**3GPP TSG RAN Meeting #89-e RP-20xxxx**

**Electronic Meeting, September 14 - 18, 2020**

**Agenda item:** 9.8.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary for [89E][26][R17\_MIMO\_scope]

**Document for:** Discussion and Decision

1. Introduction

Per chairman’s instruction, the goal and pertinent contributions for this email discussion is as follows:

* Goal: Find a way forward on the proposed scope revisions.
* Input contributions covered:  1470, 1839, 1895

Table 1 Summary of the identified input contributions

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| **Tdoc** | **Summary of issue and proposals** |
| RP-201470 | Issue: Telefonica and UIC requested to be added as supporting companies right after the WID was endorsed in RAN#86. The request has not yet fulfilled since the WID has not been revised.  Proposal: Add Telefonica and UIC as supporting companies per their past and not-yet-fulfilled requests |
| RP-201839 | Issue: It is claimed that Rel-16 multi-DCI multi-TRP requirement of receive timing difference within a CP is in general too restrictive and therefore should be relaxed for Rel.17 inter-cell mTRP work (item 2b of the WID).  Proposal:   * “Clarify that a target deployment scenario (both FR1, FR2) for inter-cell operation in Rel-17 should consider non-ideal cell-phase synchronization (timing error) between the two cells.” |
| RP-201895 | Issue: On item 2b of the WID, in RAN1 #102-e, some companies argued that synchronization and timing aspects for inter-cell multi-TRP are out of scope while others think it is a natural part of the practical scenarios.  3 “factors” that require consideration for inter-cell mTRP:   * Propagation delay difference is at least similar to that of Rel-16; in addition, * Synchronization offset between multiple cells; an   + Note that inter-cell synchronization accuracy is up to 3us (TDD only) per RAN4 requirements * Backhaul between the cells can be non-ideal with certain amount of delay   + This requires separate uplink transmissions to multiple TRPs of different cells   Proposal:   * “To proceed Rel-17 inter-cell multi-TRP work, there are 2 alternatives:   + Alt. 1: Only consider factor A, same as in the case of intra-cell     - The applicable scenarios will be very limited: very tightly synchronized cells with very fast backhaul and small cell sizes.   + Alt. 2: Consider all factors A, B, and C     - Applicable to more practical scenarios * RAN Plenary to determine between Alt. 1 and Alt. 2.” |

Evidently, RP-201470 (Samsung, rapporteur) neither requires nor solicits any additional inputs - unless some other companies not listed as supporters would like to add their support as well (which is doable by online or personal emails directly to the rapporteur). Therefore, the proposed amendment on the list of supporting companies is readily accepted and requires no discussion.

Both RP-201839 (Intel) and RP-201895 (Futurewei) attempt to address the same issue raised in RAN1#102-e pertaining to item 2b of the WID.

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| 1. Enhancement on the support for multi-TRP deployment, targeting both FR1 and FR2:    1. ...    2. Identify and specify QCL/TCI-related enhancements to enable inter-cell multi-TRP operations, assuming multi-DCI based multi-PDSCH reception    3. ... |

Intel’s proposal is essentially Alt2 of Futurewei’s proposal. Since some companies voiced their preference on Alt1 in RAN1#102-e, Futurewei’s proposal seems to be a good starting point for discussion. In addition, whether the current WID on item 2b should be refined (and, if needed, how) is to be decided.

1. Summary and moderator proposals

Based on the collected inputs in section 3, the following **observation** can be made:

* Alt1 is supported by 4 companies (Apple, OPPO, Xiaomi, ZTE). Alt2 is supported by 4 companies (Huawei, Futurewei, Intel, Nokia)
* The following compromise proposal has been proposed and supported by 6 companies (Futurewei, Intel, Interdigital, LG, Qualcomm, vivo):
  + The timing offset between two TRPs at the UE side can be larger than 1 CP for FR2 and is smaller than 1 CP for FR1.

Based on the arguments from all participating companies, the restriction imposed by Rel-16 timing offset restriction (<=1 CP) is less of an issue for FR1 than for FR2. Therefore, the compromise proposal seems reasonable from moderator’s point of view.

**Proposed way forward**: Revise the WID for Rel.17 NR\_FeMIMO as follows:

1. Add two additional supporters per their requests as indicated in RP-201470 in the revised WID (to be endorsed in RAN#89-e)
2. For multi-TRP-related work in Rel.17 NR\_FeMIMO WID, clarify that the timing difference/offset between two TRPs at the UE side can be larger than 1 CP for FR2 and is smaller than 1 CP for FR1

During the intermediate round, 2 additional companies expressed the support for the compromise proposal (vivo, LG) while 4 companies are opposed to the compromise proposals and maintain their original preferences (Apple, OPPO, Xiaomi on Alt1; Huawei on Alt2).

1. Compilation of companies’ inputs

During the initial round, interested companies are encouraged to share their view on the following issue brought up by Intel and Futurewei:

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| 3 “factors” that require consideration for inter-cell mTRP:   * Factor A: Propagation delay difference is at least similar to that of Rel-16; in addition, * Factor B: Synchronization offset between multiple cells; an   + Note that inter-cell synchronization accuracy is up to 3us (TDD only) per RAN4 requirement * Factor C: Backhaul between the cells can be non-ideal with certain amount of delay (due to non-ideal cell-phase synchronization)   + This requires separate uplink transmissions to multiple TRPs of different cells   On item 2b of the NR\_FeMIMO WID, consider and choose between the two alternatives:   * Alt. 1: Only consider factor A, same as in the case of intra-cell   + The applicable scenarios will be very limited: very tightly synchronized cells with very fast backhaul and small cell sizes. * Alt. 2: Consider all factors A, B, and C   + Applicable to more practical scenarios |

Table 1 Inputs

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| **Company** | **View** |
| *Initial round* | |
| Apple | We are supportive of “Add two additional supporters per their requests as indicated in RP-201470”  However, we are not supportive of relaxing the inter-cell MTRP timing difference to exceed 1 CP.  In RP-193186, it is explicitly captured that    Relaxing the timing difference to be more than 1 CP will require UE to use two FFT window to process two TRP transmission. Similar discussion has been carried out in V2X as well and prohibited there. We also discussed this with our RAN4 team, similar discussion is also carried out for the DAPS hand over in which there is no UE requirement for multiple FFT window. Even though the MRTD can be up to 6 us for DAPS, it is only the performance lower bound. For NW who cares about the UE performance, NW should strive to reduce the MRTD to be within CP.  Furthermore, as captured in RP-193186, multiple bullets were removed due to the compromise needed for the WID approval and to fulfill the down scoping request from the plenary Chair. Every single bullet has its own justification. If we ever want to discuss to extend the WID scope at this stage, we think it is fairer to reconsider all the past proposals instead of restricting to only a single proposal. |
| Qualcomm | It is a bit unclear why the above items are called ‘Factors’. Factor A, for example, is a particular solution, it is not a factor for consideration. So we might misunderstand some details of what is being proposed.  We acknowledge that limiting the timing differences to very small values limits the applicable scenarios. However, we believe that this was discussed before.  In our view, adding the larger timing offset scenario should only be considered if it doesn’t result in up-scoping of the WID.  From the DL baseband perspective, adding larger timing offsets would not seem a significant up-scoping; however, when FR1 is considered where the TRPs are received with the same antenna/RF, then additional RF aspects, such as AGC setting, etc. would need to be also considered.  Perhaps as a compromise, a limited FR2-only scenario could be further considered, where the signals from the two TRPs are received by the UE with two different antenna panels. We note that in the case of FR2, larger timing offsets are already considered for L1/L2-centric mobility, where the UE is expected to switch between cells with the larger timing offset between them. |
| Nokia | We are supportive of Alt 2 above, i.e. consider all factors A, B, and C listed above and ensure that Rel-17 mTRP is applicable to more practical scenarios. While the discussion document cited by Apple above was the understanding at that point of time, it is also true that overall understanding of the limitations in Rel-16 solution has evolved since then, and hence it is timely to update the WID to clarify that these scenarios are in scope of the Rel-17 WID, thus ensuring that the applicability of Rel-17 mTRP is not restricted by Rel-16 assumptions. Having said that we agree with Qualcomm above that the impact of such clarification should not result in significant up-scoping of the WID. |
| ZTE | We agree that we should avoid up-scoping of the FeMIMO WI at current stage. This is the most critical factor for assessment as we have many other items to be completed.  We have similar understanding that the non-synchronized issue has been discussed during drafting process of the WID. The current WID clearly indicates item 2b should focus on QCL/TCI enhancements based on M-DCI framework, where the existing M-DCI framework in Rel-16 is established assuming timing difference <= 1 CP.  In our view, to include DL aspects of larger timing difference will lead to significant up-scoping. UE needs separate IFFT windows for reception of two PDSCHs. If UE only has single IFFT operation, it is hard to implement such inter-cell MTRP to receive two PDSCHs at a time. How the current M-TRP structure works especially when two PDSCHs overlap in time and frequency domain is not clear.  Regarding QC’s suggestion to focus on FR2 multi-panel UEs, if timing difference issue for such UEs is anyway to be discussed and addressed in item 1 for L1/L2-centric mobility, there is no need to update the current scope of item 2b.  So our suggestion is to keep item 2b as it is now, or to clarify it assumes timing difference <= 1 CP for multiple TRPs. |
| Intel | 1. We agree with Nokia and Qualcomm that the scenarios with larger timing offset should be considered in Rel-17 MIMO WID. As explained in [RP-201839.zip](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_89e/Docs/RP-201839.zip) such scenarios have high practical importance and are already considered in other WIs such as Rel-16 DAPS. It is very hard to image deployment of inter-cell multi-TRP feature allowing only very small timing differences at the UE, resulting into 3x, 6x, 24x tighter requirement for the NW (at SCS 15 kHz, 30 kHz and 120 kHz respectively) than existing TDD synchronization requirement.  2. Though we don’t think the proposed clarification in Alt. 2 is up-scoping of WID, we are OK with Qualcomm proposal to consider the corresponding scenarios for FR2 only with multi-panel UEs, where the synchronization restriction would be more limiting.  3. We also have comment on Factor A in Alt 2. In our understanding there is no justification to inherit Rel-16 restrictions (originating from intra-cell multi-TRP) in Rel-17 work focusing on inter-cell multi-TRP operation. We think some further clarifications on Factor A in Alt. 2 may be needed.  In summary, we are supportive of Alt 2, with some clarifications/modifications to Factor A and possible restrictions of the scenarios to FR2 only. |
| OPPO | We should avoid expanding the current scope of FeMIMO WI since the timeline of R17 has already been expected with a delay of 6 months. Supporting the timing difference more than 1 CP will increase the standardization effort significantly, and expand the scope of WI.   * As many companies said in RAN1 meeting and in this email, this issue was discussed during the preparation of this WID last December. However, it was down-scoped since there are two many tasks in the WID and cannot be studied/specified in timely. We don’t see some solid argument that the situation was changed from last December. Thus, it is not reasonable to add back this task * For the scenarios with timing difference more than 1 CP, there are many solutions for M-TRP transmission. E.g., scheme based on the framework of R16 M-TRP, scheme based on the framework of dual-connectivity with overlapped carriers and so on. Firstly, we need to discuss the simulation assumption for the “loosely-synchronized” network. What are the exact values of timing difference? 2 CPs or 10 CPs or larger timing difference? Secondly, we need solid/throughout simulations/evaluations to down-select the solutions by considering the different values of timing difference. Thus, a huge workload is expected for this new task * As Apple/ZTE explained above, it will impact the UE implementation and a lot of additional work are needed to address the corresponding issues.   In summary, we don’t support expanding the current scope of FeMIMO WI to support timing difference more than 1 CP. |
| InterDigital | In general, we agree with that restricting the timing offset to a small value limits applicable scenario. On the other hand, we prefer not to expand current WID scope considering that its scope is already quite huge for the given timeline.  Therefore, we are ok to consider larger timing offset as long as it requires no (or minimum) standards efforts. For example, allowing larger timing offset than 1 CP in FR2 only as proposed by Qualcomm. |
| FUTUREWEI | We support Alt 2. Our view is that Alt 2 is the correct understanding of the current WID scope for 2b, and should not be viewed as an up-scoping. Timing difference potentially longer than CP is a natural scenario for inter-cell deployment.  As Qualcomm and most companies agreed, limiting the timing differences to very small values limits the applicable scenarios. This is especially true for inter-cell deployment. If the designed feature can only be used in very limited deployment scenarios, this feature will not be useful in practice. We should strive to design usable features.  Regarding Intel’s comment on Factor A, we agree that for R17, the propagation delay difference can be larger than R16. We saw Nokia also has a similar consideration. We are fine to further clarify this.  Note that if the scenario is not clarified, we are not sure how the item 2b can proceed in WG with different understandings from different companies. We should strive to clarify the scenarios here in RAN.  We sympathize the concerns from some companies on the received timing difference exceeding 1 CP. However, simply limiting the time difference to very small value undesirably limits the applicable scenarios. To move forward, along the line of what Qualcomm proposed, here is compromised proposal:   * Consider factors of propagation delay difference, synchronization offset between multiple cells, and non-ideal backhaul between cells; and * Timing difference at the receiver side can be larger than 1 CP for FR2 and is smaller than 1 CP for FR1. |
| *Intermediate round* | |
| Huawei | We prefer Alt 2 above considering it will enable more practical scenarios for Rel-17 mTRP in both FR1 and FR2. Including larger timing difference among two cells for DL transmission may or may not lead to more expensive UE implementation considering the potential trade-off of CA and multi-DCI based MTRP transmission, which was widely discussed during UE cap design.  Moreover, since DAPS can handle up 6us to a certain extent, a certain trade-off with regarding to achievable timing difference for FR1 and FR2 between DAPS and multi-DCI based MTRP transmission can be made and discussed further in RAN1*.*  We don’t support limiting it to FR2 only though, since the scenario is useful and necessary for FR1 also. As commented by Intel, the deployment of inter-cell multi-TRP feature allowing only very small timing differences at the UE at some SCS e.g. 15 kHz, 30 kHz and 120 kHz are very challenging, it is obvious that 15 kHz and 30 kHz is for FR1 thus we don’t think we should limit it to FR2 only. And as commented above UE complexity can be tradeoff among CA and multi-DCI based MTRP even for FR1 also. |
| vivo | Thanks moderator for proposed way forward, we support the proposals |
| LG | We have similar view with Nokia, Futurewei and Intel in that assuming <1 CP will seriously limit the usage of MTRP. We think that Factor A should also be relaxed to support propagation delay difference much larger than that of Rel-16 for URLLC scenarios. It is because even cell/TRP-center UE can have benefit on DL/UL repetition based or SFNed transmission schemes considering potential beam blockage by human body or other materials especially for FR2 deployments. During RAN1#102e, similar discussion on considering large Tx/Rx delay between TRPs were happen in many different items in Rel-17 FeMIMO WI such as Item1, Item2a, Item2b, Item2c. Internal delay between UE panels can also be considered as one additional factor to create some delay. Therefore, it is highly desirable if we can conclude on some common assumption for MTRP scenarios in general, to be applicable to all items in FeMIMO. So, we propose to revise the moderator’s proposal as below (changes in red).  For ~~item 2b of~~ the Rel.17 NR\_FeMIMO WID, clarify that the Tx/Rx timing offset between two TRPs ~~at the UE side~~ can be larger than 1 CP for FR2 and is smaller than 1 CP for FR1 |
| Xiaomi | We agree that we should avoid up-scoping of the FeMIMO WI at current stage. Relaxing the timing difference to be more than 1 CP will require UE to use two FFT window to process two TRP transmission. And it will increase the standardization effort significantly, and expand the scope of WI. So we don’t agree to support timing difference more than 1 CP. |
| Apple | We still have concern on extending the timing offset between TRP to beyond 1 CP for both FR1 and FR2.  The general guideline is not to increase the WID scope which we feel is not the intention of the initial proposal to consider timing difference exceeding 1 CP. If there is no specific design that companies would like to push into the 3GPP, we do not understand why we need to spend time discussing extending the current FeMIMO scope here.  During the UE feature discussion, PDSCH overlapping type is one of the most heated debate and lasted for many meetings until we reach a compromise. We have essentially 3 separate FGs to handle PDSCH overlapping for this purpose. However, looking back, we still feel that the capability design is not complete in terms of at least three areas (1) PRG matching between two TRP (2) VRB to PRB interleaving consistency between two TRP (3) AP-ZP-CSI-RS rate matching handing between two TRPs. All of the these can impact the UE channel estimation and demod design if UE truly wants to optimize its performance. Note, this is when two PDSCH is CP aligned in which case interference handling is per sub-carrier. However, when two PDSCH is not CP aligned, the interference can be much harder to handle and, furthermore, the discussion of the TA and other issues such as power control etc. may not even be avoidable. Having experienced the MTRP UE capability discussion in terms of OOO and overlapping, as well as the per FSPC discussion for MDCI MTRP and FDMSchemeB, we do not want to open up the design for MRTD beyond 1 CP.  Furthermore, we understand the for FR2, due to the large SCS, it is harder to ensure MRTD to be within 1 CP. However, FR2 has more concern on the UE power consumption and thermal dissipation than anything else in the practical deployment. It is much desirable for NW to ensure MTRD to be within 1 CP to truly realize the performance gain that MTRP can provide. We also believe URLLC solution should not solely reply on the UE complexity while NW kept insisting that they cannot achieve good back-haul or good synchronization between two TRPs. An asynchronous MTRP deployment with little or no coordination between TRP clearly performs worse than synchronous MTRP deployment with good coordination between TRP. We are not fine to shift the complexity to the UE for UE to bridge the gap caused by something NW cannot achieve.  In the end, again, we do not agree to extend the current FeMIMO WID to include receiving timing difference > 1CP for neither FR1 nor FR2. |
| OPPO2 | Thanks moderator for the new proposal. We support the 1st bullet, but cannot support the 2nd bullet.  Reply the comment that “supporting timing difference larger than 1 CP will not result in (significant) up-scoping of WID”: In addition to the additional workload we have explained above, we also copy and paste as below some additional issues/topics from RAN1 contributions of some proponents of timing difference larger than 1 CP. Thus, supporting CP larger than 1 CP will enlarge the FeMIMO scope and will lead to a large additional workload  *1. the UE may need to have the capability of supporting multiple tracking loops and FFT windows*  *2. multiple PRACH configurations for multiple TRPs are needed*  *3. multiple TAs have to be maintained by the UE, or Support TRP-specific TA offset value in UL transmission for inter-cell multi-TRP*  *4. When multiple tracking loops and FFT windows are needed on the same carrier on the same OFDM symbol for a UE to receive PDSCH/PDCCH from inter-cell multi-TRPs, whether the standards specify UE assumptions/behaviour under multiple QCL/TCI states should be clarified. For example, the standards may take an explicit approach, that is, the standards specify some UE behaviours such as “the UE applies multiple FFT windows on the same carrier on the same OFDM symbol based on the multiple TCI states for DL receptions”, which may not be preferred. On the other hand, the standards may take a more implicit approach, that is, the standards specify only the minimum UE assumptions such as “the UE assumes multiple QCL assumptions that respectively link to multiple SSBs (directly or indirectly through one or more RS) on the same carrier on the same OFDM symbol based on the multiple TCI states for DL receptions”. This should be discussed in Rel-17.* |

# References

1. RP-201470 Revised WID: Further enhancements on MIMO for NR Samsung
2. RP-201839 MIMO multi-TRP timing constraints for inter-cell operation Intel Corporation
3. RP-201895 Discussion on multi beam enhancement vivo