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

**Electronic Meeting, August 15 - August 26, 2022**

**Source: China Telecom**

**Title: WF on UL Tx switching across 3/4 bands with single TAG**

**Agenda Item: 11.15.2**

**Document for: Approval**

# Way Forward

### Sub-topic 2-1: Switching period for Tx switching across 3/4 bands

#### Issue 2-1-1: Set of values for Tx switching period

RAN4 agreements have been captured in the reply LS to RAN1.

#### Issue 2-1-2: Granularity of Tx switching period

RAN4 agreements have been captured in the reply LS to RAN1.

#### Issue 2-1-3: Exact value of Tx switching period

*Summary of round 1 discussion*

* + Option 1: Reuse the ***same*** switching period for each band pair as UE reported in Rel-16/17, i.e., UE does not need to report new or larger switching period per band pair for Rel-18. (China Telecom, HW, Xiaomi, OPPO, ZTE, CMCC)
	+ Option 2: Although the set of switching periods is the same as in Rel-16/17, a ***different*** value can be reported for each band pair in Rel-18 band combination with 3/4 bands. (MTK, QC, Samsung, OPPO, Sony, vivo, Apple)
	+ Option 3: needs further clarification (Nokia)
		- Nokia: The two options need to be clarified. Suppose a switching period for CA\_n1-n2 is X us.
			* If a UE supports Tx switching across n1, n2 and n3, then, does option 1 says that X us is applicable to a case CA\_n1-n2 is the UL?
			* On the other hand, does option 2 say that the value may not be always the same as that of X us?

***Discussion in round 2:***

* + In moderator’s understanding, the example from Nokia does reflect the difference of option 1 and option 2.
	+ With this understanding, further discussion on the two options and possible compromised proposal are encouraged.

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| **Company** | **Comments** |
| Nokia | We’d like to discuss this after all other aspects related to signaling become clear. Option 1 has advantage in terms of signaling overhead reduction while the Option 2 has advantage in terms of switching performance meaning that a UE does not have to take max period among UL pairs with the different number of bands pool(2, 3 or 4) if the required periods are different.CA\_n1-n2 (across 2 bands) : period of 35 usCA\_n1-n2 (across 3 bands, e.g., n1, n2 and n3): period of 140 usCA\_n1-n2 (across 4 bands, e.g., n1, n2, n3 and n4): period 210 usOption 1 may force UE to report 210 us while Option 2 allows UE to report the minimum required period for each case. |
| China Telecom | The main motivation of option 1 is not for reducing the singalling overhead, but **not increase** the switching time in the case with 3/4 bands configured.In our understanding, in Nokia’s example above, If CA\_n1-n2 (across 2 bands) : period of 35 us,Then, CA\_n1-n2 (across 3 bands, e.g., n1, n2 and n3): period of 35 us, and CA\_n1-n2 (across 4 bands, e.g., n1, n2, n3 and n4): period of 35 usFor Rel-18, although the configured bands are increased to be 3 or 4, the switching is still conducted between 2 bands for each switching occasion, with the same UE switching behavior as in Rel-16/17. Therefore, the switching time is not expected to be increased with 3/4 bands configured. |
| Nokia | To: CTCIf the real UE implementation can bring the same value as CTC assume that “across 3 or 3” doesn’t increase switching period in terms of implementation at all, it’s not a problem with Option 1. We are just saying if your assumption doesn’t hold with Option 1, the UE has to report the max. Hence we would like to know specific reasons and the details if UE vendors prefer to option 2. |
| Huawei, Hisilicon | We support Option 1. The reason that a switching period different from Rel-16 was introduced in Rel-17 is that Rel-16 does not support the Tx switching of 0T+2T ↔ 2T+0T. We don’t think there is a novel switching pattern between band pair in Rel-18 other than 0T+2T ↔ 2T+0T and 0T+2T ↔ 1T+1T. No matter how many bands are configured to the UE, the value of switching period depends on the band pair with 2 bands the Tx chain switched to and switched from. For the case that the switching periods of two band pairs are different, the UE would report the two values with the specified rules. And the same switching period for each band pair as Rel-16/17 can be reused. |
| NTT DOCOMO | If the option 1 is based on the assumption CTC mentioned, out preference is option 1. |
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### Sub-topic 2-2: Impact from switching of one Tx chain on the other Tx chain

#### Issue 2-2-1: Impact on the band with the number of Tx chain ***changed*** due to switching

RAN4 agreements have been captured in the reply LS to RAN1.

#### Issue 2-2-2: Impact on the band with the number of Tx chain ***unchanged*** due to switching

* Issue description
	+ When one of the two Tx chains is triggered to switch from one band (named “band A”) to another band (name “band B”), and the other Tx chain is maintained on a different band (named “band C”), is the other Tx chain is **expected or not expected** to be used for transmission on band C during the switching period?

*Note:* this is a new scenario/pattern not discussed in Rel-16/17 (NTT DOCOMO, China Telecom)

*Summary of round 1 discussion:*

* + Option 1: Expected (China Telecom, ZTE, NTT DOCOMO & CMCC - for advanced UE assumption, Nokia)
	+ Option 2: Not expected (Apple, MediaTek, NTT DOCOMO & CMCC & vivo - for baseline UE assumption, Samsung, OPPO, Huawei, HiSilicon, Sony, Apple)

***Discussion in round 2:***

* + Is the following proposal from DCM and CMCC agreeable?
		- Baseline UE assumption: Not expected
		- For advanced/optional UE assumption: Expected

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| **Company** | **Comments** |
| Nokia | We support the above proposal. |
| China Telecom | We support the above proposal as compromise.The impact of switching between one band pair on another band will bring system performance degradation. A trade-off needs to be considered. |
| Huawei, Hisilicon | We disagree with the proposal. The baseline assumption is applicable for all cases.If Option1 is considered, for the case that the switching periods between A→B and C→D are different, the Tx chain completing switching first (e.g., A→B) should be allowed to transmit first and the uplink transmission on the other Tx chain(e.g., C→D) follows. The consequence is the uplink transmission on band B is ahead of that on band D. It is an obstacle to perform UL CA on the two bands.Furthermore, for the case that the switching periods between B→A and C→A are different, what should the UE do with the advanced assumption?Option 1 should not be pursued considering there are too many complicated scenarios. |
| NTT DOCOMO | Thank you, Huawei, for pointing out. We understand that such additional scenario may happen if we agree option 1.If such additional scenario is too complicated, one possible way is to limit the scenario mentioned in issue 2-2-2, i.e., when A+C is changed to B+C, C can continue transmission. We are open to discuss the down selection of scenarios. |
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### Sub-topic 2-3: Possible mechanisms for dynamic Tx carrier switching across the configured bands

#### Issue 2-3-2: Switching cases for CA option 2

*Summary of round 1 discussion:*

* + Proposal 1 (China Telecom): For Tx switching across 3 and 4 bands in Rel-18, for CA option 2 (i.e., dual UL), first confirm the feasibility that the 2 Tx chains can be switched between 2 different band pairs at the same time (e.g., Tx #1 from band A to band B, Tx #2 from band A to band C).
		- OPPO: It is feasible
		- HW: suggest focusing on the UL CA option 1 first
		- ZTE: Switching can happen at the same time, or the completion of switching should be at the same time?
			* China Telecom reply: the question is whether switching can happen at the same time.
		- Nokia: Is the below case included in above proposal? We assume this is within the scope of Rel-18 MC\_enh, but it needs to be discussed further if RAN4 specifies requirements for all the cases or not.



* + - * China Telecom reply: Yes, it is about the case you elaborated. It is also our understanding that this case in the Rel-18 scope, unless it is identified as unfeasible from UE side.
		- MTK: This is feasible only when timing difference between the different band pairs is small enough such as single-TAG for all the band pairs.

***Discussion in round 2:***

* Is the following proposal agreeable?
	+ From UE implementation perspective, in single-TAG scenario, it is feasible that the switching of 2 Tx chains between 2 different band pairs (e.g., Tx #1 from band A to band B, Tx #2 from band A to band C) can be conducted at the same time.
		- Whether this switching scenario is supported in Rel-18 is up to RAN1 decision.
		- If this switching scenario is supported in Rel-18, FFS whether to define corresponding requirements in RAN4.

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| **Company** | **Comments** |
| Nokia | We would like to see feedback of impact on switching period on this case and similar cases compared to the cases switching happens within the selected two UL band pairs. Because this will significantly increase the number of capabilities to be reported. |
| China Telecom | We think this is a valid case for CA option 2.Regarding Nokia comment, to our understanding, the per band pair switching period still applies in this case (e.g., applies to switching between A+B, and switching between A+C, respectively). No new switching period to be reported. |
| Huawei, Hisilicon | In our opinion, we should get some conclusion on option 1 first. With less complexity, it is easier to get some progress. |
| NTT DOCOMO | We are OK with the moderator’s  |
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### Sub-topic 2-4: PUSCH preparation time

#### Issue 2-4-1: PUSCH preparation procedure time / scheduling delay

To be discussed in RAN1.

### Sub-topic 2-5: Other issues

#### Issue 2-5-1: Concurrent UL transmission on 2 bands

RAN4 agreements have been captured in the reply LS to RAN1.

#### Issue 2-5-2: Number of bands supporting 2Tx

RAN4 agreements have been captured in the reply LS to RAN1.

#### Issue 2-5-3: Support of intra-band UL CA

* The following observation is aligned with the current WI scope approved in RAN plenary. Further update on the WI scope is not precluded and is up to RAN plenary decision.
	+ Observation: Scope of the WI is limited such way that only one band among 3 or 4 bands that are part of the configured TX switching scheme can have intra-band UL CA configured.

#### Issue 2-5-4: RF requirements for UL 3/4 bands CA

*Tentative agreement from round 1 summary:*

* + No need to define RF requirements for UL CA with UL simultaneous transmission on 3 and 4 bands in the WI.
	+ Further discuss the need of RF requirements for 3 and 4 band UL with non-simultaneous Tx operation.

***Proposed WF (updated the 2nd bullet):***

* + No need to define RF requirements for UL CA with UL simultaneous transmission on 3 and 4 bands in the WI.
	+ Further discuss the need of RF requirements for Tx switching across 3 and 4 UL bands with simultaneous transmission on up to 2 bands.

***Discussion in round 2:***

* Is the proposed WF agreeable?

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| **Company** | **Comments** |
| Nokia | Clarification of the 2nd bullet, for instance, if a UE is configured with Band A, B, C and D while Band A and B are used for transmission, does the 2nd bullet mean that we are going to discuss if there are requirements for Band C and Band D, e.g., these need to meet Tx OFF power etc? |
| China Telecom | It looks the 2nd bullet is high-level clarification on the scope, and the details are encouraged to be further checked. |
| Huawei,Hisilicon | We are ok with the first bullet. Given the comments from Nokia, we also would like to see more clarification for the possible RF requirements |
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