**3GPP TSG-RAN2 Meeting #112-e R2-20yxxxx**

**e-Meeting, xx-yy, 2020**

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

**Title: Agreeable details of RRC-based solution for SDT (RACH and CG)**

**Agenda item:** **xxxx**

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

# Introduction

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

* [Post111-e][925][R17 Small Data] Agreeable details of RRC-based solution (RACH and CG) (ZTE)

Scope:

• Develop further understanding of detailed steps for the RRC-based solution for both CG and RACH based schemes (e.g. contents of the first UL message, security aspects, and subsequent network and UE procedure etc).

• Identify any impacts to other WGs (e.g. RAN1)

Outcome: Report, Agreeable proposals and identified impacts to other groups

Deadline: Long

**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:

**Tuesday Oct 13th 0700 UTC**

# Overall procedure for RRC-based small data transmission

## UE procedure upon moving to INACTIVE

Currently when the UE moves to INACTIVE state, the following are performed:

1. MAC is reset and default MAC cell group configuration is released
2. RLC entities for SRB1 are reestablished
3. All SRBs and DRBs are suspended, except SRB0

First question is whether any changes are needed for any of the above procedures to support SDT. Since some changes are expected for CG (e.g. handling of TAT timer and MAC configuration etc) compared to RACH, discussion for RACH and is separated for this issue:

|  |
| --- |
| **Q 2.1.1: For small data, for RACH based solutions (i.e. 2-step and 4-step RACH based SDT configured but no CG) are there any changes needed to the current procedure when UE moves to INACTIVE state?** **i.e. can the UE perform the following actions*** **MAC reset and default MAC cell group released**
* **RLC entities for SRB1 reestablished**
* **SRBs and DRBs are suspended except SR0**

**If any changes are needed for any of the above procedure, please elaborate.** **Note: The goal of this question is to identify what aspects can be kept as it is and which aspects need updates and further discussion.**  |
| **Company** | **Views: e.g.: All can be reused/Some changes needed (explanation)** | **Rapporteur summary** |
| ZTE | Yes, all can be reused for RACH-based solution Note that when CG resources are also configured, then the UE doesn’t know whether the CG resources will be valid or not when the RESUME is to be initiated (e.g. there may have been a cell change in the meanwhile etc). So, if CG resources are configured then may be some changes are needed (e.g. the UE may keep some of the MAC context – specifically something related to TAT and the CG specific MAC configuration). Apart from that the rest can be reused. The CG specific aspects can be discussed as part of the question below.  |  |
| Mediatek | Yes, all the above actions can be reused for RACH-based solution.  |  |
| OPPO | Yes, above three actions can be reused as baseline for RACH-based SDT solutions. For the second action, RLC entity for SRB1 is re-established and resumed for the reception of DL RRC message before moving into RRC\_CONNECTED. Considering that DRBs should be resumed in RRC\_INACTIVE for SDT, we are wondering whether the RLC entities for DRBs should also be re-established. |  |
|  |  |  |

|  |
| --- |
| **Q 2.1.2: For small data, when CG based SDT resources are configured are there any changes needed to the current procedure when UE moves to INACTIVE state?** **Specifically, are there any changes needed for the following existing procedures:** * **MAC reset and default MAC cell group released (please comment on handling of TAT – e.g. whether the current TAT can be run in INACTIVE state or a new timer is needed and whether some MAC configuration specific to CG will need to be stored etc)**
* **RLC entities for SRB1 reestablished**
* **SRBs and DRBs are suspended except SR0**

**If any changes are needed for any of the above procedure, please elaborate.** **Note: The goal of this question is to identify what aspects can be kept as it is and which aspects need updates and further discussion.**  |
| **Company** | **Views: e.g.: All can be reused/Some changes needed (explanation)** | **Rapporteur summary** |
| ZTE | When MAC is reset, the TAT timer is stopped. However, for CG solution, some timer is needed to ensure the TA alignment at the UE is monitored during INACTIVE state. We think we can reuse the existing TAT for this. So, some changes are needed for MAC Reset for this case. Apart from this, we think the rest can be reused. With regards to the CG configuration, we think this can be stored as part of the INACTIVE state context in the UE.  |  |
| Mediatek | For UL time alignment in INACTIVE to enable CG based SDT transmission, there are two solutions:1. Use current TAT: since current TAT only works in CONNECTED, the current UL time alignment mechanism needs to be modified to cover the INACTIVE state.
2. Introduce a new timer specific for CG based SDT transmission: the current TAT mechanism for CONNECTED will not be impacted. This timer is started when CG resources are configured and stopped when CG resources are released. UE restarts the timer when a TA command/adjustment is received.

In our understanding, both solutions can work. But we prefer option 2 to introduce a new TA timer specific for CG based SDT for sake of clear function and clean specification. UE also needs to store the CG-related configurations as part of the UE INACTIVE AS Context to enable CG-based SDT transmission later in INACTIVE. The detailed CG configuration can be discussed in stage-3. The above procedures can be reused expect for MAC reset. The MAC reset needs to be changed that it keeps running and is not stopped when MAC is reset.  |  |
| OPPO | Firstly, we agree that above actions can also be reused for CG based SDT solution.For the timer maintained during UE in RRC\_INACTIVE, we think either keeping the current TAT or introduce a new timer can work. Since the function has already been used in LTE PUR transmission, we prefer a new timer included in the CG configuration and keep the actions when MAC is reset as legacy.  |  |
|  |  |  |

## UE procedure upon initiating small data transmission

Currently, the NAS will provide an access category and resume cause is obtained. Based on this, the UE performs UAC procedure. The question is whether this procedure can be reused for small data transmission as well.

|  |
| --- |
| **Q 2.2.1: For RACH and CG, can the existing UAC procedure, to determine whether access attempt is allowed, be reused for small data transmission?**  |
| **Company** | **Views: e.g.: Yes can be reused/Some changes needed (explanation)** | **Rapporteur summary** |
| ZTE | Yes, we think UAC shall be applicable (as normal) even for SDT and the existing UAC check shall be reused. For Resume cause, for data arrival, UE will determine the resume cause by interaction with NAS and this can be kept as it is. For non-data arrival cases (e.g. RNA Update), the resume cause is determined by AS and this can also be kept as it is.  |  |
| Mediatek | Yes, the existing UAC procedure can be reused for SDT in INACTIVE. For resume cause, we have slightly different opinions from ZTE. In last RAN2 meeting it is agreed that small data transmission is configured by the network on a per DRB basis, we assume that NAS layer doesn't need to indicate the intention to initiate SDT in INACTIVE when requesting the resume of a connection and AS decides to initiate SDT based on the DRB configuration. In other words, SDT can only be triggered for certain resume causes.  |  |
| OPPO | Yes. The UAC procedure can be reused. |  |
|  |  |  |

## Handling of user plane and contents of first UL message

At RAN2#111e, the following agreement was made:

Agreement: *Small data transmission is configured by the network on a per DRB basis*

Currently, the UE only re-establishes and resumes SRB1 upon initiating Resume procedure. The DRBs are resumed only upon receiving the *RRCResume* message from the network. In case of small data, the intention is to also include user plane data in the first uplink message (i.e. before RRCResume is received by the UE). In order to be able to do this, the UE shall also re-establish and resume the DRBs which are subject to small data transmission per the agreement above. The following question is to confirm this understanding:

|  |
| --- |
| **Q 2.3.1: For both RACH and CG based solutions, upon initiating RESUME procedure, should the UE reestablish and resume the DRBs that are configured for small data transmission (along with the SRB1)?**  |
| **Company** | **Views: Yes (DRBs should also be resumed) / No (explain)** **Note: companies can also include any comments on changes (if any) to the PDCP suspend/resume operation**  | **Rapporteur summary** |
| ZTE | Yes, in general the DRBs configured for SDT shall be reestablished and resumed upon initiating the RESUME procedure (and even before receiving the RRCResume message). The data from these DRBs then can be submitted by PDCP to the MAC layer. However, some changes may be needed for the PDCP suspend/resume procedure: For the legacy PDCP suspend/resume procedure, the PDCP PDU stored for TX will be discarded, and TX\_NEXT, RX\_NEXT, RX\_DELIV will be set to initial value. Since the data transmission in INACTIVE state is allowed through SDT, the NW may push the UE to INACTIVE state even if some small data transmission is expected, to cover this scenario, we think the PDCP PDU stored for TX shall not be discarded and the varaibles shall not be reset. To achieve this, one simple solution is to perform DRB suspension without PDCP suspension, or only perform the t-Reordering related operation in PDCP resume for SDT. |  |
| Mediatek | Yes, DRBs should be resumed. But definitely, there are some necessary changes to current resume procedures. CP: In current resume procedure, DRBs are resumed (together with SRB2, SRB3 if configured) when RRCResume message is received. For SDT, only DRBs configured with SDT should be resumed together with SRB1when RRCResumeRequest message is to be transmitted. UP: we think current PDCP suspend procedure can be reused without change. For the scenario described by ZTE, we are not sure whether it’s a typical or particular network implementation. In our understanding, if some small data transmission is expected when UE in CONNECTED and the PDCP PDUs have already been stored in UE buffer, the network should keep the UE in CONNECTED mode and send to UE to INACTIVE after the transmission of the small data burst is completed. Then UE can initiate SDT later for the following bursts of UL data transmission in INACTIVE. In this case, UE suspends the DRBs and suspends PDCP when it is sent to INACTIVE state by RRCRelease message with suspendConfig. UE resumes DRBs when SDT in INACTIVE is initiated.  |  |
| OPPO | Yes, UE should at least resume the DRBs subjecting to SDT when the procedure is initiated. In addition, we should further discuss whether it is allowed to trigger SDT when data is available for both SDT allowed DRBs and not allowed DRBs, in which case the SDT is triggered for SDT allowed DRBs. If SDT is still supported in this case, we think all DRBs should be resumed for buffer status reporting. |  |
|  |  |  |

Currently, the first UL message will contain only the CCCH message in case of the legacy resume procedure. Assuming both SRB0 and DRBs are resumed for small data transmission per the above discussion, MAC will submit UL DRB data along with the CCCH data. In addition, MAC may also generate any MAC CEs (e.g. BSR) depending on the size of the available resources. Based on this, the following is discussed:

|  |
| --- |
| **Q 2.3.2: Do companies agree that the first UL message (i.e. MSG3 for 4-step RACH, MSGA payload for 2-step RACH and the CG transmission for CG) may contain the following contents (depending on the size of the message):*** **CCCH message (i.e. RRCResumeRequest)**
* **DRB data from one or more DRBs which are configured by the network for small data transmission**
* **MAC CEs (e.g. BSR)**
 |
| **Company** | **Views: Yes / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, once the DRBs are resumed per Q 2.3.1 above, the multiplexing and assembly unit in MAC will collect the data and assemble the MAC PDU per the existing rules and priorities – i.e. no changes are foreseen for this. The contents of the first UL message may then comprise the CCCH/DRB/MAC CE(s) – again depending on the priorities and the payload size (i.e. size of the MSGA/MSG3 payload or the CG grant TB size).  |  |
| Mediatek | Yes, for RRC-based methods, the above elements can be contained in the first UL message subject to LCP procedure.  |  |
| OPPO | Yes. |  |
|  |  |  |

## Security framework

Currently, the UE uses the stored security context to generate the contents of *ResumeRequest* message and derives new security context (i.e. new keys) by using the NCC value received in the Release message. The question is whether this can be reused for both RACH and CG in case of RRC-based solution.

|  |
| --- |
| **Q 2.4.1: In case of RRC-based solution, for both RACH and CG based solutions, do companies agree that the contents of the RRCResumeRequest message (specifically the ResumeMAC-I) is generated using the stored security context – i.e same as Rel-16.**  |
| **Company** | **Yes / No (explain)** | **Rapporteur summary** |
| ZTE | Yes. This can be the same as legacy.  |  |
| Mediatek | Yes. For more clarification, UE should have NCC prior to initiate RRC-based SDT. The NCC should be provided to the UE by the previous RRCRelease message with suspendConfig which sent UE to INACTIVE. UL data in Msg3 is integrity protected and ciphered using newly derived key. Old integrity key is used to generate ResuemMAC-I.  |  |
| OPPO | Yes. |  |
|  |  |  |

Subsequently, the UE generates new keys using the stored security context and the NCC value received in the previous RRCRelease message and uses the new keys for the data transmission which happens after the reception of RRCResume message. However, in case of small data transmission, the DRB data may already be included in the first UL message per the discussion above. So, the question is whether the new keys can be generated and used for the data that is included in the first UL message.

|  |
| --- |
| **Q 2.4.2: For both RACH and CG based solutions, do companies agree that new keys are generated using the stored security context and the NCC value received in the previous RRCRelease message (i.e. same as legacy procedure) and these new keys are used for generating the data of DRBs that are configured for small data transmission.**  |
| **Company** | **Yes / No (explain)** | **Rapporteur summary** |
| ZTE | Yes. This can be the same as legacy.  |  |
| Mediatek  | Yes. Same comment as above question.  |  |
| OPPO | Yes |  |
|  |  |  |

## Subsequent data transmission

At RAN2#111-e, the following agreement was made:

*Agreement: When UE is in RRC\_INACTIVE, it should be possible to send multiple UL and DL packets as part of the same SDT mechanism and without transitioning to RRC\_CONNECTED on dedicated grant. FFS on details and whether any indication to network is needed.*

Currently, in case of RACH (i.e. 2-step and 4-step RACH), upon successful completion of the RACH procedure (i.e. contention resolution), the UE will be monitoring C-RNTI search space for subsequent scheduling messages (both in UL and DL). The network can hence transmit DL messages and schedule the UE for further UL transmissions using the C-RNTI based scheduling. The question whether this can be used to allow multiple UL/DL messages per the above agreement.

|  |
| --- |
| **Q 2.5.1: For RACH based solutions, do companies agree that upon successful completion of contention resolution, the UE shall monitor C-RNTI search space for further UL and DL scheduling from the network?**Note: the understanding is that with this approach, it is up to the network to whether to allow subsequent UL/DL messages or to send RRCResume message in DL (i.e. no further discussion is needed on this aspect). Companies can comment on this understanding too.  |
| **Company** | **Yes / No (if No, explain then how to enable the multiple UL and DL packets without moving to connected)** | **Rapporteur summary** |
| ZTE | Yes, the UE shall monitor the C-RNTI search space for further scheduling messages on the PDCCH:* In case of RACH, this is the usual procedure and needs no further changes
* In case of CG, some further discussion might be needed (see below)
 |  |
| Mediatek | Generally Yes. UE shall monitor PDCCH addressed to C-RNTI for subsequent data transmission for both DL and UL. In other words, UE relies on the dynamic scheduling to enable subsequent data transmission. However, it is FFS whether common search space or UE specific search base or both need to be monitored.  |  |
| OPPO | Yes, this can be one of the options to schedule the UL grant for subsequent transmission. We can also study the method to schedule the UL grant together with the contention resolution indication addressed by TC-RNTI or MsgB-RNTI. |  |
|  |  |  |

Then, for CG case, there is no need for contention resolution since the assumption is that dedicated resources are used in the same serving cell. It is worth confirming this understanding first.

|  |
| --- |
| **Q 2.5.2: In case of CG, do companies agree that there is no need for contention resolution since dedicated resources are used in the same serving cell – i.e. no cell change?** |
| **Company** | **Yes / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, there is no need for an explicit contention resolution step for CG since dedicated resources are used in the same serving cell.  |  |
| Mediatek | Absolutely yes.  |  |
| OPPO | Yes. |  |
|  |  |  |

Then, since same serving cell is used for CG, it is possible for the UE to be configured with a UE ID to be used for the new resume procedure. This could be same as the C-RNTI used in the previous RRC-Connection or some other UEID configured by the network (e.g. SDT-RNTI) etc. Companies are invited to comment on which UE ID the UE will monitor after sending the initial UL message on the configured CG resources.

|  |
| --- |
| **Q 2.5.3: For CG based solution, do companies agree that after transmitting the first UL message on the CG resource, the UE shall monitor a configured UE RNTI? If yes, which RNTI is this (options are: old C-RNTI, some other RNTI configured by the network – such as SDT-RNTI, other options – please elaborate)** |
| **Company** | **Yes, UE shall monitor an RNTI – clarify which RNTI / No explanation** | **Rapporteur summary** |
| ZTE | Yes, the UE shall monitor a UE specific RNTI. We think this can be the same as the C-RNTI used in the previous RRC Connection, which will be stored in UE Inactive AS context anyway for the calculation of Resume MAC-I. Since the CG resources are assumed to be valid only in the same serving cell, as long as the CG resources are valid, the C-RNTI of the UE can also be considered to be valid in the cell.  |  |
| Mediatek | We think C-RNTI can be used.  |  |
| OPPO | Yes, UE shall monitor an RNTI for the response of the transmitted UL message and/or the UL grant for subsequent transmission. We prefer C-RNTI. |  |
|  |  |  |

# Other aspects with potential impact to other WGs

## Resource configuration

For RACH based solution, a few companies mentioned that separate RACH resources can be configured for SDT. The question is whether both separate and shared RACH resources are allowed for SDT and if so, how to distinguish MSG2/MSGB for SDT from normal legacy MSG2/MSGB. The overall design here may impact RAN1 and hence it is worth having an initial discussion on this earlier so as to trigger the necessary investigations in RAN1 if any.

|  |
| --- |
| **Q 3.1.1: For RACH based solution, do companies agree that the following options should be allowed for SDT*** **Shared RACH resources between SDT and non-SDT**
* **Separate RACH resources between SDT and non-SDT**
 |
| **Company** | **Yes, both should be allowed / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, both options should be allowed |  |
| Mediatek  | I think from UE aspect, a particular RACH resources for SDT should be configured. But from network aspect, those RACH resources can be shared or separate resources from non-SDT.  |  |
| OPPO | Yes, we think both the two options can work. From the network configuration perspective, considering that the preambles have been partitioned into multiple components due to the introduction of 2-step RACH, we think the second option is more feasible. |  |
|  |  |  |

|  |
| --- |
| **Q 3.1.2: Do companies agree that the MSG2/MSGB for SDT needs to be distinguished from the normal MSG2/MSGB? If the answer is yes, please also explain how to distinguish this (e.g. separate RNTI, Corset and/or search space etc)** |
| **Company** | **Yes, MSG2 and MSGB should be distinguished from legacy (explain how) / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, If separate RACH resource pool for SDT and non-SDT is allowed, then some ambiguity may exist in the MSG2/MSGB for different RA resource pool, since the same RA-RNTI/RAP-ID may be used in the two separate resource pool. To solve this issue, the following alternatives can be considered:Alt1: RA-RNTI based solution (e.g. a special RA-RNTI can be used to indicate the MSG2/MSGB for SDT, and more information can be included in MAC RAR to identify UE)Alt2: Separate SearchSpace/CORESET (needs RAN1 input)For the two alternatives above, we think alternative 2 is more straightforward. Also considering one of the intention to allow the configuration of separate RA resource pool for SDT is to avoid the congestion on non-SDT RA resource, having a separate SearchSpace/CORESET can be used to avoid the congestion on the legacy RA SearchSpace/CORESET.Therefore, we prefer to have separate SearchSpace/CORESET from RAN2 perspective, and ask RAN1 to confirm the feasibility |  |
| Mediatek | Yes. From RAN2 aspect, MSG2/MSGB for SDT needs to be distinguished from the normal MSG2/MSGB. The above mentioned methods through separate RNTI or separate COREST/search space are workable and need to be evaluated by RAN1.  |  |
| OPPO | No, this issue also exists in CFRA and CBRA. We think the ambiguity can be avoided depending on network configuration.  |  |
|  |  |  |

## Cell reselection and failure handling

Currently, RLM and beam failure detection are not applicable before *RRCResume* is received and UE relies on T319 for detecting failures. The first question is whether the T319 is to be extended to support SDT and the subsequent question then is whether we can rely on the T319 for detecting SDT failure.

|  |
| --- |
| **Q 3.2.1: Do companies agree that T319 should be extended to support SDT and if yes, by how much** |
| **Company** | **Yes (provide value range) / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, T319 should be extended. We think the range should be enough to cover typical round trip time for the upper layer ack messages if any. This is important to avoid a subsequent paging to deliver the response messages in the opposite direction. In case of LTE and NB-IoT, the timer is extended to take also into account the massive repetitions used on the air interface. Given this is not the target of this WI, we think the extended T319 just needs to be in the order of a few seconds (we propose 10 sec)  |  |
| Mediatek | Yes. T319 needs to be extended. But considering the diverse cases considered for SDT, we can have several values, which can be configurable.  |  |
| OPPO | No. Considering the backward compatibility, we prefer to introduce a new timer other than extending T319. If T319 is extended, legacy UEs have to keep monitoring PDCCH for a long time, which is power consumption. We can introduce a new timer which has the same function as T319 but with longer value for SDT.Since the transmission times and the scheduled uplink grant are up to network, it is difficult to determine a suitable timer value to guarantee that the subsequent transmissions can be completed within the timer. Another solution it that T319 can be restarted when UL for new transmission is received or a new UL is transmitted, in which way we can keep the value of T319 as it is.  |  |
|  |  |  |

|  |
| --- |
| **Q 3.2.2: Do companies agree that we can rely on T319 expiry for failure handling and no need to have RLM/beam failure detection during STD?** |
| **Company** | **Yes (we can rely on T319) / No (explain)** | **Rapporteur summary** |
| ZTE | Yes, we think this is sufficient.  |  |
| Mediatek | It depends on how the subsequent data transmission is designed. If subsequent data transmission requires certain measurement, it’s possible to have RLM. But we agree that we should not have complicated and power consuming measurement for data transmission in INACTIVE.  |  |
| OPPO | Yes. Since the procedure is for RRC\_INACTIVE UEs, we prefer to keep it in a simple way. |  |
|  |  |  |

Finally, currently cell reselection is possible while T319 is running. If this happens, UE moves to IDLE mode. The question is whether the same approach can be adopted with SDT (in which case there will be potentially data loss) or if some optimisation is needed to avoid data loss in this case.

|  |
| --- |
| **Q 3.2.3: How to handle cell reselection during T319 for the case of SDT****Option 1: No optimizations (UE moves to IDLE mode) this will result in data loss and it is up to higher layers in the UE to recover the lost data****Option 2: RAN2 will define solutions to potentially recover the lost data (companies can provide basic details of the mechanisms)** |
| **Company** |  **Option 1 / Option 2 with comments** | **Rapporteur summary** |
| ZTE | In general, option 2 will enable SDT to be used for more services and hence we think RAN2 should consider option 2. If option 2 is to be pursued, the following basic design can be used: * When cell reselection happens during SDT, the UE Remains in INACTIVE state and suspends all the DRBs
* After selecting the new cell, UE initiates PDCP level retransmission for the unacknowledged PDCP PDUs
* Further discussion however is needed on how to handle the security context in this case:
	+ Depending on when the cell reselection happens, we need to discuss and decide whether the new security keys are generated based on the stored security context (i.e. security context in the UE’s INACTIVE context) or whether the new keys are generated after replacing the keys in the stored security context.
	+ The other option is to use Reestablishment procedure to recover the security context and then proceed with UP recovery. Again, details need to be further discussed in RAN2.
 |  |
| Mediatek | Option1 is the baseline. We assume that SDT in INACTIVE will not endure a long time and the probability of cell reselection should be low. Option 2 is a minor optimization but has lots of impacts/changes/complexity at both UE side and network side.  |  |
| OPPO | Option1. It up to UE implementation to avoid data loss. |  |
|  |  |  |

# Conclusion and proposals

TBD

# 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

# Annex (contact details for email discussions)

|  |  |  |
| --- | --- | --- |
| Company | Contact name | Contact email |
| Mediatek | Yuanyuan Zhang | Yuany.zhang@mediatek.com |