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

**Toulouse, France, August 21st – 25th, 2023**

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| *CR-Form-v12.2* |
| **DRAFT CHANGE REQUEST** |
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|  | **38.214** | **CR** | **-** | **rev** | **-** | **Current version:** | **17.6.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Introduction of UL Tx switching across up to 4 bands |
|  |  |
| ***Source to WG:*** | Nokia |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_MC\_enh-Core |  | ***Date:*** | 2023-09-08 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Introduction of specification support for UL Tx Switching across up to 4 bands |
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| ***Summary of change:*** | In clauses 6.1.6 and 6.1.6.2.2 (new), introduced UE procedures to support the uplink switching with 3 or 4 bands. |
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| ***Consequences if not approved:*** | Incomplete specification support for Rel-18 UL Tx switching across up to 4 bands |
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| ***Clauses affected:*** | 6.1.6, 6.1.6.2.0 (new heading), 6.1.6.2.2 (new) |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

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### 6.1.6 Uplink switching

The UE may omit uplink transmission during the uplink switching gap $N\_{Tx1-Tx2}$if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap $N\_{Tx1-Tx2}$is indicated by UE capability *uplinkTxSwitchingPeriod2T2T* if *uplinkTxSwitching-2T-Mode* is configured, and *uplinkTxSwitchingPeriod* otherwise in clauses 6.1.6.1, 6.1.6.2.0, 6.1.6.3, and is determined in clause 6.1.6.2.2 for uplink switching with 3 or 4 uplink bands:

- If a UE indicated a capability for uplink switching with *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination

- Configured with a MCG using E-UTRA radio access and with a SCG using NR radio access (EN-DC), or

- Configured with uplink carrier aggregation, or

- Configured in a serving cell with two uplink carriers with higher layer parameter *supplementaryUplink*.

The conditions under which the switching gap may be present are defined for each of the cases in clauses 6.1.6.1, 6.1.6.2, and 6.1.6.3 respectively.

If an uplink switching is triggered for an uplink transmission starting at *T0*, after *T0-Toffset*, the UE is not expected to cancel the uplink switching, or to trigger any other new uplink switching occurring before *T0* for any other uplink transmission that is scheduled after *T0-Toffset*, where *Toffset* is the UE processing procedure time defined for the uplink transmission triggering the switch given in clause 5.3, clause 5.4, clause 6.2.1, clause 6.4 and in clause 9 of [6, TS 38.213].

The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier before the switching gap and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier after the switching gap.

For uplink switching with 3 or 4 uplink bands

- 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 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.

- 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.

[- For an uplink switch the UE determines the band of the switching period location as defined in [8, TS 38.101-1] based on the configured priority of the bands, where the priority per band is provided by the higher layer parameter [*BandPriorityList*]. The switch is located on either

- the switch-from band(s) if the highest priority band is a switch-to band, or

- the switch-to band(s) if the highest priority band is a switch-from band.]

#### 6.1.6.1 Uplink switching for EN-DC

For a UE indicating a capability for uplink switching with *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination configured with a MCG using E-UTRA radio access and with a SCG using NR radio access (EN-DC), if the UE is configured with uplink switching with parameter *uplinkTxSwitching*,

- for the UE configured with *switchedUL* by the parameter *uplinkTxSwitchingOption*, when the UE is to transmit in the uplink based on DCI(s) received before $T\_{0}-T\_{offset}$or based on a higher layer configuration(s):

- when the UE is to transmit an NR uplink that takes place after an E-UTRA uplink on another uplink carrier then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the two carriers.

- when the UE is to transmit an E-UTRA uplink that takes place after an NR uplink on another uplink carrier then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the two carriers.

- the UE is not expected to transmit simultaneously on the NR uplink and the E-UTRA uplink. If the UE is scheduled or configured to transmit any NR uplink transmission overlapping with an E-UTRA uplink transmission, the NR uplink transmission is dropped,

- for the UE configured with *uplinkTxSwitchingOption* set to 'dualUL'*,* when the UE is to transmit in the uplink based on DCI(s) received before $T\_{0}-T\_{offset}$or based on a higher layer configuration(s):

- when the UE is to transmit an NR two-port uplink that takes place after an E-UTRA uplink on another uplink carrier then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the two carriers.

- when the UE is to transmit an E-UTRA uplink that takes place after an NR two-port uplink on another uplink carrier then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the two carriers.

- the UE is not expected to transmit simultaneously a two- port transmission on the NR uplink and the E-UTRA uplink.

- in all other cases the UE is expected to transmit normally all uplink transmissions without interruptions.

- when the UE is configured with *tdm-PatternConfig* or by *tdm-PatternConfig2*

- for the E-UTRA subframes designated as uplink by the configuration, the UE assumes the operation state in which one-port E-UTRA uplink can be transmitted.

- for the E-UTRA subframes other than the ones designated as uplink by the configuration, the UE assumes the operation state in which two-port NR uplink can be transmitted.

#### 6.1.6.2 Uplink switching for carrier aggregation

##### 6.1.6.2.0 Uplink switching with two uplink bands

For a UE indicating a capability for uplink switching with *BandCombination-UplinkTxSwitch* or *uplinkTxSwitchingPeriod2T2T* for a band combination, and if it is for that band combination configured with uplink carrier aggregation:

- If the UE is configured with uplink switching with parameter *uplinkTxSwitching*, when the UE is to transmit in the uplink based on DCI(s) received before $T\_{0}-T\_{offset}$or based on a higher layer configuration(s):

- When the UE is to transmit a 2-port transmission on one uplink carrier on one band and if the preceding uplink transmission is a 1-port transmission on another uplink carrier on another band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- When the UE is to transmit a 1-port transmission on one uplink carrier on one band and if the preceding uplink transmission is a 2-port transmission on another uplink carrier on another band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- For the UE configured with *uplinkTxSwitchingOption* set to 'switchedUL', when the UE is to transmit a 1-port transmission on one uplink carrier on one band and if the preceding uplink transmission was a 1-port transmission on another uplink carrier on another band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- For the UE configured with *uplinkTxSwitchingOption* set to 'dualUL', when the UE is to transmit a 2-port transmission on one uplink carrier on one band and if the preceding uplink transmission was a 1-port transmission on a carrier on the same band and the UE is under the operation state in which 2-port transmission cannot be supported in the same band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- For the UE configured with *uplinkTxSwitchingOption* set to 'dualUL', when the UE is to transmit a 1-port transmission on one uplink carrier on one band and if the preceding uplink transmission was a 1-port transmission on another uplink carrier on another band and the UE is under the operation state in which 2-port transmission can be supported in the same band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- For the UE configured with *uplinkTxSwitchingOption* set to 'dualUL', if the UE is configured with *uplinkTxSwitching-DualUL-TxState* set to 'oneT', when the UE is under the operation state in which 2-port transmission can be supported on one carrier on one band followed by no transmission on any carrier on the same band and 1-port transmission on the other carrier on another band the UE shall consider this as if 1-port transmission was transmitted on both uplinks, otherwise the UE shall consider this as if 2-port transmission took place on the transmitting carrier.

- If *uplinkTxSwitching-2T-Mode* is configured, when the UE is to transmit a 2-port transmission on one uplink carrier on one band and if the preceding uplink transmission is a 2-port transmission on another uplink carrier on another band, then the UE is not expected to transmit for the duration of $N\_{Tx1-Tx2}$ on any of the carriers.

- The UE is not expected to be scheduled or configured with uplink transmissions that result in simultaneous transmission on two antenna ports on one uplink carrier on one band, and any transmission on another uplink carrier on another band.

- In all other cases the UE is expected to transmit normally all uplink transmissions without interruptions.

##### 6.1.6.2.1 void

##### 6.1.6.2.2 Uplink switching with 3 or 4 uplink bands

For a UE indicating a capability for uplink switching with *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination configured with uplink carrier aggregation with 3 or 4 bands, the behaviour in subclause 6.1.6.2.0 applies when the two bands involved in the uplink switching belong to different uplink serving cells, and the behavior in subclause 6.1.6.3 applies when the two bands involved in the uplink switching belong to one uplink serving cell, with the following exceptions:

- 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',

- 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}.

- 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, 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, 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}.

- The UE is not expected to be scheduled or configured to transmit on more than two uplink bands at any given time.

- If the UE indicated a [*uplinkTxSwitchingOptionForBandPair*] set to ‘DualUL’, or ‘Both’ for a band pair in the band combination, the UE can be configured with *uplinkTxSwitchingOption* set to 'dualUL' for that band pair.

- If the UE indicated a [*uplinkTxSwitchingOptionForBandPair*] set to ‘SwitchedUL’, or ‘Both’ for a band pair in the band combination, the UE can be configured with *uplinkTxSwitchingOption* set to 'switchedUL' for that band pair.

- 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.

- If the UE is configured with *uplinkTxSwitching-DualUL-TxState* set to 'oneT', if a band in the band combination is not configured as dualUL for any band pair it belongs to, when the UE is to transmit a 1-port transmission on a carrier on the band the UE shall consider this as if 2-port transmission took place on the transmitting carrier.

#### 6.1.6.3 Uplink switching with two uplink bands for supplementary uplink

For a UE indicating a capability for uplink switching with *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination configured in a serving cell with two uplink carriers with higher layer parameter *supplementaryUplink*:

- If the UE is configured with uplink switching with parameter *uplinkTxSwitching*,

- If the UE is to transmit any uplink channel or signal on a different uplink on a different band from the preceding transmission occasion based on DCI(s) received before $T\_{0}-T\_{offset}$or based on a higher layer configuration(s), then the UE assumes that an uplink switching is triggered in a duration of switching gap $N\_{Tx1-Tx2}$, where $T\_{0}$ is the start time of the first symbol of the transmission occasion of the uplink channel or signal and $T\_{offset}$ is the preparation procedure time of the transmission occasion of the uplink channel or signal given in clause 5.3, clause 5.4, clause 6.2.1, clause 6.4 and in clause 9 of [6, TS 38.213], respectively. During the switching gap $N\_{Tx1-Tx2}$, the UE is not expected to transmit on any of the two uplinks.

- In all other cases the UE is expected to transmit normally all uplink transmissions without interruptions.

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