**3GPP TSG-RAN WG4 Meeting # 96-e R4-201xxxxx**

**Electronic Meeting, 17-28 Aug., 2020**

**Agenda item:** 7.11.3

**Source:** Moderator (Huawei, HiSilicon)

**Title:** Email discussion summary for [96e][219] NR\_RF\_FR1\_RRM

**Document for:** Information

# Introduction

This email thread discusses the RRM performance part for Tx switching between two uplink carriers in agenda 7.11.3.

List of candidate target of email discussion for 1st round and 2nd round:

* 1st round: Invite companies to review the recommended WF in each sub-topic, and provide comments.
* 2nd round: TBA

# Topic #1: Test case

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2011114 | Huawei, Hisilicon | Proposal: Two test cases shall be define to verify the interruption due to UE dynamic switching between two uplink carriers:   1. DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case   Herein the interruptions on victim LTE serving cells and victim NR serving cells are both verified.  -Test configurations   |  |  | | --- | --- | | Config | Description | | 1 | LTE FDD, NR 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode | | 2 | LTE FDD, NR 30kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode | | Note : The UE is only required to be tested in one of the supported test configurations. | |   -UE antenna configuration   |  |  | | --- | --- | | PCell (LTE carrier 1) | 1x2 | | PSCell (NR carrier 2) | 2x2 |  1. DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case   -Test configurations   |  |  | | --- | --- | | Config | Description | | 1 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode; | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; | | Note: The UE is only required to be tested in one of the supported test configurations | |   -UE antenna configuration   |  |  | | --- | --- | | PCell (NR carrier 1) | 1x2 | | PSCell (NR carrier 2) | 2x2 | |

## Open issues summary

### Sub-topic 1-1: Test case list

**Issue 1-1-1: Test case for no DL interruption**

* Background

It is agreed in [R4-2002815] that there is no DL interruption in the following cases:

* + SUL+TDD
  + TDD+TDD CA with the same UL-DL pattern
  + TDD+TDD EN-DC with the same UL-DL pattern

The corresponding core requirements are descripted in TS38.133 as below,

“No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption.*”

* Proposals
  + Option 1: No test cases are defined for the above cases.
* Recommended WF
  + Is option 1 agreeable?

**Issue 1-1-2: Test case list for Tx switching between two uplink carriers**

* Proposals
  + Option 1: Two test cases shall be define to verify the interruption due to UE dynamic switching between two uplink carriers:

1. DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case
2. DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case

* Recommended WF
  + Two test cases shall be define to verify the interruption due to UE dynamic switching between two uplink carriers:

1. DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case
2. DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case

### Sub-topic 1-2: Test case for DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case

* Proposals
  + Option 1: DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case, herein the interruptions on victim LTE serving cells and victim NR serving cells are both verified.

-Test configurations

|  |  |
| --- | --- |
| Config | Description |
| 1 | LTE FDD, NR 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode |
| 2 | LTE FDD, NR 30kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode |
| Note : The UE is only required to be tested in one of the supported test configurations. | |

-UE antenna configuration

|  |  |
| --- | --- |
| PCell (LTE carrier 1) | 1x2 |
| PSCell (NR carrier 2) | 2x2 |

* Recommended WF
  + Is option 1 agreeable?

### Sub-topic 1-3: Test case for DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case

* Proposals
  + Option 1: Test case for DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case:

-Test configurations

|  |  |
| --- | --- |
| Config | Description |
| 1 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode; |
| 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |
| Note: The UE is only required to be tested in one of the supported test configurations | |

-UE antenna configuration

|  |  |
| --- | --- |
| PCell (NR carrier 1) | 1x2 |
| PSCell (NR carrier 2) | 2x2 |

* Recommended WF
  + Is option 1 agreeable?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1  Issue 1-1-1:  Issue 1-1-2:  Sub topic 1-2:  Sub topic 1-3: |
| China Telecom | Sub topic 1-1  Issue 1-1-1: Ok with the recommended WF.  Issue 1-1-2: Ok with the recommended WF.  Sub topic 1-2: Ok with the recommended WF.  Sub topic 1-3: Suggest to cover the typical scenario of FDD 15kHz + TDD 30Hz SCS. Maybe we can update config. 2 as follows?  NR carrier 1 ***15*** kHz SSB SCS, ***10*** MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |
| MTK | **Issue 1-1-1: Test case for no DL interruption**  Support the WF  **Issue 1-1-2: Test case list for Tx switching between two uplink carriers**  Support the WF  **Sub-topic 1-2**  Only config 2 is needed. Typically, carrier 1 is located at low band and carrier 2 is located at high band which is TDD. Therefore 30KHz makes more sense.  **Sub-topic 1-3**  Perhaps we only need one test case for  NR carrier 1: 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2: 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode;  **To CMCC**: We may need to study a bit about the testability if we carrier 1 is on a TDD band. If the switch happens during 2 UL slots of both carriers, then actually there is no DL slot interrupted by the switch.  **To all**: We may also need to study on how to design the test case in order to check this symbol-level interruption. If the interruption collides with beginning of a DL slot which is used for PDCCH, then it will make the whole slot useless. Therefore, it is better to arrange the interruption happens only at the end of a DL slot. |
| CMCC | **Issue 1-1-1: Test case for no DL interruption**  Agree with the recommended WF  **Issue 1-1-2: Test case list for Tx switching between two uplink carriers**  Agree with the recommended WF  Sub-topic 1-2  In the table of test configurations, the note says UE is only required to be tested in one of the supported test configurations. Since test 1 and test 2 has different SCS, which has different interruption time. In our view, both of them should be tested. Also if we test one of them, which one should be chosen if UE supports both.  Sub-topic 1-3  For the test configurations, we propose to add config 3 and 4 in the following table. We propose TDD band combinations for switching in this meeting. And TDD CA combinations can have different DL/UL patterns which will cause interruption. For config 1 and 2, we are OK to remove them if no other companies support to have them.   |  |  | | --- | --- | | Config | Description | | 1 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode; | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; | | 3 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; | | 4 | NR carrier 1 30 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; | | Note: The UE is only required to be tested in one of the supported test configurations | |   Also, we propose to further clarify the note. We prefer to test all the configurations. And if it is proposed to test one of them, which one should be tested? |
| Huawei | Issue 1-1-1: support the recommended WF.  Issue 1-1-2: support the recommended WF.  Sub-topic 2-1: to MTK, we also think configuration 2 is typical. Could we only have config.2 in this test case? @China Telecom @CMCC  Sub-topic 1-3: as commented by China Telecom, MTK and CMCC, the configuration can be modified as below,   |  |  | | --- | --- | | Config | Description | | 1 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |   For the note “The UE is only required to be tested in one of the supported test configurations”, this is a general applicability principle for all the test cases in RRM. The motivation of adding this note is to reduce the test numbers. Herein we gave an example, in the interruption test (A.6.5.2), we agree that there is different interruption length for different SCS, but the note is still here. We suggest the same principle is applied for FR1 WI. |
| vivo | Sub. 1-1-1: ok with the recommended WF.  Sub. 1-1-2: ok with the recommended WF.  Sub. 1-2 We agree with MTK that only one case (here is configuration 2) is enough  Sub. 1-3, Agree with Huawei’s latest comments. The note should be kept. |
| Intel | Issue 1-1-1: option 1 is OK.  Issue 1-1-2: recommended WF looks good.  Sub-topic 1-2: since UE only needs to pass 1 test, we see no harm to introduce 2 tests. However, if majority prefer to keep config 2 only, we are also fine. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| N/A | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| --- | --- |
|  | **Status summary** |
| **Sub-topic 1-1** | **Issue 1-1-1: Test case for no DL interruption**  In the first round discussion, 6 companies discussed this issue. All companies agreed with the recommended WF.  *Tentative agreements:*  No test cases are defined for the following cases:   * + SUL+TDD   + TDD+TDD CA with the same UL-DL pattern   + TDD+TDD EN-DC with the same UL-DL pattern   *Candidate options:*  *Recommendations for 2nd round:*  Consensus is reached, and no further discussion is needed.  **Issue 1-1-2: Test case list for Tx switching between two uplink carriers**  In the first round discussion, 6 companies discussed this issue. All companies agreed with the recommended WF.  *Tentative agreements:*  Two test cases shall be defined to verify the DL interruption due to UE dynamic switching between two uplink carriers:  1. DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case.  2. DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case.  *Candidate options:*  *Recommendations for 2nd round:*  Consensus is reached, and no further discussion is needed. |
| **Sub-topic 1-2** | **Sub-topic 1-2: Test case for DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case**  In the first round discussion, 6 companies discussed this issue. After offline discussion, companies think config#2 is typical and enough.  *Tentative agreements:*   * + DL Interruptions at UE switching between LTE 1Tx carrier and NR 2Tx carrier in inter-band ENDC case, herein the interruptions on victim LTE serving cells and victim NR serving cells are both verified.   -Test configurations   |  |  | | --- | --- | | Config | Description | | 1 | LTE FDD, NR 30kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode |   -UE antenna configuration   |  |  | | --- | --- | | PCell (LTE carrier 1) | 1x2 | | PSCell (NR carrier 2) | 2x2 |   *Candidate options:*  *Recommendations for 2nd round:*  Consensus is reached, and no further discussion is needed. |
| **Sub-topic 1-3** | **Sub-topic 1-3: Test case for DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case**  In the first round discussion, 6 companies discussed this issue. Some consensus are made, and some issues raises.  *Tentative agreements:*  1.The following configurations can be removed:   |  |  | | --- | --- | | Config | Description | | 1 | NR carrier 1 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode; | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, FDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |   2.At least the following configuration shall be tested:   |  |  | | --- | --- | | Config | Description | | 1 | NR carrier 1: 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode;  NR carrier 2: 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |   *The remaining issues:*   1. Whether the TDD CA combination configuration with different UL/DL patterns has to be tested?  |  |  | | --- | --- | | Config | Description | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |      1. How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).  * Option 1: Interruption happens only at the end of a DL slot   More discussion are expected in the second round.  *Recommendations for 2nd round:*  Needs further discussion. |

*Recommendations on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | Way Forward on test case for DL interruption due to Tx switching between two uplink carriers | Huawei, HiSilicon |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

**Sub-topic 1-3: Test case for DL Interruptions at UE switching between NR uplink carrier 1 and NR uplink carrier 2 in inter-band uplink CA case**

**Issue 1-3-1: Whether the TDD CA combination configuration with different UL/DL patterns is tested?**

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| --- | --- |
| Config | Description |
| 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |

* Option 1: Yes
* Option 2: No

**Issue 1-3-2: How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).**

* Option 1: Interruption happens only at the end of a DL slot

Encourage to discuss more details on this issue.

## Companies views’ collection for 2nd round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| MTK | **Issue 1-3-1: Whether the TDD CA combination configuration with different UL/DL patterns is tested?**  We are not sure if some quick conclusion can be achieve here. Maybe postpone the issue to next meeting so that companies have time to bring some more analysis.  **Issue 1-3-2: How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).**  We think at least RAN4 can first try to agree to avoid the interruption on PDCCH. Otherwise the whole DL slot is gone.  The detail of test case may depend on the MRTD, the following RRC configuration and UL/DL configuration in Issue 1-3-1.  UplinkTxSwitching-r16 ::= SEQUENCE {  uplinkTxSwitchingPeriodLocation-r16 BOOLEAN,  uplinkTxSwitchingCarrier-r16 ENUMERATED {carrier1, carrier2}  RAN4 can configure the PDSCH to occupy all non-interrupted OFDM symbols to ensure the UE does not cause longer and unexpected interruption. |
| China Telecom | **Issue 1-3-1: Whether the TDD CA combination configuration with different UL/DL patterns is tested?**  Yes.  Based on the agreement in RF session, there is no DL interruption for TDD+TDD with the *same* UL/DL pattern.  For TDD+TDD with different UL/DL patterns, if there will be no test for DL interruption, does it mean no DL interruption is allowed? Otherwise, we think it is natural to develop test cases for TDD+TDD with different UL/DL patterns as well.  **Issue 1-3-2: How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).**  Firstly, generally we agree with the above points by MediaTek.  The figures below show possible locations for DL interruption for the case of FDD 15kHz SCS + TDD 30kHz SCS, where TDD pattern of DDDSU+DDSUU is used:    (a) UL switching period is configured to be located in carrier 1    (b) UL switching period is configured to be located in carrier 2  According to the figures, the DL interruption may happen in the beginning, middle, or at the end of one DL slot, or may cross two DL slots, depending on the location of the UL switching period and length of DL interruption, etc.  Moreover, in the figures, the MRTD and TA adjustment accuracy are not considered.  Given these preliminary analyses, we think Issue 1-3-2 is a very important issue, but may not easy to reach conclusion in this meeting. Therefore, in this meeting we suggest to identify the factors to be considered, and make decision in the next meeting. For example, the following needs to be discussed:  1) Location of the UL switching period, i.e., in carrier 1 or carrier 2  2) TDD patterns including the configuration of the special slot  3) MRTD and TA adjustment accuracy  4) PDSCH mapping type, use type A?  5) PDCCH and PDSCH duration for different DL slots in each carrier |
| CMCC | **Issue 1-3-1: Whether the TDD CA combination configuration with different UL/DL patterns is tested?**   |  |  | | --- | --- | | Config | Description | | 2 | NR carrier 1 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode;  NR carrier 2 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode; |  * Option 1: Yes * Option 2: No   Yes. N41 and n79 can have different UL/DL pattern. With UL Tx switching, the UL slots can be used more efficiently. We see this is a valid scenario, and would like to test this scenario.  **Issue 1-3-2: How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).**  Agree with MTK that the DL interruption on PDCCH need to be avoided. Then what MRTD value need to be used for the test need to be studied. |
| vivo | Issue 1-3-2  Agree with MTK’s observation and the question is how to locate the location of an interruption then a particular part of a slot can be avoided. |
| Huawei | **Issue 1-3-1: Whether the TDD CA combination configuration with different UL/DL patterns is tested?**  No strong opinion.  **Issue 1-3-2: How to verify the symbol-level DL interruption in test (this issue is applied to inter-band ENDC test case as well).**  In our understanding, the aim of RRM test is to verify the functionality. It is impossible to verify every configuration, for example different DL interruption location, different MRTD setting, etc. We need to design a proper setup and verify whether UE can satisfy the DL interruption requirements. We suggest only to test the DL interruption located in the end of DL slot.  In TS 38.133, there is test case for verifying Radio Link Monitoring Scheduling Restrictions. We think the similar idea can be referred. This test verifies that the UE can correctly receive the PDCCH scheduled on the symbols right before the DL interruption so that it sends ACK/NACK correctly. It is required UE to support *pdcch-MonitoringAnyOccasions* or *pdcch-MonitoringAnyOccasionsWithSpanGap*. As the current requirements for DL interruption can be reached to 6 symbols, if the DL interruption located in the beginning or the middle of the slot, then the whole slot may be dropped, and it is failed to verify symbol level interruption.   |  |  |  |  | | --- | --- | --- | --- | |  | NR Slot length (ms) | Uplink Tx switching period Note1 | | | 35us | 140us | | 0 | 1 | 2 | 3 | | 1 | 0.5 | 3 | 6 | | 2 | 0.25 | 4 | 10 | | Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod.* | | | | |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| R4-2012050 | *agreeable* |