3GPP TSG-RAN WG2 Meeting #116bis Electronic R2-220xxxx

Elbonia, 17 – 25 January 2022

**Agenda item: 8.6.3**

**Source: Nokia (Rapporteur)**

**Title: Report of [Post116-e][510][SDT] CCCH and DCCH (Nokia)**

**WID/SID: NR\_SmallData\_INACTIVE - Release 17**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report of the following email discussion:

* [Post116-e][510][SDT] CCCH and DCCH (Nokia)

 Scope: Aim to have CRs describing each solution and discuss technical points on the two solution such that a decision can take place next meeting.

 Deadline: Long

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

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| --- | --- | --- |
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# 3 Discussion

Agreeing on a solution option between CCCH- and DCCH-based solution for the non-SDT data arrival during SDT procedure has been challenging and open for several meetings already. Details of the solutions and related issues have been discussed, e.g., in [1-7] in the previous RAN2#116-e meeting.

The intention of this discussion is to gather companies’ views on the presented issues for both solutions to guide the discussion on agreeing on a solution basis for the long-lasting issue.

Since solution opponents for both solutions provided specific issues of the solutions, it seems fair to ask what companies think about these issues as online discussion was mainly about debating that there are open issues in both solutions without solid answers if the issues were actually meaningful in terms of specification effort. The intention would be also to describe how the issue is solved in the solution option, ie., more details of each solution should be described.

Even though both solutions on high level have been clear for pretty much everyone, they are shortly recapped hereinafter for convenience:

 When SDT procedure is ongoing (ie., SDT has been initiated by RRC layer) and data arrives into a buffer of at least one SRB/DRB not configured for SDT, the UE

* DCCH solution: triggers a transmission of an RRC message over SRB1 (tbc.) indicating the availability of data in the buffer of the SRB(s)/DRB(s) not configured for SDT. The RRC message is transmitted as SDT data in the SDT procedure. Based on the RRC message, the NW may bring the UE into CONNECTED mode.
* CCCH solution: terminates the SDT procedure and triggers an RRC resume procedure (non-SDT). Based on the *RRCResumeRequest*, the NW may bring the UE into CONNECTED mode.

## 3.1 Questions on DCCH based solution

[2, 6] provides a set of open issues wrt. DCCH-based solution. These issues are discussed hereinafter.

Firstly, it should be discussed whether a new resume cause is needed, e.g. if non-SDT is triggered by RNA update or signalling while SDT was triggered for data etc. The CT1 reply on this aspect provided in [8] is not completely clear but seems to assume that for suspended resources, NAS will require Service Request procedure to be initiated and NAS will need to provide UAC parameters based on the reason for that Service Request. This may need to be further clarified from CT1.

**Question 1**: Do you agree that resume cause needs to be indicated in the RRC message for non-SDT data indication for DCCH based solution? Further, should this be confirmed from CT1 with an LS?

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| Answers to Question 1 |
| Company | Yes/No | CT1 LS: Yes/No | Technical Arguments |
| ZTE | No | No | Firstly, we think this discussion is common to CCCH and DCCH solutions. We need to design the solution to work independent of NAS triggers for both CCCH and DCCH case. Then, we want to point out that none of this is new (i.e., even in legacy resume, new data or new NAS procedure can arrive whilst T319 is running). The current behaviour is that once a resume procedure is initiated (i.e. T319 is running), AS doesn’t respond to any new triggers from NAS except NAS abort procedure. This legacy behaviour should not be changed in Rel-17 just for SDT! If we change this behaviour for SDT, then we will have two procedures in AS (when SDT is running, AS will respond to new triggers from NAS whilst when SDT is not running, AS will continue with existing resume procedure and such a situation is not good). Hence, the non-SDT data arrival indication should be fully handled within AS without any need for NAS triggers both for CCCH and DCCH solutions.  Thus, for non-SDT data arrival, we don’t think the resume cause is needed in the DCCH message. In our view, non-SDT data arrival indication is a RAN level indication used to indicate to the network that there is new data which is for non-SDT RBs. This is consistent with the feedback from CT1 [8] that “once small data transmission is initiated the UAC parameters (access category and access identity) for subsequent UL data for non-SDT DRBs to use will be the same as those for UL data for SDT DRBs”, it seems the resume cause will not change during the SDT, thus there is no need to include the resume cause again in the DCCH message.Even further, we think if there is some ambiguity here, we should actually clarify it for legacy resume first! But, we think the AS procedure here is fairly clear (i.e. once there is an ongoing resume procedure, AS doesn’t respond to any further triggers from NAS until the previous resume procedure is complete and this legacy behvaiour should not be changed).  |
| Samsung | No | No | We do not see any need to indicate resume cause. |
| Intel | No | No | On the RNA topic, how RNAU is handled in relation to an SDT procedure needs to be discussed by RAN2 independently on which solution is chosen to handle the non-SDT traffic during an SDT session. We explained in R2-2109620 that two possible behaviours are proposed by companies:* Option 1) T380 is stopped upon start of the SDT session.
* Option 2) T380 continues running upon of the SDT session. T380 will be restarted as legacy on receipt of RRC Release message.

Our preference is that periodic RNAU timer (T380) continues running during the SDT procedure. However, if T380 expires during an ongoing SDT proc., UE does not need to notify the network as UE already communication ongoing with the network while SDT procedure is ongoing. Therefore, there is no need to send RNAU cause value to the network while the SDT session is ongoing.On the NAS/CT1 topic, CT1 did not have consensus on the NAS handling during SDT procedure as captured in their LS C1-215152. In our understanding, there is no need to contact CT1 on this again. If CT1 reaches consensus in future meetings and agrees on the cause, RAN2 could easily incorporate it in the UL DCCH msg in used. On summary, from RAN2 point of view, it seems sufficient to notify the network that non-SDT data is available as explained in [1]. |
| OPPO | No | No | The RRC message itself can be used as the indication of non-SDT data arrival. |
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**Summary 1**: TBD.

**Proposal 1**: TBD.

Regardless of the responses to Question 1, the details of the content of the RRC message for non-SDT data indication should be discussed. For instance, is there a need to include further information on top of the indication, like SRB(s)/DRB(s) information with data, *resumeCause* (see previous question), amount of data, etc.

**Question 2**: What information should be included in the RRC message for non-SDT data indication for DCCH based solution?

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| Answers to Question 2 |
| Company | Technical Arguments |
| ZTE | Since UE only needs to inform NW the arrival of non-SDT data, we don’t see the need to have any extra information besides the message itself (i.e. an empty message as proposed in [4] is sufficient). |
| Samsung | Non SDT data indication is sufficient. |
| Intel | UE only needs to notify to the network that non-SDT data is available. This can be done via a new UL RRC message as shown in drafted CR of [4], or as a new container defined within the *UEAssistanceInformation* message as shown in the drafted CR of [7]. As we explained in previous Q1, from RAN2 point of view, there is no strictly need for UE to provide any additional information. |
| OPPO | Share same view as ZTE. No extra information needs to be included in RRC message. |
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**Summary 2**: TBD.

**Proposal 2**: TBD.

Another issue is whether a new UL RRC message would be defined, or an existing UL RRC message (like *UEAssistanceInformation*) could be utilized for the purpose.

**Question 3**: Do you prefer to introduce a new UL RRC message for the non-SDT data indication for DCCH based solution? If not, which existing UL RRC message is preferred to be utilized and why?

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| Answers to Question 3 |
| Company | Yes/No | Technical Arguments |
| ZTE | Yes, but no strong view | We have slight preference to use a new DCCH message, which can minimize the impact on specs. But if majority want to use the existing message, it is also fine. We don’t think this is a critical issue, and we can simply follow the majority view. |
| Samsung | Yes but | Slightly prefer new message as it has less overhead. However, if majority view is to use legacy message, we are ok to use *UEAssistanceInformation* |
| Intel | Yes | We have slightly preference to define a new UL RRC msg. as it seems cleaner and with less overhead (with corresponding drafted CR in [4]). However, if majority view prefers reusing an existing UL RRC msg, we are open to use *UEAssistanceInformation* message (with corresponding drafted CR in [7]).  |
| OPPO | Yes but | We prefer to use a new RRC message but we are also fine to reuse UEAssistantInformation. |
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**Summary 3**: TBD.

**Proposal 3**: TBD.

The error recovery for DCCH based solution is also unclear, unlike in CCCH based solution where T319 is started when the resume procedure is initiated. While the details of the SDT failure timer are yet unclear, generally it has been agreed to be longer than T319 to account the unknown time required to complete the SDT procedure. Hence, the SDT failure timer applicability for non-SDT data arrival is questionable, for instance, in case the non-SDT data is high priority traffic, e.g. an emergency call.

**Question 4**: Do you agree the SDT failure timer is not sufficient for error handling in case of non-SDT data indication for DCCH based solution? If yes, what should be the UE behaviour in case the network is not responding for the DCCH based non-SDT data indication?

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| Answers to Question 4 |
| Company | Yes/No | Technical Arguments |
| ZTE | No | We think SDT failure timer is sufficient.First of all it is unclear why the UE aborting the ongoing connection and initiating a new RACH procedure (which may or may not succeed) has a better chance of success than UE sending a DCCH message using dedicated resources in the ongoing connection (radio conditions won’t change just because UE decides to ignore dedicated resources such as dedicated UL grant etc). The point is that if there is some problem on the Uu, (and hence the UE finds itself in a condition where UL DCCH message is not going through), initiating a new RACH procedure (which then relies on RACH, RAR, contention resolution and then providing the same information as the original information seems to provide no advantage at all! Hence, we don’t think any additional mechanism is needed. RLC retransmission can ensure the DCCH message can reach NW successfully, and we can rely on the NW to ensure the DCCH message can be treated correctly.  |
| Samsung | No | Share ZTE’s views |
| Intel | No | We understand that SDT failure timer is defined to determine any error handling during an ongoing SDT session. Moreover, we do not understand why special error handling is required for UL RRC msg notifying that non-SDT data is available in comparison with other UL SDT signaling/data that could be sent during an ongoing SDT session. If for any failure cases, there was no response, this scenario is also equally possible/applicable to the new connection for CCCH solution. So we see no difference between the two failure cases. In addition, for the example mention of high priority traffic (e.g. an emergency call), there is no special handling defined either for a UE in RRC\_CONNECTED. On other hand, as explained in previous Q1, if CT1 were to agree that corresponding cause information is critical, RAN2 could easily incorporated it in the UL DCCH msg to be used. |
| OPPO | No | Share the same view as ZTE. |
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**Summary 4**: TBD.

**Proposal 4**: TBD.

For CCCH based solution, the NW can respond with existing RRC messages as specified. For DCCH based solution, however, this is not completely clear. For instance, can the NW respond with *RRCReject* based on the RRC message for the non-SDT data indication and would the UE go to RRC\_INACTIVE mode based on it? Furthermore, would the UE terminate the ongoing SDT procedure or continue with it?

**Question 5**: Do you agree that the NW can respond with *RRCReject* for the RRC message for the non-SDT data indication? If yes, what should be the UE behaviour in this case?

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| Answers to Question 5 |
| Company | Yes/No | Technical Arguments |
| ZTE | No | The UE has already sent an RRCResumeRequest message. So, if the network may have already retrieved the UE context and once the UE context is available, there is actually no need to use RRCReject anymore. The purpose of RRCReject is when the UE context is not yet retrieved. Of course, if the UE context has not been retrieved (or network is unable to identify the UE etc, then the network can send RRCReject to the UE – this is legacy behaviour). So, whether or not RRCReject is used depends on whether or not network is able to retrieve the UE context. This has nothing to do with CCCH or DCCH solution to be used! The actual UE behaviour upon receiving the RRCReject is also the same as legacy and needs no changes (as this can only happen in case UE context is not retrieved).  |
| Samsung | No | Share ZTE’s views |
| Intel | No | We understand that RRCReject msg can only be used in respond to the RRCResumeRequest msg. When UE has an ongoing SDT procedure with UL/DL SDT data being exchanged, we understand that network should not respond with RRCReject. If there is a congestion situation, network can always choose to send RRCRelease msg to terminate the SDT procedure similarly to legacy operation in RRC\_CONNECTED. |
| OPPO | No | RRCReject is one of the responses to RRCResumeRequest/RRCSetupRequest. We do not think this message can be used as the feedback for a DCCH message. In addition, RRCReject can be sent after RRCResumeRequest is received for overload balancing, it is unreasonable to send an RRCReject message in an ongoing SDT procedure. |
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**Summary 5**: TBD.

**Proposal 5**: TBD.

Another case described in [6] is in case the NW initiates the transmission of *RRCRelease* message before receiving the RRC message for non-SDT data indication from the UE, what would be the UE behaviour. Naturally, the UE does not know if the NW received the non-SDT data indication before or after triggering the RRC Release.

**Question 6**: What should be the UE behaviour in case it receives *RRCRelease* message after transmitting the RRC message for non-SDT data indication to NW?

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| Answers to Question 6 |
| Company | Technical Arguments |
| ZTE | No matter non-SDT data indication has been send or not, once RRC release message is received and there is data still buffered on UE side, the UE will initiate another resume procedure accordingly, which is the same as the current resume procedure triggered by DL Non-SDT data in case SDT without anchor relocation.By the way this exact case can happen today in connected mode as pointed out multiple times! i.e. UE is in connected mode, new pending data or NAS procedure is initiated, but, network sends RRCRelease to the UE (before the new procedure is completed). Then what is the UE behaviour in the above case? The same behaviour would also apply for this case too.  |
| Samsung | UE will process the RRC Release in same manner irrespective of whether it has send non-SDT data indication or not. After processing the RRC Release, if there is data in buffer, UE will initiate resume procedure as usual. |
| Intel | As we explained in [7], if this happens there will be pending data or NAS procedure and hence a new connection will be triggered by NAS. Further, it should be noted that this can happen anyway even today for a UE in RRC\_CONNECTED. For example, UE may be in connected mode and may receive *RRCRelease* msg just when the upper layers in UE initiates some new procedure (which the network is not yet aware of). And we don’t say that the UE terminates the ongoing procedure autonomously in this case. Moreover, even in CCCH case, if the UE sends second *RRCResumeRequest* message, the network can still send RRCRelease for the ongoing SDT session before the gNB can decode the 2nd *RRCResumeRequest* message. The consequences of such collision case for CCCH solution could be even worse. If the network sent an *RRCRelease* msg just as the UE is aborting the SDT session (or just after), the UE will not receive the *RRCRelease* msg (as it is not monitoring the C-RNTI of the aborted SDT session). The network is not aware of UE’s aborting actions (i.e. not monitoring of the PDCCH) neither that the UE has not received the *RRCRelease* msg of the SDT procedure successfully terminated. Now if the UE sends the second *RRCResumeRequest*, the network will treat this as a normal Resume request and the second *RRCResumeRequest* for non-SDT data will fail. Recovery from this is unclear and might probably results for the UE having to go through RRC IDLE.  |
| OPPO | UE goes into normal RRC\_INACTIVE state and then trigger a new RRC resume procedure. |
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**Summary 6**: TBD.

**Proposal 6**: TBD.

RAN3 has agreed that the last serving gNB decides whether to relocate the UE context or not when the SDT procedure is initiated. However, in case the RRC message for non-SDT data indication is received by the receiving gNB, the context shall be transferred to the receiving gNB in case the UE is brought into RRC\_CONNECTED mode. This would be no longer a decision of the last serving gNB.

**Question 7**: Do you agree that the receiving gNB shall be able to indicate to the last serving gNB and force UE context relocation in case of RRC message for non-SDT data indication is received by the receiving gNB (ie., against current RAN3 agreement)?

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| Answers to Question 7 |
| Company | Yes/No | Technical Arguments |
| ZTE | No/Question is based on wrong assumption | The question seems to be based on wrong assumption that there will be context relocation in this case. But, we already agreed that this will not happen. The anchor gNB in this case will not relocate the context, but will simply send RRCRelease message (per the agreement below). So, we should not discuss this again (note there is nothing against RAN3 agreement here because the anchor gNB is still in-charge but it just sends the UE back to INACTIVE in this case). * “No new solution is defined to prevent data loss or duplication for the scenario where the anchor relocation is required in the middle of an SDT session, i.e. network can release UE back into RRC\_INACTIVE”
 |
| Samsung | No | As already agreed context relocation is not performed in the middle of the SDT procedure.  |
| Intel | No | The RAN3 agreement is when UE initiates an SDT session and not in the middle of SDT session.In addition, RAN2 already agreed that when SDT procedure is done without relocating the context, this would not be relocated in the middle, as shown in corresponding RAN2 agreement below. Reference to RAN2#115e related agreement: *“No new solution is defined to prevent data loss or duplication for the scenario where the anchor relocation is required in the middle of an SDT session, i.e. network can release UE back into RRC\_INACTIVE*”Therefore, we do not agree that it is required in Rel-17 to “*indicate to the last serving gNB and force UE context relocation in case of RRC message for non-SDT data indication is received by the receiving gNB*”. |
| OPPO | No | In our understanding, the question is focused on anchor without relocation solution. First of all, we agree with ZTE and Samsung that context relocation in the middle of SDT is precluded. In addition, we do not think receiving gNB is able to decode this DCCH message since the PDCP entity is located at anchor gNB. It is up to anchor gNB to determine whether there is non-SDT data arrival by receiving DCCH message. |
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**Summary 7**: TBD.

**Proposal 7**: TBD.

Finally, DCCH based solution is described to overperform CCCH based solution since the link between the UE and the NW is already “available”. However, since the SDT procedure is considered to be fairly short, the likelihood that the RA procedure for initial SDT transmission has not been completed upon the non-SDT data arrival into the UE buffer can be regarded also meaningful, ie., most of the time in the SDT procedure is spent in the RA procedure in case the SDT data can be included in the MSGA/Msg3 completely. Same applies for CG-SDT transmission, ie., NW may have not responded to the UE (or the UE even transmitted the initial CG transmission) before the non-SDT data arrival. Since the payload size of SDT Msg3/MsgA/CG is generally thought to be larger, the probability for it to succeed compared to regular RA procedure Msg3/MsgA could be thought to be lower – also since the UE may be moving away from cell centre.

**Question 8**: Do you agree CCCH solution would generally outperform DCCH solution when RA procedure for RA-SDT is not completed or when no response is received for initial CG-SDT transmission?

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| Answers to Question 8 |
| Company | Yes/No | Technical Arguments |
|  | No | Since RACH procedure has already been initiated, we don’t see any benefit to cancel the ongoing RACH/CG transmission and initiate another RACH procedure. Furthermore, in case of legacy RACH procedure, we don’t do this. i.e. if the RRC has initiated a RACH procedure for resume, and then if some other trigger comes from higher layer (before RACH procedure is completed), RRC doesn’t abort the ongoing RACH procedure. So, is the intention of the moderator to make the SDT procedure somehow different to the legacy RACH procedure? Seems if we go this way, we should also discuss the legacy RACH procedure then and to us it seems strange (otherwise, we will have different UE behaviour for RACH completion with and without SDT and this is not good). In addition, a new CCCH procedure will interrupt the ongoing SDT data transmission, which will lead to the lost of data over Uu and waste of resource (i.e. new CCCH is not aware of DU, and DU will schedule UE continuously for retransmission). |
| Samsung | No | First we do not agree that non SDT data indication will occur often while the initial RA procedure for SDT is ongoing. Even if it occurs, continuing RA procedure is better than terminating and initiating a new RACH procedure. |
| Intel | No to Q8 (CCCH is even worse) | We are confused by the logic used in the question.We share the view that SDT procedure should aim to be short and if so, the likelihood for non-SDT data to arrive during an ongoing SDT procedure should be very low. Just because SDT session is short, it does not increase the chance of non-SDT data arrival during RACH. The chance of non-SDT data arrival during RACH is dependent on RACH duration and the data arrival rate and does not increase because the duration of SDT session is short. Further, aborting an ongoing RACH procedure which is likely to succeed (success is more likely than failures in a system) and starting a new RACH procedure will result in longer delay for CCCH solution and worse performance.So not only do we not agree with the question but also believe that CCCH handling for this scenario is even worse. |
| OPPO  | No | For the case described above, it is confusing why UE does not wait for the feedback of the UL transmission but terminates a well-going procedure. Even for CCCH solution, we think UE can wait until the confirmation of first UL is received. Based on this understanding, we think the case can not explain why CCCH solution is more effective than DCCH solution. |
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**Summary 8**: TBD.

**Proposal 8**: TBD.

## 3.2 Questions on CCCH-based solution

[5] lists number of issues for CCCH based solution. These issues are discussed hereinafter.

Firstly, security issues are described. [5] indicates that UE autonomous horizontal key derivation when switching from SDT procedure to RRC resume procedure would violate security principles. This may need to be clarified from SA3.

**Question 9**: Do you see a concern in UE autonomous horizontal key derivation when switching from SDT procedure to RRC resume procedure? Further, should this be confirmed from SA3 with an LS?

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| Answers to Question 9 |
| Company | Yes/No | SA3 LS: Yes/No | Technical Arguments |
|  | Yes | Yes | Firstly the key derivation during RRCResume is specified in SA3 specs. There will be changes needed in this procedure (please see some details provided below in section 3.3 – for draft CRs required). So, at least to get these changes done on SA3 side, we should send an LS to SA3 (otherwise, it is unclear how SA3 will update their specs).Then, we do have concern on the UE autonomous horizontal key derivation based solution since SA3 have said such autonomous horizontal key derivation is not allowed in case of reestablishment – of course they might conclude this case is different but we are not sure if RAN2 can simply make such assumption and proceed. What we want to avoid is that we proceed with this assumption when companies block this solution in SA3! This is the main reason whey we are a bit concerned about proceeding with CCCH only approach. Then, we need to agree the following details first and we are not sure which group should agree these (these details are captured in SA3 spec (see 33.501 – extract below in section 3.3). * How to understand the UE autonomous horizontal key derivation here. Whether the UE autonomous horizontal key derivation will be made based on the key stored in INACTIVE UE context (the one used before UE enter INACTIVE state), or the new one derived in the SDT operation.
* How to handle the mismatch between UE side and NW side in case the original CCCH has not been confirmed before the new CCCH procedure is initiated.
* Which NW entity will do the UE verification and key derivation in case the UE context has been relocated in SDT operation, whether new RAN3 procedure will be required?
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| Samsung | Yes | Yes | RAN2 cannot decide this aspect. This should be discussed in SA3 |
| Intel | Yes | Yes | By default, we check with SA3 when we make any security related changes. As we explained in [7], we understand that this point hence needs to be checked with SA3 as the usage of horizontal key derivation on UE side creates potential new risks on SA3 security requirement for forward security. In previous SA3 LS S3-182541, the proposal (in case of reestablishment) was that the UE autonomously derives a new key (after reestablishment) and this new key is horizontally derived according to the solution on the table at that time and SA3 did not allow such mechanism at that point (quoting the above violation). Simple horizontal key derivation is not the only issue, the issue is also that the network may have a new {NH, NCC} pair whilst the UE is autonomously performing horizontal key derivation despite this. |
| OPPO | Yes | Yes | Similar issue has been ever discussed for legacy RRC resume procedure. When T319 expires or cell is re-selected during an ongoing RRC resume procedure, UE will go to IDLE. One of the reasons why UE does not keep in RRC\_INACTIVE and trigger another RRCresume procedure is there is no NCC to derive a new security key. Consecutive horizontal key derivation has also been discussed but was not adopted. We think it is better to follow the results of previous discussion otherwise RAN2/SA3 has to revisit what have been agreed. |
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**Summary 9**: TBD.

**Proposal 9**: TBD.

[5] further indicates that same security key would be used by two NW nodes in case the KgNB used to cipher the UL data during the SDT procedure is used as input key for the *resumeMAC-I* generation for the *RRCResumeRequest* used for the non-SDT data indication. This may need to be clarified from SA3.

**Question 10**: Do you see a concern in using the same KgNB used to cipher the UL data during SDT procedure for *resumeMAC-I* generation for the *RRCResumeRequest* used for non-SDT data indication? Further, should this be confirmed from SA3 with an LS?

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| Answers to Question 10 |
| Company | Yes/No | SA3 LS: Yes/No | Technical Arguments |
|  | Yes | Yes | We presume this question is about the key reuse issue identified with horizontal key derivation. From what we understand, the CCCH proponents are arguing that although the same key is used in two different nodes, it is okay because one key is used just for resumeMAC-I verification in the anchor node whilst the same key is used for integrity protection in the other node. May be this argument can satisfy SA3, but may be this won’t. From our side the main concern is that if we rule out DCCH solution (which will of course have no such issues), and if SA3 says that this is not allowed, then we will be in a situation where we have nothing for this! This situation should be avoided. In any case, SA3 should be consulted on the overall new security framework regardless of what we decide (not only to check it but also to implement it as noted above).  |
| Samsung | Yes | Yes | Whether same key can be used in two different nodes should be be discussed in SA3 |
| Intel | Yes | Yes | As we explained in [7], we understand that SA3 needs to be at the minimum contacted to confirm that there is no issue as this scenario has never done before. There are two points that should be confirmed with SA3:1. The same KgNB is used by two different network nodes, firstly by the current gNB for data before the new CCCH message (i.e. during the ongoing SDT procedure) and then by the old gNB to verify the *ResumeMAC-I* for the second CCCH message (i.e. after the non-SDT data is detected and UE autonomously terminates the ongoing SDT procedure).
2. KgNB key is specific to a cell and the cell ARFCN-DL is used to derive the key [TS33.501§A.1]. The solution will require the key that is specific to the UE’s current cell now being used by the old cell to verify *ResumeMAC-I* for the second CCCH message
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| OPPO | Yes | Yes | Check with SA3 |
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**Summary 10**: TBD.

**Proposal 10**: TBD.

On the other hand, it was not completely clear if the horizontally generated key would be used for the *resumeMAC-I* generation for the *RRCResumeRequest* used for non-SDT data indication. Or whether another solution is intended.

**Question 11**: What key should be used and which input parameters for the *resumeMAC-I* generation for the *RRCResumeRequest* used for non-SDT data indication?

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| Answers to Question 11 |
| Company | Yes/No | Technical Arguments |
|  | TBD | Firstly different solutions will have different consequences and different implications on other groups. Unless we have a fixed solution on the table that we can all agree on as the CCCH candidate, it is impossible to evaluate all implications. Our main concern is that we are now running out of time to discuss all solutions. So, we think we should just stick with one flavour (perhaps the horizontal key derivation one) and check if this works or not.  |
| Intel | Discussion with SA3 required before a solution can be finalized by RAN2 | This depends on how CCCH approach works which is still not fully clear to us as different proposals were described in [2] and during the corresponding online discussions. Our understanding from [2] is that * (1) Resume MAC-I calculation/inputs needs to be updated for the 2nd RRCResumeRequest msg. Different inputs of the resumeMAC-I can be updated by using for example
	+ (a) The KRRCint key used during the SDT proc. (instead of the one stored in the UE AS Inactive Context before initiating the SDT proc); or,
	+ (b) The COUNT is updated in TS 33.501 to start in 2 (instead of 1)
* (2) Horizonal key derivation for subsequent data is done as proposed in CCCH solution.

With CCCH solution, the security risk of re-use of the same I-RNTI across two SDT sessions needs to be verified with SA3 as previous LS response from SA3 (R2-2109065) was not clear on this regard. In normal Resume procedure, a different I-RNTI is allocated for each Resume so the same I-RNTI is not used across two sessions to prevent tracking the UE. Another related open item raised during email disc. 507 is about which *source-c-RNTI* should use when calculating the *VarResumeMAC-Input*  for the 2nd *RRCResumeRequest.* E.g. should this be the one used when UE was previously CONNECTED or new on in used during the SDT operation.*VarResumeMAC-Input  ::=     SEQUENCE* *{    sourcePhysCellId                        PhysCellId,*  *targetCellIdentity                      CellIdentity,*  *source-c-RNTI                           RNTI-Value }*This last topic requires coordination with SA3 as it was not asked in previous LS. |
| OPPO | Up to SA3 inputs |  |
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**Summary 11**: TBD.

**Proposal 11**: TBD.

Next issue described is that the security keys between UE and network may go out of sync (e.g. if the 2nd *RRCResumeRequest* used for non-SDT data indication using the new key is sent before the contention resolution of the 1st *RRCResumeRequest* is completed, ie., in the SDT procedure). On the other hand, it seems the UE could take this into account already when terminating the SDT procedure and initiating the RRC resume procedure for non-SDT data indication in which case it could use the initial key which should work as in legacy.

**Question 12**: Do you agree the UE can use the initial key (the same key used for *resumeMAC-I* for the *RRCResumeRequest* in SDT procedure) for deriving the *resumeMAC-I* for the *RRCResumeRequest* used for non-SDT data indication in case the RA procedure of the SDT procedure is not completed?

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| Answers to Question 12 |
| Company | Yes/No | Technical Arguments |
|  | No | Since RRC layer has no idea whether the RACH procedure is completed in MAC or not. Even in case the RACH procedure is still ongoing, UE has no idea whether first CCCH message has been received by NW successfully or not.In addition, SA3 highlight in the LS that such kind of repetition should be avoided. Hence, we think the UE behaviour should be independent of the success or failure of the previous RACH procedure. So, UE should always derive a new key after sending RRCResumeRequest first time. Of course the consequence of this is that if the first CCCH message is not received, then the resume may not succeed. This is a suboptimality that we need to live with in case we go this way.  |
| Samsung | No | Prefer to have same solution irrespective of whether RA procedure is completed or not. |
| Intel | No (see comment) | We understand there are multiple network/UE synchronization scenarios to be discussed. The respond to Q12 would depend on the response in previous Q11 (i.e. which input is modified to the resumeMAC-I calculation of the 2nd RRCResumeRequest), and on when the UE is allowed to abort the RA procedure associated with an SDT procedure to initiate the non-SDT data. If the UE is allowed to abort it during the first RA-SDT RACH attempt, it can result in a mismatch between UE and network as the network is expecting the first *RRCResumeRequest* while the UE is sending the second non-SDT data *RRCResumeRequest* with a potentially different calculation of the resumeMAC-I. In addition, UE might perform horizontal key derivation for the subsequent data while the network is not aware of the key being used by the UE. |
| OPPO | No | Why not wait until RACH procedure is completed? |
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**Summary 12**: TBD.

**Proposal 12**: TBD.

Data loss is indicated in [5] to be a bigger concern compared to DCCH based solution as the NW may be transmitting DL SDT data and UL SDT data in the UE could be lost. While the DL data is more for NW implementation to handle, the UL data loss should be discussed. Currently, the UE discards all stored PDCP PDUs upon suspend procedure while the PDCP SDUs should be kept. In that sense, it seems the UL data loss should be less of an issue.

**Question 13**: Do you agree the PDCP entity retains the PDCP SDUs in the buffer upon PDCP entity suspend and, hence, the data loss in UL should basically not happen in case of CCCH based solution? Do you see a concern in DL data handling?

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| Answers to Question 13 |
| Company | UL data Yes/No | DL data Yes/No | Technical Arguments |
| ZTE | No | No | One issue is whether the COUNT value will be reset or not in PDCP suspend operation. If PDCP Count is reset (current behaviour in PDCP suspend operation), then there is no way to ensure the lossless transmission since there is no way to ensure the in order transmission without redundant packet. In addition, the data packet for UM DRB will be lost. Although the data lost in UM DRB is allowed, it should be avoided as much as possible. |
| Samsung |  |  | In DL data loss can occur for UM DRBs. In UL, whether to reset COUNT or not should be discussed. |
| Intel | See comment | See comment | We agree that UL and DL SDT data when not acknowledge would be buffered in UE and network side. The specifications need to be updated to guarantee that the UE (re)transmits that UL SDT data. However, we understand there might be problems to (re)transmit the corresponding DL SDT data unless new mechanism are defined. To address this, RAN2/RAN3 would require discussion and coordination on their work as normally the network does not associate a new connection request with the data from the old one. In addition, RAN3 impact might be larger than just stage-2 impact e.g. old\_ anchor gNB performs MAC-I verification for the 2nd RRCResumeRequest when the serving gNB already has a UE context and UL/DL data in its buffers, therefore the relocation of the UE context requires some update at the minimum to perform *ResumeMAC-I* verification and not to lose the DL data already available in UE’s buffers. How this may be done should be discussed by RAN3On top of the data loss, there could also potentially be duplication of data (due to PDCP suspend operation). By suspending PDCP, the PDCP SNs are reset and hence it is not possible to detect and discard duplicates if the network and UE were to re-tx from the last acked packet before the second CCCH message. In addition, duplicates could be just as disruptive to TCP as data lost and this does not occur in case of DCCH which is a key difference. Another concern with the data handling is that the DL SDT data unnecessarily sent and loss over Uu when the network keeps sending it whilst the UE is in the middle of a new UL procedure after autonomously had aborted a previously good SDT procedure (which the network is not aware of).  |
| OPPO | No | No | Depends on whether COUNT is reset and the security key used for the newly triggered RRC resume procedure. |
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**Summary 13**: TBD.

**Proposal 13**: TBD.

Another issue is how the NW would identify the *RRCResumeRequest* used for non-SDT data indication, e.g., in the case the NW did not know the UE attempted SDT before the RRC resume procedure. For instance, is there a need to specify a new *resumeCause* for the purpose, does the UE indicate this in an LCID in the MAC layer (similarly to RedCap identification indication), is the UE provisioned with different I-RNTI to use in this case, or is this left to NW implementation.

**Question 14**: Do you agree the UE shall indicate to NW the *RRCResumeRequest* is used for non-SDT data indication? If yes, which solution should be specified for this purpose?

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| Answers to Question 14 |
| Company | Yes/No | Technical Arguments |
| ZTE | Depends | It depends on the detailed solution. If the existing CCCH procedure can be reused as it is, then there is no need to indicate this; otherwise, if different CCCH approach is expected from legacy resume procedure, then NW has to distinguish the two cases. From our point of view, the main intention of CCCH solution is to reuse the existing CCCH approach. If we introduce a new CCCH procedure, then the benefit of CCCH solution is gone and we are just left with all the disadvantages (such as lost data over Uu, extra latency in providing non-SDT data arrival indication etc). |
| Samsung |  | Prefer to reuse the existing procedure. |
| Intel | Depends | We understand that the network needs to be able to differentiate that this is a 2nd *RRCResumeRequest* msg that was initiated in the middle of the SDT procedure, however how this is done depends on how CCCH solution is modelled. Therefore, the solution may depend on the response in previous Q11 i.e. which input is modified to the *resumeMAC-I* calculation of the 2nd *RRCResumeRequest*. Alternatively, it was mentioned during email discussion 507, that the I-RNTI could be used by network to detect this. On this topic, it is important to mention, that previous SA3 LS was not clear on whether I-RNTI needed to also be updated as discussed during August online session. |
| OPPO |  | If the security keys used for first and second RRC resume procedure are same, including the ones applied for the generation of resumeMAC-I and data ciphering, there is no need to make the distinguish. Otherwise, it is important for the network to know whether this is the second RRCResumeRequest in order to decide the security to use. |
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**Summary 14**: TBD.

**Proposal 14**: TBD.

Similarly to DCCH based solution wrt. Question 7, some RAN3 impact may be foreseen when the new *RRCResumeRequest* used for non-SDT data indication is received by the NW. For instance, whether the UE context shall not be released by the last serving gNB only after the SDT procedure for the UE is completed (either by moving the UE into CONNECTED mode or directing back to INACTIVE mode). On the other hand, if the context was already relocated, would it not be possible for the receiving gNB to perform the UE integrity check in this case; while, in case the context was not already relocated, then the last serving gNB obviously has the context and could do the check.

**Question 15**: Do you see that there may be some RAN3 impact with the CCCH solution? If yes, what impact is foreseen, and do you see a concern with it?

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| Answers to Question 15 |
| Company | Yes/No | Technical Arguments |
| ZTE | Yes | We need to first decide which node performs the verification. Since IRNTI will be used, our assumption is that the verification of the second CCCH message is done by the old anchor gNB. Then when there was anchor relocation up front, there will be some impacts to RAN3 in this case as noted above. Moderator seems to indicate that the new target gNB can do the verification, may be this is possible, but this also needs some changes in RAN3 since we assume the old I-RNTI always points to the old anchor gNB. If we want the target gNB to verify the new resumeMAC-I, then it seems we need some new behaviour here (also some restriction is needed in the network to say that the I-RNTI shall not be reused until the UE is released). Seems this is needs some RAN3 discussion.  |
| Samsung | Yes | As per current procedure resumeMAC-I is always verified by old anchor gNB. If same is followed for resume for non SDT data indication, UE context needs to be stored in old anchor gNB even after the context is transferred to serving gNB during the SDT procedure. If resumeMAC-I is verified by new GNB , this is a new behaviour and needs to be discussed and specified by RAN3. |
| Intel | Yes | Expected RAN3 impacts are:* (A) Old\_ anchor gNB needs to keep the UE context after the actual UE context is transferred to the current/serving gNB for the ongoing SDT session. This is because:
	+ 1) To perform Resume-MAC-I verification of the second CCCH message even after the UE context is transferred to the current gNB.
	+ 2) The I-RNTI in the second CCCH message is the old I-RNTI from the old anchor gNB
* (B) RAN3 also needs to discuss when and how this UE context in the old anchor gNB can eventually be released.
* (C) Old anchor gNB needs to differentiate the 2nd *RRCResumeRequest* message and use the new gNB key to verify the ResumeMAC-I.
* (D) The inputs to the *ResumeMAC-I* calculation is not decided. If it is based on the current C-RNTI (of the new gNB) used during the SDT data transfer before the second CCCH message, RAN3 has to discuss and define a mechanism to transfer that C-RNTI to the old anchor gNB. If it is the old C-RNTI used in the anchor gNB, RAN3 has to define a mechanism to ensure that this is reserved and not used by another UE (this will also require changes to UE handling to store the use the C-RNTI of the old anchor gNB)
* (E) Old anchor gNB needs to indicate to the new anchor gNB using new Xn message to move a UE (w/ context previously relocated) to RRC\_CONNECTED state. This would allow the serving gNB not to lose that DL data already available in buffers (i.e. stored during the SDT procedure that was terminated by UE autonomously).
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| OPPO | Yes | Share same view as Samsung. |
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**Summary 15**: TBD.

**Proposal 15**: TBD.

Last question in [5] considers cell re-selection during SDT procedure. This should generally not be the decision point to select between DCCH and CCCH based solution since regardless of the CCCH solution, the cell re-selection case may not be specified. However, it would be good to get an understanding if companies would prefer this case to be specified in case the CCCH solution is selected.

**Question 16**: Would you agree to specify to specify solution based on the CCCH based solution for cell re-selection during SDT procedure (in case CCCH based solution is agreed to be specified)?

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| Answers to Question 16 |
| Company | Yes/No | Technical Arguments |
|  | No | Our concern is that this is now getting too late to specify this solution in Rel-17 in any case and there seems to be no willingness to specify this in the first place unfortunately. We thought we could do this in Rel-18 but seems this will not happen either. Overall, we think companies believe that this is not important anymore. Hence, we are concerned that it is too late now to consider this case. Then, if majority of companies prefer to now also cover this solution for cell reselection, then we could use CCCH solution only for cell reselection. If it is only the cell re-selection, then we can simply reuse the same key for the previous RRC Resume Request to derive the resume MAC-I for the second CCCH, and there will be no security issues for such case (since the cell ID will be different). However, RAN3 impact will still be there, and more discussion is required to understand the whole picture of the solution. We are not sure if this is really feasible now with the time left.  |
| Samsung | No | We have already agreed that UE transition to RRC\_IDLE upon cell reselection. No need to re-open this discussion.  |
| Intel | See comment | RAN2 already agreed not to enable cell reselection scenario in Rel-17 as baseline.*“3. Events that trigger a termination or failure of an ongoing SDT session 1) cell reselection, 2) expiry of the SDT failure detection timer, 3) when Max retx is reached in RLC. RLC AM max retransmission functionality remains unchanged.* *4. When a UE detects a failure of an ongoing SDT session, UE transitions autonomously into RRC\_IDLE (as baseline solution). If time allows or have a ready solution we can consider further optimizations.”*Therefore, we prefer focus RAN2 limited work to enable the solution required to handle non-SDT data during an SDT procedure without adding other scenario that will increase the work load. If time is available for this WI after concluding the other solution, we are open to discuss the required solution to handle cell reselection scenario. However, from Rel-18 SDT discussions, we understand that this was not an scenario supported by majority of companies. |
| OPPO | No |  |
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**Summary 16**: TBD.

**Proposal 16**: TBD.

## 3.3 Draft CRs

In the previous meeting, [2] (Annex) and [4] presented initial RRC CRs for the CCCH based solution and DCCH based solution, respectively. Given the above issues not resolved, complete CRs could not be presented before the issues are resolved. However, companies are being asked if the above CR drafts can be used as baseline for both of the solutions and start from those when further details are clarified based on the questions.

**Question 17**: Do you agree to use [2] (Annex) and [4] CR drafts as baseline CRs for the CCCH based solution and DCCH based solution, respectively? If not, what are the issues?

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| Answers to Question 17 |
| Company | CCCHYes/No | DCCHYes/No | Technical Arguments |
|  | Further changes needed (see comments) | Yes | We are fine with the DCCH CR and if any updates are needed based on the majority views above, this can be done within RAN2 for this approach. For the CCCH CR, further discussion is needed for the following aspect:* Since the PDCP suspend operation is performed for each DRB, lossless transmission can not be ensured (out of order packet and redundant packet can not be avoided).
* The security part need to be confirmed by SA3 first.
* Since NAS layer will not distinguish the SDT DRB and Non-SDT DRB, the triggering of second CCCH procedure should be captured in RAN (e.g. the second CCCH shall only be triggered in case there is data available for non-SDT DRB).

We also think the CR needs some further changes as noted below: Then for SA3 specs, we need to change the following too and there may be other changes need… (up to SA3). The actual changes will depend on the solution chosen… for the horizontal key derivation, we need SA3 to modify the following procedure (assuming SA3 are okay with this).  |
| Samsung | No | Yes | Agree with changes suggested by ZTE for RRC CR. Security aspects and related impact to SA3 spec can be discussed by SA3. |
| Intel | Functional changes are missing | Yes (see comment) | For DCCH, if majority of companies prefer using a new UL RRC msg, the draft CR is available in [4], however for *UEAssistanceInformation* message, the draft CR is available in Annex of [7].For CCCH, many details still need to be confirmed with SA3 and RAN3 with regard to the feasibility of the actual solution. Or even if another option is chosen for the security and network handling. For the specific version of the CCCH solution proposed in the CR, we understand that this CR is not capturing all required details to enable the actual solution. Some of the issues and/or missing parts are the following:* (A) Aborting of the ongoing SDT session on non-SDT data arrival is not captured.
* (B) Potential data loss, out of order delivery and interruption as PDCP is suspended which results on a reset of the PDCP COUNT (issue #6 of [5]). There would be needed to capture something on RAN2/RAN3 TS e.g. UP for the handling of the DL data stored in gNB’s buffer.
* (C) It is not captured how 2nd *RRCResumeRequest* message is differentiated e.g. different calculation of the *resumeMAC-I*.
* (D) It is not captured how UE autonomously performs the horizonal key derivation for subsequent data (after the 2nd *RRCResumeRequest* message).
* (E) FFS if any change is needed to the information stored in the UE AS Context e.g.
	+ 1) C-RNTI in used during the SDT proc. and this depends on RAN3 decisions on whether C-RNTI can be stored in the old gNB or new C-RNTI can be provided to the old gNB. so, FFS whether there is any impact in old anchor gNB when having to decode the 2nd *RRCResumeRequest* message.
	+ 2) I-RNTI used in the second CCCH-message. FFS whether I-RNTI needs to be updated for the 2nd CCCH msg, this might need to be checked again with SA3 as previously explained.
* (F) FFS if any new mechanism to guarantee that the security keys between UE and network are not go out of sync (e.g. if the 2nd *RRCResumeRequest* using the new key is sent before the contention resolution of the 1st *RRCResumeRequest* is completed or if the 2nd *RRCResumeRequest* using the new key is sent when network has sent the *RRCRelease* msg associated to the successful termination of the SDT proc.).
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| OPPO | No | Yes | Agree with ZTE. |
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**Summary 17**: TBD.

**Proposal 17**: TBD.

## 3.4 Preferred option(s) & possible compromise

The selection process between DCCH and CCCH based solutions have been in a deadlock for a while and a compromise proposal to specify both solutions was presented in the previous meeting. For instance, such that the CCCH based solution is used in case the RA procedure for the SDT procedure has not been completed or no NW response has been received for the initial CG-SDT transmission; and DCCH based solution is used after this point. Naturally, this would require more discussion after the above issues are resolved if the compromise would be preferred by most of the companies.

In the following, companies are asked still to provide their preferred option(s) from the following:

 - Option 1: DCCH solution

 - Option 2: CCCH solution

 - Option 3: Compromise solution (ie., both)

If you are OK with both options individually **but not with compromise solution** please indicate Option 1/2.

**Question 18**: Which option(s) do you prefer?

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| Answers to Question 18 |
| Company | Option(s) | Technical Arguments |
|  | Option 1 | Option 1 should be adopted for Non-SDT data arrival. Option 3 can be considered for cell re-selection case, but only if we have a consensus to support this (this is probably too late otherwise). |
| Samsung | Option 1 |  |
| Intel | Option 1  | Our first preference is option 1 but we are not opposed to consider option 3 in certain scenarios. As we mentioned earlier, apart from the performance issues with CCCH solution, the other main issue with the CCCH solution is the impact on RAN3 and SA3 which will take time to resolve and makes it difficult to complete in Rel-17. Considering the limited time left for Rel-17, another alternative compromise could be to introduce the DCCH solution for Rel-17 and the CCCH solution in Rel-18 along with the failure recovery handling where SDT session ends abruptly i.e. without UE control. |
| OPPO | Option 1 |  |
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**Summary 18**: TBD.

**Proposal 18**: TBD.

# 4 Conclusion

TBD.

# References

[1] [R2-2109617](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2109617.zip) DCCH-based indication of non-SDT data arrival, Intel Corporation, ZTE corporation, Sanechips, Samsung, CMCC, Qualcomm, OPPO, Sharp, Xiaomi, Sony, CATT, FGI, Asia Pacific Telecom, Radisys

[2] [R2-2110596](file:///C%3A%5Cevutukuri%5Cwork%5C5G%5CRAN2%5Cdocs%5CR2-2110596.zip) Non-SDT data arrival, Huawei, HiSilicon, InterDigital, LGE, Ericsson, ASUSTeK, Nokia, Nokia Shanghai Bell, Google, Rakuten Mobile, Fujitsu, NEC

[3] [R2-2109619](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2109619.zip) DCCH vs CCCH based approach for indication of non-SDT data arrival, Intel Corporation, ZTE corporation, Sanechips, Samsung, Qualcomm, OPPO, Sharp, Xiaomi, Sony, CATT, Apple

[4] [R2-2109618](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2109618.zip) Draft CR for introduction of DCCH solution for non-SDT data arrival, ZTE corporation, Sanechips, Intel Corporation, Samsung, CMCC, Qualcomm, OPPO, Sharp, Xiaomi, Sony, CATT, FGI, Asia Pacific Telecom, Radisys

[5] [R2-2111275](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2111275.zip) Comments on the proposed CCCH solution for non-SDT data arrival, Intel Corporation, Apple, ZTE

[6] [R2-2111509](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2111509.zip) Further clarifications on non-SDT arrival solutions, Huawei, HiSilicon, InterDigital, LGE, Ericsson, ASUSTeK, Nokia, Nokia Shanghai Bell, Google, NEC, Fujitsu, Rakuten Mobile

[7] [R2-2111523](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2111523.zip) Comments to [R2-2111509](file://D://__%E4%BC%9A%E8%AE%AE%5C2021%5C202111_RAN2%5CTSGR2_116-e%5CDocs%5CR2-2111509.zip) for non-SDT data arrival, Intel Corporation, ZTE corporation, Sanechips, Samsung, Xiaomi, Qualcomm, Apple, Radisys

[8] [R2-2109308](file:///C%3A%5Cevutukuri%5Cwork%5C5G%5CRAN2%5Cdocs%5CR2-2109308.zip), Reply LS on Small data transmission, Source: CT1