**3GPP TSG-RAN WG4 Meeting #111 R4-24XXXXX**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

**Agenda item:** 7.13.4

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

**Title:** Topic summary for [111][215] NR\_MC\_enh

**Document for:** Information

# Introduction

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

**Online handling**

(Online) Issue 1-1: Whether to introduce new UE capability for Dormant BWP switching on multiple CCs RRM requirements with DCI 0-3/1-3

(Online) Issue 2-4: SRS configuration and AP CSI-RS for L1-RSRP reporting for FDD-TDD Tx switching across 3 or 4 bands

(Online) Issue 2-5: SRS configuration and AP CSI-RS for L1-RSRP reporting for TDD-TDD Tx switching across 3 or 4 bands TC

(Online) Issue 1-3: DL interruption for Tx switching across 2 bands and 2 TAGs case

# Topic #1: Core requirements for R18 Multi-carrier enhancement

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2408287 | vivo | Observation 1: *bwp-SwitchingMultiDormancyCCs-r16* cannot be used for dormant BWP switching on multiple CCs in RRM requirements if the BWP switch is triggered by SCell dormancy indication in DCI format 0-3/1-3.Observation 2: *bwp-SwitchingMultiCCs-r16* can be reused for BWP switching on multiple CCs in RRM requirements if the BWP switch is triggered by bandwidth part indicator in DCI format 0-3/1-3.Proposal 1: Revise existing RRM requirements for DCI based BWP switch on multiple CCs to include new DCI 0-1/1-3 based BWP switch.Proposal 2: Introduce a new UE capability for incremental delay in RRM requirements for DCI-based BWP switch on multiple CCs for multi carrier enhancement as in Table 1. |
| R4-2408288 | vivo | CR to correct RRM requirements for DCI based BWP switching on multiple CCs for multi-carrier enh |
| R4-2409471 | Nokia, Nokia Shanghai Bell | 1. No distinction was made in 1-TAG and 2TAGs cases for 2 bands scenario in the legacy case.
2. Existing requirements for DL interruption for Tx switching across 2 bands can be applied to DL interruption for Tx switching across 2 bands and 2 TAGs case.
 |

## Open issues summary

### Sub-topic 1: Core requirements for R18 Multi-Carrier enhancement

**(Online) Issue 1-1: Whether to introduce new UE capability for Dormant BWP switching on multiple CCs RRM requirements with DCI 0-3/1-3**

***Background***

1. *A new UE capability 49-9 on SCell dormancy indication within active time in DCI format 0\_3/1\_3 in NR multi-carrier enhancement were introduced in RAN1.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Features*** | ***Index*** | ***Feature group*** | ***Components*** | ***Prerequisite feature groups*** |
| *49. NR\_MC\_enh* | *49-9* | *SCell dormancy indication within active time in DCI format 0\_3/1\_3* | *Support for SCell dormancy indication sent within the active time on PCell with DCI format 0\_3/1\_3* | *6-5, at least one of {49-1, 49-1b, 49-2,49-2b}* |

1. *In existing DCI based BWP switch delay on multiple CCs requirements (in TS38.133 clause 8.6.2A), incremental delay (i.e., D) for simultaneous BWP switch depends on different UE capabilities:*

*-bwp-SwitchingMultiCCs-r16 for switching between non-dormant BWPs, and*

*-bwp-SwitchingMultiDormancyCCs-r16 for switching between non-dormant and dormant BWPs.*

*Where bwp-SwitchingMultiDormancyCCs-r16 (that’s FG 6-3) is defined as below. The prerequisite of FG 6-3 is FG 18-4 or 18-4a, which are for format 0-1/1-1 or format 2-6, respectively*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Features* | *Index* | *Feature group* | *Components* | *Prerequisite feature groups* |
| *6. LTE\_NR\_DC\_CA\_enh* | *6-3* | *Dormant BWP switching on multiple CCs RRM requirements* | *Incremental delay for BWP switch processing on additional SCells in DCI based simultaneous dormant BWP switching on multiple SCells* | *RAN1 feature 18-4 or 18-4a*  |
| *18. MR-DC/CA enhancement* | *18-4* | *SCell dormancy indication within active time* | *Support for SCell dormancy indication sent within the active time on PCell with DCI format 0\_1/1\_1* | *6-5* |
| *18. MR-DC/CA enhancement* | *18-4a* | *SCell dormancy indication outside active time* | *Support for SCell dormancy indication sent outside the active time on PCell with DCI format 2\_6* | *19-1* |

* Proposals
	+ Option 1(vivo): Introduce a new UE capability for incremental delay in RRM requirements for DCI-based BWP switch on multiple CCs for multi carrier enhancement

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 38. NR\_MC\_enh  | 38-9 | Dormant BWP switching on multiple CCs RRM requirements with DCI 0-3/1-3 | Incremental delay for BWP switch processing on additional SCells in DCI 0-3/1-3 based simultaneous dormant BWP switching on multiple SCells | 49-9 | Yes | N/A | There may be additional unclear BWP switching delay if simultaneous dormant BWP switching is triggered by DCI 0-3/1-3. | Per UE | No | No | N/A | The candidate values are:● {100us, 200us} for UE indicates type1 in bwp-SwitchingDelay● {200us, 400us, 800us, 1000us} for UE indicates type 2 in bwp-SwitchingDelayThe total BWP switching delay will be captured in TS38.133UE needs to indicate either of the candidate values | Optional with capability signalling |

* Recommended WF

Further discussion.

**Issue 1-2: Update on RRM requirements for DCI based BWP switch on multiple CCs, if the capability in issue 1-1 is introduced**

* Proposals
	+ Option 1(vivo): Revise existing RRM requirements for DCI based BWP switch on multiple CCs to include new DCI 0-1/1-3 based BWP switch.

|  |
| --- |
| * clause 8.6.2A DCI based BWP switch delay on multiple CCs

*<omit non-related content>*D is the incremental delay for each additional CC involved in simultaneous BWP switch and depends on UE capability *bwp-SwitchingMultiCCs-r16* [TS 38.306, 14] for switching between non-dormant BWPs, and *bwp-SwitchingMultiDormancyCCs-r16* or [*UE capability for incremental delay with DCI format 0-3/1-3*] for switching between non-dormant and dormant BWPs. |

* Recommended WF

Further discussion.

**(Online) Issue 1-3: DL interruption for Tx switching across 2 bands and 2 TAGs case**

* Proposals
	+ Option 1(Nokia): Existing requirements for DL interruption for Tx switching across 2 bands can be applied to DL interruption for Tx switching across 2 bands and 2 TAGs case.
* Recommended WF

Further discussion.

# Topic #2: Performance requirements for DL interruption for Tx switching across 3/4 bands

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2408547 | Huawei, HiSilicon | Observation 1: The time offset settings in Rel-18 Tx switching with dual TAGs test cases don’t match WF R4-2321390 and the TAG settings are unclear.Observation 2: Under current SRS configuration, UE transmits SRS to every serving cell in every slot.Proposal 1: Clarify the following in TX switching across 3 or 4 bands for dual TAGs test cases:* For A.6.5.7D.3:
	+ Cell 1 and Cell 2 belong to a TAG, Cell 3 belongs to the other TAG.
	+ Time offset to Cell 1 is set to 0 us and 9 us for Cell 2 and Cell 3 respectively.
* For A.6.5.7D.4:
	+ Cell 1 and Cell 2 belong to one TAG, Cell 3 and Cell 4 belong to the other TAG.
	+ Time offset to Cell 1 is set to 0 us, 9 us and 9 us for Cell 2, Cell 3 and Cell 4 respectively.

Proposal 2: Align the nominal RSRP levels of all cells to -84dBm/SCS in Rel-18 Tx switch test cases. Es/Noc level are updated accordingly.Proposal 3: Update *periodicityAndOffset-p* of SRS to ensure SRS is transmitted in special slot.Proposal 4: In FDD-TDD Tx switching across 3 or 4 bands test cases, set SRS *periodicityAndOffset-p* = sl10,6 for Cell 1 and Cell 2, and SRS *periodicityAndOffset-p* = sl20,3 for Cell 3 (and Cell 4) Proposal 5: In FDD-TDD Tx switching across 3 or 4 bands test cases, AP CSI-RS for L1-RSRP reporting is triggered* in the slot overlapping with the first S slot of every radio frame on NR TDD cell for Cell 1 and Cell 2,
* in the second S slot of every radio frame for Cell 3 (and Cell 4).

Proposal 6: In TDD-TDD Tx switching across 3 or 4 bands test cases, set SRS *periodicityAndOffset-p* = sl20,5 for Cell 1 and Cell 2, and SRS *periodicityAndOffset-p* = sl20,3 for Cell 3 (and Cell 4).Proposal 7: In TDD-TDD Tx switching across 3 or 4 bands test cases, AP CSI-RS for L1-RSRP reporting is triggered* in the first special slot of every radio frame for Cell 1 and Cell 2,
* in the second special slot of every radio frame for Cell 3 (and Cell 4).

Proposal 8: Update SRS and AP CSI-RS configurations in Rel-16/17 Tx switch test cases in the same way. |
| R4-2408548 | Huawei, HiSilicon | Correction CR to multi-carrier enhancement RRM test cases\_R18 |

## Open issues summary

### Sub-topic 1: DL interruption TC

***Background***

*The below four TCs have be specified in current spec:*

*A.6.5.7D.1 DL interruptions at switching across three uplink bands in TDD-TDD CA for single TAG*

*A.6.5.7D.2 DL interruptions at switching across four uplink bands in FDD-TDD CA for single TAG*

*A.6.5.7D.3 DL interruptions at Tx switching across three uplink bands in FDD-TDD CA for 2 TAGs*

*A.6.5.7D.4 DL interruptions at Tx switching across four uplink bands in TDD-TDD CA with different UL/DL pattern for 2 TAGs*

**Issue 2-1: Clarification of TAG and time offsets in Dual TAGs test cases**

* Proposals
	+ Option 1 (Huawei):Clarify the time offset in TX switching across 3 or 4 bands for **dual** TAGs test cases:

For A.6.5.7D.3:

Cell 1 and Cell 2 belong to a TAG, Cell 3 belongs to the other TAG.

Time offset to Cell 1 is set to 0 us and 9 us for Cell 2 and Cell 3 respectively.

For A.6.5.7D.4:

Cell 1 and Cell 2 belong to one TAG, Cell 3 and Cell 4 belong to the other TAG.

Time offset to Cell 1 is set to 0 us, 9 us and 9 us for Cell 2, Cell 3 and Cell 4 respectively.

* Recommended WF

It is agreed in [R4-2321390] that time offset is 0us for the same TAG and 9us for 2TAG. The proposal is to clarify that all time offsets are compared to Cell1. Is option 1 agreeable?

**Issue 2-2: Alignment of RSRP Levels among Tx switching test cases**

***Background***

*In current TCs, Noc, Es/Noc, SS-RSRP and Io level are various. From RAN5 perspective, all cells having the same RSRP reporting range can significantly simplify RAN5 TT analysis.*

|  |  |  |
| --- | --- | --- |
|  | ***FDD Cells (15KHz SCS + 10MHz CBW)*** | ***TDD Cells (30KHz SCS + 40MHz CBW)*** |
|  | ***Noc*** ***(in dBm/ 15kHz)*** | ***Es/Noc******(in dB)*** | ***Nominal******SS-RSRP******(in dBm/ SCS)*** | ***Io******(in dBm/Ch BW)*** | ***Noc*** ***(in dBm/ 15kHz)*** | ***Es/Noc******(in dB)*** | ***Nominal******SS-RSRP******(in dBm/ SCS)*** | ***Io******(in dBm/Ch BW)*** |
| ***A.6.5.7D.1*** | *N/A* | *N/A* | *N/A* | *N/A* | *-104* | *17* | *-84* | *-55.79* |
| ***A.6.5.7D.2*** | *-104* | *17* | *-87* | *-58.96* | *-104* | *14* | *-87* | *-55.79* |
| ***A.6.5.7D.3*** | *-104* | *17* | *-87* | *-58.96* | *-104* | *14* | *-87* | *-55.79* |
| ***A.6.5.7D.4*** | *N/A* | *N/A* | *N/A* | *N/A* | *-104* | *17 for Cell 1**14 for other Cells* | *-84 for Cell 1**-87 for other Cells* | *-55.79 for all Cells* |

* Proposals
	+ Option 1 (Huawei): Align the nominal RSRP levels of all cells to -84dBm/SCS in Rel-18 Tx switch test cases to reduce RAN5 work load.
* Recommended WF

Further discussion

**Issue 2-3: Principle for SRS configuration and triggering aperiodic CSI-RS for L1-RSRP reporting**

***Background***

*It is agreed in [R4-2321390] that DL interruption is to be verified in S slots. However according to current SRS resource configuration, periodicityAndOffset-p is set to sl1,0. which means UE shall send SRS on each carrier in each slot available for UL. In the worst case, the UE may need to send SRSs on 4 carriers at the same time.*

*Table A.4.4.1.1.1-3: SRS Configuration for Timing Accuracy Test*

|  |  |  |
| --- | --- | --- |
| *SRS-Resource* | *SRS-ResourceId* | *0* |
| *nrofSRS-Ports* | *Port1* |
| *transmissionComb*  | *n2* |
| *combOffset-n2* | *0* |
| *cyclicShift-n2* | *0* |
| *resourceMapping**startPosition* | *0* |
| *resourceMapping**nrofSymbols*  | *n1* |
| *resourceMapping**repetitionFactor* | *n1* |
| *freqDomainPosition* | *0* |
| *freqDomainShift* | *0* |
| *freqHopping**c-SRS* | *14 for test configuration 1,2,4,5**25 for test configuration 3,6* |
| *freqHopping**b-SRS* | *0* |
| *freqHopping**b-hop* | *0* |
| *groupOrSequenceHopping* | *Neither* |
| *resourceType* | *Periodic* |
| *periodicityAndOffset-p* | *sl1, 0* |

* Proposals
	+ Option 1 (Huawei):Update *periodicityAndOffset-p* in SRS configuration and ensure SRS transmission and aperiodic CSI-RS for L1-RSRP reporting is overlapped/in the special slot.
* Recommended WF

Further discussion

**(Online) Issue 2-4: SRS configuration and AP CSI-RS for L1-RSRP reporting for FDD-TDD Tx switching across 3 or 4 bands**

* Proposals
	+ Option 1 (Huawei): In FDD-TDD Tx switching across 3 or 4 bands test cases,

set SRS *periodicityAndOffset-p* = sl10,6 for Cell 1 and Cell 2, and SRS *periodicityAndOffset-p* = sl20,3 for Cell 3 (and Cell 4) ,

AP CSI-RS for L1-RSRP reporting is triggered

* + - in the slot overlapping with the first S slot of every radio frame on NR TDD cell for Cell 1 and Cell 2,
		- in the second S slot of every radio frame for Cell 3 (and Cell 4).
* For Information

With the proposal option 1, SRS configurations and AP CSI-RS configurations are updated as follow:

* FDD Cells (Cell 1 and Cell 2): set periodicityAndOffset-p = sl10,6, AP CSI-RS for L1-RSRP reporting is triggered in the slot overlapping with the first special slot of every radio frame on NR TDD cell.
* TDD Cell(s) (Cell 3, and Cell 4 if applicable): set periodicityAndOffset-p = sl20,3, AP CSI-RS for L1-RSRP reporting is triggered in the second special slot of every radio frame on NR TDD cell.

The time domain locations of SRS, AP CSI-RS and DL interruption are depicted in Figure 1.

**

*Figure 1: Proposed time domain location of SRS, CSI-RS and interruption under proposed SRS configuration for FDD-TDD Tx switching test*

* Recommended WF

Further discussion

**(Online) Issue 2-5: SRS configuration and AP CSI-RS for L1-RSRP reporting for TDD-TDD Tx switching across 3 or 4 bands TC**

* Proposals
	+ Option 1 (Huawei): In TDD-TDD Tx switching across 3 or 4 bands test cases,

set SRS periodicityAndOffset-p = sl20,5 for Cell 1 and Cell 2, and SRS periodicityAndOffset-p = sl20,3 for Cell 3 (and Cell 4),

AP CSI-RS for L1-RSRP reporting is triggered

* + - in the first special slot of every radio frame for Cell 1 and Cell 2,
		- in the second special slot of every radio frame for Cell 3 (and Cell 4).
* *For Information*

*Under current test configuration (as shown in figure 2) S slot on Cell 1/2 collides with the 2nd S slot of every 8 slots on Cell 3 once every radio frame. Checking DL interruption on all Cells at the same time, which implies SRS shall be transmitted on all Cells at the same time, which violates the intention of testing.*

**

*Figure 2: time domain location of SRS, CSI-RS and interruption under current test configuration in current TDD-TDD Tx switching test*

*With the proposal option 1, SRS configurations and AP CSI-RS configurations are updated as follow:*

* *TDD Cells with UL/DL pattern “DDDSUUUUDD” (Cell 1 and Cell 2): set periodicityAndOffset-p = sl20,5, AP CSI-RS for L1-RSRP reporting is triggered in the first special slot of every radio frame on Cell 1 and Cell 2.*
* *TDD Cell(s) with UL/DL pattern “DSUU” (Cell 3, and Cell 4 if appplicable): set periodicityAndOffset-p = sl20,3, AP CSI-RS for L1-RSRP reporting is triggered in the second special slot of every radio frame on Cell 3 (and Cell 4).*

*The time domain locations of SRS, AP CSI-RS and DL interruption are depicted in figure 3.*

**

*Figure 3: Proposed time domain location of SRS, CSI-RS and interruption under proposed SRS configuration for TDD-TDD Tx switching test*

* Recommended WF

Further discussion

**Issue 2-6: Update on Rel-16/17 Tx switch test cases**

* Proposals
	+ Option 1 (Huawei):Update SRS and AP CSI-RS configurations in Rel-16/17 Tx switch test cases in the same way.
* Recommended WF

If the above technical issues have achieved conclusions, the same principle can be applied to early release. No need to discuss on this issue.