**3GPP TSG-RAN WG4 Meeting #104-e-bis R4-22xxxxx**

**Electronic Meeting, October 10 - October 19, 2022**

**Agenda item:** 6.19.2

**Source:** Ericsson

**Title:** WF on UL Tx switching with multiple TAGs

**Document for:** Information

# Introduction

This email thread discusses the UE RF aspects for Rel-18 Multi-carrier enhancements WI, including the following topics:

* Topic #2: Tx switching with multiple TAGs
* 2nd round: there will be 2 sub-threads
  + 1 sub-thread with email title ‘[104-bis-e][139] NR\_MC\_enh\_UERF - General and Tx switching with 1 TAG’, and cover the following tdocs (sub-thread led by China Telecom)
  + WF on UL Tx switching across 3/4 bands with single TAG
  + LS on Rel-18 UL Tx switching
  + 1 sub-thread with email title ‘[104-bis-e][139] NR\_MC\_enh\_UERF - Tx switching with 2 TAGs’, and cover the following tdoc (sub-thread led by Ericsson)
  + WF on UL Tx switching with multiple TAGs

It is appreciated that the delegates for this topic put their contact information in the table below.

Contact information

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| **Company** | **Name** | **Email address** |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #2: Tx switching with multiple TAGs

## Summary for 1st round and 2nd round discussion

### Sub-topic 2-1: UL switching time and outage time

#### Issue 2-1-1: UL switching time

GTW Agreement:

* The UL switching time is the same for single TAG and dual-TAG cases

#### Issue 2-1-1A: on the wording in the FFS bullet

*Background (captured in the WF R4-2215163):*

* + *FFS:*
    - *UE may omit the uplink transmissions corresponding to any TAG during the UE switching time.*

*Summary of round 1 discussion*

* + Proposal 1: UE requirements are written in such way that network defines UE behaviour (i.e., specify UE behaviour such that UE respects UL grants in all situations and requirements for UE are written such that network assigns grants according to the defined UE behavior). (QC)
    - CTC, E///, OPPO: Agree with technical point.
  + Proposal 2: Reuse the existing wording in TS 38.214, i.e., “UE may omit the uplink transmissions corresponding to any TAG during the UE switching time.” (China Telecom, OPPO, E///, Sony)
    - Nokia: We tend to agree with Proposal 2 at least in terms of “Reuse the existing wording in TS 38.214” However, we are afraid that the captured text in the last meeting WF looks odd. It’s not understandable specifically for a part of “corresponding to any TAG”. Pure RF UL switching period itself is irrelevant from TAGs. We don’t see the reason to include that part… For proposal 1, 3 and 4, they are a kind of options that network may take, but they must not be mixed with UE RF requirements.
  + Proposal 3: When multi-TAG UL Tx switching is configured to UE the precondition should be NW will take the TA differences into account in the UL transmission scheduling. (OPPO)
    - CTC, E///: Agree with technical point.
  + Proposal 4: For the case of Tx switching with multi-TAG for the two uplink carriers, the UE is not expected to transmit PUCCH/PUSCH/SRS on OFDM symbols that overlaps with the switching period on both the carriers. (HW)
    - CTC, E///: Agree with technical point.
  + Proposal 5: symbols at the trailing edge of the subslots/slots on carrier 2 must be blanked by the gNB during the switching period prior in the switch back to carrier 1. (QC, Apple)
    - Apple: For dual TAG scenarios, we need to make sure that the network will take care of the timing difference between the bands by its scheduling. The specification should capture this as a side condition on network behaviour.

*Recommendations for 2nd round:*

* Further discuss the possible wording for the WF and the CR.

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| **Company** | **Comments** |
| OPPO | Some of the wording from proposals can be considered or combined. We would like to see the concrete proposal from moderator or other companies for further discuss. |
| Huawei | Prefer Proposal 4.  For all of the proposals, companies are ok with scheduling restriction.  Proposal 2 looks like a UE behavior. We suggest to reuse the description as RRM spec “the UE is not expected to transmit PUCCH/PUSCH/SRS on OFDM symbols that overlaps with the switching period on both the carriers” |
| Ericsson | The wording of proposal 1 could be modified to follow 38.214 when switching is configured for both all single UL and dual UL cases for UL CA and for SUL:  “[…] the UE is not expected to transmit for the duration of on any of the two carriers.”  The wording ‘may omit’ is used in the main clause of 6.1.6 since a UE dropping behavior is defined for EN-DC.  For the dual TAG case, the same applies but the location of the switching period of on must be defined. The scheduling by the network or test system must be such that the UE is not expected to transmit during the switching gap, no UE (dropping) behavior is specified for UL CA and SUL.  The Proposal 1 could be refined to  “The UE is not expected to transmit for the duration of the switching period on any of the two carriers for any timing difference between carriers” |
| Nokia | Thanks Ericsson for the comment. We understand the argument from Ericsson. “may omit” or “not to expected” can be further discussed in the next meetings. But we really don’t believe “*corresponding to any TAG”* is needed*.*  For proposals 1, 3 and 5, there is no need to mention something on network beharvious in UE RF spec. Network would take into account TA depending on deployment circumstances, reported switching period etc. Why is this so special? Spec doesn’t say anything how network utilize e.g., Powe classes etc. |
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#### Issue 2-1-2: UL outage time and RAN4 CR text

#### Issue 2-1-2A: RAN4 CR text

*Summary of round 1 discussion*

* + Option 1: Modify the time mask for TX switching to include the case of dual TAG with different timing advance on the two TAGs. (E/// - see CR in R4-2215954, Sony, Samsung, Apple - to discuss further based on option 1, QC - agree to introduce new time mask but the E/// CR needs to be modified)
    - E///: The mask should be specified so that the UE functionality can be properly tested with timing differences between the uplink carriers.
    - Apple: To define a side condition which specifies network behaviour. The time mask for carriers involved in the switching is captured in the RF specification, while impact on other carriers is captured in the RRM specification.
  + Option 2: Apply same approach as in R17 V2X that the time mask only contains the UE hardware requirement (switching period), and no TA difference included. (OPPO, Huawei - see CR in R4-2216655, Xiaomi, MTK)
    - The impact of Tx switching with multiple TAGs can be considered as scheduling restriction.

*Recommendations for 2nd round:*

* Further discuss.

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| **Company** | **Comments** |
| OPPO | Option 2. |
| Huawei | Option 2.  The time masks reflect the RF capability of the UE, but TA is up to network configuration. As option 1 mixed UE implementation with network configuration.  The test case according to the modified time mask as Option 1 cannot distinguish the real UE capability. |
| Ericsson | Option 1. The UE switching functionality must also be verified for a case for which the scheduling accounts for the actual location of the switching period with different TA on the two TAGs. The test does not mandate any scheduling behavior in the field, but the network must make sure that the UE is not expected to transmit during the switching period no matter the timing difference between the carriers in the TAGs. The location of the switching period in relation to the time T0. |
| Nokia | Tends to agree with Option 2. Though it depends on the content, we are afraid that the scenarios captured in RAN4 UE RF requirements as a snapshot are wrongly referred to by RRM discussion. |
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#### Issue 2-1-2B: UL outage time

*Summary of round 1 discussion*

* + Proposal 1 (China Telecom)
    - For deriving the UL outage time, use half of the difference between the actual TAs on the two TAGs.
    - For the timing and measurement error, 3 aspects need to be considered, including: a) BS synchronization accuracy, b) UE transmit timing error, c) TA quantization error.
    - For BS synchronization accuracy for synchronized network, the BS synchronization accuracy requirement of 3us defined in clause 7.4.2 of TS 38.133 can be used.
    - For UE transmit timing error, the requirement defined in clause 7.1 of TS 38.133 can be seen an upper bound, and the sum of maximum UE transmit timing error is 1.56 us for the carriers with 2 TAGs.
    - For TA quantization error, as defined in TS 38.213, it can be up to 5.2 us for 15 kHz SCS.

**E/// comment:** We agree with Proposal 1 but note that all aspects are already included in MTTD specified for inter-band in 38.133.

* + Proposal 2: The “Outage time” discussion should be moved to RRM session considering the parameters other than switching time are all RRM parameters like MTTD, Timing and measurement errors. (OPPO, Nokia, Xiaomi, MTK)
  + Proposal 3: Refine the agreement that “band C is not expected to be available for transmissions for the duration of the switching time + **any partial symbol on any band overlapping with switching time**. (QC)
    - China Telecom, Huawei, E///: Agree with the technical point when the UL outage time is in the unit of OFDM symbols.
  + Proposal 4: No need to capture the exact UL outage time in the spec, since it affect BS scheduling only according to our CR in R4-2216655. (HW)

*Recommendations for 2nd round:*

* Further discuss.

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| **Company** | **Comments** |
| China Telecom | On Proposal l, responses to E/// comments:  E/// comment 1:We agree with Proposal 1 but note that all aspects are already included in MTTD specified for inter-band in 38.133.  CTC response: We understand the other aspects are already included in the MTTD. But as seen in the 1st bullet of our proposal, we suggest not to use the MTTD, but to use half of the difference between the actual TAs on the two TAGs.  E/// comment 2: On TA quantization error, E/// commented in RRM session that 5.26us is too large and 0.26 us is the correct number.  CTC response: After further checking,  should be 0.52us but not 5.2 us, sorry for my mistake!  *As specified in TS 38.213, for a SCS of  kHz, the timing advance command for a TAG indicates the change of the uplink timing relative to the current uplink timing for the TAG in multiples of .*  With this, we are open to consider 0.52us or half of 0.52us. |
| OPPO | Proposal 2. |
| Huawei | Support Proposal 4.  The factors included in UL outage time have already defined in RRM spec. We think Proposal 2 to discuss UL outage time in RRM session is reasonable.  Additionally, a question for ‘UL outage time’, does it refer to the outage period on the bands of switched-to and switched-from, or the outage period on each band that is configured for Rel-18 Tx switching? Or, the outage time refers to the interruption of UL transmissions? |
| Ericsson | We prefer Proposal 3 and disagree with Proposal 4.  The maximum outage time is the sum of the switching period and the MTTD. The latter already accounts for a multiple TAG, the MTTD for up to 30 us propagation delay difference is 34.6 us, slightly shorter than one symbol. The MTTD for the start of the UL slots will not change with switching. A switching period will be allocated at the start of the slot of a carrier if the switching period is configured for this carrier.  The DL interruption length (on any carrier) is allowed for any DL symbol that overlaps with the switching period that occurs simultaneously on both carriers no matter the timing difference. The start of the DL interruption on any carrier is not specified, the location of the interruption depending on the absolute timing advance (w r t the DL timing reference per TAG), the same for the single-TAG case.  For coexistence cases where there are different NTA,offset on the two TAGs, then the MTTD would have to include NTA,offset (this does not change the arguments above, the switching period still the same).  Proposal 3 is correct in practice as the network must account for any switching in terms of an integer number of symbols, and that time T0 is at a symbol boundary.  The time masks can be specified as follows, for the switching period on carrier 1:    and on carrier 2    The time masks also specify the location of the switching period in relation to the time T0, which must be specified for the network to account for the required PUSCH preparation time and where to schedule additional blanked symbols. In practice the above outage times must be an integer number of symbols for any timing difference (including the same TA on both TAGs). Any blanked symbols in the masks are on either carrier 1 or carrier 2, not both.  It is observed that the maximum outage time is the sum of the switching period and the MTTD, the TA corresponding to a 30 us propagation time difference. If there are different NTA,offset on the two TAGs then the MTTD would have to include NTA,offset (the same within each TAG) for the same MTTD to apply. |
| Nokia | This must be done in RRM. It’s better to leave the discussion to RRM. Now people have started to say UL outage time = UL interruption by referring to UE RF session agreement. |
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### Sub-topic 2-2: PUSCH preparation time

GTW Agreement:

* The timing difference effect and switching period have already been considered in the PUSCH preparation time in the current specification, and further specification update is not needed.

### Sub-topic 2-3: Sceanrio

*Summary of round 1 discussion*

* + E///: the “three-band” case of an FDD-TDD combination with intra-band non-contiguous CA in the TDD band, two band entries within the TDD, could also be considered; the carriers in the FDD and TDD band belonging to separate TAGs.
    - CTC, OPPO, HW, Xiaomi, Apple: intra-band non-contiguous CA is not covered in the Tx switching scenario.
  + MTK: Since NR DC was not considered in R-16/R-17 Tx switching, it is not considered for multi-TAG operation for R-18 Multi-carrier enhancements.
    - CTC, OPPO, HW, MTK, Xiaomi, vivo, Apple: Support

*Tentative agreements:*

* In RAN4 understanding:
  + The band combinations containing intra-band non-contiguous CA is not considered in the WI.
  + NR-DC with multi-TAG operation is not considered in the WI.

### Sub-topic 2-4: Location of switching period

*Recommendations for 2nd round:*

* + Encourage proposals on the location of switching period for Tx switching across 3 or 4 bands with 2-TAG.

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| **Company** | **Comments** |
| Huawei | We suggest to further think about it in the next meeting. |
| Ericsson | The location of the switching period must be specified in relation to the time T0 also for 3 and 4 uplink carriers. The switching period must precede the time T0 for consistency with the existing two band/carrier cases. No difference from the single-TAG case.  For the existing single-TAG cases, the mask could be clarified as follows (also for SUL): |
| Nokia | We agree with Huawei. It’s better to discuss them in the next meetings rather than rushing into agreeing something without understanding the issues correctly. |
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