**3GPP TSG RAN#105**

**Melbourne, Australia, September 9th – 12th, 2024**

**Title: Way Forward on Rel-19 MIMO Scope Expansion**

**Source: RAN1 Chair**

# Introduction

Multiple RAN1 proposals have been proposed to RAN#105 for inclusion as part of Rel-19 MIMO. The following proposals have been proposed:

Table 1. Rel-19 MIMO proposals submitted to RAN#105.

|  |  |  |
| --- | --- | --- |
| **Proposal** | | **Proponents** |
| **A** | SRS port grouping for TDD low-complexity 6/8RX receiver | **RP-241774** Samsung, CMCC, MediaTek, Ericsson, Huawei, HiSilicon, NTT DOCOMO, NTT CORPORATION, ZTE, OPPO, vivo, CableLabs, CATT, China Telecom, China Unicom, Deutsche Telekom, DISH Network, ETRI, Fraunhofer IIS, Fraunhofer HHI, Futurewei, Google, HONOR, Interdigital, KDDI, KT Corporation, Kyocera, LG Electronics, LG Uplus, NEC, New H3C, NICT, Sharp, SK Telecom, Sony, Tejas Networks, Verizon, Vodafone, Xiaomi  **RP-241765** Qualcomm (at least Proposal B, C)  **RP-241895** Intel (at least Proposal B, C) |
| **B** | 2TA without CoresetPoolIdx association for asymmetric DL sTRP/UL mTRP |
| **C** | 3T6R SRS antenna switching |
| **D** | 3T3R SRS antenna switching | **RP-241765** Qualcomm |
| **E** | PRG (precoder granularity) for PUSCH transmission (applicable of CP-OFDM only) | **RP-241819** vivo, Samsung, Spreadtrum, Verizon, Deutsche Telekom, China Unicom, NTT DOCOMO, InterDigital CHTTL |
| **F** | 3-Tx partial-coherent codebook for ranks 1, 2, and 3 | **RP-242029** Ericsson, Qualcomm, InterDigital, NEC, Samsung  **RP-241941** China Mobile (3 TX partial-coherent codebook) |
| **G** | UE capability for non-codebook-based UL transmission |

The purpose of this document is to collect company views on the proposed Rel-19 RAN1 objectives and recommend a way forward.

# WG status on Rel-19 MIMO

Overall, RAN1 progress on Rel-19 MIMO has been good. Even with reduced TUs (2.5 TUs 🡪 2 TUs) starting from Q4, moderator’s assessment (as RAN1 chair) is that the current RAN1 objectives can be completed on time. However, considering the importance of completing Rel-19 on time, a conservative approach is preferred with regards to any up scoping. A proposal should be only considered if it has minimal RAN1 impact (i.e. can be completed within 1~2 meeting cycles without any RAN1 TU increase) and requires no TU increase in other RAN WGs. Additionally, considering there is no additional RAN1 TU for the new proposals, it would not be feasible to have a study phase.

Following is assessment on the required effort to complete the work in RAN1, RAN2, and RAN4.

Table 2. Assessment on required effort to complete the work in RAN1. Assessments for RAN1, RAN2, RAN4 were done by RAN1, RAN2, RAN4 Chairs, respectively.

| **Proposal** | | **Required additional RAN1 effort** | **Required additional RAN2 effort** | **Required additional RAN4 effort** |
| --- | --- | --- | --- | --- |
| **A** | SRS port grouping for TDD low-complexity 6/8RX receiver | Small | Small | Small (Demod perf) |
| **B** | 2TA without CoresetPoolIdx association for asymmetric DL sTRP/UL mTRP | Small | Small | Small (RRM) |
| **C** | 3T6R SRS antenna switching | Small | Small | Small |
| **D** | 3T3R SRS antenna switching | Small | Small | Small (UE RF) |
| **E** | PRG (precoder granularity) for PUSCH transmission (applicable for CP-OFDM only) | Small | Small | Small (Demod perf) |
| **F** | 3-Tx partial-coherent codebook for ranks 1, 2, and 3 | Medium (e.g. codebook, DL control signaling design) | Small | Medium (UE RF, Demod perf) |
| **G** | UE capability for non-codebook-based UL transmission | Small | Small | Small (Demod perf) |

The above assessment has been made under the assumption that study phase for the additional RAN1 objectives is not needed and RAN1 can proceed with discussions on how to support these features. If a study phase is required for an objective, recommendation from the moderator is to not include the objective for Rel-19. Also, although the required effort for each proposal may be small, it does not imply RAN1, RAN2, RAN4 are okay to take ALL proposals. To ensure timely completion of Rel-19 MIMO, moderator recommends minimizing the number of newly approved proposals (if any) in RAN#105.

# Company views on additional RAN1 objectives for Rel-19 MIMO

Companies are invited to share their views on proposals A, B, C, D, E, F, G using Table 3. (No need to additionally indicate support in case your support is already captured in Table 1.)

Table 3. Company views on Rel-19 MIMO proposals submitted to RAN#105.

| **Company** | **Comment** |
| --- | --- |
| Apple | 3T6R ( C ) is already approved in the last RAN#104 meeting and captured as part of Rel-19 RAN4 led RF enhancement WID (RP-241656)  We agree to limit the number of proposals that can be approved. We prefer the following three  B. 2TA extension for single-DCI Multi-TRP  F. Partial coherent codebook based 3Tx PUSCH operation  G. nonCodebook based 3Tx PUSCH operation |
| Ericsson  (Mattias F) | For **F** (3Tx) RAN1, we don’t agree the RAN1 effort is medium, based on the proposed alternatives in the inbox, there is not much room left for creativity, since we reuse the 2Tx/4Tx codebooks. Regarding control signalling. the (partial- + non-coherent) codebooks are nested already; no different principle from Rel-15 so it should be straightforward to design the DCI information. An RRC configuration only is needed beyond that, there is no MAC CE stuff here.    For **F** (3Tx) RAN4, we believe the effort is small or even zero in RAN4, since **for demod** requirements use so far for UL MIMO, only the diagonal precoder (TPMI0) is tested for 3Tx and 4Tx, hence the test makes no difference between non-coherent/partial coherent/coherent. Also, this 3Tx PCCB is optional for UE, no need to define a test for it. Moreover, for **UE RF**, there is no test for partial coherent for 4Tx, not sure why there need to be one for 3Tx?    Ericsson support **also D** (3T3R) since it is a practically useful configuration for a 4RX and 3Tx UE, that allows reciprocity based MIMO using only one OFDM symbol SRS (note that some operators TDD special slot pattern cannot use 3 OFDM symbols needed for e.g. 2T4R antenna switching. Note that the work in RAN1 is basically zero if we support 3T6R, since 3T3R is one SRS resource in the set and 3T6R is two such SRS resources.    **On E**,(UL PRG) we wonder why only demod perf is listed? The frequency selective precoding will impact PAPR of the PUSCH transmission and hence also MPR (i.e. UE RF work is needed). In the current proposal, the precoder cycling is not specified by RAN1, so more RAN4 work is definitely needed. Study is needed on appropriate PRG sizes, probably from both performance/ran1 perspective, as well as implementation / gNB Rx demod perspective.  What ranks are supported for PRG cycling?  Only rank 1? Up to rank 8? |
| Samsung | **Re moderator assessment on the RAN1/2/4 effort for each item and up-scoping recommendation only for “specify(ing)” without “study phase”, we concur on the overall assessment.**  Our **priority** is the **A+B+C as a package** described in the WF x1774 (supported by 40 companies, including almost all companies supporting the other two WFs x1819 and x2029). Note that the necessity for A (SRS PG) and B (2TA) have been demonstrated, evaluated, and well-documented since RAN1#117 (May 2024), including their impacts on **RAN2 and RAN4 workload** (the amount of work doesn’t require TU increase in RAN2/4) – cf. references in x1174 as well as x1965, x2039, and x2101.  Depending on the scope, we can be open to the other lower-priority items (D, E, F, and/or G) **only if** A+B+C are already included in the up-scoping package. **Else**, we don’t see much value in up-scoping and hence would rather see no up-scoping for Rel-19 MIMO Ph5 WI.  Re E, to resolve some concerns from the opponents, it is possible to further limit the scope for e.g. only rank-1 (cf. x2101) and “no enhancement on DMRS and PTRS” (cf. x1819).  Re D, Qualcomm has clarified offline: It is not to support 3T3R SRS antenna switching as a feature to be implemented (**already precluded in RAN1#116**), but to add a UE capability signalling to facilitate the UE notifying the NW that it is “not capable” of reciprocity operation (e.g. TX and RX 3-antenna arrays are separate). In this case, it doesn’t revert any RAN1 decision. Therefore, we are fine if the objective is *worded* as follows:  *Specify UE capability signalling for 3T3R:*   * *Note: This doesn’t require specifying 3T3R SRS antenna switching*   Re F, we have lingering concern on the workload given our experience in Rel-15/18 (as also mentioned by the moderator). This concern is resolved in the WF x2028 since the proposed design is specific and almost final. Alternatively, the following *restriction* can be included in the WID Objective based on the known proposals from Qualcomm and Huawei:  *The rank-1, 2, and 3 partially-coherent precoders are based on the QPSK alphabet and derived from the Rel-15 2Tx full-coherent/4Tx partially-coherent design, with a total of 10 precoders across ranks 1, 2, and 3*   * *Note: The amplitude of the QPSK elements in a rank-3 partial-coherent precoders can be different to equalize transmitted power across layers and Tx ports.* * *Note: Combined with the already agreed 7 non-coherent precoders (cf. RAN1#116), this yields a 17-precoder 3-antenna-port UL codebook* |
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# WF on additional objectives for Rel-19 MIMO

TBD