**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:

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| **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 SRB0**

**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. |  |
| LG | We think DRB suspension needs more discussion. When a DRB is suspended, PDCP status variables are initialized. However, such initialization may not be needed for SDT.In addition, BSR configuration used for RRC\_INACTIVE needs more discussion because the default MAC cell group configuration includes BSR configuration. |  |
| CMCC | All the above three actions can be reused. If BSR or another MAC CE can be included in MSGA or MSG3, some configuration, e.g. Logical channel group, should not be released when perform RRC suspend. |  |
| Sharp | Yes, all the above actions can be reused as baseline for RA based SDT. |  |
| CATT | All can be reused. We don’t see a need for changing the behavior for the UE moving to INACTIVE state because of introduction of small data transmission (RACH based) in INACTIVE state. |  |
| ITRI | Yes, all above actions could be reuse as baseline for the RACH-based solution. |  |
| Huawei, HiSilicon | All can be reused but it should be “release default MAC Cell group configuration” |  |
| Nokia, Nokia Shanghai Bell | Yes. |  |
| Ericsson | Yes, as baseline |  |
| Qualcomm | Yes, current procedure of moving to RRC\_INACTIVE can be reused for RACH based schemes. |  |
| Panasonic | Yes, the above actions can be reused as the baseline for the RACH based schemes.  |  |

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| **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 SRB0**

**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.  |  |
| LG | For CG transmission, a new TAT is needed. We think the new TAT is similar to the legacy TAT, but is only used in RRC\_INACTIVE. Detailed behavior of the new TAT needs more discussion.For DRB suspension and BSR configuration, see our comments in Q2.1.1. |  |
| CMCC | MAC entity cannot be totally reset，CG relative configuration should be retained or partially retained. TA value should be reused for small data transmission and current TAT can be reset. We are fine to introduce a new timer for CG based SDT. |  |
| Sharp  | The above actions can be reused for CG based SDT and for the timing alignment, a new timer as clarified by Mediatek is preferred to avoid the impact on current TA timer. |  |
| CATT | We would like that the SDT solution should have minimum impact to the existing functionality and procedures. Therefore we think having a new TA timer is better for SDT. A new timer, pur-TimeAlignmentTimer is defined to maintain TAT in LTE. We could follow the same approach for SDT in NR. We agree that the above exiting procedure to be reused while moving to INACTIVE state.  |  |
| ITRI | All above actions could be reuse as baseline for the CG based solution.Regarding to whether a new TAT is needed, we think introducing a new TAT similar will help make the functionality clearer. Therefore, we prefer a new timer be introduced for the TA validity purposes. |  |
| Huawei, HiSilicon | All can be reused as baseline. For TAT, we prefer to have a new timer to follow the design in PUR. |  |
| Nokia, Nokia Shanghai Bell | Yes. TA maintenance and CG configuration in INACTIVE mode needs to be additionally specified. |  |
| Ericsson | Yes, changes are needed but should be based on legacy. I.e changes to TAT and how to retain a CG configuration based on existing functionality and use. |  |
| Qualcomm | A new TA timer should be introduced for CG based solution. CG configuration should be stored in RRC\_INACTIVE state, hence some changes are needed for MAC reset. |  |
| Panasonic | Some changes are required, especially for the TA maintenance and the validity control for the CG configuration after UE moving to RRC\_INACTIVE.  |  |

## 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.

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| **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. |  |
| LG | SDT is different from RRC Resume. The purpose of SDT is data transmission, not resuming RRC connection. Thus, we think UAC is not applicable to SDT. Similarly, Resume cause is not applicable to SDT. |  |
| CMCC | Yes，the UAC mechanism can be reused. |  |
| Sharp | Yes, the UAC could be reused. |  |
| CATT | Yes, we think the existing UAC procedure can be reused for small data transmission.  |  |
| ITRI | Yes, the UAC should also be applied for SDT in INACTIVE and the current UAC procedure could be reused for SDT. |  |
| Huawei, HiSilicon | Yes, but agree with MTK and LG that the cause of mo-data may not be applicable anymore. The old gNB should be able to know that the context retrieval is due to small data transmission |  |
| Nokia, Nokia Shanghai Bell | UAC is normally applicable for access attempts with SDT. However, there should be a mechanism for the NW to block the SDT specifically. |  |
| Ericsson | Support for UAC should be possible, and then reused as in legacy.  |  |
| Qualcomm | Yes. Regarding the resume cause, share the same view with MTK. |  |
| Panasonic | Yes, the existing UAC mechanism should 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:

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| **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. |  |
| LG | The question is not correct. The SDT procedure is not the Resume procedure.However, DRB re-establishment is needed to change the security key. |  |
| CMCC | UE remains work in RRC\_inactived state after small data transmission. Network will not transimit RRCResume message to UE, even if there are subsequence data packets. If the DRB that are configured for small data transmission is resumed, relative DRB release procedure or timer to trigger DRB release is needed, which may increase complexity and against to the original intention of SDT. |  |
| Sharp | Yes, at least the DRBs configured for SDT should be resumed.For the PDCP resumption, if duplication is configured, it should be deactivated in SDT. |  |
| CATT | Yes, at least the DRBs configured for SDT should be resumed upon initiating RESUME procedure for SDT. Whether to resume all DRBs (including DRBs not configured with SDT) should be discussed. How to handle data arrival of DRBs (including SDT DRBs and non-SDT DRBs) during the small data transmission should be discussed. We don’t see the scenario proposed by ZTE is a typical scenario for SDT. If there is data still available for transmission, there is no benefit of the NW sending the UE to INACTIVE. We don’t see a great benefit on keeping PDCP variables. The current PDCP procedure without changes can be reused. Also we prefer minimum change=s on the legacy procedure due introduction of SDT in INACTIVE state.  |  |
| ITRI | Yes, but only for the DRBs configured with SDT should be resumed during the SDT procedure. |  |
| Huawei, HiSilicon | Yes, but not sure why re-establish DRB. The UE simply resume DRBs that are used for SDT |  |
| Nokia, Nokia Shanghai Bell | Yes, we share the views with Mediatek. |  |
| Ericsson | Similarly to other companies, DRBs configured for SDT should be resumed. The details here need to be discussed further. |  |
| Qualcomm | Yes. We share the same views with MTK. If there are still some data stored in the UE buffer, network should keep the UE in the RRC\_CONNECTED state and transit UE to RRC\_INACTIVE state after the user data transmission is finished. The legacy PDCP suspend/resume procedure does not need to be changed. |  |
| Panasonic | Yes, but only the DRBs associated with SDT shall be resumed. The details on how the association is created need further discussion.  |  |

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:

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| **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)**
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| **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. |  |
| LG | RAN2 didn’t agree that CCCH message is RRCResumeRequest message. Some elements of RRCResumeRequest message may need to be included, e.g. I-RNTI and shortMAC-I, but the CCCH message may be different from the RRCResumeRequest message. Whether to reuse RRCResumeRequest message needs more discussion.For DRB data, we are not sure whether multiplexing of multiple DRBs should be allowed considering the limited size of UL grant. Moreover, we are not sure whether it is ok to include DRB data in the first UL message considering the potential loss due to the collision. It also needs more discussion. |  |
| CMCC | CCCH message is needed at least for RRC-involved SDT;MAC CE can be include in the first UL message, however, more discussion on MAC CE transmission restriction is needed, e.g., data priority is higher than MAC CE. |  |
| Sharp | Yes |  |
| CATT | CCCH message is transmitted in the MSGA/MSG3 as usual. Depending on the size of the message and the detail of the solution, it would also be possible to transmit UL data from one or more DRB and MAC CE (assistance information). However the details of DRB multiplexing, MAC CE and prioritization should be further discussed.  |  |
| ITRI | Yes, the above contents can be contained in the first UL message for SDT. |  |
| Huawei, HiSilicon | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes. It needs to be discussed whether the CCCH message contains *RRCResumeRequest* or a new RRC message defined for SDT. |  |
| Ericsson | Yes. The contents of the CCCH message should be discussed. For multiplexing DRBs, we think a baseline is to include also data for only DRB configured for SDT and MAC CE.  |  |
| Qualcomm | Yes. At least the above contents can be contained in the first UL message. But it should not exclude any other UE assisted information such as traffic pattern information that could be included in CCCH message together with *RRCResumeRequest* in a new RRC message or included in new MAC CE together with Buffer Status information. |  |
| Panasonic | Yes, the above should be the baseline. Additionally, UE assistance information indicating the traffic patterns or UE’s preferred RRC state can be contained as well. This is for the case where UE may have frequent UL small data that will not be accumulated at UE’s buffer. In such case, something other than the BSR can be sent to gNB, so that gNB can configure dedicated resources accordingly or even ask UE to transition to RRC\_CONNECTED. |  |

## 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.

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| **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. |  |
| LG | For UE authentication purpose, ResumeMAC-I is needed. However, it is not correct to say that the RRC message is the RRCResumerequest message. |  |
| CMCC | Yes. |  |
| Sharp | Yes |  |
| CATT | Yes. The legacy procedure should be used. |  |
| ITRI | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes |  |
| Ericsson | Yes |  |
| Qualcomm | Yes. The legacy can be reused. |  |
| Panasonic | 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.

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| **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 |  |
| LG | New key should be used for SDT. The issue is whether the new key is used for all SDT or the new key is generated each time SDT is performed. |  |
| CMCC | Yes. |  |
| Sharp | Yes |  |
| CATT | Yes, legacy procedure can be used in key generation. We wonder how this applies to subsequent data transmission. Whether the same procedure with new key generation to be used for every UL SDT.  |  |
| ITRI | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Nokia, Nokia Shanghai Bell | Yes. The new keys are used for the ResumeMAC-I generation as well as ciphering of the SDT data. |  |
| Ericsson | Yes |  |
| Qualcomm | Yes. |  |
| Panasonic | 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.

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| **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)
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| 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. |  |
| LG | For the UE to monitor PDCCH after SDT transmission, the network may need to send an indication to the UE. We think a new RNTI, e.g. SDT-RNTI is needed for SDT in RRC\_INACTIVE. |  |
| CMCC | Whether move to RRC\_connected state is under network control. If network response SDT with contention resolution, UE transfers to RRC\_connnected and monitor C-RNTI; if no contention resolution is received from network, UE remains in RRC\_inactived.  |  |
| Sharp | Yes |  |
| CATT | Generally Yes that C-RNTI can be used to address the UE, if dynamic grant is given for subsequent data transmission. According to on the current spec, the UE is allowed to monitor the C-RNTI on common search space upon successful completion of contention resolution. However, common search space may be limited when the number of UEs for subsequent small data transmission is high. |  |
| ITRI | Yes. For RACH based solutions, UE monitors C-RNTI search space for subsequent transmission could be one of the option. |  |
| Huawei, HiSilicon | First of all, not clear what does it mean by C\_RNTI search space and not sure if the search space ue-specific search space or common search space?We are generally fine with the dynamic grant approach for the subsequent UL with RA-based scheme, since TA does not need to be requested again. |  |
| Nokia, Nokia Shanghai Bell | Yes, the UE monitors C-RNTI. Up to RAN1 which search space the UE monitors its C-RNTI. |  |
| Ericsson | Yes. Not sure a new RNTI is needed. |  |
| Qualcomm | The question is unclear on whether asking the C-RNTI or search space. UE may monitor the PDCCH addressed by C-RNTI for the further DL/UL dynamic scheduling from the network. But for the search space, it depends on network configures what kind of search space (common or UE-specific) for PDCCH monitoring and we think it needs more discussion. This part has RAN1 impact.In addition, it is not enough for UE to rely on dynamic scheduling only for subsequent data transmission. For example, UE may send the first object as small data, and its buffer becomes empty. But once network returns its ACK, UE’s application layer may generate another object to send. Hence the dynamic scheduling can only handle the one shot-traffic rather than the small data traffic with gaps in between. We think other solutions for subsequent small data transfer should also be studied, i.e. using Configured Grant resource to transmit subsequent small data after RACH. |  |
| Panasonic | Yes, UE shall monitor C-RNTI for receiving the dynamic grants from gNB to enable the subsequent data transmission. How long UE needs to keep monitoring C-RNTI and the relevant timer (T319 or other timer) will have specification impact and therefore need further discussion. Another way to enable the subsequent data transmission is to rely on the CG resources that are configured after the RACH-Based SDT, which should be also supported. |  |

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.

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| **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. |  |
| LG | RAN2 didn’t agree that the CG is dedicated resource. If the CG is shared resource, contention resolution is needed. |  |
| CMCC | Yes. |  |
| Sharp | Yes |  |
| CATT | Yes |  |
| ITRI | We share the same view as LG that whether the CG resources are dedicated resource should be discussed first. |  |
| Huawei, HiSilicon | No, We think the resource can be shared between time/frequency/DMRS port, like what we had for configured grant in R15. Although UE use dedicated signalling to configure CG resource for the UE, while for different UEs, whether time/frequency/DMRS port is different or the same is up to network implementation. Even though no contention resolution is needed, some ACK for data should be considered. |  |
| Nokia, Nokia Shanghai Bell | There is no need for contention resolution if the UE has dedicated resources. But it needs to be discussed if the CG is allowed in a single cell case only or also in multi-cell case and whether the possibility is to provide only dedicated CG resources or also common resources are possible. |  |
| Ericsson | This should be pending the discussion on if dedicated CG resources are available.  |  |
| Qualcomm | We should first discuss whether configured CG resource solution is dedicated for UE or not. If it is dedicated, contention resolution is not needed.  |  |
| Panasonic | 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.

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| **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. |  |
| LG | It has to be discussed first whether the subsequent data transmission after CG transmission is performed using CG or DG. If the subsequent data transmission uses CG, then PDCCH monitoring is not needed.However, if the subsequent data transmission uses DG, then PDCCH monitoring is needed. For the UE to monitor PDCCH after SDT transmission, the network may need to send an indication to the UE. For PDCCH monitoring, we think a new RNTI, e.g. SDT-RNTI is needed. |  |
| CMCC | For CG based solution, no serving cell change is common understanding. The C-RNTI is valid. UE can monitor C-RNTI for subsequent downlink data in a period of time (a timer). UE stop monitoring C-RNTI and moves to RRC\_inactive after the above timer expired.  |  |
| Sharp | Yes, a UE shall monitor an RNTI for retransmission and new transmission. A new RNTI, e.g. SDT-RNTI is preferred. |  |
| CATT | In CG, the UE stays in the same cell, hence C-RNTI of the previous RRC connection can be used to address the UE from RAN2 point of view. However, it needs to discuss detail of subsequent data transmission solution when using CG. Is that dynamic grant is used for subsequent data transmission?Also PUR-RNTI is introduced for PUR based on a request from RAN1. It would be good to check whether there are lower layer implications for use of C-RNTI.  |  |
| ITRI | We share the same view as LG, that we should discuss first whether subsequent data transmission after CG transmission is performed by using CG or DG.In using CG for subsequent data transmission case, UE may not need to monitor a configured UE RNTI for subsequent data transmission.In using DG for subsequent data transmission case, UE will need to monitor a configured UE RNTI. In this case, we prefer using a new configured UE RNTI. |  |
| Huawei, HiSilicon | Yes. We prefer to follow the legacy PUR approach to have a new RNTI for monitoring. the old C-RNTI is only used for shortMAC-I derivation and not used for PDCCH monitoring. it can be allocated by the NW to the other UEs. |  |
| Nokia, Nokia Shanghai Bell | UE needs to monitor some RNTI, e.g., for NW response. It seems unnecessary to restrict to C-RNTI at this stage, especially, since it has not been agreed whether the CG based solution works within one cell or multiple cells. |  |
| Ericsson | The details and support of subsequent SDT transmission needs to be progressed more, and if procedures differ between CG and DG. It is not clear if a “new” RNTI is needed. |  |
| Qualcomm | We prefer a new RNTI monitoring for network response. |  |
| Panasonic | For CG based solution, it is assumed that UE shall still stay in the same cell. Therefore C-RNTI can be reused as long as both gNB and UE have not released the 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.

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| **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**
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| **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. |  |
| LG | Shared RACH resource is default, and separate RACH resource should also be allowed. In addition, we think separate BWP needs to be considered considering that SDT requires larger bandwidth than legacy RA procedure. |  |
| CMCC | Both optional configurations are ok.For 2-step, MSGA size for SDT is different from legacy 2-step RACH. We slightly prefer separate RACH resource configuration between SDT and non-SDT for 2-step RA. |  |
| Sharp | At least separate RACH resources between SDT and non-SDT could be support.For shared RACH resources between SDT and non-SDT, RAN1’s feedback may be necessary. |  |
| CATT | From UE perspective, separated RACH resources for SDT should be considered. In this way, the network can distinguish SDT UEs and send the UL grant accordingly. |  |
| ITRI | We prefer that particular RACH resource for SDT. |  |
| Huawei, HiSilicon | RACH occasion can be both separated or shared. But RACH resource in terms of time/frequency/code should be separated between SDT and non-SDT. |  |
| Nokia, Nokia Shanghai Bell | We are unsure what does the “shared RACH resource” specifically mean, ie., whether it is just same RO with separate preambles between SDT and non-SDT. |  |
| Ericsson | This should be up to NW configuration and supported as baseline. We understand the term “shared resources” similar to what was discussed for 2-step/4-step RA with for example same RO etc. |  |
| Qualcomm | The separate RACH resources between SDT and non-SDT should be supported. |  |
| Panasonic | We think both options should be supported and it is up to network to choose which option.  |  |

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| **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.  |  |
| LG | Yes. We think separate BWP needs to be considered, and ask RAN1 about the feasibility. |  |
| CMCC | Yes, MSG2 and MSGB should be distinguished from legacy. Separate RNTI is OK if RACH resource id separate between SDT and non-SDT.Whether Corset or search space can work is RAN1 issue. |  |
| Sharp | Yes, MSG2 and MSGB should be distinguished from legacy. For any possible solutions, RAN1’s feedback is necessary. |  |
| CATT | Yes. MSG2 and MSGB should be distinguished from legacy. solutions should be investigated by RAN1. |  |
| ITRI | First, we agree that the MSG2/MSGB for SDT needs to be distinguished from the normal MSG2/MSGB. However, how to avoid that could be resolved through network configuration. |  |
| Huawei, HiSilicon | We agree with the above company and think it is more suitable to let RAN1 to decide. Actually, in R16, for the 2-step RACH discussion, the decision was finalized by RAN1 |  |
| Nokia, Nokia Shanghai Bell | We are unsure why they would need to be distinguished. If separate RO is used for SDT and non-SDT, then the distinguishing happens by the RNTI. However, if same RO is used, seems the same MSG2/MSGB can be used by the NW to address the SDT and non-SDT responses – MSG2 can provide different size of grants for different UEs and MSGB already supports transmitting SDUs. |  |
| Ericsson | We share the same view as Nokia. Details need to be discussed to decide on what is needed. If necessary, then both a new RNTI set (e.g. offset) or separate Search Space/CORESET can be possible solutions. |  |
| Qualcomm | If the separate RO is used for SDT and non-SDT, the RA-RNTI can already be distinguished for the MSGB/Msg2 reception. For the separate SearchSpace/CORESET solution, it should be decided by RAN1. |  |
| Panasonic | No. Not sure what are the actual merits of having such separation. This also requires network to distinguish the preambles for SDT and non-SDT in the first place. |  |

## 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.

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| **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.  |  |
| LG | The SDT is different from the RRC Resume, and whether to reuse T319 for SDT needs more discussion. |  |
| Sharp | We share some view of OPPO. Extended T319 could impact legacy UE. A new timer could avoid this drawback. And if it is difficult to determine a suitable timer value considering subsequent transmissions, such a new timer could be restarted when new transmission is transmitted. |  |
| CATT | Whether T319 can be reused with extending the range should be further discussed. In any case, an extended timer would be required to count for subsequent small data transmission. The value of the timer depends on how we define subsequent data transmission.  |  |
| ITRI | No, we don’t prefer to extend T319. The current T319 value is workable for the “RNA update procedure with UE context relocation” case. In that case, UE context retrieve and network path switch will be performed. We are not sure whether any additional time will be needed for SDT case.Another aspect, if we configure an extended T319, the UE may keep monitoring PDCCH for a long time for resume failure case. The power consumption concern should be taken into account. |  |
| Huawei, HiSilicon | We prefer to have a new timer for SDT transmission. While for the value of the timer, we think the value should be extended than that of T319. IN addition to the normal caluculation we had for RNAU, for SDT, there is also time spent for waiting for the DL data from UPF. Hence, it is reasonable to extend the length of the timer compared to that of T319 |  |
| Nokia, Nokia Shanghai Bell | Due to the subsequent SDT transmissions the SDT session length is arbitrary, hence, it needs to be discussed whether the current functionality is suitable for SDT. |  |
| Ericsson | Since SDT is different from RRC Resume, it may be simpler for defining a new timer. This can be based on legacy handling cf. T319. |  |
| Qualcomm | Yes. T319 should be extended. The value can be configurable. |  |
| Panasonic | No, extending T319 will have negative impact to the legacy UEs, as well as to the new UEs intending to use the RRC resume procedure for non-SDT purposes. If we want to reuse T319 for SDT failure handling, we also need to consider the possible subsequent data transmissions. Restarting T319 upon each UL data transmission or upon each BSR transmission could be one option to extend the lifetime of C-RNTI. Another option is T319 is started/stopped as it is now, and a new timer is started/restarted upon each UL data transmission or upon each BSR transmission. UE keeps monitoring C-RNTI as long as either T319 or the new timer is still running. |  |

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| **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. |  |
| LG | The SDT is different from the RRC Resume, and whether to reuse T319 for SDT needs more discussion. |  |
| CMCC | Yes. T319 should to be extended. |  |
| Sharp | The failure handling in RRC layer is necessary, T319 or T319-like timer is ok. However, the failure detection in lower layer should also be considered if necessary, especially for subsequent data transmission. |  |
| CATT | We think this should be further studied based on the detail solution for subsequent data transmission.  |  |
| ITRI | We share the same view as Mediatek that it should depend on how the subsequent data transmission is designed. Therefore, whether to reuse T319 for SDT handling RLF and beam failure needs more discussion. |  |
| Huawei, HiSilicon | It is ok for us not to have RLM/beam failure detection during SDT. But does it mean we only rely on T319/New timer for the failure handling? how about the RLC counter for RLF? |  |
| Nokia, Nokia Shanghai Bell | Whether T319 is sufficient needs to be discussed. The beam validity should be taken into account at least for the CG based solution. |  |
| Ericsson | Needs some more discussion. |  |
| Qualcomm | It needs further study based on the solution of subsequent data transmission. |  |
| Panasonic | Yes, we think the failure handling based on T319 or T319-like timer is sufficient.  |  |

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.

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| **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. |  |
| LG | First, the SDT is different from the RRC Resume, and whether to reuse T319 for SDT needs more discussion.For cell reselection during SDT, we agree with Mediatek that the option 2 is minor optimization.  |  |
| CMCC | No optimization is baseline.  |  |
| Sharp | Option 1. |  |
| CATT | Option 1. Considering it is a corner case, we prefer to keep the procedure simple and leave it to higher layers in the UE to recover the lost data. |  |
| ITRI | We prefer option 2. If the cell reselection happens during SDT transmission, the inactive UE will enter idle mode in current procedure. If the SDT transmission causes anchor relocation, some additional signaling is needed to handle the inactive UE moving to idle mode event.A simple approach for the option 2 is taking the serving cell signal quality as a criteria related to whether triggers SDT. - If the serving cell signal quality is good enough, the cell reselection will not happen. Therefore, the inactive state UE could trigger SDT without considering cell reselection. - If the serving cell signal quality is not good enough, the cell reselection may happen soon. In this case, the inactive state UE may include an indicator within the SDT to inform network that the subsequent data transmission should be prevented due to the bad signal quality. |  |
| Huawei, HiSilicon | We prefer Option2. For RACH-based scheme, we have considered mobility even in the WI description that we considered for anchor relocation. Similarly here, we should also consider the scenario when the UE mobility during data transmission and data loss should be avoided somehow.  |  |
| Nokia, Nokia Shanghai Bell | Since the subsequent data can extend the SDT procedure arbitrarily, the cell reselection scenario seems to become more frequent than in legacy connection setup/resume procedures. Furthermore, multiple SDT data transmissions can be performed before the cell reselection happens which can lead to loss of quite much data. Hence, it seems desirable to consider options how the data loss could be avoided. |  |
| Ericsson | We are not sure cell reselection is such a common problem that it needs an optimized solution as in Opt 2. |  |
| Qualcomm | We prefer Option 1. |  |
| Panasonic | We prefer Option 2, as the likelihood of UE reselecting another cell will increase if the SDT procedure is prolonged due to the subsequent data transmissions. If it is a non-corner case, we think enhancements are required. |  |

# 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)

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