3GPP TSG-RAN WG1 Meeting #105-e R1-210xxxx

e-Meeting, 19th – 27th May 2021

**Agenda Item: 8.6.1.3**

**Title: FL summary #1 on duplex operation for RedCap**

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

**Document for: Discussion, Decision**

# Introduction

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

This document summarizes contributions [3] – [30] submitted to agenda item 8.6.1.3 and captures the following email discussion for the RedCap WI.

|  |
| --- |
| [105-e-NR-R17-RedCap-03] Email discussion regarding aspects related to duplex operation – Chao (Qualcomm)* 1st check point: 5/21
* 2nd check point: 5/25
* Final check: 5/27
 |

The issues in this document are tagged and colour coded with High priority or Medium priority.

In a first round of this discussion, companies were invited to comment on the High Priority questions/proposals.

# HD-FDD switching time

## General

RAN1#104e made the following agreements related to switching time [2]:

|  |
| --- |
| Agreements:* (Working assumption) 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
* Sending an LS to RAN4 to inform the above working assumption, and to ask for feedback if any
	+ The LS will not include the two FFS bullets

Draft LS in [R1-2102094](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Inbox/R1-2102094.zip) is approved. Final LS to be uploaded/updated depending on whether or not there are additional agreements for RedCap related to RAN4. Final LS in [R1-2102146](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Inbox/R1-2102146.zip) |

RAN1#104bis-e made the following WA regarding HD-FDD switching time for RedCap [2]:

|  |
| --- |
| Working assumption:* For HD-FDD, no additional UE behavior for switching position determination is specified as compared to the existing specification.
 |

From the received response, no issue is found for reusing the existing mechanism to determine the switching position for HD-FDD RedCap UEs. Therefore, the following proposal can be considered.

**High Priority Proposal 2-1:** Confirm following working assumption

* For HD-FDD, no additional UE behavior for switching position determination is specified as compared to the existing specification

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y | We are ok with the proposal |
| Spreadtrum | Y |  |
| vivo | Y |  |
| Huawei, HiSi | Y |  |
| CATT | Y |  |

## Open issue: whether to define the guard time in symbol units

Contributions [3, 5, 8, 7, 10, 11, 13, 27, 28] express views on whether to define the guard time in symbol units.

* No need to define the guard time in symbol units
	+ Supported by Ericsson, vivo, CATT, ZTE, Nokia, China Telecom, Sharp
* The guard time is defined in the symbol units instead of the actual time unit. [1] OFDM symbol duration for 15, 30 or 60 kHz SCS can be considered
	+ Supported by WILUS, Qualcomm
* Further discuss after deciding whether TDD-like configuration is supported
	+ Supported by Asia Pacific Telecom, FGI

The issue has been discussed in the last RAN1 meeting. Decision cannot be made since it may be related to the decision on whether to introduce semi-static TDD-like slot format for HD-FDD RedCap UEs. Also, it may need the reply LS from RAN4 for the transition time.

# Collision handling

## Case 1: Dynamically scheduled DL reception vs. semi-statically configured UL transmission

RAN1#104bis-e reached the following agreements [2]:

|  |
| --- |
| Agreements:* For Case 1 (dynamically scheduled DL reception vs. semi-statically configured UL transmission), reuse the existing collision handling principles in Rel-15/16 NR for operation on a single carrier /single cell in unpaired spectrum.
	+ FFS whether the timeline is extended to include the RX/TX switching time for HD-FDD
 |

The remaining FFS is regarding whether the timeline in the above rule should be extended to include the Tx/Rx switching time for HD-FDD.

Contributions [3, 5, 16] indicated that the FFS is relevant only for the case of UE capable of partial cancellation. In such case, gNB can take into account the Tx/Rx switching time when scheduling dynamic DL to avoid collision with switching time and there is no need to extend the timeline to include the Tx/Rx switching time. Contributions [6, 8, 11, 14, 19, 28] express the similar view.

Contributions [4, 7, 18] expressed views that whether to introduce an extended timeline to include the switching time can be further discussed, after RAN4 providing feedback about the Tx/Rx switching time.

In the contribution [9] it was viewed that similar to BWP switching time and uplink switching gap that have been included in *Tproc,2*, the Tx/Rx switching can be considered in PUSCH preparation time *Tproc,2* for HD-FDD case.*.*

It was noted in the contribution [27] that UE may switch to UL transmission before the DCI scheduling a DL reception is decoded and in such case a UL-to-DL switching time is needed for UE to cancel the configured UL transmission and to perform the DL reception.

Normally, PUSCH preparation time *Tproc,2* is much larger than the Tx/Rx switching time and therefore UE could perform PUSCH preparation at the same time as Rx/Tx switching. Also, gNB would be expected to ensure sufficient switching time is available for UE before DL reception. Then, the necessity to extend the timeline to include the Tx/Rx switching time is not clear. But this can be revisited if a large Tx/Rx switching time is introduced by RAN4.

**High Priority Proposal 3.1-1:**

* For Case 1, the existing timeline in Rel-15/16 NR for operation on a single carrier /single cell in unpaired spectrum is reused for HD-FDD
	+ Can revisit if a large Tx/Rx switching time is required for HD-FDD based on RAN4 feedback

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp |  | It can be remained as “FFS” waiting for RAN4 feedback |
| Spreadtrum | Y | As summarized above, we think gNB can take into account the Tx/Rx switching time when scheduling dynamic DL to avoid collision with switching time and there is no need to extend the timeline to include the Tx/Rx switching time.But at this stage, we can accept the FL proposal. |
| vivo | Y |  |
| Huawei, HiSi | Y |  |
| CATT | Y | OK |

## Case 2: Semi-statically configured DL reception vs. dynamically scheduled UL transmission

RAN1#104bis-e reached the following agreements [2]:

|  |
| --- |
| Agreements:* For Case 2 (semi-statically configured DL reception vs. dynamically scheduled UL transmission), reuse the existing collision handling principles in Rel-15/16 NR for operation on a single carrier/single cell in unpaired spectrum
	+ The semi-statically configured DL reception may include PDCCH (excluding ULCI), SPS PDSCH, CSI-RS or PRS.
		- FFS on PDCCH carrying ULCI, including whether or not it is supported by RedCap UEs (including potential difference between HD vs. FD RedCap UEs)
	+ The dynamically scheduled UL transmission may include PUSCH, PUCCH, SRS or PRACH triggered by PDCCH order
 |

The remaining FFS is regarding whether or not the UL cancellation indicator (UL CI) is included as part of PDCCH in the collision handling rule.

Contribution [30] has expressed view that ULCI is a key enabler for the coexistence of IWSN and URLLC devices in a spectral efficient manner and RedCap UE can support ULCI without an increase in UE complexity. Therefore, in contribution [30] it is proposed that RedCap UE should prioritize reception of PDCCH carrying ULCI over dynamically scheduled UL transmission

In contribution [6] it is viewed that a minimum value of UL CI periodicity needs to be considered for HD-FDD RedCap UE to monitor ULCI.

Contributions [7, 8] propose that ULCI is not supported by HD-FDD RedCap UE, and contributions [11, 19, 20] indicate whether or not ULCI is supported by RedCap UEs can be discussed in a later stage for UE feature discussion.

Contributions [3, 4, 5, 9, 16, 18, 20, 24, 28, 29] express view that no special handling is required to support ULCI for HD-FDD RedCap UEs. It is noted in contribution [3] that it may not even be possible to make an exception in the rule by simply excluding PDCCH carrying UL CI unless some indication is introduced to allow UE to distinguish a PDCCH carrying ULCI from other PDCCHs without actually decoding it.

Since a clear majority view is not to have an exception for PDCCH carrying ULCI in the collision handling rule, the following proposal can be considered.

**High Priority Proposal 3.2-1:**

* For Case 2, no special handling for PDCCH carrying ULCI, if supported

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y |  |
| Spreadtrum |  | This proposal means the dynamically scheduled UL is prioritized when the dynamically scheduled UL is overlapped with UL-CI.If we adopt this proposal, it may bring negative impacts to URLLC. The UL-CI is introduced to cancel the UE’s UL transmission without higher requirements on latency/reliability, and maintain the performance of URLLC service. If the UL-CI is dropped, the transmission information of URLLC is unknown to the RedCap UE, and the follow-up transmission in UL from RedCap may bring interference to URLLC.Therefore, we think the UL-CI is very important in coexistence scenarios, and the reception of PDCCH carrying ULCI should be prioritized over dynamically scheduled UL transmission. Further, considering the periodicity of UL-CI is relatively small (from mini-slot level to 10 slots), it may lead to very frequent switching between UL and DL or even have no opportunity to transmit in UL for RedCap, so we think the UL-CI periodicity should be no smaller than X slots for RedCap UEs. |
| vivo | Y |  |
| Huawei, HiSi | Y |  |
| CATT | Y |  |

## Case 3: Semi-statically configured DL reception vs. semi-statically configured UL transmission

RAN1#104bis-e reached the following agreements [2]:

|  |
| --- |
| Agreements:* For Case 3, semi-statically configured DL reception vs. semi-statically configured UL transmission
	+ A HD-FDD UE does not expect to receive both dedicated higher layer parameters configuring transmission from the UE in the set of symbols of the slot and dedicated higher layer parameters configuring reception in the set of symbols of the slot
	+ A HD-FDD UE does not expect to receive both dedicated higher layer parameters configuring transmission from the UE in the set of symbols of the slot and cell specific higher layer parameters configuring reception in the set of symbols of the slot
	+ A HD-FDD UE does not expect to receive both cell specific higher layer parameters configuring transmission from the UE in the set of symbols of the slot and dedicated higher layer parameters configuring reception in the set of symbols of the slot
	+ FFS on cell-specifically configured DL reception vs. cell-specifically configured UL transmission
	+ FFS: whether or not there are conditions that need to be considered
 |

The remaining FFS is regarding a collision between cell-specifically configured DL reception and cell-specifically configured UL transmission.

Many contributions express view that an exception could be made for the case of cell-specially configured DL reception vs. cell-specially configured UL transmission, particularly SSB vs. valid ROs where overlapping occasions are allowed.

Contributions [5, 7, 12, 17] indicate there are some overlapping between case 3, case 5 and case 8, and further identification on the cell-specifically configured DL reception and cell-specifically configured UL transmission other than SSB and valid ROs are required.

Contributions [4, 5, 6, 7, 9, 11, 14, 16, 22, 26, 28, 29] express view that the cell-specifically configured DL reception may also comprise cell specific PDCCH (i.e. in Type-0/0A/1/2 CSS set) and the corresponding PDSCH (i.e. on paging/SI occasions).

In contributions [4, 11, 14] it is viewed that the cell specially configured UL transmission comprises also cell specific PUCCH configured by PUCCH-ConfigCommon.

Since common PUCCH is used only before RRC connection, and the DL reception and UL transmission for initial access procedure are sequentially operated for a given UE, it seems no need to define collision handling rule for common PUCCH. Collision handling or prioritization can be left to UE implementation.

**High Priority Question 3.3-1: For case 3 of cell-specially configured DL reception vs. cell-specially configured UL transmission, is it sufficient to consider the following subcases? To avoid overlapping with case 5 and case 8, can these subcases be discussed under Case 8?**

* **Subcase 1: Configured SSB vs. valid RO**
* **Subcase 2: PDCCH in CSS and the corresponding PDSCH vs. valid RO**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y |  |
| Spreadtrum | Y |  |
| vivo |  | Indeed there were some overlap among different cases. We would be fine if these cases (collision between cell-specific configured DL and cell-specific configured UL ) will be explicitly discussed in case 5 or case 8.  |
| Huawei, HiSi | Almost | In case 2-step RACH is supported later some rewording is needed. The RO and PRU are bundled in 2-step RACH, and these are also cell-specially configured UL resource, thus, the “RO” in this proposal needs to be changed to “RO, or RO+PUSCH in msgA”. |
| CATT | Y | For Subcase 1, discussion in either case 5 or case 8 is fine to us. |

## Case 4: Dynamically scheduled DL reception vs. dynamic scheduled UL transmission

RAN1#104bis-e reached the following agreements [2]:

|  |
| --- |
| Agreements:* For Case 4: dynamically scheduled DL reception vs. dynamic scheduled UL transmission, reuse the existing collision handling principles in Rel-15/16 NR for operation on a single carrier /single cell in unpaired spectrum
	+ That is, it is considered as an error case if a dynamically scheduled DL reception overlaps with a dynamically scheduled UL transmission
 |

From the received responses, no open issue has been identified for Case 4.

## Case 5: Configured SSB vs. dynamically scheduled or configured UL transmission

RAN1#104bis-e reached the following working assumptions [2]:

|  |
| --- |
| Working assumption:* If a dynamically scheduled UL transmission overlaps with an SSB, down-select one of the following options:
	+ Option 1: Follow the handling of case 2 that dynamic UL is prioritized over SSB
	+ Option 2: Reuse the existing collision handling principles of Rel-15/16 for NR TDD that SSB is prioritized over dynamic UL
	+ Option 3: Leave to UE implementation whether to receive the SSB or transmit the UL transmission
	+ Other options are not precluded
* If a semi-static configured UL transmission overlaps with an SSB, down-select from the following options:
	+ Option 1: Up to gNB configuration to avoid such collision and if it happens it is an error case
	+ Option 2: Reuse the existing collision handling principles of Rel-15/16 for NR TDD that SSB is prioritized over semi-static UL
	+ Option 3: Leave to UE implementation whether to receive the SSB or transmit the UL transmission
	+ Other options are not precluded
* FFS: whether/how to account for Tx/Rx switching time before and after the set of SSB symbols
* FFS: whether or not the semi-static configured UL transmission includes a valid RO
 |

For the case of configured SSB overlaps with dynamically scheduled UL transmission, companies’ views are summarized in Table 3.5-1.

**Table 3.5-1: Views on collision handling for configured SSB vs. dynamically scheduled UL transmission**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Description  | Companies | # of Companies |
| Option 1 | Follow the handling of case 2 that dynamic UL is prioritized over SSB | Ericsson, Huawei, CATT, China Telecom, WILUS, ASUSTEK | 6 |
| Option 2 | Reuse the existing collision handling principles of Rel-15/16 for NR TDD that SSB is prioritized over dynamic UL | Nokia, Intel, Apple, LGE, Xiaomi, Qualcomm, OPPO, Potevio, Lenovo, Sharp, DCM, Panasonic, MTK, IDCC, NordicSemi | 15 |
| Option 3 | Leave to UE implementation whether to receive the SSB or transmit the UL transmission | Apple, Samsung, Spreadtrum, CMCC, ASUSTEK | 5 |
| Option 4 | If SSB is indicated by SSB-MTC, SSB is prioritized; otherwise the dynamically scheduled UL is prioritized | vivo | 1 |
| Option 5 | If dynamically scheduled UL is during RA procedure, UL transmission is prioritized; otherwise the SSB reception is prioritized | ZTE | 1 |

Based on Table 3.5-1 above, clearly Option 2 is the preferred option by major companies. From the received response, the concern on Option 2 is less flexible compared to Option 1, however, it imposes less impact on UE measurement using SSB consistent with TDD. For example, the SSB-based neighbor cell RRM measurement (SSB within SMTC) will not be cancelled by DCI.

**High Priority Proposal 3.5-1:**

* For Case 5 of SSB overlaps with dynamically scheduled UL transmission, re-use the existing collision handling principles of Rel-15/16 for NR TDD that configured SSB is prioritized over dynamic UL
	+ Configured SSB includes the SSB indicated by *ssb-PositionsInBurst* and/or *SSB-MTC*

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y |  |
| vivo | Y |  |
| Huawei, HiSi | N | Prioritizing SSBs used also for legacy UEs will just restrict network configuration/dynamic scheduling for RedCap UEs. And especially for HD-FDD in FDD network reusing the rules designed for TDD brings similar network restriction to a FDD network where it does not have to before, which is not desirable. From UE perspective, a RedCap UE is not expected to support too many collision handling rules. Sometime the SSBs do not necessarily to be decoded, and consider those as normal semi-static resources is simpler and sufficient. |
| CATT | N | We think dynamic UL should be prioritized in this case. A gNB will schedule the UE with a dynamic grant only when the gNB thinks it is proper and urgent. Even if dynamic UL is prioritized, if the gNB would like to leave the UE to receive SSB, it can choose not to send the dynamic grant.Note that the SSB occupies non-negligible number of DL symbols and we don’t want them totally unavailable for UL transmission. |

For the case of configured SSB overlaps with semi-statically configured UL transmission except valid RO, companies’ positions are summarized in Table 3.5-2.

**Table 3.5-2: View on collision handling for semi-statically SSB vs. semi-statically configured UL except valid RO**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Description  | Companies | # of Companies |
| Option 1 | Up to gNB configuration to avoid such collision and if it happens it is an error case | Nokia, Lenovo (for UE-dedicated configured UL), Sharp | 3 |
| Option 2 | Reuse the existing collision handling principles of Rel-15/16 for NR TDD that SSB is prioritized over semi-static UL | CATT, Apple, Samsung, LGE, Xiaomi, WILUS, Qualcomm, OPPO, Potevio, Lenovo (for cell specific configured UL), DCM, Panasonic, MTK, IDCC, NordicSemi | 15 |
| Option 3 | Leave to UE implementation whether to receive the SSB or transmit the UL transmission | Ericsson (based on RRM requirement), Intel, Apple, Spreadtrum, CMCC, ASUSTEK | 6 |
| Option 4 | If SSB is indicated by SSB-MTC, SSB is prioritized; otherwise the semi-static UL transmission prioritized | vivo | 1 |
| Option 5 | If semi-static UL is in RA procedure, UL transmission is prioritized; otherwise the SSB reception is prioritized | ZTE | 1 |
| Option 6 | Follow the handling of Case 3 by considering SSB as semi-statically configured DL. The exact procedure depends on whether the semi-static UL is UE specific or cell level configured  | Huawei, China Telecom | 2 |

Based on Table 3.5-2 above, clearly Option 2 is the preferred option by major companies. From the received response, the concern on Option 1 is that it is difficult to avoid overlapping of some periodic occasions. Option 3 may lead to increased gNB blind decoding of UL transmission or UE’s power consumption in case NW assumes UE prioritizes SSB. Option 2 can be reasonable to reuse the existing collision handling principles of Rel-15/16 for NR TDD.

**High Priority Proposal 3.5-2:**

* For Case 5 of SSB overlaps with semi-statically configured UL except valid RO, re-use the existing collision handling principles of Rel-15/16 for NR TDD that configured SSB is prioritized over configured UL
	+ Configured SSB includes the SSB indicated by *ssb-PositionsInBurst* and/or *SSB-MTC*

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | N | The gNB should avoid configuring semi-static UL overlaps with the SSB.For example, if a periodic PUCCH that overlaps with the SSB is cancelled, it will introduce an additional HARQ delay. |
| vivo | Y |  |
| Huawei, HiSi | N | Prioritizing SSBs used also for legacy UEs will just restrict network configuration for RedCap UEs, e.g. configured UL grant with short periodicity will not be able to be used, or introducing more delay thus more power consumption for RedCap UEs if SSBs are prioritized.It would be desirable to enable more flexibility for network to handle different priority for collision handing in different scenarios. |
| CATT | Y, partially | We can accept prioritizing SSB in this case, or give the decision to network as HW suggested. |

Regarding to the FFS on whether/how to account for Tx/Rx switching time before and after the set of SSB symbols, there are different views as summarized below

* 2 companies: Ericsson, vivo, think there is no need to account for Tx/Rx switching time before and after the set of SSB symbols
* 1 company, ZTE, views Tx/Rx switching time should be considered for determining the collision
* 1 company: LGE, thinks the Rx-to-Tx switching time after the set of SSB symbols neds to be accounted for HD-FDD
* 1 company, Samsung, thinks the Tx/Rx switching time is considered for SRS overlapped with SSB since SRS can be transmitted before and/or after the set of SSB symbols

Since the UE behavior as described in the working assumption for Case 9 can ensure that Tx/Rx switching time is fulfilled for the case of SSB immediately followed by an UL transmission or SSB immediately follows the last symbol of an UL transmission, it is reasonable not to account for Tx/Rx switching time before and after the set of SSB symbols.

**High Priority Question 3.5-1:**

* For Case 5, is it sufficient not to account for Tx/Rx switching time before and/or after the set of SSB symbols for HD-FDD? If not, please provide the justifications why it cannot be covered by the working assumption for Case 9.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | N | It depends on if SSB is always prioritized and can be remained as FFS |
| vivo | Y | We agree with the FL assessment.  |
| Huawei, HiSi | Y |  |
| CATT |  | Not sure whether there are some cases need to consider the switching time, e.g. CG-PUSCH repetitions overlapping with SSB and if SSB is prioritized. We can keep it as FFS. |

## Case 8: Dynamic or semi-static DL vs. valid RO

Table 3.6-1 summarizes the proposed options for the case of valid RO overlaps with dynamically scheduled DL reception.

**Table 3.6-1: View on collision handling for dynamic DL vs. valid RO**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Description  | Companies | # of Companies |
| Option 1 | Reuse the existing collision handling principles of Rel-15/16 for NR TDD for operation on a single carrier /single cell in unpaired spectrum  | Ericsson, ZTE, Qualcomm, Intel, Apple, Potevio, Lenovo, IDCC | 7 |
| Option 2 | Leave to UE implementation whether to receive the SSB or transmit the PRACH on a valid RO | Spreadtrum, Nokia, CMCC, ASUTEK | 4 |
| Option 3 | Follow the handling of Case 1 to cancel PRACH based on a timeline (Interpretation 2 in R1-2103809) | CATT, China Telecom | 2 |
| Option 4 | Valid RO including Ngap symbols before the valid RO is prioritized over dynamic UL (Interpretation 3 in R1-2103809) | LGE, DCM, Panasonic, NordicSemi | 4 |
| Option 5 | Down-select from the options provided in R1-2103809 | vivo | 1 |

In RAN1#104bis-e meeting, an issue on collision handling for PRACH transmission for Rel-15/16 NR was discussed in email thread [104b-e-NR-7.1CRs-03], and the summary can be found in R1-2103809. Although there are different interpretations of the existing collision handling principles on the current spec, the issues will not be further discussed for Rel-15 and Rel-16.

**High Priority Question 3.6-1:**

* For Case 8 of valid RO overlaps with dynamically scheduled DL reception, is it sufficient to down-select from the following options? If not, what other options can be considered?
	+ Option 1: Reuse the existing collision handling principles of Rel-15/16 for NR TDD for operation on a single carrier /single cell in unpaired spectrum
	+ Option 2: Leave to UE implementation whether to receive the SSB or transmit the PRACH on a valid RO
	+ Option 3: Follow the handling of Case 1 to cancel PRACH based on a timeline (Interpretation 2 in R1-2103809)
	+ Option 4: Valid RO including Ngap symbols before the valid RO is prioritized over dynamic UL (Interpretation 3 in R1-2103809)
	+ Option 5: When the cancellation timeline is satisfied, the UE neither performs transmission nor receives any DL signal/channels on the symbols overlapping with PRACH occasion (Interpretation 1 in R1-2103809)

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y |  |
| Spreadtrum | Y | Fine with the FL proposal. Fix a possible typo:* For Case 8 of valid RO overlaps with dynamically scheduled DL reception, is it sufficient to down-select from the following options? If not, what other options can be considered?
	+ Option 1: Reuse the existing collision handling principles of Rel-15/16 for NR TDD for operation on a single carrier /single cell in unpaired spectrum
	+ Option 2: Leave to UE implementation whether to receive the SSB or transmit the PRACH on a valid RO
	+ Option 3: Follow the handling of Case 1 to cancel PRACH based on a timeline (Interpretation 2 in R1-2103809)
	+ Option 4: Valid RO including Ngap symbols before the valid RO is prioritized over dynamic ~~U~~DL (Interpretation 3 in R1-2103809)
	+ Option 5: When the cancellation timeline is satisfied, the UE neither performs transmission nor receives any DL signal/channels on the symbols overlapping with PRACH occasion (Interpretation 1 in R1-2103809)
 |
| vivo |  | Regarding option 1, clearly no common understanding on how to interpret Rel-15/16 TDD behavior, as captured in R1-2103809. We should either remove option 1, or try to clearly spell out what is the intended behavior. We are fine with other options.  |
| Huawei, HiSi |  | Whatever option is agreed it will imply R15/R16 is the same handing, since it is agreed to reuse the handling from R15/R16.We would prefer companies who choose Option1 also indicate their opinion of other options, as it is not clear to us which one is the R15/R16 behavior in mind.In addition, can PUSCH in msgA be accounted in the above? Since it is associated with RO and cell specific, it would be good to treat it together instead of taking it in other cases separately. |
| CATT |  | First of all, since this proposal is discussing dynamic DL vs. valid RO, it seems Option 2 is unnecessary to be placed here.Secondly, we have similar concern with vivo.  |

For the case of valid RO overlaps with semi-statically configured DL reception, contribution [5] proposed to clarify whether the semi-static DL includes only cell-specifically configured DL reception with the assumption of the UE-dedicated configured DL covered by the agreement for Case 3. The contribution [7] also pointed out that following the RAN1#104-e and RAN1#104bis-e agreements there could be two different directions for handling the collision between UE-dedicated configured DL and valid RO.

**High Priority Question 3.6-2:**

* For Case 8 of valid RO overlaps with semi-statically configured DL reception, is it common understanding that the semi-statically configured DL includes only cell specifically configured DL reception (i.e. SSB, PDCCH in Type-0/0A/1/2 CSS set and the corresponding PDSCH)?

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Spreadtrum | Y |  |
| vivo | Y |  |
| CATT |  | We are open to this issue. If semi-statically configured DL includes only cell specifically configured DL reception, this means valid RO is considered as the cell-specific UL transmission in RAN1#104bis-e agreement in Case 3. |

Table 3.6-2 summarizes the proposed options for the case of valid RO overlaps with SSB.

**Table 3.6-2: View on collision handling for valid RO vs. SSB**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Description  | Companies | # of Companies |
| Option 1 | Leave to UE implementation whether to receive the SSB or transmit the PRACH on the valid RO | Ericsson, CATT, Intel, Samsung, Spreadtrum, Nokia, CMCC, Panasonic | 8 |
| Option 2 | SSB is prioritized over valid RO | LGE, OPPO, China Telecomm | 3 |
| Option 3 | When random access procedure is triggered, the PRACH preamble transmission is prioritized; otherwise, SSB reception is prioritized | ZTE | 1 |

Based on Table 3.6-2 above, clearly Option 1 is the preferred option by major companies. Therefore, the following proposal can be considered.

**High Priority Proposal 3.6-2:**

* For Case 8 of valid RO overlaps with configured SSB, leave to UE implementation whether to receive the SSB or transmit the PRACH on the valid RO

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y | We are ok with the proposal |
| Spreadtrum | Y |  |
| vivo | Y |  |
| Huawei, HiSi | N | Our understanding is the RO is invalid in R15.  |
| CATT | Y |  |

Table 3.6-3 summarizes the proposed options for the case of valid RO overlaps cell-specific configured DL except SSB.

**Table 3.6-3: View on collision handling for valid RO vs. cell specific configured DL except SSB**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Description  | Companies | # of Companies |
| Option 1 | Reuse the existing collision handling principles of Rel-15/16 for NR TDD for operation on a single carrier /single cell in unpaired spectrum | Ericsson, ZTE, Apple, LGE, WILUS, IDCC, DCM, NordicSemi | 8 |
| Option 2 | Leave to UE implementation whether to receive the DL or transmit the PRACH on the valid RO | CATT, Nokia, Intel, Spreadtrum, CMCC | 5 |
| Option 3 | If semi-static DL is PDCCH in Type-2 CSS set, then PDCCH in Type-2 CSS set is prioritized; otherwise the valid RO is prioritized | vivo | 1 |
| Option 4 | Cell-specific configured DL is prioritized over valid RO | China Telecomm | 1 |
| Option 5 | Configured by network, e.g. via a priority indicator | Huawei, Samsung | 2 |

**High Priority Question 3.6-3:**

* For Case 8 of valid RO overlaps with cell-specific configured DL except SSB, is it sufficient to down-select from the following options? If not, what other options can be considered?
	+ Option 1: Reuse the existing collision handling principles of Rel-15/16 for NR TDD for operation on a single carrier /single cell in unpaired spectrum
	+ Option 2: Leave to UE implementation whether to receive the DL or transmit the PRACH on the valid RO
	+ Option 3: If semi-static DL is PDCCH in Type-2 CSS set, then PDCCH in Type-2 CSS set is prioritized; otherwise the valid RO is prioritized
	+ Option 4: Cell-specific configured DL is prioritized over valid RO
	+ Option 5: Configured by network, e.g. via a priority indicator

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | Y |  |
| Spreadtrum | Y | Fine with the FL proposal.  |
| vivo |  | Same comment as for **High Priority Question 3.6-1:,** we think Option 1 is unclear due to lack of common understanding about existing behavior. We should either remove option 1, or try to clearly spell out what is the intended behavior.  |
| Huawei, HiSi | Almost | Similar comments that, PUSCH in MsgA may need to be accounted for together. |
| CATT |  | Similar concern as vivo.  |

Contributions [18, 19] express view on whether to account for Tx/Rx switching time before and after the valid RO. The contribution [18] proposed that if Ngap symbols are specified for HD-FDD RedCap UEs, it can be utilized as the RX/TX switching time; otherwise the RX/TX switching time can be additionally considered. The contribution [19] indicated that the Rx-to-Tx switching time before the valid RO needs to be accounted for HD-FDD.

Similar to Case 5, the UE behavior as described in the working assumption for Case 9 can ensure that Tx/Rx switching time is fulfilled, and therefore, it is reasonable not to account for Tx/Rx switching time before and after the valid RO.

**High Priority Question 3.6-4:**

* For Case 8, is it sufficient not to account for Tx/Rx switching time before and/or after the valid RO for HD-FDD? If not, please provide the justifications why it cannot be covered by the working assumption for Case 9.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | N | It can be remained FFS before discussion for **3.6-3** |
| vivo | Y | We agree with FL assessment.  |
| CATT |  | We think this is similar to the SSB case. We can go back here when the SSB case is clear. |

## Case 9: Collision due to direction switching

RAN1#104bis-e reached the following working assumptions [2]:

|  |
| --- |
| Working assumption:* For HD-FDD, reuse the same principle as Rel-15/16 UE not capable of full-duplex communication
	+ A HD-FDD UE is not expected to transmit in the uplink earlier than [*NRX-TX Tc*] after the end of the last received downlink symbol in the same cell
	+ A HD-FDD UE is not expected to receive in the downlink earlier than [*NTX-RX Tc*] after the end of the last transmitted uplink symbol in the same cell
	+ FFS NTX-RX and NRX-TX
	+ FFS: how it jointly works with the agreement for other collision cases
 |

Contributions [5, 8, 16, 24] support to confirm the working assumption.

Regarding how it jointly works with the agreement for other collision cases, contributions [3, 5, 11, 14, 24, 29] express the following views.

* Ericsson [3]: Collision with the switching time after applying collision handling rules may occur, and for such an occasion, it is up to UE to ensure that the switching time is satisfied
* ZTE [11]: Any collision handling principle for Case1~Case 8 should follow the restriction defined for Case 9
* Intel [14]: The similar issue may exist in NR TDD. Further study on the two solutions
* MTK [24]: gNB makes sure that collision due to direction switching either does not occur or can be tolerated
* NordicSemi [29]: The conclusion from NR TDD in RAN#98b can be followed by HD-FDD UE

Since the working assumption for Case 9 is proposed to reuse the same principle as Rel-15/16 UE not capable of full-duplex communication, it is reasonable to follow the same conclusion for TDD. Considering there is nothing in the specification for NR TDD on this issue, there is no need to introduce any special rule to HD-FDD.

**High Priority Proposal 3.7-4:** Confirm the following working assumption with removing the last FFS.

* For HD-FDD, reuse the same principle as Rel-15/16 UE not capable of full-duplex communication
	+ A HD-FDD UE is not expected to transmit in the uplink earlier than [*NRX-TX Tc*] after the end of the last received downlink symbol in the same cell
	+ A HD-FDD UE is not expected to receive in the downlink earlier than [*NTX-RX Tc*] after the end of the last transmitted uplink symbol in the same cell
	+ FFS NTX-RX and NRX-TX.
	+ ~~FFS: how it jointly works with the agreement for other collision cases~~

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Spreadtrum | Y | Fine to confirm the above working assumption. |
| vivo | Y |  |
| Huawei, HiSi | Y |  |
| CATT | Y |  |

# Semi-static UL/DL configuration and dynamic SFI

## Open issue: Whether to introduce semi-static UL/DL pattern

Contributions [3, 7, 8, 10, 11, 12, 13, 14, 19, 20] express view on whether to support semi-static TDD-like slot pattern for HD-FDD.

Contributions [3, 7, 8, 11, 12] propose that semi-static UL/DL pattern is not considered for HD-FDD due to the following drawbacks

* Negative impact on scheduling flexibility
* Increased scheduling complexity when there are other FD-FDD UEs in a cell
* Will have significant specification impact

Contributions [10, 14, 20] think there are clear benefits for HD-FDD UEs to be configured with semi-static UL/DL pattern, such as UE power consumption reduction, compressed Type1 HARQ-ACK codebook size, and allowing gNB to control collision handling and prioritization for the collision between cell-specifically configured DL and UL operation.

In contribution [10] it is also proposed that multiple slot formats with complementary DL and UL configurations can be specified for RedCap UEs supporting Type-A HD-FDD operation and sharing the same cell.

Contributions [13] indicate that whether it is up to gNB to configure the TDD-like slot pattern needs further study.

Contribution [19] expresses view that the semi-static slot format should not be mandatory to support for HD-FDD.

**High Priority Proposal 4-1:**

* Further study on whether and what amount of power saving gains can be achieved from configuring semi-static UL/DL pattern to HD-FDD RedCap UEs and decide in RAN1#106-e whether or not to support semi-static UL/DL pattern for HD-FDD

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Sharp | N |  |
| Huawei, HiSi | N | Open for discussion if there are sufficient benefits, possibly in addition to power saving gains. |
| CATT | N |  |

## Open issue: Whether to support dynamic SFI

Contributions [12, 14, 18] express view whether dynamic SFI can be optionally supported by HD-FDD RedCap UEs.

In contribution [12] it is viewed that the SFI indication that requires the group-common DCI monitoring may be too much complexity for HD-FDD operation

Contribution [14] thinks such feature may be beneficial for use in various industrial IoT applications relying on dynamic TDD operations.

Contribution [18] indicates that SFI can be used to cancel one of the directions whether the semi-statically configured DL is received, or the semi-statically configured UL is transmitted.

# Other aspects

**Definition and identification of HD-FDD UE**

A few contributions [12, 16] express views on reporting the UE capability of HD-FDD.

* OPPO [12]: The HD-FDD capability of RedCap UE should be identifiable by gNB during the initial access
* Apple [16]: HD-FDD support is reported through UE capability framework for RedCap devices

**FD-FDD fallback to HD-FDD**

One contribution [16] expresses views on enabling FD-FDD fall back operation to HD-FDD

* Apple [16]: Support a signaling mechanism to enable HD-FDD operation for a FD-FDD capable RedCap UE

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [RP-210918](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Docs/RP-210918.zip) | Revised WID on support of reduced capability NR devices | Nokia, Ericsson |
| [2] | [R1-2104027](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2104027.zip) | RAN1 agreements for Rel-17 NR RedCap | Rapporteur (Ericsson) |
| [3] | [R1-2104181](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104181.zip) | Duplex operation for RedCap | Ericsson |
| [4] | [R1-2104285](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104285.zip) | Duplex operation for RedCap | Huawei, HiSilicon |
| [5] | [R1-2104367](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104367.zip) | Discussion on RedCap half-duplex operation | vivo, Guangdong Genius |
| [6] | [R1-2104429](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104429.zip) | Discussion on duplex operation for RedCap | Spreadtrum Communications |
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| [8] | [R1-2104545](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104545.zip) | Aspects related to duplex operation | Nokia, Nokia Shanghai Bell |
| [9] | [R1-2104618](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104618.zip) | Discussion on collision handling of HD-FDD operation | CMCC |
| [10] | [R1-2104679](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104679.zip) | Type-A HD-FDD for RedCap UE | Qualcomm Incorporated |
| [11] | [R1-2104712](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104712.zip) | HD-FDD for reduced capability NR devices | ZTE, Sanechips |
| [12] | [R1-2104784](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104784.zip) | On half-duplex operation | OPPO |
| [13] | [R1-2104852](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104852.zip) | Discussion on duplex operation for RedCap | China Telecom |
| [14] | [R1-2104913](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104913.zip) | On support of HD-FDD for RedCap | Intel Corporation |
| [15] | [R1-2105053](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105053.zip) | Discussion on aspects related to duplex operation | Potevio Company Limited |
| [16] | [R1-2105113](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105113.zip) | Duplex operation for RedCap | Apple |
| [17] | [R1-2105219](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105219.zip) | Half duplex operation for RedCap | Lenovo, Motorola Mobility |
| [18] | [R1-2105318](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105318.zip) | HD-FDD Operation for RedCap UEs | Samsung |
| [19] | [R1-2105431](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105431.zip) | Aspects related to the duplex operation of RedCap | LG Electronics |
| [20] | [R1-2105569](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105569.zip) | Discussion on Half-duplex FDD operation of Redcap UE | Xiaomi |
| [21] | [R1-2105637](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105637.zip) | Discussion on the duplex operation of redcap UEs | Sharp |
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| [25] | [R1-2105748](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105748.zip) | Duplex operation for RedCap UEs | InterDigital, Inc. |
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