**3GPP TSG-RAN WG4 Meeting # 106 R4-23XXXXX**

**Athens, Greece, February 27 – March 3, 2022**

**Agenda item:** 9.22.4

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

**Title:** Topic summary for [106][221] NR\_MC\_enh

**Document for:** Information

# Introduction

This email thread discusses the RRM core requirements of WI on Multi-carrier enhancements.

# Topic #1: DL interruption for Tx switching across 3/4 bands

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2300165 | China Telecom | Proposal 1: Not define the RRM requirements for RTD > 6us due to the following reasons:1) The 6 us RTD can already cover the typical scenarios in real deployments where two uplink bands are needed.2) The RTD of larger than 6 us is not handled by more advanced UE implementation, but just requires the network to avoid scheduling over larger length of DL interruption.3) The DL interruption can happen very frequently, and larger DL interruption will bring further DL performance degradation.Observation 1: Very sufficient margin has been considered for deriving the DL interruption length in Rel-16/17.Proposal 2: For Rel-18 Tx switching across 3/4 bands with 2 TAGs and 6 us RTD, reuse Rel-16/Rel-17 values for length of DL interruption, i.e., the DL interruption length is 7 symbols for 30 kHz SCS and 210 us Tx switching period. |
| R4-2300226 | Apple | Proposal 1: no need to further consider requirements for RTD>6us, given that RTD=6us can already cover most of the typical deployments.Proposal 2: DL interruption for 30kHz with 210us UL Tx switching shall be 8 symbols. |
| R4-2300818 | CMCC | Proposal 1: Define DL interruption length for Rel-18 Tx switching across 3/4 bands with 2 TAGs as follows:

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 8 |
| 2 | 0.25 | 4 | 10 | 14 |

Proposal 2: The requirements in proposal 1 is derived based on RTD=6us side condition, but can also applicable to RTD>6us. The exact applicable RTD values depend on the SCS and switching period.  |
| R4-2300839 | Qualcomm | Proposal 1: Add the following note to the requirement derived by the side condition RTD<=6us:*The interruption requirements are derived based on the designated RTD range <= 6us as the side condition. The applicable RTD ranges of this requirement, when the RTD is larger than 6us, depend on the SCS and switching period.*RTD>6us is out of RAN4 RRM test scope.Proposal 2: Set interruption requirement in 30kHz SCS and 210us switching time to 8 symbols.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | [8] |
| 2 | 0.25 | 4 | 10 | 14 |

 |
| R4-2301201 | ZTE | Observation 1: RTD=6 is applicable to the urban scenario where the inter-site distance is not larger than 1km.Observation 2: A few scenarios with RTD>6us can be avoided through appropriate network scheduling. |
| R4-2301333 | vivo | Proposal 1: For R18 Tx switching across 3/4 bands with 2 TAGs and RTD = 6us, DL interruption length (in symbols) is in table below.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 8 |
| 2 | 0.25 | 4 | 10 | 14 |

Proposal 2: There is no need to specify DL interruption requirements for RTD>6us for 2-TAG case. |
| R4-2301358 | Nokia, Nokia Shanghai Bell | Proposal 1: UE shall inform network the RTD value or at least if the RTD side condition is fulfilled. Observation 1: For an RTD=9.33us (an ISD of 2km) DL interruption time won’t change in comparison of DL interruption time already agreed for RTD=6us.Proposal 2: Define the interruption requirements for RTD < [9]us assuming an ISD of 2km. Proposal 3: Introduce following requirements for RTD > 6us with MRTD = 33us as mentioned in the following Table. |
| R4-2301359 | Nokia, Nokia Shanghai Bell | Proposal 1: The UE shall not perform UL Tx switching if it has performed an UL Tx switching within MinSeparationTime.Proposal 2: The UE shall not perform UL Tx switching if it has performed an UL Tx switching within MinSeparationTimeforMultiTAGs in multi-TAGs scenario. |
| R4-2301833 | Huawei, HiSilicon | Proposal 1: Regarding the non-collocated inter-band scenario for Tx switching across 3/4 bands with 2 TAGs, DL interruption requirements are defined assuming RTD<=6us. Proposal 2: For Rel-18 Tx switching across 3/4 bands, the values of DL interruption length difference between single TAG and 2TAGs are quite small.Proposal 3: If one downlink carrier is indicated to be interrupted by two band pairs for dynamic switching simultaneously, the DL interruption length and location on the victim carrier is determined by the maximum of uplink switching periods of the two band pairs. |
| R4-2301834 | Huawei, HiSilicon, China Telecom | CR |
| R4-2301896 | Ericsson | Observation 1: for the dual-TAG case, the DL interruption duration on both DL carriers is still only determined by the duration of the Tx switch within the switching period. The existing allowed DL interruption length on NR carrier(s) in units of OS allowed for the single-TAG case can be reused for dual-TAG case with the RTD up to the maximum allowed MRTD = 33 us.Observation 2: There is no need to limit RTD for dual tag case, since RTD only determines the position in time of the switch, but not the duration.Proposal 1: Reuse Rel-16/Rel-17 values for length of DL interruption for dual TAG case.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod* |

Proposal 2: MRTD for dual tag case can be same as for inter band CA and NR DC, that is, 30 µsObservation 3: for the single-TAG case, the DL interruption duration on both DL carriers is determined by the duration of the Tx switch within the switching period. The RTD and TA adjustment uncertainty only determine when the interruption starts on any one of the DL carriers in addition to the absolute TA. Proposal 3: Reuse Rel-16/Rel-17 values for length of DL interruption for single TAG, colocated case, for 2 bands.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod* |

Observation 4: For more than 2 bands and single TAG collocated case then UE RF session in RAN4 might conclude different switching periods. |
| R4-2302364 | MediaTek | Proposal 1: DL interruption length in R16/R17 can be reused for R18 Tx switching across 3/4 bands with 2 TAGs. |

**Recommendation of contributions to be presented: R4-2300165 (China Telecom), R4-2300818 (CMCC)**

## Open issues summary

*Background: In RAN4#104b-e meeting it is agreed that DL interruption length and starting point with single TAG are the same as that of R-17 TX switching between 2 bands. The open issue is DL interruption length* ***with 2 TAGs*** *which would be discussed in the following.*

**Issue 1-1: whether to define requirements for RTD>6us in non-collocated inter-band scenario for Tx switching with 2 TAGs**

* Proposals
	+ Option 1(China Telecom, Apple, CMCC, Qualcomm, ZTE, vivo, Huawei): **NOT** define the RRM requirements for RTD > 6us
	+ Option 2(Nokia):
		- Define the interruption requirements for RTD < [9]us assuming an ISD of 2km;
		- Define the interruption requirements for RTD > [9]us with MRTD = 33us.
	+ Option 3 (Ericsson): The existing allowed DL interruption length for the single-TAG case can be reused for 2TAG case with the RTD up to the maximum allowed MRTD = 33 us.
* Recommended WF

*For information: R4-2300818 from CMCC provided the maximum RTD that can be supported by the DL interruption lengths (which is derived from RTD=6us). It is observed that the supported RTD values can be more than 6us. That’s to say, the DL interruption length requirements are derived based on RTD=6us side condition, but can also be applicable to RTD>6us.*

|  |  |  |
| --- | --- | --- |
|  | *NR Slot length (ms)* | *Uplink Tx switching period* |
|  |  | *35us* | *140us* | *210us* |
| *0* | *1* | *2 (20us RTD)* | *3 (33us RTD)* | *4 (33us RTD)* |
| *1* | *0.5* | *3 (19us RTD)* | *6 (21us RTD)* | *8 (22us RTD)* |
| *2* | *0.25* | *4 (9us RTD)* | *10 (11us RTD)* | *14 (11us RTD)* |

Need further discussion

**Issue 1-2: How to capture the note in DL interruption table for Tx switching with 2 TAGs**

|  |
| --- |
| *The following is agreed in RAN4#105 meeting [R4-2220417]:**<Agreement>: Issue 1-1: RTD for non-collocated inter-band scenario for Tx switching with 2 TAGs**Agreements on GTW:** + *Use RTD=6us side condition for non-collocated inter-band case to derive DL interruption length for 2TAGs case.*
	+ *FFS if requirements for RTD > 6us is needed*
	+ *Note: RTD value will be captured in the specification as an informational note in the table for DL interruption length for 2TAGs as an assumption to derive the values.*
 |

* Proposals
	+ Option 1(QC): Add the following note in interruption table:

“*The interruption requirements are derived based on the designated RTD range <= 6us as the side condition. The applicable RTD ranges of this requirement, when the RTD is larger than 6us, depend on the SCS and switching period.*”

* + Option 2(Huawei, China Telecom): Add the following note in interruption table:

“*RTD=6us is assumed to derive the DL interruption length.*”

* Recommended WF

Need further discussion.

**Issue 1-3: DL interruption length for Tx switching with 2 TAGs**

* Proposals
	+ Option 1 (China Telecom, MediaTek, Ericsson): For R18 Tx switching across 3/4 bands with 2 TAGs, reuse Rel-16/Rel-17 values for length of DL interruption.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |

* + Option 2(Apple, CMCC, Qualcomm, vivo, Huawei, Mediatek): DL interruptions for R18 Tx switching across 3/4 bands with 2 TAGs are as below,

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 8 |
| 2 | 0.25 | 4 | 10 | 14 |

Note: only the value which is marked in red is different with R16/R17 interruption, other values are the same.

* + Option 3(Nokia):
1. **Define the interruption requirements for RTD < [9]us assuming an ISD of 2km.**
2. **Introduce following requirements for RTD > 6us with MRTD = 33us as mentioned in the following Table.**

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 3 | 4 | 5 |
| 1 | 0.5 | 4 | 7 | 9 |
| 2 | 0.25 | 7 | 13 | 17 |

Note: the values which are marked in red are different with R16/R17 interruption.

* Recommended WF

Need further discussion.

**Issue 1-4: Consideration on the scenario that one downlink carrier is indicated to be interrupted by two band pairs for dynamic switching simultaneously**

* Proposals
	+ Option 1(Huawei): If one downlink carrier is indicated to be interrupted by two band pairs for dynamic switching simultaneously, the DL interruption length and location on the victim carrier is determined by the maximum of uplink switching periods of the two band pairs.
* Recommended WF

Need further discussion.

**Issue 1-5: Additional signalling for Tx switching with 2 TAGs**

* Proposals
	+ Option 1(Nokia): UE shall inform network the RTD value or at least if the RTD side condition is fulfilled.
* Recommended WF

Need further discussion.

**Issue 1-6: Minimum Separation Time between two consecutive UL Tx Switching**

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| --- |
| *The following is agreed in RAN1#111:** *(working assumption) If two uplink switching are triggered and result in UL transmissions on more than 2 bands within any two consecutive reference slots, then the time duration between the end of all transmission(s) prior to the first uplink switching and the start of all transmission(s) after the second uplink switching within the two reference slots is expected to be not less than a minimum separation time*
	+ *The minimum separation time is a sum of X us and the switching gap required for the second uplink switching.*
	+ *X us is subject to UE capability with a value set of {0us, 500us}*
 |

* Proposals
	+ Option 1(Nokia):
		- The UE shall not perform UL Tx switching if it has performed an UL Tx switching within MinSeparationTime.
		- The UE shall not perform UL Tx switching if it has performed an UL Tx switching within MinSeparationTimeforMultiTAGs in multi-TAGs scenario.
* Recommended WF

Encourage companies to check and identify whether there are impacts on RAN4 RRM.

**Issue 1-7: New issue for Tx switching with single TAG**

* Proposals
	+ Option 1(Ericsson): Reuse Rel-16/Rel-17 values for length of DL interruption for single TAG, colocated case, for 2 bands.

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod* |

* Recommended WF

*In RAN4#104b-e meeting it is agreed that DL interruption length and starting point with single TAG are the same as that of R-17 TX switching between 2 bands. Moderator think this issue is closed.*