**3GPP TSG RAN WG1 Meeting #100bis-E R1-2002806**

**e-Meeting, April 20 – 30, 2020**

**Source: Moderator (Intel Corporation)**

**Title: Summary of email discussions for [100b-e-NR-Mob-Enh-01]**

**Agenda item: 7.2.9**

**Document for: Discussion**

# Introduction

In this contribution, we summarize the email discussion approved for discussion during RAN1 #100bis-E. Chairman has approved three email discussion threads for RAN1 #100bis-E. The following are the approved email discussions:

* [100b-e-NR-Mob-Enh-01] Email discussion/approval on UL cancellation in UL DAPS-HO by 4/24; if necessary, followed by endorsing the corresponding TP by 4/30 – Daewon (Intel)
* [100b-e-NR-Mob-Enh-02] Email discussion/approval on power sharing mode for UL DAPS-HO by 4/23; if necessary, followed by endorsing the corresponding TP by 4/29 – Daewon (Intel)
* [100b-e-NR-Mob-Enh-03] Email discussion/approval on PDCCH/PDSCH restrictions for DL DAPS-HO by 4/22; if necessary, followed by endorsing the corresponding TP by 4/28 – Daewon (Intel)

This contribution summarizes the email discussion for [100b-e-NR-Mob-Enh-01].

# Email Discussion [100b-e-NR-Mob-Enh-01]

This discussion is regarding the uplink cancellation in UL DAPS-HO (Issue #2 from [11]).

**Issue and Proposal Summary:**

The DAPS-HO allows for UEs that support dynamic power sharing to drop (or cancel) transmissions of less-prioritized transmission, namely transmission from the source cell. However, UE may not be completely aware of the transmission collision of source and target until a specific time before the transmission is about to occur. This issue has been identified during RAN1 #99 and was not completely resolved. A note was captured as part of an agreement to allow investigation further into this issue.

Several companies have provided input on this issue. The following is a summary of proposals from contributions.

* Proposal by Huawei [1]: For UL cancellation to source cell, the time interval between the end of scheduling DCI from target cell and the start of UL transmission to source cell should be at least Toffset symbols.
  + Toffset = Tproc,2, where Tproc,2 is determined according to Section 6.4 of TS 38.214, assuming d2,1 = 1, d2,2 = 0, µ corresponds to the smallest SCS between the SCS of the PDCCH in target cell and the SCS of the UL transmission to the target cell, and N2 corresponds to a PUSCH preparation time for UE processing capability 1 in Section 6.4 of TS 38.214.
  + The following is the proposed TP:

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| **15 Dual active protocol stack based handover**  < Unchanged parts are omitted >  If  - the UE does not provide *UplinkPowerSharingDAPS-HO*, and  - UE transmissions on the target cell and the source cell overlap  the UE transmits only on the target cell  If a UE indicates support of cancelling uplink transmission to the source MCG, the UE shall cancel an uplink transmission to source cell started from *Toffset* symbols after the end of PDCCH which schedules/triggers an uplink transmission to target cell that collides with the uplink transmission to source cell, where *Toffset* = *Tproc,2*, where *Tproc,2* is determined according to [6, TS 38.214] assuming *d2,1 = 1*, *d2,2**= 0*, *µ* corresponds to the smallest SCS between the SCS of the PDCCH and the SCS of the uplink transmission on the target cell, and *N2* corresponds to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214]. |

* Proposal by ZTE [2]: For collision between an ongoing UL transmission to one cell and an upcoming UL transmission to the other cell, no cancellation timeline is needed and when to stop source cell transmission in case of resource collision should be up to implementation.
* Proposal by Intel [3]: A UE does not expect to receive scheduling grant for transmission that requires cancelling a transmission for scenarios which UE cannot fully know overlapping of source and target cell transmission would happen in advance.
  + The following is proposed TP:

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| 15 Dual active protocol stack based handover *< Unchanged parts are omitted >*  UE transmissions on the target cell and the source cell overlap if they are in  - overlapping time resources if the carrier frequencies for the target MCG and the source MCG are intra-frequency and intra-band  - overlapping time resources and overlapping frequency resources if the carrier frequencies for the target MCG and the source MCG are not intra-frequency and intra-band  A UE does not expect to receive scheduling of a transmission that requires canceling the transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format and the SCS configuration of the UE transmission on the source cell. If the UE transmits PRACH using 1.25 kHz or 5 kHz SCS on the source cell, the UE determines  assuming SCS configuration .  A UE does not expect receive scheduling of a transmission that requires canceling the transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant on the target cell, after a number of symbols that is smaller than msec, where  is a time duration of  symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured,  is a time duration of  symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and the UE considers that  and  correspond to the smaller of the SCS configurations for the PDSCH on the target cell and the transmission on the source cell. For , the UE assumes  [6, TS 38.214]. |

* Proposal by Samsung [4] : The timeline based on Rel-15 uplink cancellation due to SFI (clause 11.1.1 of TS38.213) is more adequate for DAPS-HO. For the cancellation due to target cell msg3, we follows similar logic with the gap between msg2 and msg3 (clause 8.3 of TS38.213) to ensure enough processing time.
  + Uplink cancellation rule is applied to all UEs supporting DAPS-HO, including UEs provide no or semi-static power sharing capability. Asking a UE cannot do dynamic power sharing to follow a timeline based on other dynamic power sharing option feature does not make sense. This implies UplinkPowerSharingDAPS-HO=dynamic is mandated capability in DAPS-HO.
  + Depending on UE implementation, cancellation and power control may require different mechanism in the uplink transmission process. Also, T\_offset is still under discussion in NR/DC WI and it involves the time dealing with overlapping transmission among two cell groups. Since RAN2 already agreed DAPS HO involves only PCells in source and target cell, we are looking at two very different procedures here.
  + The following is the proposed TP:

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| 15 Dual active protocol stack based handover ----omitted----  UE transmissions on the target cell and the source cell overlap if they are in  - overlapping time resources if the carrier frequencies for the target MCG and the source MCG are intra-frequency and intra-band  - overlapping time resources and overlapping frequency resources if the carrier frequencies for the target MCG and the source MCG are not intra-frequency and intra-band  A UE does not expect to cancel a transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format and the SCS configuration of the UE transmission on the source cell. If the UE transmits PRACH using 1.25 kHz or 5 kHz SCS on the source cell, the UE determines  assuming SCS configuration .  A UE does not expect to cancel a transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant on the target cell, after a number of symbols that is smaller than msec, where  is a time duration of  symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured,  is a time duration of  symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and the UE considers that  and  correspond to the smaller of the SCS configurations for the PDSCH on the target cell and the transmission on the source cell. For , the UE assumes  [6, TS 38.214].  ----omitted---- |

* Proposal by Apple [6]: After the UL cancellation schemes are completed, then to determine which scheme is adopted by DAPS HO.
  + For NR-DC based scheme, it is applied to UE with dynamic power sharing capability. To compute the transmission power for SCG UL transmission starting at time T0, the UE would check the PDCH received before the T0-T\_offset that trigger an overlapping MCG UL transmission. How to determine the T\_offset is still open. If the scheme is re-used, before the source cell transmit the UL, i.e., configured grant PUSCH or dynamic grant PUSCH, it would check the target cell PDCCH scheduled PUSCH whether it is colliding with source cell transmission.
  + For eURLLC based scheme, UL transmission cancellation timeline is defined, UE will cancel the low priority UL transmission starting from Tproc, 2+d1 after end of the last symbol of the PDCCH scheduling the high priority transmission. The minimum processing time of the high priority channel is Tproc,2 +d2. Current agreements only focus on the case that high priority dynamic grant PUSCH transmission is colliding with low priority PUSCH/PUCCH. If the scheme is re-used, for DAPS HO, the open issue is the timeline of PUCCH transmission to target cell colliding with the PUSCH/PUCCH transmission to the source cell.

**Discussion Summary:**

Companies are encouraged to provide comments on the proposal above. Comments should include views on whether proposal by Huawei [1], ZTE [2], Intel [3], Samsung [4], and/or Apple [6] is/are acceptable or not. Also, if companies have a merged proposal based on proposal from above companies, please do provide them below as well.

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| Company Name | Comments/Views |
| Huawei/HiSilicon | We think Tproc,2 with N2 corresponds to a PUSCH preparation time for UE processing capability 1 would be efficient to cancel the uplink to source cell. No need to define additional timeline to address the MSG3 transmission to target cell. |
| Ericsson | We cannot leave this up to UE implementation – that could lead to that the UE never cancels the transmission to target.  We are not comfortable saying that the UE does not expect to receive a certain scheduling grant: the NW will try its best to avoid a collision and the rule is to give OK behavior also in case a collision does occur.  We believe we should have special behavior for Msg3.  The difference between the proposals in [1] and [4] is if the SCS of the source or target is used to calculate the offset. But in order to reuse something that is already in R15 of the spec, we slightly prefer the solution in [4]. We could still improve on the TP – we think the statement “last symbol of a CORESET” is imprecise, since the CORESET does not have a starting position, only a length. |
| Qualcomm | We think proposals in [3] and [4] could be starting point.  We agree some timeline should be specified for UL cancellation. However, whether UE should follow the timeline or not should be UE capability as discussed in FG 21-2a. Again, we would like to quote RAN2#107bis agreement that it is up to UE to select transmission to either source or target:   |  | | --- | | **Agreements for NR**   1. We do not support TDM pattern. 2. We leave it up to network implementation how to coordinate UL scheduling. 3. For single UL transmission, we will not specify rules how UE handles which link to transmit if UL should be sent to both source and target. |   Hence, we would like to add “For a UE indicating support of cancelling transmission to the source cell, the ~~A~~ UE does not expect to …” in the beginning of both paragraphs in proposals [3] and [4].  Furthermore, “DCI format scheduling a transmission” is mentioned in [3] and [4] – we prefer to clearly specify concrete format here e.g., either format 0\_0 or 0\_1 or both. |
| Samsung | We want to share our understanding for the differences of available TPs associated with timeline. Let’s focus on the cancellation due to dynamic transmissions other than msg3 first.  The described UE behavior from Huawei’s TP is very similar to our TP, which can deal with cancelation of part of transmission to source cell which satisfying the timeline. The differences between two TPs are mostly wording. For reference, our TP is sourced from the timeline based on Rel-15 uplink cancellation due to SFI (clause 11.1.1 of TS38.213), which has very similar uplink cancellation behavior from our view.  The description from Intel looks very similar but the UE behavior can be quite different.  Intel’s TP:  “A UE does not expect to receive scheduling of a transmission that requires canceling the transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] …”  Samsung’s TP:  “A UE does not expect to cancel a transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214]…..”  Intel’s TP sounds like UE is not required to cancel the transmission unless it receives the target cell DCI T2 symbols before the start of the source cell transmission. i.e., this corresponds to full-cancellation scheme. We chose partial cancellation since it could benefit the overall system performance during DAPS HO. Also, since partial cancellation behavior already exists in SFI handling, it does not require more complexity than Rel-15 UE. We are fine with full-cancellation as well, but the wording can be discussed further.  For Huawei’s comments regarding msg3, we are open to discuss whether this is needed. In our view, msg3 is an important component during HO so it is hard to be ignored in a WI for mobility. |
| Nokia | Firstly, we also think that RAN1 should specify the UE behavior in this aspect. The RAN2 agreement quoted by Qualcomm is just saying that RAN2 shall not specify any UE behavior in this aspect. (Thus in our view RAN1 should specify the behavior and this should be the minimum baseline capability for the UE, but that is FG discussion).  As per TP, we think proposal in [4] would be a good starting point to determine the timeline (including Msg3). |
| ZTE | We don’t see clear motivation to specify this timeline. The main reason is summarized as follows:   * **No benefit from network side.** For UL dropping due to SFI in Rel-15 and intra-UE multiplexing in URLLC, two overlapped UL transmissions belong to the same cell. It means that the gNB can know the exactly ending symbol of the dropped UL transmission according to the defined timeline. Therefore, gNB can still attempt to decode the dropped UL transmission based on the transmitted symbols and re-schedule another transmission for the same or different UE on the symbols being canceled. However, it is not the case for DAPS handover since two overlapped UL transmissions belong to different CGs. That is, the source cell cannot exactly know when the UE may stop UL transmission. Therefore, defining timeline may not bring any benefit for network. * **No benefit from UE side.** From the perspective of the UE, it can stop source transmission at any time before the UL transmission of target cell if the timeline is not defined. This is beneficial for UE implementation compared to defining timeline for cancellation since there is no restriction for cancellation time. Therefore, when to stop source cell transmission in case of resource collision can be up to UE implementation. * **Such collision should be a corner case.** It is RAN2 understanding that coordination between the source cell and the target cell is needed before performing DAPS handover in order to ensure the configuration of source cell and target cell will not exceed the UE capability. The coordination includes the UL transmission resources coordination such as the information of slots/subframes that the source cell may use to schedule for UL transmission. It can skip these slots when scheduling, i.e. target cell may not schedule UL transmission on these slots/subframes. It is very similar as the network coordination for UL subframes allocation for MCG and SCG for the UE with single UL transmission scheme in MR-DC. In addition, it would be a very short time for a UE completing DAPS handover. It make such collision really a corner case. |
| MTK | It seems majority of companies prefer to specify the timeline and corresponding UE behavior. If this is the case, we prefer the TP proposed by Intel [3]. |

**Feature lead observation and summary (based on feedback received until 4/22 3pm UTC-7):**

* Based on feedback so far, we may want to first focus on the question on whether we should specify a timeline for UE to perform UL cancellation for source cell transmission during collision cases or not.
* Once we conclude to either specify or not specify, the details of the TP could be work on further.
* Please provide 2nd round of feedback on the following questions.

**Suggested Focus for 2nd round of discussion:**

* **Part 1)** Let’s first focus on how to deal with the issue in principle:
  + **ALT A)** RAN1 to specify timing offset and related UE behavior on the UL transmission cancellation for UL DAPS for the problematic cases (e.g. intra-frequency cases, or intra-band cases, or inter-frequency cases when UE does not support simultaneous UL transmission, etc)
  + **ALT B)** RAN1 to specify a generic UE behavior and have the UE handle problematic cases by implementation
  + **ALT C)** No need to specify any additional UE behavior on UL transmission cancellation beyond what is available in current spec.
* Companies are

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| Company Name | Answer to Part 1  (Alt A/B/C) | Comments/Views for Part 1 |
| Apple | Alt B | In Rel.15, the basic UL cancel capability was already defined, i.e., Tproc, 2. UE can perform the cancellation without defining the new timeline. The cancellation is left to UE implementation is enough. Such as, when UL transmissions are collided, the UL transmission to source is dropped or cancelled. |
| Ericsson | Alt A | Alt A is our first preference, and we could probably reuse some timeline that is already in the specification.  We do not understand Alt B.  We could be open to Alt C also, but the implications for the UE behavior is unclear. |
| Nokia | Alt A | In my understanding, even if we follow the Rel-15 timeline (based on Tproc2) we would need to define something in Section 15 for the time line. |
| ZTE | Alt C | For Alt A, a UE has to stop transmission at a certain point.  For Alt C, a UE can stop source transmission at any time before the UL transmission of target cell. This is beneficial for UE implementation. Since we don’t identify any benefits to define this timeline also at network side, we think Alt C should be the way to go. |
| Samsung | ALT A) | In order to cancel the uplink transmission of source cell on time, UE needs to be aware of the potential overlapping target cell transmission a certain time before the start of source transmission cancellation. In Rel-15, solution for similar procedure is to define a timing offset associated to the cancellation processing time after the scheduling DCI which causes the cancellation behavior. After the timing offset UE is required to perform the cancellation. Before the timing offset UE behavior is not specified. This is the general UE behavior in the TP from [4].  Regarding ZTE’s statement “a UE can stop source transmission at any time before the UL transmission of target cell.” We believe this statement is based on the fact that UL transmission to target cell couldn’t be scheduled before Tproc,2 after target scheduling DCI, so source cell cancellation can always happens before that. However, Tproc,2 is depended on the SCS of scheduling and scheduled cells. The above statement is only true if the associated Tproc,2 is more relaxed in target cell than source cell. |
| Huawei, HiSilicon | Alt A | Alt A. RAN1 spec defines, when uplink to source and targets collides, UE transmit only target. However, in some cases, transmitting only target cannot always be guaranteed, which needs to be subject to a timeline. For example, before UE obtaining the scheduling of uplink to target, UE does not know the collision will happen so that still transmit the uplink. Then there might be problem for conformance test because UE behavior is not compliant with the spec. In this sense, we think the timeline is needed to be defined in spec as well as the corresponding UE behavior.  The thing related to UE feature which is more urgent is whether UE just report support/not support or can report a specific value for defining the timeline just as URLLC does. In general, we would like to have a good system-wise performance for DAPS with less scheduling restriction and less stringent UE implementation requirement, though frankly longer timeline may be more friendly to UE implementation. We would like to hear other companies’ views. |

* **Part 2-A)** Assuming that RAN1 agrees to specify timing offset and related UE behaviors on the UL transmission cancellation for UL DAPS, is there a need to specify on how to handle Msg 3?
  + **Option 1) Yes,** need to specify in RAN1 spec
  + **Option 2) No,** can be handled with generic text description for nominal cases
  + For both options above, what is the required text proposal? (or which of the proposed TP provide above is acceptable?)

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| Company Name | Answer to Part 2-A  (Yes/No) | Comments & suggested/acceptable TP for Part 2-A |
| Apple | No | The same offset can be applied to Msg3 as well, the gap between RAR and Msg3 is larger than Tproc, 2. So Msg3 transmission will not be impacted. |
| Ericsson | No | It would be preferable to reuse the same solution, but that assumes that the preparation time is sufficient also for Msg3.  We are open to define a different timeline as well |
| Nokia | [Tentative no] | If we can agree the Tproc2 (from the end of PDSCH) applies also for Msg3 we are OK with it, but if this is not sufficient, then we need a separate timeline. |
| Samsung | Yes | We think msg3 is an important transmission during handover so it needs to be included. msg3 has very different process time from Tproc2 since it involves interpreting msg2 which requires higher layer processing. This consideration is already in Rel-15. In TP from [4], we took the Rel-15 gap between msg2 and msg3 as the process time. We think it is a valid candidate. |
| Huawei, HiSilicon | Yes or No | Depends on the timeline to be defined. Open to more discussion. The gap between RAR and MSG3 defined in Rel-15 is a bit conservative, for example, the capability only corresponds to capability 1 that is because it is general RACH stage for which UE capability has not been reported to NW. This is not the case for DAPS in which duration UE has connected to source gNB and reported capability to source gNB and the capability has transferred to target gNB before handover. Therefore, reusing the gap between RAR and MSG3 may not be necessary. We can take care of this case when defining the timeline for other dynamic scheduling cases. |

* **Part 2-B)** Assuming specific timing offset description is not needed, what is needed to be corrected in the current specification to make sure UE is adequately handling problematic cases?

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| Company Name | suggested/acceptable TP for Part 2-B |
| Apple | The possible TP could like below with the red text.  If  - the UE does not provide *UplinkPowerSharingDAPS-HO*, and  - UE transmissions on the target cell and the source cell overlap  the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.  UE transmissions on the target cell and the source cell overlap if they are in  - overlapping time resources if the carrier frequencies for the target MCG and the source MCG are intra-frequency and intra-band  - overlapping time resources and overlapping frequency resources if the carrier frequencies for the target MCG and the source MCG are not intra-frequency and intra-band |
| Ericsson | If no timeline is defined, we do not realize that anything is needed. |
| ZTE | We don’t see any spec impact if no timeline is defined. |
| Samsung | Current spec is mandated UE to “transmit only on the target cell” under overlapping/colliding conditions between UL transmissions to source and target cell. This is something UE cannot do if violating the timeline based on cancellation processing time. If no timeline is defined, the last sentence below needs to be relaxed.  “If  - the UE does not provide *UplinkPowerSharingDAPS-HO*, and  - UE transmissions on the target cell and the source cell overlap  the UE may transmit only on the target cell “ |
| Huawei, HiSilicon | N.A. because we think the timeline is needed to be defined. But can be revisited if the conclusion to part 1 is clear. |

**Feature lead observation and summary (based on feedback received until 4/22 3pm UTC-7):**

* Part 1) The majority seems to be with ALT A
  + RAN1 to specify timing offset and related UE behavior on the UL transmission cancellation for UL DAPS for the problematic cases (e.g. intra-frequency cases, or intra-band cases, or inter-frequency cases when UE does not support simultaneous UL transmission, etc).
  + Although, I understand this might not be the preferred approach, let try to work with this.
* Part 2) There is slight majority with not specifying text to handle Msg 3
  + Let work with the assumption to not have specific behaviors to handle Msg 3, but have a generic handling of the issue that would cover cases including Msg 3.
* With the above understanding, let see what we could agree on. Usually it would be easier to agree to the principles, but for this case, the text required is the principle that we need to agree on. Therefore, FL suggest to directly work the TP.
* I have selected TP from Samsung as baseline for further improvement. Please provide further comments. Especially on how the text could be updated to accommodate generic handling of Msg 3 cases.

**Suggested Focus for 3rd round of discussion:**

**Suggested TP for approval**

* A UE does not expect to cancel a transmission on the source cell in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell, after a number of symbols that is smaller than the PUSCH preparation time *T*proc,2 for the corresponding PUSCH processing capability [6, TS 38.214] assuming *d*2,1 = 1 and *μ* corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format and the SCS configuration of the UE transmission on the source cell. If the UE transmits PRACH using 1.25 kHz or 5 kHz SCS on the source cell, the UE determines *T*proc,2 assuming SCS configuration .

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| Company Name | Suggested changes to the TP for approval in order to be acceptable |
| ZTE | We provided some initial comments to clarify the motivation. Basically we found no benefits to define such timeline no matter from NW or UE point of view (Details are provided in the summary). But it seems companies rushed to discuss the details of the TP instead of the motivation first.  The only response on the motivations was from Samsung as copied below. But our view is that the cancellation is not necessary to be based on a timeline. I draw two cases below. For Case 1, there is no issue as long as the UE cancels the transmission to source cell no later than the start of transmission to target cell, i.e. t2. In other words, the UE can cancel transmission to source cell at any time before t2, instead of have to be in t1~t2 based on current TP. For Case 2, before transmitting to source cell, the UE already knows the transmission to target cell is started, and the whole transmission to source cell should be dropped. There is no reason to artificially define a timeline based on the DCI of target cell.  All in all, there would be no issue as long as UE would cancel the transmission to source cell. And, it could leave up to UE implementation for where it will start to cancel. If companies worry about UE may not cancel transmission to source cell. We are fine to have the TP suggested by Intel (also copied at the end of the text).   |  | | --- | | Regarding ZTE’s statement “a UE can stop source transmission at any time before the UL transmission of target cell.” We believe this statement is based on the fact that UL transmission to target cell couldn’t be scheduled before Tproc,2 after target scheduling DCI, so source cell cancellation can always happens before that. However, Tproc,2 is depended on the SCS of scheduling and scheduled cells. The above statement is only true if the associated Tproc,2 is more relaxed in target cell than source cell. |       I also have questions/comments if we go with a timeline using a time reference by a DCI format scheduling the transmission on the target cell. (Sorry to make such comments late but I assumed we should discuss the motivation first)  --Are we assuming there is only transmission with associated DCI on target cell during HO? What if the transmission to target cell is a CG PUSCH or PUCCH with P-CSI/HARQ-ACK for SPS, etc.  --For case 1, the UE can only cancel transmission to source cell after t1. That is, cancellation during anytime within t1~t2 is possible. Still, such information is also not known at network.  --For case 2, with or without defining a timeline, the whole transmission have to be dropped due to UE has no capability for simultaneous transmission. But based on the TP now, does the UE can only cancel starting from t2? Then what should the UE do during t1 and t2? I think the timeline defined here would make this case as an error case.  -- Most importantly, what's the benefits to define this timeline? (as I have asked from the beginning)   Would be appreciated companies can first clarify above, and we would be supportive about the timeline as long as we are convinced here. Thanks~ |
| Samsung | We absolutely disagree that a UE does not have an issue to cancel transmission in case 2. By the time a UE finished decoding of target DCI, a UE would have/should have already started processing of source transmission, and there is no guarantee that a UE can fully cancel that transmission. This is what we have said from the beginning. This is fundamental of all cancellation schemes for rel-15 SFI, rel-16 URLLC etc. Denying this means denying necessity of all these timelines.  Dropping behavior being up to UE implementation without ensuring the quality is one thing, but saying that a UE can always do it perfectly is plain wrong. For example, in the following description for rel-16 intra-UE prioritization cancellation timeline, if CG PUSCH is replaced by source cell and DG PUSCH is replaced by the target cell, this exactly becomes case 2 in the figure.       “if a PUSCH corresponding to a configured grant and a PUSCH scheduled by a PDCCH on a serving cell are partially or fully overlapping in time,  *…*  *-* the UE shall cancel the PUSCH transmission corresponding to the configured grant at latest starting *M* symbols after the end of the last symbol of the PDCCH carrying the DCI scheduling the PUSCH, and transmit the PUSCH scheduled by the PDCCH, where  -     *M = Tproc,2 +d1, where Tproc,2* is given by clause 6.4 for the corresponding PUSCH timing capability assuming *d2,1*= 0 and *d1* is determined by the reported UE capability”  Also, the wording of our TP did not mean a UE cannot cancel during T2 time in case 1. If problematic, then we can change it to ‘a UE is not required to’. After all, it is just a wording issue.  Further details can definitely be discussed, but semi-static target transmission should not be a part of timeline since the only important thing is when a UE knows the existence of dynamic transmission, and our TP covers all dynamic transmissions.  After all, I don’t see why this issue requires convincement unless we want to say that a UE may or may not cancel with whatever quality since the whole rel-15/rel-16 spec is the evidence. |
| ZTE  (2nd comments) | I don't follow this part. For case 2, our understanding is that if we defined a timeline as T\_pro2, the UE can only cancel transmission to source cell after t2, which means it cannot solve the issue here, since there is still overlapping transmission during t1~t2. I meant, without defining a timeline, a UE would not transmit anything for source cell once it begins transmission to target cell (it is not necessary to have to bundle with the DCI for target cell if no timeline defined). If you figure out a case that the UE cannot, then I would assume the UE cannot do it even you defines the timeline.  First of all, the timeline for URLLC in the spec is still in open I think. In addition, one reason we define the timeine in URLLC is that the two transmissions are in one cell, gNB knows full information, and it can avoid such collision if it knows UE cannot be able to cancel low priority transmission. But here it is not the case for DAPS handover since two overlapped UL transmissions belong to different CGs. That is, the collision cannot be avoided even we define a timeline.  Agree that we can discuss the TP later once we think it is necessary. |
| Samsung | Thanks for feedback. Yes, a UE cannot cancel transmission during t1~t2 in case 2. However, a UE will and should cancel transmission clearly after t2, and it will do better if the timeline is enough to fully cancel clearly. If this behavior has absolutely no benefit, then this case may not be very useful. Still, large portion of target cell transmission can be preserved. With or without timeline, a UE may not be fully cancel in case 2, but without timeline, a UE behavior even after t2 will be up in the air. Also, without timeline, network will never know how much time would be enough for this UE even if it wants to avoid such a situation since the behavior is not regulated. If all network vendors believe that such information is absolutely useless, and if we all are happy to make this entire behavior up in the air, then we can accept the situation as long as dropping behavior in the spec becomes recommendation something like ‘may’ as we suggested. |
| ZTE | ZTE has added one more Figure below for a better understanding on case 2.  For case 2, a UE would know there is a transmission to source cell at t1, and a transmission to target cell at t2. In URLLC, d1 is defined as the time a UE requires for canceling a transmission (from the UE realizes it should cancel to it will cancel), where d1 = 0,1,2 symbols, which is much smaller than T\_pro2 and T\_pro2' . That means, the UE would know there is collision before t3, and can drop the whole transmission to source cell. But with the timeline defined by current TP, it is bundled with the DCI scheduling the transmission to target cell, which makes the UE cannot cancel the transmission, i.e., cannot solve the overlapping issue here.  Actually we think, instead of defining a strictly timeline let UE follow, shouldn't be better to leave UE implementation. From NW side, NW will know it will cancel the whole transmission for case 2. For case 1, no matter define or not a timeline, the NW will not know where a UE will cancel.  As we repeated many times, there is benefits to define the timeline in Rel-15 or URLLC since the overlapping transmissions are in one cell, but we failed to see the benefits here. |
| Samsung | I do not prefer to drag URLLC discussion too much here. Short answer to your question, we disagree. d1 there is not the amount of time a UE requires to cancel. It is ‘additional’ time allowed for a UE which we are not asking for here.  Under the current cancellation mechanism from rel-15, T\_proc,2 minus DCI decoding time is provided as cancellation preparation time for a UE after realizing dynamic trigger, and it is definitely not something which can be done within d1. I hope not rediscussing fundamentals of rel-15 cancellation because it will just drag the discussion. |
| ZTE | Agree that we may no need to drag too much rel-15 cancellation or URLLC cancellation here. So, I will not argue on how to interpret d1 (though we have different understandings here). But, please allow me to wrap up the discussion here.    For Case 1,   * with a timeline, a UE is not expected/required to cancel before t1, i.e., the UE would most possibly cancel transmission to source cell after t1, but could also cancel before t1 if the UE is capable of. We don't think the current TP explicitly reflects that the UE shall cancel before t2, but can be reflected by spec saying ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.’ as once suggested by Intel. * without a timeline, there is no restriction on t1 since anyway the UE may cancel before or after t1. Similarly, the UE shall cancel before t2, by spec saying ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.’     By saying above, it seams no big difference whether to specify a timeline or not for Case1. From NW point of view, it will not know where the UE will cancel the transmission. From UE point of view, it is also quite similar with or without a timeline. Of course, no timeline would leave more room for UE.    For Case 2,   * specifying a cancellation timeline will not fundamentally solve the collision since a UE cannot cancel between t1~t2. If the entire UE behavior is unclear since there are still overlapping symbols and UE cannot support simultaneous transmission, defining a cancellation timeline will not help to avoid such collision since the two transmissions belong to different CGs. From NW side, it will always try to decode the transmission of target cell. * without a timeline, UE may or may not be able to drop the whole transmission. (Though we think the UE can drop because T\_proc,2 minus DCI decoding time, i.e., cancellation preparation time, would be sufficient for cancellation. To be honest, we think the time a UE requires to cancel a trasnmission should be much less than the time for preparing a transmission). UE behavior on at which point it will cancel source cell is up in the air, but anyway NW will try to decode the transmission of target cell.   Similarly, we don't see a clear motivation for a timeline for Case 2. From NW perspective, with or without a timeline, NW doesnt' know where the UE will cancel but it will always try to decode the transmission of target cell. From UE perspective, there is no good to have an additional timeline.  If we understand correctly about above, we still don't see any clear motivation to define such timeline in DAPS. |
| Huawei | Not sure if Huawei can understand the cases ZTE illustrated for the timeline. The case in our mind for defining the timeline is: If the DCI scheduling uplink to target comes late, UE has been preparing uplink to source and there is no time to decode the DCI and also get prepared for uplink transmission to target, and then UE still can transmit the uplink to the source. In other words, UE cancels the uplink part which UE is capable to cancel.  If UE should cancel the part which UE is capable to cancel but does not cancel due to the timeline, the timeline defined may not be proper. |
| ZTE  (follow up to Huawei’s question) | If I understood correctly, your thinking below is referred to Case 2 below. That is, if the UE finds it cannot cancel transmission to source cell to avoid the collision. Then, UE can choose to cancel target cell. I would say this is also a good way to implement in Case 2 because the UE can make it at least for one transmission, though it is transmission to source cell. So, I would assume you also think the timeline defined to cancel transmission to source cell is not proper, which will limit UE implementation. From NW side, gNB will always try to decode transmission to target cell in target cell, and of course try to decode transmission to source cell in source cell, i.e., no ambiguity. |
| Huawei | We firstly agreed on UE always prioritizes target when uplink transmissions to source and target collides which has been implemented in the spec. However, in some cases (as I mentioned in the earlier email), UE is not able to cancel uplink to source but have to drop uplink to the target, so such behavior is not compliant with the description in the spec. Therefore, the cases of UE not canceling uplink is necessarily stated in the spec, otherwise, it cause UE the compliant test trouble.  By “timeline defined may not be proper” Huawei actually meant the defined values for timeline might be too tight or too loose. We did mean defining the timeline is not proper. |
| Ericsson | A few comments:  ZTE wrote the following for case 1:  …without a timeline, there is no restriction on t1 since anyway the UE may cancel before or after t1. Similarly, the UE shall cancel before t2, by spec saying ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.’  We agree that would be a desirable behavior, but we are not sure that it would result in reasonable UE complexity. To us, this would be the critical point: we do not want to enforce too difficult requirements on the UE, which may prevent the functionality to be introduced in the market.  If a timeline would be defined, it would serve as a guidance to the NW how carefully it would synchronize the UL scheduling. |
| ZTE | Response to Huawei:  Firstly, I am just wondering whether it is so important to specify the cases you mentioned, i.e., UE is not able to cancel uplink to source but have to drop uplink to the target. Because, as you also noted, we agreed on UE always prioritizes target transmission when collision happens. We think it could be fine to leave it for implementation as I mentioned. In addition, I am not quite sure how to reflect these cases in spec with defining a timeline.  Response to Ericsson:  For Case 1, we think it should be an essential functionality for a UE supporting DAPS to be able to cancel transmission to source cell before t2. Without defining a timeline would only leave more room for UE to implement. For NW, we of course would like to have something helpful for scheduling. But as I said before, we don't see much benefits from NW side.  Sorry for dragging the discussion. But we would be OK for specifying a timeline as long as we find there is indeed clear motivation for this. Unfortunately, we haven't see that so far. |
| Samsung | Let’s first assume T2 is the process time for cancellation starting from the end of DCI, and T2 is defined using the smaller SCS associated with DCI and UL to be canceled. (This is Rel-15 cancellation behavior, we don’t want to debate on this here.)  We feel the UE behavior you described is not consistent  when timeline is not defined. Our view is when timeline is not defined, UE is mandated to do what spec ask unless the spec says it is up to UE implementation. Your UE behavior description in case 1 looks likes “UE is mandated to do what spec ask”.  But in case 2 it looks more like “up to UE implementation”. So Let’s separate these into 3 solutions:  Solution 1: The UE transmits only on the target cell, the transmission to source cell is dropped or cancelled  Solution 2: Up to UE implementation.  Solution 3: A clear cancellation timeline is defined. UE need to ensure cancellation to source cell after T2. UE may cancel before T2 if it is more capable and willing to do so.  We actually feel Solution 1 means no difference from current spec. Both Solution1/Solution2 are without timeline and Solution3 is timeline based.  For the case 1, it is true that Solution 1 “the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled” may work. However, how does this description work in a slightly modified case 1 below as case 3?  Case 3:    Solution1: without timeline-> “the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled” specifies a behavior UE cannot do in  case 3. The required cancellation in portion “t1~t2” is outside UE’s capability.  Solution2: without timeline-> it may cancel the transmission earlier then t2 if UE is capable and willing to do. Or it can delay its cancellation time or does not cancel at all.  Solution3: With timeline, UE will guarantee to cancel to source cell after t2. UE may cancel before t2 if it is capable and willing to do.  Case 2:  Solution1: without timeline-> “the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled” specifies a behavior UE cannot do in  case 2. The required cancellation in portion before t2 is outside UE’s capability.  Solution2: without timeline-> UE behavior is unspecified, it may cancel the transmission earlier then t2 if UE is capable and willing to do. Or it can delay its cancellation time or does not cancel at all.  Solution3: With timeline, UE will guarantee cancel to source cell after t2. UE may cancel before t2 if it is capable and willing to do.  To sum-up, Solution 1:“the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled” does not work. It only works on the original case 1. With this solution, the only choice UE vender can do is not to support cancellation (if such capability exists at the end), or not to support DAPS-HO at all.  In case 2 or 3, likes you said, “anyway NW will try to decode the transmission of target cell”.  “Solution 2” vs “Solution 3” is “at least portion after T2 of transmission to target cell, quality is guaranteed” vs “the quality of the transmission to target cell is not guaranteed”. It is clear which one is better for overall system performance? Timeline has a clear benefits for network here.  From UE’s point of view, Solution 2 is always the easiest to do from implementation point of view. However, if “when to cancel the transmission is up to UE implementation” means the same as “cancellation does not always happens”. Is this what Network vender want?  Define a timeline does not necessary solves the collision-àTrue. However, none of your proposed solutions can solves the collision either. At least timeline can guarantee the quality target cell transmission after a certain time. And it is something UE are capable to do.  Solution 3 provides a best balance which has benefits to both UE(for not asking it cannot do) and gNB (guarantee a certain portion of source cell to be cancelled). We think it is the right way to go.  Finally, we want to further address our concern that current spec does not imply “up to UE implementation” as the UE behaviors.  If the timeline is not agreed and no further spec changes are made, we think at least the following should be captured in UE feature for cancellation support:  “When and how source cell transmission is cancelled and when and how target cell transmission starts is up to UE implementation” |
| MediaTek | We (MTK) agree that there could be many transmission cases which may impacted differently by the timeline.  However, similar to why RAN1 defined Toffset for NR-DC UL power sharing between MCG and SCG (as shown below) to determine at what timing would UE finalized the transmission power for MCG/SCG, we think it is better to define a timeline. |
| ZTE | Response to Samsung:  - Yes, our thinking is Solution 1. For case 2, the reason we think it's up to UE is that case 2 should be an error case. Because the UE has no way to support transmission on target cell in this case, with or without defining a cancellation timeline. There are always corner cases not specified in the spec, it doesn't mean UE shall support the error cases. But I also understand your concern, I provided an alternative below.  For case 1 - solution 3 mentioned from Samsung  - Agree that Solution 1 may be out of UE capability. But, same to Solution 3, it is still out of UE capability even we define a timeline since there is still overlapping during t1~t2.  For case 2 – solution 3 mentioned  - I will not argue whether Solution 1 is out of UE capability or not. But, same to Case 3, it is out of UE capability for Solution 3 too.  For the summary:  Xianghui: Same as above. If you say Solution 1 doesn't work for Case 2/3, you should also say Solution 3 also doesn't work for Case 2/3.  Xianghui: As above, for case 2/3, the UE behavior is unclear anyway, at least during the overlapping part. Actually, they should be regarded error cases since we have agreed to transmit only on target cell and drop transmission on source cell in case of overlapping, while the UE have no way to support this for case 2/3. What I was trying to say is that defining a cancellation timeline doesn't help anything here. As for the performance part (assuming they are valid cases), we are not sure how much benefit it will bring since the beginning part of transmission to target cell is not transmitted(usually where DMRS is located).  Solution 2  Xianghui: Our thinking is Solution 1.  Xianghui: But at least for Case 1, where a UE starts transmission on target cell should not be up to UE implementation, i.e., the whole transmission on target cell is transmitted.  For Case 1, which is assumed as T2,target is equal to or larger than T2,source, both solution 1 and Solution 3 work. Since it is common understanding that T2,source is sufficient for cancellation, then the cancellation timeline is redundant for case 1. In addition, no capability is needed since cancellation in such case should be an essential functionality. What we may need is to clarify that: ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.’  The controversial part is for case 2/3, which is assumed as T2,target is smaller than T2,source.  We agree that none of the solutions can solve the issue perfectly. There could be two ways out:  Alt 1. Case 2/3 should be error cases.  Meaning that, NW should try to avoid such cases, e.g. 1)making sure T2,target is larger than T2,source, i.e., converting case 2/3 to case 1. 2) Using TDM pattern, if possible, to even avoid collision. 3) other ways?. If such error cases happen, it's up to UE implementation. For this alternative, no cancelllation timeline is needed and no corresponding capability is need.  Alt 2. Making sure in the spec that the sentence ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled.’ only applies to Case 1. For example, capturing some text as follows. For this alternative, no **cancelllation** timeline is needed and no corresponding capability is need.   |  | | --- | | ‘the UE transmits only on the target cell, the transmission to source cell is dropped or cancelled, if the number of symbols from a last symbol of a CORESET where the UE detects a DCI format scheduling a transmission on the target cell to a first symbol of the transmission is equal to or larger than the PUSCH preparation time Tproc,2 for the corresponding PUSCH processing capability [6, TS 38.214] assumingd2,1 = 1 and μ corresponds to the smallest SCS configurationbetween the SCS configuration of the PDCCH carrying the DCI formatand the SCS configuration of the UE transmission on the source cell. If the UE transmits PRACH using 1.25 kHz or 5 kHz SCS on the source cell, the UE determinesTproc,2 assuming SCS configuration μ=0. |   Our preference is Alt 1 as explained. But If I understand correctly about Samsung's concern, they are also not OK with no spec change.  Though, we think it is clear that cancellation timeline is redundant for case 1 and cannot solve collision for case 2/3, we are fine to go with something like alt 2 to address Samsung's concern for progress. |
| Samsung | From what we see, there are two main discrepancies between us:  1.      Are Case 2/3 error cases?  We think they are not error cases. Although we agree gNBs may have some control to limit these cases, current spec does not rule them out. UE cannot be implement in a way assuming they do not exists.  2.      Solution 3 (timeline) does not work in Case 2/3?  We think it does work but you think it doesn’t. What we mean “Solution 3 works” is that UE does not have problem to support it once the timeline based UE behavior (only requires to cancel the portion after T2) is defined. Of course this will leave out some partial overlapping region on in the air in case2/case3.    Here is to say, we agree that UE will has no difficulty to perform cancellation to source cell in case 1.  So we are also ok if spec can be modified in a way that case 2/case 3 are error cases. Then above two discrepancies are not issues anymore.    Our view is error cases can be created by TP for timeline if we only allow full cancellation. Full/partial cancellation can be discussed in TP stage.  Without timeline, no case is an error case. |
| ZTE | Based on Samsung’s latest comments above, I think we have reached preliminary consensus on Case 1, i.e., UE will have no difficulty to perform cancellation for Case 1. As for Case 2/3, we prefer to treat as error cases without spec change. But, considering the discussion so far and for sake of progress, we are also be ok to modify the spec to exclude Case 2/3. We would say the TP is for specifying the case the UE can support for cancellation, rather than for defining where the UE should cancel a transmission.  Regarding Toffset for NR-DC commented by Mediatek, we see many differences from here, e.g., the Toffset is to make power control of a CG itself more accurate while the cancellation timeline is canceling transmission on another CG which makes the benefits not very clear. But anyway we think it may be better to focus on the issues here.  Based on above, we suggest the following changes, and fine to discuss the details during TP preparation phase.  ALT A)  1.    Agree in principle to the following:  1.    Details of full/partial cancellation based on a ~~the~~ time offset, and how to define the time difference, including other details, can be worked out during the TP preparation phase.  2.    ~~UE does not expect to cancel a transmission on the source cell if the time difference between the source cell transmission and PDCCH scheduling a target cell transmission is shorter than a specified time offset, Toffset.~~  3.    FFS: how to deal with the UE capability for UL transmission cancellation if agreed by [100b-e-NR-UEFeatures-Mobility-03] discussion thread. |
| Huawei | Somehow I am not sure if the discussion twisted K2 and Tproc,2 together. From UE perspective, if K2 is long enough, I guess UE should be able to cancel the source always but if K2 is too short, UE is not expected to do things that beyond UE’s capability. From NW perspective, if NW can accept any scheduling restriction, NW can avoid any potential collision without dynamic gNBs communication because all possible values for K is known to both gNBs.  However, defining the time offset in the spec somehow is doing something in between, i.e., not restricting NW too much but also not require UE to cancel the uplink that is beyond UE’s capability. How to reach this, I guess we need a bit more discussion per my observation of the discussion.  Therefore, for progress, we can agree the suggested following in principle  1.    Details of full/partial cancellation based on a ~~the~~ time offset, and how to define the time difference, including other details, can be worked out during the TP preparation phase.  2.    ~~UE does not expect to cancel a transmission on the source cell if the time difference between the source cell transmission and PDCCH scheduling a target cell transmission is shorter than a specified time offset, Toffset.~~  3.    FFS: how to deal with the UE capability for UL transmission cancellation if agreed by [100b-e-NR-UEFeatures-Mobility-03] discussion thread. |

**Feature lead observation and summary (based on feedback received until 4/24 8pm UTC-7):**

* Based on discussion until 4/24 8pm UTC -7, feature lead suggested two alternatives for agreement, ALT A and ALT C.
* ALT D was proposed by ZTE as a comprise after further discussion at 4/28 8pm UTC -7.
* Feature lead suggest to further discuss with the following alternatives.

**Suggested Focus for 4th round of discussion:**

ALT A)

Agree in principle to the following:

* UE does not expect to cancel a transmission on the source cell if the time difference between the source cell transmission and PDCCH scheduling a target cell transmission is shorter than a specified time offset, Toffset.
  + Details of the time offset, and how to define the time difference, including other details, can be worked out during the TP preparation phase.
  + FFS: how to deal with the UE capability for UL transmission cancellation if agreed by [100b-e-NR-UEFeatures-Mobility-03] discussion thread.

ALT C)

No additional specification change is needed for UL cancellation

* FFS: how to deal with the UE capability for UL transmission cancellation if agreed by [100b-e-NR-UEFeatures-Mobility-03] discussion thread.

ALT D)

Agree in principle to the following:

* Details of full/partial cancellation based on a ~~the~~ time offset, and how to define the time difference, including other details, can be worked out during the TP preparation phase.
* ~~UE does not expect to cancel a transmission on the source cell if the time difference between the source cell transmission and PDCCH scheduling a target cell transmission is shorter than a specified time offset, Toffset.~~
* FFS: how to deal with the UE capability for UL transmission cancellation if agreed by [100b-e-NR-UEFeatures-Mobility-03] discussion thread.

**The following is the status summary (at the 4/29 1am UTC -7):**

* Ericsson, Nokia, Samsung, Huawei, Hisilicon has expressed they are supportive of ALT A.
* ZTE has concerns for ALT A, prefers ALT C.
* ZTE suggested the comprise ALT D proposal. Huawei expressed they are willing to accept the proposal ALT D

# Reference

1. R1-2001530, “Remaining issues on DAPS-HO,” Huawei, HiSilicon
2. R1-2001624, “Remaining issues on NR mobility enhancements in physical layer,” ZTE
3. R1-2002011, “Corrections to Physical layer aspects of NR mobility enhancement,” Intel Corporation
4. R1-2002148, “Remaining issues for NR Mobility Enhancement,” Samsung
5. R1-2002221, “Remaining physical layer aspects of dual active protocol stack based HO,” Nokia, Nokia Shanghai Bell
6. R1-2002344, “On remaining issues on NR mobility enhancements,” Apple
7. R1-2002490, “Correction to UL power sharing for DAPS HO,” Ericsson
8. R1-2002558, “Maintenance for NR mobility enhancements,” Qualcomm Incorporated
9. R1-2001531, “Remaining PHY aspects for CHO,” Huawei, HiSilicon
10. R1-2001625, “Discussion on FR2 mobility interruption enhancements,” ZTE
11. R1-2002010, “Issue Summary for NR Mobility Enhancements,” Moderator (Intel Corporation)