**3GPP TSG-RAN WG4 Meeting #97-e R4-200XXXX**

**Electronic Meeting, 2-13 Nov., 2020**

**Agenda item:** 12.2.2.2, 12.2.2.3

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [97e][134] NR\_RF\_FR1\_enh\_Part\_2

**Document for:** Information

# Introduction

This email thread discusses the RF requirements on Rel-17 Tx switching enhancement for inter-band SUL and uplink CA, including:

* Topic #1: 2Tx-2Tx switching between carrier 1 and carrier 2 (discussed in section 1)
* Topic #2: 1Tx-2Tx and 2Tx-2Tx switching between band A and band B, with 2 contiguous aggregated carriers on band B (discussed in section 2)

List of candidate target of email discussion for 1st round and 2nd round:

* 1st round: Invite companies to review the recommended WF in each sub-topic, and provide comments (if any) directly under each issue in section 1.2 and 2.2.
* 2nd round: TBA

# Topic #1: 2Tx switching between carrier 1 and carrier 2

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014717 | Qualcomm Incorporated | Observation: No new time masks are needed compared to the Rel-16 version of the switched tx feature.  Proposal: Rel-17 version of switched tx can re-use switching period capabilities from Rel-16. |
| R4-2014739 | CMCC | Observation 1: time mask requirement including switching period is band agnostic.  Proposal 1: R16 time mask requirements could still apply for 2Tx (1 carrier)-> 2Tx (1 carrier) switching scenario.  Proposal 2: to enhance UL capacity, it is suggested all the following band combinations could support SUL cases 1,2,3 and related switching scenarios in R17.   * Band n80 + Band n41 or n79 * Band n81 + Band n41 or n79 * Band n95+ Band n41 or n79 * Band n97+ Band n41 or n79 * Band n98+ Band n41 or n79   Proposal 3: to enhance UL capacity, it is suggested all the following band combinations could support CA cases 1,2,3 and related switching scenarios in R17.   * Band n3 + Band n41 or n79 * Band n8 + Band n41 or n79 * Band n39+ Band n41 or n79 * Band n40+ Band n41 or n79 * Band n41+ Band n79 |
| R4-2015182 | ZTE Wistron Telecom AB | Observation 1: For UL Tx switching in Rel-16, one of the two Tx chains can remain unchanged during UL Tx switching operation.  Proposal 1: RAN4 specify one set of requirements applicable for both modes of 2Tx switching.   * Both modes are option 1 and option 2.   Proposal 2: Switching period is configurable at either carrier #1 or carrier #2.  Proposal 3: When specifying the length of switching period for 2Tx switching, TAE between two Tx chains should be taken into account. |
| R4-2015197 | China Telecom | Proposal 1: Allow different capabilities for length of switching period for 2Tx switching between carrier 1 and carrier 2.  Proposal 2: Semi-statically configure the switching period on one of the two uplink carriers for 2Tx switching between carrier 1 and carrier 2.  Proposal 3: Define different capabilities for UEs with and without DL interruption for 2Tx switching between carrier 1 and carrier 2. |
| R4-2015262 | Xiaomi | Observation 1: there may be multiple kinds of switching periods between different cases for UL TX switching period in release 17.  Proposal 1: For the UL Tx switching enhancement in R17, it should be decided whether it is enough to report only one switching period or not for all cases as shown in table 2.  Table 2: Tx switching cases in Rel 17 based on uplink CA band combination   |  |  | | --- | --- | |  | Number of Tx chains in WID (carrier 1 + carrier 2) | | Case 1 | 1T+1T | | Case 2 | 0T+2T | | Case 3 | 2T+0T | |
| R4-2015283 | Huawei, HiSilicon | Proposal 1: Specify 35us, 140us and 210us as the options from which a UE choose to report its capability of switching period for Tx switching between 2Tx carriers in Rel-17, which is to reuse the values defined in Rel-16 for 1Tx – 2Tx switching.  Proposal 2: Reuse Rel-16 mechanism on location of the switching periods in Rel-17 for UE Tx switching between 2Tx carriers. |
| R4-2015325 | vivo | Observation: The basic requirements impact and structure for Rel-17 switching is similar to Rel-16 Tx switching.  Proposal 1: The Rel-16 number of the location of the UL switching period requirement can be kept or at least used as baseline for Rel-17.  Proposal 2: The Rel-16 requirements for DL reception interruption, including the interruption length, signalling scheme, applicability etc. could be reused or at least used as baseline for Rel-17.  Proposal 3: Further consider power class stability and alignment in Rel-17 based on Rel-16 solution. At least consider further refinement of power boost in inter-band case and the impact of introduction of HPUE in Rel-17 UL CA.  Proposal 4: Further consider the UL-MIMO and transmission rank related clarifications in Rel-17 based on Rel-16. |
| R4-2015355 | OPPO | *Observation 1: In Rel-16, the “Tx” in cases means Tx chain ability* *which can be further configured by NW for Tx transmission, but this interpretation seems have no impact to RAN4 requirement definition.*  *Observation 2: In Rel-17, two general scenarios are included, i.e. switch between 2Tx at low band and 2Tx at high band, switch between 1CC at low band and 2 contiguous CC at high band*  *Observation 3: Switching between case1/2, between case2/3, among case1/2/3 are also listed in WID, however, there is no much difference among these scenarios in terms of switching time requirements and can be considered together.*  *Observation 4: The UE architecture for Tx switching from Rel-16 to Rel-17 is minor, and the switching time for Rel-16 can be reused.*  *Proposal 1: It is proposed to reuse the Rel-16 time mask for Tx switching scenarios in Rel-17.* |

## Open issues summary

Open issues for 2Tx-2Tx switching between carrier 1 and carrier 2 are summarized below:

### Sub-topic 1-1: Switching time mask related requirements

**Issue 1-1-1: Length of switching period**

* Proposals
  + Option 1: Reuse Rel-16 values for UL CA and SUL, i.e., report {35us, 140 us, or 210us} per pair of UL bands per band combination, and apply the same set of values for switching between different cases in the WID (QC, CMCC, Huawei, HiSilicon, vivo, OPPO)
  + Option 2: TAE between two Tx chains should be taken into account for 2Tx switching (ZTE)
  + Option 3: Decide whether it is enough to report only one switching period or not for all cases. (Xiaomi)
* Recommended WF
  + Given no substantial technical issues identified, can we agree option 1?

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| **Company** | **Comments** |
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**Issue 1-1-2: Location of switching period**

* Proposals
  + Option 1: Reuse Rel-16 agreement for UL CA and SUL, i.e., semi-statically configure the switching period on one of the two uplink carriers (CMCC, ZTE, CTC, Huawei, HiSilicon, OPPO, vivo)
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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**Issue 1-1-3: Transient period**

* Proposals
  + Option 1: Reuse Rel-16 agreement for UL CA and SUL, i.e., 2x10 us transient period in addition to the switching period (CMCC, OPPO)
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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**Issue 1-1-4: UL outage due to switching**

* Proposals
  + Option 1: Reuse Rel-16 agreement, i.e., UL outage due to switching is applicable to both carrier 1 and carrier 2
    - *Note:* the Rel-16 agreement can be found in slide #3 of [R4-1913041](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_92Bis/Docs/R4-1913041.zip).
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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### Sub-topic 1-2: Applicability of DL interruption

**Issue 1-2: Applicability of DL interruption**

* Proposals
  + Option 1 (CTC, vivo): Reuse Rel-16 agreement, i.e.,
    - For SUL+TDD and TDD+TDD CA with the same UL-DL pattern, DL interruption is not required.
    - For the other duplex mode combinations, define different capabilities for UEs with and without DL interruption.
      * UE capability is defined as per band per band combination for each band pair supporting UL Tx switching.
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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### Sub-topic 1-3: Other aspcets

**Issue 1-3-1: Power boosting for PC3 UL CA**

* Background: Rel-16 agreement on power boosting for PC3 UL CA ([RP-201365](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-201365.zip))
  + *….*
  + *In the CR, the power boosting for carrier 2 with 2Tx is only applied to PC3 CA, i.e., not applied to PC2 CA (the same per BC power class, i.e. PC3 in this case is applied regardless of transmission in Case 1 or Case 2).*
* Proposals
  + Proposal 1: Further consider power class stability and alignment in Rel-17 based on Rel-16 solution. At least consider further refinement of power boost in inter-band case and the impact of introduction of HPUE in Rel-17 UL CA (vivo)
* Recommended WF
  + Encourage more companies’ feedback on:
    - With PC2 introduced for inter-band UL CA in Rel-17, is power boosting still needed for PC3 UL CA with Rel-17 2Tx-2Tx switching?

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| **Company** | **Comments** |
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**Issue 1-3-2: 2-layer MIMO support**

* *Background: Rel-16 description on 2-layer MIMO support for carrier 2 in TS 38.101-1:*
  + *….both single layer and two-layer transmission with 2 antenna ports, and single layer transmission with 1 antenna port shall be supported on NR UL carrier 2…*
* Proposals
  + Proposal 1: Further consider the UL-MIMO and transmission rank related clarifications in Rel-17 based on Rel-16. (vivo)
* Recommended WF
  + Encourage more companies’ feedback on:
    - For carrier 1 in 2Tx-2Tx switching, is it mandatory or optional to support 2-layer PUSCH transmission?
    - For carrier 2 in 2Tx-2Tx switching, can we reuse the above agreement in Rel-16, i.e., mandatory to support 2-layer PUSCH transmission?

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| **Company** | **Comments** |
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## Companies views’ collection for 1st round

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

## Summary on 2nd round

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Tx switching between band A and band B

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014717 | Qualcomm Incorporated | *(The same proposals for band B with single carrier or two contiguous aggregated carriers)*  Observation: No new time masks are needed compared to the Rel-16 version of the switched tx feature.  Proposal: Rel-17 version of switched tx can re-use switching period capabilities from Rel-16. |
| R4-2014739 | CMCC | *(The same proposals for band B with single carrier or two contiguous aggregated carriers)*  Observation 1: time mask requirement including switching period is band agnostic.  Proposal 1: R16 time mask requirements could still apply for 2Tx (1 carrier)-> 2Tx (1 carrier) switching scenario.  Proposal 2: to enhance UL capacity, it is suggested all the following band combinations could support SUL cases 1,2,3 and related switching scenarios in R17.   * Band n80 + Band n41 or n79 * Band n81 + Band n41 or n79 * Band n95+ Band n41 or n79 * Band n97+ Band n41 or n79 * Band n98+ Band n41 or n79   Proposal 3: to enhance UL capacity, it is suggested all the following band combinations could support CA cases 1,2,3 and related switching scenarios in R17.   * Band n3 + Band n41 or n79 * Band n8 + Band n41 or n79 * Band n39+ Band n41 or n79 * Band n40+ Band n41 or n79 * Band n41+ Band n79 |
| R4-2015198 | China Telecom | *(The same proposals for band B with single carrier or two contiguous aggregated carriers)*  Proposal 1: Allow different capabilities for length of switching period for Tx switching between 1 carrier on band A and 2 contiguous aggregated carriers on band B.  Proposal 2: Semi-statically configure the switching period on one of the two uplink carriers for Tx switching between 1 carrier on band A and 2 contiguous aggregated carriers on band B.  Proposal 3: Define different capabilities for UEs with and without DL interruption for Tx switching between 1 carrier on band A and 2 contiguous aggregated carriers on band B. |
| R4-2015325 | vivo | *(The same proposals for band B with single carrier or two contiguous aggregated carriers)*  Observation: The basic requirements impact and structure for Rel-17 switching is similar to Rel-16 Tx switching.  Proposal 1: The Rel-16 number of the location of the UL switching period requirement can be kept or at least used as baseline for Rel-17.  Proposal 2: The Rel-16 requirements for DL reception interruption, including the interruption length, signalling scheme, applicability etc. could be reused or at least used as baseline for Rel-17.  Proposal 3: Further consider power class stability and alignment in Rel-17 based on Rel-16 solution. At least consider further refinement of power boost in inter-band case and the impact of introduction of HPUE in Rel-17 UL CA.  Proposal 4: Further consider the UL-MIMO and transmission rank related clarifications in Rel-17 based on Rel-16. |
| R4-2015355 | OPPO | *(The same proposals for band B with single carrier or two contiguous aggregated carriers)*  *Observation 1: In Rel-16, the “Tx” in cases means Tx chain ability* *which can be further configured by NW for Tx transmission, but this interpretation seems have no impact to RAN4 requirement definition.*  *Observation 2: In Rel-17, two general scenarios are included, i.e. switch between 2Tx at low band and 2Tx at high band, switch between 1CC at low band and 2 contiguous CC at high band*  *Observation 3: Switching between case1/2, between case2/3, among case1/2/3 are also listed in WID, however, there is no much difference among these scenarios in terms of switching time requirements and can be considered together.*  *Observation 4: The UE architecture for Tx switching from Rel-16 to Rel-17 is minor, and the switching time for Rel-16 can be reused.*  *Proposal 1: It is proposed to reuse the Rel-16 time mask for Tx switching scenarios in Rel-17.* |

## Open issues summary

Open issues for 1Tx-2Tx and 2Tx-2Tx switching between band A and band B (with 2 contiguous aggregated carriers on band B) are summarized below:

### Sub-topic 2-1: Switching time mask related requirements

**Issue 2-1: Switching time mask related requirements**

* Proposals
  + Option 1: For switching time mask related requirements for inter-band SUL and CA (including the length of switching period, location of switching period, transient period and uplink outage due to switching), the same agreements are applied for the scenarios with either one carrier or two contiguous aggregated carriers on band B (QC, CMCC, CTC, vivo, OPPO)
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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### Sub-topic 2-2: Applicability of DL interruption

**Issue 2-2: Applicability of DL interruption**

* Proposals
  + Option 1 (CTC, vivo): The same agreements are applied for the scenarios with either one carrier or two contiguous aggregated carriers on band B, i.e.,
    - For SUL+TDD and TDD+TDD CA with the same UL-DL pattern, DL interruption is not required.
    - For the other duplex mode combinations, define different capabilities for UEs with and without DL interruption.
      * UE capability is defined as per band per band combination for each band pair supporting UL Tx switching.
* Recommended WF
  + Can we agree option 1?

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| **Company** | **Comments** |
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### Sub-topic 2-3: Other aspcets

**Issue 2-3-1: Power boosting for PC3 UL CA**

* Background: Rel-16 agreement on power boosting for PC3 UL CA ([RP-201365](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-201365.zip))
  + *….*
  + *In the CR, the power boosting for carrier 2 with 2Tx is only applied to PC3 CA, i.e., not applied to PC2 CA (the same per BC power class, i.e. PC3 in this case is applied regardless of transmission in Case 1 or Case 2).*
* Proposals
  + Proposal 1: Further consider power class stability and alignment in Rel-17 based on Rel-16 solution. At least consider further refinement of power boost in inter-band case and the impact of introduction of HPUE in Rel-17 UL CA (vivo)
* Recommended WF
  + Encourage more companies’ feedback on:
    - With PC2 introduced for inter-band UL CA in Rel-17, is power boosting still needed for PC3 UL CA with Rel-17 1Tx-2Tx and 2Tx-2Tx switching between two uplink bands?

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| **Company** | **Comments** |
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**Issue 2-3-2: 2-layer MIMO support**

* *Background: Rel-16 description on the UL-MIMO support for carrier 2 in TS 38.101-1:*
  + *….both single layer and two-layer transmission with 2 antenna ports, and single layer transmission with 1 antenna port shall be supported on NR UL carrier 2…*
* Proposals
  + Proposal 1: Further consider the UL-MIMO and transmission rank related clarifications in Rel-17 based on Rel-16. (vivo)
* Recommended WF
  + Encourage more companies’ feedback on:
    - In 2Tx-2Tx switching, for carrier 1 on band A, is it mandatory or optional to support 2-layer PUSCH transmission?
    - In both 1Tx-2Tx and 2Tx-2Tx switching, for the two contiguous carriers on band B, is it mandatory or optional to support 2-layer PUSCH transmission?

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| **Company** | **Comments** |
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## Companies views’ collection for 1st round

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

## Summary on 2nd round

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |