3GPP TSG-RAN WG1 Meeting #108-e R1-22xxxxx

e-Meeting, February 21st – March 3rd 2022

**Agenda Item: 8.6.1.2**

**Title: FL summary #1 on other aspects of UE complexity reduction for RedCap**

**Source: Moderator (Qualcomm Inc.)**

**Document for: Discussion, Decision**

# Introduction

This feature lead (FL) summary (FLS) concerns the Rel-17 work item (WI) for support of reduced capability (RedCap) NR devices [1]. Earlier RAN1 agreements for this WI are summarized in [2].

This document summarizes contributions [3] – [19] submitted to agenda item 8.6.1.2 and relevant parts of contribution [20] submitted to other agenda items and captures this email discussion on other aspects of UE complexity reduction for RedCap:

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| [108-e-R17-RedCap-02] Email discussion for maintenance on other aspects of UE complexity reduction – Chao (Qualcomm)* 1st check point: February 25
* Final check point: March 3
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# HD-FDD

## Issue #1: SSB overlapping with semi-statically configured UL

For collision handling between SSB and semi-statically configured UL transmission, it is noted in contributions [13, 14] that the current specification in clause 17.2 of TS 38.213 only covers the non-overlapping case of “back-to-back” without sufficient gap, and the collision handling for the overlapping case is missing. The following TP is proposed in [13, 14] to implement the agreement for the overlapping case.

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| ===================== Unchanged parts are omitted=====================If a HD-UE would transmit a PUSCH, or PUCCH, or PRACH, or SRS ~~based on a detected DCI format~~ and the HD-UE is indicated presence of SS/PBCH blocks by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* in a set of symbols, the HD-UE does not transmit PUSCH or PUCCH or PRACH if a transmission would overlap with any symbol from the set of symbols and the HD-UE does not transmit SRS in the set of symbols.===================== Unchanged parts are omitted ===================== |

**FL1 High Priority Proposal 2.1-1**

* Endorse the above text proposal to TS 38.213, clause 17.2

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| **Company** | **Y/N** | **Comments** |
| Nordic | Y |  |
| Intel | Y | We support the FL proposal. |
| Qualcomm | Y |  |
| vivo | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| Spreadtrum  | Y  |  |
| DOCOMO | Y |  |
| Sharp | Y |  |
| Xiaomi | Y |  |
| ZTE, Sanechips | Y |  |
| China Telecom | Y |  |
| LGE | Y (with modification) | We support the text proposal with the modifications as suggested below.===================== Unchanged parts are omitted=====================If a HD-UE would transmit a PUSCH, or PUCCH, or PRACH, or SRS ~~based on a detected DCI format~~ based on a configuration by higher layers and the HD-UE is indicated presence of SS/PBCH blocks by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* in a set of symbols, the HD-UE does not transmit PUSCH or PUCCH or PRACH if a transmission would overlap with any symbol from the set of symbols and the HD-UE does not transmit SRS in the set of symbols.===================== Unchanged parts are omitted ===================== |
| Panasonic | Y |  |
| Samsung | Y |  |
| CMCC |  | Since SSB vs valid RO case is up to UE implementation, here PRACH configured by higher layers should be precluded. We suggest following modification. ===================== Unchanged parts are omitted=====================If a HD-UE would transmit a PRACH based on a detected DCI format, or PUSCH, or PUCCH, ~~or PRACH~~, or SRS ~~based on a detected DCI format~~ and the HD-UE is indicated presence of SS/PBCH blocks by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* in a set of symbols, the HD-UE does not transmit PUSCH or PUCCH or PRACH if a transmission would overlap with any symbol from the set of symbols and the HD-UE does not transmit SRS in the set of symbols.===================== Unchanged parts are omitted ===================== |

## Issue #2: Collision handling between SSB and Msg3 (re)transmission and PUCCH for Msg4/MsgB

For Case 5 of SSB overlapping with UL transmission, the remaining issue is how to handle the collision between SSB and Msg3 (re)transmission and PUCCH for Msg4/MsgB. The following FL proposal was discussed in the last RAN1 meeting but no consensus was achieved.

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| **Updated FL3 High Priority Proposal 5.1-1:*** For Case 5 of SSB overlapping with Msg3 (re)transmission ~~and~~ or PUCCH for Msg4, reuse the existing collision handling principles of Rel-15/16 for NR TDD that SSB is prioritized over Msg3 and PUCCH for Msg4
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Based on the received response, companies’ positions have not changed as compared to last RAN1 meeting.

* 12 companies [03, 06, 07, 08, 09, 10, 12, 13, 15, 16, 18, 19] prefer to reuse the same handling as for other dynamically scheduled UL transmission and prioritize the SSB.
* 3 companies [04, 11, 14] have a preference to prioritize Msg3 or PUCCH for Msg4/MsgB over SSB
* Contribution [06, 11, 20] propose other approach, e.g., leaving it to UE implementation for a compromise

The potential impacts on random access procedure and coexistence with legacy FDD UEs are further analysed and discussed in contributions [04, 06, 07, 09, 12, 13, 15, 16]. Companies’ views are quite divergent. It is viewed in contributions [07, 09, 12, 15, 16] that no critical issues are observed for prioritizing SSB over Msg3 or PUCCH for Msg4/MsgB. However, contribution [04] indicates that the RACH performance will be seriously degraded if Msg3 or PUCCH for Msg4/MsgB is dropped in the overlapped resources.

Since majority does not view any critical issue for prioritizing SSB over Msg3 or PUCCH for Msg4/MsgB, unified solution is desirable considering specification impact [03, 12, 16]. No optimization would be necessary in the maintenance phase while the other option (i.e., drop SSB) may have better scheduling flexibility [08]. Therefore, the moderator suggestion is to reuse the same handling as for other dynamically scheduled UL transmission. If it is not acceptable, then leaving it to UE implementation could be considered for a compromise.

**FL1 High Priority Proposal 2.2-1:**

* For Case 5 of SSB overlapping with Msg3 (re)transmission or PUCCH for Msg4/MsgB, reuse the same handling as for other dynamically scheduled UL transmission and prioritize the SSB

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| **Company** | **Y/N** | **Comments** |
| ZTE, Sanechips |  | **Prioritizing SSB or msg3/PUCCH for msg4**If we consider gNB scheduling to avoid the collision of SSB vs msg3/PUCCH for msg4, then actually we do not need to define the priority, since the collision would not happen and we only need to agree gNB scheduling is used to avoid this kind of collision.However, gNB scheduling would have impacts on the NR FDD UE and FD-FDD RedCap UE. More specifically, all the msg3 scheduling for FDD-RedCap UE and HD-FDD RedCap UE would be delayed if msg1 identification is configured, since HD-FDD RedCap UE is not identified. If msg1 identification is not configured, besides FDD-RedCap UE and HD-FDD RedCap UE, NR FDD UE also would be delayed due to the scheduling without identification. For the case that the collision is possible to happen, defining priority for SSB or msg3/PUCCH for msg4 is needed. Prioritizing SSB means the msg3/PUCCH for msg4 would be dropped by the UE(gNB does not know the dropping since gNB does not identify which UE is HD-FDD RedCap UE) when the collision happens. The following issues need to be considered.**From the NW side, prioritizing SSB would cause gNB detection problem**Since the msg3 is dropped and msg3 dropping is not known by gNB, the gNB detection performance by combining msg3 initial transmission and retransmission would be worse. Therefore, the gNB detection problem would be caused if SSB is prioritized and msg3 for HD-FDD RedCap UE is dropped.**From the UE side, prioritizing SSB would cause larger access delay for the UE**The HD-FDD RedCap UE access delay would be larger since the msg3/PUCCH for msg4 is dropped. If msg3/PUCCH for msg4 is prioritized, the access delay is similar as legacy.**Other aspects:*** **Spec impacts:**

according to the agreement from CE

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| AgreementAll slots are considered as available slots for Msg3 repetition for both FD-FDD UEs and HD-FDD RedCap UEs. |

if the overlapped slots are not available for transmission, the dropping rule of msg3 or PUCCH for msg4 should be captured in CE if SSB is prioritized. In this case, the spec impacts also would be increased. However, prioritizing msg3 would not have this kind of spec impacts. * **Regarding receiving SSB:**

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| * “From RAN2 perspective, if a RedCap UE in idle/inactive mode is configured with a separate initial BWP associated with no SSB (CD or NCD) for RACH, it is up to UE implementation to perform new RSRP measurement in a DL BWP associated with CD-SSB before Msg1/A retransmission.”
 |

RAN2 actually agree that UE implementation can be used for receiving SSB for measurement when RACH procedure on separate initial BWP is configured. Therefore, prioritizing SSB or msg3/PUCCH for msg4 would not impact the SSB receiving for measurement.* **Msg2/msg4 VS SSB need to be handled if SSB is prioritized:**

According to RAN1 agreement:

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| Agreement: [38.213, 38.331]* For FR1,
	+ For a separate initial DL BWP (if it does not include CD-SSB and the entire CORESET#0) from RAN1 perspective,
		- If it is configured for random access while not for paging in idle/inactive mode, RedCap UE does NOT expect it to contain SSB/CORESET#0/SIB.
 |

Based on this agreement, I will generally think the RACH procedure is prioritized over SSB, which ensures the UE access. Assume SSB is prioritized over msg3/PUCCH for msg4 for measurement, does this mean when SSB overlaps with msg2 and msg4(in separate initial DL BWP), the UE also need to prioritize the SSB and drop the msg2 and msg4 for measurement? In this case, the collision case for SSB overlapping with msg2/msg4 may also need to be handled . **UE implementation**If we consider leave collision of SSB vs msg3/PUCCH for msg4 to UE implementation and UE can choose to prioritize SSB or msg3/PUCCH for msg4, some similar issues can not be avoided.In this case, gNB does not need to avoid the collision by scheduling. However, gNB detection problem still exist, since the gNB can not know the UE behaviour exactly. Also, if the UE choose to prioritize the SSB, access latency and more serious NW congestion also would be caused.Additionally, spec impacts also are caused in CE. That is, if All slots are considered as available slots for Msg3 repetition for both FD-FDD UEs and HD-FDD RedCap UEs, whether to drop msg3 transmission or not is up to the HD-FDD RedCap UE, which should be captured in the spec.Similarly, SSB overlapping with msg2 and msg4 also need to be considered if UE implementation is adopted for collision of SSB vs msg3/PUCCH for msg4. If msg3/PUCCH for msg4 is prioritized, all the above mentioned issues are gone. It is also beneficial for the NW and the UE side. Sorry for the long text, I hope the detailed analysis can reach to all of you and we are clear about all the pros and cons before jump to to conclusion.  |
| Nordic  | Support |   |
| Intel | Y | We support the FL proposal. |
| Qualcomm | Y | Support the FL proposal |
| vivo | Y |  |
| Nokia, NSB | Y | We support the FL proposal. |
| CATT |  | Although FL proposal seems to be a simpler choice and may be acceptable, we want to make it clear that: (1) It is a little strange that a HD-FDD RedCap UE is able to perform the whole random access procedure in a separate initial DL BWP without any SSB (agreed in AI 8.6.1.1), but we still prioritize SSB than Msg3 when it appears…(2) If SSB is prioritized, and considering the following CE agreement:

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| AgreementAll slots are considered as available slots for Msg3 repetition for both FD-FDD UEs and HD-FDD RedCap UEs. |

additional work is needed to further clarify that for HD-FDD and Msg3 case, SSB will lead to PUSCH dropping in *Step 2* of Rel-17 available slot counting mechanism (CE topic), rather than available slot determination in original *Step 1*. |
| Spreadtrum | Y | From the perspective of complexity, we prefer to support FL proposal. Also, we are open to the issues mentioned by ZTE, if companies think those issues are critical, we can consider other solutions (e.g., Msg 3 PUSCH (or PUCCH for Msg 4) is prioritized). |
| DOCOMO | Y | We don’t see any critical issues for having a unified solution with other dynamically scheduled UL transmission. Regarding the spec impact, we don’t think additional work is necessary for this case, since HD-FDD collision handling is done per symbol basis, not per slot basis, similar to TDD case. |
| Sharp | Y |  |
| Xiaomi | Y |  |
| China Telecom |  | We do not want any impact on CE WI. The comments from ZTE can be further considered and checked.  |
| LGE | Y | Regarding the additional spec impact, similar to DOCOMO, we also don’t think additional work is needed to conform to the CE agreements. |
| Panasonic |  | Seeing the majority view, we accept the FL proposal.  |
| Samsung | Y | Support the FL proposal and would like to share our view further about ZTE explanation.**NW impacts**First of all, the gNB scheduling for the collision avoidance is not a new one because there may be Rel-15 HD-FDD UEs in the cell regardless of the discussion for HD-FDD RedCap UE. In addition, the gNB implementation when the collision is allowed is already existing one because potential missing UL transmissions should be anyway handled in NW side due to UE PDCCH decoding failure or gNB PUCCH mis-detection.**Spec impacts**Regarding the discussion for available slot in CE, we understand it can be related to the discussion (at least for PUSCH) in Issue #7 and then we don’t see a need to have further spec. impact due to SSB prioritization over msg 3/PUCCH for msg4.It is not clear whether SSB overlapping with msg2/msg4 is a really issue because they seems a collision between two different DL signals which may be up to gNB scheduling. |
| CMCC |  | From the perspective of having unified solution, we prefer to support FL proposal. We are also open to discuss the issues mentioned by ZTE. |

## Issue #3: Whether to support other cases of the “back-to-back” non-overlapping UL/DL without sufficient gap

In the RAN1#106b-e and 107-e meeting, the following were agreed for the “back-to-back” non-overlapping UL/DL without sufficient gap. The remaining issues is whether to allow other cases of the “back-to-back non-overlapping UL/DL without sufficient gap, e.g., between dedicated configured DL and dedicated configured UL, between dynamically scheduled DL and RRC configured UL, or between RRC configured DL and dynamically scheduled UL.

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| Agreements:* (Working Assumption) The “back-to-back” non-overlapping UL/DL without sufficient gap between RRC configured UL and DL may happen, i.e., are allowed for HD-FDD UEs.
	+ RRC configured DL/UL includes at least cell specific higher layer parameters configured DL/UL
	+ Discuss further whether to specify a clear UE behavior, or leave it to UE implementation to ensure that the switching time is satisfied
	+ Note: This does not mean a HD-FDD UE is required to support the back-to-back UL/DL switching without sufficient gap

Agreement: * For the case of the “back-to-back” non-overlapping UL/DL without sufficient gap between cell specific configured DL and cell-specific configured UL, e.g., SSB or PDCCH in CSS vs. valid RO, it is up to UE implementation to ensure that the switching time is satisfied

Agreement: * The “back-to-back” non-overlapping UL/DL without sufficient gap between cell-specific configured DL and dedicated configured UL may happen, i.e., allowed for HD-FDD UEs
	+ E.g., SSB vs. CG PUSCH, PUCCH or SRS
	+ Configured UL transmission is cancelled (as in the overlapping case)
* The “back-to-back” non-overlapping UL/DL without sufficient gap between dedicated configured DL and cell-specific configured UL may happen, i.e., allowed for HD-FDD UEs
	+ E.g., PDCCH in USS, SPS PDSCH, CSI-RS or DL PRS vs. valid RO
	+ Leave it to UE implementation to cancel either DL reception or UL transmission to ensure sufficient switching time
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In contribution [16], it is proposed that all the other cases of the “back-to-back” non-overlapping UL/DL without sufficient gap are not allowed since it is easier for gNB to avoid collision when performing dedicated configuration or dynamic scheduling. Contributions [04, 19] have a different view that the scenarios involved with dynamic DL/UL should be allowed and the corresponding collision handling principles as in the overlapping cases can be applied.

According to [21], the motivation for supporting the “back-to-back” non-overlapping UL/DL without sufficient gap is to efficiently support coexistence with FD-FDD UEs and relax network configuration restriction, there is no strong need to extend to other subcases which would be managed by proper gNB implementation. Considering no optimization would be necessary in the maintenance phase, the following FL proposal can be considered to conclude the discussion.

**FL1 Medium Priority Proposed Conclusion 2.3-1**

* All the other cases of the “back-to-back” non-overlapping UL/DL without sufficient gap are not allowed

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| **Company** | **Y/N** | **Comments** |
| Nordic  | N |  |
| Intel | Y | We support the FL proposal.  |
| Qualcomm |  | If a cell allows HD-FDD RedCap UE to access, at least the “back-to-back” non-overlapping UL/DL without sufficient gap are not allowed in RRC connected mode. |
| vivo | Y |  |
| CATT | Y | In last meeting we should aware that gNB can easily avoid such cases, if at least one of the channel is ‘UE dedicated configured’ or ‘dynamically scheduled’ |
| DOCOMO | Y |  |
| Xiaomi | Y |  |
| ZTE, Sanechips | Y | Similar view with CATT. Additionally,a clarification is needed, that is, if ‘partial cancellation’ is supported, does it also use the same solution to ensure sufficient gap? |
| China Telecom | Y | We are fine with FL proposal. |
| LGE | Y | Not a strong preference, but we are fine with the FL proposal. |
| Samsung | Y | We believe it was already discussed in RAN1#107-e and so we understand the consensus was to remove other cases from the FL proposal 5.3-1. |
| CMCC | Y |  |

## Issue #4: PRACH overlapping with dynamically scheduled PDSCH or CSI-RS

Contribution [06] indicates that the text related to PRACH for collision handling between semi-statically configured UL and dynamically scheduled PDSCH or CSI-RS should be deleted since RAN1 has agreed that whether to transmit PRACH is up to UE implementation, which is already captured in another paragraph in TS 38.213, clause 17.2.

The corresponding TP proposed by [06] is as follows.

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| ===================== Unchanged parts are omitted=====================If a HD-UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH in a set of symbols and the UE detects a DCI format indicating to the HD-UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then - the HD-UE does not expect to cancel the transmission of the PUCCH or PUSCH in the set of symbols if the first symbol in the set occurs within $T\_{proc,2 }$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format; otherwise, the HD-UE cancels the PUCCH, or the PUSCH, or an actual repetition of the PUSCH [6, TS38.214], determined from clauses 9 and 9.2.5 or clause 6.1 of [6, TS38.214]~~, or the PRACH transmission in the set of symbols~~.- the HD-UE does not expect to cancel the transmission of SRS in symbols from the subset of symbols that occur within $T\_{proc,2}$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format. The HD-UE cancels the SRS transmission in remaining symbols from the subset of symbols. $T\_{proc,2}$ is the PUSCH preparation time for UE processing capability 1 [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 SRS, PUCCH, PUSCH or $μ\_{r}$, where $μ\_{r}$ corresponds to the SCS configuration of the PRACH if it is 15 kHz or larger; otherwise $μ\_{r}=0$.===================== Unchanged parts are omitted ===================== |

**FL1 High Priority Proposal 2.4-1**

* Endorse the above text proposal to TS 38.213, clause 17.2

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| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
| Intel | Y | We support the TP since PRACH is not included in Case 1 overlapping |
| Qualcomm | Y |  |
| vivo | Y | Following correction is also needed to remove the PRACH part. ================== Unchanged parts are omitted===================If a HD-UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH in a set of symbols and the UE detects a DCI format indicating to the HD-UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then - the HD-UE does not expect to cancel the transmission of the PUCCH or PUSCH in the set of symbols if the first symbol in the set occurs within $T\_{proc,2 }$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format; otherwise, the HD-UE cancels the PUCCH, or the PUSCH, or an actual repetition of the PUSCH [6, TS38.214], determined from clauses 9 and 9.2.5 or clause 6.1 of [6, TS38.214]~~, or the PRACH transmission in the set of symbols~~.- the HD-UE does not expect to cancel the transmission of SRS in symbols from the subset of symbols that occur within $T\_{proc,2}$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format. The HD-UE cancels the SRS transmission in remaining symbols from the subset of symbols. $T\_{proc,2}$ is the PUSCH preparation time for UE processing capability 1 [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 SRS, PUCCH, PUSCH ~~or~~ $μ\_{r}$~~, where~~ $μ\_{r}$ ~~corresponds to the SCS configuration of the PRACH if it is 15 kHz or larger; otherwise~~ $μ\_{r}=0$.================ Unchanged parts are omitted ================== |
| Nokia, NSB | Y |  |
| CATT | Y | Also fine with vivo’s additional update. |
| Spreadtrum | Y | Additional update from vivo is reasonable. |
| DOCOMO | Y | Also support the update from vivo |
| Sharp | Y | Also fine with vivo’s update. |
| Xiaomi | Y | Also support vivo’s update |
| ZTE, Sanechips | Y | We are fine with vivo’ updated TP. |
| China Telecom | Y | We are fine with vivo’s update. |
| LGE | Y | Also fine with the correction from vivo. |
| Panasonic | Y | We also support vivo's update. |
| Samsung | Y | Also, OK with vivo’s update. |
| CMCC | Y | We are fine with vivo’s update. |
| Intel2 | Y | We also support vivo's update. |

## Issue #5: Partial UL cancelation

It is noted in contributions [04, 06] that the current specification in the clause 17.2 of TS 38.213 does not consider whether HD-FDD UE supports partial cancellation or not. Considering partial cancellation is an optional capability introduced in Rel-16, it can be supported by HD-FDD RedCap UE as an optional capability too. Therefore, contributions [04, 06] suggest RAN1 to reach consensus on whether HD-FDD RedCap UE can optionally support partial cancellation. The corresponding TP proposed by [06] is as follows.

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| ===================== Unchanged parts are omitted=====================If a HD-UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH in a set of symbols and the UE detects a DCI format indicating to the HD-UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then - If the HD-UE does not indicate the capability of [partialCancellation], the HD-UE does not expect to cancel the transmission of the PUCCH or PUSCH in the set of symbols if the first symbol in the set occurs within $T\_{proc,2 }$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format; otherwise, the HD-UE cancels the PUCCH, or the PUSCH, or an actual repetition of the PUSCH [6, TS38.214], determined from clauses 9 and 9.2.5 or clause 6.1 of [6, TS38.214], or the PRACH transmission in the set of symbols.- If the HD-UE indicates the capability of [partialCancellation], the HD-UE does not expect to cancel the transmission of the PUCCH or PUSCH in symbols from the set of symbols that occur within $T\_{proc,2}$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format. The HD-UE cancels the PUCCH, or the PUSCH, or an actual repetition of the PUSCH [6, TS 38.214], determined from clauses 9 and 9.2.5 or clause 6.1 of [6, TS 38.214]. - the HD-UE does not expect to cancel the transmission of SRS in symbols from the subset of symbols that occur within $T\_{proc,2}$ relative to a last symbol of a CORESET where the HD-UE detects the DCI format. The HD-UE cancels the SRS transmission in remaining symbols from the subset of symbols.  $T\_{proc,2}$ is the PUSCH preparation time for UE processing capability 1 [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 SRS, PUCCH, PUSCH or $μ\_{r}$, where $μ\_{r}$ corresponds to the SCS configuration of the PRACH if it is 15 kHz or larger; otherwise $μ\_{r}=0$.===================== Unchanged parts are omitted ===================== |

**FL1 High Priority Proposal 2.5-1**

* Endorse the above text proposal to TS 38.213, clause 17.2

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| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
| Intel | N | We prefer to not support capability [partialCancellation] for HD-UE. Otherwise, it results in a tricky handling “back-to-back” non-overlapping UL/DL without sufficient gap after handling [partialCancellation], and may need further discussions. |
| Qualcomm | Y |  |
| vivo | N | We prefer not to support partial cancellation for RedCap UEs |
| Nokia, NSB |  | We have slight preference not to support partialCancellation to simplify collision handling due to the gap |
| CATT | Y | By default a RedCap UE can optionally support optional features from normal UE. Considering that partialCancellation is already supported in TDD for normal UE, it should be fine to apply in HD-FDD case for RedCap UE.If this is not agreeable, instead, we may draw a conclusion that HD-FDD RedCap UE does not support partialCancellation, and inform this conclusion to AI 8.16.8.  |
| DOCOMO | N | We agree that RedCap UE can optionally support optional features by default. However, if partial cancellation is supported for HD-FDD UE, further discussion is necessary for the case of “back-to-back” non-overlapping UL/DL without sufficient gap, as pointed out by Intel. Also, there would be no strong motivation to introduce partial cancellation for RedCap UEs. Considering the maintenance phase, we don’t think this issue is essential and prefer not to support partial cancellation for HD-FDD UE.By the way, if partial cancellation is supported for HD-FDD UE, it should be discussed whether existing capability FG 22-9 can be reused for HD-FDD UE since it was defined for TDD case in Rel-16. If not, it has RAN2 signalling impact, which must be concluded as soon as possible. |
| ZTE, Sanechips |  | If ‘partialCancellation’ is supported, the HD-FDD RedCap UE may not drop the whole transmission of PRACH/PUCCH/PUSCH when collision happens, and can transmit the non-overlapping part of PRACH/PUCCH/PUSCH especially when transmission with repetitions is supported for the above UL channels. So, there are some benefits for supporting partialCancellation. Before we discuss the TP, we may need to consider the following two options:Option1: RedCap UE does not support partialCancellationOption 2: Only HD-FDD RedCap UE does not support partialCancellation |
| LGE | N | We prefer the RedCap UEs not to support partialCancellation. As the opinion on whether to support the partialCancellation is quite divided, and given this is a maintenance phase, we will have to quickly conclude on this first. |
| Panasonic | N | Our preference is not to support it as it requires further discussion. |
| Samsung | Y | There is no clear reason to exclude it from HD-FDD RedCap UE. Similar to other UE features, it can be optionally supported by HD-FDD RedCap UEs. |
| CMCC |  | We are open to further discuss this since both supporting or not supporting partialCancellation lead to other problems. As our comment to Proposal 2.6-1, if partialCancellation is not supported for RedCap, the definition of available slots for PUCCH needs to be reconsidered. |

## Issue #6: Available slots for PUCCH repetition

In contributions [13, 17], it is indicated that the HD-FDD UE behaviour on determining the available slots for PUCCH repetition is unclear, thereby proposing that HD-FDD UE determines a slot as an available slot for PUCCH repetitions when a PUCCH repetition does not overlap with a symbol with synchronization signal block (SSB) transmission indicated by *ssb-PositionsInBurst.* The corresponding TP proposed for TS 38.213 by [13] is as follows.

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| 9.2.6 PUCCH repetition procedure\*\*\* Unchanged text is omitted \*\*\*For paired spectrum or supplementary uplink band, the UE, except when it is a half-duplex UE, determines the $N\_{PUCCH}^{repeat}$ slots for a PUCCH transmission as the $N\_{PUCCH}^{repeat}$ consecutive slots starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting\*\*\* Unchanged text is omitted \*\*\*17.2 Half-Duplex UE in paired spectrum\*\*\* Unchanged text is omitted \*\*\*A HD-UE determines the $N\_{PUCCH}^{repeat}$ slots for a PUCCH transmission starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting, where a repetition of the PUCCH transmission does not include a symbol indicated as a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.\*\*\* Unchanged text is omitted \*\*\* |

Contribution [08] expresses a similar view that the following conclusion at RAN1#106-e meeting can be also applied to HD-FDD case to have a unified solution with TDD.

|  |
| --- |
| **Conclusion**It is clarified that a PUCCH repetition in case  (including the first PUCCH repetition) is postponed to the next available slot if the PUCCH repetition collides with SSB symbols or symbols indicated as DL by*tdd-UL-DL-ConfigurationCommon*or*tdd-UL-DL-ConfigurationDedicated***.*** There is no consensus in RAN1 for whether or not the above case issupported in Rel-15 for the first PUCCH repetition when the PUCCH is triggered by DCI.
 |

**FL1 High Priority Proposal 2.6-1**

* HD-FDD UE determines a slot as an available slot for PUCCH repetitions when a PUCCH repetition does not overlap with a symbol with synchronization signal block (SSB) transmission indicated by *ssb-PositionsInBurst*

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
| Intel | Y | We support the FL proposal  |
| Qualcomm |  | It is unclear to us if PUCCH repetitions are supported in a separate initial UL BWP of RedCap UE without SSB. If the proposal is for RRC connected mode only, we support the FL proposal when SSB is present in the dedicated DL BWP of RedCap UE. |
| Vivo | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | Y | Our understanding is that PUCCH repetition is supported for RRC connected mode only |
| Sharp |  | We would like to first clarify the meaning of ‘overlap with a symbol with SSB’.In previous agreements, we support the case that “back-to-back” non-overlapping UL/DL without sufficient gap between SSB and configured PUCCH may happen. And it was agreed that this case would be treated as the overlapping case, i.e., the configured UL transmission is cancelled. Therefore, we would like to ask FL whether the proposal 2.6-1 includes the case of “back-to-back” non-overlapping UL/DL without sufficient gap for configured UL PUCCH or not. |
| ZTE, Sanechips | N | From our understanding, is only for RRC connected mode. When the PUCCH is overlapped with SSB, according to the agreement, SSB is prioritized.Based on this proposal, the HD-FDD RedCap UE need to firstly switch to SSB for receiving. After SSB reception, the UE need to switch back to PUCCH transmission. Moreover, the sufficient switching gap before and after SSB should be provided, i.e., 2 gaps are needed for switching, which is quite complicated for the UE.Additionally, if the optional partialCancellation is not supported or enabled, if the PUCCH is dropped due to the collision handling rule, the whole PUCCH transmission is canceled and no any postponement is needed. |
| LGE | Y | We would be fine with the FL proposal in that it is same handling as in TDD.Regarding the question from Sharp, it is our view that the “back-to-back” non-overlapping UL/DL without sufficient gap should be regarded as the overlapping case throughout the spec for consistency. |
| Panasonic | Y |  |
| Samsung |  | We share Sharp’s question about the case of “back-to-back” non-overlapping UL/DL without sufficient gap for configured UL PUCCH and then it should be addressed. |
| CMCC |  | If partialCancellation is not supported for RedCap, we wonder whether it needs to define available slots since the whole PUCCH transmission is canceled. |
| Intel2 | Y | Our understanding is that back-to-back” non-overlapping UL/DL without sufficient gap is handled differently from overlap between UL and a SSB. For all UL (PUSCH and PUCCH), * the available slot is determined by checking the overlap between the UL and a SSB. If a slot is not available, the PUSCH or PUCCH repetition can be delayed to a next available slot.
* After the determination of available slot, UE can further check if a PUSCH or PUCCH repeition can be transmitted by checking back-to-back” non-overlapping UL/DL without sufficient gap. If it cannot be transmitted, the PUSCH or PUCCH repeition is dropped without delaying.
 |

## Issue #7: Omitting condition of DL/UL collision for HD-FDD

Contribution [17] indicates the omitting condition of DL/UL collision handling for HD-FDD, which is specified in Clause 17.2 in TS 38.213, has not yet been reflected in the TS 38.214. The corresponding TP proposed by [17] is as below.

|  |
| --- |
| ======TP to TS 38.214 V17.0.0 ======5.1.2.1 Resource allocation in time domain< unchanged text omitted>A PDSCH reception in a slot of a multi-slot PDSCH reception is omitted according to the conditions in Clause 11.1 and Clause 17.2 of [6, TS38.213].< unchanged text omitted>6.1.2.1 Resource allocation in time domain< unchanged text omitted>For PUSCH repetition Type A and TB processing over multiple slots, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1, ~~and~~ Clause 11.2A and Clause 17.2 of [6, TS 38.213]. < unchanged text omitted>For PUSCH repetition Type B, after determining the invalid symbol(s) for PUSCH repetition type B transmission for each of the *K* nominal repetitions, the remaining symbols are considered as potentially valid symbols for PUSCH repetition Type B transmission. If the number of potentially valid symbols for PUSCH repetition type B transmission is greater than zero for a nominal repetition, the nominal repetition consists of one or more actual repetitions, where each actual repetition consists of a consecutive set of all potentially valid symbols that can be used for PUSCH repetition Type B transmission within a slot. An actual repetition with a single symbol is omitted except for the case of *L*=1. An actual repetition is omitted according to the conditions in Clause 9, Clause 11.1, ~~and~~ Clause 11.2A and Clause 17.2 of [6, TS 38.213]. The UE shall repeat the TB across actual repetitions. The redundancy version to be applied on the *n*th actual repetition (with the counting including the actual repetitions that are omitted) is determined according to table 6.1.2.1-2, where *N*=1. For PUSCH repetition Type B, when a UE receives a DCI that schedules aperiodic CSI report(s) or activates semi-persistent CSI report(s) on PUSCH with no transport block by a ‘*CSI request’* field on a DCI, the number of nominal repetitions is always assumed to be 1, regardless of the value of *numberOfRepetitions*. When the UE is scheduled to transmit a PUSCH repetition Type B with no transport block and with aperiodic or semi-persistent CSI report(s) by a ‘*CSI request’* field on a DCI, the first nominal repetition is expected to be the same as the first actual repetition. For PUSCH repetition Type B carrying semi-persistent CSI report(s) without a corresponding PDCCH after being activated on PUSCH by a ‘*CSI request’* field on a DCI, if the first nominal repetition is not the same as the first actual repetition, the first nominal repetition is omitted; otherwise, the first nominal repetition is omitted according to the conditions in Clause 9, Clause 11.1, ~~and~~ Clause 11.2A and Clause 17.2 of [6, TS 38.213].< unchanged text omitted>6.1.2.3.1 Transport Block repetition for uplink transmissions of PUSCH repetition Type A with a configured grant< unchanged text omitted>A Type 1 or Type 2 PUSCH transmission with a configured grant in a slot is omitted according to the conditions in Clause 9, Clause 11.1, ~~and~~ Clause 11.2A and Clause 17.2 of [6, TS 38.213]. < unchanged text omitted> |

**FL1 High Priority Proposal 2.7-1**

* Endorse the above text proposal to TS 38.214

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
| Intel | Y | We support the FL proposal. |
| Vivo | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | Y |  |
| Sharp | Y |  |
| ZTE, Sanechips | Y |  |
| China Telecom | Y |  |
| LGE | Y | Fine with the proposal. |
| Samsung | Y |  |
| CMCC | Y |  |

## Issue #8: Collision with switching gap

Contributions [05, 13] raise concern on the following text in the clause 17.2 of TS 38.213.

In [13], it is commented that since the logic between the first condition (red) and the second condition (yellow) is essentially ‘OR’, UE will always drop any PUSCH or PUCCH if the PUSCH or PUCCH is not overlapped with the SSB. It is proposed to fix the problem by adding a logic ‘AND’ to the two conditions.

|  |
| --- |
| If a HD-UE would transmit a PUSCH, or PUCCH, or SRS based on a configuration by higher layers and the HD-UE is indicated presence of SS/PBCH blocks by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon*, the HD-UE does not transmit - PUSCH or PUCCH if a last symbol of the PUSCH or PUCCH transmission would not be at least $N\_{Tx-Rx}⋅T\_{c}$ [4, TS 38.211] prior to a first symbol of the next earliest SS/PBCH block- PUSCH or PUCCH if a first symbol of the PUSCH or PUCCH transmission would not be at least $N\_{Rx-Tx}⋅T\_{c}$ [4, TS 38.211] after a last symbol of the previous latest SS/PBCH block - SRS in symbols that would not be at least $N\_{Tx-Rx}⋅T\_{c}$ prior to a first symbol of the next earliest SS/PBCH block- SRS in symbols that would not be at least $N\_{Rx-Tx}⋅T\_{c}$ after a last symbol of the previous latest SS/PBCH block |

Contribution [05] points out that *NRX-TX Tc* and *NTX-RX Tc* are not the sufficient gap intended for HD-FDD UEs since there is no agreement on how the gap is defined. It is proposed in [05] to remove the gap of *NRX-TX Tc and NTX-RX Tc*restriction in section 17.2 of TS 38.213 or RAN1 to discuss and conclude the Ngap values for HD-FDD UL/DL processing.

**FL1 High Priority Question 2.8-1**

* Companies are invited to provide views on the above quoted text and any changes needed for correction

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | N | maybe rephrasing to positive wording could help?UE does transmit - PUSCH or PUCCH if a last symbol of the PUSCH or PUCCH transmission would be at least $N\_{Tx-Rx}⋅T\_{c}$ [4, TS 38.211] prior to a first symbol of the next earliest SS/PBCH block- … |
| Intel |  | As discussed in our contribution R1-2201703, our understanding is the logic between the first condition (red) and the second condition (yellow) is ‘OR’, which results in any PUSCH/PUCCH will be dropped. We would like to hear other companies views on the understanding of the current spec especially the logic of the red/yellow conditions.  |
| vivo | N | We are actually not sure about the problem with existing text. Since we have “prior to a first symbol of the next earliest SS/PBCH block” in the 1st bullet, and “after a last symbol of the previous latest SS/PBCH block” in the 2nd bullet, so the they should mean the red and yellow parts, respectively, as in the figure below (modified figure based on Intel’s) |
| CATT | N | (1) Regarding the interpretation of text, we have the same understanding with vivo.(2) Regarding the gap time, we have the following agreement in RAN1#106bis-e, and agree to reuse the existing switching times:

|  |
| --- |
| **Agreement*** For HD-FDD switching time, reuse existing switching times for UE not capable of full duplex in TS 38.211, Table 4.3.2-3.

Note: With this agreement, no need to confirm below Working Assumption(From RAN1#104e)Working Assumption (FromRAN1#104e )* For HD-FDD switching time, reuse existing switching times for UE not capable of full duplex in TS 38.211, Table 4.3.2-3.
	+ ~~FFS: whether to define the guard times in symbol units~~
	+ ~~FFS: the switching positions~~
 |

So *NRX-TX Tc* and *NTX-RX Tc* should be fine. |
| DOCOMO |  | We have the same understanding as vivo and CATT |
| Sharp | N | We share same view with vivo. |
| Xiaomi |  | We have the same understanding with vivo and CATT |
| ZTE, Sanechips | N | Similar view with vivo.  |
| China Telecom |  | We share the same understanding with vivo and CATT. |
| LGE |  | We tend to think the current wording does not cause any confusion.In Intel’s figure, to check the condition, the region in red after the SSB should be looking at the next SSB which is not drawn in the figure. We are not sure why this region should be in red without the following SSB being without sufficient gap. |
| Samsung | N | We don’t see a need of any change because we have a same understanding with vivo and CATT regarding the text and also regarding the gap. |
| CMCC |  | We have the same understanding as vivo and CATT |
| Intel2 |  | Thanks for all discussions especially the revised figure from vivo. We now understand how to interpret the specification. We agree the specification text is correct.  |

## Issue #9: Processing order for collision handling and intra-UE multiplexing/prioritization

For TDD, it is specified in TS 38.213 that DL-UL collision handling is applied after intra-UE multiplexing/prioritization. It is proposed in [08] that the same principle can be applied to HD-FDD case to have a unified solution with TDD.

**FL1 High Priority Proposal 2.9-1**

* DL-UL collision handling for HD-FDD operation is applied after intra-UE multiplexing/prioritization

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
| Intel | Y |  |
| vivo | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | Y |  |
| Sharp | Y |  |
| Xiaomi | Y |  |
| ZTE, Sanechips | Y |  |
| China Telecom | Y |  |
| LGE | Y |  |
| Panasonic | Y |  |
| Samsung | Y |  |
| CMCC | Y |  |

# On PDCCH blocking rate reduction

Contribution [09] proposes to consider configuration of separate PDCCH SS set for RedCap UEs to reduce PDCCH blocking if separated initial DL BWP for RedCap UEs is not configured. The potential spec impact is very limited, as the legacy SS set configuration can be reused for the dedicated search space set. The configuration of a dedicated search space set can be provided to UE in the same way as dedicated initial DL BWP.

Contribution [07] expresses a different view that PDCCH blocking is not expected to be an issue for RedCap UE and existing solutions can be used to mitigate PDCCH blocking if needed and therefore no new solution is needed specifically for PDCCH blocking.

Considering this has been discussed many times in the previous RAN1 meetings and companies’ position has not changed, the following moderator proposal can be considered to conclude the discussion.

**FL1 Medium Priority Proposed Conclusion 3-1:**

* There is no consensus in RAN1 for whether or not a dedicated search space set configuration is supported in Rel-17 for RedCap UEs in case of shared initial DL BWP

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic | Y |  |
| Intel | Y |  |
| Qualcomm | Y |  |
| vivo | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | Y |  |
| Sharp | Y |  |
| Xiaomi | Y |  |
| ZTE, Sanechips | N | From our understanding, separate search space set configuration, e.g., RAR or paging, can also be used for offloading, avoid UE power consumption due to unnecessary paging detection and SIB receiving. More details can be found in the tdoc R1-2201892. It also can be further discussed in AI 8.6.1.1. |
| China Telecom | Y |  |
| LGE | Y |  |
| Panasonic | Y |  |
| CMCC | Y |  |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [RP-211574](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_92e/Docs/RP-211574.zip) | Revised WID on support of reduced capability NR devices | Ericsson |
| [2] | [R1-2112506](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2112506.zip) | RAN1 agreements for Rel-17 NR RedCap | Rapporteur (Ericsson) |
| [3] | [R1-2201100](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201100.zip) | Remaining issues on RedCap half-duplex operation | vivo, Guangdong Genius |
| [4] | [R1-2201137](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201137.zip) | HD-FDD for reduced capability NR devices | ZTE, Sanechips |
| [5] | [R1-2201278](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201278.zip) | Other remaining issues for Reduced Capability NR Devices | OPPO |
| [6] | [R1-2201368](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201368.zip) | Remaining issues on other aspects related to complexity reduction | CATT |
| [7] | [R1-2201405](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201405.zip) | Other Aspects | Nokia, Nokia Shanghai Bell |
| [8] | [R1-2201483](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201483.zip) | Remaining issues on other aspects for RedCap | NTT DOCOMO, INC. |
| [9] | [R1-2201525](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201525.zip) | Other aspects for complexity reduction for RedCap Ues | Samsung |
| [10] | [R1-2201550](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201550.zip) | Discussion on other aspects for RedCap | Spreadtrum Communications |
| [11] | [R1-2201591](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201591.zip) | Other aspects for RedCap UE complexity reduction | Panasonic Corporation |
| [12] | [R1-2201669](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201669.zip) | Other UE complexity reduction aspects for RedCap | Ericsson |
| [13] | [R1-2201703](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201703.zip) | On other aspects of complexity reduction for RedCap Ues | Intel Corporation |
| [14] | [R1-2201776](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201776.zip) | Other UE complexity reduction aspects for RedCap | Apple |
| [15] | [R1-2201862](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201862.zip) | Remaining issues of collision handling of HD-FDD operation | CMCC |
| [16] | [R1-2201956](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201956.zip) | Discussion on the remaining issues of HD-FDD | Xiaomi |
| [17] | [R1-2202193](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202193.zip) | Discussion on duplex operation for RedCap UEs | Sharp |
| [18] | [R1-2202345](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202345.zip) | Other aspects related to the UE complexity reduction for RedCap | LG Electronics |
| [19] | [R1-2202418](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202418.zip) | Remaining issues on HD-FDD for RedCap UEs | Huawei, HiSilicon |
| [20] | [R1-2202146](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202146.zip) | Remaining Issues on UE Complexity Reduction | Qualcomm Incorporated |
| [21] | [R1-2112601](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112601.zip) | FL summary #3 on other aspects for RedCap | Qualcomm Incorporated |