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

**Electronic Meeting, 15th-26th, Aug., 2022**

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

**Agenda item:** 9.17.2

**Source:** Intel

**Document for:** Approval

# Way Forward on Unified TCI state

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

**Issue1-1-1a Whether UE need to track UL time/frequency for UL TCI state activation when DL-RS is associated with serving cell**

* Proposals:
  + Proposal 1: No, UL timing is derived from DL timing of serving cell
  + Proposal 2: Depends on whether source RS in active UL TCI state is a subset of source RS in DL active TCI list
  + Proposal 3: Other option

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| **Company** | **Comments** |
| Intel | Support proposal 1. It’s similar with discuss in legacy Rel-16 uplink spatial info switch. UL timing is not needed and DL timing of serving cell will be used. |
| Samsung | Support proposal 1.  For serving cell, no UL timing issue. For non-serving cell, we may need further consider. |
| Ericsson | Since only single TA is supported in Rel-17, we are fine with proposal 1. Even if UE tracks the DL timing of DL-RS, unless TA is based on the DL-RS, there is not going to be much difference. When UE has support for multiple TA, it makes sense to track separate DL timing for the UL TCI states. |
| Apple | We support proposal 1 for all UL transmission. If the UL TCI source RS is SSB from cell with diff PCI, it uses the same spatial filter as it used to receive that SSB, but Ul timing is still dependent on DL serving cell timing. |
| vivo | Proposal 1 is OK to us. However, proposal 2 can be an optimization for intra-cell M-TRP scenario, which is technically OK but can be discussed in future release. |
| MediaTek | We can support proposal 1. We think Proposal 1 and 2 are not contradicting to each other. For option 2, it somehow add a limitation between UL TCI state list and DL TCI state list, it does not limit UE behaviour on the TCI state switch. |
| ZTE | Support Proposal 1.  Regarding to Proposal 2, which can be further discussed under mTRP scenario, especially for inter-cell mTRP. |
| Huawei | Support proposal 1.  There is no timing reference RS in UL TCI state. UL timing is just derived from DL timing. |

**Issue1-1-1b Whether UE need to track UL time/frequency for UL TCI state activation when DL-RS is associated with cell with different PCI**

* Proposals:
  + Proposal 1: No, UL timing for cell with different PCI if derived from DL timing of serving cell
  + Proposal 2: Depends on whether source RS in active UL TCI state is a subset of source RS in DL active TCI list
  + Proposal 3: Other option

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| **Company** | **Comments** |
| Intel | For UL TCI state activation for SSB associated with cell with additional PCI, for more general scenario, the UL timing will be dependent on the DL timing of the other cell. therefore, we prefer proposal 2.  However, for unified TCI state switch, the requirement is defined that timing offset is smaller than CP. It seems that serving cell DL timing may still be applied for UL timing of cell with additional PCI. We are also fine with proposal 1 if majority company support it. |
| Samsung | If the assumption for requirement is within CP, non-serving cell can still decode receiving signals. In this sense, no problem for NSC either.  In our understanding, non-serving cell that TCI comes from shall be in the same TAG as serving cell, for inter-cell beam management, or otherwise NSC can hardly acquire its TA. In that case, for NSC, the timing also can be acquired by SC downlink. We may need further check RAN1 design. |
| Ericsson | We think UE may not have two TA and serving and additional serving cannot be in different TAG also till Rel-17. Therefore, we think proposal 1 is fine with us. |
| Apple | We support proposal 1.  If the UL TCI source RS is SSB from cell with diff PCI, it uses the same spatial filter as it used to receive that SSB, but Ul timing is still dependent on DL serving cell timing. We have the same TA irrespective of the source RS for UL TCI. |
| vivo | Proposal 1 is OK to us. However, proposal 2 can be an optimization for inter-cell M-TRP scenario, which is technically OK but can be discussed in future release. |
| MediaTek | We can support option 1. After checking other companies’ comment, we agree that two TA configuration is not supported in R17. |
| ZTE | We agree with Intel’s view. But we believe it is only applicable to Rel-17.  Towards Rel-18, since RAN1 has approved the following agreements in R18, so maybe further discussion is needed.  *Agreement*  *Support two TA enhancement for both intra-cell and inter-cell multi-DCI multi-TRP scenarios in Rel-18.*  *Enhancements on two TAs for UL multi-DCI for multi-TRP operation are applicable to both FR1 and FR2.* |
| Huawei | Agree with proposal 1.  UL timing for UL TCI associated to a different PCI is derived from DL timing of reference cell in the same TAG. |

**Issue1-1-2 PL-RS maintenance for active TCI**

*Moderator note: Suggest to discuss in revision of LS R4-2212689.*

**Issue1-1-3 The relation of active UL TCI state list with active DL TCI state list**

* Proposals:
  + Proposal 1(ZTE):
    - The active DL TCI state list and active UL TCI state list are independent. Active UL TCI state list should not be impacted by active DL TCI state list.
  + Proposal 1a (Apple):
    - Independent for separate UL/DL TCI state list indicated by dl-orJoint-TCI-ToAddModList for DL TCI state and ul-TCI-ToAddModList for UL TCI state . But for joint TCI state the same TCI is used for UL and DL indicated by dl-orJoint-TCI-ToAddModList
  + Proposal 2:
    - Active UL TCI should be a subset of the active DL TCI
  + Proposal 2a :
    - If UL TCI state is associated with cell with different PCI, active UL TCI state is a subset of active DL TCI state

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| **Company** | **Comments** |
| Intel | From configuration perspective, active DL TCI state list and active UL TCI state list are independent. If UL TCI state is associated with cell with different PCI, to avoid possible time tracking, we prefer proposal 2a. |
| Samsung | We support Proposal 1 and 1a.  From standard perspective, no necessary relation between each other. Spec do not impose any constraints on them. In practical field, network may consider their relationship when configure the unified TCI. |
| Ericsson | We support option 1 and option 1a. |
| Apple | We support Option 1a . For option 1 we assume it’s the separate TCI case and that is also fine. We don’t think there are restrictions on separate UL TCI to be a subset of DL active TCI state list per RAN1 or RAN2 spec. |
| vivo | We support option 1 and 1a. |
| MediaTek | Support option 1a. To our understanding, option 2 and 2a are to avoid the extra time period for timing tracking. However, if all companies think only one timing will be applied in R17, then we think it makes sense that no need such limitation. |
| ZTE | We support Option 1 and Option 1a. |
| Huawei | We agree with proposal 1 and 1a. |

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

**Issue 1-2-1 Joint TCI switching delay requirement**

* Agreement in GTW discussion:
  + keep the previous agreement and further work on the CR to further clarify the following wordings in the CR:
* *In 38.133, for DL TCI state switching,*
  + *[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.]*
* *In 38.133, for UL TCI state switching,*
  + *[In case of joint TCI state switch, UE is not expected to transmit on UL before UE completes the DL and UL TCI state switch.]*

*Moderator note: Follow the agreement of GTW, further discuss the wording in revision of CR* [*R4-2212665*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212665.zip)*.*

**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**

*Moderator note: Majority view are selected.*

* Proposals
  + Proposal 1(Intel, Apple, Huawei, Samsung):
    - Longer delay is expected.
  + Proposal 2(MTK, vivo, Ericsson, ZTE, Nokia):
    - Reuse the existing delay requirement of MAC CE based UL TCI state switch.

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| **Company** | **Comments** |
| Intel | It highly depends on the implementation of company. Since pathloss needs to be continuously updated no matter whether TCI activation command is received or not. Pathloss will be used for normal TX transmission as well. Therefore, it’s reasonable that SSB will continue to perform RX beam sweeping for continuously update the pathloss.  On the other hand, it didn’t preclude the UE behaviour that when TCI activation command arrived, SSB stopped RX beam sweeping and using the assumed RX beam. After TCI activation, SSB perform RX beam sweeping again for updating the pathloss.  From our perspective, SSB always perform RX beam sweeping make more sense. We also understand that it’s UE implementation issue, we support proposal 1, which is a compromised solution. |
| Samsung | Technical we prefer Proposal 1 as UE is assumed to sweep Rx beams and may not complete the measurement in predefined period. But in our understanding, it is actually a UE implementation issue. If companies think the delay requirement can be meet some ways, we are fine with Proposal 2. |
| Ericsson | We think the wording of longer delay is expected is used in RAN4 when there is uncertainty and cannot specify the exact delay component. Since it is not the case here, we think option 2 is more reasonable. We think option 1 do not serve the purpose of agreeing unknown TCI state to be present in the active TCI state list. |
| Apple | We support proposal 1. We support that longer delay is needed as for any SSB based measurement in FR2 we allow time for Rx beam sweep. We are also fine with using SSB based L1-RSRP measurement as the time to define the delay if necessary. We have a parallel discussion in eMIMO maintenance in [201] we support to use the same approach – either longer delay or explicitly define the delay based on L1-RSRP measurement time when SSB measurement is needed for pathloss in FR2. |
| vivo | We are still not convinced by option 1.  To Intel, for time-frequency tracking in the DL TCI switching, the SSB can also be used for L1-RSRP measurement, but no Rx beam sweeping is considered there. How do you think about this? DL time-frequency tracking needs to be continuously updated as well and SSB can be the QCL source for this.  In our understanding, if only beam alignment case is considered in RRM requirements, then UE can continuously use the same Tx beam as UL TCI for Pathloss measurement in the DL. There is no need to sweep Rx beam for this SSB index in the UL. |
| MediaTek | Support proposal 2. |
| ZTE | We support Option 2.  No matter the requirements for known case or for unknown case, the delay of PL-RS measurement has been considered, Regarding to the suitable Rx beam for PL-RS, beam alignment can guarantee this point, not need additional Rx beam sweeping latency for PL-RS. So we do not known the concern from proponent of Option 1. |
| Huawei | We support proposal 1.  UE Rx beam sweeping is always needed for SSB based PL-RS measurements in FR2 due to no TCI configuration for SSB, which is to keep the same assumption for other SSB based L1 measurements. |

**Issue 1-2-3 Wording Update of introduction for active DL/UL TCI state switch delay requirements**

*Moderator note: Discuss the detail wording in the revision of CR* [*R4-2213482*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213482.zip)*.*

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

**Issue 1-3-1 Known condition on shared RS in CA scenario**

*Moderator note: companies have different view regarding to the QCL type which can be configured to shared RS in common TCI state activation. However, for the legacy known TCI definition, no detailed QCL type is mentioned in RAN4.*

*A compromised proposal 3 is provided without mentioning detailed QCL type. Would company please check whether option 3 is acceptable?*

* Proposals
  + Proposal 1:
    - The known condition will depend on the associated RS in common TCI state and if the associated RS provides QCL-TypeD or QCL-TypeC.
  + Proposal 2:
    - The known condition will depend on the associated RS in common TCI state and if the associated RS provides QCL-TypeD.
  + Proposal 3:
    - The known condition will depend on the associated RS in common TCI state.

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| **Company** | **Comments** |
| Intel | Support proposal 3. For the legacy known TCI definition, no detailed QCL type is mentioned in RAN4. |
| Samsung | Support Proposal 3. For common TCI, following cases can be supported:  - Each CC’s TCI state is indicated separately.  - A list of CCs is configured, TCI state ID is indicated that is common to all CCs in the list. Each CC has a TCI state with that TCI state ID that is used.  - A list of CCs is configured, TCI state ID is indicated that is common to all CCs in the list. The common TCI state ID points to a TCI state in a reference CC that is used for all CCs in the list.  Though RAN1 may have some restriction on QCL type, we did not see any problem for legacy TCI known condition. No necessity to be provide any additional information. |
| Ericsson | We think from Ran1 design point of view proposal 1 is more accurate. To make progress we are fine to not mentioning QCL type also as NW anyway do not configure other than C and D. |
| Apple | We support proposal 3. We need not repeat the QCL Type if its clearly captured in RAN1 spec. |
| vivo | OK to proposal 3. |
| MediaTek | We can compromise to proposal 3 to make progress. |
| ZTE | We believe Proposal 1 is correct.  To make progress, Proposal 3 can be a compromise. |
| Huawei | We are fine with proposal 3. |

**Issue 1-3-2 Known condition on different RS in CA scenario**

*Moderator note: Majority companies support the proposal 1. Please proponent of proposal 2 check whether Proposal 1 is agreeable.*

* Proposals
  + Proposal 1:
    - Reuse the existing known condition. If the source RS is configured per CC, then the known condition is per CC.
  + Proposal 2:
    - Common TCI is for intra-band CA. RAN4 may skip the case that QCL-type is configured per CC for common TCI.

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| **Company** | **Comments** |
| Intel | Support proposal 1. |
| Samsung | If Proposal 1 do not cause any problem in CA case, it is more reasonable for CA case. |
| Ericsson | Proposal 1 is fine. |
| Apple | Support proposal 1. |
| Vivo | Support proposal 2.  As commented in the 1st round, the cross CC codepoint configuration based on MAC CE is not clear to us at this point. For example, we have not find out anywhere in RAN1/2 spec, what should be the UE behavior if the number of activated codepoints is different for different CCs in the same list.  Therefore, we propose to simplify the scenario considered in RAN4 requirements at this stage. |
| MediaTek | Support proposal 1. |
| ZTE | Fine with Proposal 1. |
| Huawei | Support proposal 1. |

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

* Proposals
  + Proposal 1:
    - Define the requirement without differentiating the triggering signaling, e.g. unifiedTCI-StateRef or simultaneousU-TCI-UpdateList1/2/3/4-r17.
  + Proposal 2:
    - Define the requirement indicated by IE simultaneousU-TCI-UpdateList1/2/3/4-r17.

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| **Company** | **Comments** |
| Intel | Support proposal 1. |
| Samsung | Prefer Proposal 1. For each of 3 common TCI cases, the requirement should be defined. |
| Ericsson | We do not think both proposals work.  Our understanding is simultaneousU-TCI-UpdateList1/2/3/4-r17 only indicates which carriers TCI relation is updated using same MAC CE. List of carriers updated for TCI relation may have same RS or different RS. If they have same RS then the delay requirement is same for all the CC indicated in this MAC CE. If they do not have same RS, then the delay requirement can be different for different CC. That means this IE cannot tell shared RS is used or not. This IE just tells the common TCI state switching or simultaneous TCI state switching is performed for the CC present in the MAC CE and do not tell about the delay required is same or different.  Our understanding of RefUnifiedTCIStateList indicates where to find the TCI state configuration for a particular CC. That means it indicates cell index and BWP. We think this IE also cannot be used as it won’t say directly which carriers have shared RS. |
| Apple | Companies have diverging views on how common TCI is indicated. In our understanding common TCI in R17 is indicated by simultaneousU-TCI-UpdateList1/2/3/4-r17.  MAC-Ce activation of the TCI states for all cells in the list simultaneously would be common TCI state switching in our understanding. We are not sure how unifiedTCI-StateRef or simultaneousU-TCI-UpdateList1/2/3/4-r17 is considered a triggering signalling. |
| vivo | No need for either proposal.  RAN1/2 has updated spec accordingly. We suggest companies check the latest 38.331. ‘RefUnifiedTCIStateList’ as mention by Ericsson is now changed into ‘unifiedTCI-StateRef’ with a different definition. We may come back in future meetings leaving ‘other options are not precluded’ |
| MediaTek | Support option 1. |

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

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

**Agreement in GTW:**

* [Longer delay applies if any TCI state is unknown in TCI state list update]. Active TCI state list can contains known and unkown TCI states.

*Moderator note: Suggest to discuss in revision of CR R4-2213940 based on the GTW agreement.*

**Issue 1-4-2 MAC CE based TCI state list update delay for unknown TCI state**

*Moderator note: Suggest to discuss in revision of CR R4-2213940 based on the GTW agreement.*

### Sub-topic 1-5 Clarification on the applicable TCI after DCI BWP switching

**Issue 1-5-1 Clarification on the applicable unified TCI after DCI BWP switching**

*Moderator note: Suggest to discuss the wording in revision of CR R4-2212665.*