**3GPP TSG-RAN2 Meeting #113-e R2-210xxxx**

**e-Meeting, 25 Jan - 05 Feb, 2021**

**Source: email discussion Rapporteur (ZTE Corporation)**

**Title: Common aspects between CG and RACH**

**Agenda item:** **8.6.1**

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

# Introduction

This document contains summary of email discussion to agree further details of the RRC-based solution for small data transmission in INACTIVE:

* [POST112-e][551][SDT] Common aspects between CG and RACH (ZTE)

Scope: Get input on: (+) RACH configuration – (preamble groups, TB sizes?), (+) Subsequent SDT transmission and indication, (+) SDT vs non SDT selection (Thresholds and order of selection), (+) Switching between CG-SDT and RA-SDT, (+) Cell Reselection handling

Output: Report, set of agreeable proposals

**Deadline for company comments:**

To allow sufficient time to summarise and submit the summary and proposals to the upcoming meeting, the following deadline for company comments is proposed:

**Wed Jan 13th 0700 UTC**

**Discussion summary**

* TBD

# Discussion

## Details of RACH configuration for RA-SDT

The following agreement was reached at RAN2#112e:

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| As a baseline, the RACH resource i.e. (RO+preamble combination) is different between SDT and non-SDT  - If ROs for SDT and non SDT are different, preamble partitioning between SDT and non SDT is not needed.  - If ROs for SDT and non SDT are same, preamble partitioning is needed |

Based on the above agreement, the network will know about the SDT cause after receiving msg1.

It should be noted that msg1 also indicates the size of the msg3/msgA payload (via the selected preamble group). Currenlty there are two different payload sizes allowed and these are indicated by selecting either preamble group A or preamble group B.

Further to the above, it should also be noted that segmentation of the DRB data is allowed and hence, if not all data fits within the first UL message then the network can schedule the rest of the data during the subsequent data transmission phase.

Keeping the above aspects and agreements in mind, the first question is whether we should allow more than 2 preamble group sizes for SDT and if so how many more shall be allowed.

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| **Q 2.1.1: For RA-SDT (i.e. 2-step and 4-step RACH) how many preamble groups shall be configured?**  **Option A: 2 (i.e. no change to the existing number)**  **Option B: more than 2 (specify how many with justification)** | | | |
| **Company** | **Option A/**  **Option B (number)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option A | We think option A is simple and sufficient. Given the fact that segmentation is possible for the data and also the fact that subsequent data transmission phase is enabled, we think optimizing the system for the packet size of the first UL packet is not really necessary. 2 different sizes for the first UL packet provides enough flexibility for the network to manage the overhead vs coverage implications for the first UL message. On top, there is also an additional threshold on the total size of the first UL packet that could be used for SDT, so, this provides the network with enough tools to configure the correct size for the first UL data packet and group A and group B can be reused without introducing a new preamble group for RA-SDT |  |
| Huawei, HiSilicon | Neither option | We do not have to introduce preamble groups for RA-SDT. We have already agreed that the RACH resource i.e. (RO+preamble combination) is different between SDT and non-SDT, so this is already sufficient for the network to differentiate legacy RA attempt from SDT RA attempt. Configuration of 2-step RA based SDT and 4-step RA based SDT should additionally include the maximum allowable TB size. In order to account for various payload sizes, we think the flexible TB size mechanism from EDT should be reused, i.e. if the payload is smaller than the maximum TBS, UE is allowed to use more robust MCS (as per network configuration as well). We should request RAN1 to work on the details of flexible TBS. |  |
| SONY | Neither option | Agree with Huawei, we should request RAN1 to work on the details of flexible TBS. |  |
| OPPO | None with comments | Just wondering, in the case of ROs for SDT and non SDT are different, in principle, there is no need to further partition the preambles? So, before we discuss how many preamble groups to be partitioned, do we need to confirm this is is ruled out? |  |
| Xiaomi | No strong preference | This could be left to the stage-3 discussion. Maybe this is not in the scope of RAN1, given that the preamble group A and B is defined in the MAC. |  |
| Fujitsu | Option A | The question may be unclear but the intention seems to be nothing special mechanism should be introduced for SDT i.e. reuse existing mechanism of preamble groups A and B for SDT. Then there is one remaining question. As ZTE mentions, in case when data size is larger than UL grant size in RAR/MSGB, SDT can rely on segmentation and subsequent transmissions. On the other hand, in case when data size is smaller than UL grant size in RAR/MSGB, the question is if the UE is allowed to use rubust MCS. However, whether this optimization is introduced should be left to RAN. |  |
| Sharp | Option A | Existing 2 preamble group sizes for SDT could be the baseline. |  |
| ASUSTeK | Option A with comment | If the preamble group is applied, two groups are enough. To enable different TB sizes, there are two existing mechanisms: preamble group A/B and flexible TB size mechanism. It’s not yet decide to reuse which one. |  |
| APT | Option A | With the subsequent data transmission mechanism, two groups as the legacy are enough. If more preamble groups are introduced, the number of preambles in each group would be decreasing, which may cause higher chance of congestion for preamble selection. On the other hand, since the purpose of SDT and non-SDT can be separated by ROs, how much amount of payload sizes of each group is feasible for SDT can be further discussed, which is also the objective of WID. |  |
| Samsung | Option A | RACH supports flexible TB size using different preamble groups. Two groups can be the baseline. |  |
| Ericsson | Option A | As stated above, in legacy the definition of two groups allows the UE to signal two possible TBSs for Msg3/MsgA. SDT could introduce one or multiple new TBSs, so it is an straightforward extension of the existing mechanism. Given this, having two possible sizes can be acceptable provided that one can be disabled. |  |
| Google | Option A | With the support of subsequent data transmission and RLC segmentation, it is not necessary to support preamble groups for SDT. |  |
| Nokia, Nokia Shanghai Bell | Option A | The 2 groups should be able to fulfill most of the use cases. Any enhancements to this could be looked in later releases. |
| CATT | Option A | We agree with ZTE, since segmentation can be performed in SDT, it is not necessary to mapping different preambles to different TB size. |  |
| InterDigital | Option A | If not all data fits in msg3/A, it can be sent using subsequent small data transmission. |  |
| NEC | Neither option | We understand that if RO is dedicated for SDT, as the network can be aware of SDT based on RO, thus there is no need to apply the current preamble group concept to SDT. And if RO is shared between SDT and non-SDT, one or more preamble groups (mapping to different TB sizes) should be used dedicated for SDT. As subsequent transmission is supported, only one SDT dedicated preamble group seems sufficient. |  |
| Mediatek | Option A | Current mechanism with two groups i.e. group A and group B is enough thanks to the support of subsequent data transmission. |  |
| LG | Neither option | We don't think preamble groups for RA-SDT need to be introduced and the configuration of the maximum TB size is enough for RA-SDT. If all data does not fit within the first UL message, BSR MAC CE can be included to indicate the rest of data in the first UL message, and the data may be transmitted in the subsequent data transmission or in RRC\_CONNECTED. |  |
| Lenovo | Option A | The legacy grouping with two groups may be enough for RACH based SDT procedure. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## Subsequent data transmission and indication

For the subsequent data transmission, one question is what happens when new UL traffic arrives (either for the DRBs that are configured for SDT or for other DRBs). Companies have noted that there will be no SR resources during the subsequent data transmission phase. If this is the case, then a BSR would be triggered and this should subsequently trigger RACH if there are no UL resources available. Companies are invited to comment on this understanding and whether any enhancements are needed for this scenario.

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| **Q 2.2.2: Do companies agree that for RA-SDT and CG-SDT during the subsequent data transmission** **if new data arrives (either for the SDT DRBs or for other DRBs), BSR shall be triggered, which will inturn trigger RACH when there are no UL resources?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | We think we can reuse the existing principles in this case and RACH should be triggered. MSG3 in this case should contain the BSR indicating the data for radio bearers that are not subject to SDT and based on this, the network can perform full RESUME. |  |
| Huawei, HiSilicon | No | We agree that BSR should be triggered when new SDT data arrives during SDT procedure. When non-SDT data arrives, the UE should directly trigger RACH procedure as only active DRBs are considered in the BSR. Also, in our understanding the question is about subsequent transmission and not about MSG3 trasmission. In case non-SDT is available before SDT procedure initiation, then the UE should directly trigger legacy RACH / RRC Resume procedure, so the situation decribed by ZTE would happen exteremely infrequently. |  |
| SONY | Yes | During the subsequent data transmission if new data arrives (either for the SDT DRBs or for other DRBs), BSR should be indicated to the network. |  |
| OPPO | Yes with some comments | Just want to confirm the intention of this question is to confirm whether UE follows the behavior of triggering a new RACH procedure when there is no available PUCCH resources for SR during SDT, i.e., when SDT data triggers BSR and further triggers SR, due to no PUCCH resources in RRC Inactive state, UE will just trigger RACH procedure following the principle in RRC Connected state.  If the above understanding is correct, we agree to resuse the same principle for the data from SDT DRBs.  Besides, in the question, it’s mentioned BSR shall be triggered “either for the SDT DRBs or for other DRBs”, However, we do not think it is desirable to use the BSR to indicate the data arrival from non-SDT DRBs. since in order to caluculate the BSR of non-SDT data, the corresponding DRBs need to be resumed. But considering that non-SDT data can not be transmitted until the UE goes into RRC\_CONNECTED, we think we can simply follow the way as legacy, that is to resume the non-SDT upon the reception or RRCResume. Therefore, we think more discussions on how to indicate the arrival of non-SDT are needed. |  |
| Xiaomi | Maybe Yes | This depends on whether the RA-SDT or CG-SDT is still considered as a RACH procedure. I guess the intention of the Question is also not to change the tigger conditions for BSR and SR. Then the current MAC procedure for the BSR transmission would trigger RACH if no UL resources are available. If the RA-SDT or CG-SDT is also considered as a type of RACH procedure, then it is up to the UE implementation whether to stop the on-going RACH or start a new RACH procedure according to the current MAC specification as quoted below.  NOTE 1: If a new Random Access procedure is triggered while another is already ongoing in the MAC entity, it is up to UE implementation whether to continue with the ongoing procedure or start with the new procedure (e.g. for SI request). |  |
| Fujitsu | Yes | Regacy BSR procedure should be reused as much as possible. There seems no need to have different BSR procedure for the SDT DRBs and the other DRBs. |  |
| Sharp | Yes with comments | For the data arrival from SDT DRBs, it is applicable to trigger a legacy BSR and if there is no UL resource, a RA could be triggered.  However for the data arrival from other DRBs, if a resume procedure is allowed to be triggered, a BSR will be triggered by SRB0 data arrival but not the data arrival from other DRBs. And if there is no UL resource, a RA could be triggered |  |
| ASUSTeK | Yes for SDT DRBs | When SDT data arrives, the UE can transmit BSR as indication for subsequent data. When non-SDT data arrives, the UE can directly trigger a RA procedure. |  |
| APT | Yes | Based on the current behavior, if new data arrives (either for the SDT DRBs or for other DRBs), BSR should be triggered.   * If there is type 1 CG resource configured for CG-SDT and the CG is valid, the UE will not trigger SR/RA, since there is an available UL resource (i.e., type 1 CG) for transmitting the BSR. **However, for this, we may need to further discuss whether we allow the UE directly trigger RA if the new data is for non-SDT. That is, the UE does not use CG in this case.** * If there is no type 1 CG resource or the UE considers that the CG is invalid, the UE will trigger SR and then trigger RA (due to no PUCCH resource). **Then the UE needs to determine which preambles/ROs should be selected based on the new data is for SDT or non-SDT.** |  |
| Samsung | Yes | For SDT DRBs, BSR will be triggered as in legacy procedure.  For non SDT DRBs, UE needs to indicate to gNB that data for non SDT DRB is available. For indication, BSR can be transmitted when data in non SDT DRB become available. For transmitting BSR, BSR can be triggered when data becomes available for non SDT DRBs. |  |
| Ericsson | Yes | Whenever possible, if new data arrives during the SDT procedure the UE should inform the gNB so that it can take further decisions on how to proceed. Nevertheless, in some cases this is not possible, e.g.: if the new data arrives after the last INACTIVE SDT transmission has been sent, there will be no further UL Grant scheduled by gNB to deliver the BSR or data as gNB is not aware of this. The UE behavior when new data arrives while SDT is ongoing should be studied in more detail beside BSR trigger/transmission in order to avoid UE exploiting this feature to send more data than what is allowed by SDT. |  |
| Google | Yes | We think Rel-16 procedure is the baseline. If BSR is triggered but there is no UL-SCH resource or PUCCH resource for SR, random access is triggered. |  |
| Nokia, Nokia Shanghai Bell | No | It would be good to keep the BSR triggers untouched, ie., in case SDT data becomes available on another SDT-DRB while there was already another SDT-DRB data available in the buffer, the BSR trigger depends on the LCH priorities. On the other hand, given SR resources are not available at this phase, it would seem desirable to avoid new RA procedure from being triggered if possible.  We think that SDT procedures and resources should be used only for SDT data and for regular data legacy procedures should be used. When data for other DRB becomes available that is not allowed for SDT, the UE should trigger RRC establishment procedure immediately using RRCResumeRequest. It should be noted that NW may not be able to deduce the availability of non-SDT-DRB data based on BSR given the Logical Channel Grouping, hence, the BSR is not suitable for this case. |  |
| CATT | Yes | For the data arrival from SDT DRBs during subsequent transmission, BSR needs to be triggered to inform the network that more data is arrived.  For the data arrival from non-SDT DRBs during subsequent transmission, BSR needs be triggered too. If a resume procedure is triggered again in this case, some issues need to be resolved. For example: 1) If SRB1 has already been resumed, whether it is allowed to send RRC message via SRB0. 2) During the legacy procedure of RRC Resume request transmission, the UE has already derived resumeMAC-I based on old key in UE Inactive AS Context and updated KgNB key based on old key. When a subsequent resume procedure is triggered, how to handle security issues needs to be further discussed. Thus, to keep it simple and align with the case of the data arrival from SDT DRBs during subsequent transmission, BSR option is preferred. |  |
| InterDigital | Yes | BSR can be included in the small data PDU if not all buffered small data fits the resource. It is preferable to allow multiplexing a BSR MAC CE without affecting the BSR triggering and cancellation procedure, for the reasons mentioned by Nokia. |  |
| NEC | Yes for SDT DRBs, but No for non-SDT DRBs | Only if the new data are all from the SDT DRBs, BSR shall be triggered. If there are new data from non-SDT DRBs, legacy RRC Resume procedure (with some changes to properly handle the ongoing SDT DRBs) should be initiated, as the non-SDT DRBs should not be resumed for SDT procedure and thus not possible to be counted in the BSR. |  |
| Mediatek | Yes for SDT DRBs  FFS on non-SDT DRBs | We also agree that BSR should be triggered when new SDT data arrives during subsequent data transmission and current BSR mechanism should be reused. In case there is no UL resources to transmit the BSR, RACH will be initiated assuming there is no SR resource configured in Inactive.  For non-SDT, it is FFS on whether non-SDT is resumed or suspended when UE initiates SDT according to the agreement made in last RAN2 meeting, i.e. ‘*For both RACH and CG based solutions, upon initiating RESUME procedure for SDT initiation (i.e. for first SDT transmission), the UE shall re-establish at least the SDT PDCP entities and resume the SDT DRBs that are configured for small data transmission (along with the SRB1). FFS for non-SDT DRBs’*. The question is only valid if non-SDT bearers are also resumed when UE initiating Resume procedure for SDT. If the non-SDT bearers are still suspended during SDT, new data arrival may require UE to perform RRC state transition to CONNECTED. |  |
| LG | Need more discussion | It has to be decided first whether the non-SDT DRB is resumed or not, which is left FFS from the last meeting.  If non-SDT DRB is not resumed in RRC\_INACTIVE, non-SDT data does not arrive at PDCP layer, and thus it does not trigger a BSR. In this case, the UE generates a RRC Resume Request message, and the RRC Resume Request message will trigger a BSR. If there is no UL resource, the UE would trigger a RA procedure, but if there is UL resource (e.g. CG-SDT resource), the UE would send the RRC Resume Request message using the available UL resource (and cancel the BSR). The non-SDT data can be transmitted only after the UE is transitioned to RRC\_CONNECTED. This is exactly the same behavior as the legacy RRC Resume procedure when the UE is in RRC\_INACTIVE and receives a data. However, it has to be discussed further whether a new RRC Resume procedure can be triggered while there is ongoing RRC Resume procedure (for SDT).  If non-SDT DRB is resumed in RRC\_INACTIVE, non-SDT data arrives at the PDCP layer, and it triggers a BSR. The PDCP and RLC layers may process the received data (which is useless because they will be re-established when RRC Resume is received), but the non-SDT data cannot be transmitted in MAC, because the non-SDT data cannot be transmitted on the SDT resource. However, the BSR can include a BS of non-SDT data, and it can be transmitted on the SDT resource. If separate LCG is allocated for non-SDT DRB, the network can identify that there is non-SDT data in the UE based on the BSR, and transitions the UE to the RRC\_CONNECTED. However, if LCG is not separated, the network cannot identify based on the BSR, and another mechanism to indicate this needs to be introduced. |  |
| Lenovo | Yes | In our view, when UE is preparing the initial transmission for SDT, there is no available non-SDT DRB, otherwise the UE will trigger the legacy resume message based on legacy RA procedure for available non-SDT DRB. Hence, in SDT procedure, the non SDT DRB will be available after UE transmit the initial TB for SDT. Hence, the BSR for non-SDT, if agreed, will be only generated and transmitted in the subsequent transmission procedure. UE could report the BSR for non-SDT to network in SDT subsequent transmission, if there is no UL grant for non-SDT BSR reporting in this procedure, it is UE implementation to continue the SDT transmission or not. More details could be studied on the behavior after non-SDT BSR reporting is transmitted to network. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## SDT vs non-SDT selection and switching

Currently the following precedures are executed by the UE before RACH procedure:

* Carrier selection (UL/SUL)
* RA-type selection
* Preamble group selection
* RACH preamble selection (randomly within the selected preamble group)

In case of SDT, we have to understand how the overall procedure works.

It seems we could reuse the procedure for carrier selection as this needs to be done apriori to ensure the correct carrier is selected between SUL and UL. i.e. upon initiating the SDT procedure, the UE shall perform the carrier selection between UL/SUL following procedures as normal.

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| **Q 2.3.1: Do companies agree upon initiating SDT, the UE first performs carrier selection as per legacy procedure?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Since the correct UL carrier needs to be selected based on coverage, the carrier selection needs to happen before the other procedures. |  |
| Huawei, HiSilicon | Yes | UE should first select SUL or NUL as the SDT configuration for those will be different. |  |
| SONY | Yes |  |  |
| OPPO | Yes | It is critical for a SDT UE to work on a correct carrier for sake of efficient user data transmission. Besides, a new carrier selection RSRP threshold other than legacy should defined for SDT. |  |
| Xiaomi | Yes |  |  |
| Fujitsu | Yes |  |  |
| Sharp | Yes |  |  |
| ASUSTeK | Yes |  |  |
| APT | Yes |  |  |
| Samsung | Yes (see comments) | If SUL is configured and if SDT configuration is available for both NUL and SUL, UE select between NUL and SUL as in legacy procedure.  However, if SUL is configured and if SDT configuration is available for only SUL, it should be possible to select SUL irrespective of legacy SUL selection criteria. Note that SUL has more UL coverage than NUL. |  |
| Ericsson | Yes | Currently it is not agreed to support SDT on SUL. If this is agreed, then it is natural to perform carrier selection as in legacy if SDT is enabled in both carriers. |  |
| Google | Yes |  |  |
| Nokia, Nokia Shanghai Bell | Yes |
| CATT | Yes |  |  |
| InterDigital | Yes |  |  |
| NEC | Yes |  |  |
| Mediatek | Yes |  |  |
| LG | Yes |  |  |
| Lenovo | Yes |  |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

Subsequent to the above, selection between CG-SDT and RA-SDT needs to be performed.

As agreed at the last meeting, the CG resources are associated with SSBs and the *UE selects one of the SSB with SS-RSRP above the threshold and selects the associated CG resource for UL data transmission*. Thus, in order to select the CG-SDT, the there should be at least one SSB above the configured RSRP threshold with CG resources configured on this SSB. Further, given that the CG resources are configured in dedicated signalling, it can be assumed that these resources shall be used when these are valid. So, the criterion for selecting between RA-SDT and CG-SDT seems to be simply whether there are any associated CG resources that are valid and are above the RSRP threshold. Thus the following question is asked:

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| **Q 2.3.2: Do companies agree that If an SSB with SS-RSRP above a configured threshold with associated valid CG resource exists, the CG-SDT is chosen, otherwise UE proceeds to RACH procedure?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Our understanding is that if valid CG-SDT resources exist then they have to be selected (since these are provided dedicatedly to the UE). So, we think if an SSB with SS-RSRP above a configured threshold with associated valid CG resources exist then they should be chosen. Note that the validity criteria for the CG-SDT resources should be satisfied for this to be applicable and these criteria are being discussed separately in email discussion #550. |  |
| Huawei, HiSilicon | Yes for the intention, but please see comments | We agree with the intention, but there may be more conditions to check the validity of CG-SDT resource, e.g. TAT is running or some other TA validity criteria. Those are discussed in the other e-mail discussion dedicated to CG-based SDT. What we can agree to in this discussion is that whenether there is a valid CG resource for SDT, CG-based SDT is performed and otherwise the UE performs RACH-based SDT. |  |
| SONY | Yes |  |  |
| OPPO | Yes | Since CG resources are dedicatedly configured, CG-based SDT should be prioritized if there is valid CG resources associated with the chosen beam. |  |
| Xiaomi | Yes |  |  |
| Fujitsu | Yes |  |  |
| Sharp | Yes | If both CG-SDT and RA-SDT could be applied or valid, we prefer always use CG-SDT. |  |
| ASUSTeK | Yes |  |  |
| APT | Yes for prioritizing CG over RA | Agree with ZTE and HW. More criterions for CG validity determination should be considered, e.g., TA timer, data volume, etc. |  |
| Samsung | Yes | CG is prioritized over RA |  |
| Ericsson | Yes, but | It is unclear if this question belongs to common aspects between CG and RACH rather than CG discussion. The set of conditions that determine if CG can be used are more complex than just considering RSRP (e.g.: TA validity should be considered). From CG/RACH decision perspective, the UE should first try to use CG if the conditions are met. If conditions are not met, whatever these conditions are, then it should attempt SDT-RACH. |  |
| Google | Yes | Similar to Rel-16 procedure, if there is no UL-SCH resource, i.e. CG resources in this case, and no PUCCH resource for SR, RACH is triggered. Otherwise, UL-SCH resources are used. |  |
| Nokia, Nokia Shanghai Bell | Yes for the intention, but | It seems the SS-RSRP should be just counted as another validation criteria rather than saying “an SSB with SS-RSRP above a configured threshold with associated **valid** CG”. |
| CATT | Yes | We agree that CG-SDT checking should be prioritized since CG resources are dedicated. It is discussed further in the other email discussion on how to define valid CG resource. |  |
| InterDigital | Yes | But this should be in conjunction with other criteria for selecting the CG for SDT, otherwise RACH is used. |  |
| NEC | Yes | We agree that CG-SDT has higher priority. And we assume that the selection between RACH-SDT and CG-SDT is made in MAC layer (which is different from the selection of PUR or EDT). In this way, the frequent cross-layer interworking between MAC and RRC layer to synchronize the validity of CG resource and TA can be avoided. |  |
| Mediatek | Yes | Existence of an SSB with SS-RSRP above a configured threshold with associated CG resource should be a criterion for CG resource validation. |  |
| LG | Yes for the intention | We agree with the intention. However, as a condition for selecting a CG scheme, whether other conditions other than RSRP threshold is considered needs to be further discussed. |  |
| Lenovo | Yes | Since CG resource is UE specific and dedicated, CG based SDT is prioritized to RACH based SDT. The conditions to determine CG validity could be further discussed, such as the SSB based RSRP, TA validity. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

If CG-SDT is chosen, then the UE will proceed with CG-SDT, but if RA-SDT is chosen, then the UE needs to then continue with RACH procedure and select the RA-type (between 2-step and 4-step RA). For this purpose an RSRP threshold is used in legacy (Rel-16) procedure (i.e. the *msgA-RSRP-Threshold*). So, the next question is whether RACH type selection can be performed (i.e. between 2-step and 4-step RACH) using the legacy procedure.

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| **Q 2.3.3: Do companies agree that if RACH procedure is initiated for SDT, the UE first performs RACH type selection as in legacy (i.e. Rel-16)?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Both 2-step and 4-step RACH may have SDT configured and hence the UE may select the appropriate RACH procedure based on the legacy RACH type selection mechanisms. |  |
| Huawei, HiSilicon | No | The RSRP threshold which is used for legacy 4-step or 2-step RACH selection is not suitable to choose SDT over 2-step RACH or 4-step RACH, because it is chosen based on the payload that is expected in legacy 2-step RA, i.e. RRC message only. To be able to send RRC message + user data using SDT, the UE should be in general in better radio conditions than in the case of legacy 2-step RA. At the same time, the payload to be sent over 2-step RA and 4-step RA with SDT will be the same, so RSRP based selection does not bring any benefit. Since the 2-step RA SDT is more resource efficient, it should be always chosen. In summary, we believe that it does not make sense for the network to configure both 2-step RA-SDT and 4-step RA-SDT simultaneously, so no selection between them is required. What we may consider is RSRP based selection between RA-SDT and legacy RA. |  |
| SONY | Yes | We think additional RSRP for the selection between RA-SDT and legacy RA is not needed, because:  For 4-step RACH, there is already a link adaptation where number of RBs and MCS are signalled by the network for message 3. Based on this, the link adaptation should work for providing *at least* the transmission of the CCCH message.  For 2-step RACH, RAN1 should design flexible payloads (TBS), may be upto 4, and a UE should be able to choose a right MCS based on radio channel condition. Based on this, the link adaptation should work for providing *at least* the transmission of the CCCH message.  Note that how to design a payload (i.e. flexible TBS) that can be transmitted at a gven radio condition is RAN1 issue. |  |
| OPPO | Yes | RSRP threshold should be the most essential selection criteria between different RACH type. Since larger amount of data is expected to be carried in MsgA payload than legacy 2-step RA, we need to further define an SDT-specific RSRP threshold for type selection. |  |
| Xiaomi | Maybe Yes | We should firstly ensure having a reliable RACH, then we can select whether to use SDT or normal RACH. Of course if both 2-step RACH and 4-step are reliable RACH (e.g. RSRP above a configured threshold as legacy), we could consider to select SDT or normal RACH before the RACH type selection. |  |
| Fujitsu | Yes | There should be no difference between RA procedure between Rel-16 and SDT. |  |
| Sharp | Yes | If both 2-step and 4-step RACH could be applied for SDT, we prefer always use 2-step RACH. |  |
| ASUSTeK | Yes | The legacy RSRP threshold for RA type selection can be applied. |  |
| APT | Yes | RSRP threshold is needed for 2-step RACH because MsgA PUSCH should be transmitted in better radio condition. |  |
| Samsung | Yes (see comments) | If SDT configuration is provided for both 2 step and 4 step, selection criteria between 2 step RA based SDT or 4 step RA based SDT, is same as in legacy. |  |
| Ericsson | Yes, see comment | There is no reason to change legacy behavior. Nevertheless, it might be interesting to study a decision mechanism that considers all procedures jointly based on UE measurements and the procedure configurations. |  |
| Google | Yes | Once deciding to perform RA-SDT, MAC should select a RACH type as in Rel-16. |  |
| Nokia, Nokia Shanghai Bell | Yes | However, RACH type selection can depend on the availability of SDT resources for the given RACH types. In any case, SDT should be always configured for 4-step when RACH based SDT can be selected but it may not necessarily be configured for 2-step. |  |
| CATT | Yes | Legacy RA type selection can be used. |  |
| InterDigital | Yes, but | this is done after the criteria for selecting RACH SDT resource is met (e.g. small data volume, rsrp, etc). |  |
| NEC | Yes | Given SDT RACH resources for both 4-step and 2-step RA are available, the legacy RA type selection can be reused. Otherwise, some modifications are necessary. For example, if the RSRP is good enough for 2-step RACH, but there is no SDT resource configured for 2-step RACH, instead, there is SDT resource for 4-step RACH, then UE should select 4-step RACH.  Thus the legacy RACH type selection procedure can’t be reused completely. |  |
| Mediatek | Yes | Assuming both 2-step and 4-step RACH are configured for SDT, legacy RACH type selection mechanism is reused. |  |
| LG | Yes | If both 2-step RA and 4-step RA are available for SDT, then the UE shall choose between the two using the legacy procedure, i.e. using the RSRP threshold. |  |
| Lenovo | Yes | The legacy mechanism to choose 2-step RACH could be reused for SDT procedure. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

After selecting the specific RACH type, the UE has to select the RACH resource. If RACH resources for SDT exist for the selected RACH type, then the question is whether a further RSRP criterion is needed for the UE to be able use the SDT RACH resources. There are two options possible:

**Option 1: An RSRP threshold is configured to select between SDT and non-SDT RACH resources:**

* If RSRP is below the configured threshold then UE performs normal RACH procedure (i.e. Non-SDT and normal RESUME procedure will be initiated)
* If RSRP is is above the configured threshold then UE proceeds with RACH using SDT RACH resources and the RA-SDT procedure can continue

**Option 2: There is no further RSRP threshold for selection between SDT and non-SDT RACH resources:**

* In this option, UE proceeds with RACH using the SDT RACH resources and SDT procedure will continue

Companies are invited to comment on the above procedure and whether they prefer option 1 or option 2

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| **Q 2.3.4: Which option do companies prefer for RACH rsource selection after selecting the RACH type?**  **Option 1: A further RSRP threshold is configured to select between SDT and non-SDT RACH resources or**  **Option 2: There is no further RSRP threshold for selection between SDT and non-SDT RACH resources**  Please explain your choice with comments and justificaiton | | | |
| **Company** | **Option 1 /**  **Option 2** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option 2 | We think option 2 is sufficient. The only implication of the option 2 is that the MSG3/MSGA size allows at least transmission of the CCCH message. The rest of the contents can be transmitted during the subsequent data transmission phase. Since this is no different to the legacy RACH procedure, we think there is no need to have an additional RSRP threshold to select between SDT and non-SDT at this stage anymore. |  |
| Huawei, HiSilicon | Option 1 with comments | As we mentioned in our previous comment, this should not be a “further” threshold. In a reasonable deployment, the threshold to choose between SDT and non-SDT RACH would always be higher (more stringent) than the one to choose between legacy 2-step or 4-step RACH. Hence, it should be checked before the legacy threshold. |  |
| SONY | Option 2 | As there are flexible payloads (TBS), the lowest payload (with an MCS) should *at least* allow the transmission of the CCCH message. |  |
| OPPO | Option1 or Option2 | That depends on the coverage where SDT is supported. If the largest coverage of the each carrier is taken into account, option2 is enough, otherwise, we still need another RSRP for the selection between SDT and non-SDT. Furthermore, we think whether to do SDT or non-SDT need to be determined earlier, i.e. closely following the carrier selection. |  |
| Xiaomi |  | No strong preference. It seems that this depends on the data amount and MCS which is used for the SDT. If the MCS is high and data amount is relatively larger, maybe an RSRP threshold can be configured to ensure the coverage. |  |
| Fujitsu | Option 2 | We also think that Option 2 is sufficient, but this discussion may need RAN1 consultation in terms of whether a new RSRP threshold is needed or not. |  |
| Sharp | Option 2 |  |  |
| ASUSTeK | Option 1 | As the objective in WI, SDT should enable larger payload size than CCCH message size for MSGA and Msg3. The RA-SDT is designed for transmitting CCCH and user data in MSGA and msg3. If the radio condition is good enough, it’s not necessary to transmit user data in subsequent transmission. |  |
| APT |  | It depends on how much payload size of Msg3/MsgA can be supported for SDT. If the supported payload size of Msg3/MsgA is not much bigger than legacy, we don’t need to introduce an additional RSRP threshold. |  |
| Samsung | Option 1 | Msg3 for SDT will be greater than legacy as CCCH + data needs to be transmitted. As a result, the UL coverage of Msg3 for SDT will be smaller compared to non SDT RA procedure. So threshold is needed to ensure that UE is in sufficient UL coverage. |  |
| Ericsson | Option 1, comment | An RSRP threshold is necessary to keep control of the resource consumption at the gNB as a resault of the MsgA/Msg3 TBS. This could be configurable. Other than that, there should be other parameters to select between SDT and non-SDT (e.g.: Data Volume and/or Msg3/MsgA available TBS) |  |
| Google | Option 2 | The subsequent data transmission and RLC segmentation can divide big data into small data for transmission. Not sure it is necessary to transmit big data in msg3. |  |
| Nokia, Nokia Shanghai Bell | Option 2 | If we already have RSRP threshold at RRC level to select between SDT and non-SDT, nothing further should be needed at MAC layer. |  |
| CATT | Option 2 | Option 2 seems sufficient. Could consult RAN1 on whether a new RSRP threshold is required or not. |  |
| InterDigital | Option 1 | Such RSRP threshold can be beneficial to ensure the UE is good radio conditions prior to transmitting a small data payload, especially since small data PDUs can be larger than the typical CCCH payload size. This threshold should be applied first before the 2 vs. 4-step RA rsrp threshold. |  |
| NEC | Option 2 | We think option 2 is sufficient. And we think RACH resources for SDT exist for the selected RACH type, once the RRC layers makes decision on SDT, the MAC layer shall perform SDT procedure finally (no fallback to legacy). |  |
| Mediatek | Option 2 | Same view as Google |  |
| LG | Option 2 | If UE determines to use RA-SDT scheme and selects RA type (i.e., 4-step or 2-step), the UE selects RA resource only in RA resource configured for SDT. Further RSRP threshold is not needed. |  |
| Lenovo | Option 1 | Although subsequent data transmission is supported in SDT, however, from the view of UE power saving, it is preferable that UE is released in Msg.4 if the data and RRC message could be totally transmitted in Msg.3. Hence, the further RSRP threshold is needed to select between SDT and non-SDT RACH resources. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

The final aspect to discuss is whether it is allowed to switch different modes (i.e. CG-SDT <-> RA-SDT and vice versa or SDT <-> non-SDT and vice versa). In Rel-16, once the RACH type is selected the same RA-type is kept until a configured number of times. Further, even after RA-type changes (from 2-step to 4-step RACH), the payload size is kept the same (to avoid rebuilding of the MAC PDU). So the question is whether companies want to support any schemes potentially requiring the rebuilding of MAC PDU in case of SDT.

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| **Q 2.3.5: Do companies think that any switching options requiring rebuilding of MAC PDU included in the first UL message are needed for SDT?** | | | |
| **Company** | **Yes (please explain) /**  **No** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | No | We think rebuilding of MAC PDU need not be supported. Both the RACH CG mechanisms will allow multiple HARQ retransmissions as part of the triggered procedure and this should be sufficient. So, once the UE selects a given mechanism between RA-SDT and CG-SDT, it shall use the same for the rest of the procedure (i.e. no switching is allowed) |  |
| Huawei, HiSilicon | Yes | We think that after a configurable number of failed SDT transmission using either CG-SDT or RA-SDT, the UE should switch to legacy RACH procedure (i.e. RACH with RRC message only). Hence the following fallback schemes should be supported, which require TB rebuilding:   * CG-SDT to legacy RACH * RA-SDT to legacy RACH   On the other hand, we think it should be possible to use CG-SDT resource for subsequent transmission in the case RA-based SDT was selected for initial transmission due to TA invalidity. When the TA becomes valid after MSG2/MSGB reception, the CG resource becomes valid again and the UE can use it. This does not require TB rebuilding though. |  |
| SONY |  | Leave it to stage 3. |  |
| OPPO | No | We prefer not to mix different mechanisms together in order to keep it simple.The UE can depend on the failure handling mechanism of each procedure if the transmission is not successful after multiple times of attempts. |  |
| Xiaomi | No | Better not support MAC PDU rebuilding as this will increase the UE implementation complexity. Maybe the gNB by implementation can try to ensure the same TBS for switching. If the same TBS cannot be ensured in some corner cases, maybe the UE can simply fallback to the normal RACH to recover the lost data via the uppler layers after entering the connected. |  |
| Fujitsu | No | As explained by ZTE. |  |
| Sharp | Yes | Fallback schemes should be supported. TB rebuilding could occurs when CG-SDT or RA-SDT fallbacks to legacy RACH. |  |
| ASUSTeK | Yes | The fallback from RA-SDT to legacy RA should be supported. The rebuild mechanism is already supported in UP-EDT. |  |
| APT | Yes | The fallback mechanism can be supported. The UE could switch between CG-SDT, RA-SDT, and legacy RACH based on the criterions and priorities of those. |  |
| Samsung | No | Same view as ZTE |  |
| Ericsson | No, comment | We should aim to avoid MAC PDU rebuilding, but it depends on the possible configurations of each procedure. E.g.: if UE falls-back to a procedure that has a different TBS for the first transmission it may need to rebuild the MAC PDU (either by adding padding bits or by moving part of the data in a second transmission). |  |
| Google | Yes but | Rebuilding of MAC PDU can be left to UE implementation. |  |
| Nokia |  | This depends on whether we allow switching between CG-SDT and RA-SDT or RA-SDT and RA, for example. |  |
| CATT | No | We share the same view with ZTE. We think the HARQ retransmission is sufficient to guarantee the reliability. It is not necessary to use PDU rebuilding. |  |
| InterDigital | Yes | Given CG based SDT can fail due to timing misalignment or beam misalignment, it is useful to fallback to RACH-based SDT. The CG resource may also be released before the completion of the retransmission. Rebuilding of MAC PDU can be left to UE implementation. |  |
| NEC | No | We want to make it simple, i.e. if the RA-SDT or CG-SDT is selected, the UE shall use it till the end. |  |
| Mediatek | Yes | We don’t need to support the mode switch between RA-SDT and CG-SDT. But we need to support the potential fallback mechanism to initiate the normal RESUME procedure to CONNECTED mode due to e.g. data arrival of non-SDT bearers. In this case, MAC PDU rebuild may be needed. |  |
| LG | No | We think rebuilding of MAC PDU shall not be supported in any case. Moreover, we are not sure whether the switching is needed. We agree with ZTE that once the UE selects a given mechanism between RA-SDT and CG-SDT, it shall use the same for the rest of the procedure. |  |
| Lenovo | Yes | For SDT procedure, the fallback to legacy RACH without the UL data in MAC PDU should be supported, the MAC PDU rebuilding is needed. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## Handling of T319 like timer

In R2-2009189, some discussion on cell reselection took place. Further, we have agreed that a new timer is defined for failure detection (and it is FFS whether the functionality will be similar to T319 or if it will be restarted after every UL/DL).

If the timer is restarted after every UL/DL, basically we will need a new mechanism and then the actual length of the SDT phase is up to the network (i.e. the network can keep the UE in SDT phase for as long as it wants by scheduling data in UL/DL). On the otherhand if a T319 like timer is used, then the maximum length of the SDT phase has an upper bound and the assumption is that any transaction that takes longer should use full RESUME and this is similar to what was used in case of EDT in LTE.

Based on the online discussion at RAN2#112, it seems the views on this topic are fairly split and it might be good to understand the motivations from various companies to see if we could proceed one way or the other in this regard. So, the following question is asked to see if some clarity on the topic can be achieved on the technical aspects. Please provide details in justification so that techinal views on both side are well understood.

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| **Q 2.4.1: Which option do companies prefer for handling of the new timer?**  **Option 1: Extended T319 like timer**  **Option 2: Timer restarted after each UL/DL**  **Please provide further technical justification for your views** | | | |
| **Company** | **Option 1**  **/**  **Option 2** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option 1 | We think option 1 is simple and sufficient (as seen from the LTE-PUR). It should be noted that the target use cases for SDT are for applications that generate short and infrequent data. The subsequent data transmission phase is only there to cover any left over data after the first initial message and any associated upper layer feedback in DL. We should not aim to design a mechanism that could potentially keep the UE indefinitely in the SDT phase. So a time bounded SDT phase (including the subsequent data transmission phase), seems more appropriate to cover these kind of applications and we think this is sufficient and no further enhancements are needed. Starting and restarting the timer will result in a lot more complexity and is also may result in error cases due to missed signalling or scheduling messages etc. |  |
| Huawei, HiSilicon | Option 2 | There are several advantages of option 2 over option 1:   * As mentioned by the discussion rapporteur, it gives the network more flexibility to terminate the procedure in the most efficient moment, e.g. by considering the (expected) subsequent data arrival * It allows the UE to detect the failure of SDT transmission earlier, since the timer in option 2 will be shorter than for option 1. E.g. if we assume the network wants to set the upper bound for SDT duration to 5 seconds, then it would take 5 seconds for the UE to wait for the SDT timer expiry to declare SDT failure (if there is no reply from the network). In case of having a timer which is restarted after each UL/DL transmission, the timer would be shorter (e.g. 1 second), so the UE would detect the failure earlier. * At the same time, this timer’s implementation would the very similar to the data inactivity timer’s implementation , which is very straightforward and simple so we do not believe this option is more complex than the other alternative at all. |  |
| SONY | Option 2 | Timing for subsequent SDT is variable, so a time bounded SDT may not be suitable, hence we prefer Option 2. |  |
| OPPO | Option1 | To make it simple, we think option1 is desirable since Option 2 would bring extra complication to both UE and gNB. |  |
| Xiaomi | Option 1 | We understand that Option 1 is not optimum, but the benefit of terminating the procedure earlier is also not very clear to us as most traffic carrired in SDT procedure would not be delay-sensitive. |  |
| Fujitsu | Option 1 | We prefer to reuse the T319 and the definition of T319 as what has been speciried from Rel-15. This means that T319 should be failure detection timer and has no other meanings e.g. SDT boundary timer and data inactitity timer. As in Rel-15, the UE starts T319 when the UE sends RRCResume plus small data and goes to IDLE when it is expired. The all SDT (first SDT and subsequent SDT) should be done during T319 running, for which we don’t see any problem. Besides, from the perspective of gNB configuration, it is simple to properly control UE activity. Specifically, once the gNB receives RRCResume, it can also start corresponding internal timer and can recoginize when T319 is expected to be expired (i.e. when the UE goes to the IDLE), so that timer state mismatch can be fully avoided. |  |
| Sharp | Option 2 | We share the same view with HuaWei. |  |
| APT | Option 2 | NW can decide whether to extend the SDT procedure by scheduling based on NW implementation. |  |
| Samsung | Option 1 | Agree with ZTE. |  |
| Ericsson | Option 2 | If the new timer is an extended T319 to account for the maximum duration of SDT, a UE that send less data and fails will have to wait a considerable amount of time before resetting its RRC state; whereas a UE with a larger amount of data to transmit would have a smaller margin for error before declaring the transaction as failed. Option 2 gives more room to control the procedure and termination. If this is not considered acceptable, the new timer in Option 1 should be at least configurable on a per UE SDT basis, and possibly also to be reset at each INACTIVE transmission. |  |
| Google | Option 1 | We think extending the timer is simpler. |  |
| Nokia, Nokia Shanghai Bell | Option 2 | This would be more convenient approach for the NW as it would not need to configure overly long timer value to account all the subsequent SDT data session lengths. |  |
| CATT | Option 1 | We prefer to define a time bounded SDT procedure which also includes the subsequent data transmission phase. It is simple to both UE and gNB. If there is more data arrival during SDT, the network can transit the UE into RRC\_CONNECTED before the timer expires.  In Option 2 , it is not clear how the UE to be aware that subsequent UL transmission is successful. Or which layer determines the successful UL transmission and whether this is communicated to the RRC layer. |  |
| InterDigital | Option 2 | Time needed for subsequent small data transmission is variable, thus making option 1 unsuitable. |  |
| NEC | Option 2 | Extended T319 like timer will be too long for the UE to recovery from SDT procedure, thus we prefer Option 2 |  |
| Mediatek | Option 1 | Simple solution is preferred. |  |
| LG | Option 1 | Given that SDT is used for short and infrequent data, time-bound for SDT procedure is sufficient, and the new timer does not need to start/restart after each UL/DL. |  |
| Lenovo | Option.2 | Similar view to HW, the new timer could be more flexible than the Timer likely to T319. We agree that Option 2 allows for a more efficient termination of the procedure. However, the details on the handling of the timer should be further discussed. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

# Conclusion and proposals

# References

1. R2-2008124, Report for Rel-16 (NR-U, Power Savings and 2-step RACH) and Rel-17 (IioT and Small Data), Session Chair (InterDigital), 3GPP TSG-RAN WG2 Meeting #111-e
2. R2-2010704, Report for Rel-16 (NR-U, Power Savings and 2-step RACH) and IIoT and Small Data, Session Chair (InterDigital), 3GPP TSG-RAN WG2 Meeting #112-e

# Annex (contact details for email discussions)

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| --- | --- | --- |
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