**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.

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

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| RAN2 #114e agreementFor 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.**

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| Company | Reply (Yes/No/Comments) | Detailed comments  |
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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?**

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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?**

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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**

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| Company | Reply (Option 1/2/3/4) | Detailed comments  |
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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?**

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## 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 agreementUE 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**

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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**

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| Company | Reply (Option 1/2/3/4) | Detailed comments |
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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?**

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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].

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| RAN2 #114-e agreementRAN2 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’?**

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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?**

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## 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.

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| RAN2 #112e agreementThe 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 agreementFFS 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)

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| TS 36.331 v16.4.05.3.3.2 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?**

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## 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.

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| 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 threshold2) RSRP is greater than or equal to a configured thresholdFFS 3) CG-SDT resources are configured on the selected UL carrier and are validC. RA-SDT criteria is considered met, if all of the following conditions are met,1) available data volume <= data volume threshold2) RSRP is greater than or equal to a configured threshold3) 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.

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| RAN2 #113e agreementFFS 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)?**

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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?**

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## 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.

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| RAN2 #113e agreementFor 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 3RAN2 #114e agreementFFS 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**

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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?**

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## 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.

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| **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?**

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| Company | Reply (Yes- all parameters are reused / No – some parameters are NOT be used) | Detailed comments  |
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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 agreementsA 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 messageA 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 agreementsFrom 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 agreementsUE 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).**

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| Company | Reply (Yes/No/Comments) | Detailed comments  |
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### **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  |
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## Others

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

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| 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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| --- | --- | --- |
| Company | Contact Info (name) | Contact Info (email address) |
| Qualcomm | Ruiming Zheng | rzheng@qti.qualcomm.com |
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