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

**e-Meeting, 12 – 20 April, 2021**

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

**Title: General and other control plane open issues for SDT (email: [Post 113-e][502])**

**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:

* [Post113-e][502][SDT] General/Other CP issues (ZTE)

Scope:

1) Non-SDT data handling (including three options),

2) Subsequent data transmission issues (e.g. BSR triggers, etc).

3) Other remaining issues

Intended outcome: Report to the next meeting.

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:

Deadline Friday March 26 1100 UTC

**Discussion summary**

* TBD

# Discussion

## Resuming non-SDT DRBs

The following agreements was made regarding SDT DRBs:

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| RAN2#111-e  Small data transmission is configured by the network on a per DRB basis  RAN2#112-e  For both RACH and CG based solutions, upon initiating RESUME procedure for SDT initiation (i.e. for first SDT transmission), the UE shall re-establish at least the SDT PDCP entities and resume the SDT DRBs that are configured for small data transmission (along with the SRB1).  RAN2#113-e (WA)  Support configuring of SRB1 and SRB2 for small data transmission for carrying RRC and NAS messages. |

Thus, only some radio bearers may be configured for SDT whilst some other radio bearers will not be configured for SDT. When SDT is initiated, then the UE resumes the SDT radio bearers. During the subsequent data transmission phase (i.e., after the first UL message has been sent), if data arrives on the non-SDT RBs, then the question is how to inform the network about the data arrival on the non-SDT RBs.

Related to the above is the question whether the UE resumes

There are two options:

1. Non-SDT RBs are also resumed:

In this option, the non-SDT RBs are also resumed and thus if there is any data for the non-SDT RBs this will be visible to the MAC layer.

1. Non-SDT RBs are not resumed:

In this option, the non-SDT RBs remain suspended. Then one question is whether the MAC entity can have the visibility of data available from upper layers in this case. A few companies have mentioned that this is a modelling issue in the UE and some of the current procedures in the MAC spec require the UE to be aware of the data over suspended RBs (as noted below for LTE).

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| 5.4.5 Buffer Status Reporting [OMITTED PART]  For the Buffer Status reporting procedure, the MAC entity shall consider all radio bearers which are not suspended and may consider radio bearers which are suspended. |

Based on the above it seems that regardless of whether or not the non-SDT RBs are resumed, modelling within the MAC can assume that data arriving on the non-SDT RBs can be visible to the MAC layer.

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| Q1: Do companies agree that regardless of whether or not the non-SDT RBs are resumed, modelling within MAC can assume that the data arriving on the non-SDT RBs can be visible to the MAC layer?  Note that the question is not about whether the BSR can be triggered (since this will depend on having MCG path etc.), it is only whether MAC layer can be aware of data or not. | | |
| Company | Yes/No | Comments |
| LG | No | The quoted text “5.4.5 BSR” is for NB-IoT, and exist only for LTE specification. In NR, such text does not exist.  If the non-SDT DRBs are not resumed, the data from non-SDT DRBs does not arrive at PDCP layer, and thus the BSR cannot reflect the data from non-SDT DRBs. |
| Nokia, Nokia Shanghai Bell | No | We think that this is irrelevant question. It has been agreed that the network can configure allowed DRBs for SDT and according to agreement it is not possible that non-SDT data arrives to MAC during SDT procedure. It is also not clear where this question directs at. |
| ZTE | Yes | Firstly, any MAC based solution will only work if the MAC entity can have the visibility of data arriving at upper layers and we think this is a pure modelling issue on the UE side (i.e. the MAC entity can be modelled in such a way that it is aware of data at higher layers as is the case in the above example). If this is not feasible, then we think MAC based solution will not work. |
| Samsung | Yes | In our view, UE is aware whether the arrived data is for SDT or non SDT RBs. Awareness at higher layer/MAC is internal modelling within the UE. |
| OPPO | Yes | We agree that it is a modelling issue and MAC can be aware of the new arrival non-SDT data based on layer interactions.  If non-SDT RBs are resumed, the corresponding data can be delivered to AS and MAC is able to trigger BSR following legacy procedure.  If non-SDT RBs are not resumed, it is also feasible for AS to be aware of whether there is new arrival non-SDT data by interacting with upper layer even though the data is actually not arrives at AS. |
| InterDigital | No | Per TS 38.321, nothing indicates that data from non-resumed DRBs is visible to the MAC entity. The question seems to suggest that MAC can report data arrival even from a non-resumed DRB, but such assumption is not validated in 38.321. |

If it is assumed that the MAC entity can be aware of the data arriving over non-SDT RB, then it seems the decision whether the non-SDT RBs are resumed or not becomes less critical from the perspective of generating an indication about data arrival over non-SDT RBs. Thus, we can discuss the following question.

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| Q2: Which option do companies prefer for the non-SDT RBs?  Option 1 (Resume): Resume also the non-SDT RBs upon initiating SDT  Note: with option 1 we still need to ensure that data mapped to non-SDT RBs is not transmitted during SDT phase (even if these RBs are resumed) – companies can comment on mechanisms needed to ensure this if the preference is for option 1.  Option 2 (Don’t resume): Don’t resume non-SDT RBs until RRCResume is received (i.e., same as today) | | |
| Company | Resume/  Don’t Resume | Comments |
| LG | Option 2 | First, the observation from the rapporteur is not correct. If non-SDT DRBs are not resumed, the data from non-SDT DRBs is not visible to MAC, as explained in our comment to Q1.  Second, there is marginal gain to resume non-SDT DRBs. The reason is explained in R2-2101513. The observations of this document are captured below.  Observation 1: Even if non-SDT DRB is resumed in RRC\_INACTIVE, there is no gain from PDCP and RLC processing point of view, because the PDCP and RLC entities are re-established when the UE receives RRCResume.  Observation 2: Even if non-SDT DRB is resumed in RRC\_INACTIVE, the network may not identify that non-SDT is generated in the UE based on BSR, if LCG is not separated between SDT DRB and non-SDT DRB.  Observation 3: The gain of resuming non-SDT DRB in RRC\_INACTIVE is that the BSR reflecting the amount of non-SDT data can be transmitted before the UE receives a RRCResume message. However, the gain is marginal because the UE can transmit non-SDT data only after the UE receives the RRCResume message, same as legacy. |
| Nokia, Nokia Shanghai Bell | Option 2, Don’t resume | It has been agreed that the network can configure allowed DRBs for SDT and it seems clear the non-SDT DRB should not be resumed and scheduled over SDT transmission opportunities but the UE needs to be brought first into CONNECTED state (e.g., with RRCResume) before this can be done. This implies a connection resume procedure needs to be performed first. |
| ZTE | Option 2 | We think the current agreement that only SDT RBs are resumed is sufficient.  If non-SDT DRBs are also resumed, then we need some special mechanism to ensure the data is not transmitted in UL during SDT phase and this might need further changes to MAC and it is better to avoid this. |
| Samsung | Option 1/ Option 2 | Both option works. In option 1, we would need to specify some LCP restrictions so that the non SDT RBs data is not multiplexed in MAC PDU during SDT. In option 2, such change would not be needed. |
| OPPO | Option2 | If non-SDT RBs are resumed together with SDT RBs, we needs to introduce new LCP restriction to gurantee that non-SDT data is not transmitted during SDT procedure. From the perspective of not mixing the data transmission procedures of different RRC states, we prefer to follow legacy DRB resumption method for non-SDT DRBs. |
| InterDigital | Option 2 | Resuming non-SDT DRBs would require an LCP restriction to ensure only SDT DRBs are multiplexed on SDT resources. Option 2 is also inline with previous agreements. |

## Indication to the network about data over non-SDT RBs

Once data arrives on a non-SDT bearer, there are multiple options to indicate this to the network:

Option 1: Another CCCH message is sent

In this option, another CCCH message (i.e., ResumeReq) is sent. As already discussed at the last meeting, with this option the open issues are:

1. How to handle the security material: Specifically, ResumeMAC-I will be repeated in the same cell case (and unlike Rel-15, this happens without any DL message from network – e.g., RRCReject). Whether this is acceptable or not needs to be confirmed by SA3.
2. NAS/AS interaction: Regarding this there are three options:
   1. NAS provides a new resume cause and triggers new resume procedure (without any changes needed within NAS) – this needs to be confirmed by CT1
   2. NAS can provide a new resume cause and trigger new resume procedure (with potentially some updates to the NAS spec) – again needs to be confirmed by CT1
   3. AS directly can trigger a new RRCResume procedure and generate a AS based resume cause (in this case we need to discuss what resume cause will be used etc. within RAN2)

Note that options a. and b. above assume that the non-SDT RBs are not resumed (i.e., option 2 for Q2). The understanding is that if non-SDT RBs are resumed, then NAS will not be involved any further in the overall procedure.

Option 2: A new MAC level indication is triggered

In this option a new MAC level indication is triggered. This could be a new MAC CE to indicate the arrival of data over non-SDT RBs.

Note that this may not be same as a BSR. As noted by few companies, BSR may not be automatically triggered (e.g., in the case when the non-SDT RB has no MCG path). So, it seems we cannot rely only on a BSR being triggered (as this will not work for all cases). So, if we want to go via MAC based indication, then it seems we need a new MAC CE to be triggered to indicate arrival of data over non-SDT bearers.

Option 3: A DCCH message is triggered

Finally, in this option a DCCH message is triggered by the UE to indicate arrival of data over non-SDT RBs.

We could define a new message or we could reuse some existing message (e.g., releasePrerence indication or something similar as commented during the online discussion). The actual payload can be small (i.e., just to indicate arrival of data over non-SDT RB or something similar – i.e., no payload is needed).

Since DCCH message uses SRB1, there is no further discussion needed on the security context as this would have been resumed already for SRB1.

So, first we can try to develop the understanding further for each of the above options.

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| Q3: For option 1 do companies agree with the overall characterization of this solution and with the open issues listed above?  Please add any further comments or questions about option 1 in company comments section so that we know the overall picture for this option. Also indicate pros and cons for this option from your perspective in the comments. | | |
| Company | Overall description is okay? (Yes/No) | Comments (pros and cons of option 1 – CCCH message) |
| LG | No | We support Option 1.  We think the main concern on CCCH is that the message itself is not security protected. But, in some cases, CCCH transmission is inevitable.  For example, if a new RRCResume procedure (for making RRC connection) is triggered when dedicated UL grant is not available, the UE has no choice but to send RRC message unprotected (i.e. using CCCH). Otherwise, the network cannot decipher the RRC message because the network does not know which UE transmits the CCCH message, and does not know the security key used for ciphering. |
| Nokia, Nokia Shanghai Bell | No | We don’t quite understand why the same security material would need to be repeated, because such behavior has not been agreed. In addition we don’t agree that NAS would need to provide new resume cause. We think that AS can directly trigger a new RRCResume procedure when non-SDT data arrives during SDT procedure. |
| ZTE | Yes | We already agreed that “*In case of RRC-based solution, for both RACH and CG based solutions, the CCCH message contains ResumeMAC-I generated using the stored security key for RRC integrity protection – i.e same as Rel-16*”. So, if another CCCH message is sent, then our understanding is that the same material will be repeated in the same cell case (unless we define an entirely new CCCH message for the non-SDT data arrival purpose and a new security MAC-I calculation mechanism for this which seems rather unnecessary!)  In our view, compared to DCCH solution, there are no real pros for the CCCH solution.  In addition to the issues listed above we would like to point out the following issues with the CCCH based solution:  Cons:   1. If CCCH message is used and if anchor relocation is performed during SDT, then the new CCCH message will be routed to the old anchor gNB based on the old I-RNTI and the old anchor gNB may not have the context anymore (since it has been relocated). Seems additional work might be needed (RAN3 may be impacted in addition to SA3/CT1) with this approach. 2. Security issue as mentioned above. It seems SA3 in general are trying to avoid repeatition of security token (even in Rel-15) and adding another case where the security material is repeated would seem not ideal in anycase. |
| Samsung | Yes | Agree with ZTE views |
| OPPO | Yes | Agree with ZTE. |
| InterDigital | No | A new RRC Resume procedure can be triggered within AS with an explicit indication to the network for the resume cause, given another RCC Resume was already transmitted. |

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| Q4: Similarly, for option 2 do companies agree with the overall characterization of this solution and with the open issues listed above?  Please add any further comments or questions about option 2 in company comments section so that we know the overall picture for this option. Also indicate pros and cons for this option from your perspective in the comments. | | |
| Company | Overall description is okay? (Yes/No) | Comments (pros and cons of option 2 – MAC level indication) |
| LG | Yes | We don’t support Option 2.  Option 2 requires a new MAC CE, which would result in huge discussion in RAN2, e.g. new MAC CE format, trigger condition, LCP consideration, etc. |
| Nokia, Nokia Shanghai Bell | No | MAC level indication would need UL grant before it can be sent causing possible delay or worst case it cannot be transmitted at all if UL grant is not scheduled for the UE. In addition this would mandate NW to perform the LCG allocation such that SDT DRBs and non-SDT DRBs would never end up being available in the same LCG to be able to realize the availability of data in the non-SDT DRB. On the other hand, it seems not possible currently to report buffer status for a suspended DRB which would also require changes in the buffer status reporting procedure.  Furthermore, MAC has the reliability issue as it is only protected by HARQ. This would automatically mean that we would need to build complex solutions to re-transmit the MAC CE and ensure it will be received by the NW. It is hard to see such a solution would be reliable enough, e.g., for emergency calls. |
| ZTE | Yes | Pros:   1. This approach is much simpler than the CCCH based approach and will not impact any other WGs other than RAN2 2. There are no security issues and there is no issue with NAS interaction   Cons:   1. Reliability of MAC level mechanism may not be as good as DCCH based mechanism and if same reliability as RRC based approach is needed we may need new mechanisms to ensure this. |
| Samsung | Yes | Agree with ZTE views |
| OPPO | Yes | Except for the reliability issue, Option2 and Opiton3 would have different impacts on Xn signaling procedure in case of without anchor relocation solution. To be specific, if anchor gNB decides not to perform the context retrievial, the target gNB is not able to decode the DCCH message, but is able to decode the MAC CE. In order to reumse the RRC connection for non-SDT data, the UE context shall be transferred from source to target. Therefore, which node to decode the indication would result in different signaling procedure between Xn interface.  If a newly introduced MAC CE is adpoted, the general procedure is as follows:   * + - 1. Target gNB receives and decodes the MAC CE that is used to inform the arrival of non-SDT data.       2. In order to resume RRC connection, the target gNB shall request for UE context.       3. The source gNB reponses the request and transfers the UE context to target gNB.       4. The target gNB directs the UE to RRC\_CONNECTED.   If a new DCCH message is adopted, it is the source gNB to decode this indication.   * + - 1. Target gNB receives the UL data including the DCCH message that is used to inform the arrival of non-SDT data. The target gNB transfers the PDCP PDU of the DCCH message to target.       2. The source gNB can be aware of the arrivial of non-SDT data after decoding the DCCH messsage and transfers the UE context to target gNB.       3. The target gNB directs the UE to RRC\_CONNECTED. Maybe an additional indication from source gNB is needed since target gNB does not know there is a requirement to resume the RRC connection.   From the perspective to follow the legacy request-reponse Xn signaling procedure, we think MAC CE is a better a choice. |
| InterDigital | No | Agree with Nokia. |

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| Q5: Finally, for option 3 do companies agree with the overall characterization of this solution and with the open issues listed above?  Please add any further comments or questions about option 3 in company comments section so that we know the overall picture for this option. Also indicate pros and cons for this option from your perspective in the comments. | | |
| Company | Overall description is okay? (Yes/No) | Comments (pros and cons of option 3 – DCCH message) |
| LG | No | We are open for Option 3.  The problem in transmitting RRCResumeRequest message using DCCH is that the message itself is security protected. It means that if the network cannot identify the UE who transmits the RRCResumeRequest message, then the network cannot decipher the RRCResumeRequest message because the network does not know the security key used for ciphering of the RRCResumeRequest message.  Thus, the use of DCCH should be limited to the case when a dedicated UL grant is available. If dedicated UL grant is not available, the UE has to send RRCResumeRequest message using CCCH. |
| Nokia, Nokia Shanghai Bell | Yes | Furthermore, DCCH is protected by ARQ in the RLC layer. |
| ZTE | Yes | To LG comment: Our understanding is that the DCCH message will be a new message (not just retransmitting the RRCResumeReq in DCCH). Even if dedicated UL grant is not available (i.e. RACH is triggered), there is no issue in transmitting a DCCH message in MSG3/MSGA payload. So, we see no issues with this.  Pros:   1. Similar to the MAC level mechanism, we think this is much simpler than the CCCH based mechanism and has no impact to other groups 2. The reliability of DCCH based mechanism is better than that of the MAC based approach |
| Samsung | Yes |  |
| OPPO | Yes |  |
| InterDigital | Yes, but | This works assuming that the UE will transmit the DCCH message only on dedicated grants. The ul-DCCH-message is intented for transmission on dedicated grants, while MgsA/Msg3 grants can face contention and the UE identity is not necessarily known. The UE context may also be unknown for a RA at the target gNB. Typically the UE has an RRC connection prior to transmitting a DCCH message. We are fine with this option provided it can be decoded for msg3/msgA as well. |

Then, finally, we can try to converge on one solution for the non-SDT data arrival based on the above discussion.

So, based on the views expressed above, companies can express their preference on which option we can proceed with and why.

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| Q6: Which option do you prefer for indicating the arrival of data over non-SDT RB?  Note1: Please indicate your first preference in the preferred option section. However, in the comments please also provide some indication on any other option which may be acceptable from your perspective (e.g., second preference etc.).  Note 2: If option 1 is preferred, please indicate which sub-option is your preference for option 1.  Note 3: For other options if there are any specific preferences or comments, please feel free to indicate this in the comments section too. | | | | |
| Company | Preferred option | | | Comments |
| 1 | 2 | 3 |
| LG | O |  |  | Option 1 should be supported.  Option 3 may be considered when dedicated UL grant is available.  We don’t support Option 2. |
| Nokia, Nokia Shanghai Bell | Yes | No | Yes | We are ok with options 1 and 3, both would work, but option 2 would really not work well for the intended scenario. |
|  | No | May be | Yes | Option 3 (DCCH based solution) is our first preference since it seems to provide a clear solution without any impact to other groups and also needs no discussion on the security aspects.  MAC based approach is acceptable to us (second priority) if this is the majority view.  CCCH based option is not suitable in our view and RAN2 cannot agree this without consulting other groups in any case. |
| Samsung | No | Yes | Yes |  |
| OPPO | No | Yes | Yes | Actually we think both Option2 and Option3 can work. We prefer Option2 more than Option3. |
| InterDigital | Yes | No | Maybe |  |

## Bearer types for SDT

A few companies have raised the topic of bearer types that should be supported for SDT. It would be good to conclude on all the following types of bearers:

1. MN terminated MCG bearer
2. MN terminated SCG bearer
3. MN terminated split bearer
4. SN terminated MCG bearer
5. SN terminated SCG bearer
6. SN terminated split bearer

For SDT, most of companies seem to assume that only the MCG path will be resumed. If this is confirmed, then any bearer subject to SDT shall have the MCG path. Then, for SN terminated bearers, further discussion will be needed if SDT is to be supported for these bearer types and RAN3 impacts need to be clarified too. So, it is good to understand company views on whether or not to support the SN terminated bearers for SDT. Keeping these aspects in mind, companies are invited to comment on which bearer types should be supported for SDT.

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| Q7: Which bearer types can be configured for SDT?  Note: In the comments, please indicate any specific aspects that need to be considered if a given bearer type is to be supported. | | | | | | | |
| Company | Bearer type supported for SDT? Y/N | | | | | | Comments |
| 1 | 2 | 3 | 4 | 5 | 6 |
| LG | O |  |  |  |  |  | We are wondering whether SCG and split bearer configuration is kept in RRC\_INACTIVE. Even if it is kept, we are wondering whether SDT should be supported for split bearer, because split bearer is typically used for high-throughput which is not the target of SDT. |
| Nokia, Nokia Shanghai Bell | Yes | No | No | No | No | No |  |
| ZTE | Y | N | Y\* | N | N | N | For MN terminated split bearer, only the MCG path should be resumed and used for SDT  If any of the SN terminated bearer types are to be supported, this would need more discussion (e.g., on how to maintain and generate the S-KgNB). In general, we think we can focus on the MN terminated bearers for SDT work. |
| Samsung | Yes | No | No | No | No | No |  |
| OPPO | Yes | No | No | No | No | No | For simplicity, we think only DRBs with MCG path are supported in SDT. |
| InterDigital | Yes | No | No | No | No | No |  |

# Conclusion and proposals

# References

1. R2-2101954, Report for Rel-17 Small data and URLLC/IIoT and Rel-16 NR-U, Power Savings, and 2step RACH, Session Chair (InterDigital)

# Annex (contact details for email discussions)

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