**3GPP TSG RAN WG1 #106-e R1-2108309**

**e-Meeting, August 16th – 27th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary for LS replies to RAN2/3/4 on inter-cell beam management

**Document for:** Discussion and Decision

## Introduction

This summary includes the following:

* Proposed LS replies to the LSs from RAN2 (x6414), RAN3 (x6418), and RAN4 (x6426)
* Summary of companies’ inputs on the proposed replies

## Summary of companies’ inputs

The following LS replies from RAN2/3/4 were submitted:

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| R1-2106414 | LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility | RAN2, Samsung |
| R1-2106418 | Reply LS to RAN1 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | RAN3, Samsung |
| R1-2106426 | Reply LS on L1/L2 centric inter-cell mobility | RAN4, Samsung |

The following input Tdocs were submitted:

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| R1-2106777 | Draft Reply LS to RAN2 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | ZTE |
| R1-2106778 | Draft Reply LS to RAN3 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | ZTE |
| R1-2106779 | Draft Reply LS to RAN4 LS on L1/L2-Centric Inter-Cell Mobility | ZTE |
| R1-2106852 | [Draft] LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility to RAN2 | Samsung |
| R1-2106853 | [Draft] LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility to RAN3 | Samsung |
| R1-2106854 | [Draft] LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility to RAN4 | Samsung |
| R1-2107070 | [DRAFT] Reply LS to RAN2 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | Lenovo, Motorola Mobility |
| R1-2107071 | [DRAFT] Reply LS to RAN3 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | Lenovo, Motorola Mobility |
| R1-2107072 | [DRAFT] Reply LS to RAN4 LS on L1/L2-Centric Inter-Cell Mobility | Lenovo, Motorola Mobility |
| R1-2107283 | Discussion on LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility | OPPO |
| R1-2107284 | Discussion on Reply LS to RAN1 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | OPPO |
| R1-2107285 | Discussion on Reply LS on L1/L2 centric inter-cell mobility | OPPO |
| R1-2107696 | Draft Reply LS on TCI update for Inter-cell Mobility [RAN2] | Apple |
| R1-2107697 | Draft Reply LS on TCI update for Inter-cell Mobility [RAN3] | Apple |
| R1-2107698 | Draft Reply LS on TCI update for Inter-cell Mobility [RAN4] | Apple |
| R1-2107813 | Draft Reply LS to RAN2 on LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility | LG Electronics |
| R1-2107963 | Draft Reply LS on RAN2 LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility | vivo |
| R1-2107964 | Draft Reply LS on RAN3 Reply LS to RAN1 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility | vivo |
| R1-2107965 | Draft Reply LS on RAN4 Reply to RAN1 LS on L1/L2-Centric Inter-Cell Mobility | vivo |
| R1-2108063 | Views on RAN2 reply LS for L1/L2 mobility | Huawei, HiSilicon |
| R1-2108064 | Views on RAN3 reply LS for L1/L2 mobility | Huawei, HiSilicon |
| R1-2108065 | Views on RAN4 reply LS for L1/L2 mobility | Huawei, HiSilicon |

Note that per RAN#92-e conclusions, the respective WID has been revised as follows [RP-211586]. Therefore:

* As far as Rel-17 work in concerned, any inquiry pertaining to a change in serving cell is no longer relevant
* The term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management” to avoid any misunderstanding that Rel-17 work includes handover enhancements (the term mobility is often understood as such especially in RAN2)

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| 1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:    1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management for intra-cell and inter-cell scenarios to support higher UE speed and/or a larger number of configured TCI states:       1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA       2. Unified TCI framework for DL and UL beam indication       3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)       4. 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). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s)          1. The beam indication is based on Rel-17 unified TCI framework          2. The same beam measurement/reporting mechanism will be reused for inter-cell mTRP          3. This work shall only consider intra-DU and intra-frequency cases    2. Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection |

### Reply to R1-2106414 (from RAN2)

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

Table 1 Proposed reply to RAN2

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| **Question: Does RAN1 assume L1 measurements (i.e. measurements not using L3 filtering) are used for triggering L1/L2 centric inter-cell mobility for Scenario 1 and/or Scenario 2?**  **Answer**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Therefore, triggering of inter-cell mobility is no longer relevant irrespective of the so-called Scenario (1 or 2). Furthermore, per the revised WID, the term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management”.  However, since a UE can receive from or transmit to a non-serving cell, the UE performs measurement and reporting with respect to the non-serving cell. In this respect, the revised WID in RP-211586 excludes L3 impact (cf. WID 1.a.iv. “... This includes L1-only measurement/reporting (i.e. no L3 impact) ...”). Therefore, RAN1 shall assume only L1 measurements. |

Table 2 Companies’ inputs: reply to RAN2

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above** |
| Qualcomm | Suggest simplified version as below. Hopefully answer the question more directly.  **Answer**: As reflected in the revised WID RP-211586, no change in serving cell is assumed, i.e. only Scenario 1 is supported in “L1/L2-centric inter-cell mobility”, which is revised as “inter-cell beam management”. At least L1 measurement is agreed in RAN1 to update the used beam(s) for Scenario 1. |
| NTT Docomo | We should reply that at least L1 measurements are needed for inter-cell mobility operation for both scenarios. However, whether L3 measurements in addition to L1 measurements are needed or not is still under discussion in RAN1.  Hence, we suggest to add following to Qualcomm’s proposal:  **Answer**: As reflected in the revised WID RP-211586, no change in serving cell is assumed, i.e. only Scenario 1 is supported in “L1/L2-centric inter-cell mobility”, which is revised as “inter-cell beam management”. At least L1 measurement is agreed in RAN1 to update the used beam(s) for Scenario 1. Whether L3 measurements in addition to L1 measurements are needed or not is still under discussion in RAN1. |
| LG | We have a similar view with Qualcomm that the simplified answer is preferred as follows.  **Answer:** As reflected in the revised WID RP-211586, RAN1 assumes L1 measurement-based beam management for Scenario 1 (Scenario 2 is down-scoped in Rel-17) |
| Lenovo/MotM | Support LG’s reply. |
| OPPO | Support the Answer proposed by Mod. |
| Intel | We do not think L3 measurement are necessary for inter-cell beam management, however, if RAN1 does decide to use such measurements, we can additionally inform RAN2 at the time when such agreement is made. We do not need to mention L3 measurements now.  Simplified answer is preferred as follows:  **Answer:** As reflected in the revised WID RP-211586, no change in serving cell is assumed, i.e. only Scenario 1 is supported in “L1/L2-centric inter-cell mobility”, which is revised as “inter-cell beam management”. RAN1 currently assumes L1 measurement-based beam management for Scenario 1. Note that Scenario 2 is down-scoped in Rel-17. |
| CATT | We are fine with Docomo’s proposal. According to the following agreement in RAN1#105-e, L3-RSRP is still FFS.  **Agreement**  On Rel.17 L1-RSRP multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP, decide by RAN1#106-e whether to support the following RS types as measurement RS or not:   * CSI-RS for mobility/RRM associated with a non-serving cell * CSI-RS for BM associated with a non-serving cell * CSI-RS for tracking associated with a non-serving cell   Note: If another beam metric other than L1-RSRP is supported (e.g. L3-RSRP is still FFS), the above also applies  Note: An RS is associated with a non-serving cell means that it is either configured for a non-serving cell or configured for a serving cell but is QCLed with a non-serving cell SSB |
| Apple | Our suggestion is to directly send RAN2 the agreement mentioned by CATT, and we do not need to talk about the WID. RAN2 should see the WID as well. |
| Huawei, HiSilicon | As suggested in RAN2 reply LS, we suggest avoiding saying “non-serving cell”, which created confusion in both RAN2 and RAN4. Instead, RAN1 can follow the tentative term received from RAN2, i.e., “cell having TRP with different PCI”, and make it clear that it can updated by RAN2 as needed. Or RAN1 can consider going with “SSB with PCI that is different from the serving cell”, which is easier to follow.  In addition, if it is intended for UE-specific channels, we suggest not saying “UE can receive from or transmit to a non-serving cell”, which has created confusion to RAN2 as mentioned in their reply LS. If the intention is about reference signals, we suggest making it clear.  In addition, if candidate schemes other than L1 measurement/reporting is to be mentioned (such as L3 measurement), we suggest including event-driven reporting. |

### Reply to R1-2106418 (from RAN3)

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

Table 3 Proposed reply to RAN3

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| **Question 1**: What does “non-serving cell” mean?  **Question 2**: What is the procedure of L1/L2-centric mobility? e.g.,   * Configuration of a non-serving cell * Deconfiguration of non-serving cell * Change of serving cell   **Question 3**: Whether both intra-frequency and inter-frequency scenarios are targeted for this new scheme?  **Answer 1**: As far as RAN1 is concerned, a “non-serving cell” is a cell with a physical cell ID (PCI) different from the PCI associated with the current serving cell(s) for which a link can be established for UE-specific channel reception and transmission.  **Answer 2**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Furthermore, per the revised WID, the term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management”. Therefore, the above question 2 is no longer relevant. Regardless, inter-cell mobility falls under RAN2 expertise and, even if it were relevant, should be answered by RAN2.  **Answer 3**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, only intra-frequency scenario for inter-cell beam management is considered. |

Table 4 Companies’ inputs: reply to RAN4

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above** |
| Qualcomm | OK for Answer 1 and 3.  For Answer 2, suggest the following wording. Because RAN1 is working on the Scenario 1 procedure. Prefer not to kick the ball to RAN2 now. We are also fine to remove the contents in the bracket if companies think no need.  **Answer 2**: As reflected in the revised WID RP-211586, no change in serving cell is assumed, i.e. only Scenario 1 is supported in “L1/L2-centric inter-cell mobility”, which is revised as “inter-cell beam management”. The detailed procedure for Scenario 1 is still under discussion. [Below is an example under discussion  Step 1: UE reports L1 measurement for SSB of serving and non-serving cell(s).  Step 2: Based on the report, gNB determined each used beam is indicated via SSB of the serving cell or a non-serving cell. ] |
| NTT Docomo | For answer 1, our understanding of “non-serving cell” means UE can receive PDSCH/PDCCH from the serving cell or transmit PUCCH/PUSCH to the serving cell, but it has a SSB/CSI-RS with a different PCI as indirect QCL source.  Support answer 2 from Qualcomm.  Support answer 3 from FL. |
| LG | For Answer 2, the slight modification is suggested for simplification as follows  **Answer 2**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Furthermore, per the revised WID, the term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management”. Therefore, the above question 2 is no longer relevant in Rel-17. |
| Lenovo/MotM | Answer 1: Support.  Answer 2: Given the decision made in RAN#92 on no change of serving cell in R17, configuration/deconfiguration of a non-serving cell shall mean RRC configuration/deconfiguration by the serving cell for the UE regarding reference signals associated with a PCID different from that of the serving cell. We propose the following answer:  **Answer 2**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Furthermore, per the revised WID, the term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management”. Therefore, ~~the above question 2 is no longer relevant. Regardless, inter-cell mobility falls under RAN2 expertise and, even if it were relevant, should be answered by RAN2.~~ configuration/deconfiguration of a non-serving cell shall mean RRC configuration/deconfiguration by the serving cell for the UE regarding reference signals associated with a PCID different from that of the serving cell.  Answer 3: Support. |
| OPPO | Re question 1: we prefer not to discuss “non-serving cell” any more since in the revised WID, no change in serving cell is assumed. Thus the RAN1 work does not need to consider any so called “non-serving cell”. Such information needs to be delivered to RAN4. We propose the following answer for question 1  **Answer 1:** Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Therefore, the above question 1 is no longer relevant. For beam measurement in RAN1, the UE only see some SSB associated with a physical cell ID that is different from that of the serving cell.  The proposed Answer 2 and 3: support |
| Intel | Answer 1 and 3: OK  Answer 2: Prefer LG’s version. We can also clarify that RAN1 understanding is that only Scenario 1 is supported and non-serving cell related configurations are received from the serving cell. In our understanding, any cell with a PCID different from the serving cell is a so-called “non-serving cell” which is supported under the WID description. |
| CATT | Answer 1: Support  Answer 2: Agree with QC’s proposal. The example in the bracket could be removed.  Answer 3: Support |
| Apple | We suggest the following revision as follows:  **Answer 1**: As far as RAN1 is concerned, a “non-serving cell” is a cell with a physical cell ID (PCI) different from the PCI associated with the current serving cell(s).  We do not even need to reply this LS. There will be no RAN3’s work due to the update of WID, and we do not think they will care our response any more. |
| Huawei, HiSilicon | Answer 1 mentioned UE-specific data transmission to a so-called “non-serving cell”, which goes against from what RAN2 mentioned in their reply LS. We prefer the updated Answer 1 from OPPO. |

### Reply to R1-2106426 (from RAN4)

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

Table 5 Proposed reply to RAN4

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| **Question 1**: It is RAN4 common understanding that for the intra-band CA scenario the primary serving cell and secondary serving cell(s) belong to the same frequency band, rather than the serving and non-serving cells belong to the same frequency band as described in the question. Likewise intra-band CA explanation, for inter-band CA case a serving cell and secondary serving cell(s) belong to different frequency bands rather than the serving and non-serving cells. Can RAN1 please further clarify the intra-band/inter-band scenarios based on above RAN4 common understanding?  **Question 2**: RAN4 would like RAN1 to clarify whether “the operation” in question 5 refers to only L1/L2-centric inter-cell mobility or both inter-cell mobility and inter-cell mTRP operations. Does RAN4 need to consider inter-cell mTRP operation into the “CA scenario” of Question 5?  **Question 3:** RAN4 also would like RAN1 and RAN2 to further clarify on the definition of non-serving cell especially whether UE shall support data/control channel reception and transmission from non-serving cell including simultaneous reception and transmission capabilities under CA scenarios.  It is restated that ‘question 5’ refers to question 5 in RAN1 LS R1-2102248.  **Answer 1**: In the context of ‘question 5’, it should be noted that RAN1 is not redefining CA. Just as the normal CA operation, so for intra-band scenario, the first serving cell (i.e., “serving cell” in ‘question 5’) and second serving cell with different PCI (i.e., “non-serving cell” in ‘question 5’) would belong to the same frequency band; in the inter-band CA, the first serving cell (i.e., “serving cell” in ‘question 5’) and second serving cell with different PCI (i.e., “non-serving cell” in ‘question 5’) would belong to different frequency bands.  However, per RAN#92-e conclusion reflected in the revised WID RP-211586, only intra-frequency scenario for inter-cell beam management is considered. Therefore, the only relevant scenario to be considered is intra-band.  **Answer 2**: Per RAN#92-e conclusion reflected in the revised WID RP-211586, no change in serving cell (hence no inter-cell mobility) is assumed. Furthermore, per the revised WID, the term “L1/L2-centric inter-cell mobility” should be replaced with “inter-cell beam management”. The “operation” in ‘question 5’ refers to both inter-cell beam management and inter-cell mTRP.  **Answer 3**: As far as RAN1 is concerned, a “non-serving cell” is a cell with a physical cell ID (PCI) different from the PCI associated with the current serving cell for which a link can be established for UE-specific channel reception and transmission. Regarding simultaneous reception and transmission, based on the revised WID:   * For inter-cell beam management, a UE can transmit to or receive from only a single cell * For inter-cell mTRP, since it assumes multi-PDSCH reception and multi-DCI, simultaneous DL reception from multiple cells is supported   The above includes cells in CA scenarios. |

Table 6 Companies’ inputs: reply to RAN4

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on the above** |
| Qualcomm | OK for Answer 1, 2, and 3 |
| NTT Docomo | Support Answer 1.  For answer 2, our understanding of question 5 is mainly for L1/L2-centric inter-cell mobility. Because in inter-cell mTRP, it is naturally that the serving cell and non-serving cell are on the same frequency.  Support answer 3. |
| Lenovo/MotM | Support Answers 1,2,3. |
| OPPO | Support Answer 1 and 2.  However, we have concern on the proposed Answer 3. The Answer 3 might imply to people that the serving cell could change, which is what assumed in revised WID. Therefore, we suggest to update Answer 3 as follows:  **Answer 3**: As far as RAN1 is concerned, no serving cell change is assumed and the “non-serving cell” actually refer to some SSBs associated with a physical cell ID (PCI) different from the PCI associated with the current serving cell for which a link can be established for UE-specific channel reception and transmission. Regarding simultaneous reception and transmission, based on the revised WID:   * For inter-cell beam management, a UE can transmit to or receive only from the serving cell and no serving cell change is assumed. * For inter-cell mTRP, since it assumes multi-PDSCH reception and multi-DCI, simultaneous DL reception from multiple cells is supported   The above includes cells in CA scenarios. |
| Intel | OK for answers 1,2 and 3. |
| CATT | Support answers 1,2, and 3 |
| Apple | We suggest the following change for Answer 1 and 3. We think we should directly answer the questions.  **Answer 1**: RAN1 shares the same understanding with RAN4.  **Answer 3**: Regarding simultaneous reception and transmission, based on the revised WID:   * For inter-cell beam management, a UE can transmit to or receive from only a single cell * For inter-cell mTRP, since it assumes multi-PDSCH reception and multi-DCI, simultaneous DL reception from multiple cells is supported   The above includes cells in CA scenarios. |
| Huawei, HiSilicon | Answer 1 mentioned “second serving cell”, which goes against the updated WID which says the serving cell remains unchanged. We suggest trying to align with the tentative term from RAN2.  Answer 3 mentioned UE-specific data transmission to a so-called “non-serving cell”, which goes against from what RAN2 mentioned in their reply LS. We suggest deleting “for which a link can be established for UE-specific channel reception and transmission”.  For the 1st sub-bullet in Answer 3, “a single cell” should be changed to “the serving cell” – to stay aligned with updated WID. For the 2nd sub-bullet, it is still being discussed whether the PDSCH(s) are considered as from multiple cells or from the serving cell only (but with different QCL sources). With this in mind, we suggest not mentioning “multiple cell”. Instead, RAN1 can simply forward to RAN4 what RAN2 mentioned in their reply LS – UE will not transmit or receive UE-specific channels with cells other than the serving cell (i.e., non-serving). |