**3GPP TSG-RAN4 Meeting #110 R4-24xxxxx**

**Athens, GR, 26 Feb – 01 Mar, 2024**

**Agenda item:** 8.15.4

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [110][129] NR\_MC\_enh\_UERF

**Document for:** Information

# Introduction

This thread discusses the maintenance for switching time and other RF aspects for Rel-18 Multi-carrier enhancements WI.

# Topic #1: Maintenance for switching time and other RF aspects

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2400851 | Huawei, HiSilicon | **Title:** (NR\_MC\_enh-Core) CR for 38.101-1: Correction on time mask for Rel-18 Tx switching**Summary of change:** 1. Modify the titles of sub-clause 6.3A.3.3.6 and sub-clause 6.3C.3.5 to ‘up to four uplink bands’. Modify ‘three or four’ band to ‘up to four’ in the NR inter-band CA and NR SUL band configuration with inter-band CA configuration according to UE capability of Rel-18 Tx switching band combination in 6.3A.3.3.6 and 6.3C.3.5.
2. Replace ‘BandCombination-UplinkTxSwitch-r18’ with ‘supportedBandPairListNR-r18’ in sub-clause 6.3A.3.3.6.
3. For the RRC configurations IE and UE capability IE introduced in Rel-18, which are not used in previous releases, remove ‘-r18’ in the IE names.
4. Restructure the part related to non-affected band with baseline UE behaviour and optional UE behaviour in different paragraphs. Correct the IE names according to the latest RAN2 specifications.
5. For the part related to Figure 6.3A.3.3.6-5, correct the IE names according to the latest RAN2 specifications.
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| R4-2400937 | China Telecom | **Title:** CR for 38.101-1: Capability update for tx switching across three or four uplink bands**Summary of change:** Update the capability for unaffected band involved for DualUL. The *uplinkTxSwitchingMaintainedUL-Trans* -*r18 is changed to be maintainedUL-Trans-r18* |
| R4-2401106 | NTT DOCOMO INC. | **Title:** Views on RAN2 LS and UE feature list for Rel-18 Tx switching**Observation 1: It is worth considering whether to make the specification more clear according to the following RAN2 agreement (agreement 1):*** **Agreement1) Rel-18 signalling can configure 2 bands UL Tx switching for a band pair that the UE supports according to the Rel-18 band pair list UE capability, in which case the network and UE assume the capability reported for R18 UL Tx switching is used.**
* **Consider whether the description of “three or four bands” for Rel-18 Tx switching in TS 38.101-1 v18.4.0 should be replaced with “up to four bands”.**
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| R4-2401277 | ZTE Corporation | **Title:** Reply LS on UL Tx switching**Abstract:** Response to: R2-2313959 |
| R4-2401844 | Ericsson | **Title:** (NR\_MC\_enh-Core) Clarification of three-band switching gap lengths for CA and SUL**Summary of change:** Clause 6.3A.3.3.1: the redundant “up to two switching pairs” is removed, wording added to reflect that 6.3A.3.3.2-6.3A.3.3.5 contains both switching between carriers and bands, correction of reference.Clause 6.3A.3.3.6:for the case of switching between bands X, Y and Z, it is clarified that the transient periods on the ‘last’ symbols are before any T0 on the ‘switched-to-carriers’. For other cases in which a switching gap is provided, relevant units are added and notation corrected.Clause 6.3C.3.0: the redundant “up to two switching pairs” is removed.6.3C.3.5: changes for SUL corresponding to those for CA in 6.3A.3.3.6. |
| R4-2402312 | MediaTek Inc. | **Title:** (NR\_MC\_enh-Core)Discussion on the UE feature list for MC\_enh**Proposal 1:** UE capability: 38-x Preferred switching band pairs |
| R4-2401523 | vivo | **Title:** Discussion of LS on UL Tx switching**Observation 1: Supporting 2 bands UL Tx switching which using Rel-18 signalling scheme.****Observation 2: Current RAN4 requirements for Rel-18 only considered across 3/4 band switching case, and current switching requirements between 2 band cannot be applied to Rel-18 signalling.****Proposal 1: Consider adding requirements to ensure 2 band requirements can also be covered for Rel-18 signalling.** * **Option 1:** Adding Rel-18 capabilities and signalling into Rel-16/17 clauses, to extend certain behaviour and requirements into 2 band cases.
* **Option 2:** Adding general descriptions to extend the 3/4 band requirements to also cover 2 band cases.

**Proposal 2: Confirm the current RAN4 requirements already align with RAN2 agreement, and the additional switching period associated with dedicated capability always have higher priority.** |
| R4-2401524 | vivo | **Title:** [Draft] Reply LS on UL Tx switching**Abstract:** Response to: R2-2313959 |
| R4-2401525 | vivo | **Title:** Corrections of UL Tx switching period applicability for 2 band case for Rel-18**Summary of change:** Add some Rel-18 signaling and corresponding scheme for 2 band cases. |

## Open issues summary

### Sub-topic 1-1: LS related topics

Topics are related to incoming LS in this meeting:

* R4-2400022 LS on UL Tx switching, original LS: R2-2313959

#### Issue 1-1-1: R4-2400022 LS on UL Tx switching

* **Background:** Theincoming LS R4-2400022 captures RAN2 agreement as shown below

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| --- |
| For Rel-18 UL Tx switching, RAN2 achieved the following agreements in RAN2 #124 meeting:* (Agreement 1)RAN2 confirms that Rel-18 signalling can configure 2 bands UL Tx switching for a band pair that the UE supports according to the Rel-18 band pair list UE capability, in which case the network and UE assume the capability reported for R18 UL Tx switching is used. RAN2 respectfully asks RAN4 and RAN1 to take this into account, and feedback to RAN2 in case there is any concern.
* (Agreement 2)RAN2 assumes that “if *switching2T-Mode-r18* IE is configured for a band pair, then 2Tx-2Tx switching period of this band pair will be considered as the input for switching period calculation, for instance, when calculating “min {max(Tswitch\_A-C, Tswitch\_B-D), max(Tswitch\_A-D, Tswitch\_B-C)}” or “max(Tswitch\_A-C,Tswitch\_B-D ,Tswitch\_A-D, Tswitch\_B-C)” for switching across 4 bands. RAN2 respectfully asks RAN4 to take this into account, and feedback to RAN2 in case there is any concern.
 |

* **Proposals for (agreement 1) in LS R4-2400022:**
* **Option 1:** Adding Rel-18 capabilities and signalling into Rel-16/17 clauses, to extend certain behaviour and requirements into 2 band cases.
* **Option 2:** Adding general descriptions to extend the 3/4 band requirements to also cover 2 band cases.

**Proposal 1 (Huawei):** Option 2. Modify the titles of sub-clause 6.3A.3.3.6 and sub-clause 6.3C.3.5 to ‘up to four uplink bands’. Modify ‘three or four’ band to ‘up to four’ in the NR inter-band CA and NR SUL band configuration with inter-band CA configuration according to UE capability of Rel-18 Tx switching band combination in 6.3A.3.3.6 and 6.3C.3.5.

**Proposal 2 (NTT DOCOMO):** Option 2. Consider whether the description of “three or four bands” for Rel-18 Tx switching in TS 38.101-1 v18.4.0 should be replaced with “up to four bands”.

**Proposal 3 (ZTE):** Option 2? RAN4 has concern on the RAN2 Agreement and RAN4 spec update is needed if RAN2 Agreement is endorsed in the end.

**Proposal 4 (vivo):** Option 1 or 2. Consider adding requirements to ensure 2 band requirements can also be covered for Rel-18 signalling.

* **Recommended WF for (agreement 1):**
	+ **TBA**
* **Proposals for (agreement 2) in LS R4-2400022:**

**Proposal 1 (vivo):** Confirm the current RAN4 requirements already align with RAN2 agreement, and the additional switching period associated with dedicated capability always have higher priority.

**Proposal 2 (ZTE):** For the band pair (e.g., band A and band B) supporting 2Tx-2Tx switching, the UE always support 1Tx-2Tx and 1Tx-1Tx switching for this band pair, and 2Tx-2Tx switching period applies to the switching cases between the band pair.

**Proposal 3 (NTT DOCOMO):** RAN2 agreements have no issue from RAN4 perspective, and hence no reply to R4-2400022 is necessary.

* **Recommended WF for (agreement 2):**
	+ **TBA**

#### Issue 1-1-2: Response to R4-2400022 LS on UL Tx switching

**Background:** The LSs are related to Issue 1-1-1: R4-2400022 LS on UL Tx switching

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| --- | --- | --- |
| R4-2401524 | vivo | **Title:** [Draft] Reply LS on UL Tx switching**Abstract:** Response to: R4-2400022 |
| R4-2401277 | ZTE Corporation | **Title:** Reply LS on UL Tx switching**Abstract:** Response to: R4-2400022 |

* **Proposals for Response to** **R4-2400022 LS:**
* **Option 1:** reply to R4-2400022 LS (vivo, ZTE).
* **Option 2:** No need to reply (NTT DOCOMO).
* **Recommended WF:**
	+ Depend on the discussion in issue 1-1-1

### Sub-topic 1-2: UE feature list

* **Background:**

Per chairman guidance:



Thus, one UE capability of ***Preferred switching band pairs*** is highlighted from Media Tek, other views from companies are also captured in the following proposals

#### Issue 1-2-1: UE capability of Preferred switching band pairs

* **Proposals:**

**Proposal 1 (MTK):** To complete the Rel-18 work on multi-carrier enhancements for TX switching, the advanced UE capability for TX switching for a band combination consisting of four different bands is proposed.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***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-x*** | ***Preferred switching band pairs*** | ***Support the indication of UE’s preferred (switched-from, switched-to) band pairs for parallel UL transmission switching for a band combination consisting of four different bands*** | ***38-1 [Rel-18 Tx switching]*** | ***Yes*** | ***No*** | ***Network can only assume the maximum switching period*** | ***Per BC*** | ***No*** | ***FR1 only*** | ***N.A*** |  | ***Optional with capability signalling*** |

* **Recommended WF:**
	+ TBA

#### Issue 1-2-2: On-going capabilities

**• Proposals:**

**Proposal 1 (NTT DoCoMo):** RAN4#110 discusses the following table as a baseline for the UE feature list for Rel-18 multi-carrier enhancements WI.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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  | 38-1  | Switching period for dynamic UL Tx switching across 3 bands in case of inter-band CA, SUL for single TAG | 1. Indicate support of dynamic UL Tx switching across 3 bands for inter-band UL CA, or SUL for single TAG.2. Indicate the supported switching period for dynamic UL Tx switching across 3 bands for inter-band UL CA, or SUL for single TAG. |   | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 2 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-2  | Switching period for dynamic UL Tx switching across 4 bands in case of inter-band CA, SUL for single TAG  | 1. Indicate support of dynamic UL Tx switching across 4 bands for inter-band UL CA, or SUL for single TAG.2. Indicate the supported switching period for dynamic UL Tx switching across 4 bands for inter-band UL CA, or SUL for single TAG. |   | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 2 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | [38-3]  | Switching period for dynamic UL Tx switching across 2 bands in case of inter-band CA, SUL for dual TAG  | 1. Indicate support of dynamic UL Tx switching across 2 bands for inter-band UL CA, or SUL for dual TAG.2. Indicate the supported switching period for dynamic UL Tx switching across 2 bands for inter-band UL CA, or SUL for dual TAG. |   | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 2 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-4  | Switching period for dynamic UL Tx switching across 3 bands in case of inter-band CA, SUL for dual TAG  | 1. Indicate support of dynamic UL Tx switching across 3 bands for inter-band UL CA, or SUL for dual TAG.2. Indicate the supported switching period for dynamic UL Tx switching across 3 bands for inter-band UL CA, or SUL for dual TAG. |   | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 2 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-5 | Switching period for dynamic UL Tx switching across 4 bands in case of inter-band CA, SUL for dual TAG  | 1. Indicate support of dynamic UL Tx switching across 4 bands for inter-band UL CA, or SUL for dual TAG.2. Indicate the supported switching period for dynamic UL Tx switching across 4 bands for inter-band UL CA, or SUL for dual TAG. |   | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 2 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-6 | Application of DL interruptions due to dynamic UL Tx switching | 1. Capability to indicate that for the band where DL interruption is needed, the RRM interruption requirements defined in RAN4 shall be applied for duplex mode combinations except the combinations- SUL+TDD- TDD+TDD CA with the same UL-DL pattern SUL+TDD  | 38-1, 38-2, 38-3, 38-4, 35-5 | Yes  | N/A  | UL Tx switching where DL interruption is needed cannot be supported.  | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Note: Field encoded as a bit map, where bit N is set to "1" if DL interruption on band N will occur during uplink Tx switching as specified in TS 38.133 [5]. The leading / leftmost bit (bit 0) corresponds to the first band of this band combination, the next bit corresponds to the second band of this band combination and so on. | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-7  | Switching Period for unaffected Band for Dual UL | 1. Indicate for a given band pair {band X and band Y}, whether/how the switching period is to be applied on band X, Y, Z, when a UL Tx switching is triggered from band pair {band X and band Z} to band pair {band Y and band Z}, as defined in 38.101-1. If absent for band Z, the UE is not required to transmit on any UL bands during the switching period reported for the band pair of band X and band Y, as defined in 38.101-12. Indicate the support of uplink transmission on band Z and is not required to transmit on band X and Y during the switching period reported for the band pair of band X and band Y, as specified in 38.101-1. 3. Indicate additionally the supported switching period for unaffected band for dual UL.  | 38-1, 38-4 | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination. | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 3 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-8  | Additional switching Period for Dual UL | 1. Indicate additionally the supported Tx switching period for switching between a band pair and another band pair or another band, when Rel-18 UL Tx switching is configured by uplinkTxSwitchingMoreBands-r18. If the capability is not reported, the switching period reported in switchingPeriodFor2T-r18 or switchingPeriodFor1T-r18 applies, as specified in TS 38.214 and TS 38.101-1. | 38-1, 38-2, 38-4, 35-5 | Yes  | N/A  | UL Tx switching across more than 2 bands cannot be supported for the band pair in the band combination. | Per BC | No | FR1 only  | Support mixture of FDD/TDD  |  Component 1 candidate value: {35us, 140 us, 210us} | Optional with capability signaling  |
| 38. NR\_MC\_enh  | 38-9  | Improved switching period for four-band switching case | 1. Support the capability that the switching period can be improved to min {max(Tswitch\_A-C, Tswitch\_B-D), max(Tswitch\_A-D, Tswitch\_B-C)} assuming UE’s preferred (switched-from, switched-to) band pairs for parallel UL transmission switching for a band combination consisting of four different bands. | 38-1, 35-5 | Yes | N/A  | Network can only assume the maximum switch period | Per BC  | No | FR1 only |  Support mixture of FDD/TDD  | Note: Detailed information can refer to the LS to RAN2 in R4-2317609  | Optional with capability signalling  |
| 38. NR\_MC\_enh  | 38-10 | UL-MIMO coherence capability for dynamic Tx switching between 2Tx-2Tx switching among 3 or 4 bands | 1. Apply UL-MIMO coherence for the 2Tx-capable UL band(s). Rel-17 signalling on UL-MIMO coherence capability for 2Tx-2Tx switching is reused | 38-1, 38-2, 38-3, 38-4, 35-5 | Yes | N/A | UL-MIMO coherence cannot be supported for UL Tx switching across more than 2 bands. | Per BC | No | FR1 only | Support mixture of FDD/TDD | Note: Detailed information can refer to the LS to RAN2 in R4-2217741. | Optional with capability signalling  |

* **Recommended WF:**
	+ TBA

### Sub-topic 1-3: CRs

#### Issue 1-3-1: CRs related to incoming LS R4-2400022

**Background:** There are two CRs submited corresponding to LS R4-2400022

|  |  |  |
| --- | --- | --- |
| R4-2400851 | Huawei, HiSilicon | **Title:** (NR\_MC\_enh-Core) CR for 38.101-1: Correction on time mask for Rel-18 Tx switching**Summary of change:** 1. Modify the titles of sub-clause 6.3A.3.3.6 and sub-clause 6.3C.3.5 to ‘up to four uplink bands’. Modify ‘three or four’ band to ‘up to four’ in the NR inter-band CA and NR SUL band configuration with inter-band CA configuration according to UE capability of Rel-18 Tx switching band combination in 6.3A.3.3.6 and 6.3C.3.5.
2. Replace ‘BandCombination-UplinkTxSwitch-r18’ with ‘supportedBandPairListNR-r18’ in sub-clause 6.3A.3.3.6.
3. For the RRC configurations IE and UE capability IE introduced in Rel-18, which are not used in previous releases, remove ‘-r18’ in the IE names.
4. Restructure the part related to non-affected band with baseline UE behaviour and optional UE behaviour in different paragraphs. Correct the IE names according to the latest RAN2 specifications.
5. For the part related to Figure 6.3A.3.3.6-5, correct the IE names according to the latest RAN2 specifications.
 |
| R4-2401525 | vivo | **Title:** Corrections of UL Tx switching period applicability for 2 band case for Rel-18**Summary of change:** Add some Rel-18 signaling and corresponding scheme for 2 band cases. |

* **Recommended WF:**
	+ Depend on the discussion in issue 1-1-1

#### Issue 1-3-2: CRs for correction

**Background:** There are two CRs submited to maintain and correct the time mask requirements

|  |  |  |
| --- | --- | --- |
| R4-2400937 | China Telecom | **Title:** CR for 38.101-1: Capability update for tx switching across three or four uplink bands**Summary of change:** Update the capability for unaffected band involved for DualUL. The *uplinkTxSwitchingMaintainedUL-Trans* -*r18 is changed to be maintainedUL-Trans-r18* |
| R4-2401844 | Ericsson | **Title:** (NR\_MC\_enh-Core) Clarification of three-band switching gap lengths for CA and SUL**Summary of change:** Clause 6.3A.3.3.1: the redundant “up to two switching pairs” is removed, wording added to reflect that 6.3A.3.3.2-6.3A.3.3.5 contains both switching between carriers and bands, correction of reference.Clause 6.3A.3.3.6:for the case of switching between bands X, Y and Z, it is clarified that the transient periods on the ‘last’ symbols are before any T0 on the ‘switched-to-carriers’. For other cases in which a switching gap is provided, relevant units are added and notation corrected.Clause 6.3C.3.0: the redundant “up to two switching pairs” is removed.6.3C.3.5: changes for SUL corresponding to those for CA in 6.3A.3.3.6. |

* **Recommended WF:**
	+ TBA