3GPP TSG RAN WG1 #102 R1-200xxxx

e-Meeting, August 17th – 28th, 2020

Source: Moderator (OPPO)

Title: Discussion in Email Thread #6

Agenda Item: 7.2.6

Document for: Discussion and Decision

1. Introduction

Rel-16 enhancement on MIMO WID includes objectives of enhancing multi-TRP/Panel transmission with ideal and non-ideal backhaul. During the work of rel-16, designs for multiple-PDCCH based and single-PDCCH based multi-TRP/Panel transmission were discussed and specified. This document provides the discussion eMIMO email thread#4:

* [102-e-NR-eMIMO-06] Default QCL for AP CSI-RS

# Default TCI state for AP CS-RS in multi-TRP

2.1 Multi-DCI based system

vivo [1], ZTE [2], Apple [9], NTT DOCOMO [14], Qualcomm [15], Nokia [16] provided proposal for determining the default QCL for AP CSI-RS when the scheduling offset is less than threshold in multi-DCI based M-TRP system. While, LGE [11] suggest that we shall discuss default beam behavior of AP CSI-RS in Rel-17.

Based on the proposals in those contributions, a draft proposal for AP CSI-RS resource in multi-DCI based multi-TRP system is provided:

**Proposal 1: In multi-DCI based multi-TRP system, if the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is less than threshold *beamSwitchTiming*, the UE determines the QCL assumption for AP CSI-RS resource as follows:**

* **If there is any other DL signal with indicated TCI state in the same symbols as the AP CSI-RS and the other DL signal is associated with the same *CORESETPoolIndex* as the PDCCH triggering the AP CSI-RS, the UE shall apply the QCL assumption of the indicated TCI state of the other DL signal.**
* **Otherwise, the UE applies the default PDSCH TCI state in multi-DCI system, i.e., the QCL parameter(s) of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* among CORESETs, which are configured with the same value of *CORESETPoolIndex* as the PDCCH triggering that AP CSI-RS, in the latest slot in which one or more CORESETs associated with the same value of CORESETPoolIndex as the PDCCH triggering that Ap CSI-RS.**
* **Note: The above behaviour is only applied when UE is configured with *enableDefaultTCIStatePerCoresetPoolIndex.* Otherwise, rel15 behaviour is applied.**

Supporting: MTK, Apple, ZTE, QC, DOCOMO (in principle and need to further clarify what the any other DL signal is), CMCC, vivo, Lenovo/MotM, Ericsson, Samsung

Not Supporting: OPPO, Spreadtrum, CATT, HW/HiSilicon, LGE

**Please input your views and comments on the draft proposal:**

|  |  |
| --- | --- |
| Company | Views and comments |
| MediaTek | Support |
| Apple | Support.  Without the change, UE will not report to support default PDSCH beam, since UE cannot support 3 default beams. |
| ZTE | Support this proposal.  The exact TP can be further discussed later. |
| OPPO | Firstly, we don’t think the system is broken without this proposal. According to previous conclusion below, if the default TCI state of AP CSI-RS is different from those of PDSCH, and UE can’t receive them simultaneously, it is up to UE implementation to handle it, e.g. UE can only detect the PDSCH. To ensure all the scheduled DL signals can be detected, gNB should avoid this situation by scheduling. There are similar cases in other place of M-TRP transmission.  ***Conclusion***  *If the indicated TCI states for multi-TRP operation cannot be received by a UE simultaneously, it is up to UE implementation how to handle this case*  Secondly, as we mentioned for several meetings, we are fine to have default TCI state for AP CSI-RS for case of without DL signal in the same symbol. Our concern is for the case of with DL signal in the same symbol. During the discussion in previous meetings, in some companies’ understanding, the proposal implies that multiplexing of AP CSI-RS and PDSCH from different TRPs (CORESETPoolIndex) in the same symbol is supported. However, unlike ideal backhaul, for non-ideal backhaul, it is difficult to avoid overlapping between PDSCH and AP CSI-RS from different TRP. In current UE feature, we only have capability for overlapped PDSCHs. It is not reasonable to mandate UE to support (partially) overlapped AP CSI-RS and PDSCH from different TRPs. Hence, we can’t support the proposal unless it is clear clarification on this.  We are also fine with the following proposal:  *UE is not expected to receive AP CSI-RS with scheduling offset less than threshold beamSwitchTiming if two values of CORESETPoolIndex are configured.* |
| QC | Support. The note can be changed to the following given that we now have a RRC param for it (do not need to refer to UE capability)   * **Note: The above behaviour is only applied when UE is configured with *enableDefaultTCIStatePerCoresetPoolIndex.* Otherwise, rel15 behaviour is applied.**   Regarding OPPO’s comment, the part related to “[PDCCH]/PDSCH” is now removed from the UE feature. |
| Spreadtrum | Just for clarification, for the first sub-bullet, the current proposal does not allow P/SP CSI-RS as the other signal for the reason that current specification does not specific the association between P/SP CSI-RS and CORESETPoolIndex, is my understanding right? If yes, the UE may need to receive 3 different beams simultaneously when there is no any other DL signal with indicated TCI state in the same symbols as the AP CSI-RS, according to current proposal. That will be beyond UE’s capability. |
| CATT | Agree with OPPO that current spec. is not broken without this proposal. The issue raised by companies can be addressed in implementation. |
| DOCOMO | Support this proposal in principle.  For the first sub-bullet, better to further clarify what the ‘any other DL signal’ refers to. |
| CMCC | Support the proposal, and support the updated “note” from QC.  We are not support the OPPO’s proposal to restrict AP CSI-RS scheduling offset. The motivation of triggering AP CSI-RS is for fast measurement, however, the restriction severely impacts the flexible scheduling of AP CSI-RS and also increases the latency of AP CSI-RS transmission. |
| vivo | Support and the updated note by QC. It is good to apply default QCL for AP-CSI-RS per TRP individually especially for non-ideal backhaul cases without any further UE efforts as the UE has already received or buffered two signals. This will enable the scheduling flexibility at the network side.  @Speadtrum: we think network can manage to avoid AP-CSI-RS overlapping with P/SP CSI-RS since the configuration of P/SP CSI-RS is semi-statically configured by the network and coordinate between the TRPs. |
| Huawei, Hisilicon | We share similar view as Spreadtrum, CATT and Oppo. Current proposal only defines “the other DL signal associated with the same *CORESETPoolIndex*” which seems to be only related to a PDSCH from the same TRP. All other cases belongs to “otherwise”. It can be risky that all other cases may include: What if the UE is only capable of single receiving beam so that shall we prioritize other signal or AP CSI-RS; what if other signaling is P/SP CSI-RS or SSB beams from the same/different TRP without the associated ion of *CORESETPoolindex*; how to ensure “otherwise” or “all other cases” follow Rel15 default behavior since currently “all other cases” will always use PDCCH beam. |
| LG | As Oppo explained, we can avoid using wrong default beam assumption by scheduling AP CSIRS after threshold. However, if majority companies have strong view on supporting fast CSI measurement, we don’t object the current proposal which looks the simplest solution. |
| Lenovo/MotM | Support this proposal. The corresponding TP can be further discussed later. |
| Ericsson | Support the proposal. |
| Samsung | Support the proposal. Besides, Rel-16 doesn’t specify behavior for M-DCI default beam on cross carrier scheduling so that the current proposal needs to be confined on same-carrier scheduling case only. In that understanding, we suggest to add the following note:  **Note 2: The above behaviour is applied at least for the same carrier scheduling case.** |
| Nokia/NSB | Support the proposal. There is good support on companies to endorse this. |

2.2 Single-DCI based system

vivo [1], ZTE [2], Apple [9], Ericsson [12], NTT DOCOMO [14], Qualcomm [15] and Nokia [16] proposed solution for determining the default QCL for AP CSI-RS when the scheduling offset is less than threshold in single-DCI based M-TRP system. And LGE[11] suggests to discuss that in rel17.

The proposals in the contributions [1][2][9][12][14][15] and [16] diverged. Different methods are proposed for both cases of when there is other known DL signal with indicated TCI states and when there is no other known DL signals with indicated TCI state(s). The methods proposed in the contributions are summarized in the following alternatives listed in the following draft proposal 2.

**Proposal 2: In singe-DCI based multi-TRP system if the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is less than threshold *beamSwitchTiming*, the UE determines the QCL assumption for AP CSI-RS resource as follows**

* **If there is any other DL signal with indicated TCI state in the same symbols as AP CSI-RS:**
  + **Alt-a1: The UE applies the TCI-state(s) of the other signal to buffer the AP CSI-RS. When the other signal is a PDSCH with one or two TCI states: if the indicated TCI state is same one of the indicated TCI-state(s) of the other signal, the UE use the indicated TCI state to measure CSI; otherwise, the UE use the 1st of the TCI state(s) of other signal to measure CSI**
    - vivo, NTT DOCOMO, MTK (1st), Apple,
    - Concerns: CATT
  + **Alt-a2: The UE applies QCL assumption of the other signal. When the other signal is a PDSCH indicated with two TCI states, the UE applies the first TCI state of those two TCI states.**
    - ZTE, Nokia, Qualcomm, Lenovo/MotM, MTK (2nd),Apple, NTT DOCOMO (2nd), Ericsson, Samsung
  + **Alt-a3: The UE applies QCL assumption of the other signal. When the other signal is a PDSCH with two TCI states, if the PDSCH is scheme 1a/2a/2b, the UE applies the 1st TCI state on AP CSI-RS with odd Id and 2nd TCI state on AP CSI-RS with even Id; if the PDSCH is scheme 3/scheme 4, the UE applies the QCL assumption of the overlapping PDSCH occasion.**
    - Ericsson, Apple
  + **Alt-a3’:The UE applies QCL assumption of the other signal. When the other signal is a PDSCH with two TCI states: For schemes 1a/2a/2b, if the indicated TCI state is same one of the indicated TCI-state(s) of the other signal, the UE applies the indicated TCI state; otherwise, the UE use the 1st of the TCI state(s) of other signal; For schemes 3/4, the UE applies the QCL assumption of the overlapping PDSCH transmission occasion.**
    - MTK, vivo
  + **Alt-a4: The UE applies QCL assumption of the other signal. When the other signal is a PDSCH indicated with two TCI states, the UE applies the first or second TCI state of those two TCI states when the PDCCH carrying the triggering DCI indicates DMRS port(s) in CDM group #0 or #1, respectively.** 
    - LGE
  + Alt5: the current spec has no issue for this case:
    - CATT, OPPO
* **Otherwise**
  + **Alt-b1: The UE applies the two TCI states corresponding to the lowest DCI codepoint among those mapped to two TCI states.**
    - Apple, OPPO, CATT
  + **Altb-b2: If the indicated TCI state is same to one of those two default TCI states, the UE use the AP CSI-RS buffered with the indicated TCI state; otherwise, the UE use the AP CSI-RS buffered with the 1st default TCI state.**
    - vivo, NTT DOCOMO, MTK(2nd), Apple,
  + **Alt-b3: If the indicated TCI sate for AP-CSI-RS is same to one those two default PDSCH TCI states, the UE applies the TCI state indicated by the DCI; otherwise, the UE applies the first of those two default DPSCH TCI states.**
    - MTK(1st), Apple
  + **Alt-b4: For AP CSI-RS resource with Odd Id, the UE applies the first one of those two default PDSCH TCI states. For AP CSI-RS with Even Id, the UE applies the second one of those two default PDSCH TCI states.**
    - Ericsson. Apple
  + **Alt-b5: The UE applies the indicated TCI state which is identical to one of default PDSCH TCI states, i.e., those two TCI states corresponding to the lowest DCI codepoint among the TCI codepoints mapped to two TCI states.**
    - Qaulcomm, MTK(2nd), Apple
  + **Alt-b6: The UE applies the first one of two TCI states corresponding to the lowest DCI codepoint among those mapped to two TCI states.**
    - Nokia, Lenovo/MotM, MTK(2nd), Apple, ZTE, Qaulcomm(2nd), NTT DOCOMO(2nd), Ericsson, Samsung
  + **Alt-b7: The UE applies the first or second TCI state of two TCI states corresponding to the lowest DCI codepoint among those mapped to two TCI states when the PDCCH carrying the triggering DCI indicates DMRS port(s) in CDM group #0 or #1, respectively.**
    - LGE
* **Note: The above behaviour is only applied when UE is configured with *enableTwoDefaultTCIStates.* Otherwise, rel15 behaviour is applied.**

Please input your views and comments on those alternatives:

|  |  |
| --- | --- |
| Company | Views and comments |
| MediaTek | If there is any other DL signal with indicated TCI state, our first preference is Alt-a1, and Alt-a2 is our second preference. Nevertheless, distinguishing “buffer” and “measure” is less important to us.  Our understanding is that when Alt-a1 or Alt-a2 is applied to a TDM scheme, the other signal would be one PDSCH transmission occasion and thus there is only one TCI state. If it is not a common understanding, we may consider the following based on Alt-a3:  **The UE applies QCL assumption of the other signal. When the other signal is a PDSCH with two TCI states:**  **1) For schemes 1a/2a/2b, if the indicated TCI state is same one of the indicated TCI-state(s) of the other signal, the UE applies the indicated TCI state; otherwise, the UE use the 1st of the TCI state(s) of other signal;**  **2) For schemes 3/4, the UE applies the QCL assumption of the overlapping PDSCH transmission occasion.**  If there is no other DL signal with indicated TCI state, our first preference is Alt-b3. Also, Alt-b2, Alt-b5, Alt-b6 are acceptable. |
| Apple | Among Alt-1a/1b/1c, we are open to go with majority view, since the three alternatives should be correct. The most important issue is to have a clear assumption of a beam to receive such kind of CSI-RS. If we cannot reach consensus, at least we can try to agree the following way, since this is at least common point among different alternatives.  **If there is any other DL signal with indicated TCI state in the same symbols as AP CSI-RS, the UE applies QCL assumption of the other signal.**  Among Alt-b1 to b6, no alternative is wrong. We are fine to go with majority view. If we cannot reach any consensus, at least we can say Rel-15 default CSI-RS beam should not be applicable to mTRP UE, since this is the common point among all aternatives.  **Otherwise, Rel-15 default aperiodic CSI-RS beam is not applied to UE that supports default PDSCH beam for mTRP.** |
| ZTE | Support Alt-2a  Support Alt-b6 (FL can remove Alt-b3) |
| OPPO | For case there is any other DL signal in the same symbols as AP CSI-RS, we don’t think there is essential issue on current spec. Even when the DL signal is PDSCH with two TCI states, UE can still apply the QCL assumptions, and perform CSI measurement/report based on a better one. That is similar to detection of PDSCHs received by two default TCI states.  For case there is no other DL signal in the same symbol as AP CSI-RS, we prefer Alt-b1 to reuse the QCL assumption of PDSCH**.**  We are also fine with the following proposal:  *UE is not expected to receive AP CSI-RS with scheduling offset less than threshold beamSwitchTiming if there is any TCI code point indicating two TCI states.* |
| QC | Support Alt-a2 for the first part.  Support Alt-b5 for the second part. Our next preference is Alt-b6 for simplicity. We think all alternatives should be explained using similar language as in the specifications. We do not need to introduce things like “buffer”.  Also, a similar not as in proposal 1 is needed:   * **Note: The above behaviour is only applied when UE is configured with *enableTwoDefaultTCIStates.* Otherwise, rel15 behaviour is applied.** |
| CATT | We don’t think it’s necessary to specify the procedure of buffering and measurement as in Alt-a1 and b2. We also don’t see issues with current spec. for the case there is any other DL signal in the same symbols as AP CSI-RS. For the case there is no any other DL signal with indicated TCI state in the same symbols as AP CSI-RS, Alt-b1 can be supported. |
| DOCOMO | For the first part, we prefer Alt-a1. But we can also accept Alt-a2 if it is the majority view.  For the second part, we prefer Alt-b2. But we can also accept Alt-b6 if it is the majority view. |
| vivo | If there is a PDSCH with two TCI states, our preference is Alt-a1. We can also support MediaTek’s proposal Alt-a3. For scheme 1a, 2a, 2b, the UE has to buffer the PDSCH with two indicated TCI states simultaneously. If the indicated TCI state for the AP-CSI-RS is one of the TCI states indicated for PDSCH, it is straightforward to measure the CSI by the AP-CSI-RS as the indicated TCI state following the network’s will.  For the case there is no other signal, we see that there are two possible cases from the alternatives:  1) Indicated TCI state for AP-CSI-RS is identical to one of default PDSCH TCI states: Alt-b2, Alt-b3 and Alt-b5 deal with such a case.  2) Indicated TCI state for AP-CSI-RS is identical to neither default PDSCH TCI states: Alt-b2, Alt-b6 belong to this case.  So we think Alt-b2 covers the two cases. And we agree to delete the description of “buffering” in Alt-2b. |
| Huawei, Hisilicon | We prefer to see single consolidated solution. Otherwise as CATT has commented, it can be always avoided by gNB implementation by default and Rel-17 can be a better place of discussion. |
| LG | Alt-a1/a3 in the first bullet and Alt-b1/b2/b3/b4/b5 in the second bullet seem have commonality that can provide more flexibility to apply the specific TCI state between two TCI states. To support this kind of flexibility, we can also consider to use information on the triggering DCI for AP CSI-RS. For example, the specific TCI state can be determined based on CDM group index of scheduled DMRS port(s) from the triggering DCI, e.g., CDM group #0/#1 for the first/second TCI state, respectively. We think this kind of approach can be more suitable for providing flexibility. So, our preference is to add the following alternatives for each bullet.  **Alt-a4: The UE applies QCL assumption of the other signal. When the other signal is a PDSCH indicated with two TCI states, the UE applies the first or second TCI state of those two TCI states when the PDCCH carrying the triggering DCI indicates DMRS port(s) in CDM group #0 or #1, respectively.**  **Alt-b7: The UE applies the first or second TCI state of two TCI states corresponding to the lowest DCI codepoint among those mapped to two TCI states when the PDCCH carrying the triggering DCI indicates DMRS port(s) in CDM group #0 or #1, respectively.**  If we can discuss this kind of UE behavior in the related Rel-17 agenda item, then more analysis and discussion for pros/cons can be possible. So, we also prefer to discuss this kind of UE behavior in the related Rel-17 agenda item rather than to decide in CR phase. |
| Lenovo/MotM | Support Alt-a2 for the first part.  Support Alt-b6 for the second part. |
| Ericsson | We indicated our preferences above. Since Alts a2 and b6 seem to have majority view, we can support these options. |
| Samsung | We are okay on Alt-a2 and Alt-b6. We are flexible on other alternatives as well, to allow UE to use Rel-16 default beam behavior for AP-CSI-RS. Besides, similar to 2-1, the current proposal needs to be confined on same-carrier scheduling case only. We suggest to add the following note:  **Note 2: The above behaviour is applied at least for the same carrier scheduling case.** |
| Nokia/NSB | To be honest, we wish that FL to remove single/two company variants at this stage. FL could suggest the majority view as the suggested proposals, and we would be ok with that. But the current formulation helps this email discussion to become useless. |

1. Reference
2. [R1-2005354](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005354.zip) Remaining issues on Multi TRP operation vivo
3. [R1-2005451](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005451.zip) Maintenance of Multi-TRP enhancements ZTE
4. [R1-2005819](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005819.zip) Maintenance on multi-TRP operation Lenovo, Motorola Mobility
5. [R1-2005853](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005853.zip) Corrections to multi TRP Intel Corporation
6. [R1-2005975](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005975.zip) Text proposals for enhancements on multi-TRP and panel Transmission OPPO
7. [R1-2006117](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006117.zip) On Rel.16 multi-TRP/panel transmission Samsung
8. [R1-2006257](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006257.zip) Discussion on remaining issues for multi-TRP operation Spreadtrum Communications
9. [R1-2006395](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006395.zip) Remaining issues for Multi-TRP in Rel-16 Huawei, HiSilicon
10. [R1-2006494](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006494.zip) Remaining issues on Multi-TRP enhancement Apple
11. [R1-2006588](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006588.zip) Discussion on remaining issues of multi-TRP/panel transmission CATT
12. [R1-2006593](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006593.zip) Text proposals on enhancements on multi-TRP/panel transmission LG Electronics
13. [R1-2006688](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006688.zip) Remaining issues on single-DCI based Multi-TRP Ericsson
14. [R1-2006689](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006689.zip) Remaining issues on multi-DCI based Multi-TRP Ericsson
15. [R1-2006700](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006700.zip) Remaining issues on multi-TRP/panel transmission NTT DOCOMO, INC.
16. [R1-2006781](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006781.zip) Multi-TRP Enhancements Qualcomm Incorporated
17. [R1-2006842](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2006842.zip) Maintenance of Rel-16 Multi-TRP operation Nokia, Nokia Shanghai Bell