3GPP RAN WG2 Meeting #113bis-e R2-210xxxx
E-meeting, 12 – 20 Apr, 2021

Agenda Item: 8.6.5

Source: Email discussion rapporteur (Huawei, HiSilicon)

Title: Report from [POST113-e][504][SDT] CG open issues

Document for: Discussion, Decision

# Introduction

This document contains the summary of email discussion for open issues on CG-based solution for small data transmission in RRC\_INACTIVE:

* [Post113-e][504][SDT] CG open issues (Huawei)

 Scope: 1) FFS points from CG agreements 2) Validity aspects, RAN2 aspects of beam selection, CG resource configuration and retransmissions for CG

 Intended outcome: Report to the next meeting.

 Deadline: long

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# CG resource configuration

## NUL and SUL

During RAN2#113e, the following agreement, highlighted in yellow, has been made in the dicussion in small data.

**Agreements**

1. CG-SDT resource configuration is provided to UEs in RRC\_Connected only within the RRCRelease message, i.e. no need to also include it in RRCReconfiguration message
2. CG-PUSCH resources can be separately configured for NUL and SUL. FFS if we allow them at the same time. This depends on the alignments CRs for Rel-16.

====omitted=====

Then, in the discussion for R16 IIOT, the following has been agreed for the CG configuration in NUL and SUL that the restriction in the field description for ConfiguredGrantConfig that Type1 configured grant may be configured for NUL and SUL simultaneously.

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| R2-2101340 Correction on the configuration of Type 1 configured grant Huawei, HiSilicon CR Rel-16 38.331 16.3.1 2404 - F NR\_IIOT-Core* [025] Agreed
 |



Based on the above agreement and agreed CR, we would like to ask the following question on the CG-SDT configuration on NUL and SUL.

**Question1: Do companies agree CG-SDT resources can be configured at the same time on NUL and SUL?**

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| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsung | Yes | It is useful to allow configuration of CG-SDT resources for both NUL and SUL at the same time. NUL coverage can be limited and SUL can be used in that case. |
| LG | Yes |  |
| ZTE | Y |  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| CATT | Yes  | SDT can align with CG configuration type 1 in RRC connected state |
| ASUSTEK | Yes |  |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | yes |  |
| Sony | Yes |  |
| Interdigital | yes |  |
| Intel | Yes |  |
| ITRI | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| vivo | Yes | This is similar to the mechanism of the legacy RACH resource configuration.  |
| Panasonic | Yes |  |
| Google | Yes |  |
| NEC | Yes |  |
| APT | Yes |  |

***Summary***

For the feedback fo the email discssion, all the comapanies asked Yes to the question that CG-SDT resources can be configured at the same time on NUL and SUL. We hence propose the following:

**Proposal: CG-SDT resources can be configured at the same time on NUL and SUL (23/23)**

## CG-SDT config request by UE

For LTE PUR, a UE may request PUR configuration to the network when the UE is in RRC\_CONNECTED. Based on the UE request, the network may decide to configure PUR to the UE and also the details of the PUR configurations, such as the periodicities. For PUR, the following highlighted parameters can be requested from UE to the network based on 36.331

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| 5.6.23.3 Actions related to transmission of *PURConfigurationRequest* messageWhen initiating the procedure according to 5.6.23.2, the UE shall set the contents of the *PURConfigurationRequest* message as follows:1> if the UE is interested to be configured with PUR, include *pur-SetupRequest* and set the contents of *pur-SetupRequest* as follows:2> set *requestedNumOccasions* to the requested number of PUR occasions requested;2> set *requestedPeriodicityAndOffset* according to the requested periodicity between consecutive PUR occasions and the requested time offset with respect to current time until the first PUR occasion;2> set *requestedTBS* to the requested TBS for the PUR occasion(s);2> if RRC response message is preferred by the UE for acknowledging the reception of a transmission using PUR, include *rrc-ACK*;1> if the UE is no longer interested to be configured with PUR:2> include *pur-ReleaseRequest*;The UE shall submit the *PURConfigurationRequest* message to lower layers for transmission. |

Note that in the email discussion [1], PUR configuration request has already been dicussed and the following has been summarized after the discussion, which may serve as the baseline for the discussion here

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| **Summary**: (13/26) companies agree with the proposal that UE can indicate to the network its preference for CG-SDT resource while being in RRC\_Connected. (2/26) companies may be OK with the proposal, e.g. if this mechanism is treated with lower priority. (11/26) companies didn’t’ see a necessity/benefit of introducing an additional request/assistance procedure. In their opinion such UE request procedure is not essential and the CG-SDT resources can be determined by the network, e.g. based on the QoS of the related DRBs/subscription. From the response though it appears that some of the companies which don’t prefer to have such a UE request mechanism, would be OK to reuse legacy UE assistance information framework to minimise the extra standardisation work. |

Based on the above summary, the following 3 options can be summarized:

* Option1: CG configuration based on network implementation. E.g, QoS of the supported traffic of the UE, and no spec change is needed
* Option2: Introduce a new RRC message, like in PUR for PUR configuration request
* Option3: Reuse the legacy UE assistance information framework for CG-SDT configuration request

Companies are invited to downselect from the above 3 options for CG-SDT configuration request.

**Question2: Which option do companies prefer for CG-SDT configuration request?**

* **Option1: CG configuration based on network implementation. E.g, QoS of the supported traffic of the UE, and no spec change is needed**
* **Option2: Introduce a new RRC message, like in PUR for PUR configuration request**
* **Option3: Reuse the legacy UE assistance information framework for CG-SDT configuration request**

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| --- | --- | --- |
| **Company** | **Option** (1/2/3) | **Additional comments** |
| Samsung | Option 1 | Network is aware of established DRBs and associated traffic for each of these DRBs. So additional information seems not essential. |
| LG | Option 1 | Option 1 is enough for Rel-17. Other options could be considered in later releases. |
| ZTE | Option 1 | We agree with Samsung and LG views above. Options 2 and 3 are optimisations in our view and can be left for future releases (as mentioned by LG) |
| Sharp | Option 3 | It is benfit for the UE to request the CG configuration instead of depending on network implementation. Existing UE assistance information could be reused. |
| Lenovo | Option 2/3 | We see some benefits in supporting a UE request mechanism. It will allow network to configure CG-SDT resources more efficiently similar to LTE PUR. Even though we would lightly prefer Option 3, it would be OK for us to reuse the legacy UE assistance information framework in order to minimize standardization efforts.  |
| CATT | Option 3 | We think it is useful to report the TBS and period. This is especially useful if SRB2 uses for SDT. The gNB may not know the these parameters, e.g. LPP |
| ASUSTEK | Option 1 |  |
| Spreadtrum | Option 1 | The CG-SDT resource can be determined based on the Qos of the related DRBs by the network before moving the UE to the inactive state. Seems no need to introduce further information provided from UE in R17. |
| OPPO | Option 1 | We are not sure whether the information provided by UE is reliable. It might be not essential for the network to make the decision when configuring CG resources. |
| Huawei, HiSilicon | Option2/3 | It is hard for the network to give UE an accurate configuration based on the QoS information for the UE. For CG-SDT configuration, what is important is the periodicity, offset and TB size and number of request CG occaions. These information are not available in the QoS information. |
| Sony | Option 1 |  |
| Interdigital | Option 1 | It is sufficient to report buffered data using BSR in the initial small data PDU. Then It’s up to the network to provide additional CG resources, if not already available. |
| Intel | Option 3 or Option 2 | We do see clear benefit of indicating the preferred UE configuration for CG-SDT. In this case, both option 2 and option 3 can work; we prefer option 3 to reuse the existing assistance information framework to limit the amount of work that needs to be done to support this feature |
| ITRI | Option 1 | We think that option 1 may be sufficient. |
| Fujitsu | Option 1 | Network has sufficient information e.g. buffer threshold, QoS information, DRB information, and so on. |
| Qualcomm | Option 2 or option 3 | We do see the benefit to allow UE sending resource request message or assistance information,i.e. option 2 or option 3. Without such mechanisms, network does not know any information about UE traffic characteristic. The QoS information can not accurately reflect the user small data requirement.  |
| Xiaomi | Option 1 |  |
| Ericsson | Option 1 | A sensible NW implementation would not depend on the UE anyway. If not known at DRB establishment for SDT, likely N periodic transmissions using RA-SDT will be required before NW identifies the traffic as periodic and configures CG-SDT |
| Nokia | Option 2/3 | Some UE assistant information could be useful for the network to configure the CG configurations.For example, the UE might have preferences for specific time occasions where the pre-configured PUSCH resources should occur. This can be due to the traffic characteristics of the application requiring SDT or it can be due to the type of UE (e.g. a Multi-USIM device). |
| vivo | Option 2/3  | We think the request allows the UE to report the characteristic of UL data traffic to the network, which is useful for CG-SDT resource configuration. To reduce the normative work, we think the legacy framework (i.e. option 2/3) can be reused for NR SDT. |
| Panasonic | Option 2/3 | Even for same services, traffic pattern and packet size can be different. In this case, it would beneficial for UE to provide assistance information regarding TB size and CG periodicity. |
| Google | Option 1 | The network could determine a CG-SDT configuration for UE according to the QoS requirments of data traffic.  |
| NEC | Option 1 | We think option 1 is sufficient. |
| APT | Option 2/3 | Option 3 should be a baseline for miminmize spec impact. But we open for option 2 which may have gain from accurate powersaving when the resource allocation meet flexible use cases. And also be benefit with resource efficiency increasing. |

***Summary***

Within the comapanies who have replied:

* 14 companies chose Option1 that CG configuration request is not needed and the CG configuration for SDT can be based on network implementation, e.g., based on the QoS information of the UE
* 8 companise chose Option2/3 that CG configuration request can be useful. The already existing UE assitance information can be used or a new message can be designed for the CG configuration request
* 2 companies chose Option3 that CG configuration reuqst can be useful and existing RRC message can be reused.

Based on the above result for the discussion, we peopose the following

**Proposal: RAN2 should further discuss whether to support CG configuration request.**

## CG resource release

In Legacy PUR, there are four mechanisms for the UE to release the PUR configurations, as specified in [4].

1. ***Released by RRCRelease message***: When the PUR procedure is terminated with RRCRelease message, the network may set the PUR configuration to release;
2. ***Released by system information***: The network can send paging to trigger the UEs to read updated system information with disabling indicator of PUR function and the UE releases the PUR configuration directly when the updated system information is received;
3. ***M consecutive skipped PUR occasions***: If the UE does not have data to transmit on PUR allocation or PUR transmission fails (i.e., not responsed by PDCCH from the network) for m consecutive PUR occasions, the UE releases the PUR configuration;
4. ***RRC procedure initiated in a different cell***: When the UE reselects to a new cell based on cell reselection rule and initiates RRC Connection Resume procedure in the new cell, the PUR configuration from the old cell should be released.

During RAN2#113, the following mechinams have been agreed for the CG resource release.

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| **Agreements**===OMITTED==3. RRCRelease message is used to reconfigure or release the CG-SDT resources while UE is in RRC\_INACTIVE===OMITTED==9. UE releases CG-SDT resources when TAT expires in RRC\_Inactive state |

And for the discussion on SDT CG configuration release when reselecting to a different cell, the following agreement has been made that it should be specified during the stage3 discussion.

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| --- |
| 8. 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) |

In the following, we continue the iscussion on CG configuration release during RRC\_INACTIVE and disucss whether some of the legacy PUR mechanisms can be reused.

### Release by system information indication

In the legacy PUR, by indication of the system information, the PUR resources of the UEs within the whole cell can be released. The indication of PUR release is carried in SIB2, with related spec highlighted in yellow:

|  |
| --- |
| -- ASN1STARTSystemInformationBlockType2 ::= SEQUENCE {====OMITTED==== [[ rlos-Enabled-r16 ENUMERATED {true} OPTIONAL, -- Need OR earlySecurityReactivation-r16 ENUMERATED {true} OPTIONAL, -- Need OR cp-EDT-5GC-r16 ENUMERATED {true} OPTIONAL, -- Need OR up-EDT-5GC-r16 ENUMERATED {true} OPTIONAL, -- Need OR cp-PUR-EPC-r16 ENUMERATED {true} OPTIONAL, -- Need OR up-PUR-EPC-r16 ENUMERATED {true} OPTIONAL, -- Need OR cp-PUR-5GC-r16 ENUMERATED {true} OPTIONAL, -- Need OR up-PUR-5GC-r16 ENUMERATED {true} OPTIONAL, -- Need OR mpdcch-CQI-Reporting-r16 ENUMERATED {fourBits, both} OPTIONAL, -- Need OR rai-ActivationEnh-r16 ENUMERATED {true} OPTIONAL, -- Need OR idleModeMeasurementsNR-r16 ENUMERATED {true} OPTIONAL -- Need OR ]]} |

Then, upon reception of such indication, the UE shall release the PUR configuration if it is no longer supported by the current network.

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| Upon receiving *SystemInformationBlockType2* (*SystemInformationBlockType2-NB* in NB-IoT), the UE shall:1> if *up-PUR-5GC* is not included and the UE connected to 5GC in RRC\_IDLE with a suspended RRC connection is configured with *pur-Config*; or1> if *up-PUR-EPC* is not included and the UE connected to EPC in RRC\_IDLE with a suspended RRC connection is configured with *pur-Config*; or1> if *cp-PUR-5GC* is not included and the UE connected to 5GC in RRC\_IDLE without a suspended RRC connection is configured with *pur-Config*; or1> if *cp-PUR-EPC* is not included and the UE connected to EPC in RRC\_IDLE without a suspended RRC connection is configured with *pur-Config*:2> if *pur-TimeAlignmentTimer* is configured, indicate to lower layers that *pur-TimeAlignmentTimer* is released;2> release *pur-Config*;2> discard previously stored *pur-Config*. |

The main reason this was introduced was that this enables the network to release all the PUR configurations given to the UE, in case of network resource shortage, or other cases. Companies are inivited to answer the following question for whether this mechanism can be reused for CG-SDT in R17.

**Question3: Do companies support to introduce a bit in the system information to indicate the support of the gNB for CG-SDT in RRC\_INACTIVE?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsung | No | Implicit release and release by RRCRelease message seems sufficient |
| LG | Maybe | We are open for this mechanism. |
| ZTE | N | Again this seems to be an optimization which is not essential.  |
| Sharp | No |  |
| Lenovo | Maybe | We are open to discuss the necessity of such mechanism, even though we also think that this will be some additional optimization.  |
| CATT | No | This seems an optimisation |
| ASUSTEK | Yes | We could follow LTE mechanism. |
| Spreadtrum | No | RRCRelease message can be used in this situation. |
| OPPO | Yes | There is benefit to introduce this mechanism and we are open to discuss it. |
| Huawei, HiSilicon | Y | It should be allowed for the network to release the CG resources reserved previously for SDT, e.g. in case of overload. Without having such bit in SI, the network can only page the UE to CONNECTED to release the resource, which contradicts the original intention to design this SDT procedure in our opinion.  |
| Sony | No | Note that CG is used when a UE has previously connected to this cell and all configurations are received at the UE. Hence, if the gNB supports it, it will configure CG resources in RRCRelease message.  |
| Interdigital | No | Release of the CG can be provided part of the RRC release message, which is sufficient. |
| Intel | No | Relying on RRCRelease message should be sufficient for the majority of possible scenarios and SIB based release mechanism does not seem essential to support (at least in this release where UE can only use CG-SDT in the cell that provided its configuration). |
| ITRI | Yes | The LTE mechanism should be followed. |
| Fujitsu | No | The NW can carefully control the SDT by restricting the number of UEs in INACTIVE for the SDT, transistion from CONNECTED to INACTIVE, and so on. The the resource for the SDT can be deliberately configured. |
| Qualcomm | No | Using RRCRelease message is sufficient. |
| Xiaomi | N |  |
| Ericsson | No | Implicit release or explicit RRCRelease is sufficient. Due to the slow nature of SIB there would not be any quick release. |
| Nokia  | Y | Should allow some group releasing via SIB to allow the NW control of the allocated resources. However, we don’t see a need to broadcast information of the features supported by the network. Anyway, the CG-SDT is configured by the network itself and it is applicable only in the cell where the resources are configured. Hence, rather we see a need for information to control the usage of the CG-SDT resources, e.g., disable the usage of those. Details can be further discussed. Not necessarily 1 bit. |
| vivo | No | Considering the CG resource is only for small data (i.e. the amount of allocated resource is small), so the network overload issue might be not so urgent. Besides, if the UE doesn’t transmit any UP data for a time, implicit release based on TAT expiry at both UE and NW side can be adopted. If the UE triggers SDT procedure, the NW can use RRC Release message to release the resource. |
| Panasonic | Yes | We are open to discuss such mechanism. |
| Google | No | It may be rare to release resources from UEs at the same time. |
| NEC | No | Since CG-SDT is only allowed in the same cell and up to NW implementation, dedicated signalling should be sufficient and adding 1 bit seems like unnecessary optimization. |
| APT | Yes | We believe this is an quite simple mechanism for gNB to control the resource reserved for SDT. |

***Summary***

Within the comapanies who have replied:

* 14 companies reply ‘No’ that they think this release by system information is optimization, other mechanism of release with TA or implicit release or release by RRC message can be used and it would be a rare case to release resources for all the UEs at the same time. Company also mentioned that the reception of system information is slow in the configuration release.
* 5 companise reply ‘Yes’ that the think this is an efficient way for the network to release the CG configuration when the network experiences resource overload.
* 2 companies chose ‘Maybe’ that they are open to the disucsion.

Based on the above results for the discussion, we propose the following:

**Proposal: Release of CG-SDT configuration by system information indication is not supported. (14/21)**

### Implicit release of CG-SDT resource

In LTE PUR, implicit release of PUR configuration for consecutively skipped PUR occasions was introduced for two reasons: (a) The PUR resource can be configured to the UE periodically with dedicated configuration, in addition to one-shot configuration, and if the PUR resource is under-utilized by the UE, it is a waste of resource in the air interface; (b) The transmission in PUR may fail and if it fails consecutively, the PUR resource is no longer reliable/useful that the UE should no longer use it.

The following has been excerpted from TS 36.331 for the implicit release of PUR configuration after skipping consecutive PUR occasions and the condidition highlighted in yellow shows the conditions when the PUR occasion shall be considered as “skipped”. Thanks to the fact that PUR transmissions which failed and were not acknowledged by the network are also treated as “skipped”, the count of skipped PUR occasions at the UE and at the network is always aligned.

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| 5.3.3.20 Maintenance of PUR occasionsThe UE configured with *pur-Config* shall:1> consider that the first PUR occasion occurs at the H-SFN/SFN/subframe given by:- H-SFN = (H-SFNRef + offset) mod 1024 occuring after FLOOR (offset/1024) H-SFN cycles;- SFN and subframe indicated by *startSFN* and *startSubframe*;where:- offset is given by *periodicityAndOffset*;- H-SFNRef corresponds to the last subframe of the first transmission of *RRCConnectionRelease* message containing *pur-Config*, taking into account *hsfn-LSB-Info*;- H-SFN cycle corresponds to the duration of 1024 H-SFNs;1> if the *pur-NumOccasions* is set to *one*, for the first PUR occasion:2> if transmission using PUR in accordance with conditions in 5.3.3.1c is not initiated; or2> if transmission using PUR in accordance with conditions in 5.3.3.1c has been initiated, after the completion of the transmission using PUR: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*;1> else:2> consider that the subsequent PUR occasions occur periodically after the occurence of the first PUR occasion at the SFN/subframe indicated by *startSubframe* and *startSFN* and periodicity given by *periodicityAndOffset*;2> if the *pur-ImplicitReleaseAfter* is configured, for each PUR occasion occurring while the UE is in RRC\_IDLE:3> if transmission using PUR in accordance with conditions in 5.3.3.1c is not initiated; or3> if PUR failure indication is received from lower layers:4> consider the PUR occasion as skipped;4> if *pur-ImplicitReleaseAfter* number of consecutive PUR occasions have been skipped:5> if *pur-TimeAlignmentTimer* is configured, indicate to lower layers that *pur-TimeAlignmentTimer* is released;5> release *pur-Config*;5> discard previously stored *pur-Config*. |

Note that in the email discussion in RAN2#113e, the following has been summarized:

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| **Summary**: (13/26) companies agree with the proposal that UE can indicate to the network its preference for CG-SDT resource while being in RRC\_Connected. (2/26) companies may be OK with the proposal, e.g. if this mechanism is treated with lower priority. (11/26) companies didn’t’ see a necessity/benefit of introducing an additional request/assistance procedure. In their opinion such UE request procedure is not essential and the CG-SDT resources can be determined by the network, e.g. based on the QoS of the related DRBs/subscription. From the response though it appears that some of the companies which don’t prefer to have such a UE request mechanism, would be OK to reuse legacy UE assistance information framework to minimise the extra standardisation work. |

Based on the above analysis, companies are invited to answer the following question:

**Question4: Do companies support to introduce an implicit CG-SDT configuration release mechanism, i.e., UE releases CG configuration upon having unused or failed a consecutive number of CG-SDT occasions?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsung | See comments | In NR, CG occasions will be mapped to SSBs and UE uses the CG occasions corresponding to suitable/best SSB. This means that UE will not use several CG occasions which are mapped to other SSBs. Counting these as unused and releasing CG-SDT resources seems not efficient. We are ok for implicit mechanism but not with following " i.e. **UE releases CG configuration upon having unused or failed a consecutive number of CG-SDT occasions"**We can use a timer based approach where the timer is started when CG-SDT resource config is received and it is restarted whenever UE uses the CG-SDT resource. If timer expires CG-SDT resources can be released. |
| LG | No | Timer based release is enough. Moreover, implicit mechanism would cause CG status mismatch between UE and network. |
| ZTE | N | Now that we agreed multiple CG configurations, these implicit release mechanisms may start to get complex. Anyway, there is one timer based mechanism to relase the resources (i.e. based on the TA). So, we think this may be sufficient.  |
| Sharp | See comments | Implicit mechanism is ok for us. Current agreed TAT expiry could be such a implicit mechanism.However, we don’t have strong view to introduce that “**UE releases CG configuration upon having unused or failed a consecutive number of CG-SDT occasions**” |
| Lenovo | See comments | We support some implicit CG-SDT release mechanism. However similar to other expressed opinions we also think that the TAT based release mechanism, e.g. based on TAT expriy, might be sufficient. In addition since CG resources may be beam specific, we need to first discuss how such implicit release mechanism, e.g. based on unused or failed a consecutive number of CG-SDT occasions, works in detail.  |
| CATT | See comment | We agree with Samsung that CG occasions/configurations may be mapped to SSBs. And CG occasions may be not used when there is no available SSB. We are OK with timer based solution. |
| ASUSTEK | No | Agree with ZTE. |
| Spreadtrum | No | Timer based solution (e.g. TAT timer) is enough and also the network can explicitly release the resource by RRCRelease message based on the network’s load. It can somehow avoid mismatch between UE and network. |
| OPPO | See some comments | We agree to introduce implicit releasing mechanism since we have already made some agreements which shall be considered as implicit release, i.e. UE releases CG resources when SDT-TAT expires, or UE moves/accesses to another cell which is different from the last serving one.But we do not think it is necessary to introduce implicit release mechanism based on consecutive skipping/failure, since the multiple CG configurations and beam based transmission would increase the complicity to make the counter aligned at network and UE. |
| Huawei, HiSilicon | No strong view | We think the releaes mechanism is beneficial of the efficeint usage of the CG resource for the UE and the network and gNB detection complexities . But, we agree that we have already agreed when the TAT expires the UE shall release the CG resource configuration. Also, CG to SSB association and multiple CG configuartions may create some complexities in this release.  |
| Sony | No | Agree with ZTE. |
| Interdigital | No | The UE may fail a number of transmissions due to temporary beam miss-alignment, which should not trigger releasing the CG configuration all together. UE can release the CG upon expiry of the TA timer anyway, and that is sufficient. |
| Intel | No | While we do see some potential benefit for this optimization, we do not see this as essential given that a timer based release mechanism is already supported and there are marked differences between NR and LTE system (e.g. due to multi-beam scenarios and the additional power saving requirements in NB-IoT). Therefore, the support of this implicit release based on consecutive skipping of CG-SDT occasions is not sufficiently motivated |
| ITRI | No | Agree with ZTE. |
| Fujitsu | No | The current agreed mechanism is sufficient. |
| Qualcomm | No | Network and UE may have different counter status of the unused or failed CG based transmission. Becasue it is possible that UE transmits small data over CG resource but network could not detect the transmission. A CG transmission not received can be miss-interpreted as a skipped occasion. |
| Xiaomi | No | Agree with ZTE. |
| Ericsson | Comment | The actual mechanism should be discussed and to what extent a CG configuration is valid. A UE would anyway not have several CG configurations active for which the implicit release apply to. |
| Nokia | No strong opinion | Could be enough with Timer (TAT) based approach.  |
| vivo | No | After reviewing comments from network vendors, it seems resource waste and blind detection on CG resources are not important issues. In this sense, we are okay to not introduce implicit for UE simplicity.  |
| Panasonic | No | Agree with ZTE |
| Google | No | The TA timer is sufficient to release CG configuration implicitly. |
| NEC | See comment | We see benefit of implicit CG release for one CG Resource, however this becomes complicated with multiple CG configurations and we think that this should be discussed in future releases if necessary |
| APT | comment | TAT expiry is suffient. However, we still saw the benefit on releasing the resource configuration once a mount of skipping or transmission failure is occurred. For example, the UE may earlier understand the data transmission is not allowed than receiving a RRCRelease message. |

***Summary***

Within the comapanies who have replied:

* No company has replied with direct support for the mechanism of implicit CG release
* 14 companies think the implicit release of CG-SDT resource should no longer be supported, given the fact that we have already agreed on the CG configuration release at TAT expiry.
* For the other companies, some mentioned about the issue of SSB to CG mapping and “skipped CG occasion”, saying that the skipped CG occasion is not suitable to determine if CG resource should be released. Others also mentioned about the issue with multiple CG configurations.

Based on the above results for the discussion, we propose the following:

**Proposal: Implict release of CG-SDT resource is not supported. (0/24)**

## CG-SDT and BWP configuration

During the email discussion in [1] in RAN2#113e, the discussion for BWP configuration for CG-SDT has been triggered on whether CG resources for SDT can be confifgured on dedicated BWP. Two options have been considered by companies:

* Option 1: The BWP associated with CG-SDT resources is initial UL BWP
* Option 2: The BWP associated with CG-SDT resources is configurable,
 e.g. UE specific dedicated UL BWP.

The summary after the discussion is as follows, which may serve as the baseline for the discussion here:

|  |
| --- |
| **Summary:**(11/25) companies support only Option 1. (14/25) companies support Option 2.Companies supporting option 2 are concerned about the congestion on initial UL BWP. Companies which are ony supporting option 1 are mostly concerned about the additional complexity when supporting dedicated UL BWP. Given that there is a slight majority for supporting option 2 it’s proposed to further discuss whether to support option 2. The aim should be to understand the additional complexity involved by option 2.  |

On the above discussion, one observation that the rapporteur would like to make is that, even if we only allow it to be configured on initial BWP, the configuration is still dedicated configuration. For Option2, it is better to be reworded as “*BWPs other than initial BWP*”.

During the email discussion in the last meeting, for the option of CG configured on BWPs other than initial UL BWP, another issue mentioned by the companies is the issue with paging, that for TDD operations, when activated UL BWP is not the initial BWP, the paired DL BWP will not be the initial DL BWP, either. Hence, in the activated BWP, the UE is not able to monitor PDCCH for paging. While, this would not be a problem if the configured non-initial BWP contains the bandwidth of the initial BWP.

Companies are invited to answer the following question:

**Question5: Which option do companies prefer for the CG-SDT configuration with regards to BWP?**

* **Option1: CG-SDT resource can only be configured on initial BWP.**
* **Option2a: CG-SDT resource can be configured on BWPs other than initial BWP.**
* **Option2b: CG-SDT resource can be configured on BWPs other than initial BWP for FDD and only if the CG-SDT BWP includes initial BWP for TDD.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** (1/2a/2b) | **Additional comments** |
| Samsung | Option 2a | Even if CG-SDT BWP does not include initial BWP, paging can be still be transmitted in CG-SDT BWP if common search space is configured in CG-SDT BWP. So we do not agree that option 2b is the only way to ensure that paging is transmitted in CG-SDT BWP. |
| LG | Option 2a |  |
| ZTE | Option 2a |  |
| Sharp | Option 2a with comments | It is not clear why NW could be configured CG-SDT either initial BWP or other BWPs. It could be NW implementation.If most companies are ok with BWPs other than initial BWP, we are ok with it too. |
| Lenovo | Option 2a |  |
| CATT | Option 1 | We think if dedicated BWP is used for SDT, some issues need to be resolved in TDD, since DL BWP is paired with UL BWP. For example, how to receive SI (e.g. posSIB(s)) during SDT. We prefer to keep it simple in R17. |
| ASUSTEK | Option 2a with comments | We also think the network is still allowed to configure CG-SDT on initial BWP (it is up to NW decision). |
| Spreadtrum | Option 1 | Option 1 is simpler for the UE and will not add additional requirement for the UE in inactive state. |
| OPPO | Option 1  |  |
| Huawei, HiSilicon | Option2a | It is up to the network configuration to configure CG-SDT on BWPs other than inital BWP provided in SIB1. |
| Sony | Option 2a or 2b | Option 2a or 2b should be supported. |
| Interdigital | Option 2a | To offload SDT traffic from the initial bwp, it can be beneficial to configure the CG on a different BWP. |
| Intel | Option 2a | Limiting to just the initial BWP seems restrictive. SDT session aims to be of short duration and should have minimal impacts on UE's activities done during RRC\_INACTIVE. Moreover for paging, gNB is aware that UE has an going SDT session (in a given BWP) and therefore, gNB may not page the UE. For other paging activities (e.g. SI monitoring), UE could anyway do the monitoring when is not performing SDT operation.  |
| ITRI | Option 1 |  |
| Fujitsu | Option 2a | We are ok to follow the slight majority. |
| Qualcomm | Option 1 | Option 1 is simpler for both UE and network. |
| Xiaomi | Option 2a |  |
| Ericsson | Option 2a |  |
| Nokia | Option 1  | Agree with CATT, we should try to keep it simple in Rel-17. |
| vivo | Option 1 | CG-SDT is intended for UP data of small size, we are not convinced why narrow bandwidth and resource load is a big issue if initial BWP is used.  |
| Panasonic | Option 2a |  |
| Google | Option 2a |  |
| NEC | Option 2a | Because CG-SDT configuration is dedicated, it is up to gNB to give the appropriate dedicated BWP. If issues are found in TDD or FDD, then we can discuss further restrictions (e.g. Option 1 or Option 2b) |
| APT | Option 2a |  |

***Summary***

Within the comapanies who have replied:

* 17 companies have replied “option 2a” that they think it is up to the network’s implementation to ensure the proper BWP for UE’s procedure in RRC\_INACTIVE, such as paging and random access.
* 7 companies have replied “option1” and think that CG-SDT configuration should only be on initial BWP.

Based on the above results for the discussion, we propose the following:

**Proposal: CG-SDT resource can be configured on BWPs other than initial BWP (17/24).**

# PDCCH monitoring after CG transmission

After CG transmission in INACTIVE, the UE still needs to monitor PDCCH for retransmission if the transmission fails or for a new transmission for subsequent uplink transmission. However, it is still unclear how the PDCCH monitoring should be controlled in the UE side for CG-SDT.

Note that as mentioned in Section 3, we have agreed that subsequent uplink transmission for CG-SDT can also be based on DG, similar to RA-SDT. Hence, we think the PDCCH monitoring after DG transmission is a common issue for both RA-SDT and CG-SDT in RRC\_INACTIVE and would like to delegate the discussion to a more general one. In this case, we don’t repeat the discusion between CG and RA-SDT.

In legacy PUR, the UE monitors PDCCH when the timer *pur-ResponseWindowTimer* is runnning as in 36.321 [5].

|  |
| --- |
| After transmission using PUR, the MAC entity shall monitor PDCCH identified by PUR-RNTI in the PUR response window using timer *pur-ResponseWindowTimer*, which starts at the subframe that contains the end of the corresponding PUSCH transmission plus 4 subframes, and has the length *pur-ResponseWindowSize.* While *pur-ResponseWindowTimer* is running, the MAC entity shall:- if the PDCCH transmission is addressed to the PUR-RNTI and contains an UL grant for a retransmission:- restart *pur-ResponseWindowTimer* at the last subframe of a PUSCH transmission corresponding to the retransmission indicated by the UL grant plus 4 subframes.- if L1 ACK for transmission using PUR is received from lower layers; or- if PDCCH transmission is addressed to the PUR-RNTI and the MAC PDU is successfully decoded:- stop *pur-ResponseWindowTimer*;- if L1 ACK for transmission using PUR is received from lower layers or the MAC PDU contains only Timing Advance Command MAC control element:- indicate to upper layers the transmission using PUR was successful;- if repetition adjustment for transmission using PUR is received from lower layers:- indicate the value of the repetition adjustment to upper layers.- discard the PUR-RNTI.- else if fallback indication for PUR is received from lower layers:- stop *pur-ResponseWindowTimer*;- indicate to upper layers PUR fallback indication is received;- if repetition adjustment for transmission using PUR is received from lower layers:- indicate the value of the repetition adjustment to upper layers.- discard the PUR-RNTI.- if the *pur-ResponseWindowTimer* expires:- indicate to upper layers the transmission using PUR has failed;- discard the PUR-RNTI. |

The UE behavior related to PUR-ResponseWindowTimer can be summarized as follows:

* Start the timer immediately after PUR transmission
* Stop the timer when fallback indication is received or PUR retransmission is scheduled
* When the timer expires, stop PDCCH monitoroing by discarding the PUR-RNTI and indicate PUR failure to upper layers

For CG retransmission, similar to PUR, we would need a machanism to control the PDCCH monitoring for new transmission/retransmission after CG. Companies are invited to answer the following question:

**Question6: Do companies agree that the UE shall start a timer after CG/DG transmission and monitor PDCCH while this timer is running?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option**  | **Additional comments** |
| Samsung | Yes |  |
| LG | Yes | We think DRX mechanism can be used in RRC\_INACTIVE. Then, drx-InactivityTimer can control the PDCCH monitoring. |
| ZTE | Yes, but same as Rel-16 | In case of NR-U we already defined such timer and this could be reused. So, we want to clarify whether a new timer will be defined, and if so why? We think the CG-baseline from Rel-16 will be sufficient for this purpose.  |
| Sharp | Yes |  |
| Lenovo | Yes | We can further discuss whether we reuse legacy timer or a new timer. |
| CATT | Yes  |  |
| ASUSTEK | Yes | We think DRX mechanism can be used for SDT. |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes | @ZTE, the CG-timer in R15 is not used for PDCCH monitoring. The CG-baseline for PDCCH monitoring in R16 is to use DRX.Then, for the companies that mentnioned DRX can be reused. In PUR, a new timer has been introduced as shown in the explanation. We think a new timer should be defined for the PDCCH monitoring after CG transmission, similar to PUR. |
| Sony | Yes | DRX should be supported for SDT. |
| Interdigital | Yes |  |
| Intel | FFS | While we do think a timer might be needed, whether or not a new timer is defined may require further discussion on how the new T319’ timer works (it is FFS whether it starts only at the beginning of the SDT session or restarted with every UL transmission). |
| ITRI | Yes |  |
| Fujitsu | Yes | What time it is can be discussed later, given that there is T319. |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes | Details needs to be discussed |
| Nokia | Yes |  |
| vivo | Yes | This is straight-forward.  |
| Panasonic | Yes |  |
| Google | Yes |  |
| NEC | Yes |  |
| APT | Yes | The details, e.g., which timer and/or DRX mechanism, can be FFS. |

***Summary***

Within the comapanies who have replied: All the companies think the UE should start a timer after CG transmission for PDCCH monitoring. While there are the following options for the timer

* To create a new timer
* To reuse the DRX mechanism for CG-SDT
* To reuse the new/old T319 timer
* To reuse the timer in NRU in the CG baseline

Based on the above results for the discussion, we propose the following:

**Proposal: UE start a window after CG/DG transmission for CG-SDT (24/24). FFS whether to design a new timer or to reuse an existing timer.**

# CG retransmission

In RAN2#113e, it has been agreed that the subsequent uplink transmission following an intiail transmission with CG in RRC\_INACTIVE can be based on either CG or DG, by the following agreement.

|  |
| --- |
| **Agreements**==OMITTED==4. 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 |

While, it is obvious that retransmission for subsequent transmission based on dynamic grant can use dynamic grant, it remains to be determined how retransmission can be done if the initial or subsequent transmission fails on CG transmission. In this section, we continue the discussion on retransmission for CG-SDT.

## Autonomous retransmission

In R16 NRU, autonomous retransmission on CG is introduced in addition to retransmission by dynamic grant such that CG retransmission can be performed on CG resources. The advantage of autonomous retransmission is that the network does not need to perform dynamic scheduling, for which downlink LBT needs to be performed on the unlicensed spectrum.

One motivation for allowing autonomous retransmission on CG-SDT resource is that the downlink beam indicated by the UE to the network through CG-SDT transmission (based on CG-SDT to SSB mapping) may not always be suitable beam for the UE with the UE’s mobility. If the beam becomes unsuitable and UE keeps monitoring the beam indicated to the network by CG-SDT, the UE will not be able to receive PDCCH. Hence, if the UE has the CG occasion to perform retransmission to the previous un-acknowledged CG transmission, the transmission can serve as BFR that can indicate a new beam to the network.

For the tdocs submitted to RAN2#113e, several of them have discussed whether to support CG retransmission on CG resource. Companies are invited to answer the following question.

**Question7: Do companies see a need to support autonomous retransmission on CG-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (Y/N) | **Additional comments** |
| Samsung | Yes |  |
| LG | No | We think retransmission on CG-SDT should be possible. However, we are wondering why the retransmission is autonomous. We think CG retransmission based on feedback should be supported. |
| ZTE | Yes, and same as Rel-16 | Again we can reuse the autonomous retransmission in CG from Rel-16 baseline. So, nothing new is needed. |
| Sharp | Yes |  |
| Lenovo |  | We are not sure whether autonomous retransmission fiunctionality is really necessary. The autonomous (re)transmission mechanism was designed for LBT failures or deprioritized grants (IIoT). Here the situation is different. Also since for SDT the periodicities between CG transmission occasions may be relatively large, it might be more efficient to rely on dynamic grants addressed to the CS-RNTI instead of autonomouts retransmissions. |
| CATT | Yes | In NR-U, autonomous retransmission is introduced because the PDU is not transmitted due to LBT failure is indicated by PHY and the network does not know that the UE has UL transmission either. This is similar in CG-SDT when BFR happen. But we think this only applies to the initial transmission. The subsequent transmissions can be handled by network, since the network can evaluate the UL grant by other information, e.g. BSR if agreed. |
| ASUSTEK | Yes | We think this is needed at least for the first transmission. |
| Spreadtrum | No | For initial transmission, fallback to RA-SDT can handle the BFR situation. For subsequent transmission, network can handle the failure situation. So no need to introduce autonomous retransmission. |
| OPPO | No | We think automonous retransmission mechanism is not necessary for CG-SDT since it is introduced for NR-U and this is not what we are focused on. |
| Huawei, HiSilicon | Yes | We see benefits for autonomous retransmission for CG-SDT. |
| Sony | No | We think this is not urget data transmission like URLLC, so dynamically assigning a retx DCI would be the baseline. |
| Interdigital | Yes | This can be beneficial when UL beams are misaligned, UL is miss-synchronization, or when channel conditions are poor. |
| Intel | Yes |  |
| ITRI | Yes | We think autonomous retransmission is needed at least for first transmission.  |
| Fujitsu | No | It would be deliberate to reuse NR-U mechanism. In addition, it would be clarifired if URLLC traffic is also the scope of SDT, and if not, DG is sufficient. |
| Qualcomm | No | The autonomous retransmission is introduced for NR-U and we don’t see it is beneficial for SDT scenario.  |
| Xiaomi | Yes | The Rel-16 IIOT CG autonomous retransmission can be reused. |
| Ericsson | No | The usecase we believe in for CG-SDT does not need autonoumos re-tx.  |
| Nokia | No | No retransmission since the NW would not be able to do soft combining without UCI. We don’t think we should introduce UCI for this as it was only supported for NR-U. |
| vivo | Yes | To improve link robustness, CG autonomous with power ramping is needed, which is similar to PRACH re-attempting.  |
| Panasonic | Yes |  |
| Google | No | The autonomous retransmission does not have significant benefit in licensed spectrum.  |
| NEC | No | We see the benefit of retransmission to request a more appropriate SSB if the current beam is not suitable anymore due to mobility. However autonomous retransmission may not be suited for CG-SDT and we prefer having legacy BFR mechanisms |
| APT | Yes |  |

***Summary***

Within the comapanies who have replied:

* 13 companies replied with “Yes” that they think autonomous retransmission can be adopted for CG-SDT. Some think that autonomous retransmission can be beneficial for BFR and only useful for initial transmission.
* 11 companies replied with “No” and think there is no significant benefits in licensed spectrum. They think that autonomous retransmission is mainly for combating the impacts of LBT in NRU and deprioritized grants in IIoT. While for CG-SDT, there is no such use case.

Based on the above results for the discussion, we propose the following:

**Proposal: RAN2 should further discussion whether to support autonomous retransmission for CG-SDT.**

## Retransmission by dynamic grant

Another approach for retransmission is retransmission by dynamic grant. For legacy PUR, etransmission by dynamic grant is supported for the UE by monitoring PDCCH addressed to PUR-RNTI while the PUR-ResponseWindow is running.

Companies are invited to reply to the following question:

**Question8: Do companies see a need to support retransmission by dynamic grant for CG-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (Y/N) | **Additional comments** |
| Samsung | Yes |  |
| LG | Yes |  |
| ZTE | Y | Again, we think this is already feasible in Rel-16.  |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| CATT | Yes | But we think enhancements are need to distinguish the NDI in retransmission of the CG and new transmission of the DG if they share the same HARQ processes. |
| ASUSTEK | Yes |  |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Sony | Yes |  |
| Interdigital | Yes |  |
| Intel | Yes |  |
| ITRI | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| vivo | Yes | This is the same as the existing CS-RNTI PDCCH scheduling retransmission mechanism. And it should be supported for CG-SDT. |
| Panasonic | Yes |  |
| Google | Yes |  |
| NEC | Yes |  |
| APT | Yes |  |

***Summary***

Within the comapanies who have replied, all the companies think retransmission can be based on dynamic grant. Based on the above results for the discussion, we propose the following:

**Proposal: Support retransmission by dynamic grant for CG-SDT. (24/24)**

## ACK feedback indication in DCI

In LTE PUR, ACK feedback indication was introduced for the PUR-CP solution to terminate the PUR procedure, which is highlighted in yellow below according to TS 36.212 [6].



The difference between CG-SDT and PUR is that (a) for CG-SDT there is no CP solution; and (b) For PUR, it only supports one-shot transmission while CG-SDT supports subsequent uplink transmission after initial transmission. While for CG-SDT, as mentioned at the beginning of the section, subsequent uplink transmission can also be based on CG.

The reason for introducing ACK feedback in PUR is that, the periodicity of PUR can be quite large (according to the configuration of PUR, the smallest periodicity is 8 H-SFNs (one H-SFN equals 10.24s) and the largest is 8192 H-SFNs). L1 ACK can shorten the time needed for PDCCH monitoring for UE.

While for CG-SDT, in the previous meeting, we have agreed that subsequent uplink can be based on CG, some mechanisms are needed for the UE to acknowledge ACK for CG transmission before performing subsequent uplink with CG (e.g., L1 ACK similar to PUR, or CG-timer similar to R15 CR).

**Question9: Do companies see a need to support L1 ACK feedback indication for CG-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (Y/N) | **Additional comments** |
| Samsung | See comments | Network can send PDCCH addressed to SDT-RNTI for a DL TB wherein TB includes RRC release message. Alternately, network can send PDCCH addressed to SDT-RNTI for a UL grant for subsequent small data transmission. So L1 ACK seems not essential. If majority view is to support it, need to send LS to RAN1 for feedback before taking any decision. |
| LG | Maybe | We think some kind of feedback mechanism is needed for CG-SDT. However, it does not necessarily be L1 ACK feedback. |
| ZTE | Y | We wonder if any new mechanism is needed for this other than what is possible in NR-U baseline in Rel-16 (i.e. CG-DFI).  |
| Sharp | Yes | L1 ACK could be used before a DL response arrival to avoid unnecessary terminatation of the transmission by RRC release. And autonomous retransmission could be avoided by reception of L1 ACK.However, unlike the L1 ACK for PUR to shorten the time for PDCCH monitoring, the UE has to keep monitoring of PDCCH till a RRC release is received or other failure case occurs. |
| Lenovo |  | We agree with Samsung that L1 ACK seems not essential.  |
| CATT | Yes | We agree L1 ACK feedback is benefial on terminating the whole SDT procedure. But we think it is only used for the last UL MAC PDU. |
| ASUSTEK | Yes |  |
| Spreadtrum | Maybe | We prefer using RRCRelease message to terminate CG-SDT. But feedback mechanism maybe beneficial in some cases. |
| OPPO | Yes | Since we have agreed to support subsequent new transmission on CG, we think L1 ACK is beneficial to shorten the time to perform new tranmsision on CG. |
| Huawei, HiSIlicon | Yes | L1 ACK is useful for early termination of PDCCH monitoring. Also, since we have already agreed to use CG for subsequent uplink, L1 ACK is already implied.  |
| Sony | Yes | L1 feedback via explicit or implicit Ack is anyway needed. |
| Interdigital | Yes | HARQ-ACK info should be provided to terminate the procedure and unnecessary PDCCH monitoring. |
| Intel | Maybe not | For RRC based CG-SDT, our understanding is that the need of using an L1 ACK feedback is not justified. On other hand, this topic could be revisited if/when RRC-less CG-SDT were enabled |
| ITRI | Yes |  |
| Fujitsu | No | We have understood that RRCRelease message will terminate CG-SDT. |
| Qualcomm | Yes | Feeback indication is beneficial in some cases. |
| Xiaomi | Yes | We can reused the Rel-16 DFI. |
| Ericsson | Maybe | Implicit ACK might be sufficient, needs some more discussion |
| Nokia | No | Agree with Samsung we can rely on other DL msg (e.g. TA MAC CE) or UL grant without introducing L1 ACK. We should not assume the NR-U mechanisms are to be supported for SDT as it increases implementation complexity quite a bit. SDT does not necessarily operate on NR-U bands. |
| vivo | Yes | Considering the length of T319 for SDT might be far larger than CG periodicity, the NW may not send any UL/DL scheduling responding to the CG PUSCH transmission (i.e. the NW would like to continue the CG-SDT procedure and there is no DL data). An explicit DL L1 feedback is needed to stop the running PDCCH monitoring window for UE power saving.  |
| Panasonic | Yes |  |
| Google | No | The network transmits RRC release to end subsequent data transmission so L1 ACK may not be needed. |
| NEC | Maybe | We agree with Samsung that we should send an LS to RAN1. |
| APT | Yes |  |

***Summary***

Within the comapanies who have replied,

* 14 companies replied with “Yes” that they think L1 ACK should be supported
* 3 companies replied with “No” that they think the network use RRCRelease to end subsequent data transmission
* 7 other companies expressed doubts on whether L1 ACK is needed. And think LS should be sent to RAN1 to see if this is necessary.

Based on the above results for the discussion, we propose the following:

**Proposal: Support L1-ACK feedback for CG-SDT. (14/24) Send an LS to RAN1 on this.**

## HARQ processes

In legacy PUR, there is only one HARQ process supported for uplink PUR transmissson.The reason why there is only one single HARQ process is supported is because for PUR, we only support one-shot uplink transmission. While, for CG-SDT, we also support subsequent uplink transmission. The advantage for support multiple HARQ process for the uplink is that the network does not need to waste time for the stop-and-wait for a single HARQ process.

Companies are inviated to answer the following question:

**Question10: Do companies see a need to support multiple HARQ process for uplink CG-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (Y/N) | **Additional comments** |
| Samsung | See comments | Subsequent UL transmission can work even with single HARQ process. Also for SDT scenario(s), we do not think that there will be lots of data to be transmitted for SDT enabled RBs.So in our view, multiple HARQ processes is not essential |
| LG | Yes | SDT is different from PUR. We don’t see a need to restrict the number of HARQ process to 1. |
| ZTE | Y | No strong view, but we think this also comes for free. i.e. no changes needed to Rel-16 baseline.  |
| Sharp |  | We prefer to discuss one HARQ process at this phase. It could be FFS for the multiple HARQ process. |
| Lenovo | Y | We don’t foresee any issues to support multiple HARQ processes. Therefore non need to restrict this to a single HARQ process.  |
| CATT | Yes  |  |
| ASUSTEK | Yes | There is no need to restrict the number of HARQ process. |
| Spreadtrum |  | SDT procedure is introduced for small data volume services. So maybe there is no need to introduce multiple HARQ process in R17. |
| OPPO | Yes | PUR is introduced for NB-IoT/MTC device with only one or two HARQ processes. But this is not the use case of SDT, so we do not need to restrict HARQ process numbers. |
| Huawei, HiSilicon | Yes | There is no issue for supporting it while it is useful to support subsequent transmissions.  |
| Interdigital | Yes | No reason to introduce new restrictions. |
| Intel | Yes | We can rely on Rel-16 design as baseline |
| ITRI | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes | Beneficial since subsequent data is to be supported and good to reduce the overall latency. |
| Nokia | Yes | PUR was defined for NB-IoT which supported only 1 process. We do not see the need to limit it for SDT here. |
| vivo | Yes | To simultaneously support more service with HARQ transmission, multiple HARQ processes are needed.  |
| Panasonic | Yes |  |
| NEC |  | No strong view but following Rel-16 baseline is fine. |
| APT | Yes |  |

***Summary***

Within the comapanies who have replied,

* 18 comapanies have replied “Yes” to the question that they think multiple HARQ processes can be supported for CG-SDT:
* 6 other comapnies think a single HARQ process is sufficient.

**Proposal: support multiple HARQ process for uplink CG-SDT. (18/24)**

# Validity Aspects

During the last meeting, the following agreements have been achieved for TA validation for CG resources.

|  |
| --- |
| 6. 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.==OMITTED===9. UE releases CG-SDT resources when TAT expires in RRC\_Inactive state |

An LS is sent to RAN1 afterwards and according to the reply LS from RAN1 in [3]. With this, we know that RAN1 is studying the issue of TA valudation for CG-SDT as of now.

|  |
| --- |
| ==OMITTED==* FFS TA validation and PUSCH validation for CG-SDT.
 |

In this section, we continue the discussion on CG resource validation.

## Time-based criterion for CG resource validity

During RAN2#113e, the following issue, highlighted in yellow, is indicated as FFS

|  |
| --- |
| 9. If CG-SDT resources are configured on the selected UL carrier and are valid, then CG-SDT is chosen. Otherwise,• If 2 step RA-SDT resources are configured on the UL carrier and criteria to select 2 step RA SDT is met, then 2 step RA-SDT is chosen• else If 4 step RA-SDT resources are configured on the UL carrier and criteria to select 4 step RA SDT is met, then 4 step RA-SDT is chosen• else UE does not perform SDT (i.e. perform non-SDT resume procedure) • If both 2 step RA-SDT and 4 step RA-SDT resources are configured on the UL carrier, RA type selection is performed based on RSRP threshold. - FFS whether RSRP threshold for RA type selection is common or different for SDT and non SDT.- FFS what validity includes if we need to deal with CG resource availability delay? |

In order to resolve the above FFS, companies are invited to answer the following question:

**Question11: Do companies think that CG resource availability delay should also be a criterion for CG validation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsung | No | CG-SDT resources are contention free. On the other hnad, RA resources for SDT are contention based and likely to incur larger delays. So in our view CG-SDT should be prioritized over RA-SDT irrespective of CG resource availability delay. |
| LG | Yes | If available CG-SDT resources are far enough, it would be better to trigger RA-SDT procedure. |
| ZTE | N | No need to have this optimization especially since it is not straightforward for the UE to compare the latency in RACH procedure to that of the CG delay latency anyway (as also mentioned by Samsung above).  |
| Sharp | No |  |
| Lenovo | No |  |
| CATT | Yes  | If CG resource availability delay is quite large, it will bring great impact on latency of the traffic. |
| ASUSTEK | No | We assume that periodicity of CG is not too large, and SDT is not designed for delay sensitive services, so there is no need to consider whether the CG resource is too far away or not. |
| Spreadtrum | No |  |
| OPPO | No | We do not think latency is criticial in SDT. |
| Huawei, HiSIlicon | Maybe | We think normally RA resources can be available much quicker that CG-SDT resources and if we configure CG resources with low periodicity to account for maximum packet delay required by the service, then too many resource might need to be reserved for SDT, impacting network capacity. On the other hand, this issue can be minimized in case we agree on CG configuration request, so if we have CG configuration request then the motivation to consider CG resource availability delay is lower.  |
| Sony | No | No optimization is needed. It is the network responsibility to ensure the periodicity of CG occasion matches the expected service level requirements. |
| Interdigital | Maybe | The current work item does not menion anything for latency of data, but that aspect can be looked into later if low latency data is supported. |
| Intel | No | Agree with ZTE |
| ITRI | No |  |
| Fujitsu | No |  |
| Qualcomm | No |  |
| Xiaomi | No |  |
| Ericsson | No | We do not think there is a Use Case with latency requirement that require this, i.e use CG if TA and valid, otherwise RA. |
| Nokia |  | CG if valid should always be priorized over RA. |
| vivo | No | From UE perspective, the UE should be able to fallback to RACH-SDT or legacy resumption procedure before transmitting the CG-PUSCH in this case. Anyway, the validation of CG resources should not take delay into account. Otherwise, the CG-SDT may never be triggered since it is a bit hard to perfectly make the CG resources match the characteristic of UPdata. What’s worse, we are not sure how to precisely validate the CG resource based on potential transmission latency?  |
| Panasonic | No |  |
| NEC | No | We think that SDT is not meant for low-latency communication. |
| APT | NO | The gNB should provide configuration which had shorter periodicity if UE has concern on delay for resource availability. Otherwise, it is merely an optimization work. |

***Summary***

Within the comapanies who have replied,

* 18 comapanies have replied “No” to the question that they think the proposed time-based criterion is not necessary for CG resource validation
* 2 companies support to take the timing of the CG occasion as criterion for CG resourcce validity
* 3 companies hold neutral views on this.

**Proposal: CG resource availability delay is not considered as a criterion for CG validation. (18/20)**

# Beam selection

In RAN2#112e, the following agreements, highlighted in yellow, have been made regarding the beam selection aspects for CG.

**Agreements:**

===omitted===

* The UE can use configured grant based small data transfer if at least the following criteria is fulfilled (1) user data is smaller than the data volume threshold; (2) configured grant resource is configured and valid; (3) UE has valid TA. FFS for the candidate beam criteria.
* 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.

One issue in the beam selection of the UE is that what the UE should do when none of the SSBs’ SS-RSRPs are above the RSRP threshold. In R15/16, for beam selection for both 2-step RA and 4-step RA, the UE would select any SSB when none of the SSBs’ RSRP is above the RSRP threshold.

Similar issue also exists for CG-SDT. Companies are invited to answer the following question:

**Question12: If none of the SSBs’ RSRP is above the RSRP threshold for beam selection for CG-SDT, should the UE select any SSB?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsung |  | No strong view |
| LG | No | In this case, the UE should trigger RA-SDT procedure. |
| ZTE | Y | This is similar to how we handle this in MAC today during the RACH procedure. So, seems this can be reused.  |
| Sharp |  | RAN1’s input may be necessary. |
| Lenovo | No  | In our view UE should trigger the RACH based scheme, i.e. RACH-SDT, in case no suitable candidate beam has been detected. We think that if there is no qualified candidate beam found it implies that the link quality is not good enough for UE to send user data via CG resource. Therefore it’s not sensible to select any SSB. |
| CATT | No | We think in this case, CG configurations, e.g. MCS maybe not suitable for SDT. It is likely the transmission may fail using CG-SDT. |
| ASUSTEK | No | The UE should switch to RA-SDT procedure. |
| Spreadtrum |  | We should wait for RAN1’s input. |
| OPPO | Maybe | We have not discussed whether the beam selection is common or seperate between RA-SDT and CG-SDT. To be specific, there are actually two possible solutions:Option1: beam selection is performed before SDT type selection. UE selects a beam with SS-RSRP above the threshold, otherwise, UE selects any beam. After the beam selection, UE determine whether there is vailid CG resources.Option2: beam selection is performed separately. If CG resources are configured, UE selects among the SSBs configured with CG resources according to RSRP threshold for CG-SDT. If there is no SSB meets the condition, UE switch to RA-SDT and selects an SSB according to the RSRP threshold for RA-SDT.For these two options, the behavior would be different. |
| Huawei, HiSilicon |  | RAN1 inputs are needed. RAN1 is discussing on the mapping between CG occassion and SSB and this might be related to the discussion here. |
| Interdigital | No | UE selects a RACH-SDT if no CG resource meets the configured RSRP therhosld. |
| Intel | Yes | As mentioned by ZTE, we do not see any reason to deviate from the “normal” RACH procedure,It is also worth mentioning that this RSRP threshold should be different from the ones defined for RACH procedure (i.e. *rsrp-ThresholdSSB* and *msgA-RSRP-ThresholdSSB*) |
| ITRI | No | In this case, the CG-SDT should not be used. However, it could be discussed further whether switches to RACH-SDT. |
| Qualcomm | No | In this case, UE should perform RACH. Because it implies the link quality is bad for SDT via CG resources. |
| Xiaomi | No | The UE should switch to RA-SDT. |
| Ericsson | Yes | UE can genrally select any SSB as long as TA is valid. The impact on SDT is then if one can assume that at least one beam is above the threshold for SDT, e.g. if the UE hasn’t moved. If it is beam selection during ongoing CG, then the TA validation criteria of RSRP+/-delta ensure that you are not below the threshold. If not RA should be triggered (with thresholds evaluated) |
| Nokia | No | Agree with others if no valid beam for CG, it should trigger RA-SDT. CG should only be used on the configured beams to avoid interference. No such issue for RA in legacy as there is always preambles allocated for each SSB. |
| vivo | No | Under the mentioned situation, it implies that the link quality is not suitable for CG PUSCH transmission. Then the UE should choose RA-SDT if configured or legacy RACH procedure otherwise.  |
| Panasonic | No | In this case, UE should select RA-SDT. |
| Google | - | We can wait for RAN1 input. |
| NEC | No | The UE should fallback to RA-SDT. |
| APT | No | In this case, the UE should trigger RA-SDT to avoid using the beam with poor qualiy in CG-SDT. |

***Summary***

Within the comapanies who have replied,

* 13 comapanies have replied “No” to the question that they think when none of the SSBs’ RSRP is above the threshold, the UE should not select any SSB
* 3 companies think UE can select any SSB in this case. Some companies think the TA validation criterion can ensure that the at least one beam is above the threshold
* 5 companies hold neutral view on this and think RAN1 input is necessary.

**Proposal: UE does not select any SSB if none of the SSBs’ RSRP is above the RSRP threshold. (18/23) FFS the UE behavior when none of the SSB’s RSRP is above the threshold**

# UL carrier selection for CG-SDT

In RAN2#113e meeting, the following has been agreed for the UL carrier selection for SDT, highlighted in yellow.

|  |
| --- |
| ===OMITTED===8. For SDT, UE performs UL carrier selection (i.e. if SUL is configured in the cell, UL carrier selected based on RSRP threshold). FFS whether the RSRP threshold for carrier selection is specific to SDT)9. If CG-SDT resources are configured on the selected UL carrier and are valid, then CG-SDT is chosen. Otherwise,• If 2 step RA-SDT resources are configured on the UL carrier and criteria to select 2 step RA SDT is met, then 2 step RA-SDT is chosen• else If 4 step RA-SDT resources are configured on the UL carrier and criteria to select 4 step RA SDT is met, then 4 step RA-SDT is chosen• else UE does not perform SDT (i.e. perform non-SDT resume procedure) • If both 2 step RA-SDT and 4 step RA-SDT resources are configured on the UL carrier, RA type selection is performed based on RSRP threshold. |

In legacy R15/R16, UL carrier selection based on a RSRP threshold is only applied for RACH but not applied for CG. For CG type1 configured on any UL carrier, they are always valid and activated and can be used whenever the CG occasions come.

We need to discuss whether the same should also be applicable for CG-SDT. Companies are invited to answer the following question:

**Question13; Do companies think the UE should perform UL carrier selection before CG-SDT transmission?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| Samsing | Yes | It is possible that UE in out of coverage of NUL and only in coverage of SUL. So it is beneficial to select UL carrier for CG-SDT. Similar to UL carrier selection for RA, selection can be performed during the CG-SDT selection procedure. |
| LG |  | The question is not clear.If the question is whether the UE should perform UL carrier selection before CG-SDT resource selection regardless of CG-SDT resource validity, then our answer is NO. The UE should select UL carrier only if there is valid CG-SDT resource. |
| ZTE | Y | We think this question is addressing the FFS when there is only one carrier (NUL or SUL) with valid CG resource and *whether in this case, the UE should select that carrier* and we think this optimisaiton is not really essential (but we don’t have a strong view). So, the UE can perform carrier selection as today based on the existing RSRP criterion and then proceed to CG vs RA selection on the selected carrier. Further, if the RSRP threshold for carrier selection can be SDT specific, the network can always configure this in such a way that the carrier with CG can be selected in case of SDT. So, no further changes are needed in the carrier selection procedure in our view.  |
| Sharp  | Yes |  |
| Lenovo | Yes | Based on current agreements, it seems that UE firstly selects the UL carrier, then decides to use the CG based SDT or RA based SDT in the selected UL carrier. |
| CATT |  | It has been agreed in last meeting that CG-SDT is chosen on the selected UL carrier. According to the agreement, UL carrier has been selected before CG-SDT is chosen. Is the discussion questioning the agreement? |
| ASUSTEK | Yes |  |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon |  No | RAN2 made the following agreement in the last meeting:1. CG-PUSCH resources can be separately configured for NUL and SUL. FFS if we allow them at the same time. This depends on the alignments CRs for Rel-16.

The CR in R2-2101340 for Correction on the configuration of Type 1 configured grant was agreed. This means that in case the UE is configured with CG on both carriers, it can use them at the same time (the network needs to ensure they do not overlap in time). Based on the agreement, the same should apply to CG-SDT, so there is no need for UL carrier selection for CG-SDT. CG-SDT will anyway be checked against minimum SS-RSRP and RSRP range as agreed in RAN2#113, so this would be redundant. Therefore, the UE does not need to select UL carrier similar to R15/R16 before CG transmission. |
| Sony | Yes | Agree with Lenovo. |
| Interdigital | Yes | UE selects the be uplink based on coverage conditions first, before looking at what best SDT resource on the selected UL to pick. Same view as ZTE. |
| Intel | Yes | As commented by ZTE and Lenovo, we think the UE should first perform carrier selection (NUL vs SUL) based on RSRP criterion as per legacy and then determine whether CG-SDT can be performed on the selected carrier (i.e. based on resources configured). In other words, UL carrier selection happens before the determination of whether the UE needs to perform SDT or not. Once an UL carrier is selected, the rest of the steps (i.e. CG vs RA based SDT, 2-step vs 4-step) can be performed. Therefore, there is no need to define a new SDT specific RSRP threshold for the carrier selection step |
| ITRI | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes | The initial carrier selection should not be SDT specific but adhere to legacy, with preceeding SDT specific threshold and resource selection. |
| Nokia | Yes |  |
| vivo | Yes | This is similar to the legacy RA procedure.  |
| Panasonic | Yes |  |
| Google | Yes |  |
| NEC | Yes |  |
| APT | Yes |  |

***Summary***

Within the comapanies who have replied, all the companies except one propose not to perform UL carrier selection before CG-SDT. Hence, we propose the following:

**Proposal: UL carrier selection is performed before CG-SDT transmission. (23/24)**

# Conclusion

Based on the above summary for the email discussion, the following proposals are proposed.

**The following proposals are potentially easily agreeable:**

**Proposal1: CG-SDT resources can be configured at the same time on NUL and SUL (23/23)**

**Proposal2: Implict release of CG-SDT resource is not supported. (0/24)**

**Proposal3: UE start a window after CG/DG transmission for CG-SDT (24/24). FFS whether to design a new timer or to reuse an existing timer.**

**Proposal4: Support retransmission by dynamic grant for CG-SDT. (24/24)**

**Proposal5: support multiple HARQ process for uplink CG-SDT. (18/24)**

**Proposal6: CG resource availability delay is not considered as a criterion for CG validation. (18/20)**

**Proposal7: UL carrier selection is performed before CG-SDT transmission. (23/24)**

**The following proposals need further discussion:**

**Proposal8: RAN2 should further discuss whether to support CG configuration request.**

**Proposal9: Release of CG-SDT configuration by system information indication is not supported. (14/21)**

**Proposal10: CG-SDT resource can be configured on BWPs other than initial BWP (17/24).**

**Proposal11: RAN2 should further discussion whether to support autonomous retransmission for CG-SDT.**

**Proposal12: Support L1-ACK feedback for CG-SDT. (14/24) Send an LS to RAN1 on this.**

**Proposal13: UE does not select any SSB if none of the SSBs’ RSRP is above the RSRP threshold. (18/23) FFS the UE behavior when none of the SSB’s RSRP is above the threshold**

# References

[1] R2-2100930 Report from email discussion [POST112-e][550][SDT] Further details of CG aspect Lenovo, Motorola Mobility

[2] R2-2101954 Session minutes for NR-U, Power Savings, NTN and 2-step RACH Session chair (InterDigital)

[3] R1-2102125 Reply LS on physical layer aspects of small data transmission

[4] TS 36.331, Radio Resource Control Protocol, 3GPP

[5] TS 36.321, Medium Access Control Protocol, 3GPP

[6] TS 36.212, Multiplexing and channel coding, 3GPP