**3GPP TSG RAN WG1 #117 R1-24xxxxx**

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

Source: Moderator (NTT DOCOMO, INC.)

Title: Summary of discussion on Multi-carrier UL Tx switching scheme

Agenda Item: 8.1

Document for: Discussion and Decision

1. Introduction

This contribution summarizes contributions submitted to AI 8.1 regarding multi-carrier UL Tx switching scheme and corresponding discussion at RAN1#117 meeting.

Any announcement regarding this summary is provided in following email thread.

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| [117-R18-Maintenance] To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc – Chair |

1. References

[1] R1-2405020 Maintenance on Multi-Carrier Enhancements for NR NTT DOCOMO, INC.

[2] R1-2405228 Draft CR on T\_offset for UL Tx switching ZTE, Apple, CATT, Ericsson, LG Electronics, Nokia, Qualcomm Incorporated, vivo, OPPO

[3] R1-2405311 Corrections on Rel-18 UL Tx switching with two configured bands Huawei, HiSilicon

[4] R1-2405312 Corrections on Rel-18 UL Tx switching period determination Huawei, HiSilicon

[5] R1-2403781 Summary#3 of discussion on Multi-carrier UL Tx switching scheme Moderator (NTT DOCOMO, INC.)

[6] R1-2400007 LS on UL Tx Switching RAN2, Huawei

[7] R1-2401776 Reply LS on UL Tx switching RAN1, NTT DOCOMO, INC.

1. Discussion

## 3.1 Further discussion on RAN2 LS [7]

At the RAN1#116 meeting, RAN1 received a LS from RAN2 in [6], and RAN1 sent a reply LS in [7] based on following RAN1 agreement. RAN1 needs further discussion on yellow highlighted case.

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| **Agreement**  RAN1 replies to RAN2 LS in R1-2400007 as below.   * RAN1 confirms that the first RAN2 agreement in the LS R1-2400007/R2-2313959 has no issue from RAN1 perspective, except for a case where Rel-18 UL Tx switching is configured with band combination {A, B} to a UE reporting support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B. For the case, RAN1 continues to discuss it.   Final LS is in R1-2401776. |

In contributions, following proposals were provided.

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| [1]  NTT DOCOMO, INC. | At the RAN1#116bis meeting, following sub-cases were identified during the discussion [4].   * Sub-case 1-1: UE supporting Rel-18 UL Tx switching supports UL CA (Dual UL) on band A and B with only 1 port support on each band. * Sub-case 1-2: UE supporting Rel-18 UL Tx switching does not support UL CA (Dual UL) on band A and B with only 1 port support on each band, while switched UL operation between band A and B is supported. * Sub-case 2-1: UE supporting Rel-18 UL Tx switching supports Rel-15 SUL operation between SUL band A and corresponding NUL band B with only 1 port support on each band. * Sub-case 2-2: UE supporting Rel-18 UL Tx switching does not support Rel-15 SUL operation between SUL band A and corresponding NUL band B with only 1 port support on each band, while switched UL operation between band A and B is supported.   For sub-case 1-1, there is no reason for NW to configure UL Tx switching with band combination {A, B} in our view. NW will configure UL CA for the band combination {A, B} in this case.  Similarly, NW will configure Rel-15 SUL operation in sub-case 2-1 and there is no reason for NW to configure UL Tx switching.  For sub-cases 1-2 and 2-2, since UL CA or Rel-15 SUL operation is not supported by the UE, there are two alternatives for NW when fallback from 3 or 4 band UL Tx switching for the UE is necessary. One is to configure 1T-1T UL Tx switching between 2 bands, and another is to configure only 1 band for UL.  In addition, if it is mandatory for UE to support UL CA or Rel-15 SUL operation when the UE supports UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B, the sub-cases 1-2 and 2-2 are not possible.  Based on above, RAN1 should down-select one of the following alternative approaches to conclude this issue.  **Alt.1**: 1T-1T UL Tx switching for band combination {A, B} is supported.   * UE can be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.   **Alt.2**: 1T-1T UL Tx switching for band combination {A, B} is not supported.   * 2-1: UE does not expect to be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.   + Note: In the Alt.2-1, UE would be configured with single UL band in sub-cases 1-2/2-2. * 2-2: UE is required to support UL CA or Rel-15 SUL operation when the UE supports UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.   + Note: In the Alt.2-2, sub-cases 1-2/2-2 are not possible, and RAN1 should ask RAN2 for final confirmation.   **Proposal 3: RAN1 should down-select one of the following alternative approaches to conclude this issue.**  **Alt.1: 1T-1T UL Tx switching for band combination {A, B} is supported.**   * **UE can be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   **Alt.2: 1T-1T UL Tx switching for band combination {A, B} is not supported.**   * **2-1: UE does not expect to be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   + **Note: In the Alt.2-1, UE would be configured with single UL band in sub-cases 1-2/2-2.** * **2-2: UE is required to support UL CA or Rel-15 SUL operation when the UE supports UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   + **Note: In the Alt.2-2, sub-cases 1-2/2-2 are not possible, and RAN1 should ask RAN2 for final confirmation.**   After solving the issue on whether to support 1T-1T switching with only 2 bands, RAN1 should inform the decision to RAN2 and RAN2 agreement should be reflected to TS38.214 to allow configuring Rel-18 parameters even when only 2 bands are configured for UL Tx switching.  According to the discussion at the RAN1#116bis meeting, following TP is enough to reflect the RAN2 agreement.  **Proposal 4: RAN1 should agree on the following TP after solving the issue on whether to support 1T-1T switching with only 2 bands.**  **Reason for change:**  Capture in TS 38.214 the RAN2 agreements of configuring two bands uplink switching by Rel-18 configuration signaling.  **Summary of change:**  Replace “3 or 4 uplink bands” by “up to 4 uplink bands” in section 6.1.6 and 6.1.6.2.2.  **Consequence if not approved:**  Rel-18 configuration signaling cannot be used for the case of configuring two bands uplink switching.   |  | | --- | | **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------**  6.1.6 Uplink switching  The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap 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 based on UE capability *uplinkTxSwitchingPeriodForBandPair* in clause 6.1.6.2.2 for uplink switching with up to 4 uplink bands if *UplinkTxSwitchingMoreBands* is configured:  - 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.  *< Unchanged parts are omitted >*  6.1.6.2.2 Uplink switching with up to 4 uplink bands  *< Unchanged parts are omitted >*  **----------------------------------------------- *TP* *end*------------------------------------------------** | |
| [3]  Huawei, HiSilicon | **Reason for change:**  Capture in TS 38.214 the following RAN2 and RAN1 agreements of configuring two bands uplink switching by Rel-18 configuration signaling.   |  | | --- | | R1-2400007/R2-2313959:  For Rel-18 UL Tx switching, RAN2 achieved the following agreements in RAN2 #124 meeting:   * 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. |  |  | | --- | | R1-2401776:  RAN1 confirms that the first RAN2 agreement in the LS R1-2400007/R2-2313959 has no issue from RAN1 perspective, except for a case where Rel-18 UL Tx switching is configured with band combination {A, B} to a UE reporting support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B. For the case, RAN1 continues to discuss it. |   **Summary of change:**  Replace the phrase of “with 3 or 4 uplink bands” with “with up to 4 uplink bands”  **Consequence if not approved:**  Incomplete specification on uplink Tx switching with two configured bands.   |  | | --- | | **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------**  6.1.6 Uplink switching  The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching or UplinkTxSwitchingMoreBands*. The switching gap 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 based on UE capability *uplinkTxSwitchingPeriodForBandPair* in clause 6.1.6.2.2 for uplink switching with up to 4 uplink bands if *UplinkTxSwitchingMoreBands* is configured:  - 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.  < Unchanged parts are omitted >  6.1.6.2.2 Uplink switching with up to 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 up to 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 with the parameters *uplinkTxSwitching*, *uplinkTxSwitchingOption* and *uplinkTxSwitching-2T-Mode* beingreplaced by *UplinkTxSwitchingMoreBands, switchingOptionConfigForBandPair* and *switching2T-Mode,* respectively, and the behaviour in subclause 6.1.6.3 with the parameter *uplinkTxSwitching* being replaced by *UplinkTxSwitchingMoreBands* 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 *switchingOptionConfigForBandPair* set to 'dualUL',  < Unchanged parts are omitted >  **----------------------------------------------- *TP* *end*------------------------------------------------** | |

This issue was extensively discussed at RAN1#116bis meeting, and there were companies’ views that RAN1 should make decision on whether/how to handle concerned scenario of 1T-1T switching with only 2 bands before capturing RAN2 agreement into RAN1 specification [5]. Therefore, before discussing TPs in [1] and [3], RAN1 should discuss whether/how to handle the concerned scenario e.g., based on the proposal 3 in [1].

### **Proposed agreement 3.1-1**

**RAN1 should down-select one of the following alternative approaches to conclude this issue.**

**Alt.1: 1T-1T UL Tx switching for band combination {A, B} is supported.**

* **UE can be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**

**Alt.2: 1T-1T UL Tx switching for band combination {A, B} is not supported.**

* **2-1: UE does not expect to be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**
  + **Note: In the Alt.2-1, UE would be configured with single UL band in sub-cases 1-2/2-2.**
* **2-2: UE is required to support UL CA or Rel-15 SUL operation when the UE supports UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**
  + **Note: In the Alt.2-2, sub-cases 1-2/2-2 are not possible, and RAN1 should ask RAN2 for final confirmation.**

Note:

* Sub-case 1-1: UE supporting Rel-18 UL Tx switching supports UL CA (Dual UL) on band A and B with only 1 port support on each band.
* Sub-case 1-2: UE supporting Rel-18 UL Tx switching does not support UL CA (Dual UL) on band A and B with only 1 port support on each band, while switched UL operation between band A and B is supported.
* Sub-case 2-1: UE supporting Rel-18 UL Tx switching supports Rel-15 SUL operation between SUL band A and corresponding NUL band B with only 1 port support on each band.
* Sub-case 2-2: UE supporting Rel-18 UL Tx switching does not support Rel-15 SUL operation between SUL band A and corresponding NUL band B with only 1 port support on each band, while switched UL operation between band A and B is supported.

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| Company | Comment |
| Huawei, HiSilicon | A simple and complete solution for fallback operation has been provided by RAN2 LS. As requested by RAN2 LS, the question is not whether RAN1 like it or not but whether any technical issue is identified. There is no technical issue to revert RAN2 agreement. Therefore, the discussion point should not be whether RAN2 solution is supported or not.  Additionally, it is so clear that the current RAN1 spec supports RAN2 agreement and only a simple text change “with up to 4 uplink” is needed.  If companies prefer to mandate UEs to support normal UL-CA for a band pair supporting dualUL and force gNBs to configure normal UL-CA for such fallback operation, we are open for it. But It does not make sense to mandate UEs to support zero gap switching for a band pair supporting “switchedUL” for UL-CA or SUL simply because the UE reports switchedUL to indicate that a gap is needed for 1port-1port operation otherwise dualUL is reported.  Instead of reverting RAN2 agreement without technical reasoning, a better way is a follow-up of last meeting discussion on UE capability reporting for fallback operation, therefore, a revised propocal could be  ***Revised proposal:***  *For the concerned two-band case in reply LS R1-2401776,*   * *there is no technical issue identified for the case if “switchedUL” is reported for the band pair of the two bands.* * *If “duaUL” is reported for the band pair, in RAN1 understanding, the UE is mandated to report support of normal UL-CA for the band pair. If it is confirmed by RAN2, then the UE is not expected to be configured with dualUL of UL Tx switching for the band pair.* |
| ZTE | Based on the previous discussion in RAN1#116bis meeting, companie assume hold different assumptions on the number of UE Tx chains for this issue, i.e., some companies assume this proposal is for the UE with only 1 Tx chain, while others assume this proposal is for the UE with 2 Tx chains.  However, according to the following agreements made in RAN1#111, UE with only 1 Tx chain is not expected to perform UL Tx switching.  **Agreement (RAN1#111)**  There is no restriction on number of bands supporting up to 2 ports UL transmission for both switched UL and dual UL and for both 3 bands and 4 bands.   * It is up to UE capability to support 2 ports UL transmission on none/some/all of the 3 or 4 bands * Note: UE with only 1 Tx chain is not expected to perform UL Tx switching (no spec impact)   Thus, we propose to clarify the FL proposal as following. **Proposed agreement 3.1-1 (updated by ZTE)** **For UE with 2 Tx chains, RAN1 should down-select one of the following alternative approaches to conclude this issue.**  **Alt.1: 1T-1T UL Tx switching for band combination {A, B} is supported.**   * **UE can be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   **Alt.2: 1T-1T UL Tx switching for band combination {A, B} is not supported.**   * **2-1: UE does not expect to be configured with 2 bands UL Tx switching for band combination {A, B} when UE reports the support of UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   + **Note: In the Alt.2-1, UE would be configured with single UL band in sub-cases 1-2/2-2.** * **2-2: UE is required to support UL CA or Rel-15 SUL operation when the UE supports UL Tx switching for band combination {A, B, C} /{A, B, C, D} and no UL-MIMO on band A nor band B.**   + **Note: In the Alt.2-2, sub-cases 1-2/2-2 are not possible, and RAN1 should ask RAN2 for final confirmation.**   **Note: UE with only 1 Tx chain is not expected to perform UL Tx switching (no spec impact)**  We are open to discuss the 1T-1T switching for UE with only 1Tx chain if majority companies have interests on this topic. But we should at least make it clear whether the intention is to cover this case or not. |
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### **(Pending) Proposed agreement 3.1-2**

* Agree on following TP

**Reason for change:**

Capture in TS 38.214 the RAN2 agreements of configuring two bands uplink switching by Rel-18 configuration signaling.

**Summary of change:**

Replace “3 or 4 uplink bands” by “up to 4 uplink bands” in section 6.1.6 and 6.1.6.2.2.

**Consequence if not approved:**

Rel-18 configuration signaling cannot be used for the case of configuring two bands uplink switching.

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| **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------**  6.1.6 Uplink switching  The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap 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 based on UE capability *uplinkTxSwitchingPeriodForBandPair* in clause 6.1.6.2.2 for uplink switching with up to 4 uplink bands if *UplinkTxSwitchingMoreBands* is configured:  - 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.  *< Unchanged parts are omitted >*  6.1.6.2.2 Uplink switching with up to 4 uplink bands  *< Unchanged parts are omitted >*  **----------------------------------------------- *TP* *end*------------------------------------------------** |

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| Company | Comment |
| Ericsson | The proposed TP causes conflict in the specification:   * Basically, the TP causes in this there is double specification for 2 band cases. * It also conflicts with the statemention follow-up the change “if *UplinkTxSwitchingMoreBands* is configured:”.   Moreover, checking carefully the agreement and spec, it seems no spec change is needed.  The way I understand the agreement is that:   * UE indicates its capability for UL Tx switching on 3 or 4 bands. * NW **configures** the UE with UL TX switching for 2 bands.   So, the question is whether the agreement implies the NW configures the UE with *UplinkTxSwitchingMoreBands*. It seems that is not the case and hence , not clear if any TP is needed. |
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## 3.2 TP for clarifying Toffset

In contributions, following proposal was provided.

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| [2]  ZTE, Apple, CATT, Ericsson, LG Electronics, Nokia, Qualcomm Incorporated, vivo, OPPO | **Reason for change:**  In RAN1#116 meeting, the following agreements were agreed.   |  | | --- | | **Agreement**   * Agree on following TP   --------------------------------------- TP of TS 38.214 start----------------------------------------  6.1.6 Uplink switching  < Unchanged parts are omitted >  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  - determined based on the switching gap defined for a single Tx switching in [8, TS 38.101-1] when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain,  - 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], otherwise.  < Unchanged parts are omitted >  ----------------------------------------------- TP end------------------------------------------------ |   The Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch. The UE processing procedure time may be different in case of one single Tx switching or two Tx switchings, e.g., in section 6.4 of TS38.214, Tswitch is considered in the calculation of PUSCH preparation procedure time.  The intention of the above TP is to reflect that, for the concerned switching case “the two Tx chains triggered to switch between two different band pairs (e.g., band A + band B -> band C+ band D)”, Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch **and a single Tx switching is assumed**. However, the current when-otherwise structure of the above TP delivery a different meaning, i.e., the Toffset is determined based on the switching gap defined for a single Tx switching. In other words, following the above TP, the Toffset is the switching gap instead of the UE processing procedure time.  **Summary of change:**  Clarify that, for the concerned switching case, Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch **and a single Tx switching is assumed**.  **Consequence if not approved:**  The definition of Toffset is not correct for the concerned switching case.   |  | | --- | | **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------** 6.1.6 Uplink switching The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap 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 based on UE capability *uplinkTxSwitchingPeriodForBandPair* 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(s) 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 switching gap defined for a single Tx switching in [8, TS 38.101-1] is assumed when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain.  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 configured with 3 or 4 uplink bands  - 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 *uplinkTxSwitchingMinimumSeparationTime*, when within any two consecutive reference slots corresponding to numerology *µUL*,  - 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 *uplinkTxSwitchingMinimumSeparationTime*, no additional restrictions apply.  - If an uplink switching is triggered for uplink transmission(s) with a gap between the start of the first uplink transmission(s) and the end of the last preceding uplink transmission(s) that is smaller than the determined switching gap , the UE determines the band of the switching period location, defined in [8, TS 38.101-1] based on the priority of the bands configured by *uplinkTxSwitchingBandList*. Among the bands either in switch-from or switch-to bands but not both, 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.  **----------------------------------------------- *TP* *end*------------------------------------------------** | |

This issue was discussed at the RAN1#116bis meeting [5]. Based on above, as the issue on current text based on RAN1#116 agreement is clarified, the proposal can be discussed.

### **Proposed agreement 3.2-1**

* Agree on following TP

**Reason for change:**

In RAN1#116 meeting, the following agreements were agreed.

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| **Agreement**   * Agree on following TP   --------------------------------------- TP of TS 38.214 start----------------------------------------  6.1.6 Uplink switching  < Unchanged parts are omitted >  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  - determined based on the switching gap defined for a single Tx switching in [8, TS 38.101-1] when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain,  - 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], otherwise.  < Unchanged parts are omitted >  ----------------------------------------------- TP end------------------------------------------------ |

The Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch. The UE processing procedure time may be different in case of one single Tx switching or two Tx switchings, e.g., in section 6.4 of TS38.214, Tswitch is considered in the calculation of PUSCH preparation procedure time.

The intention of the above TP is to reflect that, for the concerned switching case “the two Tx chains triggered to switch between two different band pairs (e.g., band A + band B -> band C+ band D)”, Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch **and a single Tx switching is assumed**. However, the current when-otherwise structure of the above TP delivery a different meaning, i.e., the Toffset is determined based on the switching gap defined for a single Tx switching. In other words, following the above TP, the Toffset is the switching gap instead of the UE processing procedure time.

**Summary of change:**

Clarify that, for the concerned switching case, Toffset is the UE processing procedure time defined for the uplink transmission triggering the switch **and a single Tx switching is assumed**.

**Consequence if not approved:**

The definition of Toffset is not correct for the concerned switching case.

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| **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------** 6.1.6 Uplink switching The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap 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 based on UE capability *uplinkTxSwitchingPeriodForBandPair* 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(s) 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 switching gap defined for a single Tx switching in [8, TS 38.101-1] is assumed when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain.  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 configured with 3 or 4 uplink bands  - 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 *uplinkTxSwitchingMinimumSeparationTime*, when within any two consecutive reference slots corresponding to numerology *µUL*,  - 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 *uplinkTxSwitchingMinimumSeparationTime*, no additional restrictions apply.  - If an uplink switching is triggered for uplink transmission(s) with a gap between the start of the first uplink transmission(s) and the end of the last preceding uplink transmission(s) that is smaller than the determined switching gap , the UE determines the band of the switching period location, defined in [8, TS 38.101-1] based on the priority of the bands configured by *uplinkTxSwitchingBandList*. Among the bands either in switch-from or switch-to bands but not both, 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.  **----------------------------------------------- *TP* *end*------------------------------------------------** |

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| Company | Comment |
| Huawei, HiSilicon | Thanks for the proposal and keeping the legacy UE behavior of T\_offset unchanged.  With the proposed change, the sentence “*The switching gap defined for a single Tx switching in [8, TS 38.101-1] is assumed when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain.*” should be deleted for the following reasons,   * Switching gaps have been defined in S6.1.6.2.2 for all cases of dualUL. * A new switching gap defined by the sentence overlaps with the existing switching gaps, implying two different values of switching gap for the same dualUL operation. Such overlap should be avoided, i.e. only one UE behavior in term of switching gap should be specified. * If any correction to switching gap for dualUL deems necessary, better to specify it in S6.1.6.2.2 or simply in RAN4 spec so that it makes sure that all spec texts impacted by switching gaps, e.g. UE processing time, are impacted by the same specified switching gaps. |
| ZTE | @Huawei, it is clear the draft CR doesn’t introduce any new switching case. The concerned switching case for above draft CR is A🡪B+C or A+B 🡪 C+D, both of these two switching cases have already been captured in the S6.1.6.2.2.  S6.1.6.2.2 doesn’t specify whether one Tx switching instance or two Tx switching instances should be considered for A🡪B+C or A+B 🡪 C+D under the condition “when the Tx switching involves more than two bands, and there are at least two UL transmissions after switching on two switch-to bands that trigger the uplink switching, which are at least partially overlapped in time domain”. The previous agreement and the current draft CR is trying to clarify this. |
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## 3.3 TP for Rel-18 UL Tx switching period determination

In contributions, following proposal was provided.

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| [4]  Huawei, HiSilicon | **Reason for change:**  In the following RAN2 #125 agreement for R18 uplink Tx switching, the effective switching gap is determined based on RRC parameter instead of UE capability:   * *To refine the RAN4 agreed RRC configuration as below: For each band pair, a RRC parameter is introduced to configure switching period value between value 35 us and 140 us. When the RRC parameter is absent, 210us is applied.*   TS 38.331   |  | | --- | | ***switchingPeriodConfigForBandPair***  Indicates the value of switching period for the band pair as specified in TS 38.214 [19], clause 6.1.6. Value *n35us* represents 35 us, *n140us* represents 140us. If the field is absent, 210 us is applied. |   **Summary of change:**  For R18 uplink Tx switching, the switching gap is determined based on RRC parameter *switchingPeriodConfigForBandPair*.  **Consequence if not approved:**  Not in line with RAN2 specifications   |  | | --- | | **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------**  6.1.6 Uplink switching  The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching or UplinkTxSwitchingMoreBands*. The switching gap 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 based on higher layer parameter *switchingPeriodConfigForBandPair* in clause 6.1.6.2.2 for uplink switching with 3 or 4 uplink bands if *UplinkTxSwitchingMoreBands* is configured:  - 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.  < Unchanged parts are omitted >  **----------------------------------------------- *TP* *end*------------------------------------------------** | |

Based on above, it seems just a reflection of RAN2 agreement and hence the proposal can be discussed.

### **Proposed agreement 3.3-1**

* Agree on following TP

**Reason for change:**

In the following RAN2 #125 agreement for R18 uplink Tx switching, the effective switching gap is determined based on RRC parameter instead of UE capability:

* *To refine the RAN4 agreed RRC configuration as below: For each band pair, a RRC parameter is introduced to configure switching period value between value 35 us and 140 us. When the RRC parameter is absent, 210us is applied.*

TS 38.331

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| ***switchingPeriodConfigForBandPair***  Indicates the value of switching period for the band pair as specified in TS 38.214 [19], clause 6.1.6. Value *n35us* represents 35 us, *n140us* represents 140us. If the field is absent, 210 us is applied. |

**Summary of change:**

For R18 uplink Tx switching, the switching gap is determined based on RRC parameter switchingPeriodConfigForBandPair.

**Consequence if not approved:**

Not in line with RAN2 specifications

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| **--------------------------------------- *TP of TS38.214* *start*-----------------------------------------**  6.1.6 Uplink switching  The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching or UplinkTxSwitchingMoreBands*. The switching gap 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 based on higher layer parameter *switchingPeriodConfigForBandPair* in clause 6.1.6.2.2 for uplink switching with 3 or 4 uplink bands if *UplinkTxSwitchingMoreBands* is configured:  - 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.  < Unchanged parts are omitted >  **----------------------------------------------- *TP* *end*------------------------------------------------** |

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| Company | Comment |
| Ericsson | Agree that the behaviour should be based on the configuration (that respects the reported capability by the UE).  With this change, I also think the spec becomes more clear and the TP proposed in section 3.1-2 is not needed. |
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1. Conclusion

TBD