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

**Electronic Meeting, 10th-19th, Oct., 2022**

**Title:** WF on FeMIMO RRM impact for unified TCI state

**Agenda item:** 4.5.1

**Source:** Intel

**Document for:** Approval

# Way Forward on Unified TCI state

### Sub-topic 1-1 Active UL TCI state

**Issue1-1-1a If source RS in UL TCI state is in the DL active TCI list:**

* Agreements:
	+ No time/frequency tracking is needed.

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| **Company** | **Comments** |
| Apple | No separate time/frequency tracking is needed as UE is maintaining timing for RS in active DL TCI state list.  |
| Ericsson | We are fine with tentative agreement  |
| Intel | Support tentative agreement |
| ZTE | Fine with the Agreements |
| vivo | OK to the tentative agreement. |
| MediaTek | In general, we are fine with agreement. But, we prefer to have some modification to make it clearer.No additional time/frequency tracking for the source RS in UL TCI state is needed during TCI state switch. |

**Issue1-1-1b If source RS in UL TCI state is not in the DL active TCI list:**

* Proposals:
	+ Proposal 1: No time/frequency tracking is needed
	+ Proposal 2: Time/frequency tracking is needed
	+ Proposal 3: No requirement for the case. Adding applicability rules for current UL TCI switching when source RS in active UL TCI state is a subset of source RS in DL active TCI list
	+ Proposal 4: other option

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| **Company** | **Comments** |
| Apple | We support Proposal 1. The UL TCI state like UL spatial relation info gives the spatial filter for UL transmission only and not other QCL information. The UL timing is based on the DL serving cell timing and not the UL TCI state. What is the Ul timing to be used in a slot where 2 signals with different UL TCI state are to be transmitted. Also, if UE should follow the timing of DL-RS in UL TCI state, what is the expected behaviour if the RS in UL TCI is SRS?  |
| Ericsson | This is discussed over many meetings. Clearly there is different understanding among companies. Looking at the below IE, our understanding is maximum number of DL and UL TCI across CC seems independent. Unless there is a maximum RS (including DL and UL TCI) UE need to track is specified, our understanding is they are independent. unifiedSeparateTCI-r17                      SEQUENCE{         maxConfiguredDL-TCI-r17                     ENUMERATED {n4, n8, n12, n16, n24, n32, n48, n64, n128},         maxConfiguredUL-TCI-r17                     ENUMERATED {n4, n8, n12, n16, n24, n32, n48, n64},         maxActivatedDL-TCIAcrossCC-r17              ENUMERATED {n1, n2, n4, n8, n16},         maxActivatedUL-TCIAcrossCC-r17              ENUMERATED {n1, n2, n4, n8, n16}     } OPTIONAL,We think we should check with RAN1 so that we do not want to introduce additional restriction in RAN4 than what is specified in RAN1/2. |
| Intel | Prefer Option 1. It’s possible that the source RS in target UL TCI is different from the RS which is the reference of current DL timing. There may be performance loss due to timing mismatch. From our understanding, NW may try to avoid such configuration. UE will not spend more effort for time tracking for the case.For proposal 3, configuration of active UL TCI state and DL TCI active state are independent, and there is no limitation, we are open to further discuss. It’s something like previous discussion about Rel-16 uplink spatial info switch with PL-RS activation. RL-RS may be different from source RS in UL TCI, then the uplink power calculation may not be accurate. However, since there is no limitation in RAN1/RAN2, the final requirement didn’t consider add constraints. |
| ZTE | UL timing is derived from DL timing, No matter additional requirements defined or NW configuration guarantee, UE can transmit UL based on UL timing obtaining.We originally prefer Proposal 2. But if go along with Proposal 2, which means the UL TCI state switching requirement needs some update. Considering the additional workload, we can compromise to Proposal 3.For Proposal 1, we agree with Intel, the performance loss due to timing mismatch is possible, however Proposal 2 and 3 can avoid such performance loss. |
| vivo | In R17, from UE perspective, option 1 is preferred. However, we see the point in option 2 and we think such enhancement can be discussed in RAN1/RAN2 firstly in e.g. R18. Therefore, we think option 3 can be a compromised solution in R17. Note that it is only applicability to RRM requirements. |
| MediaTek | Disagree with option2. UE should not be required to perform additional time/frequency tracking for the source RS in the target UL TCI state. Prefer option 3. The source RS in the UL TCI is subset of DL active TCI state list. If no, no UE requirement will be applied. |

### Sub-topic 1-2 MAC CE based TCI state Switching delay requirements

**Issue 1-2-1 Joint TCI switching delay requirement for DL TCI state switch**

* Proposals:
	+ Proposal 1(Intel, MTK, vivo, Ericsson, Apple, Samsung,vivo, Qualcomm):
		- Remove the square bracket:

- In case of joint TCI state switch, UE is not expected to receive on DL before UE completes the DL and UL TCI state switch.

* + Proposal 2(Nokia):
		- For joint TCI state switch, if the UL TCI state switch delay exceeds the DL TCI state switch delay, the UE is required to receive in DL up to THARQ before it completes UL TCI state switch.
	+ Proposal 3(ZTE):
		- No matter whether UL TCI state switching completed or not, UE can receive DL by the target DL TCI state given that DL TCI state switching has been finished. So we suggest the bullet in square brackets can be ignored.

*Moderator note: As majority company support Proposal 1, suggest proponent of other proposals to check whether proposal 1 is agreeable.*

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| **Company** | **Comments** |
| Apple | Support proposal 1. |
| Ericsson | We think proposal 2 is kind of solution to dela with potential long UL TCI state switching. We are fine to further look into it. |
| Intel | Support proposal 1. Without HARQ feedback, NW can’t ensure that UE can receive correctly. |
| ZTE | Based on the discussion in GTW, Proposal 1 is acceptable to us. |
| vivo | We support option 1. |
| MediaTek | Support proposal 1 |

**Issue 1-2-2 MAC-CE based UL TCI state switching delay when SSB is indicated as PL-RS in UL TCI state for FR2**

* Proposals
	+ Proposal 1(Apple, Samsung, Huawei):
		- When PL-RS in UL TCI state switch is SSB in FR2, longer delay is expected.
	+ Proposal 2(Huawei, Apple, Samsung):
		- If no consensus can be achieved in RAN4, we suggest that there is no requirements when SSB is indicated as PL-RS in UL TCI state in FR2.
	+ Proposal 3(Intel):
		- When SSB is indicated as PL-RS in UL TCI state for FR2, the total delay is:

 - n+THARQ + 3ms + NM*\** (Tfirst\_target-PL-RS + 7\*Ttarget\_PL-RS + 2ms)

* + Proposal 4(MTK, vivo, Ericsson, ZTE, Qualcomm):
		- Reuse the existing delay requirement of MAC CE based UL TCI state switch.
	+ Proposal 5(Nokia):
		- known conditions:
		- The UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + $3N\_{slot}^{subframe,µ}$ + NM*\** (1\*Ttarget\_PL-RS + Tprocessingms) / *NR slot length*.

where:

 - NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.

 - PL-RS is considered maintained if the DL RS associated with the UL TCI state is in the active TCI state list.

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| **Company** | **Comments** |
| Apple | Proposal 1 or 2 is fine with us. With proposal 3, we are giving the UE 3 more sample to do RX beam sweeping? We don’t see how that is sufficient.  |
| Ericsson | We support proposal 4. |
| Intel | Prefer Proposal 3.To Apple: Since the SNR condition for TCI activation is higher than -6dB, less samples can be used for pathloss calculation compared with L3 measurement. Similar with L1-RSRP measurement, where 1 sample is used. Here we propose to use 1\*8=8 samples. Then Q can be 7. |
| ZTE | Prefer Proposal 4. |
| vivo | Prefer proposal 4. We think 5 samples are already enough. We think PL-RS measurement is different from L1 measurement. The requirement of ‘using 5 samples’ is only applicable when TCI state is known. Since UL TCI is known, there is no need for Rx beam sweeping. |
| MediaTek | Support proposal 4. |

### Sub-topic 1-3 Common TCI state switching in CA case

**Issue 1-3-1 Common TCI state switching delay requirement**

* Agreements:
	+ No further spec change is needed

### Sub-topic 1-4 TCI state list update delay

**Issue 1-4-1 Whether to consider unknown TCI state in the TCI state list**

* Proposals
	+ Proposal 1(Samsung, Apple, MTK, Huawei):
		- Longer delay applies if any TCI state is unknown in TCI state list update. Active TCI state list can contain known and unknown TCI states.
	+ Proposal 2(Ericsson, Nokia, ZTE,vivo):
		- Define the detailed delay requirement

*Moderate note: The wording of proposal 1 is from the GTW agreement with removed bracket in RAN4 #104 meeting.*

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| **Company** | **Comments** |
| Apple | We support option 1 as first priority, as the use case for unknown TCI state is unclear since we are trying to cover the case of MAC-CE activation and DCI based TCI state switch. |
| Ericsson | Support option 2. We agreed that unknown TCI state can be part of the TCI state list. We do not think specifying exact delay is not possible. Option 1 approach is used only when the delay requirement is uncertain. We do not see any uncertainty part in delay specification for this case. Option 1 do not help NW behaviour.  |
| ZTE | Prefer Proposal 2. |
| vivo | We prefer Proposal 2 but also fine to accept proposal 1. |
| MediaTek | Support proposal 1. |