**3GPP TSG-RAN WG4 Meeting # 95-e R4-2009032**

**Electronic Meeting, 25 May – 5 June, 2020**

**Agenda item:** 6.13.2

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

**Title:** Email discussion summary for [95e][220] NR\_RF\_FR1\_RRM

**Document for:** Information

# Introduction

This email thread discusses the RRM requirements for Tx switching between two uplink carriers in agenda 6.13.2 and the proposals on DL interruption in other papers in 6.13.1.5 are treated in this thread as well.

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: Title

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2006035](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006035.zip) | China Telecom | Proposal 1: Use Option 1 for the DL interruption length, and add in the CR that the requirements are applicable for co-located deployment.  Observation 1: For the DL interruption location/Starting point, it seems the two options become the same, if only co-located deployment is considered. |
| [R4-2006211](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006211.zip) | Apple | Proposal 1: Length of DL interruption due to UL Tx switching is proposed as   |  |  |  |  |  | | --- | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | | 35us | 140us | 210us | | Uncertainty UL switching window | | | | 101us | 206us | 276us | | 0 | 1 | 3 | 5 | 5 | | 1 | 0.5 | 4 | 7 | 9 | | 2 | 0.25 | 7 | 13 | 17 |   Based on the analysis above, the starting point of DL interruption should be determined by TA+TA uncertainty+MRTD. |
| [R4-2006572](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006572.zip) | MediaTek inc. | Proposal 1: The length of the interruption is symbols.  Proposal 2: The location of the interruption equals the OFDM symbols fully or partial overlapped with the UL switching period |
| [R4-2006805](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006805.zip) | CMCC | Proposal 1: It is proposed to define DL interruption requirements based on option 1 in last meeting WF (i.e. switching period length + 1 OFDM symbol).  Proposal 2: It is proposed that the DL interruption is the OFDM symbols fully or partial overlapped with the UL switching period. |
| [R4-2007346](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007346.zip) | OPPO | Observation 1: DL interruption time may be larger than UL switching time.  Proposal 1: The starting time should not be later than the end of UL switching period, which can be determined by TA + TA uncertainty + MRTD.  Proposal 2: Define DL interruption length for EN-DC and NR SA according to Table 1, 2 and 3.  Table 1: DL interruption on NR carrier(s) for switching between two uplink carriers in EN-DC (FR1)   |  |  |  |  | | --- | --- | --- | --- | |  | NR Slot length (ms) | Uplink Tx switching period(symbol) Note1 | | | 35us | 140us | | 0 | 1 | 3 | 5 | | 1 | 0.5 | 4 | 7 | | 2 | 0.25 | 7 | 13 | | Note 1: Uplink Tx switching period depends on UE capability *[TBD]* | | | |   Table 2: DL interruption on E-UTRA carrier(s) for switching between two uplink carriers in EN-DC (FR1)   |  |  | | --- | --- | | Uplink Tx switching period(symbol) Note1 | | | 35us | 140us | | 3 | 5 | | Note 1: Uplink Tx switching period depends on UE capability [*TBD*] | |   Table 3: DL interruption on NR carrier(s) for switching between two uplink carriers in NR SA (FR1)   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | NR Slot length (ms) | Uplink Tx switching period(symbol) Note1 | | | | 35us | 140us | 210us | | 0 | 1 | 3 | 5 | 5 | | 1 | 0.5 | 4 | 7 | 9 | | 2 | 0.25 | 7 | 13 | 17 | | Note 1: Uplink Tx switching period depends on UE capability *[TBD]* | | | | | |
| [R4-2007731](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007731.zip) | Huawei, Hisilicon | Proposal 1: For FDD-TDD uplink CA, due to Tx switching between two uplink carriers, UE is allowed to cause DL interruption on NR carrier(s) depending on UE capability of X OFDM symbols that overlap with the UL switching period.  Table 1. DL interruption length in the unit of OFDM symbols (X) for FDD-TDD uplink CA   |  |  |  |  |  | | --- | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | | 35us | 140us | 210us | | 0 | 1 | 2 | 3 | 4 | | 1 | 0.5 | 2 | 5 | 7 | | 2 | 0.25 | 3 | 9 | 13 |   Proposal 2: DL interruption are the OFDM symbols fully or partial overlapped with the UL switching period.  Proposal 3: For inter-band EN-DC, due to Tx switching between two uplink carriers, UE is allowed to cause DL interruption on LTE carriers depending on UE capability of Y OFDM symbols that overlap with the UL switching period and UE is allowed to cause DL interruption on NR carriers depending on UE capability of Z OFDM symbols that overlap with the UL switching period  Table 2. DL interruption length in the unit of OFDM symbols (Y) for inter-band EN-DC   |  |  | | --- | --- | | UL switching period | | | 35us | 140us | | 2 | 3 |   Table 3. DL interruption length on NR carrier(s) in the unit of OFDM symbols (Z) for inter-band EN-DC   |  |  |  |  | | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | 35us | 140us | | 0 | 1 | 2 | 3 | | 1 | 0.5 | 2 | 5 | | 2 | 0.25 | 3 | 9 | |

## Open issues summary

### Sub-topic 1-1: DL interruption length

* Proposals
  + Option 1 (China Telecom, MediaTek, CMCC, Huawei):

- For FDD-TDD uplink CA, UE is allowed to cause X OFDM symbols DL interruption on NR carrier(s), depending on UE capability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | | |
| 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 2 | 5 | 7 |
| 2 | 0.25 | 3 | 9 | 13 |

-For inter-band EN-DC, UE is allowed to cause DL interruption of Y OFDM symbols on LTE carriers, depending on UE capability,

|  |  |
| --- | --- |
| UL switching period | |
| 35us | 140us |
| 2 | 3 |

UE is allowed to cause DL interruption of Z OFDM symbols on NR carriers, depending on UE capability

|  |  |  |  |
| --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | |
| 35us | 140us |
| 0 | 1 | 2 | 3 |
| 1 | 0.5 | 2 | 5 |
| 2 | 0.25 | 3 | 9 |

* + Option2 (Apple, OPPO)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | | |
| 35us | 140us | 210us |
| Uncertainty UL switching window | | |
| 101us | 206us | 276us |
| 0 | 1 | 3 | 5 | 5 |
| 1 | 0.5 | 4 | 7 | 9 |
| 2 | 0.25 | 7 | 13 | 17 |

* Recommended WF
  + WID [RP-192282] stated that UL switching only address the case of co-located and synchronized network deployment for the two UL carriers. **No** propagation delay between the two carriers is considered. Then MRTD could be 3us. As option 2 considers MRTD (**3**us) and TA adjustment accuracy (up to 130**ns**), if we recalculate the table of option 2, the interruption length is the same as option 1.

After the above analysis, is option 1 agreeable?

### Sub-topic 1-2: DL interruption location

* Proposals
  + Option 1: The location of the interruption equals the OFDM symbols fully or partial overlapped with the UL switching period (China Telecom, MediaTek, CMCC, Huawei)
  + Option 2: Starting point of DL interruption should be determined by TA+TA uncertainty+MRTD (China Telecom, Apple, OPPO)
* Recommended WF
  + If the recommended WF of sub-topic 1-1 is agreed, option 1 and option2 are similar.

As the interruption length is the OFDM symbol level, is option1 agreeable?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MTK | **Sub-topic 1-1: DL interruption length**  Agree with the recommended WF **Sub-topic 1-2: DL interruption location** Agree with the recommended WF |
| China Telecom | **Sub-topic 1-1: DL interruption length**  Agree with the recommended WF **Sub-topic 1-2: DL interruption location** Agree with the recommended WF |
| CMCC | **Sub-topic 1-1: DL interruption length**  Agree with the recommended WF **Sub-topic 1-2: DL interruption location** Agree with the recommended WF |
| Huawei | **Sub-topic 1-1: DL interruption length**  Agree with the recommended WF  **Sub-topic 1-2: DL interruption location**  Agree with the recommended WF |
| Apple | **Sub-topic 1-1:**  The proposed WF to assume no propagation delay difference is helpful. However, the related calculation is still not 100% correct. With no propagation delay difference considered, the interruption length should be ceil((switching period+2\*TA uncertainty+6us-CP length)/symbol duration)+1. Let’s take 30kHz SCS with 35us switching period as an example, interruption time should be ceil((35+6+0.26)/35.7)+1=3. The new table should be   |  |  |  |  |  | | --- | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | | 35us | 140us | 210us | | Uncertainty UL switching window with collocated assumption | | | | 41.26 | 146.26 | 216.26 | | 0 | 1 (symbol duration~71.4us) | 2 | 3 | 4 | | 1 | 0.5(symbol duration~35.7us) | 3 | 6 | 7 | | 2 | 0.25(symbol duration~17.9us) | 4 | 10 | 14 |   Highlighted entries are different from option 1.  **Sub-topic 1-2:**  Firstly, we think interruption can happen within the range of switching period+TA+2\*TA uncertainty+2\*3us. As what we commented in sub-topic 1-1, 1 extra symbol is needed for some cases compared with option 1. That means 1 symbol during the interruption is actually not overlapped with UL switching period. Since this information is unknown to NW, no DL reception is expected from UE.  Let’s assume UL switching starts from the beginning UL slot n, denoted as Tn. Interruption on DL should happen between Tn-MRTD-TA uncertainty and Tn+MRTD+TA uncertainty+UL switching period. For collocated cases, it is within [Tn-3.14us, Tn+3.14us+UL switching period] |
| Qualcomm | **Sub-topic 1-1: DL interruption length**  Agree with the recommended WF  **Sub-topic 1-2: DL interruption location**  Agree with the recommended WF |

### 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** |
| R4-2007732 | China Telecom: In the LS to RAN2 approved in the last meeting, it was agreed that: For the band where DL interruption is needed, the RRM interruption requirements defined in RAN4 shall be applied.  So, we suggest to reflect this agreement in the RRM CR, i.e., the RRM interruption requirements apply for the band reporting that DL interruption is needed, and UE not reporting the capability means DL interruption is not required. |
| Huawei: to China Telecom  It is a good point. As “DL interruption is needed” is a capability, the interruption requirements are supposed to reflect two cases:  1. RRM interruption length we are discussing is applied for the band reporting that DL interruption is needed;  2. No interruption is allowed for UE not reporting the capability “DL interruption is needed”. Otherwise a UE who interrupted DL may cheat to report “DL interruption is not needed”. |
|  |
| R4-2007733 | Same comment as that for R4-2007732. |
| Huawei: the comments make sense. |
|  |

## 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** | **Sub-topic 1-1: DL interruption length**  In the first round discussion, 6 companies discussed this issue. 5 companies agree with the recommended WF (i.e., option1), while 1 company supports revised option2 (shown in below).  *Tentative agreements:*  No.  *Candidate options:*   * Option 1 (China Telecom, MediaTek, CMCC, Huawei, Qualcomm):   - For FDD-TDD uplink CA, UE is allowed to cause X OFDM symbols DL interruption on NR carrier(s), depending on UE capability   |  |  |  |  |  | | --- | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | | 35us | 140us | 210us | | 0 | 1 | 2 | 3 | 4 | | 1 | 0.5 | 2 | 5 | 7 | | 2 | 0.25 | 3 | 9 | 13 |   -For inter-band EN-DC, UE is allowed to cause DL interruption of Y OFDM symbols on LTE carriers, depending on UE capability,   |  |  | | --- | --- | | UL switching period | | | 35us | 140us | | 2 | 3 |   UE is allowed to cause DL interruption of Z OFDM symbols on NR carriers, depending on UE capability   |  |  |  |  | | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | 35us | 140us | | 0 | 1 | 2 | 3 | | 1 | 0.5 | 2 | 5 | | 2 | 0.25 | 3 | 9 |  * Option 2 (Apple)  |  |  |  |  |  | | --- | --- | --- | --- | --- | | u | NR slot length (ms)  of victim cell | UL switching period | | | | 35us | 140us | 210us | | Uncertainty UL switching window with collocated assumption | | | | 41.26 | 146.26 | 216.26 | | 0 | 1 (symbol duration~71.4us) | 2 | 3 | 4 | | 1 | 0.5(symbol duration~35.7us) | 3 | 6 | 7 | | 2 | 0.25(symbol duration~17.9us) | 4 | 10 | 14 |   *Note: Highlighted entries are different from option 1.*  *Recommendations for 2nd round:*  Needs further discussion. |
| **Sub-topic 1-2** | **Sub-topic 1-2: DL interruption location**  In the first round discussion, 6 companies discussed this issue. 5 companies agree with the recommended WF (i.e., option1), while 1 company supports option2.  *Tentative agreements:*  No.  *Candidate options:*   * Option 1 (China Telecom, MediaTek, CMCC, Huawei, Qualcomm):   The location of the interruption equals the OFDM symbols fully or partial overlapped with the UL switching period   * Option 2 (Apple)   Interruption on DL should happen between Tn-MRTD-TA uncertainty and Tn+MRTD+TA uncertainty+UL switching period (UL switching starts from the beginning UL slot n, denoted as Tn).  *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 DL interruption on LTE carriers at 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*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2007732 | to be revised |
| R4-2007733 | to be revised |

## Discussion on 2nd round (if applicable)

**Sub-topic 1-1: DL interruption length**

* Option 1 (China Telecom, MediaTek, CMCC, Huawei, Qualcomm):

- For FDD-TDD uplink CA, UE is allowed to cause X OFDM symbols DL interruption on NR carrier(s), depending on UE capability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | | |
| 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 2 | 5 | 7 |
| 2 | 0.25 | 3 | 9 | 13 |

-For inter-band EN-DC, UE is allowed to cause DL interruption of Y OFDM symbols on LTE carriers, depending on UE capability,

|  |  |
| --- | --- |
| UL switching period | |
| 35us | 140us |
| 2 | 3 |

UE is allowed to cause DL interruption of Z OFDM symbols on NR carriers, depending on UE capability

|  |  |  |  |
| --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | |
| 35us | 140us |
| 0 | 1 | 2 | 3 |
| 1 | 0.5 | 2 | 5 |
| 2 | 0.25 | 3 | 9 |

* Option 2 (Apple)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| u | NR slot length (ms)  of victim cell | UL switching period | | |
| 35us | 140us | 210us |
| Uncertainty UL switching window with collocated assumption | | |
| 41.26 | 146.26 | 216.26 |
| 0 | 1 (symbol duration~71.4us) | 2 | 3 | 4 |
| 1 | 0.5(symbol duration~35.7us) | 3 | 6 | 7 |
| 2 | 0.25(symbol duration~17.9us) | 4 | 10 | 14 |

*Note: Highlighted entries are different from option 1.*

* Recommended WF

In the first round discussion, 6 companies discussed this issue. 5 companies agree with option1, while 1 company supports option2.

Encourage companies to provide views on this issue.

**Sub-topic 1-2: DL interruption location**

* Option 1 (China Telecom, MediaTek, CMCC, Huawei, Qualcomm):

The location of the interruption equals the OFDM symbols fully or partial overlapped with the UL switching period

* Option 2 (Apple)

Interruption on DL should happen between Tn-MRTD-TA uncertainty and Tn+MRTD+TA uncertainty+UL switching period (UL switching starts from the beginning UL slot n, denoted as Tn).

* Recommended WF

In the first round discussion, 6 companies discussed this issue. 5 companies agree with option1, while 1 company supports option2.

Encourage companies to provide views on this issue.

## Companies views’ collection for 2nd round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| MTK | **Sub-topic 1-1: DL interruption length**  The difference between Option 1 and Option 2 is on how to address the uncertainty of an exact interruption time location.   * Option 1 is generic by capturing only the interruption length but leave the starting point to be decided by network implementation. The only margin is added to address the issue of unaligned TX and Rx symbol boundary due to absolute TA uncertainty. * Option 2 tries to add more uncertainties to the starting point, e.g., MRTD between different CCs and TA uncertainty.   From our understanding, the uncertainty due to MRTD and TA affect only to the starting time of the interruption, it will not increase the length of the interruption period. Just like the figure below, The possible region with interruption is extended due to these uncertainties, but the switch period itself should remain the same. Based on this understanding, we think it is still sufficient to go with **Option 1**. How to handle the uncertainty on starting time can be further discussed in Sub-topic 1-2.    **Sub-topic 1-2: DL interruption location**  To our understanding, the uncertainty due to MRTD and TA could exists. However, it is very difficult to capture the exact value in spec.   * MRTD is only the maximum value UE may experience between the DL of a pair of CCs. The exact received timing difference (RTD) could be rather smaller than MRTD and is suffering from UE’s timing estimation inaccuracy. We do not think RTD can be 100% accurately captured in spec. * Absolute TA (difference between UL and DL symbol boundaries) is another quantity we believe that it is not possible to be accurately captured in spec. It involves the TA accuracy margin (which we assumed it to be relatively small), UE’s potential DL timing change and timing estimation accuracy. Furthermore, if UE is gradually adjusting its UL timing based on the requirements in Section 7.1.2 of TS38.133. During this transient period, it is also not possible for BS to now the absolute TA   To deal with the uncertainty, one way is to capture all uncertainties in the starting symbol of the interruption as Option 2. The other way like Option 1 is to keep the spec simple and leave it to BS implementation, e.g., BS can still avoid scheduling some additional OFDM symbols which has high risk to be interrupted by the Tx switch. Our preference is Option 1. |
| Huawei | **Sub topic 1-1 DL interruption length**  The difference between option 1 and option 2 is interruption uncertainty is considered or not. In our understanding, the interruption uncertainty due to MRTD and TA adjustment accuracy could exist. We already agreed that the DL interruption is OFDM symbol level, the granularity is smaller than slot level we ever defined. Considering the time uncertainty, one more symbol interruption in some cases makes sense. Option 2 is acceptable to us.  Sub topic 1-2 DL interruption location  Option 1. We think the actual impacted symbols are still the OFDM symbols fully or partial overlapped with the UL switching period. At least this description can cover the most majority cases. |
| China Telecom | **Sub-topic 1-1: DL interruption length**  From our side, option 1 with shorter interruption length would be more preferred. Meanwhile, since the Tx switching can happen frequently, the network may need to avoid scheduling the interrupted OFDM symbols to minimize the impact to the whole slot. In addition, based on the discussion in RF session, one possible chipset/UE implementation is that for some difficult band combinations, DL interruption cannot be avoided for carrier 1 (probably with 15kHz SCS) but can be avoided for carrier 2 (probably with 30kHz SCS). Here the interruption length for 15kHz SCS in option 1 and option 2 are the same. So, we can accept option 2.  **Sub-topic 1-2: DL interruption location**  It seems not easy to capture option 2 in the spec. Option 1 is more clear and preferred by us. |
| CMCC | **Sub-topic 1-1: DL interruption length**  **Prefer option 1 but can live with option2, since only 1 additaionl symbol is added for some cases**  **Sub-topic 1-2: DL interruption location**  **Option 1** |
| Qualcomm | **Sub-topic 1-1: DL interruption length**  After reviewing the feedbacks from companies, we understand option 1 reflects the minimal interruption length from UE POV. However, option 2 has considered uncertainty in the TA and MRTD which leads to a slightly more conservative estimate but reserves the certainty in the expected interruption length. Given such a defined expectation on the interruption, it may be friendly for network to predict the affected number of DL symbols in the worst case. To balance the impact on UE and potential optimization in the scheduling at the NW side for skipping the interrupted symbols, we could compromise to option 2.  **Sub-topic 1-2: DL interruption location**  Option 1 is still preferred. |
| Apple | **Topic 1-1: the same comments as the first round. Option 2 is preferred**  **Topic 1-2: After some calculation, we realized option1 and option2 can be equivalent. we are OK with option 1.** |

### CRs/TPs comments collection

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2008624  (Revised from R4-2007732) | Company A |
| Company B |
|  |
| R4-2008625  (Revised form R4-2007733) | Company A |
| Company B |
|  |

## 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** |
| R4-2008623  (WF) | *agreeable* |
| R4-2008624  (CR) | *agreeable* |
| R4-2008625  (CR) | *agreeable* |