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

Agenda Item: 8.6.1

Source: Email discussion rapporteur (Samsung)

Title: Report from email discussion [POST113-e][501][SDT] Selection criteria and overall Procedure

Document for: Discussion, Decision

# Introduction

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

* [Post113-e][501][SDT] Selection criteria and overall Procedure (Samsung)

 **Scope:** Discussion on overall procedure, including:

1) Threshold handling for CG/RA before and during SDT ((and other FFS points from last meeting for overall procedure),

2) Order of selection,

3) Switching between CG/RA (whether to support it and other details)

 **Intended outcome:** Report to the next meeting.

**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: **Fri March 26th 1100 UTC**

# Discussion

## RSRP threshold for selecting between SDT and non SDT procedure

RAN2 has discussed the RSRP threshold for selecting between SDT and non-SDT procedure in RAN2 #113e and following agreements were made.

**RAN2 #113e Agreements [1]:**

* FFS: RSRP threshold to select between SDT and non-SDT procedure.
* FFS also whether this RSRP threshold to select between SDT and non-SDT procedure is used for CG-SDT, RA-SDT, or both and whether the RSRP threshold is the same for CG-SDT and RA-SDT. FFS when the RSRP threshold check is made

Note that this threshold is different from threshold used for selecting RA type and UL carrier selection. The main motivation for this threshold is to ensure that link quality is good enough for UL transmission to be successful.

**Q1. Do you agree that RSRP threshold is used to select between SDT and non-SDT procedure?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| LG | Yes |  |
| ZTE | Y |  |
| Samsung | Yes |  |
| ETRI | Yes |  |
| Sharp | Yes |  |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| APT | Y |  |
| NEC | Yes |  |
| ASUSTeK | Yes |  |
| ITRI | Yes |  |
| Ericsson | Yes |  |
| Intel | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Interdigital | Yes |  |
| Lenovo | Yes |  |
| Sony | No | We don’t think the RSRP threshold is needed to select between SDT and non-SDT procedure. It said above that the motivation of this threshold is to ensure that link quality is good enough for UL transmission to be successful. However, we already have a threshold that ensures the UL transmission to be successful in general, that is the selection between two different payloads for SDT given by Preamble Group A and B as shown on the figure below where only one carrier is assumed. If there is a transmission failure for either groups, there is a mechanism to handle the failure as discussed in the email discussion “**[Post113-e][503][SDT] T319 cell reselection**”, also see Q15.Hence we think there is no need for RSRP threshold to select between SDT and non-SDT procedure. As RAN2 agreed, the only threshold is needed is data volume threshold.In addition, there is a threshold for RA-Type selection in case 4-step and 2-step RACHs are configured in the same BWP. In this case, 4-step RACH can be used at the cell edge while 2-step RACH can be applied other areas of the cell. |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |

**Q2. Do you agree that RSRP threshold is needed for both RA-SDT and CG-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| LG | Yes |  |
| ZTE | Y |  |
| Samsung | Yes |  |
| ETRI | Yes |  |
| Sharp | Yes |  |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| APT | Y |  |
| NEC | Yes |  |
| ASUSTeK | Yes |  |
| ITRI | Yes |  |
| Ericsson | Yes | Top level threshold |
| Intel | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Interdigital | Yes |  |
| Lenovo | Yes |  |
| Sony | No | See our comments on Q1. |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |

**Q3. If RSRP threshold is used to select between SDT and non-SDT procedure, which option do you prefer for configuring this RSRP threshold?**

* **Option 1: RSRP threshold is the same for CG-SDT and RA-SDT**
* **Option 2: RSRP threshold is separately configured for CG-SDT and RA-SDT**

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| --- | --- | --- |
| **Company** | **Preferred option** | **Additional comments** |
| LG | Option 1 |  |
| ZTE | Option 1 | Since we will have beam level RSRP threshold anyway, it seems yet another RSRP threshold specifically for CG-SDT is not really useful for SDT v non-SDT selection.  |
| Samsung | Option 1 |  |
| ETRI | Option 1 | It depends on Q6. If option 1 is adopted for Q6 (i.e. data volume threshold is the same for CG-SDT and RA-SDT), separate RSRP thresholds are not need for CG-SDT and RA-SDT. |
| Sharp | Option 1 | A RSRP is agreed to be used for evaluation of the CG-SDT resource validation. If CG-SDT is still valid, the RSRP threshold here could be the same for CG-SDT and RA-SDT. |
| Spreadtrum | Option 1 | RSRP change may be used to check whether CG resources can be used. Then no need to specify another RSRP threshold for CG-SDT. |
| OPPO | Option 1 | Same view with ZTE. |
| APT | Option 1 | The selection of SDT and non-SDT may be performed by RRC. However, the selection of RA-SDT and CG-SDT may be performed by MAC. It will introduce the complexity on inter-layer behaviors if the RSRP threshold is separately configured for CG-SDT and RA-SDT.  |
| NEC | Option 1 |  |
| ASUSTeK | Option 1 | It could be a high level threshold to select between SDT and non-SDT procedure. If the radio condition is above the threshold, the UE initiates SDT and then choose CG or RA resources. |
| ITRI | Option 1 |  |
| Ericsson | Option 1 | Assuming this is a Top level threshold so that the UE may at least perform 4-step RA if fulfilled. |
| Intel | Option 1 | CG/RA SDT will both allow sub-sequent SDT traffic during a given SDT session, therefore we do not see essential to have different RSRP thresholds for each of them (as per option 2).  |
| Huawei, HiSilicon | Option 1 | We think there should be a single RSRP check done either right before or right after SDT data volume check, i.e. before UE makes a decision whether to initiate legacy RRC resume or SDT procedure. |
| Interdigital | Option 1 |  |
| Lenovo | Option 1 | Same view as ZTE.  |
| Fujitsu | Option 1 | It seems to need RAN1 consultation, but for simplicity, the same threshold is enough. |
| Qualcomm | Option 1 |  |
| Xiaomi | Option 1 |  |

## RSRP threshold for carrier selection

RAN2 has discussed the RSRP threshold for UL carrier selection in RAN2 #113e and following agreements were made.

**RAN2 #113e Agreements [1]:**

* 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.

**Q4 Which option do you prefer for the RSRP threshold for carrier selection**

* **Option 1: RSRP threshold for carrier selection is specific to SDT**
* **Option 2: RSRP threshold for carrier selection is same for SDT and non SDT**

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| --- | --- | --- |
| **Company** | **Preferred option** | **Additional comments** |
| LG | Option 1 |  |
| ZTE | Option 1 | We think this threshold can be used to direct the UE to the correct carrier when CG resources are configured only on one of the two carriers.  |
| Samsung | Option 1 |  |
| ETRI | Option 1 |  |
| Sharp | Option 1 | If SDT is selected based on the RSRP mentioned in Q1, the specific RSRP for SDT could be used. |
| Spreadtrum | Option 2 | UE performs UL carrier selection first. It is not sure that SDT will be selected after checking whether the related SDT resources are available and SDT selection criteria is satisfied. So no need to spicify different RSRP threshold. |
| OPPO | Option 1 | That depends on whether the RSRP threshold for SDT/non-SDT selection is configured per carrier or per cell. If the SDT/non-SDT RSRP threshold is configured per carrier, we should follow the legacy RSRP threshold for carrier selection (Option2).UE shall first perform carrier selection and then make selections between SDT and non-SDT. The drawback of this procedure is that UE might select to a carrier where there is no SDT resources, for example, CG resources are only configured on SUL but the RSRP of UE is good enough to select NUL.But if the SDT/non-SDT RSRP threshold is configured per cell, Option1 is reasonable. Because if the UE has been in the area where SDT can be performed based on the SDT/non-SDT RSRP threshold, the next step is to find suitable resouces to execute the procedure, including carrier, type. Therefore, the RSRP threshold for carrier selection is not to gurantee that UE can work on NUL but to gurantee that UE can perform SDT on NUL.From our side, we think the second solution is more desirable. |
| APT | Option 1 | The requirement on radio quality for SDT and non-SDT should be different. |
| NEC | Option 1 |  |
| ASUSTeK | Option 1 | If UE checks the RSRP threshold for SDT/non-SDT before UL carrier selection and RA type selection (as Q7), the RSRP threshold for carrier selection should be different for SDT and non-SDT. |
| ITRI | Option 1 |  |
| Ericsson | Option 1 | Option 1 simplifies the solution; i.e. NUL coverage is the same irrespective of if SDT is used of not. |
| Intel | Option 2 | We do not see essential having a different threshold for carrier selection specific for SDT operation. |
| Huawei, HiSilicon | Option 2 | There is a slight discrepancy between the agreements RAN2 made during the last meeting. The agreement quoted above seems to suggest that carrier selection is for both CG-SDT and RA-SDT. On the other hand, RAN2 made also the following agreement: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. Hence, firstly we would like to clarify that carrier selection threshold is only for RA-SDT. In that situation, it seems there is no good justification for having a threshold different than the legacy one.  |
| Interdigital | Option 1 |  |
| Lenovo | Option 1 |  |
| Sony | Option 1 |  |
| Fujitsu | Option 1 | It seems to need RAN1 consultation, but different threshold seems to be needed to support different requirement for SDT from that for non-SDT. |
| Qualcomm | Option 1 |  |
| Xiaomi | Both Option 1 and 2 | The Rel-15 RSRP threshold for UL carrier selection for non-SDT is already their since Rel-15. The Rel-16 RSRP threshold for UL carrier selection for non-SDT should anyway be optional. If the Rel-16 RSRP threshold is not configured, the Rel-15 RSRP threshold would be common for both SDT and non-SDT. |

## RSRP threshold for RA type selection

RAN2 has discussed the RSRP threshold for RA type selection in RAN2 #113e and following agreements were made.

**RAN2 #113e Agreements [1]:**

* 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.

**Q5. Which option do you prefer for the RSRP threshold for RA type selection**

* **Option 1: RSRP threshold for RA type selection is specific to SDT**
* **Option 2: RSRP threshold for RA type selection is same for SDT and non SDT**

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| --- | --- | --- |
| **Company** | **Preferred option** | **Additional comments** |
| LG | Option 1 |  |
| ZTE | Option 1 | Since we agreed that the RACH resources can be configured separately for SDT and non-SDT, having a separate RSRP threshold for RA type selection for SDT seems straightforward (i.e. by including this in the SDT RACH configuration).  |
| Samsung | Option 1 |  |
| ETRI | Option 1 |  |
| Sharp | Option 1 | If SDT is selected based on the RSRP mentioned in Q1, the specific RSRP for SDT could be used. |
| Spreadtrum | Option 1 |  |
| OPPO | Option 1 |  |
| APT | Optoin 1 | MsgA PUSCH transmission for SDT may need better radio quality than non-SDT. (e.g., in the case that the payload size of SDT is larger than non-SDT) |
| NEC | Option 1 |  |
| ASUSTeK | Option 1 | Same as Q4. |
| ITRI | Option 1 |  |
| Ericsson | Option 1 | Configurable depending on typical payload sizes etc. |
| Intel | Option 1 |  |
| Huawei, HiSilicon | Option 1 | The payload in SDT msgA will be larger than this in non-SDT msgA, so the threshold should account for that. |
| Interdigital | Option 1 |  |
| Lenovo | Option 1 |  |
| Sony | Option 1 |  |
| Fujitsu | Option 1 | It seems to need RAN1 consultation, but different threshold seems to be needed to support different requirement for SDT from that for non-SDT. |
| Qualcomm | Option 1 |  |
| Xiaomi | Both Option 1 and 2 | Same comments as for Q5. |

## Data volume threshold for selecting between SDT and non SDT procedure

RAN2 has discussed the data volume threshold for in RAN2 #111e and following agreements were made.

**RAN2 #111e Agreements [2]:**

* Small data transmission is configured by the network on a per DRB basis
* Data volume threshold is used for the UE to decide whether to do SDT or not. FFS how we calculate data volume.

In last meeting, some companies [11][12][13] have proposed to configure separate data volume threshold for CG-SDT and RA-SDT as the payload sizes can be quite different for CG-SDT and RA-SDT.

**Q6. Which option do you prefer for configuring the data volume threshold?**

* **Option 1: data volume threshold is the same for CG-SDT and RA-SDT**
* **Option 2: data volume threshold is separately configured for CG-SDT and RA-SDT**

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| --- | --- | --- |
| **Company** | **Preferred option** | **Additional comments** |
| LG | Option 1 |  |
| ZTE | Option 1 | Given that subsequent data transfer is allowed, the data volume threshold can be a overall threshold that decides whether or not SDT is allowed. Hence, this can be common between CG and RA cases and any data left after the first UL message can be handled during the subsequent data transmission phase.  |
| Samsung | Option 1 | Agree with comments from ZYE |
| ETRI | Option 1 |  |
| Sharp | Option 2 |  |
| Spreadtrum | Option 1 |  |
| OPPO | Option1 |  |
| APT | Option 1 | Same view as ZTE. |
| NEC | Option 1 | Given that common RSRP threshold is to be applied for CG-SDT and RA-SDT as majority (as of now) supports it in Q3, common data volume threshold seems reasonable, although this may reduce a flexibility from network point of view.  On the other hand, if separate RSRP threshold is applied for CG-SDT and RA-SDT, separate data volume threshold would be more useful. |
| ASUSTeK | Option 2 | The data volume threshold can be configured in CG configuration. |
| ITRI | Option 1 |  |
| Ericsson | Option 1 | We assume Option 1 is the top level DVT for performing SDT (agreed). The question is if additional threshold(s) are needed. Option 2 would set thresholds related to the CG grant TB size/periodicity and the RA config (e.g. msgA PUSCH). This detailed refinement with the added complexity has no clear benefit as there is anyway large uncertainty in the e.g. data volume and estimation in resource allocation/use etc. |
| Intel | Option 1 | It would be good to also discuss how data volume is defined. In our view, data volume threshold to trigger SDT should be defined as an upper limit on the amount of data in the buffer (for SDT DRBs) when SDT is first initiated by the UE (as explained in R2-2100365). Moreover, RAN2 needs to also discussed whether L2 headers should be or not included as part of the volume calculation. |
| Huawei, HiSilicon | It depends | We think this depends on whether CG-SDT and RA-SDT is targeted at different services for a single UE. If that is the case, then it may make sense to have the thresholds configured separately.  |
| Interdigital | Option 1 | Same view as ZTE. |
| Lenovo | Option 1 |  |
| Sony | Option 1 |  |
| Fujitsu | Both | Both Options 1 and 2 work. Option 1 can be the same with Option 2 if the network configures the same value for CG-SDT and CG-RA, or different values for CG-SDT and CG-RA. |
| Qualcomm | Option 1 |  |
| Xiaomi | Option 1 |  |

## SDT/Non-SDT Selection Procedure

RAN2 has made the following agreements for selecting between SDT and non SDT.

**RAN2 #111e Agreements [2]:**

* Small data transmission is configured by the network on a per DRB basis
* Data volume threshold is used for the UE to decide whether to do SDT or not. FFS how we calculate data volume.

**RAN2 #113e Agreements [1]:**

* FFS: RSRP threshold to select between SDT and non-SDT procedure.
* FFS also whether this RSRP threshold to select between SDT and non-SDT procedure is used for CG-SDT, RA-SDT, or both and whether the RSRP threshold is the same for CG-SDT and RA-SDT. FFS when the RSRP threshold check is made
* FFS If both carriers can be selected and CG resources are available on one carrier only, does the UE select the carrier with CG
* 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)
* 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.

**Based on the above agreements, upon arrival of data only for DRB(s) for which SDT is enabled, the high level procedure for selection between SDT and non SDT procedure can be as follows:**

If CG-SDT criteria is met:

* UE selects CG-SDT. UE initiate SDT procedure

Else if RA-SDT criteria is met:

* UE selects RA-SDT. UE initiate SDT procedure

Else:

* UE initiate non SDT procedure.

**Criteria for selecting CG-SDT:** CG-SDT criteria is considered met, if all of the following conditions are met,

1) available data volume <= data volume threshold (threshold is as per discussion (i.e. Q6) in section 2.4)

2) RSRP is greater than or equal to a configured threshold (if agreed as per discussion (i.e. Q1, Q2) in section 2.1, threshold is as per discussion (i.e. Q3) in section 2.1)

3) CG-SDT resources are configured on the selected UL carrier and are valid

* Note:
	+ UE checks the condition 1) and 2) before 3).
	+ There is FFS on carrier selection for CG-SDT, which will be discussed in email discussion #504.
		- FFS, If both carriers can be selected and CG resources are available on one carrier only, does the UE select the carrier with CG selection of UL carrier for CG-SDT is FFS.

**Criteria for selecting RA-SDT:** RA-SDT criteria is considered met, if all of the following conditions are met

1) available data volume <= data volume threshold (threshold is as per discussion (i.e. Q6) in section 2.4)

2) RSRP is greater than or equal to a configured threshold (if agreed as per discussion (i.e. Q1, Q2) in section 2.1, threshold is as per discussion (i.e. Q3) in section 2.1)

3) 4 step RA-SDT resources are configured on the selected UL carrier and criteria to select 4 step RA SDT is met; or

2 step RA-SDT resources are configured on the selected UL carrier and criteria to select 2 step RA SDT is met:

* Note:
	+ UE checks the condition 1) and 2) before UL carrier selection and RA-Type selection.
	+ For RA-SDT, if SUL is configured in the cell, UL carrier is selected based on RSRP threshold (threshold is as per discussion (i.e. Q4) in section 2.2)
	+ RA type selection is performed based on RSRP threshold (threshold is as per discussion (i.e. Q5) in section 2.3)

Note that detailed modelling (e.g. RRC/MAC interactions, etc) of the above procedure can be discussed during stage 3 discussions.

**Q7. Do you agree with the high level procedure for selection between SDT and non SDT procedure as described above? If not, you can provide detailed comments/alternate procedure (if any).**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comments** |
| LG |  | Agree with Rapporteur suggestion. |
| ZTE | Yes | In general the procedure looks fine to us. It should be noted that there will be other criteria to be checked as well (e.g. whether DRB on which the data arrives is allowed for SDT or not etc), but we understand that the intention of rapporteur is that the above procedure is not exhaustive (and there will be other straightforward additions to it based on other agreements made). |
| Samsung | Yes |  |
| ETRI | Yes |  |
| Sharp |  | **We are ok with general procedure above. However, we don't think there should be limitation for sequence of each step.****E.g, as per Criteria for selecting CG-SDT, the validation of CG-SDT could go first other than to be done at the end. So the first bullet of the note could be removed.****Such a sequence could be done by UE implementation.** |
| Spreadtrum | Yes |  |
| OPPO | Yes |  |
| APT | Y | Agree with the principle proposed by rapportuer, but the order of the selections for different criteria should be further discussed. The order may be influenced based on which layer to perfrom the selection and the configured threshold is the same or separated for CG-SDT/RA-SDT (i.e., Q3-Q6). |
| NEC | Yes |  |
| ASUSTeK | Yes |  |
| ITRI | Yes |  |
| Ericsson | Yes | In principle ok. Details need to be dicussed. For example, for a CG to be valid the TA check involves a RSRP check. Thresholds should be optionally configurable, i.e if 4-step RA SDT is supported in the whole cell for a certsin msg3. |
| Intel | Yes with comments | We agree with the general flow, although there may be additional scenarios that require further consideration, e.g. failure scenarios. In addition, we understand that UE should 1st select UL carrier before before doing any other checked (e.g. SDT vs non-SDT) as explained in Q4.  |
| Huawei, HiSilicon | Not entirely | In general, we agree with the described procedure, but there are some points that we would like to raise:* + - * SUL/NUL selection – as we indicated in the response to Q4, there is no need for carrier selection for CG-SDT
			* Depending on the conclusions to other questions, conditions 1) and 2) can be common for both CG-SDT and RA-SDT and hence they might be separated from CG-SDT and RA-SDT criteria and then the procedure would be slightly different, i.e.:
				+ UE first checks condition 1) and 2) to decide whether to perform SDT or non-SDT / legacy resume procedure
				+ If SDT is performed, then conditions for CG-SDT are checked (TA validity, RSRP range etc.)

If conditions for CG-SDT are not met, then conditions for RA-SDT are checked, i.e. SUL/NUL selection and RA type selection for SDT |
| Interdigital | Yes |  |
| Lenovo | Yes | General principle of higher layer procedure is fine for us. We think that there might be additional criteria to be checked by the UE for the selection steps. However those can be addressed later together with the modelling discussion. |
| Sony | Not entirely | We don’t agreed SDT Threshold, see our comments on Q1. However, we are ok with rest of the procedure as proposed above. |
| Fujitsu | Yes | It is high-level procedure, and further details can be discussed later. |
| Qualcomm | Yes | General principle could be as baseline. |
| Xiaomi | Yes |  |

## Switching from CG-SDT to RA-SDT

According to RAN2#113e agreements, UE prioritises CG-SDT over RA-SDT at the time of initiating SDT procedure. In [8] [3] [7] [4] it is proposed to allow switching from CG-SDT to RA-SDT during the SDT procedure. According to the proponents, switching to RA-SDT is beneficial when a) CG-resource corresponding to a good beam is not available or b) transmission(s) on CG resource fails or c) TA becomes invalid during the SDT procedure. On the other hand, according to [5], if switching is allowed then we may also have to consider rebuilding of the payload and the overall procedure will be unnecessarily complex.

**Q8. Do you agree to allow switching from CG-SDT to RA-SDT?**

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| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| LG | No | If switching from CG-SDT to RA-SDT is allowed, RAN2 should discuss MAC PDU rebuilding issue, on which we have strong concerns. Once CG-SDT procedure is triggered, the UE has to finish this CG-SDT procedure. If the CG-SDT procedure is failed, the MAC PDU is lost. |
| ZTE | N | Both RA-SDT and CG-SDT will have inbuilt mechanism for retransmission multiple times and hence we think there is no need to have a mechanism for switching on top. Once the mechanism fails, UE can simply invoke the failure (e.g. reestablishment or Resume again etc).  |
| Samsung | N |  |
| ETRI | No | Agree with ZTE |
| Sharp | N | When CG-SDT transmission fails, UE has to review the condition if SDT could be retriggered. From our perspective, it is a new procedure. The UE has to terminate the failed CG-SDT, and consequently, there is no switching. |
| Spreadtrum | Yes | It may benefit to the retransmission scenario. |
| OPPO | N |  |
| APT | Y | It is possible that some of criteria for CG-based SDT become invalid during the CG-SDT procedure, e.g., no beam is qualified, TA timer expires, etc. To allow the UE switch to RA procedure can recover the beam and TA. After that, UE can switch back to perform SDT procedure using CG in RRC\_INACTIVE, e.g., within subsequent transmission period, without triggering the legacy RRC connection resume procedure.In addition, rebuilding may not be needed if we introduce some restrictions, e.g., payload size for RA-based SDT and CG-based SDT is the same (i.e., based on the discussion in Q10).  |
| NEC | N |  |
| ASUSTeK | Yes | Rebuilding is required for retransmission case. If CG-SDT becomes invalid for subsequent small data transmission, the UE can trigger RA-SDT for subsequent small data without rebuilding. |
| ITRI | N |  |
| Ericsson | No | If we have restransmissions and also TA evaluation this should be enough. Reuse failiure handling from legacy. |
| Intel |  | In our understanding, the switch from CG-SDT to RA-SDT will always be possible based on UE’s implementation. Moreover in our understanding, LTE PUR already reflects similar behaviour with the following note added in TS 36.331 upon PUR fallback or PUR failure “*NOTE: For transmission using PUR, further UE actions upon reception of PUR fallback or PUR failure indication from lower layers (see TS 36.321 [6]) is left up to implementation*”. Therefore any UE that wants to switch from CG-SDT to RA-SDT will treat it as a new initiation of the SDT procedure using RACH. This may involve PDU “rebuilding” however the details can be left to UE implementation (e.g. to prevent data loss, UE may start again with the PDCP SDU). |
| Huawei, HiSilicon | No | While in R16, we agreed that the TBS for different groups should be the same for 2-step RA and 4-step RA, it is hard to make such assumption for CG and RA that they should always have the same time TBS. Furthermore, in case transmission via CG-SDT is unsuccessful, there is a high chance RA-SDT will also fail causing additional delay for sending data. Therefore, we think that if initial CG-SDT fails the UE should perform legacy RRCResumeRequest procedure.  |
| Interdigital | Yes | This can be beneficial when UL beams are not aligned for CG or when there are UL synchronization issues.  |
| Lenovo | No | The question is what exactly switching implies. For example we think that when TAT expires, UE sould perform random access procedure to regain synchronization. Similar when there is no qualified beam (above threshold) for CG-SDT, UE should use RACH. However we think that in those cases the SDT procedure is completed (unsuccessfully) and UE has to start new procedure. |
| Sony | No |  |
| Fujitsu | Yes | We are positibe to allow the switching. As discussed below (from Q9), there are some ways to avoid rebuilding. Even if there are still concerns, the switching can be controlled by UE capability and NW option. |
| Qualcomm | Yes | It is good to allow UE to switch to RA-SDT if the cause of the failed SDT in CG resource is that TA becomes invalid or number of failure retransmissions on CG resources is above a threshold. Such switching mechanism could help UE to finish the SDT quickly w/o involve additional signalling such as performing legacy RRC resume procedure. Rebuilding of MAC PDU, if it happens, could be left to UE implementation. |
| Xiaomi |  | We have not strong preference on this point. If we do not allow the switching from CG-SDT to RA-SDT, the UE would have to fallback to the non-SDT procedure when the CG becomes invalid during the CG-SDT procedure. Then the fallback to the non-SDT from the SDT would probably also cause the MAC PDU rebuilding. |

SDT procedure consists of two phases, initial data transmission phase and subsequent data transmission phase. UL transmission in the initial data transmission phase includes at least RRC message and CG resources is used during this phase. During subsequent data transmission, dynamic grant addressed to UE's C-RNTI is used in addition to CG resources. In [3] it is proposed to allow switching from CG-SDT to RA-SDT during both initial and subsequent data transmission phase.

**Q9.** **If switching from CG-SDT to RA-SDT is supported, which of the following options do you agree?**

**a) switching from CG-SDT to RA-SDT is allowed during both initial and subsequent data transmission phase**

**b) switching from CG-SDT to RA-SDT is allowed during initial data transmission phase**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (a/b)** | **Additional comments** |
| LG | None |  |
| ZTE | N/A | No switching is supported |
| Samsung | - | No switching |
| ETRI | - | No switching |
| Sharp | - | No switching |
| Spreadtrum | a |  |
| OPPO | - | No Type switching. |
| APT | A | Not clear why only allow during initial data transmission phase. |
| NEC | - | No switching |
| ASUSTeK | a |  |
| ITRI | - | No switching |
| Ericsson | - | No switching |
| Intel | b | We understand that during subsequent transmission phase (option a), UE operation is the same regardless on whether UE is doing RA-SDT and CG-SDT (i.e. network can provide dynamic grants to continue its ongoing SDT session or can fallback the UE into RRC\_CONNECTED by resuming the suspended RRC connection or by establishing a new RRC connection). And for initial phase, this can be left up to UE implementation as explained in Q8. |
| Huawei, HiSilicon | None | We assume that case a) described by the rapporteur above (i.e. “CG-resource corresponding to a good beam is not available”) is already covered for initial SDT transmission, i.e. the minimum SS-RSRP is already checked before choosing CG-SDT resource. We do not treat this case as an actual “switching” as the UE is still in SDT scheme selection phase in our understanding. |
| Interdigital | A |  |
| Lenovo | - |  |
| Fujitsu | a |  |
| Qualcomm | A |  |
| Xiaomi |  | The subsequent data transmission is scheduled by C-RNTI. It is not clear which trigger condition(s) are used to trigger the switching from CG-SDT to RA-SDT for the subsequent data transmission. |

If switching from CG-SDT to RA-SDT is allowed, then the next question is whether rebuilding of MAC PDU is needed or not when UE switches from CG-SDT to RA-SDT. If rebuilding of MAC PDU is needed, rebuilding details can be specified or left to UE implementation.

**Q10. If switching from CG-SDT to RA-SDT is supported, do you think that switching from CG-SDT to RA-SDT requires rebuilding of MAC PDU?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (y/n)** | **Additional comments** |
| LG | Yes |  |
| ZTE | N | In general, we think this depends on the contents and the size. The size can be left to network implementation as was done in 2-step RACH case where it is up to network to configure the payload size for CG and RA appropriately so that no rebuilding is needed. Further it also assumes that the same RRC message is included in both RA and CG case in the first UL message. Perhaps we can first agree this * i.e. that the RA and CG case the first UL message includes the same CCCH message (i.e. RRCResumeRequest).
 |
| Samsung | Yes | Rebuilding is needed if payload size is not same for CG and RA |
| ETRI | Yes | Agree with Samsung |
| Sharp | Y | Depending on Q6 if specific the data volume threshold is used, there is a big chance to rebuild MAC PDU. |
| Spreadtrum | Yes |  |
| OPPO | Yes | Same view with Samsung. |
| APT | N | Same view as ZTE. |
| NEC | Yes | The size of the UL grant is very likely not the same for CG resource and RAR. |
| ASUSTeK | Yes |  |
| ITRI | N | Same view as ZTE. |
| Ericsson | Depends | Switching would need rebuilding if the TB similarly as in 2-step to 4-step vary in size etc. |
| Intel | Depends | We share the same view as explained by Ericsson. However, when a rebuild may be required, the decission could be left up to UE implementation that handles in a way this as a new access via RA-SDT considering the details explained in Q8/Q9.  |
| Huawei, HiSilicon | Probably yes | RA-SDT is configured commonly for all UEs in the cell while with CG-SDT the goal is to provide a resource that is tailored for a specific UE (i.e. to its service requirements and its current radio conditions). It would be counterproductive to require the network to always ensure the same TBS for RA-SDT and CG-SDT. Furthemore, for RA-SDT we agreed there can be two preamble groups to support different TBS, so would we now require the UE to choose always the preamble group based on the CG TBS? |
| Interdigital | Depends | Only if the TBS is different between RACH and CG resources, which is dependent on network configuration. |
| Lenovo | Yes | Agree with Samsung |
| Fujitsu | No | Same view as ZTE. |
| Qualcomm | Depends | It depends on network configuration on the uplink grant resources of RACH and CG configuration. But the rebuilding of MAC CE could be left UE implementation as we explained in Q8. |
| Xiaomi |  | This depends on how we model the switching procedure. If we allow the RRC to re-submit the same CCCH message after switching, then there is no need for MAC PDU rebuilding. Alternatively, we could also have MAC to reuse the CCCH message in the old MAC PDU via MAC PDU rebuilding. |

**Q11. If switching from CG-SDT to RA-SDT requires rebuilding of MAC PDU, are the details of MAC PDU rebuilding specified or left to UE implementation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (A/B)****A: Details are specified****B: Left to UE implementation** | **Additional comments** |
| LG | B |  |
| ZTE | B | If rebuilding is needed we prefer to leave this to UE |
| Samsung | B |  |
| ETRI | B |  |
| Sharp | B |  |
| Spreadtrum | B |  |
| OPPO | B |  |
| APT | B |  |
| NEC | B |  |
| ASUSTeK | B |  |
| ITRI | B |  |
| Ericsson | A/B | Depends on the details and if the same CCCH message (and payload) is transmitted |
| Intel | B | We are ok adding a similar kind of note included for LTE PUR. |
| Huawei, HiSilicon | B |  |
| Interdigital | B |  |
| Lenovo | B |  |
| Fujitsu | B |  |
| Qualcomm | B |  |
| Xiaomi | B |  |

**Q12. If switching from CG-SDT to RA-SDT is supported, under what condition(s) is UE allowed to switch to RA-SDT during the SDT procedure?**

**- Option 1: TA becomes invalid**

**- Option 2: Consecutive failures on CG resource**

**- Option 3: CG-resource corresponding to a good beam is not available**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (Option 1/2/3)** | **Additional comments** |
| LG | None |  |
| ZTE | N/A | No switching |
| Samsung | - | No switching |
| ETRI | - | No switching |
| Sharp | - | No switching |
| Spreadtrum | Option 2 |  |
| OPPO | - | No switching. |
| APT | Options 1, 2, 3 |  |
| NEC | - | No switching |
| ASUSTeK | Option 1, 2, 3 |  |
| ITRI | - | No switching |
| Ericsson | - | This topic should wait until we decide if switching is supported, when we know HARQ feedback mechanisms and when the beam handling has been discussed.  |
| Intel | - | We suggest post-pone this discussion until stage-2 details of the CG/RA SDT operation have progressed more e.g. to better understand which are the possible failure and fallback scenarios foreseens, |
| Huawei, HiSilicon | No switching to RA-SDT, but… | The UE should not switch to RA-SDT from CG-SDT. However, it is useful to use normal RACH procedure for all these cases when they occur during subsequent data phase of SDT procedure. Using RACH to get time alignment when the UE has data to send in UL is already what is done today. For option 2 and option 3, it is also useful to handle them via RACH procedure in case the UE has data to send and the network does not provide a dynamic grant to the UE.  |
| Interdigital | Options 1 and 2 | This can be discussed a later stage  |
| Lenovo | Option 1,2,3 | As mentioned in Q8, there would be no switching involved. CG-SDT procedure is completed (unsuccessfully) and UE has to start with new procedure.  |
| Fujitsu | All options |  |
| Qualcomm | Option 1, 2 and 3 |  |
| Xiaomi | Option 1 and 2 | We think the CG resource should be configured for all beams (i.e. all SSB(s)). |

## Switching from SDT to Non-SDT

In [8] [9][10][7], it is proposed to allow switching from SDT procedure to to non-SDT procedure i.e. RRC Connection resume procedure. The initial UL transmission during the SDT procedure includes RRC message and UL data. According to proponents, there may be cases when the network cannot decode such a big PDU successfully due to bad wireless environment conditions. To overcome this it is proposed that network can send an indication to switch to non-SDT procedure if it finds SDT is not suitable for the UE, similarly to the switching in PUR and EDT in LTE. Alternatley, UE can switch to non-SDT transmission when a configured number of SDT attempts fail, e.g. due to not having enough power to transmit the PDU carrying user data and CCCH SDU.

**Q13. Do you agree to allow switching from SDT to Non-SDT procedure i.e. RRC Connection resume procedure?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply** (y/n) | **Additional comments** |
| LG | Yes |  |
| ZTE | Y | Note that we already agreed that the network can send RRCResume message at any point during SDT. So, this seems sufficient? |
| Samsung | Y |  |
| ETRI | Yes |  |
| Sharp | Y |  |
| Spreadtrum | Yes |  |
| OPPO | Yes | In our understanding, we think the switching from SDT to non-SDT should include both UE triggered and network triggered. |
| APT | Y | Both explicit and implicit methods should be taken into account. |
| NEC | Y |  |
| ASUSTeK | Yes | Same view with OPPO. |
| ITRI | Y |  |
| Ericsson | Yes | The gNB should always be able to send RRCResume and bring the UE to connected etc. With RSRP threshold and good configurations this should not be a big issue. No further optimizations needed. |
| Intel | Yes  | We support using “RRC Connection resume procedure” via the fallback mechanism where a UE with an ongoing SDT session may get RRCResume to resume the RRC connection or RRCSetup to establish a new RRC connection in order to exchange the non-SDT. Note that we do not support for a UE to send again RRCConnectionRequest while UE has an ongoing SDT session (which is a topic already discussed on email discussion #502). |
| Huawei, HiSilicon | Yes | This question is not about RRCResume in our understanding (which is just one regular way to terminate SDT procedure). We think the fallback is needed in case the initial SDT transmission cannot be detected/decoded by the network. In case of 2-step RA-SDT the fallback is needed in case the network detects preamble but cannot decode msgA. We think falbackRAR can be used to switch to legacy 4-step RA in this case.Similarly, in case there is no reply from the network at all for the initial SDT transmission (e.g. SDT transmission fails a configured number of times), the UE should trigger legacy RRC Resume procedure. |
| Interdigital | Yes |  |
| Lenovo | Yes |  |
| Sony | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| Xiaomi | Yes |  |

SDT procedure consists of two phases, initial data transmission phase and subsequent data transmission phase. UL transmission in the initial data transmission phase includes RRC message and UL data. The RRC message is similar to one which is transmitted during the non SDT procedure. So switching to non SDT procedure seems beneficial only during the initial data transmission phase.

**Q14.** **If switching from SDT to Non-SDT is supported, do companies agree that switching from SDT to Non-SDT is allowed only during the initial data transmission phase?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (y/n)** | **Additional comments** |
| LG | No | We think switching from SDT to non-SDT should be possible in any phase of SDT procedure. |
| ZTE | N | The Switching can be initated by sending RRCResume in DL at any stage. This aspect need not be further discussed sicne it is up to network to initiate this (even if the UE initiates SDT, the network may move the UE to CONNECTED state for whatever reason)… So, the UE simply shall follow the DL RRC message received (i.e. RRCResume or RRCRelease).  |
| Samsung | N |  |
| ETRI | No | . |
| Sharp | No |  |
| Spreadtrum | No |  |
| OPPO | No | For UE triggered switching, it is allowed only during the initial data transmission phase. For network triggered switching, it is allowed at subsequent data transmission phase. |
| APT | N | It should depend on NW, so any time of the SDT procedure is preferred. |
| NEC | N |  |
| ASUSTeK | No |  |
| ITRI | N |  |
| Ericsson | No | (Q13) The gNB should always be able to send RRCResume and bring the UE to connected etc. With RSRP threshold and good configurations this should not be a big issue. No further optimizations needed. |
| Intel | No | Our preference is to allow a fallback into CONNECTED at any time, i.e. while UE starts or has an ongoing SDT session and this will also handle the data on non-SDT DRB. If the fallback is done via RRCResume, data continuity is guaranteed; however if the fallback is done via RRCSetup, UE will have to have to handle the retransmission in order to guarantee the data continuity (as network trigger the establishment of a new connection).  |
| Huawei, HiSilicon | It depends what is meant | We understand this question is mainly about handling failures of initial SDT transmission. We agree that the network can send RRCResume at any point in time during SDT procedure, but we see it more as one way to terminate SDT procedure. The main difference is that the UE does not send another RRC Resume Request while this has to happen for the cases we described in our reply to Q13 (i.e. when the network is not able to decode initial CCCH message).In any case, other cases where we think UE should switch to legacy Resume procedure is non-SDT data arrival and cell reslection during SDT, but that is rather out of scope of this discussion. |
| Interdigital | No | This could also happen during the subsequent SDT phase. |
| Lenovo | N |  |
| Sony | No |  |
| Fujitsu | No | The switching is allowed at any point of time. |
| Qualcomm | No |  |
| Xiaomi |  | The following 2 options in Q15 to trigger the switching from SDT to non-SDT seem only valid during the intial data transmission phase. If companies prefer to adopt the solution for all phases, RAN2 should avoid extra enhancments for the SDT-to-non-SDT switching during the subsequent SDT phase. For Option 1, if the SDT procedure is successfully completed, the gNB can send the RRCRelease message to send the UE to IDLE/INACTIVE, or send RRCResume message to send the UE to CONNECTED. It is not clear why a gNB would send an indication to swich the UE to non-SDT procedure (i.e. start over by re-sending the same RRCResumeRequest message) after the successful reception of the RRCResuemRequest message. Only for the initial transmission phase, the gNB may need to send a new indication to force to the UE to re-start from the non-SDT procedure to ensure a faster recovery of the RRC connection. The extra standard efforts for the switching to the non-SDT procedure during the subsequent data transmission phase may also require more RAN2 discussion.For Option 2, this option is only to count the UL transmission during the initial transmission phase.  |

**Q15. If switching from SDT to Non-SDT is supported, which of the following option(s) is preferred by you for triggering switching?**

 **- Option 1: Network sends indication to switch to non-SDT procedure**

 - **Option 2: Initial UL transmission (in msgA/Msg3/CG resources) fails configured number of times**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply**  | **Additional comments** |
| LG | Option 1 | If network wants to make the UE to transit to RRC\_CONNECTED, the network sends RRCResume message. |
| ZTE | Option 1 | But we are not sure why RRCsetup should be sent as commented by LG. We think RRCResume can also be sent and this will ensure that the security context is maintained. So, the normal procedure should be to have RRCResume and of course the network can also send RRCsetup (in case the UE context cannot be retrieved etc), but this should be the error case (i.e. fallback case – again no change to how it works today).  |
| Samsung | Option 1 | Network can send RRCResume. Network can also send UE to switch to non SDT by indication in FallbackRAR/RAR for 2SRA/4SRA respectively. |
| ETRI | Both | Network can send RRCResume message to switch. Also, the UE must be able to trigger the transition to RRC\_CONNECTED state when the UL transmission fails over the configured number of times. |
| Sharp | Both |  |
| Spreadtrum | Option 1 |  |
| OPPO | Both | Option1 is for network triggered case, Option 2 is for UE triggered case. |
| APT | Both | Option 2 is more like a fallback mechanism, which can also be a error handling by UE itself. Since option 1 and 2 are not mutually exclusive, both options can be supported.  |
| NEC | Option 1 | Option 2 requires MAC PDU rebulilding which we don’t want. |
| ASUSTeK | Both | Both NW and UE can trigger this fallback. The UE can also switch to non-SDT when subsequent UL transmission fails configured number of times. |
| ITRI | Option 1 |  |
| Ericsson | Option 1 | For RA SDT we already have failiure handling (Fallback/RAR etc). Again, the gNB should always be able to send RRCResume and bring the UE to connected etc. With RSRP threshold and good configurations this should not be a big issue. No further optimizations needed. |
| Intel | 1 (with comments on 2)  | Option 1 should be supported.Option 2 can also be considered, but it should be discussed in conjunction with all the failure scenarios/handlings (as explained in our response to Q7). |
| Huawei, HiSilicon | Both option 1 and option 2 | We think both options are needed as they address different cases:* Option 1 addresses the cases where the network is able to decode at least preamble (for RA-SDT) or DMRS (for CG-SDT)
* Option 2 addresses the case where the UE does not receive any reply from the network for its initial SDT transmission

We cannot rely on RRCResume in these cases as sending RRC Resume requires the network to successfully decode RRC Resume Request message.  |
| Interdigital | Both | Option 2 is also needed in the case where the SDT payload was never received by the network. |
| Lenovo | Option 1 | We think Option 1 is enough |
| Sony | Both option 1 and option 2 | Agree with Huawei. |
| Fujitsu | Both, but | For Option 1, since SDT pcoredure is carried out during INACTIVE mode, power saving is important, so that the UE may not always monitor PDCCH in order to receive the indicate. Some mechanism seems to be needed to ensure that the UE monitors the PDCCH to receive the indication. |
| Qualcomm | Both option 1 and option 2 | Both network triggered and UE triggered should be supported. Network can sends RRCResume or set indication in fallbackRAR to switch UE back to non-SDT procedure if network can decode the preamble successfully.UE triggered based solution is useful for the case that UE does not get any response from network (for a certain time) during SDT initialization stage. |
| Xiaomi | Both |  |

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[12] R2-2101177, CP aspects for SDT, Ericsson

[13] R2-2101203, User Plane common aspects, Nokia

# Annex (contact details for email discussions)

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