**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. | #1: There doesn’t seem to be a consensus for this modification. See ZTE’s comment #3. I haven’t made any modification for now.#2: If RAN4 thinks that their agreement should be captured in RAN1 specs, then that would call for an LS from RAN4 to RAN1. Otherwise we’d need a RAN1 agreement to do this. #3: This seems similar to #2, RAN4 has agreed to something. However, isn’t this already covered by the Rel-17 text, where UE can report 1T-2T and 2T-2T for the same band pair, in which case the determination of the applicable gap duration depends on whether *uplinkTxSwitching-2T-Mode* is configured for the band pair or not. So it seems RAN4 has agreed to something RAN1 has already specified inRel-17. |
| 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. |

 | #1: Yes, based on the May RAN1 discussions and the subsequent RAN#100 discussions it seems pointless to discuss this issue until RAN#101 has resolved it. #2: This was discussed also post-RAN1#113. I would suggest [] around the text for now and attempt to resolve the issue in Q4 in coordination with RAN4.#3: Due to differences in views, the CMCC comment #1 has not been implemented. |
| 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}. | #1: There doesn’t seem to be a consensus for this modification. See ZTE’s comment #3. I haven’t made any modification for now. |
| 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. | #1: There is indeed no point rediscussing the same topic again in the WG level. RAN P discussion on the matter would help here!#2: It is very likely we need to postpone this CR to RAN1#114bis /RAN1#115.#3: As commented to ZTE, this was controversial in RAN1#113. I would suggest [] around the text for now and attempt to resolve the issue in Q4 in coordination with RAN4. |
| 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. | #1 I certainly sympathise with your views, I suppose nobody appreciates this deadlock and I really hope some discussion on this topic is going to happen very soon (RANP, RAN1) so we can move forward! From my perspective, I do my best to use every single discussion opportunity in the hope that some change one way or the other, is going to happen...#2 Here we would appreciate some guidance From RAN4 on the official channels, I am sure this is going to happen.#3 It seems not everybody is on the same page with making this change right now so we need to postpone. |

# 3 Discussion – second round

The comments in this section are based on version 1 of the draft CR available in the **Post RAN1#114 discussion.**

Second checkpoint for this discussion:  **is September 6, 9.00 am UTC!**

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| Company | Comments | Editor reply/Notes |
| Apple | Thanks, Mihai, for your great efforts.Just one minor comment related to the text related for minimum separation time. In RAN1#114, we agreed on the FFS related to FG 49-Y. Below is the agreement from RAN1#114 and basically, in our understanding, this means that UE will need to report one of the 2 candidate values. Not sure, if we explicitly need to capture the text for the case, if 0us is reported. **Agreement*** Remove text in “Consequence if the feature is not supported by the UE” for FG49-Y.

Another general comment about the duplication of text between RAN1 and RAN4 specs, we agree with your feedback that this can be handled up on further coordination in the future meetings. |  |
| Qualcomm | Thanks to Mihai for the great efforts to promote.We agree it’s pointless to repeat the discussion on the switching scenarios and beyond this, we have following comments on the rest parts of the CR.1. Switching period location

As pointed by many companies, the agreement misses some switching band pair combinations for below cases. The CR needs some additional sentence to cover these cases.a) The highest priority band is in both “switch-from” and “switch-to” band groupsb). The band with highest priority is not in neither of “switch-from” or “switch-to” band groups.2.Switching behavior by “unaffected band”. Seems there are different understanding on the wording. Given this is from RAN4, if no consensus in RAN1, some clarification might be helpful to better understand the intention and details.3. The “switching period” was agreed in RAN4 and RAN4 make some additional agreement in each meeting. If RAN1 spec also cover similar agreement, it’s hard to align RAN1 and RAN4 spec. We propose to remove unnecessary duplication to make RAN1 spec clean and stable.Based on above considerations, we support to postpone the CR discussion in Oct. meeting. With RAN-P guidance, we could resolve the issue together. |  |
| Nokia, NSB | 1. On the SUL question: In the RAN1#113 we were not able to endorse the CR because of the contentious issue related to simultaneous configuration/transmission of SUL carriers. The situation is now different in the sense that RAN#100 gave itself an action point to address the issue in RAN#101. Given the situation RAN1 should of course continue working on the CR, but it will not be possible to agree to the CR for submission now. RAN1 has to wait for the RAN#101 decision and finalize the CR in Q4 for RAN#102 approval.
2. On the duplication of specification between RAN1 and RAN4. Our preference would be to define the behaviour in 38.214, but we would not have a big issue just referencing RAN4 specs in 38.214 either. For now having the part square-bracketed is fine and we can resolve the possible overlaps in Q4.
3. On the minimum separation time, the current definition should cover the case that FG49-Y is not reported, or FG49-Y reports a different value than 500 us. For clarity we could modify the bullet to say that other values (that is 0 us) does not add any other restirctions (also suggest to change the order of the bullets):

- If two contiguous intra-band uplink carriers are configured to a UE, the UE may assume that the active UL BWPs of the two carriers are configured with the same subcarrier spacing.- The UE does not expect to perform more than one uplink switching in a reference slot with *µUL*, where the *µUL* corresponds to the maximum subcarrier spacing of the active UL BWPs of all the configured uplink carriers.- If 500 µs is determined by the UE capability [*MinSwitchSeparation*], within any two consecutive reference slots corresponding to numerology *µUL*, when the UE first performs one uplink switch and later performs another uplink switch and at least three bands are involved in the transmissions before the first switch, between the first switch and the second switch, and after the second switch, the separation time between the start of all transmission(s) after the first switch and the start of all transmission(s) after the second switch is not expected to be less than 500 µs. If other than 500 µs is determined by the UE capability [*MinSwitchSeparation*], or the capability is not reported by the UE, no additional restrictions apply. |  |
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