3GPP RAN WG2 Meeting #113bis-e R2-210xxxx

eMeeting April 12th – April 20th, 2021

Agenda Item: 8.6.3

Source: InterDigital (email discussion rapporteur)

Title: [DRAFT] [Post113-e][503][SDT] T319, cell reselection and re-establishment

Document for: Discussion, Decision

# Introduction

This discussion document is intended to define the new T319-like timer for small data transmission, as well as address cell reselection during SDT procedure and related security aspects. The following objectives have been provided by session chair:

* [Post113-e][503][SDT] T319, cell reselection and re-establishment (InterDigital)

Scope: 1) Extended T319 timer/new handling (option on how to start/maintain timer) 2) how to deal with timer expiry, 3) Cell reselection handling and related security aspects

Intended outcome: Report to the next meeting.

The following deadlines are provided:

* Initial deadline (for companies' feedback): **Friday 2021-03-26 23:59 UTC**

# Discussion

## SDT failure detection timer

In Rel-16, to detect transmission failure in INACTIVE state UE starts T319 timer upon transmission of *RRCResumeRequest/RRCResumeRequest1*. TS 38.331 [1] defines timer operation as follows:

| Timer | Start | Stop | At expiry |
| --- | --- | --- | --- |
| T319 | Upon transmission of *RRCResumeRequest* or *RRCResumeRequest1.* | Upon reception of *RRCResume,* *RRCSetup, RRCRelease, RRCRelease* with *suspendConfig* or *RRCReject* message, cell re-selection and upon abortion of connection establishment by upper layers. | Perform the actions as specified in 5.3.13.5. |

The current maximum value of T319 may be insufficient to account for multiple small data packets during subsequent small data transmission, possibly leading to unnecessary transmission failure and data loss since the UE transitions into IDLE mode upon timer expiry.

Extending T319 could avoid premature declaration of RRC connection resume failure during subsequent small data transmission. However, as T319 is configured in *ue-TimersAndConstants* in SIB1, the same T319 value applies to all UEs within the cell, which would impact legacy procedures such as RNAU and RRC connection resume by increasing detection time of connection resume failure.

It was therefore agreed in R2#112e to introduce a new timer, **referred to as SDT failure detection timer in this discussion**, to detect and handle failures during the small data procedure [2]:

**Agreements**

Define a new timer. FFS whether it has the same definition as T319 or it is restarted every UL/DL

Considering this timer is intended to detect small data transmission failure, it was proposed in [3, 4] that SDT failure detection timer be started upon initial small data transmission, with [3] further adding reception of DL small data as a start condition.

**Q1: Do you agree SDT failure detection timer starts upon transmission/reception of initial small data PDU?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| ZTE | Agree (transmission)  For reception case the question is not clear to us | Note that all SDT sessions will be initiated by the transmission of the first UL message (i.e. the CCCH message) at which point the failure detection timer shall be started. So, the failure detection timer should start upon transmitting the first UL message (i.e. at similar point as when the legacy T319 is started).  It is unclear to us why the timer shall be started at reception of some message in DL. Perhaps this is related to option 2 in Q3, but since that is being discussed separately, we will provide our views for restarting the timer as part of Q3. |
| Intel | Agree | We confirm that a new time (like T319) should start at the initiation of the SDT session. We prefer updating the wording “transmission/reception of initial small data PDU” to “SDT session” (or other term) that may not bring ambiguity (e.g. SDT session is only started with an UL transmission). |
| LG | Disagree | We think the timer should start upon initial transmission. We don’t understand why the timer should start upon initial reception. |
| Spreadtrum | Agree, but | We want to introduce a T319-like timer that the UE start the timer when transmitting the first UL RRC message to start the SDT procedure. We don’t see the scenario that UE start the timer when receiving small data PDU. |
| Huawei, HiSilicon | Agree | The timer should be first started with initial small data transmission and be restarted for each subsequent small data transmission or reception. |
| OPPO | Agree with some comments | For transmission of initial small data PDU, does it refer to the time when SDT is initiated (same as T319)? If this understanding is right, our answer is positive.  We also do not understand why including reception case.  The exact time to start T319 is described as follows:  5.3.13.2 Initiation  The UE initiates the procedure when upper layers or AS (when responding to RAN paging, upon triggering RNA updates while the UE is in RRC\_INACTIVE, or for sidelink communication as specified in sub-clause 5.3.13.1a) requests the resume of a suspended RRC connection.  The UE shall ensure having valid and up to date essential system information as specified in clause 5.2.2.2 before initiating this procedure.  Upon initiation of the procedure, the UE shall:  …  1> start timer T319;  1> set the variable *pendingRNA-Update* to *false*;  1> initiate transmission of the *RRCResumeRequest* message or *RRCResumeRequest1* in accordance with 5.3.13.3. |
| Sony | Agree | We are ok the SDT failure detection timer starts upon transmission/reception of initial small data (SDT). |
| Ericsson | Agree | Timer handling at reception can be discussed although a successful reception would constitute of a successful connection. |
| ASUSTeK | Agree | The timer should be started upon successful transmission of initial small data. |
| CATT | Disagree | We think T319 should start at the initiation of the RRCResumeRequest message for SDT. At the expiry of T319 and the SDT data is on-going, and then the SDT failure detection timer should be started.  We assume that the SDT failure detection timer handling is conducted at the RRC layer as the same way as T319 timer handling.  There is a possibility that the UE may be given a grant which is sufficient to provide RRCResumeRequest without SDT data in response to SDT data transmission request. This is the fallback mechanism. In this case, if the SDT failure timer has already started at the initiation of the SDT transmission, the UE have to start T319 timer when sending RRCResumeRequest message for fallback. However if T319 timer start at the initiation of SDT data transmission, handling of fallback doesn’t require special timer handling. |
| ITRI | Agree | We support that the new defined timer (i.e., SDT failure detection timer) should be started at the initiation of the SDT session. |
| Samsung | See comments | Timer should be started when SDT session/procedure is initiated. |
| NEC | Agree for transmission | The T319-like timer should start upon initial transmission of UL small data. |
| Sharp | Agree | We agree that SDT failure detection timer starts upon transmission.  It is not clear for us on the reception case. |
| Fujitsu | Agree | The timer should be started at initial small data transmission and be restarted at each subsequent small data transmission. |
| Xiaomi | Agree for transmission | It is not clear to us why the timer should restart at the reception of DL data. |
| Panasonic | Agree, but | We agree that the SDT failure detection timer shall start upon transmission of initial small data PDU, but not upon the reception of small data. The SDT procedure is triggered by an UL transmission, and then a DL reception may occur after the UL transmission, which means the SDT failure detection timer shall has already started upon the first DL reception. |
| Qualcomm | Agree for transmission | The timer starts upon transmission, i.e. the first UL message including the CCCH message. The reception is unclear or us. |
| Lenovo | Agree | This timer will be started upon the initial SDT transmission and restarted for the subsequent transmission or reception after the initial UL small data transmission. |
| vivo | Disagree | This timer should be started upon the initiation of the SDT procedure, which is similar to the existing starting point of T319. |

For RRC-based SDT, an RRC message is transmitted along with initial small data. If this RRC message is *RRCResumeRequest* or *RRCResumeRequest1* both SDT failure detection timer and legacy T319 timer would be running simultaneously, which may lead to data loss if T319 is configured with a shorter duration and expires (sending the UE to IDLE) before completion of SDT procedure.

**Q2: Do you agree if *RRCResumeRequest* or *RRCResumeRequest1* is transmitted for the purposes of SDT, legacy T319 timer is not started? (i.e. failure detection relies on new SDT failure detection timer instead)**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| ZTE | Agree | Since the new timer is agreed, the legacy timer doesn’t apply for SDT anymore. |
| Intel | Agree | A new timer will be started instead than T319 with similar purpose. However, we are also ok to further discuss this during stage-3 discussion. |
| LG | Agree |  |
| Spreadtrum | Agree |  |
| Huawei, HiSilicon | Agree | We agree a single timer to control SDT procedure is sufficient and using T319 at the same time may cause some issues. |
| OPPO | Agree |  |
| Sony | Agree | For SDT procedure, the new timer must be used as per agreement. |
| Ericsson | Agree |  |
| ASUSTeK | Disagree | The legacy T319 can be used to detect the failure of RA procedure for initial transmission. The new timer can be used to detect the failure of subsequent transmissions. |
| CATT | Disagree | See comments in Q1, we prefer to start T319 upon transmission of initial small data PDU, and start SDT failure timer when T319 expires and SDT is on-going. With this actions, the legacy connection resume procedure can be kept with as less modifications as possible, while the timer to detect RRC connection resume failure during subsequent small data transmission is extended |
| ITRI | Agree | Since the new timer is introduced and has similar purpose as T319 timer. It is reasonable to disable T319 when the new timer is running. |
| Samsung | Agree |  |
| NEC | Agree |  |
| Sharp | Agree |  |
| Fujitsu | Agree |  |
| Xiaomi | Agree |  |
| Panasonic | Agree |  |
| Qualcomm | Agree |  |
| Lenovo | Agree | If a new timer is introduced as in Q1, legacy T319 is not necessary. |
| vivo | Agree | Due to the introduction of the new timer, any behavior related to SDT procedure is supposed to be transparent to the operation of the legacy T319. |

In [Post112-e][551][SDT], the following FFS details were further captured regarding timer duration:

Option 1) extended T319 like timer, or;

Option 2) timer restarted after each UL/DL.

Proponents of Option 1 state that extending the duration of SDT failure detection timer to accommodate subsequent SDT would be a simple solution, and that having a time bound on subsequent small data transmission (as in LTE EDT) is acceptable considering the target use case for SDT is applications with short and infrequent data.

Proponents of Option 2 note an extended timer restricts the network to configuring a timer duration based on the predicted total/max time for subsequent small transmission. Considering this duration is variable, defining a timer duration which can accommodate all scenarios may be difficult, and result in unnecessary delay to SDT transmission failure detection.

**Q3: What is the preferred SDT failure detection timer handling to accommodate subsequent SDT?**

* **Option 1: An extended timer to accommodate full duration of subsequent SDT;**
* **Option 2: Timer is restarted upon (re)transmission or reception of small data;**
* **Option 3: Other, please describe.**

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| **Company** | **Preferred Option(s)** | **Additional comments** |
| ZTE | Option 1 | We prefer option 1, but if option 2 is the majority view, we think we can reuse something similar to dataInactivityTimer for option 2. |
| Intel | Option 1 | The benefit of restarting the timer at each UL/DL (with option 2) is that it provides more flexibility and avoids SDT being time bound as the actual time required for SDT cannot be predicted in advance. It also allows a shorter T319’ such as failures can be detected more quickly. On the other hand, the time bound nature of T319’ (with option 1) can be seen as a benefit because, it limits SDT duration and avoids new potential scenarios to address from a long SDT duration. Moreover, SDT mechanism by its very definition should be of short duration. In addition, with option 1, the network can always do a fallback to RRC\_CONNECTED if the UE is running out of timer, which is similar to new data arrival handling. Hence, we don’t see strong motivation to allow long durations of a given SDT session via option 2. |
| LG | Option 1 | We think the timer governs one SDT procedure. |
| Spreadtrum | Option 1 |  |
| Huawei, HiSilicon | Option 2 | We think there are several advantages of option 2 over option 1:   * it gives the network more flexibility to terminate the procedure in the most efficient moment, e.g. by considering the (expected) subsequent data arrival (even though we agree SDT should be short in principle, we do not see a reason to restrict the duration up front, e.g. in case the UE is stationary and a lengthier SDT procedure would not increase failure probability) * 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. * The number of subsequent uplink transmission is undefined and it would be difficult to “accommodate the full duration for subsequent uplink” |
| OPPO | Option 1 | We think this new timer is maintained by RRC, if we adopt Option2, frequent layer interactions between RRC and lower layers are needed to (re-)start this timer. For example, lower layer indicates the retransmission/reception of small data to upper layer, by which RRC restarts the timer. From simplicity perspective, we prefer Option1. |
| Sony | Option 2 | The SDT duration is variable so restarting after each UL/DL is reasonable. |
| Ericsson | Option 2 | Agree with Huawei |
| ASUSTeK | Option 2 | Agree with Huawei. |
| CATT | Option 1 | Option 1 is simple. Option 2 introduces additional complexity. |
| ITRI | Option 1 | We share the same view as Intel. |
| Samsung | Option 1 | Same view as intel |
| NEC | Option 2 | Agree with Huawei.  In addition, for option 2, to avoid frequent RRC and MAC interworking, the timer for subsequent transmission can be a MAC layer timer.  We are also OK if the majority support option 1. |
| Sharp | Option 2 | Agree with Huawei. |
| Fujitsu | Option 1 |  |
| Xiaomi | Option 1 | We think that the smart gNB implementation can configure a proper timer value. And the UE can provide assistance information (e.g. expected traffic pattern) to the gNB to facilitate the configuration of the timer value. |
| Panasonic | Option 2 | Agree the analysis provided by Huawei. |
| Qualcomm | Option 1 | In option 1, the timer is in RRC layer like T319. The option 2 (re)starts the timer when UE transmits small data in lower layer, and stops conditions are based on RRC message. |
| Lenovo | Option 2 | Same view as Huawei, it is not easy to define the full duration of the subsequent SDT procedure. |
| vivo | Option 1 | For UE simplicity, we prefer option 1.  For option 2, it seems the timer may enter into an expiry state in some cases. For example, given that both the CG resources and UL traffic data can be periodic within a very very long period, if this new timer is restarted at each UL transmission after initiating the CG-SDT, how can the UE determine that the UL transmission has been failed since the timer might never expire without other new-designed mechanisms? |

Legacy T319 timer is stopped upon reception of a response RRC message (e.g. *RRCResume*), cell re-selection, or abortion of connection establishment by upper layers. Assuming the network may respond with a similar set of RRC messages, the same stop conditions may also apply to SDT failure detection timer.

**Q4: Which legacy T319 stop conditions are also applicable to SDT failure detection timer?**

* **1: Reception of *RRCResume***
* **2: Reception of *RRCSetup***
* **3: Reception of *RRCRelease***
* **4: Reception of *RRCRelease* with *SuspendConfig***
* **5: Reception of *RRCReject***
* **6: Cell reselection**
* **7: Abortion of connection establishment by upper layers**
* **8: Other, please describe.**

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| **Company** | **Applicable stop condition(s)** | **Additional comments** |
| ZTE | Depends on answer to Q3 | If option 1 is adopted for Q3, then the timer shall be stopped upon all the legacy conditions listed above (i.e. 1-7) |
| Intel | 1 to 7 | 1) 2) would be sent when network fallbacks the UE into RRC\_CONNECTED.  3) 4) would be sent when the network wants to end the SDT session while it keeps the UE in RRC\_IDLE for 3) and in RRC\_INACTIVE for 4).  5) could be applicable to SDT similarly to legacy access. This would allow the network to respond reject SDT traffic under congestion situations. Moreover, this scenario might be more critical when gNB is overloaded and cannot fetch the UE AS Context.  6) 7) might require further discussion aiming to prevent data loss and duplication during an SDT session, as explained in R2-2100366. |
| LG | 8. Completion of SDT procedure | We think the timer governs one SDT procedure. The timer stops when the SDT procedure is completed. Which event should be considered as SDT procedure completion needs further discussion. |
| Spreadtrum | 1 to 7 | Legacy conditions could be considered. |
| Huawei, HiSilicon | Conditions 1 to 7 | We think the same conditions as for legacy T319 should apply regardless of the chosen option as per Q3.  In addition to that, if we agree to trigger another RRC Resume procedure for non-SDT then T319 should also be stopped upon new RRC Resume Request transmission. |
| OPPO | 1 to 7 | Legacy conditions should be baseline. |
| Sony | 1 to 7 |  |
| Ericsson | 1-7 | No matter if Option 1 or 2 is adopted, conditions 1-7 should still be applicable (the only difference is the re-starting of the timer in Option 2). |
| ASUSTeK | 1 to 7 | The timer should be stopped when the RRC resume procedure is completed or stopped. |
| CATT | 1 to 7 | And the UE also stops SDT failure detection timer if running when SDT fallback indication from MAC Layer is received. |
| ITRI | 1 to 7 | We think the legacy conditions should be baseline. |
| Samsung | 1 to 7 and others (see comments) | Timer should also be stopped if integrity check failure occurs while the timer is running. |
| NEC | 1 to 7 | Legacy conditions could be applied. |
| Sharp | 1-7 |  |
| Fujitsu | 1 to 7 |  |
| Xiaomi | 1-7 |  |
| Panasonic | 1 to 7 |  |
| Qualcomm | 1 to 7 |  |
| Lenovo | 1 to 7 |  |
| vivo | 1 to 7 | The legacy mechanism can be reused. No new issues are found from our perspective. |

## Cell re-selection during SDT procedure

As per legacy procedure if cell reselection occurs while T319 is running, UE transitions to IDLE. Adopting similar behaviour while SDT failure detection timer is running (i.e. during ongoing SDT procedure) would lead to interruption of small data transmission and possible data loss.

However, several contributions [5, 10, 12] note cell reselection occurring during an SDT procedure would be rare and transitioning to IDLE and re-attempting the SDT procedure on a new cell is a simple solution with minimal specification impact. Even if UE transitions to IDLE during cell reselection, [4-6] note that UE could recover lost data from higher layers (i.e. PDCP retransmission) without complexity and specification change, and data loss prevention could be left to UE implementation.

Alternatively, proponents of enhancement note subsequent small data would extend the SDT procedure increasing the probability of cell reselection during SDT, and that small data transmission should have a similar reliability to connected mode data transmission. It is further noted in [6] that retransmission based on UE implementation may result in data duplication as the PDCP SN for the data is not maintained in the network and UE when UE goes to IDLE.

**Q5: Which of the following do you agree with:**

1. **The possibility of small data loss during cell re-selection justifies enhancement to existing procedures (i.e. UE should not transition to IDLE as in legacy T319 behaviour)**
2. **Existing recovery mechanisms (e.g. higher-layer retransmission) are sufficient to prevent small data loss even if UE transitions to IDLE during cell reselection;**
3. **Cell re-selection during SDT is a corner case, no enhancement/recovery mechanism is necessary;**
4. **Other, please describe**

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| **Company** | **Supported statement(s)** | **Additional comments** |
| ZTE | Option 1 (unless there are some showstoppers or significant impacts) | We think option 1 should be considered as long as there are no obvious show-stoppers for this.  If we identify some critical issues with option 1 then other options can be the fallback solutions. |
| Intel | 1 | We think UE should continue in RRC\_INACTIVE after cell reselection is triggered during an SDT session, as explained in R2-2100366.  If UE stays in RRC\_INACTIVE (instead of transitioning into RRC\_IDLE upon triggering cell reselection during an ongoing SDT session), data loss can be prevented using existing recovery mechanisms (e.g. higher-layer retransmission)  On other hand, if a UE transitions into RRC\_IDLE upon triggering cell reselection during an ongoing SDT session, any DL small data would always be lost. |
| LG | Option 3 | We belive cell re-selection during SDT procedure is corner case because SDT procedure is used for “Small Data” transmission. The SDT procedure would not take long time. |
| Spreadtrum | 1 | As the data volume will not be very large for SDT, we could support the keep UE in RRC\_INACTIVE after cell reselection for SDT. |
| Huawei, HiSilicon | 1 | We think statement 2 is not true because this would lead to worsened 3GPP network performance as seen by the user when SDT is enabled. In general, the service requirements will not change regardless of whether the UE is configured with SDT or not, so relying on upper layers is not a real solution in our opinion. In addition, higher layer retransmission mechanism can only work for DRBs with RLC AM. For RLC UM, the PDCP PDUs will not be retransmitted at PDCP re-establishment.  Since the SDT procedure will be lengthier than legacy RRC Resume, statement 3, which was true for legacy RRC Resume procedure, is not true for SDT procedure. |
| OPPO | Option 3 | We also think that cell reselection during SDT is a corner case even though the timer is prolonged. Considering the workload to define a solution to avoid data loss and duplication, we prefer to follow legacy UE behaviour. |
| Sony | Option 1 |  |
| Ericsson | Option 3 | Procedure likely very short so option 3 should be the base line unless serious issues can be shown. Very long procedure times for subsequent data can be avoided by data volume threshold etc. It has been shown that there is no benefit of allowing many subsequent transmissions for SDT compared to connected. |
| ASUSTeK | Option 3 | Enhancements can be discussed in later release. |
| CATT | Option 2/ option 3 | Considering the complexity of enhancements, we don’t see strong motivation to support enhancement/recovery mechanism in AS layer |
| ITRI | Option 2 and Option 3 | If we consider the saving cell quality as one of triggering SDT procedure criterion, cell reselection during SDT will be a corner case. |
| Samsung | Option 1 |  |
| NEC | Option 3 | Cell reselection during SDT is a corner case, the enhancement can be considered in further release. |
| Sharp | Option 3 |  |
| Fujitsu | Options 2/3 | SDT is small data transmission. It can be completed during the UE is connecting to the current serving cell. |
| Xiaomi | Option 1 |  |
| Panasonic | Option 1, but | Since the SDT procedure may need to accommodate multiple subsequent data transmissions, it could be much longer than a legacy RRC resume procedure; therefore cell re-selection during the SDT might occur more frequently than before. However, we don’t think option 1 means there is only one enhancement (i.e., UE should not transition to IDLE as in legacy T319 behaviour). As mentioned in our contribution R2-2100817, we think if cell reselection would occur during SDT, UE only needs to send a ‘bye’ message to the original cell and the rest can rely on the legacy behaviour (i.e., entering into IDLE). |
| Qualcomm | Option 3 | We prefer the legacy behaviour. The RSRP threshold limits the cell edge UEs to trigger SDT and the whole SDT procedure is short because of data volume threshold. Thus, it is low chance that cell reselection happens during SDT procedure. |
| Lenovo | Option.1 | Since subsequent data transmission is allowed in SDT, we do not think it is a corner case that UE will perform cell re-selection during SDT procedure. The small data loss in SDT should be avoided. |
| vivo | Option 1 | Basic mobility with service continuity may be considered for CG-SDT when the cell size is small. |

An alternative solution to transitioning to IDLE is for UE to remain in INACTIVE and attempt a second RRC Resume to the new cell. However, per TS 33.501 [7] UE is provided with updated I-RNTI and NCC in subsequent *RRCRelease* with *suspendConfig* messages to prevent tracking of UE based on I-RNTI value. This may lead to security concerns if UE attempts the new Resume procedure before completion of the first and does not receive updated I-RNTI and NCC. One option mentioned in [4,6] is to temporarily allow re-use of the NCC and I-RNTI from the former cell to initiate an RRC Resume in the new cell, which could then be updated afterwards.

**Q6a: From RAN2 perspective, if UE remains in INACTIVE during cell reselection can same NCC and I-RNTI be used temporarily for RRC Resume procedure in new cell?**

**Note: A related discussion is ongoing in email discussion [Post113-e][502] [8] for data arriving on non-SDT DRBs. Companies are asked to highlight issues specific to cell reselection, if available.**

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| **Company** | **Yes/No** | **Additional comments** |
| ZTE | Yes | In general, we think this can be the case. Note that unlike in the same cell case, the same MAC-I will not be repeated (since the physical Cell ID will be different after cell reselection). So, the issue is slightly different to the repetition of CCCH message which is being discussed in the other email discussion.  Then our proposal in [11] was to use RRCRestablishment instead of RRCResume (i.e. I-RNTI is not used). RRCResume and RRCReestablishment are both very similar, but if we use RRCRestablishment, upon successful completion UE moves to connected mode directly. In addition, the following differences are worth noting:  If RRCResume is used: (i.e. I-RNTI is used as UE ID), then the message is routed to the old anchor and there may be some additional work needed (in RAN3) if there was anchor relocation and since there is no context fetch procedure at anchor gNB upon RRCResume, this procedure might actually fail unless RAN3 defines new procedure to support this.  If RRCReestablishment is used: (i.e. the UE ID points to the cell in which reselection happens), then the Reestablishment message is routed to the new gNB, but in this case, if there was no anchor relocation, then again some impact will be there for RAN3 to verify the UE.  It would be good to understand the above differences and then if we agree to support some mechanism, we need to first agree which way to go (i.e. RRCResume or RRCReestablishment)? |
| Intel | Yes | Yes, from RAN2 perspective. |
| LG | No | First, this is unnecessary optimization for corner case.  Second, there is security concerns. |
| Spreadtrum | Yes | Yes, or other message can be considered. |
| Huawei, HiSilicon | Yes | The situation where the same NCC/I-RNTI is used in two different RRC Resume procedures can happen already in several cases in NR and LTE already, e.g.  - in both NR and LTE, when the resume procedure is rejected by network and second resume procedure is triggered at a later point in time  - in NR, during fallback from 2-step RA to 4-step RA (no second RRC resume message is generated and the old one is transmitted)  - in LTE, during fallback from PUR to EDT RA or non-EDT RA after PUR transmission is not successful  - The RRC Reestablishment is also similar in the sense that UE identity as used in another cell is disclosed in a potentially new cell and the same NCC is used to calculate shortMAC-I.  This situation is no different for cell reselection during SDT, so we think it is acceptable similarly as in other cases. |
| OPPO | No | We do not think trigger another RRC resume procedure in the new cell is feasible due to security issues. |
| Sony | Yes | RRC Resume is a quicker procedure. |
| Ericsson | No | If this was not feasible for legacy/Rel-15, and then also agreed as simpler to let the UE go to Idle instead of optimizing for this rare event, there is no reason why we should optimize for SDT => Just reuse the legacy principle and let the UE go to Idle in the new cell in the rare case of cell re-selection during SDT. |
| ASUSTeK | No | Agree with OPPO. |
| CATT | No | During legacy RRC connection resume procedure, the UE can only re-use same NCC and I-RNTI when RRCReject message is received. The network responses RRCReject message only when congestion is detected. That means the resumeMAC-I in RRCResumeRequest message is not verified in this case. However, the network may verify the UE with the received resumeMAC-I before cell reselection happens. We need to check with SA3 first whether there is security issue. |
| ITRI | No | We share the same view as OPPO. |
| Samsung | Yes | We do not see issue in using same NCC and I-RNTI upon cell reselection as Resume MAC I generated will be different.  Even in R15/R16, UE is allowed to use same NCC/I-RNTI upon reselection e.g. UE initiates resume in cell 1 and receives reject. UE remains in RRC\_INACTIVE. UE reselects to Cell 2. RRC resume in cell 2 uses same NCC and I-RNTI. |
| NEC | Not sure | If the same NCC and I-RNTI is used for the UE, and the UE moves back and forth between cells, there may be security issue, we need to be careful about this. |
| Sharp | No |  |
| Fujitsu | No | Should follow legacy procedure. |
| Xiaomi | Yes |  |
| Panasonic | No | Due to the potential security issues we think it is better/simpler for UE to enter IDLE while camping on the new cell during SDT. |
| Qualcomm | No |  |
| Lenovo | FFS | It could be acceptable if it is verified to be no security issue by the SA3, since this NCC/I-RNTI may have been successfully applied by the initial SDT procedure. Generally, the RRC re-establishment procedure could be applied in the subsequent SDT procedure with cell reselection, because RRCReestablishment message does not need to consider the security issue caused by the used NCC in SDT procedure. |
| vivo | No | It might be better to ask SA3 to provide feedback on this issue. |

If temporarily reusing NCC and I-RNTI value in sperate cells is supported from a RAN2 perspective, possible impacts and feasibility should be verified by SA3.

**Q6b: If ‘Yes; to Q6a, is an LS to SA3 necessary?**

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| **Company** | **Yes/No** | **Additional comments** |
| ZTE | Yes | Once some basic framework is agreed, we should inform SA3 to check whether there are any issues from security perspective. |
| Intel | Yes | SA3 should be consulted on the risk and, if needed, with possible solutions to mitigate the associated risk. For example, possible approaches are that the network should then move the UE to CONNECTED, or back to INACTIVE (with the suspend and SDT configuration), use horizontal key derivation etc as discussed in [R2-2008992] |
| Spreadtrum | Yes |  |
| Huawei, HiSilicon | OK to send | As indicated above, we think there are already cases where a similar situation occurs, so we do not create a new security issue here. However, RAN2 can make an agreement and check with SA3 for any security issues. |
| Sony |  | It is too early to send LS, but we are open for it. |
| CATT | Yes |  |
| Samsung | Yes |  |
| Sharp | Yes |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |

An alternative solution described in [4,6] is to provide UE with a new I-RNTI and NCC while SDT procedure is ongoing. Proponents of this solution are invited to describe how such signalling would work.

**Q6c: Are additional mechanisms (e.g. not relying on RRC Release message) needed to provide an updated I-RNTI/NCC value during SDT procedure? If ‘Yes’, please describe.**

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| **Company** | **Yes/No** | **Additional comments** |
| ZTE | No | The problem with this approach is that this may still not work because the cell reselection may happen even before the DL message is received. So, there is no guarantee that the above procedure will work for all cases anyway. So, there is no need to optimise for this.  Note that we already agreed that the RRC message in DL terminating the SDT procedure will be sent at the end. So, based on this, it seems it is not possible to send a new I-RNTI/NCC midway through the SDT procedure. |
| Intel | Maybe | Depending on SA3 response. Additional mechanism may be needed for other security reasons as well regarding network authentication as discussed in last meeting.  As we explained in Q6b, possible options could be that in a future SDT session, network could already respond to the 1st UL SDT with *RRCRelease* message included updated *SuspendConfig* (moving back the UE into RRC\_INACTIVE with updated security information) or with a fallback into RRC\_CONNECTED (in order to fully authenticate the UE and update the security). |
| Spreadtrum | No | But it depends on SA3’s response. It is difficult for the network to determine when to send new I-RNTI/NCC before UE performing cell reselection. |
| Huawei, HiSilicon | Maybe | This can be considered in case SA3 identifies there is a security issue that has to be solved. The simplest solution would be to carry these parameters in an RRC message different than RRCRelease or in a modified RRCRelease which would not terminate SDT procedure. There is a very low chance that cell reselection happens before the UE is able to receive DL message as we already have parameters allowing to prevent cell edge UEs from triggering SDT, i.e. minimum SS-RSRP for CG-SDT and/or minimum RSRP threshold for SDT. |
| Sony | No | We agree with ZTE. |
| Ericsson | No | Corner case does not justify the added complexity. |
| ASUSTeK | No |  |
| CATT | No | Share the same view with ZTE, cell reselection may happen before the DL message is received. |
| ITRI | No |  |
| Samsung | No | Same view as ZTE |
| Sharp | No |  |
| Fujitsu | No |  |
| Xiaomi | No | Agree with ZTE. |
| Panasonic | No | Same reason as we described in Q6a. |
| Qualcomm | No |  |
| Lenovo | Maybe | It depends on SA3 decision on this issue. |
| vivo | No | For UE simplicity, we don’t think this optimization is essential. |

UE in CONNECTED for which AS security is activated with SRB2 and at least one DRB setup may initiate an RRC re-establishment procedure to continue RRC connection. Application of this procedure to cell reselection during SDT could avoid drawbacks of other candidate solutions such as potential data loss if transitioning to IDLE or security concerns of second Resume procedure. However, specification currently defines the re-establishment procedure only for connected mode UEs and would require extension to support INACTIVE UEs with SDT.

NOTE: resumption of SRB2 is currently a working assumption, however, for the purposes of this discussion it can be assumed that SRB2 is resumed during SDT.

**Q7: Assuming SRB2 is resumed, can RRC re-establishment procedure be extended to INACTIVE UEs with ongoing SDT procedure? If ‘No’ please provide technical reason(s) which preclude this.**

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| **Company** | **Yes/No** | **Additional comments** |
| ZTE | Yes | As explained above (see Q6a), both RRCResume and RRCRestablishment can work but they will have different implications on the network signalling. So, we need to be clear on what are the impacts and we could use the appropriate solution. |
| Intel | No | Technically speaking re-establishment could be extended, however we do not see this an essential behaviour for SDT session that targets to be a short and simple mechanism. Moreover, enabling re-establishment procedure during an SDT session would end up adding complexity to UE and network side and we think other solutions as discussed above are simpler. |
| LG | No | Cell re-selection during SDT procedure is corner case, and the proposal is unnecessary optimization for corner case. |
| Spreadtrum | No | Technically re-establishment procedure could be used here. But other solution could be considered to prevent data loss. |
| Huawei, HiSilicon | No | In our understanding resumption of SRB2 is subject to network control, similarly as for DRBs. Hence, it cannot be assumed that SRB2 is always resumed. Other than that, RRC Reestablishment is targeted for UEs in RRC Connected instead and not for UEs in RRC Inactive, so we are wondering why it is proposed to use RRC Reestablishment instead of RRC Resume procedure. In RRC Reestablishment Request, the UE is also reusing an old NCC, so from security perspective it seems the same.  Another issue is that for CG-SDT, the UE may not be provided with a C-RNTI, but with another kind of RNTI, so it is not clear RRC Reestablishment can be reused directly. |
| OPPO | No |  |
| Sony | No | We think re-establishment requires existence of RLF declaration. |
| Ericsson | No | Rare event that does not need to be optimized, see previous responses. |
| ASUSTeK | No | Agree with Intel. |
| CATT | No | If RRC re-establishment procedure is extended to inactive UEs with ongoing SDT upon cell re-selection, some modifications also need to be considered. For example:  - How to set the C-RNTI to find the UE context as in legacy RRC re-establishment procedure the C-RNTI is set with the one in the source PCell (reconfiguration with sync or mobility from NR failure) or used in the Pcell in which the trigger for the re-establishment occurred (other cases).  - How to set the physCellId to find the anchor gNB as in legacy RRC re-establishment procedure it is set to the physical cell identity of the source Pcell (reconfiguration with sync or mobility from NR failure) or of the Pcell in which the trigger for the re-establishment occurred (other cases). |
| ITRI | No |  |
| Samsung | No |  |
| NEC | No | The RRC Reestablishment is for CONNECTED state UE, extending to INACTIVE stated will bring lots of open issues. |
| Sharp | No |  |
| Fujitsu | No |  |
| Xiaomi | No |  |
| Panasonic | No | Entering into IDLE would be simpler and have less specification impact. |
| Qualcomm | No | It causes much complexity to extend RRC reestablishment to inactive state. |
| Lenovo | Yes | For SDT, except the cell reselection, it is possible that maximum number of RLC retransmission is achieved in the SDT procedure since subsequent SDT is introduced. |
| vivo | No | For an INACTIVE UE performing SDT, we don’t see the benefit of supporting RRC re-establishment, compare to the fallback to legacy RRC resumption/establishment procedure. |

**Q8: What is the preferred UE behaviour for cell re-selection during an on-going SDT procedure?**

* **Option 1: UE transitions to IDLE and initiates an SDT procedure on the new cell;**
* **Option 2: UE remains in INACTIVE;**
* **Option 3: UE performs RRC re-establishment procedure;**
* **Option 4: Other, please describe**.

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| **Company** | **Preferred Option(s)** | **Additional comments** |
| ZTE | Option 3 | Other options can be investigated if option 3 is not seen as viable. |
| Intel | 2 | We support staying in INACTIVE when SDT operation is possible in the new cell. Note that legacy transitions from RRC\_INACTIVE to RRC\_IDLE would still be applicable e.g. when re-selecting to LTE. Handling of last data sent in the ongoing SDT session just before triggering cell reselection would be left up to UE implementation aiming to prevent data loss and duplication during an SDT session, as explained in Q4 |
| LG | Option 1 | But we are open for Option 2. |
| Spreadtrum | Option 2 |  |
| Huawei, HiSilicon | Option 2 | There are some mistakes/unclarities in the options:   * In option 1, the UE cannot trigger SDT once it goes to RRC IDLE * In option 2, we understand the intention is to say: “UE remains in INACTIVE and initiates SDT/RRC Resume procedure in the new cell”. * In option 3, we understand the intention is to say: “UE remains in INACTIVE and initiates RRC re-establishment procedure in the new cell”   As mentioned above in reply to Q6a, there are many cases already where the UE resends its identity and reuses the same NCC in another cell, so from security perspective there is no additional issue. Remaining in RRC Inactive and sending another RRC Resume is then the simplest solution. |
| OPPO | Option 1 |  |
| Sony | Option 2 | Agree with Huawei. We are also open for Option 1. |
| Ericsson | Option 1 | If the UE is in IDLE it cannot RRCResume with SDT so this would-be legacy RA. Option 2 needs some more discussion and could be discussed if supported for RA SDT. |
| ASUSTeK | Option 1 | The UE transitions to IDLE but cannot initiate an SDT procedure on the new cell. |
| CATT | Option 4 | Considering the complexity of enhancements, we prefer to follow legacy procedure for cell reselection during RRC connection resume procedure, i.e. UE transitions to IDLE and informs upper layer the release of the RRC connection together with the release cause. The AS layer will enter RRC\_IDLE while NAS layer will trigger NAS recovery procedure upon receiving indicator from AS layer, then RRC connection establishment procedure will be triggered in AS layer and the UE will switch from idle to connected mode. |
| ITRI | Option 4 | We share the same view as CATT that the legacy procedure should be considered first. |
| Samsung | Option 2 |  |
| NEC | Option 4 | The UE shall follow the existing behaviour, i.e. transition to IDLE and initiate RRC setup procedure on the new cell by NAS recovery. |
| Sharp | Option 1 |  |
| Fujitsu | Options 2 | During cell reselection procedure, the UE will remain in the serving cell, but once the UE reselects the new cell, Option 1 should be taken. |
| Xiaomi | Option 2 |  |
| Panasonic | Option 1/4 | We agree UE shall perform Option 1 when cell re-selection occurs during an SDT procedure. Moreover, just right before the cell-reselection occurs (e.g., when the link quality of the serving cell drops below a certain threshold), UE can inform the serving cell by sending the BSR indicating empty buffer in the nearest UL grant, so that the serving cell can stop providing any further UL grants to the UE. |
| Qualcomm | Option 1 | UE transitions to IDLE but can not send RRC resume to initiate the SDT procedure in new cell. |
| Lenovo | Option.3 | For option.1, if UE moves to IDLE, it could not trigger an SDT procedure since SDT in R17 is for inactive UE, the inactive AS context may be discarded by UE when UE in IDLE mode.  For option.2, if another RRC Resume procedure for SDT is initiated, the data in this SDT procedure may be lost.  For option.3, the data in this SDT procedure may be not lost by the RRCReestablishment procedure.  So, we prefer option.3. |
| vivo | Option 2 | Option 2 may be considered for CG-SDT when the cell size is small. |

## SDT failure detection timer expiry

Current behaviour upon legacy T319 timer expiry is to transition to IDLE. However, enhancements applicable to cell reselection (i.e. higher-layer retransmission, remaining in INACTIVE, or RRC re-establishment) may also be applicable to SDT failure detection timer expiry to prevent small data loss during connection failure.

**Q9: Are the same potential UE behaviours listed in Q8 also applicable to SDT failure detection timer expiry? If ‘No’, please describe aspect(s) specific to timer expiry which would preclude an option(s).**

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| **Company** | **Yes/No** | **Additional comments** |
| ZTE | Yes | The failure behaviour should be the same for all possible failure events during SDT |
| Intel | Yes | And, if possible, we should adopt the same solution (whatever the solution adopted is) as for cell reselection scenario. |
| LG | Yes |  |
| Spreadtrum | Yes |  |
| Huawei, HiSilicon | Rather not | They could be in theory applicable, but it is rather a question of whether we want these approaches to be applied to SDT failure case. Using RRC Reestablishment for the UE in RRC Inactive itself seems inappropriate. It should be noted that the timer is supposed to detect a failure at the UE, e.g. the UE may not even receive any reply for its initial SDT message. In such case, it seems the UE should go to IDLE and reattempt connection from this state. |
| OPPO | Yes |  |
| Sony | Yes |  |
| Ericsson | Yes |  |
| ASUSTeK | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| Samsung | Yes |  |
| NEC | Yes |  |
| Sharp | Yes |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| Panasonic | Yes |  |
| Qualcomm | No | They are different scenarios. The UE behaviours may not be the same. |
| Lenovo | Yes |  |
| vivo | Yes |  |

**Q10: Assuming options described for cell reselection are also applicable for SDT failure detection timer expiry, what is the preferred UE behaviour at SDT failure detection timer expiry?**

* **Option 1: UE performs actions in TS 38.331, section 5.3.13.5 (i.e. transition to IDLE as per legacy T319 timer) and attempts RRC connection setup;**
* **Option 2: UE remains in INACTIVE;**
* **Option 3: UE performs RRC re-establishment procedure;**
* **Option 4: Other, please describe**.

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| **Company** | **Preferred Option(s)** | **Additional comments** |
| ZTE | Option 3 |  |
| Intel | 2 | Aligned with our preference for cell reselection. |
| LG | Option 1 | But we are open for Option 2. |
| Spreadtrum | Option 1 |  |
| Huawei, HiSilicon | Option 1 | We think the procedure as specified for T319 expiry can be reused. |
| OPPO | Option 1 |  |
| Sony | Option 2 | It is reasonable a UE to remain in INACTIVE state. |
| Ericsson | Option 1 |  |
| ASUSTeK | Option 1 |  |
| CATT | Option 1 |  |
| ITRI | Option 1 |  |
| Samsung | Option 2 |  |
| NEC | Option 1 |  |
| Sharp | Option 1 |  |
| Fujitsu | Option 1 |  |
| Xiaomi | Option 1 |  |
| Panasonic | Option 1 |  |
| Qualcomm | Option 1 |  |
| Lenovo | Option.3 |  |
| vivo | Option 1 | The legacy behavior should be reused. |

**Q11: Are there any other SDT failure detection timer or cell-reselection related aspects RAN2 should discuss?**

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| **Company** | **Other Aspects** |
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# Summary

<To be generated pending company feedback>

# Conclusion

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