**3GPP TSG-RAN WG4 Meeting # 107 R4-23XXXXX**

**Incheon, KR, May 22nd - May 26th, 2023**

**Agenda item:** 8.24.4

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [107][142] NR\_MC\_enh\_UERF

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# Introduction

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

* Topic #1: Tx switching across 3/4 bands with single TAG
* Topic #2: Tx switching with dual TAGs
* Topic #3: Reply LS to RAN2

# Topic #1: Tx switching across 3/4 bands with single TAG

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307156 | Huawei, HiSilicon | Discussion on Multi-carrier enhancements with single TAGProposal 1: Adding new values to the agreed switching period set is not expected.* Rel-18 Tx switching can work well based on the previous agreement without error.
* Adding new values would increase the complexity from the perspective of network.

Proposal 2: Sum of two switching periods is not expected.* The illustrated time mask on summing of two switching periods has been precluded in the last meeting since it violate the RAN1 agreement.
* According to RAN1’s evaluation, too long switching period would results in worse performance for Tx switching than semi-static UL CA or single uplink.
* The worse optional capability results from the sum of switching periods should not be introduced considering optional capability is equivalent to advanced capability from RAN2’s logic.

Proposal 3: The UEs that support barely switching sequentially for two band pairs, should either complete switching during a single determined switching gap as agreed in RAN1, or relinquish supporting Rel-18 Tx switching and fallback to Rel-16/17.Observation 1: Fixed time domain switching period location for Rel-16/17 is not backward-compatible.Proposal 4: RAN4 don't support defining time domain location of switching period in Rel-16/17.Proposal 5: The actual start point of the transmission on the switch-to bands can be defined per Tx switching instance in Rel-18.* The actual start point of transmission is different from T0
* Define one actual start point Tstart for both the band pairs in the Tx switching instance

Proposal 6: No need to introduce the band configurations for Rel-18 Tx.* Band combinations along with UL configuration are up to the operators’ demand. And the existing CA/SUL band combinations can be reused for Rel-18 Tx switching.
* The network would schedule the switching between band pairs for a band combination according to the reported band pairs and UL configurations. And the network can avoid scheduling Tx switching that result in concurrent transmission for two bands without UL CA configuration.
* Rel-18 should introduce Tx switching capability per band combination.

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| R4-2307157 | Huawei, HiSilicon | On ambiguity issue of the exact switching band pairsObservation 1: The switching period resulting from the baseline assumption max {Tswitch\_A-C, Tswitch\_B-D, Tswitch\_A-D, Tswitch\_B-C} is related to four band pairs. In this case, the UE performs switching only in two band pairs and it is possible to have a shorter switching period than the baseline value.Observation 2: If the UE is able to perform Tx switching with the band pairs that are corresponded to shorter switching period, the UE could utilize more resources to transmit uplink signal/channels compared to baseline.Observation 3: Rel-18 Tx switching introduces optional/advanced UE capability based on UE implementation to get better performance.Proposal 1: For the parallel switching of two Tx chain in the case {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T} on bands {A, B, C, D}, in addition to the baseline UE assumption agreed in RAN4 #105, introduce optional UE capability with the switching period min {max(Tswitch\_A-C, Tswitch\_B-D), max(Tswitch\_A-D, Tswitch\_B-C)}. |
| R4-2307254 | China Telecom | Remaining issues for NR Multi-carrier enhancementsProposal 1: For Rel-18 Tx switching across 3 or 4 bands, define the time relation of the switching period location and T0 for two cases with the switching period located on the switch-from carrier and switch-to carrier respectively, and the definition of exact switching period location should not conflict with RAN1 agreement on the configuration of switching period location.Proposal 2: For Tx switching between {1T, 1T, 0T} and {0T, 0T, 2T}, introduce advanced optional UE ability to allow the Tx chain #1 to be used for transmission during the time duration of (Tswitch\_2 - Tswitch\_1).* Tswitch\_1 and Tswitch\_2 are the switching periods of Tx chain #1 and Tx chain #2 respectivelyand Tswitch\_1 < Tswitch\_2.
* Apply the same UE capability with the same granularity for this scenario and for the scenario approved in RAN4 LS in R4-2303507.

Proposal 3: Mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx, considering: 1) UL throughput benefit, 2) moderate complexity increase, 3) specification consistency with the Rel-16/17 Tx switching, 4) specification consistency with RAN2 for Rel-18 Tx switching.Proposal 4: The band combinations supporting Rel-18 Tx switching across 3/4 bands are up to UE implementation and reporting, and there is no need to introduce the band configurations for Rel-18 UL Tx switching in RAN4 specification, considering that:* No BC specific requirement for Rel-18 Tx switching is needed. For the use of Tx switching across 3/4 bands, the generic Rel-18 Tx switching requirement (i.e., CR endorsed in RAN4 #106) and the existing CA/SUL BC specific requirements are sufficient.
* The band combinations supporting Rel-16/17 Tx switching are up to UE implementation and reporting.

Proposal 5: When there are necessary BC specific RF requirements to be discussed and specified, e.g., DL interruption due to Tx switching, we support to discuss the requirement per BC basis and capture the agreement in the RAN4 specification. |
| R4-2307255 | China Telecom, [NTT DOCOMO, Huawei, Hisilicon, CMCC, OPPO, ZTE] | CR for 38.101-1: Time mask for switching across three or four uplink bands |
| R4-2307304 | NTT DOCOMO, INC. | Views on Rel-18 Tx switchingProposal 1: Take option 2 if RAN4 agrees to define the time relationship between the location of the switching period and T\_0 in RAN4 specification.Observation 1: If we follow the following RAN2 agreement, UE supporting 2Tx needs to indicate UL MIMO capability.* *For UE capability of 2-port UL transmission, RAN2 reuse the per-FS UL-MIMO UE capability (no spec change).*

Proposal 2: Mandate 2-layer UL-MIMO support for carrier(s) capable of 2TxProposal 3: Regarding band configurations for Rel-18 Tx switching, take option 1. If it is not agreed, take option 2 as a compromise.* Option 1: Not to explicitly list the band configurations, which means all existing *band* configurations can support Rel-18 Tx switching based on optional UE capability (Our preference).
* *Option* 2: Not to introduce a new table but to introduce a new column or NOTE into existing band configuration tables to indicate which band combination can support Rel-18 Tx switching, and the indication in the specification can be updated directly by submitting CR, which means we don’t need to follow a basket WI approach.

Observation 2: It is RAN1 understanding that it is possible that the two Tx chains are switched concurrently between two different band pairs for one Tx switching instance during a single switching gap for the three examples. and that whether two Tx chains are switched simultaneously or sequentially for one Tx switching instance during the single determined switching gap is up to RAN4.Observation 3: The RAN1 understanding is aligned with the current RAN4 discussion status. |
| R4-2307742 | Ericsson | On the time masks for Tx switching between 3-4 bandsWe observe thatObservation 1: for the ‘exact location of the switching period’, Option 1 (the switching period immediately precedes the time T0) would have allowed predictable UE behavior and predictable location of DL interruptions. The definition of the time relationship between the location of the switching period and T0 location (Option 3) is specified by RAN1 in 38.214 for the two-band case, the switching period part of the preparation phase for scheduled transmissions. The same should apply for the switching band pairs of a 3-4 band combination.and propose thatProposal 1: for switching within one band pair of a 3-4 band combination* if an uplink switching is triggered for an uplink transmission starting at T0 based on higher layer configuration(s) or DCI(s) received before T0 − Toffset as specified in 38.214 and the UE is not scheduled or configured with uplink transmissions for a duration of at least the uplink switching gap $N\_{Tx1-Tx2}$ on any of the carriers before T0, then
* transient periods of 10 s are located at the end of the last symbol(s) scheduled on the carriers before T0 and at the start of the first symbol(s) scheduled or configured after T0.

without concurrent switching on any other band pair. The band propriety configured by the gNB can be ignored in this case.and that the network can assume that swtiching is completed at the time(s) T0 if the entire switching period required for concurrent swtiching is absorbed by a transmission gapProposal 2: if for concurrent switching on two band pairs the network provides a transmission gap on all carriers absorbing the sum of the switching period capabilties of the said band pairs, then transmissions start the time(s) T0 with switching completed and * transient periods of 10 s are located at the end of the last symbol(s) scheduled on the carriers before the time(s) T0 and at the start of the first symbol(s) scheduled or configured after the time(s) T0.

For BC we propose thatProposal 3: for Rel-18 band combinations with Tx switching band pairs, it is assumed that * the Rel-18 switching band combinations are specified in the 38.101-1 (not only the switching band pairs)
* the UE does not have to support switching across all switching band pairs of a supported band combination; fallback means that all band pairs including the released band/carrier are also released.
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| R4-2308162 | ZTE Corporation | On Tx switching across 3 or 4 bands for single TAGProposal 1. For the switching scenario without ambiguity, it is feasible to introduce advanced optional UE capability (per band per band pair per BC) to allow one Tx chain to start transmission earlier if the switching time for this Tx chain is shorter.Proposal. It is beneficial to resolve the switching pattern ambiguity issue when 2 Tx chains are switched between two different band pairs for one Tx switching instance.Proposal. At current stage, we think the original value sets in the previous agreement can still work.* Switching period longer than 210us would cause NW performance degradation
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| R4-2308244 | vivo | Further discussion on RF aspects of UL Tx switching with single TAGProposal 1: Postpone the discussion of exact location of switching period until feedback from RAN1 can be received.Proposal 2: Not introduce advanced optional UE ability for either 4 band or 3 band switching cases. Proposal 3: If UE is not capable for concurrent TX switching on the two TX chains, enable sum of two switching as optional UE behaviour, and this could be beneficial for more use of Tx switching feature.Proposal 4: Not mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx. |
| R4-2308929 | MediaTek Inc. | Discussion on remaining issues on Tx switchingObservation 1: While keeping previous agreement, neither of the two Tx chains is expected to be used for transmission during the switching periods, network can only reserve a gap with max{Tswitch\_A-C, Tswitch\_B-D} or max{Tswitch\_A-D, Tswitch\_B-C} whichever is longer if ambiguity issue is not resolved.Observation 2: There may be uplink transmission utilization improvement, $∆\_{2-1}$, $∆\_{3-1}$ or $∆\_{3-2}$, if switching band pairs can be explicitly indicated without impact on RAN1 requirements.Proposal 1: Enhancements for Rel-18 Tx switching o Resolving the switching pattern ambiguity issue if it is determined that it is possible that 2 Tx chains are switched between two different band pairs for one Tx switching instance* + - * By resolving the switching pattern ambiguity issue, the switching period can be the switching capability of switched band pairs.

o RAN4 agrees UE indication capability to resolve the ambiguity issue of the exact switching band pairs when concurrent switching occursObservation 3: Associating the ordering of bands for defining switch-from and switch-to pairs in switching configuration commands may resolve the ambiguity issue without additional cost.Proposal 2: RAN4 to agree on the band ordering based approach to resolve the ambiguity issue.Proposal 3: Send an LS to RAN1/2 for the approach to resolve ambiguity issue for UE enhancement. |
| R4-2308930 | MediaTek Inc. | Draft LS on Rel-18 UL Tx switching on ambiguity issue |
| R4-2308971 | OPPO | R18 Tx switching across 3 and 4 bandsObservation 1: It is unclear why only 70us and 175us are needed but 140+140, 35+210, 140+210, 210+210 are not needed.Observation 2: Large switch period will make the Tx switching feature no useful.Observation 3: It is UE choice which value among 35us, 140us and 210us will be reported, and if UE cannot do parallel switching of two band pairs then it is free to choose a larger value to cover the whole switching periods.Proposal 1: Reuse the existing switching periods {35us, 140us, 210us} for the Tx switching among 3 or 4 band cases.Observation 4: The switching period among 4 bands was already agreed as max {Tswitch\_A-C, Tswitch\_B-D, Tswitch\_A-D, Tswitch\_B-C}. And further solve the switching patter ambiguity is not something necessary to enable this Tx switching feature.Observation 5: It is UE implementation dependent on the switched band pairs on each Tx chain. And if it is decided by NW scheduling then it will mandate UE to support all Tx switching band pair cases since UE cannot know how NW will schedule the switched band pairs beforehand. This is not acceptable in UE design.Proposal 2: The switched band pairs in each Tx chain is determined by UE implementation rather than decided by NW scheduling, otherwise it will mandate UE to implement with all band pair switch cases in each Tx chain.Observation 6: For the switching from A+B to C+D, the PLL freq of each Tx chain will be changed which leads to the switching period in implementation at least 140us. And whether 210us will be applied depends on whether the whole Tx chain needs to be reloaded.Observation 7: There is no benefit when the two Tx chain switching periods are same. The benefit only shows when one of the Tx chain needs to be reloaded for all components, i.e. 210us applied for this chain and 140us apply for the other chain. And this is corner case.Proposal 3: There is no clear benefit to solve this no harm “ambiguity”.Proposal 4: Consider following two UE indication-based approaches if there is still interests to solve this no harm “ambiguity”.* + - * + Approach 1: Introduce new Tx switching period capability for the switched case from A+B to C+D and other band group pairs before and after switching.
				+ Approach 2: Introduce new per Tx chain-based Tx switching capability
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| R4-2309003 | Xiaomi | Discussion on UL Tx switchingProposal 1: No need to define the time relationship between the location of the switching period and T0 in RAN4 specificationProposal 2: Option A2 can be considered for sequential switching case.  |
| R4-2309479 | Apple | On Time T0, switching period location, time masks for TX switching with multi-TAGProposal 1: The switching period end should always be anchored to the start of the UL transmissions on the switched-to carrier for both single-TAG and dual-TAG cases.Proposal 2: We understand time T0 to be the time at which the UE starts UL transmissions on the switched-to carrier after the switching period, for both single-TAG and dual-TAG. |
| R4-2309480 | Apple, Ericsson, Qualcomm | Rel-18 band configurations for TX Switching across 3 or 4 bandsObservation #1: In the current specifications (see Table 5.5A.3.2-1 and Table 5.5A.3.3-1) there are 3-band and 4-band CA combinations where there are no band pairs configured for UL CA. Therefore, UL Tx switching cannot be configured for those band combinations.Observation #2: Not all the band pairs within a 3-band or 4-band CA combination can be configured for UL Tx switching because in the current specifications there are 3-band and 4-band CA combinations where only some band pairs are configured for UL CA. (see Table 5.5A.3.2-1 and Table 5.5A.3.3-1).Observation #3: For every band pair configured for UL Tx switching within the 3-band or 4-band CA combination, the switching mode (0Tx+2Tx, 2Tx+0Tx, 1Tx+1Tx) should be defined, based on the UL MIMO capability on each band.Proposal: Based on the three observations made above, and for the ease of implementation, we propose that band configurations for UL Tx switching across 3 and 4 bands should be included in the specifications. |
| R4-2309482 | Apple | On UL MIMO and Tx switchingObservation #1: Tx switching and UL-MIMO features are configured differently in the Release 18 specifications and should be independently implemented to allow flexibility.Observation #2: There are implementation and cost challenges for implementing UE UL-MIMO feature. This could make this feature optional, and not mandatory. Observation #3: In the current Release 18 specifications, the UL-MIMO feature is only defined for a limited number of NR bands whereas there are several UL CA combinations that do not involve UL-MIMO bands. Observation #4: The RF requirements in Release 18 are grouped separately for UL-MIMO and TxD and the corresponding requirements are defined in different clauses. Proposal: Given the observations #1, #2, 3, and #3 as described above, we prefer not to mandate the 2-layer UL-MIMO support for carrier (s) capable of 2Tx to provide more flexibility to the UE on implementing those features. Feature independence is desirable for the UE. |
| R4-2309683 | Qualcomm Incorporated | UE Switching time in more complicated casesObservation 1: Allowing UE a longer switching time for {1T,1T,0T,0T} to {0T,0T,1T,1T} case increases UL opportunities and therefore network performance. Observation 2: In RAN1 feasibility study and simulations for 3 and 4 band TX switching, longer switching time for all cases was assumed and throughput gain over 2-band switching case is still achievedObservation 3: If longer switching time is specified for case {1T,1T,0T,0T} to {0T,0T,1T,1T} that is valid only for dualUL, the dualUL network throughput performance over the switchedUL is still much better. And made the following two proposals:Proposal 1: When both TX chains are switched in UE, UE is allowed for longer switching time with one of the possible solutions:1. the switching time is the sum of the two applicable switching periods.
2. New switching periods capabilities are defined as uplinkTxSwitchingPeriod1T1Tto2T and uplinkTxSwitchingPeriod1T1Tto1T1T per two band pairs

Proposal 2: When another band unaffected by the switching is transmitting while switching between two other band occur, the switching period is double the value declared by the UE for these bands.  |

## Open issues summary

### Sub-topic 1-1: Length of switching time for certain scenarios

#### Issue 1-1-1: Switching case across four bands, i.e., {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T}

***Background: WF in RAN4 #106-bis-e***

* *Further discuss in the next meeting:*
	+ *Option A: As optional UE behaviour, total switching period can be extended if UE is not capable for concurrent TX switching on the two TX chains.*
		- *Option A1: add new values {70, 175} usec in addition to the agreed set of {35 us, 140 us, 210 us}*
		- *Option A2: Sum of two switching periods*
	+ *When UE is scheduled to switch two TX chains in such way that switching periods may overlap, the switching period is extended for both band pairs and total switching time is the sum of possible switching periods for the band pairs involved.*
	+ *When UE is scheduled for transmissions so that the switching is from two bands with one TX each to another two bands one TX each, denoted for example A+B to C+D, and it cannot be determined if UE switches TX chains from A to C or D or from B to C or D, the switching time is sum of max{Tswitch\_A-C, Tswitch\_A-D,} and max{Tswitch\_B-C, Tswitch\_B-D}.*
	+ *Include clearly the aspect that when two TX chains are switched with different lengths of the switching periods, none of the TX chains are expected to be used for transmissions.*
	+ *Option B: Keep the previous agreements*
* **Proposals:**
	+ Option A: As optional UE behaviour, total switching period can be extended if UE is not capable for concurrent TX switching on the two TX chains. (vivo, Xiaomi, QC)
		- ~~Option A1: add new values {70, 175} usec in addition to the agreed set of {35 us, 140 us, 210 us}~~
		- Option A2: Sum of two switching periods (vivo, Xiaomi, QC)
	+ When UE is scheduled to switch two TX chains in such way that switching periods may overlap, the switching period is extended for both band pairs and total switching time is the sum of possible switching periods for the band pairs involved.
	+ When UE is scheduled for transmissions so that the switching is from two bands with one TX each to another two bands one TX each, denoted for example A+B to C+D, and it cannot be determined if UE switches TX chains from A to C or D or from B to C or D, the switching time is sum of max{Tswitch\_A-C, Tswitch\_A-D,} and max{Tswitch\_B-C, Tswitch\_B-D}.
	+ Include clearly the aspect that when two TX chains are switched with different lengths of the switching periods, none of the TX chains are expected to be used for transmissions.
		- Option A3: New switching periods capabilities are defined as uplinkTxSwitchingPeriod1T1Tto2T and uplinkTxSwitchingPeriod1T1Tto1T1T per two band pairs (QC)
	+ QC:
		- * Allowing UE a longer switching time for {1T,1T,0T,0T} to {0T,0T,1T,1T} case increases UL opportunities and therefore network performance.
			* In RAN1 feasibility study and simulations for 3 and 4 band TX switching, longer switching time for all cases was assumed and throughput gain over 2-band switching case is still achieved
			* If longer switching time is specified for case {1T,1T,0T,0T} to {0T,0T,1T,1T} that is valid only for dualUL, the dualUL network throughput performance over the switchedUL is still much better.
	+ Option B: Keep the previous agreements (HW, ZTE, OPPO)
		- HW:
	+ Adding new values to the agreed switching period set is not expected.
		- * Rel-18 Tx switching can work well based on the previous agreement without error.
			* Adding new values would increase the complexity from the perspective of network.
	+ Sum of two switching periods is not expected.
		- * The illustrated time mask on summing of two switching periods has been precluded in the last meeting since it violate the RAN1 agreement.
			* According to RAN1’s evaluation, too long switching period would results in worse performance for Tx switching than semi-static UL CA or single uplink.
	+ The worse optional capability results from the sum of switching periods should not be introduced considering optional capability is equivalent to advanced capability from RAN2’s logic.
		- ZTE: Switching period longer than 210us would cause NW performance degradation
		- OPPO:
	+ It is unclear why only 70us and 175us are needed but 140+140, 35+210, 140+210, 210+210 are not needed.
	+ Large switch period will make the Tx switching feature no useful.
	+ It is UE choice which value among 35us, 140us and 210us will be reported, and if UE cannot do parallel switching of two band pairs then it is free to choose a larger value to cover the whole switching periods.
* **Recommended WF:**
	+ Companies are encouraged to review the new Option A3 from Qualcomm.

#### Issue 1-1-2: Switching case across three bands, i.e., {1T, 1T, 0T} to {0T, 0T, 2T}

***Background: WF in RAN4 #106-bis-e***

* *Further discuss in the next meeting:*
	+ *Option A: As optional UE behaviour, total switching period can be extended if UE is not capable for concurrent TX switching on the two TX chains.*
		- *Option A1: add new values {70, 175} usec in addition to the agreed set of {35 us, 140 us, 210 us}*
		- *Option A2: Sum of two switching periods*
	+ *When UE is scheduled to switch two TX chains in such way that switching periods may overlap, the switching period is extended for both band pairs and total switching time is the sum of possible switching periods for the band pairs involved.*
	+ *Option B: Keep the previous agreements*
* **Recommended WF:**
	+ If any further conclusion can be made for Issue 1-1-1, it applies to Issue 1-1-2 as well.

#### Issue 1-1-3: The unaffected band case

***Background: WF in RAN4 #106-bis-e****:*

* *Further discuss in the next meeting:*
	+ *Option 1: When UE is scheduled for UL transmissions on any band other than the bands involved in switching, the switching time is the sum of switching periods indicated for the band pair involved in switching and the band pair including the unaffected band and the switch-to band*
	+ *Option 2: For the two band pairs switching with one common band, e.g., band pair A+B and band pair B+C, the band B is involved in switching event and it is not the unaffected band.*
	+ *Option 3: The previous agreement should be reused*
* **Proposals:**
	+ Option 1: When UE is scheduled for UL transmissions on any band other than the bands involved in switching, the switching time is the **sum** of switching periods indicated for the band pair involved in switching and the band pair including the unaffected band and the switch-to band (vivo)
	+ Option 2: When another band unaffected by the switching is transmitting while switching between two other band occur, the switching period is **double** the value declared by the UE for these bands. (QC)
	+ Option 3: The previous agreement should be reused (HW, ZTE, OPPO)
* **Recommended WF:**
	+ Further discuss.

### Sub-topic 1-2: 2-layer UL-MIMO support for carrier(s) capable of 2Tx

***Background: WF in RAN4 #106-bis-e*:**

* *Further discuss in the next meeting:*
	+ *Option 1: Mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx*
		- *DCM: RAN2 agreed that UL MIMO capability is used for UE to indicate 2Tx support. It means that UE need to indicate UL MIMO capability if UE wants to indicate 2Tx capability.*
	+ *For UE capability of 2-port UL transmission, RAN2 reuse the per-FS UL-MIMO UE capability (no spec change).*
	+ *Option 2: Not mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx*
* **Proposals:**
	+ Option 1: Mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx (China Telecom, NTT DOCOMO)
		- China Telecom: considering the aspects that: 1) UL throughput benefit, 2) moderate complexity increase, 3) specification consistency with the Rel-16/17 Tx switching, 4) specification consistency with RAN2 for Rel-18 Tx switching.
		- DCM: RAN2 agreed that UL MIMO capability is used for UE to indicate 2Tx support. It means that UE need to indicate UL MIMO capability if UE wants to indicate 2Tx capability.
	+ *For UE capability of 2-port UL transmission, RAN2 reuse the per-FS UL-MIMO UE capability (no spec change).*
	+ Option 2: Not mandate 2-layer UL-MIMO support for carrier(s) capable of 2Tx (vivo, Apple)
		- Apple:
	+ Tx switching and UL-MIMO features are configured differently in the Release 18 specifications and should be independently implemented to allow flexibility.
	+ There are implementation and cost challenges for implementing UE UL-MIMO feature. This could make this feature optional, and not mandatory.
	+ In the current Release 18 specifications, the UL-MIMO feature is only defined for a limited number of NR bands whereas there are several UL CA combinations that do not involve UL-MIMO bands.
	+ The RF requirements in Release 18 are grouped separately for UL-MIMO and TxD and the corresponding requirements are defined in different clauses.
* **Recommended WF:**
	+ Further discuss.

### Sub-topic 1-3: Band configurations for Rel-18 Tx switching

* Proposals:
	+ Option 1: No need to introduce the band configurations for Rel-18 Tx switching in RAN4 specification, which means all existing *band* configurations can support Rel-18 Tx switching based on optional UE capability (Huawei, China Telecom, NTT DOCOMO)
		- Huawei:
	+ Band combinations along with UL configuration are up to the operators’ demand. And the existing CA/SUL band combinations can be reused for Rel-18 Tx switching.
	+ The network would schedule the switching between band pairs for a band combination according to the reported band pairs and UL configurations. And the network can avoid scheduling Tx switching that result in concurrent transmission for two bands without UL CA configuration.
	+ Rel-18 should introduce Tx switching capability per band combination.



* + - China Telecom:
	+ The band combinations supporting Rel-18 Tx switching across 3/4 bands are up to UE implementation and reporting.
	+ No BC specific requirement for Rel-18 Tx switching is needed. For the use of Tx switching across 3/4 bands, the generic Rel-18 Tx switching requirement (i.e., CR endorsed in RAN4 #106) and the existing CA/SUL BC specific requirements are sufficient.
	+ When there are necessary BC specific RF requirements to be discussed and specified, e.g., DL interruption due to Tx switching, we support to discuss the requirement per BC basis and capture the agreement in the RAN4 specification.
	+ Option 2: for the ease of implementation, we propose that band configurations for UL Tx switching across 3 and 4 bands should be included in the specifications. (Apple, Ericsson, Qualcomm)
		- Observation #1: In the current specifications (see Table 5.5A.3.2-1 and Table 5.5A.3.3-1) there are 3-band and 4-band CA combinations where there are no band pairs configured for UL CA. Therefore, UL Tx switching cannot be configured for those band combinations.
		- Observation #2: Not all the band pairs within a 3-band or 4-band CA combination can be configured for UL Tx switching because in the current specifications there are 3-band and 4-band CA combinations where only some band pairs are configured for UL CA. (see Table 5.5A.3.2-1 and Table 5.5A.3.3-1).
		- Observation #3: For every band pair configured for UL Tx switching within the 3-band or 4-band CA combination, the switching mode (0Tx+2Tx, 2Tx+0Tx, 1Tx+1Tx) should be defined, based on the UL MIMO capability on each band.
	+ Option 3: Not to introduce a new table but to introduce a new column or NOTE into existing band configuration tables to indicate which band combination can support Rel-18 Tx switching, and the indication in the specification can be updated directly by submitting CR, which means we don’t need to follow a basket WI approach. (NTT DOCOMO)
* **Recommended WF:**
	+ Companies are firstly encouraged to check if there is any technical misunderstanding for the Observation #1 and #2 under Option 2, especially considering the following text from the RAN4 endorsed CR:

*For each uplink band pair, according to the capability [uplinkTxSwitching-OptionSupport],*

*– if* ***switchedUL is supported****, uplink transmission on any one band of the band pair in the band combination shall be supported according to the scheduling commands, and* ***the corresponding inter-band CA requirements with one UL band on band X or band Y shall be satisfied****;*

*– if* ***dualUL is supported****, simultaneous uplink transmission on the two NR UL bands from the band pair for which dualUL is declared in the band combination shall be supported according to the scheduling commands, and* ***the corresponding inter-band CA requirements with two uplink bands shall be satisfied****.*

### Sub-topic 1-4: Exact location of switching period

* ***Background: WF in RAN4 #106-bis-e***

*For Rel-18 Tx switching, further discuss the following options taking into account RAN1 response:*

* + *Option 1: the switching period immediately precedes the time T0 at which a transmission starts on a carrier following a Tx switch from a preceding transmission*
		- *Option 1a: the switching period ends at time T0*
	+ *Option 2: define the time relation of the switching period location and T0 for two cases with the switching period located on the* ***switch-from*** *carrier and* ***switch-to*** *carrier respectively.*
		- *The switching period location is determined based on the following RAN1 agreement:*

*The gNB configures priority for each band. The UE determines the switching period location on either switching-from band(s) or switching-to band(s) that is involved in the UL Tx switching and is not with the highest priority band.*

* + *Option 3: No need to define the time relationship between the location of the switching period and T\_0 in RAN4 specification*
* **Proposalsfor Rel-18 Tx switching across 3 or 4 bands:**
	+ Option 1: The switching period end should always be anchored to the start of the UL transmissions on the switched-to carrier (Apple)
		- T0 is the time at which the UE starts UL transmissions on the switched-to carrier after the switching period, for both single-TAG and dual-TAG.
	+ Option 2: define the time relation of the switching period location and T0 for two cases with the switching period located on the **switch-from** carrier and **switch-to** carrier respectively. (HW, China Telecom, NTT DOCOMO)
		- NOTE: The switching period location is determined based on the following RAN1 agreement:

*The gNB configures priority for each band. The UE determines the switching period location on either switching-from band(s) or switching-to band(s) that is involved in the UL Tx switching and is not with the highest priority band.*

* + - HW: Define one actual start point Tstart for both the band pairs in the Tx switching instance.
		- NTT DOCMO: note that “sufficient time gap” here does not mean “Toffset” but means “switching periods”
	+ Option 3: No need to define the time relationship between the location of the switching period and T\_0 in RAN4 specification (Xiaomi)
	+ Option 4: For switching within one band pair of a 3-4 band combination (E///)
		- if an uplink switching is triggered for an uplink transmission starting at *T0* based on higher layer configuration(s) or DCI(s) received before *T0* − *Toffset* as specified in 38.214 and the UE is not scheduled or configured with uplink transmissions for a duration of at least the uplink switching gap $N\_{Tx1-Tx2}$ on *any of the carriers* before *T0*, then
	+ transient periods of 10 s are located at the end of the last symbol(s) scheduled on the carriers before *T0* and at the start of the first symbol(s) scheduled or configured after *T0*.

without concurrent switching on any other band pair. The band propriety configured by the gNB can be ignored in this case.

* + - if for concurrent switching on two band pairs the network provides a transmission gap on all carriers absorbing the sum of the switching period capabilties of the said band pairs, then transmissions start the time(s) T0 with switching completed and
	+ transient periods of 10 s are located at the end of the last symbol(s) *scheduled* on the carriers before the time(s) *T0* and at the start of the first symbol(s) scheduled or configured after the time(s) *T0*.
	+ Option 5: Postpone the discussion of exact location of switching period until feedback from RAN1 can be received. (vivo)
* **Recommended WF:**
	+ To conclude this issue in time and also consider the RAN1 specification status, further discuss option 1 and option 2 after RAN4 receives the RAN1 feedback.

### Sub-topic 1-5: Switching case across three bands, i.e., switch between {1T, 1T, 0T} and {0T, 0T, 2T}

#### Issue 1-5-1: Advanced optional UE ability

* ***Background: WF in RAN4 #106-bis-e***
	+ *Option 1: For the switching scenario without ambiguity, i.e., the two Tx chains are on the same band before or after switching (switch between {1T, 1T, 0T} and {0T, 0T, 2T}), introduce advanced optional UE ability to allow the Tx chain #1 to be used for transmission during the time duration of (Tswitch\_2 - Tswitch\_1).*
		- *Tswitch\_1 and Tswitch\_2 are the switching periods of Tx chain #1 and Tx chain #2 respectively,and Tswitch\_1 < Tswitch\_2.*
		- *Option 1a: apply the same UE capability for this scenario and for the following scenario agreed in the previous meetings. (MTK, China Telecom, ZTE)*

*RAN4 LS approved in R4-2303507:*

*When one of the two Tx chains is triggered to switch from one band (named “band A”) to another band (name “band B”), the other Tx chain is maintained on a different band (named “band C” or “band D” in the case of 4-band) and the number of Tx chain on band C or band D is unchanged due to the switching, RAN4 agreed the granularity of the optional UE capability to allow UL transmission on the band with the number of Tx chain unchanged during UL switching as follows:*

* *Per band (only for the band(s) in the band combination but not included in the pair of bands before and after switching) for each pair of bands before and after switching in each band combination.*
	+ *Option 2: Not introduce advanced optional UE ability*
* **Proposals:**
	+ Option 1: For Tx switching between {1T, 1T, 0T} and {0T, 0T, 2T}, introduce advanced optional UE ability to allow the Tx chain #1 to be used for transmission during the time duration of (Tswitch\_2 - Tswitch\_1) (China Telecom, ZTE)
		- Tswitch\_1 and Tswitch\_2 are the switching periods of Tx chain #1 and Tx chain #2 respectivelyand Tswitch\_1 < Tswitch\_2.
		- Apply the same UE capability with the same granularity for this scenario and for the scenario approved in RAN4 LS in R4-2303507.
	+ Option 2: Not introduce advanced optional UE ability (vivo)
* **Recommended WF:**
	+ Further discuss.

### Sub-topic 1-6: Switching case across four bands, i.e., {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T}

#### Issue 1-6-1: Ambiguity issue

* ***Background: WF in RAN4 #106-bis-e***
	+ *RAN4 maintains the baseline assumption in Issue 1-2-3 agreed in R4-2220546 during RAN4#105.*
	+ *Neither of the two Tx chains is expected to be used for transmission during the switching periods in Rel-18*
	+ *Encourage companies to study the benefit to resolve the switching pattern ambiguity issue when 2 Tx chains are switched between two different band pairs for one Tx switching instance*
		- *At least for single TAG*
		- *FFS whether it applies to dual TAG*
* **Views on the benefit:**
	+ View #1: If the UE is able to perform Tx switching with the band pairs that are corresponded to shorter switching period, the UE could utilize more resources to transmit uplink signal/channels compared to baseline. (HW, ZTE, MTK)
	+ View #2: There is no clear benefit to solve this no harm “ambiguity”. (OPPO)
		- OPPO: There is no benefit when the two Tx chain switching periods are same. The benefit only shows when one of the Tx chain needs to be reloaded for all components, i.e. 210us applied for this chain and 140us apply for the other chain. And this is corner case.
* **Proposals on the solutions to resolve the switching pattern ambiguity issue:**
	+ Option 1: For the parallel switching of two Tx chain in the case {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T} on bands {A, B, C, D}, in addition to the baseline UE assumption agreed in RAN4 #105, introduce optional UE capability with the switching period **min** {max(Tswitch\_A-C, Tswitch\_B-D), max(Tswitch\_A-D, Tswitch\_B-C)}. (HW)
	+ Option 2: RAN4 to agree on the **band ordering** based approach to resolve the ambiguity issue. (MTK)
		- Associating the ordering of bands for defining switch-from and switch-to pairs in switching configuration commands may resolve the ambiguity issue without additional cost.
	+ Option 3: Introduce new Tx switching period capability **for the switched case** from A+B to C+D and other band group pairs before and after switching. (OPPO)
	+ Option 4: Introduce new **per Tx chain-based** Tx switching capability (OPPO)
* **Recommended WF:**
	+ Further discuss

#### Issue 1-6-2: Advanced optional UE ability

* ***Background: WF in RAN4 #106-bis-e***
	+ *For the switching scenario of {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T} on bands {A, B, C, D}, discuss and decide whether or not to introduce the advanced optional UE ability to allow one Tx chain to start transmission earlier if the switching time for this Tx chain is shorter.*
* **Proposals:** For the switching scenario of {1T, 1T, 0T, 0T} to {0T, 0T, 1T, 1T} on bands {A, B, C, D}, with the ambiguity issue **resolved** or **unresolved**
	+ Option 1: not to introduce the advanced optional UE ability to allow one Tx chain to start transmission earlier if the switching time for this Tx chain is shorter. (vivo)
* **Recommended WF:**
	+ Is option 1 agreeable?

# Topic #2: Tx switching with dual TAGs

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307158 | Huawei, HiSilicon | Discussion on Multi-carrier enhancements with multiple TAGObservation 1: Time mask is not applicable when gNB provides sufficient time between the end of the UL transmission on the switch-from carrier and the start of the UL transmission on the switch-to carrier that is longer than the switching period, since no transmission is affected and the RRC configuration of uplinkTxSwitchingPeriodLocation does not take effect.Observation 2: The introduction of T0 is to avoid twisted-order scheduling. And T0 represents the starting symbol of the scheduled or configured PUSCH transmission.Observation 3: When the time of no UL transmission allocated is longer than the switching period, fixed time domain location of switching period would cause backward compatibility issue and sacrifice the flexibility of the UE.Observation 4: When the time of no UL transmission allocated is shorter than the switching period, and the switching period location is configured on the switch-to band, fixed time domain location of switching period is conflict with the RRC configuration.Observation 5: RAN5 specified the test procedure according to the time mask in RAN4 spec that ‘Measure the output power of UE PUSCH transmission for carrier 1 during slot n-1 excluding a transient period of 10 µs and a Switching period X µs in the end of slot n-1’.Observation 6: Time mask is not used to specify the network scheduling restriction.Proposal 1: In 2-TAG, the time mask may not be modified due to the scheduling restriction.Proposal 2: 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/bands.Proposal 3: The standard impact from Tx switching in 2-TAG is:* Option a: Scheduling restriction

The UE is not expected to transmit PUCCH/PUSCH/SRS on OFDM symbols that overlaps with the switching period on both the carriers/bands. * Option b: The duration for UE omitting uplink transmission is switching period+1 symbol.
 |
| R4-2307159 | Huawei, HiSilicon, Xiaomi | draftCR for 38.101-1 to clarify the time mask for switching with multiple TAGs |
| R4-2307743 | Ericsson | The dual-TAG caseProposal 1: amend the specification of the transient period locations for the case when the network provides a transmission gap before T0 long enough to absorb the entire switching period for all cases in clause 6.1.6 using the notions of 38.214: - if an uplink switching is triggered for an uplink transmission starting at T0 based on higher layer configuration(s) or DCI(s) received before T0 − Toffset as specified in 38.214 and the UE is not scheduled or configured with uplink transmissions for a duration of at least the uplink switching gap on any of the carriers before T0, transient periods of 10 ms are located at the end of the last symbol(s) scheduled on the carriers before T0 and at the start of the first symbol(s) scheduled or configured after T0also for the dual TAG case with the UE scheduled or configured with uplink transmissions that do not result in- simultaneous transmission on two antenna ports on one uplink carrier on one band, and any transmission on another uplink carrier on another band and- transmission of any one of the carriers during the uplink switching gap for a timing difference between the uplink carriers up to the MTTD = 34.6 µs.FurthermoreProposal 2: there is no need to specify the minimum UL outage time for the dual TAG case. The minimum outage UL time for dual TAG in number of OS would be evident from the time masks with TA difference: one more OFDM symbol of a duration longer than MTTD may be needed as compared to the minimum outage for single-TAG case.  |
| R4-2307744 | Ericsson | CR: Time masks for uplink Tx switching with dual TAG  |
| R4-2309003 | Xiaomi | Discussion on UL Tx switchingProposal 3: Do not modify the time mask for Tx switching for multiple TAGs. |

## Open issues summary

### Sub-topic 2-1: RF specification impact

* **Proposals:**
	+ Option 1 (E///):
		- Proposal 1: amend the specification of the transient period locations for the case when the network provides a transmission gap before T0 long enough to absorb the entire switching period for all cases in clause 6.1.6 using the notions of 38.214:
	+ if an uplink switching is triggered for an uplink transmission starting at T0 based on higher layer configuration(s) or DCI(s) received before T0 − Toffset as specified in 38.214 and the UE is not scheduled or configured with uplink transmissions for a duration of at least the uplink switching gap $N\_{Tx1-Tx2}$ on any of the carriers before T0, transient periods of 10 ms are located at the end of the last symbol(s) scheduled on the carriers before T0 and at the start of the first symbol(s) scheduled or configured after T0

also for the dual TAG case with the UE scheduled or configured with uplink transmissions that do not result in

* + simultaneous transmission on two antenna ports on one uplink carrier on one band, and any transmission on another uplink carrier on another band and
	+ transmission of any one of the carriers during the uplink switching gap $N\_{Tx1-Tx2} $for a timing difference between the uplink carriers up to the MTTD = 34.6 µs.
		- Proposal 2: there is no need to specify the minimum UL outage time for the dual TAG case. The minimum outage UL time for dual TAG in number of OS would be evident from the time masks with TA difference: one more OFDM symbol of a duration longer than MTTD may be needed as compared to the minimum outage for single-TAG case.
	+ Option 2: Do not modify the time mask for Tx switching for multiple TAGs. The impact of Tx switching with multiple TAGs can be considered as scheduling restriction. (HW, Xiaomi)
		- HW: The standard impact from Tx switching in 2-TAG is:
	+ Option a: Scheduling restriction. The UE is not expected to transmit PUCCH/PUSCH/SRS on OFDM symbols that overlaps with the switching period on both the carriers/bands.
	+ Option b: The duration for UE omitting uplink transmission is switching period+1 symbol.
* **Recommended WF:**
	+ Further discuss

# Topic #3: Reply LS to RAN2

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307256 | China Telecom | Draft reply LS on the report of switching periods in Rel-18 UL Tx switchingRAN4 Answer to Question 1:RAN4 agrees with the above agreement on RAN2 intention. In addition, as described in an earlier RAN4 LS in R4-2303507, RAN4 also discussed the scenario of 1Tx-1Tx switching, i.e., the UL carriers in both bands before and after switching are capable of one transmit antenna connector, and agreed to apply the same length of switching period for 1Tx-1Tx switching and 1Tx-2Tx switching. It means that for the band pair supporting 1Tx-2Tx switching, the UE always support 1Tx-1Tx switching with the same length of switching period.RAN4 Answer to Question 2:RAN4 agrees with the above two bullets in RAN2 assumptions.RAN4 Answer to Question 3:The option 2 above matches RAN4 understanding. As described in an earlier RAN4 LS in R4-2214464, it is RAN4 understanding that: * For UE reporting different periods for 1Tx-2Tx switching and 2Tx-2Tx switching for a band pair, similar to Rel-17, it is RAN4 understanding that the 2Tx-2Tx switching period is applied when 2Tx-2Tx switching mode is configured.
 |
| R4-2307304 | NTT DOCOMO, INC. | Views on Rel-18 Tx switchingProposal 3: RAN4 answer to RAN2 question 1 in R2-2304567 is described as following:* RAN4 confirms that there is no issues for RAN2 conclusion, and it is aligned with RAN4 understanding.

Proposal 4: RAN4 answer to RAN2 question 2 in R2-2304567 is described as following:* For 1st bullet in question 2, RAN4 confirms that it has no issues from RAN4 perspective:
	+ For the band pair supporting 2Tx-2Tx switching, the UE always support 1Tx-2Tx switching.
* For 2nd bullet question 2, RAN4 confirm the following:
	+ The UE always supports 2Tx-2Tx switching on a pair of bands if the UE supports 2 layers/ports UL MIMO on the two bands

Observation 4: For question 3 in R2-2304567, it may be straightforward to take option 1. |
| R4-2308161 | ZTE Corporation | Discussion on draft reply LS on report of switching periods in Rel-18 UL Tx switchingAnswer to Question 1. RAN4’s understanding is: UE shall support 2Tx-2Tx switching on this pair of bands if the UE supports 2 layers/ports UL MIMO on the two bands. Answer to Question 2. It is also RAN4’s understanding that for the band pair supporting 2Tx-2Tx switching, the UE supports 1Tx-2Tx switching as well, and UE can report per-band-pair UE capability to support 2Tx-2Tx switching capability.Answer to Question 3. RAN4 share same understanding as Option 1. |
| R4-2308245 | vivo | [Draft] Reply LS on report of switching periods in Rel-18 UL Tx switchingFor Question 1 and Question 2, RAN4 do not have any issues.For Question 3, RAN4 believe that reusing Rel-17 principle is enough, that is for UE reporting different periods for 1Tx-2Tx switching and 2Tx-2Tx switching for a band pair, the 2Tx-2Tx switching period is applied when 2Tx-2Tx switching mode is configured. This is close to the option 2 mentioned in the LS in that this principle can be an explicit RRC configuration. |

## Open issues summary

### Sub-topic 3-1: RAN4 Answer to Question 1

**RAN2 Question 1:**

*RAN2 has discussed introduction of UE capability for length of switching periods. RAN2 has taken following RAN4 agreement in RAN4#104-e into account.*

|  |
| --- |
| *Agreement:**On the length of switching period:** *For UL switching period with Tx switching across 3 or 4 bands, RAN4 agreed to reuse the same set of values as in Rel-16/17, i.e., {35 us, 140 us, 210 us} for UL CA and SUL.*
* *The length of switching period is applied per band pair for each band combination.*
* *For each band pair, the switching period can be the same or different for 1Tx-2Tx switching and 2Tx-2Tx switching based on UE reporting, which is similar as in Rel-17.*
	+ *Note: For UE reporting different periods for 1Tx-2Tx switching and 2Tx-2Tx switching for a band pair, similar to Rel-17, it is RAN4 understanding that the 2Tx-2Tx switching period is applied when 2Tx-2Tx switching mode is configured.*
 |

*RAN2 could not achieve conclusion, but has agreed an intention below in RAN2#121bis-e:*

|  |
| --- |
| * *In support of RAN4 agreement, RAN2 intend to introduce support for two per-band-pair UE capabilities, a length of a switching period, for 1Tx-2Tx switching (like Rel-16) and that for 2Tx-2Tx switching (like Rel-17).*
 |

*Question 1. (To RAN1 and RAN4)*

*RAN2 respectfully asks RAN1 and RAN4 to take above agreement on RAN2 intention into account* *and asks for feedback if there is any issue.*

* **Proposals on RAN4 Answer to Question 1**
	+ Option 1: RAN4 agrees with the above agreement on RAN2 intention. (China Telecom, NTT DOCOMO, vivo)
		- Option 1a (China Telecom): In addition, as described in an earlier RAN4 LS in R4-2303507, RAN4 also discussed the scenario of 1Tx-1Tx switching, i.e., the UL carriers in both bands before and after switching are capable of one transmit antenna connector, and agreed to apply the same length of switching period for 1Tx-1Tx switching and 1Tx-2Tx switching. It means that for the band pair supporting 1Tx-2Tx switching, the UE always support 1Tx-1Tx switching with the same length of switching period.
* **Recommended WF:**
	+ Option 1 is agreeable, and further discuss whether to add the information in Option 1a in the reply LS.

### Sub-topic 3-2: RAN4 Answer to Question 2

**RAN2 Question 2:**

*RAN2 could not conclude whether the UE needs to explicitly report if it supports 2Tx-2Tx switching for every band pair used for Rel-18 UL Tx switching.*

*RAN2 is not sure which is the correct understanding:*

* *The UE always supports 2Tx-2Tx switching on a pair of bands if the UE supports 2 layers/ports UL MIMO on the two bands*
* *The UE may not support 2Tx-2Tx switching on a pair of bands even if the UE supports 2 layers/ports UL MIMO on the two bands (i.e., per-band-pair UE capability to report whether to support 2Tx-2Tx switching is needed, e.g. based on the presence/absence of 2Tx-2Tx switching period).*

*Question 2. (To RAN4)*

*RAN2 respectfully asks RAN4 to take below RAN2 assumptions into account and asks for feedback if there is any issue:*

* *For the band pair supporting 2Tx-2Tx switching, the UE always support 1Tx-2Tx switching.*
* *The UE reports whether it supports 2Tx-2Tx switching via per-band-pair UE capability.*
* **Proposals on RAN4 Answer to Question 2**
	+ Option 1: RAN4 agrees with the above two bullets in RAN2 assumptions. (China Telecom, ZTE, vivo)
	+ Option 2: (NTT DOCOMO)
		- For 1st bullet in question 2, RAN4 confirms that it has no issues from RAN4 perspective.
		- For 2nd bullet question 2, RAN4 confirm the following: The UE always supports 2Tx-2Tx switching on a pair of bands if the UE supports 2 layers/ports UL MIMO on the two bands
* **Recommended WF:**
	+ For 1st bullet in question 2: RAN4 agrees with this bullet
	+ For 2nd bullet in question 2: further discuss

### Sub-topic 3-3: RAN4 Answer to Question 3

**RAN2 Question 3:**

*RAN2 has discussed how the gNB knows which of the reported switching periods (for 1Tx-2Tx switching or for 2Tx-2Tx) should be applied for every switching but could not conclude.*

*Question 3. (To RAN4)*

*RAN2 respectfully asks RAN4 which of the options below matches RAN4 understanding on the selection of applied switching periods when both switching periods of 2Tx-2Tx switching and 1Tx-2Tx switching can be reported for the same band pair.*

*Option 1: Based on implicit rules, e.g. 2Tx-2Tx switching period is only applicable when performing UL switching between two bands (e.g. 2P+0P<=>0P+2P) and 1Tx-2Tx period is applied for the other switching cases (e.g. UL Tx switching that involves 3 or 4 bands, such as band A + band B<=>band C, band A+ band B <=>band C + band D). FFS on the switching case of 2P+0P<=>1P+1P.*

*Option 2: Based on explicit RRC configuration, i.e., gNB configures which period is applied. FFS on the granularity of the configuration.*

*Question 4. (To RAN1)*

*RAN2 respectfully asks RAN1 to take above discussion on RAN2 and question to RAN4 into account and asks for feedback if there is any issue.*

* **Proposals on RAN4 Answer to Question 3**
	+ Option 1: The option 1 above matches RAN4 understanding. (NTT DOCOMO, ZTE)
	+ Option 2: The option 2 above matches RAN4 understanding. (China Telecom, vivo)
* **Recommended WF:**
	+ Further discuss