**3GPP TSG RAN WG1 Meeting #114 R1-230xxxx**

Toulouse, France, August 21 – 25, 2023

**Agenda item: 9.17**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Summary of email discussion on the introduction of UL Tx switching across up to 4 bands in [Post-114-38.214-MC\_Enh]**

**Document for: Discussion and Decision**

# 1 Introduction

This document contains company observations on the draft CR to 38.214 for the Rel18 NR\_MC\_Enh, focusing primarily on the changes related to the *introduction of UL Tx switching across up to 4 bands*.

Please note that the *introduction of multi-cell PDSCH / PUSCH scheduling using DCI format 0\_3 & 1\_3* is discussed in a separate email thread/document, to facilitate our discussion! Will merge the outcome of these two draft CRs after their approval, resulting in a single draft CR on NR\_MC\_enh-Core!

First checkpoint for this discussion: **September 5th, 6.00 am UTC!**

# 2 Discussion – first round

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| Company | Comments | Editor reply/Notes |
| China Telecom | Thank you the great efforts on moderating the discussion. Our views are as below:1. On capturing the new switching condition “When the UE is to transmit a 1-port transmission on one uplink carrier on one band (1st band) and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on other different bands (2nd and 3rd band)”

For the mentioned switching condition, in the last meeting the related when bullet was deleted which had not been fully discussed by companies. We think the corresponding switching gap determination is not clearly defined in the current CR.Firstly, the below paragraph of spec only specifies how the UE determines the Tx state after switching, but does not specify how the switching gap NTx1-Tx2 is determined, i.e. does not say the UE is not expected to transmit for the duration of NTx1-Tx2.

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| - If the UE is configured with *uplinkTxSwitching-DualUL-TxState* set to 'oneT', when the UE is under the operation state in which 1-port transmission can be supported on one carrier on the 1st band and the 2nd band followed by no transmission on any carrier on these two bands and 1-port transmission on the other carrier on the 3rd band the UE shall consider this as if 1-port transmission was transmitted on the 3rd band and the band associated with the 3rd band as configured by [*AssociatedBand*], otherwise the UE shall consider this as if 2-port transmission took place on the transmitting carrier. |

Secondly, RAN1 spec is from “port” perspective. The discussed case is the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band, which is not the same as any switching case the below “when” bullets describe.

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| - When the UE is to transmit a 2-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band, then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers, where NTx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}.- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port or 2-port transmission on a carrier on the 3rd band and the UE is under the operation state in which2-port transmission can be supported on the 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band } and for the band pair {2nd band, 3rd band}.- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for band pair{the 2nd band, the 3rd band} then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.- When the UE is to transmit a 1-porttransmission on one uplink carrier on the1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3rd band and/or the 4th band and the UE is under the operation state in which 1-port transmission can be supported in the 3rd and 4th band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band}, band pair {1st band, 4th band}, band pair {2nd band, 3rd band}and band pair {2nd band, 4th band}. |

In the agreement, the discussed case is the switching case highlighted in yellow, and the above “when” bullets correspond to the switching cases highlighted in other colours respectively, which should not be mixed.**Agreement**Following new conditions are applicable to dual UL only (i.e., not applicable to switched UL)* When the UE is to transmit a 1-port or 2-port transmission on one uplink carrier on one band (1st band) and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on other different bands (2nd and 3rd band)
* When the UE is to transmit a 1-port + 1-port transmission each on one uplink carrier on different bands (1st and 2nd band) and if Tx chain state at the preceding uplink transmission is 2T on a carrier on another band (3rd band)
* When the UE is to transmit a 1-port + 1-port transmission each on one uplink carrier on different bands (1st and 2nd band) and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on one of the bands and another different band (1st or 2nd band, and 3rd band)
* When the UE is to transmit a 1-port + 1-port transmission each on one uplink carrier on different bands (1st and 2nd band) and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on other different bands (3rd and 4th band)

For the yellow highlighted switching condition, we suggest to explicitly specify the switching gap determination.1. On capturing the new RAN4 agreements

RAN4 had agreed several optional UE behaviours in RAN4 #107 that UE can additionally report new capability of [uplinkTxSwitchingPeriod1T1Tto2T], [uplinkTxSwitchingPeriod1T1Tto1T1T], or [on-unaffected-band-involved]. RAN4 specification only specifies time mask for Tx switching and is not sufficient to specify the switching gap for the case with sufficient scheduled gap or 4 bands involved, implementing the optional UE capability in RAN1 specification is necessary. In current RAN2 CR, the additional UE capability is indicated by UplinkTxSwitchingAdditionalPeriodDualUL for switching between a band pair and another band pair or another band. The suggestion is to capture the additional UE capability that reports UplinkTxSwitchingAdditionalPeriodDualUL for switching between a band pair and another band pair or another band in TS38.214 for the definition of switching gap NTx1-Tx2.1. On determining the switching period for a band pair

For a band pair in the band combination, when both switching periods for 2Tx-2Tx switching and 1Tx-2Tx switching are reported, RAN4 agreed it is based on RRC configuration per band pair to select the applied switching period. The suggestion is to replace [*uplinkTxSwitchingPeriod*] with “*switchingPeriodFor2T* or *switchingPeriodFor1T*” and add “The switching gap of a band pair is indicated by UE capability *switchingPeriodFor2T* if *switching2TMode* is configured for the band pair, and by *switchingPeriodFor1T* otherwise” in section 6.1.6.2.2.The TP for the CR in our contribution R1-2307629 can be referred. The alignment of the RRC parameter name with RAN2 specification has been taken into account in the proposed TP. |  |
| ZTE | **Issue#1**: switchedUL or dualUL for SULThe contentious sentence is deleted. Is the intention to put aside this issue for now and wait for RANP conclusion?**Issue#2**: Duplicated text between RAN1 TP and RAN4 specAs analysed in our tdoc R1-2306995 (section 3.2), we propose to have some coordination between RAN1 and RAN4 to avoid duplicated text.**Issue#3**: Regarding China Telecom’s 1st comment above, thanks for the follow-up, but we think the addition is not needed as we analysed in our tdoc R1-2306995 (section 3.2, issue#3). The UE first checks the following paragraph, if UE considers this as if 1-port transmission was transmitted on the 3rd band and the band associated with the 3rd band as configured by [AssociatedBand], then UE needs to check the other four switching cases and determine the corresponding switching gap.

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| If the UE is configured with *uplinkTxSwitching-DualUL-TxState* set to 'oneT', when the UE is under the operation state in which 1-port transmission can be supported on one carrier on the 1st band and the 2nd band followed by no transmission on any carrier on these two bands and 1-port transmission on the other carrier on the 3rd band the UE shall consider this as if 1-port transmission was transmitted on the 3rd band and the band associated with the 3rd band as configured by [*AssociatedBand*], otherwise the UE shall consider this as if 2-port transmission took place on the transmitting carrier. |

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| vivo | Comment1Similar to CTC’s comment, the following highlighted text is our understanding of each paragraph, it seems that the CR does not cover the green case in the following agreement, which refers to **band#2 1T+ band#3 1T-> band#1 (1port transmission)**. **Agreement (RAN1#111)**Following new conditions are applicable to dual UL only (i.e., not applicable to switched UL)* When the UE is to transmit a 1-port or 2-port transmission on one uplink carrier on one band (1st band) and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on other different bands (2nd and 3rd band)

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| - If more than two bands are involved in the determination of one uplink switching and if on any two of the bands the UE is configured with [*uplinkTxSwitchingOptionForBandPair*] set to 'dualUL',\*\*understanding: case1. band#2 1T+ band#3 1T-> band#1 2T \*\*- When the UE is to transmit a 2-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}.\*\*understanding: case2. band3 2T-> band1 1T + band2 1T \*\*- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port or 2-port transmission on a carrier on the 3rd band and the UE is under the operation state in which 2-port transmission can be supported on the 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band } and for the band pair {2nd band, 3rd band}.\*\*understanding: case3. band1 1T+ band3 1T-> band1 1T+ band2 1T\*\*- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for band pair{the 2nd band, the 3rd band} then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.\*\*understanding: case4. band#3 1T+ band#4 1T-> band#1 1T+ band#2 1T\*\*- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3rd band and/or the 4th band and the UE is under the operation state in which 1-port transmission can be supported in the 3rd and 4th band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band}, band pair {1st band, 4th band}, band pair {2nd band, 3rd band}and band pair {2nd band, 4th band}. |

Below are three possible switching cases if only 1-port transmission is scheduled on band#1 and if Tx chain state at the preceding uplink transmission is 1T + 1T each on a carrier on other different bands (2nd and 3rd band):1. When ‘twoT’ is configured or when there is no associated band for band#1, the switching case is: band#2 1T + band#3 1T-> band#1 2T (1port transmission),
	1. the corresponding behavior should be the same as case1 (i.e., band#2 1T + band#3 1T-> band#1 2T).
2. When the associated band of band#1 is band#2 or band#3, the switching case is: band#2 1T + band#3 1T->band#1 1T (1port transmission) + band#2 or band#3 1T (no transmission),
	1. the corresponding behavior should be the same as case3 (i.e., band#1 1T+ band#3 1T-> band#1 1T+ band#2 1T).
3. When the associated band of band#1 is band#4, the switching case is: band#2 1T + band#3 1T->band#1 1T (1port transmission) + band#4 1T (no transmission),
	1. the corresponding behavior should be the same as case4 (i.e., band#3 1T+ band#4 1T-> band#1 1T+ band#2 1T).

Thus, we propose the following change to capture the missing case\*\*\*\*change start\*\*\*\*- When the UE is to transmit a 2-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band, or when the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 2nd and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 2nd and 3rd band and if UE consider this as if 2-port transmission took place on the transmitting carrier on the 1st band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 2nd band} and for the band pair {1st band, 3rd band}. - When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port or 2-port transmission on a carrier on the 3rd band and the UE is under the operation state in which 2-port transmission can be supported on the 3rd band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band } and for the band pair {2nd band, 3rd band}.- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st band and/or the 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band, or when the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 1st and/or 3rd band and the UE is under the operation state in which 1-port transmission can be supported in the 1st and 3rd band and if UE consider this as if 1-port transmission was transmitted respectively on the 1st band and the 2nd band, where the 2nd band is configured by [*AssociatedBand*] as the associated band for the 1st band, if UE indicates [*AdvancedCapabilityDefinedbyRAN4*] for the 1st band for band pair{the 2nd band, the 3rd band} then the UE is not expected to transmit for the duration of NTx1-Tx2 on any of the carriers on the 2nd band and the 3rd band, otherwise then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers , where *N*Tx1-Tx2 is the [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {2nd band, 3rd band}.- When the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and the 2nd band, and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3rd band and/or the 4th band and the UE is under the operation state in which 1-port transmission can be supported in the 3rd and 4th band, or when the UE is to transmit a 1-port transmission on one uplink carrier on the 1st band and if the preceding uplink transmission was a 1-port transmission on a carrier on the 3nd and/or 4th band and the UE is under the operation state in which 1-port transmission can be supported in the 3nd and 4th band and if UE consider this as if 1-port transmission was transmitted respectively on the 1st band and the 2nd band, where 2nd band is configured by [*AssociatedBand*] as the associated band for the 1st band, then the UE is not expected to transmit for the duration of *N*Tx1-Tx2 on any of the carriers, where *N*Tx1-Tx2 is the max of [*uplinkTxSwitchingPeriod*] that UE indicates for the band pair {1st band, 3rd band}, band pair {1st band, 4th band}, band pair {2nd band, 3rd band}and band pair {2nd band, 4th band}. |  |
| Qualcomm | Thanks for the great efforts on the lead and promotion.We support #1 of ZTE’s comments. Based on the former discussion, seems the WG could not resolve the diverged views on supported switching scenarios when SUL is included into the band combination.We propose to postpone the post-RAN1 discussion and wait for RAN#101 guidance.We also share the same views on duplicated wording of RAN1 and RAN4 on switching period, which requires RAN1 spec need to dynamically updates based on RAN4 agreement on switching period. We propose to refer to RAN4 spec and remove the duplicated part in RAN1 spec. This might be resolved in future RAN1 meeting, which is different with the above issue. |  |
| Huawei, HiSilicon | **//Comment#1**With respect to ZTE’s comment#1 and Qualcomm commet#1, we all respect all RAN’s agreement. But please respect the 3GPP legacy that any restriction of band combinations are not captured in RAN1 spec unless technical issue is identified. After more one year discussions, there is never single technical reason to put the proposed restriction into RAN1 spec and at least 6 companies have pointed out your misinterpretation of the RAN agreement. **If anything pending on RAN discussion, it would be only whether to add the restriction into RAN4 spec. It should not be the reason to prevent RAN1 from endorsing the stable CR. It is obviously false argument that endorsing the stable CR is not in line with RAN agreement.****//Comment#2**As discussed before, the RAN4 CR has not covered all cases of switching, especially the 4-band case with dualUL. More importantly, the time mask captured in the RAN4 CR only addresses the case where the scheduled gap is less than the switching gap required by the UE. Therefore, the determined switching gap should be captured in RAN1 spec anyway.**//Comment#3**With respect to CTC’s 1st comment, it seems beneficial to explicitly describe the UE behaviour for the following case:* When the UE is to transmit a 1-port on one uplink carrier on one band (1st band) and if the preceding transmission is 1-port on both 2nd band and 3rd band.
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