**Pre-RAN1#105-e offline discussion on issue 1 of multi-beam enhancements**

## QCL for CA

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| 1.8 | [Based on offline discussion, cf. Yuki, *reformulated for better clarity*] Carrier aggregationFor TCI state(s) shared across a set of CCs (that is associated with the same gNB beam):* Alt1: CC-specific QCL-TypeD RS can be determined from the shared TCI state(s). The determined QCL-TypeD RSs for the set of CCs are further associated with a same QCL-TypeD RS.
* Alt2: A single QCL-TypeD RS is determined from the shared TCI state(s), and support enhanced QCL chain: support “i) only”, “ii) only”, or “both i) and ii)” from the following:
	+ i) the QCL type A TRS and, if any, QCL type D TRS, in the same/different CSI-RS resources
	+ ii) the QCL type A TRS and, if any, QCL type D SSB
 | **Alt1 (10)**: Nokia/NSB, NTT Docomo, Intel, Apple, APT/FGI, CATT, Huawei, HiSi,**Alt2 (7)**: vivo, Samsung, ZTE, MTK, Sony (“i only”), Qualcomm (both i and ii), Spreadtrum |

From the latest discussion moderated by Yuki (Alt1/2 description from x3559, I edited this to avoid using “common TCI” per Xi’s previous comment):

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| For QCL-Type D configuration in TCI state(s) shared across a set of CCs (that is associated with the same gNB beam):* **Alt1**: Separate QCL-Type D RS for each of the CCs can be determined from the TCI state(s). The determined QCL-Type D RSs for the set of CCs are further associated with a same QCL-Type D RS.
* **Alt2**: A single QCL-Type D RS for the set of the CCs is determined from the TCI state(s), and support enhanced QCL chain:
	+ Alt.2-1: Support Opt. A only.
	+ Alt.2-2: Support Opt. B only.
	+ Alt.2-3: Support both Opt. A and Opt. B.

Options of the enhanced QCL chain:* Opt. A: The QCL-Type A TRS and, if any, QCL-Type D TRS, in the same/different CSI-RS resources.
* Opt. B: The QCL-Type A TRS and, if any, QCL-Type D SSB.

---Example of QCL chain for both Alt.1 and Alt.2 are illustrated in the below Fig.1-2. Alt.1 has no impact on Rel.15 QCL chain, and Alt. 2 will introduce the new QCL chain (red allows in Fig.2).Figure 2-1: Example of QCL chain of Alt. 1 (same QCL chain as Rel.15)  a) Opt. A b) Opt. BFigure 2-2: QCL chain of Alt. 2 (Red part is new QCL chain from Rel.15) As commented by Yushu, when we select from the Alt.1 and Alt.2, we should also consider RLM/BFR. Note that usually RLM/BFD RS are not RRC configured, and implicitly derived as “Type D RS for CORESET”, otherwise it is not possible to update RLM/BFD RS by MAC CE). Alt.1 has no problem on this (because the QCL chain is the same as Rel.15).In Alt. 2, * RLM: as long as “Single QCL-TypeD RS” is configured on PCell/PSCell, we can derive PCell/PSCell RS as RLM RS. (seems no problem)
* BFD: if we assume “Single QCL-TypeD RS” is configured on PCell/PSCell, all SCell BFD RSs are implicitly derived as the same PCell/PSCell RS. So, it seems SCell BFR does not work in Alt. 2. (Note: in the QCL chain of Alt. 2 in Fig.2, BFD RSs of all SCells are implicitly derived as TRS on CC#0 (PCell/PSCell).)
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Table 1 Companies’ inputs: QCL for CA

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| **Please share your view on the following questions*** **Q1. What’s your view on/response to Yushu’s argument on RLM/BFR in favor of Alt1?**
* **Q2. Given that it is not very likely to support new QCL chaining rules in Rel-17 (OptA and OptB), can Alt2 proponents accept Alt1? If not, what’s the reason?**
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| **Company** | **Input** |
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### How unified TCI is applied to other signals/channels

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| 1.4 | Whether Rel-17 DL and, if applicable, joint TCI also applies to the following signals. * If not applicable, how to provide DL QCL information for those signals

Note: UE-dedicated reception on PDSCH and all/subset of CORESETs have been agreed | CSI-RS resource for CSI:* **Yes (21)**: Lenovo/MoM, Ericsson, Nokia/NSB, OPPO, Spreadtrum, MTK, APT/FGI, Intel, Convida, AT&T, Samsung, Apple (at least for default AP-CSI-RS beam), Sony, Qualcomm, Xiaomi, NTT Docomo, Intel, CATT
* **No (3)**: Huawei, HiSi, Futurewei (need further discussion)

Some CSI-RS resource(s) for BM (if so, which one(s), e.g. aperiodic, repetition ‘ON’)* **Yes (16)**: Ericsson, Nokia/NSB, OPPO, MTK, APT/FGI, Intel, AT&T, Samsung, Apple (at least for default AP-CSI-RS beam), Sony (at least for repetition ‘ON’), Qualcomm, Xiaomi, NTT Docomo, Intel
* **No (5)**: Huawei, HiSi, Futurewei (need further discussion, depending on whether the resource is repeated or not), Spreadtrum, vivo

CSI-RS for tracking:* **Yes (10)**: Lenovo/MoM, Ericsson, Spreadtrum, AT&T, Nokia/NSB, Sony, Qualcomm, CATT
* **No (5)**: Huawei, HiSi, MTK, Futurewei, NTT Docomo
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| 1.5 | Whether Rel-17 UL and, if applicable, joint TCI also applies to the following signals. * If not applicable, how to provide UL TX spatial reference information for those signals
 | Some SRS resources or resource sets for BM:* **Yes (14)**: Lenovo/MoM, Ericsson, OPPO, MTK, Intel, APT/FGI, Nokia/NSB, Sony, Qualcomm, Xiaomi, Convida
* **No (4)**: Huawei, HiSi, Futurewei (need further discussion) , Spreadtrum (reuse R15 TCI framework)
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| 1.12 | TCI for non-UE-dedicated reception on PDSCH and all/subset of CORESETsAlt1: Extend (use) Rel-17 unified TCI Alt2: Reuse Rel-15/16 TCI | **Alt1**: vivo, Samsung, Qualcomm, Futurewei, Huawei, HiSi, Ericsson**Alt2**: Apple (modify Alt2 as “reuse Rel-15/16 QCL assumption”, since many cases are for idle mode UE and there is no TCI) |

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| The following questions are pertinent to sub-issues 1.4, 1.5, and 1.12:* QA. Does Rel-17 unified TCI apply to a channel, a CORESET, or a signal *other tha*n the ones already agreed.
	+ For DL: CSI-RS resource for CSI, some CSI-RS resource(s) for BM, CSI-RS for tracking, non-UE-dedicated reception on PDSCH and all/subset of CORESETs
	+ For UL: Some SRS resources or resource sets for BM
* QB. If the answer to QA is yes for any of those channels/signals, how does this apply?
* QC. If the answer to QA is no for any of those channels/signals, how does the syste provide DL QCL or UL TX spatial reference information to the channel/signal?

In regard to QB, it was pointed out (by Claes) that two possible interpretations exist. We use CSI-RS resource for CSI as an example to illustrate the point. * Interpretation 1: The CSI-RS resource for CSI shares the same (Rel-17 DL or, if applicable, joint) TCI state machine (hence ‘DL RX beam tracking loop’) as that for UE-dedicated reception on PDSCH and all/subset of CORESETs. This works regardless of the values of M and/or N.
	+ In this case, the Rel-17 DL or, if applicable, joint TCI state used for the CSI-RS resource for CSI needs to be associated with some UE-dedicated reception on PDSCH and all/subset of CORESETs.
* Interpretation 2: The CSI-RS resource for CSI uses a different (Rel-17 DL or, if applicable, joint) TCI state machine (hence ‘DL RX beam tracking loop’) as that for UE-dedicated reception on PDSCH and all/subset of CORESETs. This requires M>1 and/or N>1.
	+ In this case, a separate Rel-17 DL or, if applicable, joint TCI state dedicated to the CSI-RS resource for CSI can be used without any association with any UE-dedicated reception on PDSCH and all/subset of CORESETs.
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Table 2 Companies’ inputs: unified TCI applied on other signals/channels

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| **Please share your view on the following questions*** **Q1. Regardless your views on 1.4/1.5/1.12, which interpretation do you hold?**
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| **Company** | **Input** |
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