3GPP TSG-RAN WG2 Meeting #117 electronic ***R2-220xxxx***

Online, February 21 – March 03, 2022

**Agenda item:** 8.24.1

**Source:** China Telecom

**Title:** [draft] Summary of [AT117-e][053][NR17] UL TX Switching (China Telecom)

**WID/SID:** NR\_RF\_FR1\_enh

**Document for:** Discussion and Decision

# Introduction

This document is the report of the following email discussion:

* [AT117-e][053][NR17] UL TX Switching (China Telecom)

Scope: Treat R2-2203117, R2-2202812, R2-2202814, R2-2203114, R2-2202813, R2-2203115, R2-2203116. Determine agreeable parts. Agree/endorse CRs.

Intended outcome: Report, Agreed CRs, Endorsed UE cap CRs (or draft CRs) (38306, 38331) for Merge.

Deadline: EOM

Rapporteur suggests dividing the discussion into 2 phases.

For **Phase 1** discussion, rapporteur suggests companies provide comments **before Friday W1 UTC 13:00 (Feb 25),** so that we can try to figure out the agreeable parts and start to discuss how to update the Running CRs earlier. The Phase 1 report will be submitted **before online CB W2 if needed.**

For **Phase 2** discussion, rapporteur plans to start it at **Monday W1 (Feb 28)**, which can focus on updating the Running CRs based on the agreeable parts discussed in Phase 1 and try to agree/endorse CRs.

**Contact from companies**

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| Company | Contact: Name (E-mail) |
| China Telecom | Pei Lin (linp@chinatelecom.cn) |
| Nokia, Nokia Shanghai Bell | Tero Henttonen (tero.henttonen@nokia.com) |
| Huawei, HiSilicon | Rui Wang(wangrui46@huawei.com) |
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# Phase 1 Discussion

In the last RAN2 meeting, RRC configuration and UE capability reporting to support Rel-17 UL Tx switching enhancement were discussed and many agreements were reached. Only the following remaining issues on UE capability reporting were left for further discussion.

* Regarding whether switching option can be reported differently for 1T2T and 2T2T, RAN2 waits for RAN1 conclusion.
* Regarding UL MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching, RAN2 waits for RAN1

Besides, based on the company contributions submitted in this meeting, some clarifications on RRC configuration for Rel-17 UL Tx switching enhancement and stage-2 CR to TS 38.300 may also need further discussion.

## Stage 2 CR

R2-2202814 proposes to add a new clause 5.4.x for the description of UL Tx switching. An example of TP for TS 38.300 is given below:

5.4.x Uplink Tx switching

In uplink CA or SUL, uplink Tx switching can be configured to enable 1Tx/2Tx transmission on one band and 2Tx transmission on the other band in a TDM manner, or 1Tx transmission on one band plus 1Tx transmission on the other band (for CA only) for UE supporting two transmit antenna connectors.

**Q1: Do companies agree with the intention of the CRs above?**

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| **Company** | **Agree/ Not agree** | **Comments** |
| China Telecom | Agree | We think a general description of UL Tx switching in TS 38.300 is needed, which provides an overall introduction of this feature. |
| Nokia, Nokia Shanghai Bell | Not agree | Couple of comments:   * + The sentence "In uplink CA or SUL" seems unnecessary - that's aprt of UE capabilities, and hence clear from Stage-3 specifications.   + The term "transmit antenna connectors" is very unclear and sounds like RF details, not something we usually capture in Stage-2. Removing that would remove the ambiguity and simplify the text greatly.   + It's not correct to use "band" here since UE is not configured with bands but serving cells, even if the UL Tx switching is only defined for inter-band (UL CA or SUL) cases. But UE requires two serving cells to be configured with this feature, so it's far clearer to use "cell" in the description.   + The essence of the feature is to switch UL from one carrier to another carrier. This should be the starting point to explain ewhat the feature is about, not which UEs are capable of it (that's defined by UE capabilities and we don't usually mention those in Stage-2).   + The "TDM manner" is a bit misleading: We presume it intends to say that UE automatically switches back eventually, but in practice the actual UL Tx switching is done based on DCI indication.   In summary, we think the following would be sufficient for this feature in Stage-2:  *Uplink Tx switching enables UE to temporarily switch the UL from one serving cell to another serving cell for enabling 2Tx UL transmission on that serving cell.* |
| Huawei, HiSilicon | (Proponent)  Agree with the intention, open to discuss wording | We think the stage2 description of UL Tx switching can help people to understand the intention and benefit of the feature, because only reading stage 3 specifications, it is not crystal clear about the usage scenario which has been only captured in the WID so far.  We are open to discuss the detailed wording as Nokia suggested.  Some quick response to Nokia’s comment:   * Regarding whether to mention “in uplink CA and SUL”, we feel there is not harm to include the scenario where this feature might be performed as other features. * Regarding the term "transmit antenna connectors", we see the point and fine to remove/replace this term. * Regarding the term of band, we think the key point on whether/how the Tx can be switched is the uplink transmissions are on two different band but not two different cell(in CA case, there could be two cells on one band to share the same Txs, no need to switch Tx between such cells.). But if companies do not prefer using band, we can consider to use carrier, which can cover both of CA and SUL case. * Regarding the term of TDM, it is to clarify that UE will not be configured/scheduled with simultaneously uplink transmission with 2 Tx. |
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## RRC configuration

R2-2203117 suggests adding some clarifications on the field description of *uplinkTxSwitchingCarrier*. As per the current field description of *uplinkTxSwitchingCarrier* in the baseline running CR R2-2201873, there is no explicit description on which band can be configured as *carrier2* in case of 1Tx-2Tx switching.

An example of TP for TS 38.331 is given below:

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| ***uplinkTxSwitchingCarrier***  Indicates that the configured carrier is carrier1 or carrier2 for dynamic uplink Tx switching, as defined in TS 38.101-1 [15] and TS 38.101-3 [34]. In case of (NG)EN-DC, network always configures the NR carrier as carrier 2.  In case of inter-band UL CA or SUL, for dynamic uplink Tx switching between 2 bands with 2 uplink carriers or 3 uplink carriers as defined in TS 38.101-1 [15], network configures the uplink carrier(s) on one band as carrier1 and the uplink carrier(s) on the other band as carrier2, and only the uplink carrier(s) on the band where UE supports 2-layer UL MIMO capability can be configured as carrier2. This field is set to the same value for the carriers on the same band. |

Companies are welcome to give comments on P4 within R2-2203117 for the configuration of 2Tx-2Tx switching.

**Q2: Do companies agree P4 within R2-2203117 as it is: Add “only the uplink carrier(s) on the band where UE supports 2-layer UL MIMO capability can be configured as carrier2” in the field description of *uplinkTxSwitchingCarrier* in the baseline running CR R2-2201873?**

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| **Company** | **Agree/ Not agree** | **Comments** |
| China Telecom | Agree | Based on the current field description of *uplinkTxSwitchingCarrier* in the baseline running CR R2-2201873, there is no explicit description on which band can be configured as *carrier2* in case of 1Tx-2Tx switching. We think some clarification is needed to make it clear. |
| Nokia, Nokia Shanghai Bell | Agree with intent, no CR needed | We agree this was always the intent but it's already indicated in multiple specifications. For example, this is from TS38.306:  ***ULTxSwitchingBandPair-r16***  Indicates UE supports dynamic UL Tx switching in case of inter-band CA, SUL, and (NG)EN-DC as defined in TS 38.214 [12], TS 38.101-1 [2] and TS 38.101-3 [4]. The capability signalling comprises of the following parameters:  - *bandIndexUL1-r16* and *bandIndexUL2-r16* indicate the band pair on which UE supports dynamic UL Tx switching. *bandindexUL1*/*bandindexUL2* xx refers to the xxth band entry in the band combination. UE shall indicate support for 2-layer UL MIMO capabilities on one of the indicated two bands in each FeatureSet entry supporting UL 1Tx-2Tx switching, and only the band where UE supports 2-layer UL MIMO capability can work as carrier2 as defined in TS 38.101-1 [2] and TS 38.101-3 [4].  Since the whole point of the UL Tx switching was to enable UL MIMO when it was not possible on either carrier alone, it seems obvious and already captured in 38.306, so duplicating the same text in 38.331 doesn't seem necessary. |
| Huawei, HiSilicon | Agree | We are fine to include such description to either 38331 or 38306. |
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## UE capability reporting

### UL MIMO coherence capability for 2Tx-2Tx switching

Regarding the UL MIMO coherence capability reporting for Rel-17 UL 2Tx-2Tx switching, the following agreements were reached in RAN2#116bis-e meeting.

* Add a new per-band per BC UE capability in *BandCombination-UplinkTxSwitch* to indicate UL MIMO coherent capability specific for 2Tx-2Tx switching.
* Regarding UL MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching, RAN2 waits for RAN1

As per RAN1 discussion in RAN1#107-e meeting , the discussion scope is limited to 4Tx UL MIMO coherence with no impact on UL Tx switching, and whether to introduce a new per-FS UL MIMO coherence capability proposed by some companies mainly focuses on a more generic case, which is a different issue from the previous RAN4 discussion on UL MIMO coherence capability for UL Tx switching. Based on that, companies have common understanding that the RAN1 discussion on UL MIMO coherence capability is for non-Tx switching case and has no impact on UL MIMO coherence capability reporting for Tx switching as discussed in the last RAN2 meeting.

Besides, whether a new per-FS UL MIMO coherence capability for non-Tx switching case can be introduced by RAN1 is still not sure.

Considering the Rel-17 tight timeline for RAN2 work, R2-2203117 suggests RAN2 can first discuss the detail design for this issue based on the clear agreement from RAN4, and gives the following proposal*.*

Proposal 1: RAN2 discusses the detail design of UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching based on RAN4 agreement, and can revisit it if needed when RAN1 makes clear conclusion on non-Tx switching case in the future.

Companies are welcome to give comments on P1 within R2-2203117.

**Q3: Do companies agree P1 within R2-2203117 as it is: RAN2 discusses the detail design of UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching based on RAN4 agreement, and can revisit it if needed when RAN1 makes clear conclusion on non-Tx switching case in the future?**

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| **Company** | **Agree/ Not agree** | **Comments** |
| China Telecom | Agree | Firstly, we think companies have common understanding that the RAN1 discussion on UL MIMO coherence capability is for non-Tx switching case and has no impact on UL MIMO coherence capability reporting for Tx switching as discussed in the last RAN2 meeting.  Besides, whether a new per-FS UL MIMO coherence capability for non-Tx switching case can be introduced by RAN1 is still not sure.  Therefore, we suggest RAN2 discuss the detail design of the detail design of UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching based on RAN4 agreement, and can revisit it if needed when RAN1 makes clear conclusion on non-Tx switching case in the future. |
| Nokia, Nokia Shanghai Bell |  | We can progress based on current assumptions, but once ASN.1 is to be frozen there needs to be a decision on whether the capability is adopted or not. If RAN1 hasn't concluded, it seems like this is an open issue in both RAN1 and RAN2 and should be then also reported as such in the WI status report. |
| Huawei, HiSilicon | Agree | The potential new UE capability (ie. per-FS UE capability reporting for UL MIMO coherence for Rel-17) is under discussion in RAN1, the final check point is Mar 1, so we understand it would be concluded by Monday W2, then RAN2 can check whether we need to revisit this part of signalling design. |
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If “Agree” is selected for Q3, companies are welcome to give comments on the following 2 options raised in last RAN2 meeting.

* Option 1: Extend the *BandParameters* in *BandCombinationList*
* Option 2: Introduce a new field *UplinkTxSwitchingBandParameters-v17xx* in *BandCombination-UplinkTxSwitch-v17xx*

**Q4: Regarding the detail design of UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching, which option do companies prefer?**

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| **Company** | **Option 1/ Option 2** | **Comments** |
| China Telecom | Option 2 | Since the motivation of RAN4 to introduce a new UL MIMO coherence capability for UL Tx switching is to allow the UE to indicate a different UL MIMO coherence capability when UL Tx switching is configured, the capability for UL Tx switching will not be used for non-UL Tx switching case.  In this sense, Option 1 may be confusing to include the UL-MIMO coherence capability for UL Tx switching in the general band parameter.  Therefore, we prefer to go for Option 2 to introduce a new field *UplinkTxSwitchingBandParameters-v17xx* to report the UL Tx switching specific band parameters for a given band combination, which can also minimize the potential spec maintenance work in the future. |
| Nokia, Nokia Shanghai Bell | No strong view | Both options can work. |
| Huawei, HiSilicon | Option 2 | Agree with China Telecom, this capability will not be reported in legacy BC list, thus better not to include it in legacy bandParameters. And we also prefer to have a general field name for this per-band per-BC capability for better future-proof. |
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If “Option 2” is selected for Q4, companies are welcome to give comments on the following signalling design proposed in R2-2203117.

Proposal 2: Introduce a new field *UplinkTxSwitchingBandParameters-v17xx* to report the UL Tx switching specific band parameters for a given band combination, which comprises of the following parameters:

- *bandIndex-r17* indicates a band on which UE supports dynamic UL Tx switching with another band in the band combination.

- *uplinkTxSwitching2T2T-PUSCH-TransCoherence-r17* is used to report UL MIMO coherence capability for Rel-17 2Tx-2Tx switching.

An example of TP for TS 38.331 is given below:

BandCombination-UplinkTxSwitch-v17xx ::= SEQUENCE {

supportedBandPairListNR-v17xx SEQUENCE (SIZE (1..maxULTxSwitchingBandPairs)) OF ULTxSwitchingBandPair-v17xx OPTIONAL,

uplinkTxSwitchingBandParametersList-r17 SEQUENCE (SIZE (1.. maxSimultaneousBands)) OF ULTxSwitchingBandParameters-r17 OPTIONAL

}

ULTxSwitchingBandParameters-r17 ::= SEQUENCE {

bandIndex-r17 INTEGER(1..maxSimultaneousBands),

uplinkTxSwitching2T2T-PUSCH-TransCoherence-r17 ENUMERATED {nonCoherent, fullCoherent} OPTIONAL

}

**Q5: For the detail design of UL MIMO coherent capability reporting for 2Tx-2Tx switching, do companies agree P2 within R2-2203117 as it is: Introduce a new field *UplinkTxSwitchingBandParameters-v17xx* to report the UL Tx switching specific band parameters for a given band combination, which comprises of the following parameters:**

**- *bandIndex-r17* indicates a band on which UE supports dynamic UL Tx switching with another band in the band combination.**

**- *uplinkTxSwitching2T2T-PUSCH-TransCoherence-r17* is used to report UL MIMO coherence capability for Rel-17 2Tx-2Tx switching?**

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| **Company** | **Agree/ Not agree** | **Comments** |
| China Telecom | Agree | We think the above proposals can correctly capture RAN4 agreements on UL MIMO coherence capability for Rel-17 2Tx-2Tx switching. |
| Nokia, Nokia Shanghai Bell | Disagree | Is there a reason we cannot put that capability inside the *supportedBandPairListNR-v17xx*? Since this is all Rel-17 configuration, it seems strange to create another IE just for this purpose. |
| Huawei, Hisilicon | Agree | To answer to Nokia’s question, this capability is indicated as a per-band per-BC cap in the RAN4 LS, not related to the supported band pair for a given BC, that is why it cannot be put under band pair. |
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### Whether switching option can be reported differently for 1Tx-2Tx and 2Tx-2Tx

In the baseline running CR R2-2201940, there is one FFS on switching option reported for 2Tx-2Tx switching. Companies didn’t reach consensus on how to handle the FFS in the last RAN2 meeting.

Regarding whether switching option can be reported differently for 1Tx-2Tx and 2Tx-2Tx, it is under discussion in RAN1, RAN2 made the agreement to wait for RAN1 decision in the last RAN2 meeting.

However, considering the Rel-17 tight timeline for RAN2 work, if RAN1 can’t reach an agreement to allow different switching options reported for 1Tx-2Tx and 2Tx-2Tx in the Feb RAN1 meeting, R2-2203117 suggests RAN2 remove the FFS captured in the baseline running CR and can revisit it if needed based on RAN1 conclusion in the future.

To make progress, the following way-forward for switching option capability reporting for 1Tx-2Tx and 2Tx-2Tx is proposed in R2-2203117.

Proposal 3: For switching option capability reporting for 1Tx-2Tx and 2Tx-2Tx, RAN2 takes the following way-forward.

* Way-forward:Remove the sentence of “FFS: whether switching option can be reported differently for 1T2T and 2T2T” from the running CR, if RAN1 can’t reach an agreement to allow different switching options reported for 1Tx-2Tx and 2Tx-2Tx in the Feb RAN1 meeting. And RAN2 can revisit it if needed based on RAN1 conclusion in the future.

Companies are welcome to give comments on P3 within R2-2203117.

**Q6: Do companies agree P3 within R2-2203117 as it is: For switching option capability reporting for 1Tx-2Tx and 2Tx-2Tx, RAN2 takes the following way-forward.**

* **Way-forward: Remove the sentence of “FFS: whether switching option can be reported differently for 1T2T and 2T2T” from the running CR, if RAN1 can’t reach an agreement to allow different switching options reported for 1Tx-2Tx and 2Tx-2Tx in the Feb RAN1 meeting. And RAN2 can revisit it if needed based on RAN1 conclusion in the future?**

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| **Company** | **Agree/ Not agree** | **Comments** |
| China Telecom | Agree | Firstly, in our understanding, it is not necessary to introduce a new UE capability to report different switching option supported by the UE for 1Tx-2Tx and 2Tx-2Tx switching. If UE can support 2Tx-2Tx switching and Tx switching between 2 UL bands for Rel-17 Tx switching, it can easily support 1Tx-2Tx switching between 2 UL carriers for Rel-16 Tx switching for the same option.  Besides, considering the Rel-17 tight timeline for RAN2 work, if RAN1 can’t reach an agreement to allow different switching options reported for 1Tx-2Tx and 2Tx-2Tx in the Feb RAN1 meeting, we suggest RAN2 can take the above way-forward. |
| Nokia, Nokia Shanghai Bell | Disagree | We are fine to consider this as working assumption, but we should keep the FFS. We are fine to progress based on "same switching option capability", but retain FFS that this is pending RAN1 decision.  Otherwise, companies will just go to RAN1 and say this was agreed in RAN2 and therefore RAN1 needs to agree to the same. |
| Huawei, HiSilicon | Agree | We understand the proposals without agreements by the end of a WI means no support of this proposal, because it is not necessary and possible to say not to support xx for every proposal explicitly.  And to address Nokia’s concern, maybe we can capture "same switching option capability" is up to RAN1 in chair notes. |
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## Any others issues

Rapporteur understands the R2-2202812, R2-2202813 and R2-2203114 are resubmissions of the baseline running CRs on RRC configuration and UE capability reporting for UL Tx switching enhancements.

If companies have any concerns on either contribution or any other issues, please comment in below table.

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| **Company** | **Comments** |
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## Phase 1 Summary

TBD**.**

# Phase 2 Discussion

TBD.

# Conclusion

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# Reference

1. R2-2203117 Discussion on remaining issues for UL Tx switching enhancement China Telecom, Huawei, HiSilicon discussion Rel-17 NR\_RF\_FR1\_enh
2. R2-2202812 RRC configuration for UL Tx switching enhancement Huawei, HiSilicon, China Telecom, Apple, CATT CR Rel-17 38.331 16.7.0 2909 - B NR\_RF\_FR1\_enh-Core
3. R2-2202814 stage 2 CR for UL Tx switching enhancement Huawei, HiSilicon, China Telecom CR Rel-17 38.300 16.8.0 0411 - F NR\_RF\_FR1\_enh-Core
4. R2-2203114 Running CR to TS38.306 to support Tx switching enhancements (UE capability) China Telecom, Huawei, HiSilicon, Apple, CATT draftCR Rel-17 38.306 16.7.0 B NR\_RF\_FR1\_enh
5. R2-2202813 UE capability reporting for UL Tx switching enhancement Huawei, HiSilicon, China Telecom, Apple, CATT draftCR Rel-17 38.331 16.7.0 NR\_RF\_FR1\_enh-Core R2-2201940
6. R2-2203115 Draft CR to TS 38.306 on UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching China Telecom, Huawei, HiSilicon draftCR Rel-17 38.306 16.7.0 F NR\_RF\_FR1\_enh
7. R2-2203116 Draft CR to TS 38.331 on UL-MIMO coherence capability reporting for Rel-17 2Tx-2Tx switching China Telecom, Huawei, HiSilicon draftCR Rel-17 38.331 16.7.0 F NR\_RF\_FR1\_enh