL coverage than NUL. Some companies [28] [38] propose that UE directly selects the carrier with SDT configuration if SDT resources are configured on either SUL or NUL. While some other companies [36] propose that once the carrier has been selected, the SDT procedure is carried out on the selected carrier.

Companies are invited to answer the following questions.

### **Question 12: For CG resource, if both carriers could be selected and CG resources are available on one carrier only, should UE select the carrier with CG resource directly (w/o considering the RSRP threshold)?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | No | As agreed in RAN2#113bis, UL carrier selection is performed before CG-SDT selection. |
| ZTE | No | We already made the agreement that: “*UL carrier selection is performed before CG-SDT selection*”. So, carrier selection will happen ahead of CG-SDT/RA-SDT resource selection. There should not be further discussion on this agreement. |
| Samsung | See comments | If CG resources are configured on SUL only and RSRP of the downlink pathloss reference is not less than the configured threshold, it should be possible to use CG-SDT unless we agree that CG resources are always configured on both SUL and NUL. |
| Fujitsu | No | We understand that UL carrier selection is done prior to CG-SDT selection. |
| Google | No | RAN2 has agreed that UE selects carrier before SDT selection. |
| LG | No | This issue was discussed in RAN2#113bis, and following agreements were made:  UL carrier selection is performed before CG-SDT selection |
| OPPO | See comments | This depends on whether carrier selection is performed when both SUL and NUL are configured or both SUL and NUL are configured with SDT resources. The same question can be raised when RA-SDT resources are available on one carrier. We should discuss these together. |
| Sharp | No |  |
| Lenovo | No | Agree with Asustek, ZTE |
| FGI, APT | No | This may increase the complexity of the specification. |
| Intel | No | Based on our understanding, it has been agreed that carrier selection happens before (and is agnostic to) determining if resources for CG-SDT are configured on NUL/SUL. Moreover, it is up to the NW to configure both the CG resources and the RSRP thresholds for carrier selection, so there should not be any issue with this approach |
| Apple | No | Same view as other companies. RAN2 has agreed that UL carrier selection is performed before the CG-SDT selection. |
| CATT | No | If the UE directly selects the UL carrier configured with SDT, the overall SDT selection procedure is different from the agreed procedure. Then, new discussions on SDT selection procedure is needed to make sure the “new” procedure can work. |
| InterDigital | No | Already agreed, as pointed above |
| vivo | No | We also agree with ASUSTek. |
| Huawei, HiSIlicon | No | The UE should select the UL carrier based on the DL pathloss reference first and then check if there is suitable CG resource on the selected UL carrier. The current MAC CR has already been implemented in this manner. We should not discuss this any further |
| ITRI | No |  |
| Ericsson | No | The SUL can in principle always be selected since its rsrp may be higher than for the NUL, but the reason to have a selection is to load balance between the carriers, and this should remain for CG-SDT. |
| Nokia | No | Carrier selection should first meet the RSRP threshold. |

Companies are invited to further answer the following questions.

### **Question 13: Do companies agree that one of the CG-SDT selection criteria should consider the CG-SDT resources are configured on the selected UL carrier and are valid?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes |  |
| ZTE | Yes | Already agreed above though! So, no need for further agreement on this. |
| Samsung | Yes |  |
| Fujitsu | Yes |  |
| Google | Yes |  |
| LG | Yes |  |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes |  |
| Intel | Yes |  |
| Apple | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| vivo | Yes |  |
| Huawei, HiSilicon | YEs |  |
| ITRI | Yes |  |
| Ericsson | Yes |  |
| Nokia |  | First carrier selection based on RSRP. If the selected carrier is not configured with CG-SDT, then perform RA-SDT or non-SDT if no RA-SDT. |

## RNTI for CG-SDT

In Rel-15/16 NR CG transmission, UE should monitor both C-RNTI and CS-RNTI in RRC\_CONNECTED state. In CG-SDT, it has been agreed the retransmission by DG is supported for CG-SDT and there is possible new DL message transmitted as the response message from DG. UE might monitor previous configured C-RNTI (configured in RRC\_CONNECTED) or a new UE-specific RNTI configured by network.

The previous RAN2 meetings have made the following agreements.

|  |
| --- |
| RAN2 #113e agreement  For CG-SDT the subsequent data transmission can use the CG resource or DG (i.e dynamic grant addressed to UE’s C-RNTI). Details on C-RNTI, can be the same as the previous C-RNTI or may be configured explicitly by the network can be discussed in stage 3  RAN2 #114e agreement  FFS CS-RNTI based dynamic retransmission is reused for CG-SDT |

In LTE PUR, the PUR-RNTI is specified in PUR configuration, and UE will monitor PUR-RNTI only during the LTE PUR procedure. However, NR SDT is different from LTE PUR. Only one-shot transmission is supported in LTE PUR.

Some companies [19] think the CG RNTI should be named differently than legacy C-RNTI as C-RNTI is always associated when a UE is in RRC\_CONNECTED state. This will improve the readability and structure of the specifications. Some companies [24] propose that UE should monitor at least the C-RNTI during SDT for the scheduling of new transmissions and retransmission of dynamic grant.

Companies are invited to answer the following question.

### **Question 14: Which option do companies prefer for UE to monitor PDCCH in CG-SDT?**

1. **The C-RNTI previously configured in RRC\_CONNECTED state**
2. **A new UE-specific RNTI, i.e. SDT-RNTI**

|  |  |  |
| --- | --- | --- |
| Company | Reply (a/b) | Detailed comments |
| ASUSTeK | a | The UE monitors the C-RNTI for DG new transmission(s) for subsequent data in CG-SDT. |
| ZTE | a | No strong view, but *option a.* seems enough (and seems to avoid signalling of a new RNTI in the RRCRelease message). |
| Samsung | a |  |
| Fujitsu | TBD | Seems better to ask RAN1 on RNTI aspect. |
| Google | b | As in LTE, a new RNTI is used to monitor PDCCH. |
| LG | b | As rapporteur explained, C-RNTI is used in CONNECTED. Thus, we need a new RNTI to differentiate from CONNECTED. |
| OPPO | a |  |
| Sharp | a |  |
| Lenovo | a |  |
| FGI, APT | a |  |
| Intel | a) | We do not see any real reason why the same C-RNTI cannot be used for CG-SDT |
| Apple | a |  |
| CATT | a |  |
| InterDigital | a | The CG is only usable only in the serving cell from which the CG configuration was received, so C-RNTI should be enough. |
| vivo | a | From the performance perspective, there is no difference between these two options. We slightly prefer option a since it helps to reduce the overhead of RRC Release message. |
| Huawei, HiSilicon | Option b, but | Can let RAN1 decide |
| ITRI | b |  |
| Ericsson | a | Simplest option and we do not see any issues w this. |
| Nokia | a | Seems to be no big difference. |

In RAN2 #114e meeting, whether CS-RNTI based dynamic retransmission mechanism can be reused for CG-SDT was discussed and the conclusion was FFS. According to the discussion, 13/25 companies agreed to have CS-RNTI, and 3/25 companies had an opposite view. There were 8/25 companies who thought the issue can be FFS and should wait for more progress in CG-SDT.

Since RAN2 SDT WI is moving towards the stage 3 discussion, the rapporteur would like to check companies’ views again to see whether any new progress can be made.

### **Question 15: Do companies agree CS-RNTI based dynamic retransmission is reused for CG-SDT?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes | Similar to type 1 CG in connected state, the UE monitors the CS-RNTI for CG retransmission(s) in inactive state.  The CS-RNTI used in connected state can be reused or the CS-RNTI can be included in the RRCRelease message. |
| ZTE | No | Our understanding is that CS-RNTI is not needed since only CG-Type 1 resources are applicable in case of SDT. |
| Samsung | No |  |
| Fujitsu | Yes | We prefer that existing mechanism is the starting point. |
| Google | Yes | The CS-RNTI based dynamic retransmission can be the baseline. |
| LG | Comments | It is still not clear how to retransmit on CG-SDT, and we want to discuss this issue later. |
| OPPO | Yes | We prefer to reuse the existing mechanism. |
| Sharp | No |  |
| Lenovo | Yes |  |
| FGI, APT | Yes | C-RNTI cannot be used for retransmission of a CG, since the UE will consider that the NDI to be toggled anyway if the UE receives an UL grant for C-RNTI and the previous transmission for the same HARQ process is CG. To avoid introducing the specification impact, the legacy mechanism for CG retransmission scheduling, i.e., using CS-RNTI, should be needed. |
| Intel | Yes | We are ok to follow Rel-16 behavior |
| Apple | Yes | We prefer to reuse existing mechanism for the CG retransmission. |
| CATT | Yes | We think network based retransmission is needed in SDT. If there is no CS-RNTI, UE will have misunderstanding on NDI. For example, the UE will treat the non-toggled NDI as retransmission when the DCI is carried in PDCCH scrambled by C-RNTI. However, if the DCI carried in PDCCH is scrambled by CS-RNTI, UE will treat NDI = 1 as retransmission. We think two RNTIs are needed to distinguish different meanings of NDI. |
| InterDigital | Yes | As in legacy |
| vivo | Yes | The legacy mechanism can be reused and it seems no extra complexity will be brought. |
| Huawei, HiSilicon | Yes | Aligning with existing procedures/specifications is straightforward. |
| ITRI | Yes |  |
| Ericsson | Yes | This also has much less impact to specifications. |
| Nokia | Yes | Can reuse existing procedure. |

## Stage 3 details of CG configuration

Configuration of the configured grant type 1 resource for NR-SDT in RRC\_INACTIVE is one of the objectives for Rel-17 NR SDT WI. Based on the current agreements made for NR CG based SDT scheme, rapporteur thinks the signalling and parameter framework specified in Rel-15 configured grant configuration (*ConfiguredGrantConfig*) including the type-1 CG configuration, i.e. *rrc-ConfiguredUplinkGrant*, can be reused as baseline for CG-SDT configuration.

As a usual RAN1/RAN2 work split, rapporteur understood all the PHY related parameters and values should be discussed and decided within RAN1. Hence the intention of the following questions is to trigger RAN1 discussion on the CG PHY parameters for NR SDT and also to identify the possible new parameters from RAN2 perspective.

|  |
| --- |
| **TS 38.331 V15.13.0**  ConfiguredGrantConfig ::= SEQUENCE {  frequencyHopping ENUMERATED {intraSlot, interSlot} OPTIONAL, -- Need S  cg-DMRS-Configuration DMRS-UplinkConfig,  mcs-Table ENUMERATED {qam256, qam64LowSE} OPTIONAL, -- Need S  mcs-TableTransformPrecoder ENUMERATED {qam256, qam64LowSE} OPTIONAL, -- Need S  uci-OnPUSCH SetupRelease { CG-UCI-OnPUSCH } OPTIONAL, -- Need M  resourceAllocation ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch },  rbg-Size ENUMERATED {config2} OPTIONAL, -- Need S  powerControlLoopToUse ENUMERATED {n0, n1},  p0-PUSCH-Alpha P0-PUSCH-AlphaSetId,  transformPrecoder ENUMERATED {enabled, disabled} OPTIONAL, -- Need S  nrofHARQ-Processes INTEGER(1..16),  repK ENUMERATED {n1, n2, n4, n8},  repK-RV ENUMERATED {s1-0231, s2-0303, s3-0000} OPTIONAL, -- Need R  periodicity ENUMERATED {  sym2, sym7, sym1x14, sym2x14, sym4x14, sym5x14, sym8x14, sym10x14, sym16x14, sym20x14,  sym32x14, sym40x14, sym64x14, sym80x14, sym128x14, sym160x14, sym256x14, sym320x14, sym512x14,  sym640x14, sym1024x14, sym1280x14, sym2560x14, sym5120x14,  sym6, sym1x12, sym2x12, sym4x12, sym5x12, sym8x12, sym10x12, sym16x12, sym20x12, sym32x12,  sym40x12, sym64x12, sym80x12, sym128x12, sym160x12, sym256x12, sym320x12, sym512x12, sym640x12,  sym1280x12, sym2560x12  },  configuredGrantTimer INTEGER (1..64) OPTIONAL, -- Need R  rrc-ConfiguredUplinkGrant SEQUENCE {  timeDomainOffset INTEGER (0..5119),  timeDomainAllocation INTEGER (0..15),  frequencyDomainAllocation BIT STRING (SIZE(18)),  antennaPort INTEGER (0..31),  dmrs-SeqInitialization INTEGER (0..1) OPTIONAL, -- Need R  precodingAndNumberOfLayers INTEGER (0..63),  srs-ResourceIndicator INTEGER (0..15) OPTIONAL, -- Need R  mcsAndTBS INTEGER (0..31),  frequencyHoppingOffset INTEGER (1.. maxNrofPhysicalResourceBlocks-1) OPTIONAL, -- Need R  pathlossReferenceIndex INTEGER (0..maxNrofPUSCH-PathlossReferenceRSs-1),  ...  } OPTIONAL, -- Need R  ...  }  CG-UCI-OnPUSCH ::= CHOICE {  dynamic SEQUENCE (SIZE (1..4)) OF BetaOffsets,  semiStatic BetaOffsets  } |

The first question related to CG resource configuration is below. Companies are invited to provide comments on which parameters in Rel-15 *ConfiguredGrantConfig* and *rrc-ConfiguredUplinkGrant* should NOT be used in CG-SDT configuration and companies are encouraged to identify the new value or range for the existing parameters.

### **Question 16: Do companies think any parameters in Rel-15 *ConfiguredGrantConfig* and *rrc-ConfiguredUplinkGrant* should NOT be reused in the CG-SDT configuration?**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes- all parameters are reused / No – some parameters are NOT be used) | Detailed comments |
| ASUSTeK | Yes |  |
| ZTE | Yes | The WI clarifies that CG-Type1 resources should be the baseline. |
| Samsung | No | Some parameters are not needed such as srs-ResourceIndicator, pathlossReferenceIndex |
| Fujitsu | Yes | Having said Yes, it is not later to work on ASN.1 aspect after many details of CG-SDT mechanism are settled down. Early decision may cause problem in the later stage when working on ASN.1 development for SDT. |
| Google | Yes |  |
| LG | Comments | Should be discussed in RAN1 first. |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes | As a baseline |
| FGI, APT | Yes | The baseline should be the same as legacy type 1 CG. However, RAN1 can determine whether any parameters are supported for SDT, e.g., *repk*. It seems we never discussed whether the repetition is supported for SDT. |
| Intel | Yes | At this stage, we are fine to keep the parameters and can discuss further it some other parameters are needed.  (Note that the question wording is “should NOT be reused”, which is a bit contradictory with the options for the reply) |
| Apple | Almost Yes | Same comments as Samsung and Intel, some parameters are not need, e.g. srs-ResourceIndicator, pathlossReferenceIndex, repK.  RAN2 has agreed to take the type-1 CG configuration as the baseline. For RAN1 parameters in detail, it should be discussed and determined in RAN1 first. |
| CATT | Yes |  |
| InterDigital | Yes |  |
| vivo | Comments | In the previous RAN1 meeting, the following agreement is made.  Agreement:   * The SSB-to-PUSCH resource mapping within the CG configuration is implicitly defined. * The ordering of the SSB and CG PUSCH resources are to be captured in RAN1 spec.   + A PUSCH resource refers to a transmission occasion and a DMRS resource used for PUSCH transmission   + The ordering of the SSB can reuse from the SSB-to-RO mapping   + The ordering of CG PUSCH resources can reuse from that of MsgA PUSCH as much as possible * FFS determination of mapping ratio and association period, e.g., explicitly signaled or implicitly derived * FFS any limitation on the combination of the parameters for CG resources   In our understanding, RAN1 will discuss the detailed configuration parameters and capture them in the 213 specs. In this sense, we don’t need to trigger them to discusss the corresponding part and think it is totally up to RAN1 discretion to design the details. So. it is hard for us to tell what parameters is needed or nor needed.  For example, if 2-step RA alike DM-RS configuration is used for CG-SDT, then Rel-15 cg-DMRS-configuration is not needed. |
| Huawei, HiSilicon | Y, but | For the layer1 parameters, they need to be confirmed by RAN1 |
| ITRI | Yes |  |
| Ericsson | Yes - comment | Baseline already agreed. Details can wait for RAN1 input etc. |
| Nokia |  | NR-U related parameters for UCI and retx timer are not needed. |

In additional to the parameters in Rel-15 *ConfiguredGrantConfig* and *rrc-ConfiguredUplinkGrant*, several new parameters related to the CG-SDT were studied in the RAN2 meetings.

In RAN2 #112e, a new TA timer was agreed for TA maintenance for CG based SDT. In the same meeting, it also has been agreed that CG resource association to SSB.

|  |
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| RAN2 #112e agreements  A new TA timer for TA maintenance specified for configured grant based small data transfer in RRC\_INACTIVE should be introduced. FFS on the procedure, the validity of TA, and how to handle expiration of TA timer. The TA timer is configured together with the CG configuration in the RRCRelease message.  From RAN2 point of view: An association between CG resources and SSBs is required for CG-based SDT. FFS up to RAN1 how the association is configured or provided to the UE. Send an LS to RAN1 to start the discussion on how the association can be made. Mention that one option RAN2 considered was explicit configuration with RRC Release message  A SS-RSRP threshold is configured for SSB selection. UE selects one of the SSB with SS-RSRP above the threshold and selects the associated CG resource for UL data transmission. |

In RAN2 #113e, it has been agreed that the RSRP change based TA validation mechanism should be introduced for SDT.

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| RAN2 #113e agreements  From RAN2 point of view, assume similar to PUR, that we introduce a TA validation mechanism for SDT based on RSRP change, i.e. RSRP-based threshold(s) are configured. Ask RAN1 to confirm. FFS on how to handle CG configuration when TA expires or when is invalid due to RSRP threshold. Details of the TA validation procedure can be further discussed. |

In RAN2 #113bis-e, it has been agreed that UE starts a window for PDCCH monitoring after CG/DG transmission for CG-SDT.

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| RAN2 #113bis-e agreements  UE start a window after CG/DG transmission for CG-SDT. FFS whether to design a new timer or to reuse an existing timer. |

Based on the agreements above, companies are invited to answer the following questions.

### **Question 17: Do companies agree the CG-SDT configuration should include the following new parameters? (all are based on the RAN2 agreements) If not, please point out which one and why.**

* **The new TA timer in RRC\_INACTIVE;**
* **The RSRP change threshold for TA validation mechanism in SDT;**
* **A response window timer for PDCCH monitoring after CG/DG transmission for CG-SDT;**
* **The SSB RSRP threshold for beam selection (i.e. UE selects the beam and associated CG resource for data transmission).**

|  |  |  |
| --- | --- | --- |
| Company | Reply (Yes/No/  Comments) | Detailed comments |
| ASUSTeK | Yes |  |
| ZTE | Yes | All based on existing agreements. Some of the parameters may depend on further RAN1 input. |
| Samsung | Yes |  |
| Fujitsu | Yes | These parameters seem to be good starting point. |
| Google | Yes |  |
| LG | Yes |  |
| OPPO | Yes |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| FGI, APT | Yes |  |
| Intel | See comments | We think at least the TA timer, the RSRP change threshold for TA validation and the RSRP threshold for SSB selection should be included. Regarding the window/timer for PDCCH, it depends on whether the T319 timer is reused for CG-SDT and RA-SDT or a new timer is defined. |
| Apple | Yes | When NW provides the new TA timer to UE which is started immediately when UE enters INACTIVE state, NW should be able to provide the TA value to UE together, and UE can update the current TA value and use it as the initial TA in INACTIVE state. |
| CATT | Yes |  |
| InterDigital | Yes |  |
| vivo | Yes |  |
| Huawei, HiSilicon | See comments, | We have agreed that there can be multiple CG configurations. If the CG-SDT configuration includes the following, it would be that the above configuration is per CG configuration, which we don’t think is necessary.  Besides, the SSB RSRP has not been agreed to be SDT specific.  To sum up, we agree these parameters are needed, but should be configured as common for all CG-SDT configurations of a UE. |
| ITRI | Yes |  |
| Ericsson | Yes - comment | The details on common or per CG config needs discussion. |
| Nokia | Comment | “A response window timer for PDCCH monitoring after CG/DG transmission for CG-SDT;” we understood the window is only needed for initial transmission, not for subsequent transmissions, thus not for dynamic grant. |

### **Question 18: Any additional parameters should be included for CG-SDT configuration in addition to those parameters discussed in Question 16 and 17?**

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| --- | --- |
| Company | Detailed comments |
| ASUSTeK | BWP configuration to indicate the separate SDT BWP. |
| ZTE | Some RAN1 input may be needed for further parameters and we can wait for their input. |
| LG | As ASUSTek indicated, separate SDT BWP information should be added. |
| OPPO | Discuss to include *configuredGrantTimer* if the response window timer for PDCCH monitoring in CG-SDT cannot cover the similar function of CGT. |
| Lenovo | A timer similar to the periodicBSR-Timer is configured in order to indicate to the NW the remaining data or new data arrival, e.g. from logical channels of same or lower priority, by triggering a periodic BSR. |
| FGI, APT | 1. Dedicated BWP for CG-SDT. 2. UE-specific search space for CG-SDT. 3. Associated SSB(s) of a CG configuration. |
| Intel | Depending on the response to Q2, the network may choose to configure UE behavior regarding whether it reevaluates the RSRP threshold criterion for each CG transmission/retransmission or once per CG-SDT session.  In addition, some RAN1 input may warrant introduction of additional parameters, so we can wait for their input. |
| Apple | 1. RAN1 parameters for the CG-SDT 2. Max consecutive failure number for CG-SDT transmission 3. TA value as the initial TA value used in INACTIVE state |
| CATT | Some parameters related to multiple CG configurations should also be included. But we can decide after more agreements are made. |
| Huawei, HiSilicon | Some RAN1 input will be needed for the additional parameters and we can wait for their input |
| ITRI | The separate SDT BWP parameters should also be included. |
| Ericsson | RAN1 input of course. Input to this needs discssion as we progress. |

## Others

### **Question 19: Companies are encouraged to list the other remaining issues of CG-SDT.**

|  |  |
| --- | --- |
| Company | Detailed comments |
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# Conclusion

This contribution is summarized with proposals as follows.

# Contact information for email discussion

|  |  |  |
| --- | --- | --- |
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| Nokia | Chunli Wu | Chunli.wu@nokia-sbell.com |

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