**3GPP TSG RAN WG1 #106bis-e R1-210xxxx**

**e-Meeting, 11 – 19 October, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Nokia)

**Title:** Moderator summary for LS reply to RAN2 on inter-cell beam management and multi-TRP in Rel-17

**Document for:** Discussion and Decision

## Introduction

This summary includes the following:

* Proposed LS replies to the LSs from RAN2 R2-2108925
* Summary of companies’ inputs on the proposed replies

## List of companies’ contributions

The following input Tdocs were submitted:

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| [R1-2110076](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110076.zip) | Draft reply LS to RAN2 on inter-cell beam management and multi-TRP in Rel-17 | LG Electronics |
| [R1-2110363](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110363.zip) | Views on RAN2 LS for inter-cell BM in R17 | Huawei, HiSilicon |
| [R1-2109049](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109049.zip) | Discussion on LS on inter-cell beam management and multi-TRP in Rel-17 | OPPO |
| [R1-2109114](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109114.zip) | Draft reply LS on inter-cell beam management and multi-TRP in Rel-17 | vivo |
| [R1-2109257](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109257.zip) | Draft reply LS on inter-cell beam management and multi-TRP in Rel-17 | ZTE |
| [R1-2109376](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109376.zip) | Draft Reply LS to RAN2 LS on on inter-cell beam management and multi-TRP in Rel-17 | Xiaomi |
| [R1-2109464](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109464.zip) | Draft Reply LS on inter-cell beam management and multi-TRP in Rel-17 | Samsung |
| [R1-2109869](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109869.zip) | Draft reply LS to RAN 2 LS on inter-cell beam management and multi-TRP in Rel-17 | Nokia, Nokia Shanghai Bell |
| [R1-2109900](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109900.zip) | [DRAFT] Reply LS on inter-cell beam management and multi-TRP in Rel-17 | Lenovo, Motorola Mobility |
| [R1-2109947](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109947.zip) | Discussion on LS reply on inter-cell beam management and multi-TRP in Rel-17 | Intel Corporation |
| [R1-2110008](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110008.zip) | Draft Reply LS on Inter-cell Beam Management and Multi-TRP | Apple |
| [R1-2110159](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110159.zip) | Draft reply LS on inter-cell beam management and multi-TRP in Rel-17 | Qualcomm Incorporated |
| [R1-2110346](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110346.zip) | Discussion of RAN2 LS on inter-cell BM and mTRP | Ericsson |

## Summary of companies’ inputs and proposed LS answers

The RAN2 LS is addressing 5 main topics: 1) Applicability of inter-cell beam management to mTRP, 2) Basic Tx/Rx operation with inter-cell beam management, 3) MAC aspects, 4) HARQ operation, 5) Physical layer configuration.

In order to simplify the discussion, we are dedicating below separate sections for company views and LS proposed reply.

### **Reply on the applicability of inter-cell beam management to mTRP**

Based on the above inputs, the following reply is proposed:

Table 1 Proposed reply to RAN2

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| **Question 1: RAN2 notes that WI objective 1 states " The same beam measurement/reporting mechanism will be reused for inter-cell mTRP "). RAN2 would like to understand if the entire inter-cell BM is also applicable to inter-cell mTRP? If not, which part is not applicable to mTRP and how does that work?****Answer 1**: Rel17 Inter-cell BM and inter-cell mTRP have common points but they are not entirely the same. The common and different points are as follows: they both use the same beam measurement/reporting mechanisms but they have different TCI signaling framework (beam indication) as inter-cell BM is based on Rel17 unified TCI while inter-cell mTRP is based on Rel15/16 TCI framework. For inter-cell BM, UE assumes that the UE-dedicated channels/RSs can be switched to a TRP with different PCI according to DCI/MAC-CE based unified TCI update; for inter-cell mTRP, UE assumes mDCI-mTRPbased multi-PDSCH reception. |

Table 2 Companies’ inputs on the applicability of inter-cell beam management to mTRP

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| **Company** | **Input** |
| Mod V0 | **The proposals for this question are pretty stable, almost unanimous views on what the answer should look like. Please share your inputs on the above** |
| Samsung | We are fine with the reply. Just one small update**Answer 1**: Rel17 Inter-cell BM and inter-cell mTRP have common points but they are not entirely the same. The common and different points are as follows: they both use the same beam measurement/reporting mechanisms but they have different TCI signaling framework (beam indication) as inter-cell BM is based on Rel17 unified TCI while inter-cell mTRP is based on Rel15/16 TCI framework. For inter-cell BM, UE assumes that the UE-dedicated channels/RSs can be switched to a TRP with different PCI according to DCI/MAC-CE based unified TCI update; for inter-cell mTRP, UE assumes that individual TRP-specific RS/channel operations are performed based on the mDCI-mTRP ~~scheme~~ based multi-PDSCH reception. |
| vivo | Fine with revision from Samsung |
| NTT DOCOMO | We’re fine with the reply. |
| Intel | Fine with proposed answer  |
| ZTE | We are fine with either FL’s or Samsung’s version. |
| Apple | Support. Revision from Samsung is also ok. |
| OPPO | We are fine with the proposed reply. |
| Ericsson | Support |
| Huawei, HiSilicon | The meaning of “TRP-specific RS/channel operation” is not immediately clear to us. Along with the revision from SS, we suggest the following simplification (blue). **Answer 1:** Rel17 Inter-cell BM and inter-cell mTRP have common points but they are not entire-ly the same. The common and different points are as follows: they both use the same beam meas-urement/reporting mechanisms but they have different TCI signaling framework (beam indica-tion) as inter-cell BM is based on Rel17 unified TCI while inter-cell mTRP is based on Rel15/16 TCI framework. For inter-cell BM, UE assumes that the UE-dedicated channels/RSs can be switched to a TRP with different PCI according to DCI/MAC-CE based unified TCI update; for inter-cell mTRP, UE assumes ~~that individual TRP-specific RS/channel operations are performed based on the~~ mDCI-mTRP ~~scheme~~ based multi-PDSCH reception. |
| LGE | Support. Revision from Samsung and Huawei is also ok. |
| Xiaomi | I think that the description, “individual TRP-specific RS/channel operations”, is meant to emphasize that the beam for RS(s)/channel(s) of each TRP is indicated by its own DCI. While if “mDCI-mTRP based multi-PDSCH reception” is clear enough, we agree with the modification of Huawei. |
| Lenovo/MotM | We are fine with either Samsung’s version or Huawei’s version. |
| Mod | Updated answer 1 according to Samsung and HS suggestions! |
| CATT | Support the proposed answer. |
| **Mod** | **Stable answer, moved in the conclusion section** |

### **Reply on basic Tx/Rx operation with inter-cell beam management**

Based on the above inputs, the following reply is proposed:

Table 3 Proposed reply to RAN2

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| **Question 2:** The WI states that "*For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done)*". Then, when the UE is configured to use both *serving cell TRP* and *TRP with different PCI*, RAN2 would like to understand the corresponding behaviour for: a) **UL and DL:** Are UL and DL always processed at the same TRP or can the UE use e.g. *serving cell TRP* for UL transmissions and *TRP with different PCI* for DL reception or vice-versa?**Answer 2.a**: For inter-cell BM, there are two beam indication modes. One mode is called joint TCI, where DL and UL beams are always same. The other mode is called separate TCI, where DL and UL TCIs are independently indicated. For the separate TCI mode, RAN1 has not agreed to introduce such restriction that DL and UL beams should not be set to different TRPs with different PCIs. |

Table 4 Proposed reply to RAN2

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| b) **System information and short message (e.g. paging):** If UE is receiving DL data from *TRP with different PCI* on dedicated channels, is the UE still able to receive short message (e.g. paging) and system information from *serving cell TRP* at the same time?**Answer 2.b**: system information [and paging] for inter-cell beam management can be only received from the serving cell TRP.  |

Table 5 Proposed reply to RAN2

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| c) **SSB reception:** is the UE able to always receive CD-SSB from *serving cell TRP* when needed and is there any impact to RRM measurements of serving or neighbour cells?**Answer 2.c**: The UE is always able to receive CD-SSB from serving cell TRP. There is no impact on RRM measurements of serving or neighbour cells. |

Table 6 Proposed reply to RAN2

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| d) **Number of TRPs:** Is the number of TRPs involved in the operation restricted to two (i.e. *serving cell TRP* and *TRP with different PCI*? Are there any restrictions on TRPs from which UE may send/receive data, or TRPs from which the UE is assumed to be able to make L1 measurements?**Answer 2.d**: RAN1 is still discussing the maximum number of RRC configured PCIs different from the serving cell for TCI beam indication, measurement and reporting and has made the following agreements:**Agreement**On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, NMAX (the maximum number of RRC-configured PCIs different from the serving cell for measurement/reporting) is up to UE capability with candidate values of at least 1 and X.* Note: The upper bound for X as agreed in AI 8.1.2.2
* When NMAXis configured to be X, the UE is RRC-configured for L1-RSRP measurement with up to X PCIs different from the serving cell PCI
* Additional restriction may be added by RAN4
* FFS: UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability

The related agreement made in AI 8.1.2.2 (inter-cell mTRP) during RAN1 #106-e is provided as follows.**Agreement**Rel. 17 inter-cell MTRP, the maximum number of additional RRC -configured PCIs per CC is denoted X and can be reported as a UE capability* For the report value of X, multiple candidate values including 1 is supported.
	+ FFS: Which values to support other than 1.
	+ Values larger than 7 are precluded
	+ RAN1 needs to agree on value(s) of X other than 1
* Down-select one of the following alternatives:
	+ Alt 1: A single value of X is reported as UE capability for any possible SSB time domain position and periodicity
	+ Alt 3: At least Two independent X values (X1, X2) are reported as a UE capability for at least two different assumptions on SSB time domain position and periodicity with respect to serving cell SSB
* The serving cell PCI is always associated with active TCI states, only 1 additional PCI can be associated with the active TCI States

For AI 8.1.2.2, i.e., inter-cell mTRP operation, only one additional PCI different from the serving cell PCI can be associated with active TCI state(s) per CC. The related agreement made in RAN1 #104b-e is copied below.**Agreement*** For intercell MTRP operation, 1 additional PCI different from the serving cell PCI is supported per CC
	+ The additional PCI is the one associated with one or more TCI states that are activated for [CSI-RS for CSI]/PDSCH/PDCCH, per CC.
	+ Applicable at least for non-cross carrier QCL indication
		- FFS: Cross carrier scheduling QCL indication
* RAN1 to decide on the maximum number of PCIs different from the serving cell PCI per CC and/or across all CCs that can be RRC-configured for multi-DCI based inter-cell multi-TRP
* Above should be specified by reusing R15 QCL rules as concluded in RAN1#104-e
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Table 7 Proposed reply to RAN2

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| e) **PCell/PSCell/SCell:** Is the inter-cell beam management applicable to any serving cell (i.e. PCell/PSCell/SCell)? That is, can intercell beam management or intercell mTRP be configured for SCell and/or PSCell in addition to PCell?**Answer 2.e**: inter-cell beam management and inter-cell mTRP can be applicable to any serving cell (i.e. PCell/PSCell/SCell). |

Table 8 Proposed reply to RAN2

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| f) **TCI switching signalling:** Which signalling should be used for TCI switching for inter-cell beam management?**Answer 2.f**: Inter-cell beam management is going to use Rel-17 unified TCI signaling where RAN1 agreed that a MAC-CE activates one or multiple TCI states out of RRC configured TCI state pool. If multiple TCI states are activated, DCI selects one TCI state among activated ones. If only one TCI state is activated, the activated TCI state is also implicitly selected without further DCI indication. |

Table 9 Proposed reply to RAN2

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| h) **Simultaneous Tx/Rx from and to “serving cell TRP” and “TRP with different PCI”:** Is it correct understanding that such simultaneous Tx/Rx is not supported for “inter-cell beam management”, but is supported for “inter-cell mTRP”? If so, what is the difference regarding their configuration that needs to be introduced by RAN2?**Answer 2.h**: It is correct understanding that simultaneous Rx in DL is not supported for inter-cell BM but supported for inter-cell mTRP, while simultaneous Tx in UL is not supported for both. From configuration perspective, regarding the last question, inter-cell BM will be supported based on the unified TCI framework to be introduced in Rel-17 so relevant Rel-17 TCI configuration parameters will be required to enable this feature. Meanwhile inter-cell mTRP feature is to extend Rel-16 multi-DCI mTRP functionality to TRPs with different PCI so that its configuration parameters will be same or similar to those defined for Rel-16 multi-DCI mTRP operation.  |

Table 18 Companies’ inputs on the basic Tx/Rx operation with inter-cell beam management

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above (please refer to the above questions as question 2.a, 2.b, 2.c, 2.d, 2.e, 2.f, 2.h)****2.a: I suggest we try to agree in this meeting under which circumstances separate TCI indication would allow the transmission/reception of DL/UL to TRPs configured to different PCIs. Based on the submitted contributions, the majority of companies would support flexible operation.** **2.b: a bit diverse views, a baseline answer is possible without further agreements.****2c: stable answers.****2d: this topic needs RAN1 discussion.****2e: stable answers.****2f: stable answers.****2h: converging answers.** |
| Samsung | For 2a: Reply is fine with the following update:**Answer 2.a**: For inter-cell BM, there are two beam indication modes. One mode is called joint TCI, where DL and UL beams are always same. The other mode is called separate TCI, where DL and UL beams are independently indicated. For the separate TCI mode, RAN1 has not ~~decided whether~~ agreed to introduce such restriction that DL and UL beams should not be set to different TRPs with different PCIs.2b to 2h agree with proposed replies. |
| Qualcomm | For 2.b, suggest the following clarification. To our understanding, both Q2 and 2b didn’t not explicitly say only asking inter-cell BM, and the LS title is for both features. So it may be good to compare both side by side, since RAN2 seems still not very clear on the difference. **Answer 2.b**: system information and paging for inter-cell beam management can be only received from the serving cell TRP. For inter-cell BM, ~~W~~when receiving PDCCH/PDSCH with colliding QCL, prioritization rule specified in Rel-15/16 can be reused. For inter-cell mTRP, it is possible for UE to receive PDCCH/PDSCH with colliding QCL from two TRPs simultaneously.For 2d, suggest to clarify the TRP # for operation for each feature as well. This is asked in the 2d, and to our understanding, both Q2 and 2d did not explicitly say only asking for inter-cell BM. The inter-cell BM answer can be revised based on future agreement. **Answer 2.d**: RAN1 is still discussing the maximum number of RRC configured PCIs different from the serving cell for measurement and reporting and has made the following agreement. The number of non-serving cell TRPs associated with active TCI state(s) is always one for inter-cell mTRP, and is under discussion for inter-cell BM. **[Mod: note that the answer incorporates your clarification but it is written in-between the agreements! I will try to format better the text in the final LS answer to have this clear.]**For 2f, suggest to add the following clarification**Answer 2.f**: Inter-cell beam management is going to use Rel-17 unified TCI signaling where RAN1 agreed that a MAC-CE activates one or multiple TCI states out of RRC configured TCI state pool. If multiple TCI states are activated, DCI selects one TCI state among activated ones. If only one TCI state is activated, the activated TCI state is also implicitly selected without further DCI indication. For 2h, suggest to clarify simultaneous Tx is not supported for both. **Answer 2.h**: It is correct understanding that simultaneous ~~Tx/~~Rx is not supported for inter-cell BM but supported for inter-cell mTRP, while simultaneous Tx is not supported for both. From configuration perspective, regarding the last question, inter-cell BM will be supported based on the unified TCI framework to be introduced in Rel-17 so relevant Rel-17 TCI configuration parameters will be required to enable this feature. Meanwhile inter-cell mTRP feature is to extend Rel-16 multi-DCI mTRP functionality to TRPs with different PCI so that its configuration parameters will be same or similar to Rel-16 CORESET pool related parameters. |
| vivo | @Qualcomm, on 2b for inter-cell mTRP, UE can receive PDCCH/PDSCH with colliding QCL from two TRPs simultaneously but system information and paging are different. |
| NTT DOCOMO | For 2a, we’re fine with it.For 2.b, agree with QC’s revision.For 2c, we’re fine with it.For 2.d, suggest following revision.**Answer 2.d**: RAN1 is still discussing the maximum number of RRC configured PCIs different from the serving cell for ~~measurement and reporting and has made the following agreement~~ different purposes for different scenarios:* For inter-cell BM, RAN1 is discussing the maximum number of RRC configured PCIs different from the serving cell for L1 measurement/reporting, as well as the maximum number of additional PCIs associated with active TCI state(s). Following agreements have been made:
	+ …
* For inter-cell mTRP, RAN1 is discussing the maximum number of RRC configured PCIs different from the serving cell. Following agreements have been made:
	+ …

**[Mod: I very much appreciate some better structure, in fact I even started to implement it according to your suggestion. The problem is some agreements are for both BM and mTRP and then it makes it a bit difficult to categorize. Even if we stay with the current format, all the technical info is provided]**For 2e, we’re fine with it.For 2f, we’re fine with either the reply or QC’s revision.For 2.g, agree with QC’s revision. |
| Intel | 2a Fine with proposed answer2b We don’t have any conclusion whether the existing QCL prioritization can be reused for inter-cell. Prefer not to mention this aspect**Answer 2.b**: system information and paging for inter-cell beam management can be only received from the serving cell TRP. ~~When receiving PDCCH/PDSCH with colliding QCL, prioritization rule specified in Rel-15/16 can be reused.~~2c Fine with proposed answer2d The following part of the sentence from RAN2 LS “…TRPs involved in the operation…” is a bit confusing to us. Our understand that it is not only limited to measured and reported TRPs, but also TRPs for beam indication. This should be reflected in the LS reply e.g. as follows:

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| **Answer 2.d**: RAN1 is still discussing the maximum number of RRC configured PCIs different from the serving cell for TCI beam indication, measurement and reporting and has made the following agreements… |

2e and 2f Fine with proposed answers2g It is not clear which link direction (DL or UL) is assumed when Tx/Rx. Suggest the following revision on top of QC’s updates.

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| **Answer 2.d** It is correct understanding that simultaneous ~~Tx/~~Rx in DL is not supported for inter-cell BM but supported for inter-cell mTRP, while simultaneous Tx in UL is not supported for both. From configuration perspective, regarding the last question, inter-cell BM will be supported based on the unified TCI framework to be introduced in Rel-17 so relevant Rel-17 TCI configuration parameters will be required to enable this feature. Meanwhile inter-cell mTRP feature is to extend Rel-16 multi-DCI mTRP functionality to TRPs with different PCI so that its configuration parameters will be same or similar to Rel-16 CORESET pool related parameters. |

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| ZTE | For Answer 2.a: Samsung’s update can well reflect what we have now.For Answer 2.b: why we need to further clarify the QCL rules for collision. It seems that this part has not been discussed recently in RAN1. We suggest to remove it as follows:**Answer 2.b**: system information and paging for inter-cell beam management can be only received from the serving cell TRP. ~~When receiving PDCCH/PDSCH with colliding QCL, prioritization rule specified in Rel-15/16 can be reused.~~For Answer 2.c/d/e: Support.For 2f, in our views, we should reply RAN2 question directly, like: Regarding TCI switching signalling, Rel-17 MAC-CE-based and/or DCI-based beam indication can be used for TCI switching for inter-cell beam managementFor 2.h, we prefer Intel’s version. |
| Apple | 2.a: OK2.b: For paging, we suggest we wait for a further RAN1 agreement, in current FL summary, issue 2.8 is discussing paging from non-serving cell. At least, we can add a bracket for paging for now. We are fine with others.2.c: OK2.d: OK2.e: OK2.f: OK with QC’s revision2.h: OK |
| OPPO | 2.b: we are fine with the proposed answer. Not ok with the ZTE’s suggestion to delete “when receiving…” because that also answers part of what the RAN2 question ask for.2.c: ok2.d: ok to send the agreements to RAN22.e: ok2.f: ok2.h: in inter-cell mTRP, we do not support simultaneous Tx in UL. So suggest to choose the version of Intel. |
| Ericsson | 2.a: We think we should state that RAN1 tried to reach consensus to introduce such a restriction, but failed. [**Mod**: I think we can keep it simpler as it should not matter to RAN2 what was RAN1 history on this]2.b: OK. We note there is an issue noted in the Fl summary on paging reception.2.d: The question is a bit unclear: what does “involved in the operation” mean? The UE can at most send/receive from one/two TRPs but may measure on multiple. Can we clarify this?2.h: Suggest to remove “so that its configuration parameters will be same or similar to Rel-16 CORESET pool related parameters” – the reference to CORESET pool is quite unclear. And it does not really tell RAN2 anything. In fact, the extensions should only be related to QCL according to the WID.[**Mod**: It seems everybody is fine with the initial text so I kept it for now, made just some small clarifications.] |
| Huawei, HiSilicon | **2.a:** Is it correct understanding that the “DL and UL beams” mentioned in this answer refers to UE beam? Is so, we suggest making it clear. If it is not sure, we suggest changing to DL and UL TCI. [**Mod**: changed to TCI]**2.b:** We suggest waiting for the decision on Issue 2.8 in agenda 8.1.1. The agreements thus far allows UE to report supporting only one active TCI state and NW to activate only one TCI state associated with PCI different from serving cell. In these cases, with the proposed Answer 2.b, NW will not be able to page the UE. At least, paging part should be put in brackets as suggested by Apple. **2.d:** We suggest waiting for the decision on Proposal 2.D in agenda 8.1.1. We hope some progress can be made there and reflected in the response to RAN2. **2.e:** As the question from RAN2 also mentioned inter-cell multi-TRP, we suggest including this aspect in the answer as well. **2.f:** Prefer QC’s revision. **2.h:** In our understanding, simultaneous UL Tx to “serving cell TRP” and “TRP with different PCI” is not supported for inter-cell multi-TRP operation in R17. We suggest making this clear in the response. Please let us know if we missed something. **[Mod:** made some clarifications, I hope you are fine with the latest!] |
| LGE | **2.a:** Related conclusion was made for this issue in this meeting (captured below)**Conclusion**On Rel-17 beam indication enhancements for inter-cell beam management, for separate DL/UL TCI, there is no consensus in restricting the indicated DL TCI and UL TCI to be associated with SSBs of a same physical cell ID.* Whether a corresponding UE feature can be introduced can be discussed in UE feature agenda

Thus, the answer needs to be updated, e.g.**Answer 2.a**: For inter-cell BM, there are two beam indication modes. One mode is called joint TCI, where DL and UL beams are always same. The other mode is called separate TCI, where DL and UL beams are independently indicated. For the separate TCI mode, it is possible that the UE can set UL beam for serving cell TRP and set DL beam for TRP with different PCI and vice-versa. ~~RAN1 has not decided whether to introduce such restriction that DL and UL beams should not be set to different TRPs with different PCIs.~~[**Mod**: I think the initial suggestion captures well the agreement and I prefer to keep it for now as everybody seems fine. ]**2.b:** Second sentence is not precise (as QC pointed out) and some part is still under discussion. We think that the first sentence is sufficient to answer for RAN2’s question. **2.c:** Support**2.d:** Direction to capture RAN1 agreements is good. Agree with QC’s comment that it needs to clarify that only one TRP can be activated by MAC-CE other than serving cell TRP for mTRP operation. For exact values, it may be better to wait for related MB and mTRP mCell agreements in this meeting.**2.e:** Support**2.f:** Support. QC’s additional sentence is also fine.**2.h:** Agree with other companies’ comments that simultaneous Tx is not possible for both MB and mTRP mCell. Other parts are fine to us. |
| Xiaomi | **2.a:** There no consensus in restricting the indicated DL TCI and UL TCI to be associated with SSBs of a same physical cell ID according to the current discussion about this question in agenda 8.1.1. It seems difficult to come to an agreement in this meeting.**2.b:** Agree with Apple. |
| Lenovo/MotM | 2a. Fine with Samsung’s version;2b. The first sentence is sufficient for RAN2, the second sentence require agreement/conclusion in RAN1.2c. Support.2d. Prefer QC’s version.2e. Support.2f. Prefer QC’s version.2h. Prefer QC’s version to clearly point that simultaneous UL transmission from different TRP with different PCI is not supported for both scenario. |
| Mod | **2.a:** small update **2.b:** added square brackets to paging and also removed the second sentence. I sympathise with QC that it would be nice to have descriptions for both technologies on how this work. We will come back to this questions towards the and of this meeting to see what progress we get in 8.1.1.**2.c:** no changes, unanimous support**2.d:** small wording updates, also on agreements**2.e:** added a small clarification on mTRP, otherwise all companies are on the same page!**2.f:** modified according to QCs suggestion**2.h:** small clarifications |
| CATT | 2.a. Support2.b. Support2.c. Support.2.d. Support.2.e. Support.2.f. Support.2.h. Support |
| Ericsson | 2.b: We do not see that we need to discuss the prioritization rule – it is part of the specification, so it applies.**[Mod] indeed, the mention on prioritization rules is not considered in the answer!**2.h: The statement “Rel-16 CORESET pool related parameters” is unclear to us. Even if it’s clear for some RAN1 delegates, it would seem unlikely that it is clear to RAN2. Suggest rewriting:Meanwhile inter-cell mTRP feature is to extend Rel-16 multi-DCI mTRP functionality to TRPs with different PCI so that its configuration parameters will be same or similar to those defined for Rel-16 multi-DCI mTRP operation.  |
| **Mod** | **2.a: Stable answer, moved in the conclusion section****2.b: need to see how the paging discussion ends and update accordingly the brackets part! If no conclusion on paging, I suggest we remove the paging mention from the answer, hence delete the text from the brackets!****2.c: Stable answer, moved in the conclusion section****2.d: replaced one agreement with the latest from this meeting! Otherwise, it looks stable and moved to conclusion section****2.e: Stable answer, moved in the conclusion section****2.f: Stable answer, moved in the conclusion section****2.h: updated according to Ericsson. Please comment only if you are NOT OK with the addition!** |

### **Reply on MAC aspects**

Based on the above inputs, the following reply is proposed:

Table 10 Proposed reply to RAN2 on MAC aspects

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| **Question 3:** RAN2 would like to understand the impacts to MAC operation, in particular:a) **Timing advance:** Is it assumed that TA is the same for both *serving cell TRP* and *TRP with different PCI*, or does UE maintain different TAs for each? **Answer 3.a**: In Rel 17 it is assumed that that a single TA is maintained by the UE for inter-cell beam management. The case of multiple TAs was discussed by RAN1 but no consensus has been reached. |

Table 11 Proposed reply to RAN2 on MAC aspects

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| --- |
| b) **RACH:** Are there any impacts to RACH operation with inter-cell beam management? That is, is it necessary to perform RACH toward TRP with different PCI e.g. for TA, BFR, etc?**Answer 3.b**: There is no impact on RACH operation, i.e., RACH transmission should be performed by the UE using the serving cell configuration. |

Table 12 Proposed reply to RAN2 on MAC aspects

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| --- |
| c) **UL PC/PHR:** When UE is configured for *TRP with different PCI* for a cell with UL, is there an impact to UL power control or PHR?**Answer 3.c**: For inter-cell mTRP operation, no impact on power control and PHR beyond what is needed to support Rel-16 defined intra-cell multi-DCI based multi-TRP operation. sDCI based mTRP PUCCH/PUSCH repetition schemes being discussed in R17, where there will be per TRP PHR reporting. However, sDCI based mTRP PUCCH/PUSCH repetition discussion is not assuming different PCIs for TRPs. For inter-cell BM operation, there are no specific changes to enhance power control or PHR reporting compared to intra-cell BM operation. |

Table 13 Companies’ inputs on the MAC aspects

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above (please refer to the above questions as question 3.a, 3.b, 3.c)****3a: stable answers, RAN1 decision in place.** **3b: stable answers****3c: discussion needed!** |
| Samsung | 3a to 3c agree with proposed replies. |
| Qualcomm | Fine for 3a to 3c |
| vivo | Ok with proposed answers |
| NTT DOCOMO | We’re fine with 3.a and 3.c.For 3.b, it is better RAN1 makes explicit agreement/conclusion before replying so, especially on PDCCH ordered PRACH to non-serving PCI. |
| Intel | 3a Suggest the following revision

|  |
| --- |
| **Answer 3.a**: In Rel 17 it is assumed that that a single TA is maintained by the UE for inter-cell beam management. The case of different TAs was discussed by RAN1 but no ~~conclusion~~ consensus has been reached. |

3b Fine with proposed reply3c We don’t agree with proposed answer comparing to intra-cell case, since PL RS in inter-cell should be linked to SSB that has PCID different from the serving cell PCID. |
| ZTE | Support 3a/b/c |
| Apple | 3.a: OK3.b: We think RAN1 has not discussed these issues, although we proposed multiple times. ☹ We think both TA and BFR are valid points for RACH. Maybe we can leave it to RAN2. 3.c: OK |
| OPPO | 3a: ok3b: ok3.c: ok |
| Ericsson | 3b: Suggest rephrasing: “There is no impact on RACH operation, i.e., RACH transmission should be performed by the UE using the serving cell configuration ”.A RACH procedure can be triggered by a PDCCH order, and that PRACH will be transmitted towards the TRP that sent the PDCCH order. |
| Huawei, HiSilicon | **3.a:** To highlight the difference with “single TA” in the 1st part of the proposed answer, we suggest changing “different TAs” in the 2nd half of the proposed answer as “multiple TAs”. **3.b:** Prefer the revision from Ericsson. **3.c:** Does “what is needed to support multi-TRP in the same cell” refers to potential enhancements on “power control and PHR” for mTRP PUCCH/PUSCH transmission being discussed/designed in R17? If so, we suggest making it clear. [**Mod**: added some clarification, please check and feel free to come up with suggestions!] |
| LGE | **3.a:** Support**3.b:** Ericsson’s revision is ok**3.c:** Not sure whether this answer is sufficient. BM agreed some UL power control related enhancements, PL RS and other PC parameter configuration in the unified TCI framework.It would be better to inform RAN2 about the related agreements. |
| Xiaomi | 3.a: OK3.b: We think that more discussion is needed to decide this question for RAN1. According to the inputs above, it is necessary to perform RACH toward TRP with different PCI in some specific scenario mentioned by Apple and Ericsson.3.c: Agree with Huawei. |
| Lenovo/MotM | 3a: Support3b: Support3c: Support |
| Mod | 3.a: small edits based on Intel and HW3.b: updated according to Ericsson’s suggestion, but there are companies who would like to see more agreements in RAN1. Let’s see where we are at the end of this meeting.3.c: added some clarifications |
| CATT | 3.a: Support3.b: Support3.c: Not support. We agree with Intel. PL RS could be linked to SSB having different PCI.**[Mod] I suggest you indicate on the current text what exact modification you prefer since the description is quite elaborate and hard to modify without knowing exactly what is your preference!** |
| Ericsson | 3.c: Support. The BM framework can be reused to indicate other-cell RSs. |
| Apple | 3.b: We suggest we only mention the status in RAN1: RAN1 has not discussed RACH related operation yet.We noticed that there will be some further discussion on BFR at next round as announced by FL, which may have impact on this.**[Mod]: please see my note below!** |
| **Mod** | **3.a: Stable answer, moved in the conclusion section****3.b: we can update the answer in case we decide something on RACH in this meeting, but for now I think the current answer is good and hence moved to the conclusion section!****3.c: I would expect further views at least from Apple and Intel as other companies seem to be OK. Please provide your edits w.r.t. the current proposal so that we can progress efficiently!** |
| Apple | 3.b: I suggest we modify the answer as follows. We can tell RAN2 our current status and RAN2 can work based on current RAN1 status, and they can also decide TA and BFR related issues. If we only tell RAN2 we do not see anything related to RACH impact, it may give RAN2 a wrong impression that we discussed TA/BFR, but failed to reach any consensus.**Answer 3.b**: Currently, RAN1 has not identified any impact on RACH operation, i.e., RACH transmission should be performed by the UE using the serving cell configuration. RAN1 has not discussed the TA maintenance and BFR related issue. |
| CATT2 | 3.c: Per our understanding, compared with intra-cell BM/mTRP, one impact on UL power control is that the PL RS could be associated with a SSB with different PCI for inter-cell BM/mTRP. We prefer the following revision:Answer 3.c: For inter-cell mTRP operation and inter-cell BM operation, the PL RS could be associated with a SSB with different PCI from the serving cell. Besides that, For inter-cell mTRP operation, no impact on power control and PHR beyond what is needed to support Rel-16 defined intra-cell multi-DCI based multi-TRP operation. sDCI based mTRP PUCCH/PUSCH repetition schemes being discussed in R17, where there will be per TRP PHR reporting. However, sDCI based mTRP PUCCH/PUSCH repetition discussion is not assuming different PCIs for TRPs. For inter-cell BM operation, there are no specific changes to enhance power control or PHR reporting compared to intra-cell BM operation. |
| SS | Regarding question 3c, as the scope of the question is mTRP with a different PCI, we suggest to delete the part sDCI not assuming a different PCIs for TRPs, this is beyond the scope of the question.c) **UL PC/PHR:** When UE is configured for *TRP with different PCI* for a cell with UL, is there an impact to UL power control or PHR?**Answer 3.c**: For inter-cell mTRP operation with different PCI, no impact on power control and PHR beyond what is needed to support Rel-16 defined intra-cell multi-DCI based multi-TRP operation. ~~sDCI based mTRP PUCCH/PUSCH repetition schemes being discussed in R17, where there will be per TRP PHR reporting. However, sDCI based mTRP PUCCH/PUSCH repetition discussion is not assuming different PCIs for TRPs.~~ For inter-cell BM operation, there are no specific changes to enhance power control or PHR reporting compared to intra-cell BM operation. |

### **Reply on HARQ operation**

Based on the above inputs, the following reply is proposed:

Table 14 Proposed reply to RAN2 on HARQ operation

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| --- |
| **Question 4:** How does the HARQ operation work with the multi-beam operation? In particular:a) **HARQ entity:** Is there a single HARQ entity handling both the *serving cell TRP* and *TRP with different PCI*?**Answer 4.a**: RAN1 assumes a single HARQ entity is used for both the serving cell TRP and TRP with different PCI. |

Table 15 Proposed reply to RAN2 on HARQ operation

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| b) **HARQ retransmissions:** Can retransmission occur from different TRP than initial transmission for the same HARQ process? E.g. can initial transmission be done from *serving cell TRP* and retransmission from *TRP with different PCI*?**Answer 4.b**: Due to assumption on the same HARQ entity, it is possible to have initial transmission and re-transmission originating from TRPs with different PCIDs. |

Table 16 Companies’ inputs on HARQ operation

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above (please refer to the above questions as question 4.a, 4.b)****4a: similar views but discussion/decision needed to endorse the operation mode.****4b: similar views but discussion/decision needed to endorse the operation mode.** |
| Samsung | 4a and 4b agree with proposed replies. |
| Qualcomm | For 4.b, suggest to add the following clarification. **Answer 4.b**: Due to assumption on the same HARQ entity, it is possible to have initial transmission and re-transmission originating from TRPs with different PCIDs. At least for inter-cell mTRP, reTx on different TRP is based on UE capability, i.e. no change w.r.t. R16. [**Mod**: it seems a few companies are not OK with this addition] |
| vivo | Fine with clarification from Qualcomm on 4b |
| NTT DOCOMO | We’re fine with the reply to 4.a and 4.b. |
| Intel | Fine with proposed reply for 4a and 4b |
| ZTE | We can support 4a and fine with QC’s update. |
| Apple | 4.a: OK4.b: OK with QC’s revision |
| OPPO | 4a: OK4b: OK |
| Ericsson | 4a: ok4b: we are ok with the original formulation. We do not recognize the text added by QC, we would think that is related to CORESETPoolIdx, i.e., FG 16-2a-8. There is not a 1-1 mapping between CORESETPoolIdx and PCI. For instance, MAC CE can be used to change the TRP corresponding to the other PCI, (without changing CORESETPoolIdx).  |
| Huawei, HiSilicon | **4.a:** OK.**4.b:** Similar to Ericsson, we prefer not to add red text from QC.  |
| LGE | **4.a:** Support**4.b:** In addition to QC’s revision, it would need to be clarified that this operation is possible only when joint HARQ-ACK is configured. |
| Xiaomi | **Answer 4.a:** OK**Answer 4.b:** I am confused with “there is not a 1-1 mapping between CORESETPoolIdx and PCI” mentioned by Ericsson. There is agreement in 106-e meeting as follows:* For inter-cell mTRP , one PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with one *CORESETPoolIndex* , another PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with another *CORESETPoolIndex*

And does the answer means that for both inter-cell mTRP and inter-cell beam management retransmission can occur from different TRP than initial transmission for the same HARQ process? It is OK for us to support this in the case of inter-cell beam management. However, for inter-cell mTRP, we agree with Qualcomm. |
| Lenovo/MotM | **4a.** Support**4b.** Support |
| Mod | **4.a:** no changes.**4.b:** no changes |
| CATT | 4.a: Support4.b: Support |
| Ericsson | 4.a: Support4.b: Support. Our point is that the “the other PCI” may change over time. |
| **Mod** | **4.a: Stable answer, moved in the conclusion section****4.b: Stable answer, moved in the conclusion section** |

### **Reply on physical layer configuration**

Based on the above inputs, the following reply is proposed:

Table 17 Proposed reply to RAN2 on Physical layer configuration

|  |
| --- |
| **Question 5:** Does the *TRP with different PCI* have an independent physical layer configuration, e.g. for PUSCH/PDSCH/PDCCH/PUCCH and PRACH? **Answer 5**: There is only one physical layer configuration and that is applied to all the PUSCH/PUCCH/PDSCH/PDCCH associated with TCI state that is associated with either serving cell PCI or another different PCI. Regarding the PRACH transmission, RAN1 has not discussed configuration of PRACH for a TRP with different PCI. |

Table 18 Proposed reply to RAN2 on Physical layer configuration

|  |
| --- |
| a) **Configuration differences:** Does RAN1 assume that only certain parameters can be different from the serving cell and if so, which ones? **Answer 5.a**: RAN1 has not discussed or concluded to provided configuration parameter(s) for TRP with different PCI. |

Table 19 Proposed reply to RAN2 on Physical layer configuration

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| --- |
| b) **Configuration of inter-cell beam management measurements and reporting:** Which RRC configuration(s) need to be provided for inter-cell beam measurement and reporting? ‎ **Answer 5.b**: RAN1 just started RRC parameter discussion and will send a separate LS for an initial outcome of the RRC parameter list after RAN1#106bis-e meeting. |

Table 20 Proposed reply to RAN2 on Physical layer configuration

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| --- |
| c) **Feature differences:** Are the RRC parameters/configurations different for inter-cell mTRP and inter-cell beam management? **Answer 5.c**: Inter-cell beam management uses the unified TCI framework, inter-cell mTRP uses the legacy Rel-15/Rel-16 TCI framework. RRC parameters for configuring each of these frameworks are different. Further details on RRC configurations will be included in the RRC parameter list. |

Table 21 Companies’ inputs on the applicability of Physical layer configuration

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above****5a: needs discussion and decision in RAN1****5b: needs discussion and decision in RAN1****5c: needs discussion and decision in RAN1** |
| Samsung | For 5: PRACH it might be better to discuss more, before making a conclusion. PRACH can be used for PDCCH order, BFR, in addition other dedicated PRACH configuration used cases.**Answer 5**: There is only one physical layer configuration and that is applied to all the PUSCH/PUCCH/PDSCH/PDCCH associated with TCI state that is associated with either serving cell PCI or another different PCI. Regarding the PRACH transmission, ~~since no common channel can be received from TRP with a different PCI, the association between PRACH preamble and SSB should only occur for SSB of serving cell TRP. Therefore, there is no~~ RAN1 has not discussed configuration of PRACH for ~~the~~ a TRP with different PCI.5a to 5c agree with proposed replies. |
| Qualcomm | For 5b, we think it is safe to say at least measurement/report config should be provided. **Answer 5.b**: ~~RAN1 just started RRC parameter discussion.~~ L1 measurement and reporting configuration for both inter-cell BM and inter-cell mTRP. |
| vivo | For 5b, the answer can be revised based on RRC parameter discussion |
| NTT DOCOMO | For 5/5.a, we’re fine with the reply for configuration of PUSCH/PUCCH/PDSCH/PDCCH. But for configuration of PRACH, it is better RAN1 makes explicit agreement/conclusion before replying so, especially on PDCCH ordered PRACH to non-serving PCI. We’re fine with the reply to 5.b/5.c. |
| Intel | 5 Suggest simplifying answer and state that there is common configuration for all channels (PRACH may require special agreement in RAN1).

|  |
| --- |
| **Answer 5** The same configuration of PUSCH/PDSCH/PDCCH/PUCCH and PRACH is assumed for serving cell TRP and TRP with different PCI |

5c Prefer to also repeat that beam measurement and reporting configuration parameters would be the same,

|  |
| --- |
| **Answer 5.c**: Inter-cell beam management uses the unified TCI framework, inter-cell mTRP uses the legacy Rel-15/Rel-16 TCI framework. RRC parameters for configuring each of these frameworks are different. Configuration of inter-cell measurement and reporting for inter-cell BM and mTRP are the same. Further details on RRC configurations will be included in the RRC parameter list. |

[Mod: I sympathise with your suggestion, but since the Q is about RRC I think we are fine with the original proposal. Thx for spotting the typo also!] |
| ZTE | For 5: In our views, PRACH can NOT be applied to the TRP with different PCI, and specifically, we do not have any additional configuration for PRACH (considering that CSS Type1 should be assumed as non-UE dedicated channel). So, we prefer to reply this issue as follows:**Answer 5**: There is only one physical layer configuration and that is applied to all the PUSCH/PUCCH/PDSCH/PDCCH associated with TCI state that is associated with either serving cell PCI or another different PCI. Regarding the PRACH transmission, since no common channel can be received from TRP with a different PCI, RAN1 confirms that there is no additional configuration of PRACH for the TRP with different PCI.For 5a/b/c, we share the same views with the moderator that some further discussion in RAN1 is needed. So, we can review the corresponding answers later, based on the latest RAN1 progress during this meeting. |
| Apple | 5: We suggest we let RAN2 decide RACH, since TA/BFR related were not discussed. Others are fine. SS’s revision is fine to us.5a: OK5b: OK5c: OK |
| OPPO | 5: OK5a: our understanding is that in this question, RAN2 wants to know what kind of RRC parameters are new due to introducing inter-cell BM. The proposed answer seems to answer question 5 but not 5a.For TRP with different PCI, the following parameters are introduced:* Some TCI states are associated with a PCI different from that of the serving cell.
* The UE can be configured to measure L1-RSRP of some SSBs associated with a PCI different from that of the serving cell.

5b: ok5c: suggest to clarify that: RRC parameters for TCI state configuration/indication are different but they share the same RRC configuration of L1-RSRP beam measurement and reporting on SSB of non-serving cell.  |
| Ericsson | 5. Propose to add that for mTRP, the serving cell configuration includes some parameters related to the transmission from the second TRP (e.g., dataScramblingIdentityPDSCH2), similar to Rel-16 mDCI mTRP5.a: For inter-cell mTRP, the WID states that only changes related to QCL assumptions should be included. This means that parameters that are not related to QCL assumptions should be the same (perhaps with the exception related to rate matching). Allthough not agreed for inter-cell beam management, it makes sense to apply the same principle.  |
| Huawei, HiSilicon | **5:** For simplicity, we prefer the current formulation from moderator (i.e., only one configuration) and prefer not to take the suggestion from Intel (i.e., same configuration). The proposed addition from Ericsson on data scrambling is not applicable to inter-cell beam management where from UE perspective the serving cell (including data scrambling) remains unchanged. **5.a:** The proposed answer seems to conflict with the answer for 5. Agree with the comment from Ericsson in principle.  |
| LGE | **5:** To us, it is a bit ambiguous what exactly ‘one physical layer configuration’ means. It may be better to clarify that the serving cell configuration includes some parameters related to the transmission from the TRP with different PCI, as Ericsson suggested. For example, SSB configuration with different PCI needs to be provided to UE for Tx/Rx from the TRP being used as QCL/spatial relation source. For another example, CORESETs in one CORESETpool can be used by TRP with different PCI for PDCCH transmission. **5.a:** We share similar feeling with Huawei that this answer could conflict with the answer for 5. It may be ok to simplify the answer further as below:**Answer 5.a**: RAN1 has not discussed or concluded to provided configuration~~s~~ parameter(s) ~~for PUSCH/PDSCH/PDCCH/PUCCH and PRACH~~ for TRP with different PCI.**5.b:** OK. It would look kinder ☺ if we add ‘and RAN1 will send a separate LS for an initial outcome of the RRC parameter list after RAN1#106bis-e meeting’**5.c:** Support |
| Xiaomi | **Answer 5:** For intra-cell mTRP in Rel16, UE may expect to receive fully/partially/non-overlapped PDSCHs in time and frequency domain scheduled by multiple PDCCHs. If only one physical layer configuration is supported for inter-cell mTRP, only fully-overlapped PDSCHs in time and frequency domain from both TRPs are supported. So, is this acceptable for us, or should we still consider to support fully/partially/non-overlapped PDSCHs for inter-cell mTRP? |
| Lenovo/MotM | 5: Support Smasung’s versin.5a: Fine with LG’s version.5b: Support5c: Support |
| Mod | **5:** removed the PRACH mention.**5.a:** made some simplifications**5.b:** no changes done, but I prefer the direction QC is suggesting, please check that!**5.c:** fixed on typo |
| CATT | 5: Support5.a: Support5.b: Support. We are also fine with QC’s proposal.5.c: Support |
| Ericsson | 5. Support5.a. OK, if this is the best we can do5.b: Support, but maybe it can be formulated like LG proposed? We do not think we should go into details here, the RRC parameter list is the right place to have that discussion.5.c Support  |
| **Mod** | **5: Stable answer, moved in the conclusion section****5.a: Stable answer, moved in the conclusion section****5.b: improved a bit the wording according to LGE’s suggestion and moved to conclusion section as the answer is non-technical as such!****5.c: Stable answer, moved in the conclusion section** |

## Conclusion

This section summarizes the final LS answer to be sent to RAN2:

**3GPP TSG RAN WG1 #106b-e R1-210xxxx**

**e-Meeting, October 11th – 19th, 2021**

**Title:** LS Reply on inter-cell beam management and multi-TRP in Rel-17

**Response to:** R2-2108925/R1-210zzzz

**Release:** Rel-17

**Work Item:** NR\_feMIMO-Core

**Source:** RAN1

**To:** RAN2

**Cc:** RAN4

**Contact Person:**

**Name:** Mihai Enescu

**E-mail Address:** mihai.enescu@nokia.com

# **1. Overall Description**

RAN1 would like to thank RAN2 for the questions related to inter-cell beam management and multi-TRP in Rel-17. RAN1 provides the following answers.

|  |
| --- |
| **Question 1: RAN2 notes that WI objective 1 states " The same beam measurement/reporting mechanism will be reused for inter-cell mTRP "). RAN2 would like to understand if the entire inter-cell BM is also applicable to inter-cell mTRP? If not, which part is not applicable to mTRP and how does that work?****Answer 1**: Rel17 Inter-cell BM and inter-cell mTRP have common points but they are not entirely the same. The common and different points are as follows: they both use the same beam measurement/reporting mechanisms but they have different TCI signaling framework (beam indication) as inter-cell BM is based on Rel17 unified TCI while inter-cell mTRP is based on Rel15/16 TCI framework. For inter-cell BM, UE assumes that the UE-dedicated channels/RSs can be switched to a TRP with different PCI according to DCI/MAC-CE based unified TCI update; for inter-cell mTRP, UE assumes mDCI-mTRPbased multi-PDSCH reception.**Question 2:** The WI states that "*For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done)*". Then, when the UE is configured to use both *serving cell TRP* and *TRP with different PCI*, RAN2 would like to understand the corresponding behaviour for: a) **UL and DL:** Are UL and DL always processed at the same TRP or can the UE use e.g. *serving cell TRP* for UL transmissions and *TRP with different PCI* for DL reception or vice-versa?**Answer 2.a**: For inter-cell BM, there are two beam indication modes. One mode is called joint TCI, where DL and UL beams are always same. The other mode is called separate TCI, where DL and UL TCIs are independently indicated. For the separate TCI mode, RAN1 has not agreed to introduce such restriction that DL and UL beams should not be set to different TRPs with different PCIs.b) **System information and short message (e.g. paging):** If UE is receiving DL data from *TRP with different PCI* on dedicated channels, is the UE still able to receive short message (e.g. paging) and system information from *serving cell TRP* at the same time?**Answer 2.b**: system information [and paging] for inter-cell beam management can be only received from the serving cell TRP. c) **SSB reception:** is the UE able to always receive CD-SSB from *serving cell TRP* when needed and is there any impact to RRM measurements of serving or neighbour cells?**Answer 2.c**: The UE is always able to receive CD-SSB from serving cell TRP. There is no impact on RRM measurements of serving or neighbour cells.d) **Number of TRPs:** Is the number of TRPs involved in the operation restricted to two (i.e. *serving cell TRP* and *TRP with different PCI*? Are there any restrictions on TRPs from which UE may send/receive data, or TRPs from which the UE is assumed to be able to make L1 measurements?**Answer 2.d**: RAN1 is still discussing the maximum number of RRC configured PCIs different from the serving cell for TCI beam indication, measurement and reporting and has made the following agreements:**Agreement**On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, NMAX (the maximum number of RRC-configured PCIs different from the serving cell for measurement/reporting) is up to UE capability with candidate values of at least 1 and X.* Note: The upper bound for X as agreed in AI 8.1.2.2
* When NMAXis configured to be X, the UE is RRC-configured for L1-RSRP measurement with up to X PCIs different from the serving cell PCI
* Additional restriction may be added by RAN4
* FFS: UE measurement behaviour when SSBs associated with different PCIs overlap, including whether this is up to UE capability

The related agreement made in AI 8.1.2.2 (inter-cell mTRP) during RAN1 #106-e is provided as follows.**Agreement**Rel. 17 inter-cell MTRP, the maximum number of additional RRC -configured PCIs per CC is denoted X and can be reported as a UE capability* For the report value of X, multiple candidate values including 1 is supported.
	+ FFS: Which values to support other than 1.
	+ Values larger than 7 are precluded
	+ RAN1 needs to agree on value(s) of X other than 1
* Down-select one of the following alternatives:
	+ Alt 1: A single value of X is reported as UE capability for any possible SSB time domain position and periodicity
	+ Alt 3: At least Two independent X values (X1, X2) are reported as a UE capability for at least two different assumptions on SSB time domain position and periodicity with respect to serving cell SSB
* The serving cell PCI is always associated with active TCI states, only 1 additional PCI can be associated with the active TCI States

For AI 8.1.2.2, i.e., inter-cell mTRP operation, only one additional PCI different from the serving cell PCI can be associated with active TCI state(s) per CC. The related agreement made in RAN1 #104b-e is copied below.**Agreement*** For intercell MTRP operation, 1 additional PCI different from the serving cell PCI is supported per CC
	+ The additional PCI is the one associated with one or more TCI states that are activated for [CSI-RS for CSI]/PDSCH/PDCCH, per CC.
	+ Applicable at least for non-cross carrier QCL indication
		- FFS: Cross carrier scheduling QCL indication
* RAN1 to decide on the maximum number of PCIs different from the serving cell PCI per CC and/or across all CCs that can be RRC-configured for multi-DCI based inter-cell multi-TRP
* Above should be specified by reusing R15 QCL rules as concluded in RAN1#104-e

e) **PCell/PSCell/SCell:** Is the inter-cell beam management applicable to any serving cell (i.e. PCell/PSCell/SCell)? That is, can intercell beam management or intercell mTRP be configured for SCell and/or PSCell in addition to PCell?**Answer 2.e**: inter-cell beam management and inter-cell mTRP can be applicable to any serving cell (i.e. PCell/PSCell/SCell).f) **TCI switching signalling:** Which signalling should be used for TCI switching for inter-cell beam management?**Answer 2.f**: Inter-cell beam management is going to use Rel-17 unified TCI signaling where RAN1 agreed that a MAC-CE activates one or multiple TCI states out of RRC configured TCI state pool. If multiple TCI states are activated, DCI selects one TCI state among activated ones. If only one TCI state is activated, the activated TCI state is also implicitly selected without further DCI indication.h) **Simultaneous Tx/Rx from and to “serving cell TRP” and “TRP with different PCI”:** Is it correct understanding that such simultaneous Tx/Rx is not supported for “inter-cell beam management”, but is supported for “inter-cell mTRP”? If so, what is the difference regarding their configuration that needs to be introduced by RAN2?**Answer 2.h**:**Question 3:** RAN2 would like to understand the impacts to MAC operation, in particular:a) **Timing advance:** Is it assumed that TA is the same for both *serving cell TRP* and *TRP with different PCI*, or does UE maintain different TAs for each? **Answer 3.a**: In Rel 17 it is assumed that that a single TA is maintained by the UE for inter-cell beam management. The case of multiple TAs was discussed by RAN1 but no consensus has been reached.b) **RACH:** Are there any impacts to RACH operation with inter-cell beam management? That is, is it necessary to perform RACH toward TRP with different PCI e.g. for TA, BFR, etc?**Answer 3.b**: There is no impact on RACH operation, i.e., RACH transmission should be performed by the UE using the serving cell configuration.c) **UL PC/PHR:** When UE is configured for *TRP with different PCI* for a cell with UL, is there an impact to UL power control or PHR?**Answer 3.c**: **Question 4:** How does the HARQ operation work with the multi-beam operation? In particular:a) **HARQ entity:** Is there a single HARQ entity handling both the *serving cell TRP* and *TRP with different PCI*?**Answer 4.a**: RAN1 assumes a single HARQ entity is used for both the serving cell TRP and TRP with different PCI.b) **HARQ retransmissions:** Can retransmission occur from different TRP than initial transmission for the same HARQ process? E.g. can initial transmission be done from *serving cell TRP* and retransmission from *TRP with different PCI*?**Answer 4.b**: Due to assumption on the same HARQ entity, it is possible to have initial transmission and re-transmission originating from TRPs with different PCIDs.**Question 5:** Does the *TRP with different PCI* have an independent physical layer configuration, e.g. for PUSCH/PDSCH/PDCCH/PUCCH and PRACH? **Answer 5**: There is only one physical layer configuration and that is applied to all the PUSCH/PUCCH/PDSCH/PDCCH associated with TCI state that is associated with either serving cell PCI or another different PCI. Regarding the PRACH transmission, RAN1 has not discussed configuration of PRACH for a TRP with different PCI.a) **Configuration differences:** Does RAN1 assume that only certain parameters can be different from the serving cell and if so, which ones? **Answer 5.a**: RAN1 has not discussed or concluded to provided configuration parameter(s) for TRP with different PCI.b) **Configuration of inter-cell beam management measurements and reporting:** Which RRC configuration(s) need to be provided for inter-cell beam measurement and reporting? ‎ **Answer 5.b**: RAN1 just started RRC parameter discussion and will send a separate LS for an initial outcome of the RRC parameter list after RAN1#106bis-e meeting.c) **Feature differences:** Are the RRC parameters/configurations different for inter-cell mTRP and inter-cell beam management? **Answer 5.c**: Inter-cell beam management uses the unified TCI framework, inter-cell mTRP uses the legacy Rel-15/Rel-16 TCI framework. RRC parameters for configuring each of these frameworks are different. Further details on RRC configurations will be included in the RRC parameter list. |

# **2. Actions:**

**To: RAN2**

**ACTION**: RAN1 respectfully asks RAN2 to take the above information into account for future work.

# **3. Date of Next TSG-RAN WG1 Meetings:**

TSG RAN WG1 Meeting #107-e Nov. 11 – 19, 2021 Online

TSG RAN WG1 Meeting #107b-e Jan. 17 – 25, 2022 Online