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

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

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

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

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

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

# Introduction

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

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

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

Output: Report, set of agreeable proposals

**Deadline for company comments:**

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

**Wed Jan 13th 0700 UTC**

**Discussion summary**

* TBD

# Discussion

## Details of RACH configuration for RA-SDT

The following agreement was reached at RAN2#112e:

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

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

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

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

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

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| **Q 2.1.1: For RA-SDT (i.e. 2-step and 4-step RACH) how many preamble groups shall be configured?**  **Option A: 2 (i.e. no change to the existing number)**  **Option B: more than 2 (specify how many with justification)** | | | |
| **Company** | **Option A/**  **Option B (number)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option A | We think option A is simple and sufficient. Given the fact that segmentation is possible for the data and also the fact that subsequent data transmission phase is enabled, we think optimizing the system for the packet size of the first UL packet is not really necessary. 2 different sizes for the first UL packet provides enough flexibility for the network to manage the overhead vs coverage implications for the first UL message. On top, there is also an additional threshold on the total size of the first UL packet that could be used for SDT, so, this provides the network with enough tools to configure the correct size for the first UL data packet and group A and group B can be reused without introducing a new preamble group for RA-SDT |  |
| Huawei, HiSilicon | Neither option | We do not have to introduce preamble groups for RA-SDT. We have already agreed that the RACH resource i.e. (RO+preamble combination) is different between SDT and non-SDT, so this is already sufficient for the network to differentiate legacy RA attempt from SDT RA attempt. Configuration of 2-step RA based SDT and 4-step RA based SDT should additionally include the maximum allowable TB size. In order to account for various payload sizes, we think the flexible TB size mechanism from EDT should be reused, i.e. if the payload is smaller than the maximum TBS, UE is allowed to use more robust MCS (as per network configuration as well). We should request RAN1 to work on the details of flexible TBS. |  |
| SONY | Neither option | Agree with Huawei, we should request RAN1 to work on the details of flexible TBS. |  |
| OPPO | None with comments | Just wondering, in the case of ROs for SDT and non SDT are different, in principle, there is no need to further partition the preambles? So, before we discuss how many preamble groups to be partitioned, do we need to confirm this is is ruled out? |  |
| Xiaomi | No strong preference | This could be left to the stage-3 discussion. Maybe this is not in the scope of RAN1, given that the preamble group A and B is defined in the MAC. |  |
| Fujitsu | Option A | The question may be unclear but the intention seems to be nothing special mechanism should be introduced for SDT i.e. reuse existing mechanism of preamble groups A and B for SDT. Then there is one remaining question. As ZTE mentions, in case when data size is larger than UL grant size in RAR/MSGB, SDT can rely on segmentation and subsequent transmissions. On the other hand, in case when data size is smaller than UL grant size in RAR/MSGB, the question is if the UE is allowed to use rubust MCS. However, whether this optimization is introduced should be left to RAN. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## Subsequent data transmission and indication

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

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| **Q 2.2.2: Do companies agree that for RA-SDT and CG-SDT during the subsequent data transmission if new data arrives (either for the SDT DRBs or for other DRBs), BSR shall be triggered, which will inturn trigger RACH when there are no UL resources?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | We think we can reuse the existing principles in this case and RACH should be triggered. MSG3 in this case should contain the BSR indicating the data for radio bearers that are not subject to SDT and based on this, the network can perform full RESUME. |  |
| Huawei, HiSilicon | No | We agree that BSR should be triggered when new SDT data arrives during SDT procedure. When non-SDT data arrives, the UE should directly trigger RACH procedure as only active DRBs are considered in the BSR. Also, in our understanding the question is about subsequent transmission and not about MSG3 trasmission. In case non-SDT is available before SDT procedure initiation, then the UE should directly trigger legacy RACH / RRC Resume procedure, so the situation decribed by ZTE would happen exteremely infrequently. |  |
| SONY | Yes | During the subsequent data transmission if new data arrives (either for the SDT DRBs or for other DRBs), BSR should be indicated to the network. |  |
| OPPO | Yes with some comments | Just want to confirm the intention of this question is to confirm whether UE follows the behavior of triggering a new RACH procedure when there is no available PUCCH resources for SR during SDT, i.e., when SDT data triggers BSR and further triggers SR, due to no PUCCH resources in RRC Inactive state, UE will just trigger RACH procedure following the principle in RRC Connected state.  If the above understanding is correct, we agree to resuse the same principle for the data from SDT DRBs.  Besides, in the question, it’s mentioned BSR shall be triggered “either for the SDT DRBs or for other DRBs”, However, we do not think it is desirable to use the BSR to indicate the data arrival from non-SDT DRBs. since in order to caluculate the BSR of non-SDT data, the corresponding DRBs need to be resumed. But considering that non-SDT data can not be transmitted until the UE goes into RRC\_CONNECTED, we think we can simply follow the way as legacy, that is to resume the non-SDT upon the reception or RRCResume. Therefore, we think more discussions on how to indicate the arrival of non-SDT are needed. |  |
| Xiaomi | Maybe Yes | This depends on whether the RA-SDT or CG-SDT is still considered as a RACH procedure. I guess the intention of the Question is also not to change the tigger conditions for BSR and SR. Then the current MAC procedure for the BSR transmission would trigger RACH if no UL resources are available. If the RA-SDT or CG-SDT is also considered as a type of RACH procedure, then it is up to the UE implementation whether to stop the on-going RACH or start a new RACH procedure according to the current MAC specification as quoted below.  NOTE 1: If a new Random Access procedure is triggered while another is already ongoing in the MAC entity, it is up to UE implementation whether to continue with the ongoing procedure or start with the new procedure (e.g. for SI request). |  |
| Fujitsu | Yes | Regacy BSR procedure should be reused as much as possible. There seems no need to have different BSR procedure for the SDT DRBs and the other DRBs. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## SDT vs non-SDT selection and switching

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

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

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

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

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| **Q 2.3.1: Do companies agree upon initiating SDT, the UE first performs carrier selection as per legacy procedure?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Since the correct UL carrier needs to be selected based on coverage, the carrier selection needs to happen before the other procedures. |  |
| Huawei, HiSilicon | Yes | UE should first select SUL or NUL as the SDT configuration for those will be different. |  |
| SONY | Yes |  |  |
| OPPO | Yes | It is critical for a SDT UE to work on a correct carrier for sake of efficient user data transmission. Besides, a new carrier selection RSRP threshold other than legacy should defined for SDT. |  |
| Xiaomi | Yes |  |  |
| Fujitsu | Yes |  |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

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

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

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| **Q 2.3.2: Do companies agree that If an SSB with SS-RSRP above a configured threshold with associated valid CG resource exists, the CG-SDT is chosen, otherwise UE proceeds to RACH procedure?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Our understanding is that if valid CG-SDT resources exist then they have to be selected (since these are provided dedicatedly to the UE). So, we think if an SSB with SS-RSRP above a configured threshold with associated valid CG resources exist then they should be chosen. Note that the validity criteria for the CG-SDT resources should be satisfied for this to be applicable and these criteria are being discussed separately in email discussion #550. |  |
| Huawei, HiSilicon | Yes for the intention, but please see comments | We agree with the intention, but there may be more conditions to check the validity of CG-SDT resource, e.g. TAT is running or some other TA validity criteria. Those are discussed in the other e-mail discussion dedicated to CG-based SDT. What we can agree to in this discussion is that whenether there is a valid CG resource for SDT, CG-based SDT is performed and otherwise the UE performs RACH-based SDT. |  |
| SONY | Yes |  |  |
| OPPO | Yes | Since CG resources are dedicatedly configured, CG-based SDT should be prioritized if there is valid CG resources associated with the chosen beam. |  |
| Xiaomi | Yes |  |  |
| Fujitsu | Yes |  |  |
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| **Comments Summary:** | | | |
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If CG-SDT is chosen, then the UE will proceed with CG-SDT, but if RA-SDT is chosen, then the UE needs to then continue with RACH procedure and select the RA-type (between 2-step and 4-step RA). For this purpose an RSRP threshold is used in legacy (Rel-16) procedure (i.e. the *msgA-RSRP-Threshold*). So, the next question is whether RACH type selection can be performed (i.e. between 2-step and 4-step RACH) using the legacy procedure.

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| **Q 2.3.3: Do companies agree that if RACH procedure is initiated for SDT, the UE first performs RACH type selection as in legacy (i.e. Rel-16)?** | | | |
| **Company** | **Yes/No (explain)** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Yes | Both 2-step and 4-step RACH may have SDT configured and hence the UE may select the appropriate RACH procedure based on the legacy RACH type selection mechanisms. |  |
| Huawei, HiSilicon | No | The RSRP threshold which is used for legacy 4-step or 2-step RACH selection is not suitable to choose SDT over 2-step RACH or 4-step RACH, because it is chosen based on the payload that is expected in legacy 2-step RA, i.e. RRC message only. To be able to send RRC message + user data using SDT, the UE should be in general in better radio conditions than in the case of legacy 2-step RA. At the same time, the payload to be sent over 2-step RA and 4-step RA with SDT will be the same, so RSRP based selection does not bring any benefit. Since the 2-step RA SDT is more resource efficient, it should be always chosen. In summary, we believe that it does not make sense for the network to configure both 2-step RA-SDT and 4-step RA-SDT simultaneously, so no selection between them is required. What we may consider is RSRP based selection between RA-SDT and legacy RA. |  |
| SONY | Yes | We think additional RSRP for the selection between RA-SDT and legacy RA is not needed, because:  For 4-step RACH, there is already a link adaptation where number of RBs and MCS are signalled by the network for message 3. Based on this, the link adaptation should work for providing *at least* the transmission of the CCCH message.  For 2-step RACH, RAN1 should design flexible payloads (TBS), may be upto 4, and a UE should be able to choose a right MCS based on radio channel condition. Based on this, the link adaptation should work for providing *at least* the transmission of the CCCH message.  Note that how to design a payload (i.e. flexible TBS) that can be transmitted at a gven radio condition is RAN1 issue. |  |
| OPPO | Yes | RSRP threshold should be the most essential selection criteria between different RACH type. Since larger amount of data is expected to be carried in MsgA payload than legacy 2-step RA, we need to further define an SDT-specific RSRP threshold for type selection. |  |
| Xiaomi | Maybe Yes | We should firstly ensure having a reliable RACH, then we can select whether to use SDT or normal RACH. Of course if both 2-step RACH and 4-step are reliable RACH (e.g. RSRP above a configured threshold as legacy), we could consider to select SDT or normal RACH before the RACH type selection. |  |
| Fujitsu | Yes | There should be no difference between RA procedure between Rel-16 and SDT. |  |
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| **Comments Summary:** | | | |
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After selecting the specific RACH type, the UE has to select the RACH resource. If RACH resources for SDT exist for the selected RACH type, then the question is whether a further RSRP criterion is needed for the UE to be able use the SDT RACH resources. There are two options possible:

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

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

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

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

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

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| **Q 2.3.4: Which option do companies prefer for RACH rsource selection after selecting the RACH type?**  **Option 1: A further RSRP threshold is configured to select between SDT and non-SDT RACH resources or**  **Option 2: There is no further RSRP threshold for selection between SDT and non-SDT RACH resources**  Please explain your choice with comments and justificaiton | | | |
| **Company** | **Option 1 /**  **Option 2** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option 2 | We think option 2 is sufficient. The only implication of the option 2 is that the MSG3/MSGA size allows at least transmission of the CCCH message. The rest of the contents can be transmitted during the subsequent data transmission phase. Since this is no different to the legacy RACH procedure, we think there is no need to have an additional RSRP threshold to select between SDT and non-SDT at this stage anymore. |  |
| Huawei, HiSilicon | Option 1 with comments | As we mentioned in our previous comment, this should not be a “further” threshold. In a reasonable deployment, the threshold to choose between SDT and non-SDT RACH would always be higher (more stringent) than the one to choose between legacy 2-step or 4-step RACH. Hence, it should be checked before the legacy threshold. |  |
| SONY | Option 2 | As there are flexible payloads (TBS), the lowest payload (with an MCS) should *at least* allow the transmission of the CCCH message. |  |
| OPPO | Option1 or Option2 | That depends on the coverage where SDT is supported. If the largest coverage of the each carrier is taken into account, option2 is enough, otherwise, we still need another RSRP for the selection between SDT and non-SDT. Furthermore, we think whether to do SDT or non-SDT need to be determined earlier, i.e. closely following the carrier selection. |  |
| Xiaomi |  | No strong preference. It seems that this depends on the data amount and MCS which is used for the SDT. If the MCS is high and data amount is relatively larger, maybe an RSRP threshold can be configured to ensure the coverage. |  |
| Fujitsu | Option 2 | We also think that Option 2 is sufficient, but this discussion may need RAN1 consultation in terms of whether a new RSRP threshold is needed or not. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

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

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| **Q 2.3.5: Do companies think that any switching options requiring rebuilding of MAC PDU included in the first UL message are needed for SDT?** | | | |
| **Company** | **Yes (please explain) /**  **No** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | No | We think rebuilding of MAC PDU need not be supported. Both the RACH CG mechanisms will allow multiple HARQ retransmissions as part of the triggered procedure and this should be sufficient. So, once the UE selects a given mechanism between RA-SDT and CG-SDT, it shall use the same for the rest of the procedure (i.e. no switching is allowed) |  |
| Huawei, HiSilicon | Yes | We think that after a configurable number of failed SDT transmission using either CG-SDT or RA-SDT, the UE should switch to legacy RACH procedure (i.e. RACH with RRC message only). Hence the following fallback schemes should be supported, which require TB rebuilding:   * CG-SDT to legacy RACH * RA-SDT to legacy RACH   On the other hand, we think it should be possible to use CG-SDT resource for subsequent transmission in the case RA-based SDT was selected for initial transmission due to TA invalidity. When the TA becomes valid after MSG2/MSGB reception, the CG resource becomes valid again and the UE can use it. This does not require TB rebuilding though. |  |
| SONY |  | Leave it to stage 3. |  |
| OPPO | No | We prefer not to mix different mechanisms together in order to keep it simple.The UE can depend on the failure handling mechanism of each procedure if the transmission is not successful after multiple times of attempts. |  |
| Xiaomi | No | Better not support MAC PDU rebuilding as this will increase the UE implementation complexity. Maybe the gNB by implementation can try to ensure the same TBS for switching. If the same TBS cannot be ensured in some corner cases, maybe the UE can simply fallback to the normal RACH to recover the lost data via the uppler layers after entering the connected. |  |
| Fujitsu | No | As explained by ZTE. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

## Handling of T319 like timer

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

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

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

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| **Q 2.4.1: Which option do companies prefer for handling of the new timer?**  **Option 1: Extended T319 like timer**  **Option 2: Timer restarted after each UL/DL**  **Please provide further technical justification for your views** | | | |
| **Company** | **Option 1**  **/**  **Option 2** | **Company comments and justification** | **Rapporteur summary** |
| ZTE | Option 1 | We think option 1 is simple and sufficient (as seen from the LTE-PUR). It should be noted that the target use cases for SDT are for applications that generate short and infrequent data. The subsequent data transmission phase is only there to cover any left over data after the first initial message and any associated upper layer feedback in DL. We should not aim to design a mechanism that could potentially keep the UE indefinitely in the SDT phase. So a time bounded SDT phase (including the subsequent data transmission phase), seems more appropriate to cover these kind of applications and we think this is sufficient and no further enhancements are needed. Starting and restarting the timer will result in a lot more complexity and is also may result in error cases due to missed signalling or scheduling messages etc. |  |
| Huawei, HiSilicon | Option 2 | There are several advantages of option 2 over option 1:   * As mentioned by the discussion rapporteur, it gives the network more flexibility to terminate the procedure in the most efficient moment, e.g. by considering the (expected) subsequent data arrival * It allows the UE to detect the failure of SDT transmission earlier, since the timer in option 2 will be shorter than for option 1. E.g. if we assume the network wants to set the upper bound for SDT duration to 5 seconds, then it would take 5 seconds for the UE to wait for the SDT timer expiry to declare SDT failure (if there is no reply from the network). In case of having a timer which is restarted after each UL/DL transmission, the timer would be shorter (e.g. 1 second), so the UE would detect the failure earlier. * At the same time, this timer’s implementation would the very similar to the data inactivity timer’s implementation , which is very straightforward and simple so we do not believe this option is more complex than the other alternative at all. |  |
| SONY | Option 2 | Timing for subsequent SDT is variable, so a time bounded SDT may not be suitable, hence we prefer Option 2. |  |
| OPPO | Option1 | To make it simple, we think option1 is desirable since Option 2 would bring extra complication to both UE and gNB. |  |
| Xiaomi | Option 1 | We understand that Option 1 is not optimum, but the benefit of terminating the procedure earlier is also not very clear to us as most traffic carrired in SDT procedure would not be delay-sensitive. |  |
| Fujitsu | Option 1 | We prefer to reuse the T319 and the definition of T319 as what has been speciried from Rel-15. This means that T319 should be failure detection timer and has no other meanings e.g. SDT boundary timer and data inactitity timer. As in Rel-15, the UE starts T319 when the UE sends RRCResume plus small data and goes to IDLE when it is expired. The all SDT (first SDT and subsequent SDT) should be done during T319 running, for which we don’t see any problem. Besides, from the perspective of gNB configuration, it is simple to properly control UE activity. Specifically, once the gNB receives RRCResume, it can also start corresponding internal timer and can recoginize when T319 is expected to be expired (i.e. when the UE goes to the IDLE), so that timer state mismatch can be fully avoided. |  |
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| **Comments Summary:** | | | |
| **Proposals:** | | | |

# Conclusion and proposals

# References

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

# Annex (contact details for email discussions)

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