**3GPP TSG RAN #106 RP-243265**

**Madrid, Spain, December 10th – 13th, 2024**

**Title: Moderator Summary for 3T3R SRS Antennas Switching in Rel-19**

**Source: RAN1 Chair (Samsung)**

# Introduction

Rel-19 MIMO work item objectives were updated in RAN#105. In particular the following update was made for 3T3R (RP-242394):

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| 1. Specify non-coherent UL codebook to facilitate 3-antenna-port codebook-based transmissions, enhancement(s) to enable 3T6R SRS antenna switching, as well as UE capability signaling for 3T3R antenna switching and 3-antenna-port non-codebook-based transmissions, without enhancement on UL full power transmission and without enhancement on SRS resource   Note: UL full power transmission mode 1 and 2 are not supported.  Note: Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching. |

In RAN1, there is debate whether or not the above WID objective precludes specification change on SRS configuration details and SRS resource/set definition for ‘3T3R’ antenna switching. In RAN#106, the following tdocs were submitted on this issue:

* RP-242488 On the Scope of Rel-19 NR MIMO Phase 5 InterDigital, Inc.
* RP-242618 Discussion on 3T3R SRS antenna switching capability in Rel-19 MIMO vivo
* RP-243173 on Rel-19 MIMO 3T3R Apple

# Discussions

Moderator proposes to select one of the following 3 alternatives in RAN#106.

* Alt 1: RAN clarifies that for ‘3T3R’ antenna switching, SRS configuration details including SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1
  + Update WID accordingly
* Alt 2: Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching (i.e. SRS configuration details including SRS resource/set definition for ‘3T3R’ antenna switching is not supported) as part of Rel-19 MIMO in RAN1
* Alt 3: 3T3R SRS antenna switching is not supported as part of Rel-19 MIMO
  + Update WID accordingly

Note that the RAN1 workload required for each of the three alternatives is marginal.

Companies are invited to provide their views using the table below.

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| **Company** |  | **Comments** |
| vivo | Alt1 or alt 3 | In our view alt2 is not reasonable. We should not intentionally introduce a broken feature in the spec. Either we introduce a complete UE feature or we remove the UE feature. |
| Apple | Alt 1 or Alt 3 | We are fine with either Alt 1 or Alt 3.  Alt 2 should be avoided. Without specifying the 3T3R features in the specification, e.g., TS38.214, we fail to see the justification to specify the corresponding UE capability. |
| OPPO | Alt.1 | We support Alt.1 in principle. In our view, the WID can kept as it is (RAN clarification is sufficient for this case) or modify it to avoid the potential confusion as suggested by Alt.1.  For all the antenna configuration xTxR (x=1,2,4,8), there are descriptions on the UE capability from the perspective of the SRS configuration. Thus, it is nature to have similar description for 3T3R. If without such kind of description, the spec is broken. Thus, Alt.1 is our preference.  For Alt.2, the spec will be broken. Thus, we should avoid it.  For Alt.3, it will revert RAN agreement. Thus, we should avoid it.  The main concern from Huawei is on a UE with only 3 physical antennas (that is the intention of the proponents). Thus, not sure whether it can address Huawei’s concern if we can agree some conclusion like: A UE supporting 3T3R antenna switching should be equipped with 4 or more physical antennas. |
| Nokia | Alt.1 or Alt.3 | We agree with vivo and Apple above that we should only add UE feature for something that has corresponding support in specifications. |
| InterDigital | Alt 1 with a note | We are supportive Alt 1 but we may add a note to address Huawei’s concern on introducing new type of UEs (i.e., standalone capability of 3T3R) as following:   * Alt 1: RAN clarifies that for ‘3T3R’ antenna switching, SRS configuration details including SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1   + Update WID accordingly   + Note: ‘3T3R’ is a downgrade antenna switching configuration of ‘3T6R’ and it doesn’t imply that standalone ‘3T3R’ capability is introduced. |
| Ericsson | Alt.1 (no WID change) | In favour of Alt.1 as it implies that we complete the feature RAN agreed to have in September (whereas Alt.2 is leaving a broken feature and Alt.3 is reverting previous agreement).  However, we don’t see a WID update is needed in Alt.1 since the WID mentions no further *enhancements*, we don’t want to set a precedence that completing a half-done feature is seen by 3GPP as an enhancement. 3GPP should specify complete and working features.  We think RAN clarification is sufficient in the line of:  **Conclusion:**  As a RAN guidance on the 3T3R issue, necessary specification changes needed to enable the capability “3T3R SRS antenna switching” is expected by the WID  In addition, OPPO’s suggestion to address Huawei’s concern by a short sentence in such conclusion can be helpful to close this issue. |
| CMCC | Alt. 1 | In our understanding, Alt.1 is the intention to support 3T3R antenna switching when we discussed the scope expansion for Rel-19 MIMO WI. The confusion in RAN1 comes from the NOTE statement in the WID “Note: Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching.”  Hence, we support to directly clarify in the WID that SRS configuration including SRS resource/set definition for 3T3R antenna switching should be specified in Rel-19.  And to avoid the potential risk to open the door for 3R UE (not sure any company propose this), the NOTE proposal from InterDigital can be considered. |
| ZTE | Alt-1 | First of all, we believe that, for newly introduced feature of 3T3R from last RAN plenary, 3T3R should be captured as in a downgraded feature for UE supporting >3R. That implies that, for the subsequent discussion, we should assume that the pre-requisition feature of this 3T3R should be based on legacy UE feature of xTyR antenna switching.  Then, for enabling this 3T3R, we believe that the corresponding SRS configuration should be supported in RAN1. Per our understanding, the corresponding spec impact is very limited (due to the fact that muting one port out of 4-port SRS is provided per SRS resource set, i.e., a general configuration framework decoupling with SRS usage).  Finally, for RAN guidance, besides for one choice of updating the corresponding WID, alternatively, the following RAN conclusion may be sufficient without WID update:  **Proposed conclusion:** For ‘3T3R’ antenna switching, SRS configuration details including SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1. |
| DOCOMO | Alt 1 | We support Alt.1. RAN1 agreed to introduce UE capability of 3T3R per updated WID. However, unless RAN1 spec. specify UE behavior of 3T3R, the meaning of supporting/not-supporting UE capability of 3T3R becomes up to UE implementation. Hence, from technical perspective, we believe it is better to specify UE behavior of 3T3R. We also note that specification impact of 3T3R is very small. |
| CATT | Alt. 1 with clarification that 3 Rx UE is not introduced | Among the three alternatives, our preference is Alt.1 because Alt. 2 introduces a broken feature and Alt. 3 contradicts with the previous RAN agreement.  We prefer to update the WID to make the scope clear instead of having a conclusion which may cause potential confusion in the future.  For Alt. 1, it is important to clarify that we are not introducing 3Rx UE and that should be explicitly captured in the WID as well. OPPO’s suggestion or InterDigital’s note can be considered as a starting point. |
| Samsung | Alt1 or Alt3 | The wording of the current WID suggests Alt2, i.e. supporting SRS resource configuration for 3T3R doesn’t seem to be a part of objective 4. We do acknowledge and sympathize, however, with the above comments re Alt2. Therefore, although we are not supportive of Alt1, since the workload is marginal and there is no strong technical reason not to support it, we can accept Alt1 if the majority view is as such (or Alt3 is also ok).  If we proceed with *Alt1*, this can be resolved in RAN1#120 Athens *without RAN intervention* (hence no WID update).  But *if RAN intervention is needed*, from **rapporteur** perspective:   * A *simple guidance* from RAN that objective 4 does not preclude the support of SRS resource definition for 3T3R antenna switching will suffice. For instance, the *conclusion* suggested by @Ericsson is a good starting point. * But if RAN would like to revise the WID to address this (we are also fine), a simple revision to clarify the support of 3T3R antenna switching without limiting it to only UE capability signaling is also fine for us and can be prepared for RAN#106, as follows (only Objective 4 needs to be revised – Justification remains the same):   [**Objective 4**] *Specify non-coherent UL codebook to facilitate 3-antenna-port codebook-based transmissions, enhancement(s) to enable 3T6R and 3T3R SRS antenna switching, as well as UE capability signaling for ~~3T3R antenna switching and~~ 3-antenna-port non-codebook-based transmissions, without enhancement on UL full power transmission and without enhancement on SRS resource*  *Note: UL full power transmission mode 1 and 2 are not supported.*  *~~Note: Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching.~~* |
| Huawei，HiSilicon | Alt.2 or Alt.3 | We are OK for Alt.3 or Alt.2. But concerns on Alt.1.  Current spec is clear, Alt.2 is what we agreed in last RAN Plenary. Please note that the WID change in last RANP is based on the discussion of “Not enable 3T3R in Rel-19, and it is only the fallback capability for 3T6R”. So, Alt.2 is no problem as the same as WID said only UE capability supported.  **For current Alt.1, we have strong concerns on it.** In last RAN1 meeting, 3T3R is agreed as an independent UE capability. **We do not think we need to introduce such 3T3Rx UEs/devices in Rel-19,** which decreases NW performance.  If companies do not intend to introduce such 3Rx UE or devices. We should have clear restrictions captured on 3T3R in spec, such as IDC mentioned *“‘3T3R’ is only a downgrade antenna switching configuration of ‘3T6R’ and there is no standalone ‘3T3R’ capability is introduced.”* And the work for RAN WGs is also need to be clear, it’s only SRS configuration, nothing else:  Alt 1: RAN clarifies that for ‘3T3R’ antenna switching, SRS configuration ~~details including~~ i.e., SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1.   * where ‘3T3R’ is only a downgrade antenna switching configuration of ‘3T6R’ and there is no standalone ‘3T3R’ capability is introduced. |
| Xiaomi | Alt 1 | We support Alt 1.  For Alt 2, we share same views with vivo/Apple/Nokia. We need to specify something to make the feature workable. It doesn’t make sense to only have certain UE capability while nothing makes it feasible.  For Alt 3, it is against previous RAN agreement.  We think the intention of have the note saying ‘Other than UE capability signaling, no other enhancement is specified for 3T3R SRS antenna switching’ is not to preclude SRS configuration details. Instead, it is an obvious assumption to make 3T3R SRS switching happen although it does cause confusion.  In order to address HW’s concern, we think the proposal from IDC is a way to go. |
| Intel | Alt 1 (no WID update needed) | Prefer Alt 1.  Similar view as Ericsson. We don’t believe WID update is needed, and simple RAN conclusion is sufficient to close the matter. |
| Huaiwei, HiSilicon2 |  | After offline discuss with companies, we could accept following updated version for Alt.1 for progress the issue:  Alt 1: RAN clarifies that for ‘3T3R’ antenna switching, SRS configuration ~~details including~~ i.e., SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1.   * where ‘3T3R’ is only applicable for the UE equipped with 4Rx or 6Rx antenna ports. * No RAN4 impact. |
| Ericsson |  | Proposal from Huawei is ok from us, good to also mention 4Rx UE here since it’s the most common device type |
| OPPO |  | We are fine with Huawei’s latest proposal. It would be a good way to move forward and complete the specification of this feature. |
| Qualcomm |  | Always an interesting discussion about 3T3R… The 3GPP specification had xTxR for x=2, 4, 8, i.e. for any number of Tx supported for UL MIMO. So given that 3GPP introduced 3Tx, we thought as a minimum to introduce 3T3R in itself. Of course, 3Rx is not introduced by this in any way. 3T3R can be for 8Rx, 6Rx or 4Rx. Therefore, we are ok with the Huawei proposal, as long as 8Rx is added, as follows:  Alt 1: RAN clarifies that for ‘3T3R’ antenna switching, SRS configuration ~~details including~~ i.e., SRS resource/set definition for ‘3T3R’ antenna switching can be discussed and supported as part of Rel-19 MIMO in RAN1.   * where ‘3T3R’ is only applicable for the UE equipped with 4Rx, ~~or~~ 6Rx or 8Rx antenna ports.   No RAN4 impact. |
| InterDigital |  | We are also ok with Qualcomm’s version to include 8Rx case. |
| Huawei, HiSilicon3 |  | Comments to QC:  What’s the use case of 3T3R if the UE supporting 8Rx already? Since 3T3R only measure 3 Rx out of 8Rx, most channel information is lost. We can not see it can work. Generally, for 8Rx, anyway we need SRS antenna switching such as 2T8R, 4T8R. Introducing 3T3R for 8Rx is meaningless.  The design should be useful in practical use cases. We do not see the usage of 3T3R for UE with 8Rx. So, it should not be included. |
| Qualcomm |  | Ok, let me try this again.  For a 3Tx UE, the gNB will configure 3-port SRS for codebook-based UL usage, i.e. for the UL, not the DL. As you undoubtably know, sometimes, the gNB prefers not to configure additional SRS for CSI acquisition purpose, in order to conserve UL capacity. In these cases, the same SRS resource is overloaded and used for two usages. Of course, whenever the number of Rx ports is larger than the number of Tx ports, this solution gives only partial channel estimation for reciprocity-based beamforming. But per our observation, the gNB quite often prefers to make this choice. This is no different between 8Rx and 6Rx or 4Rx. The way it works today is that the gNB configures two different SRS for the two usages, but the actual physical resource is configured to be identical. Of course, this will require configuring 3T3R for 8Rx UEs, which is the subject of the current proposal.  Note that when the UE has 2Tx and 8Rx then 2T2R can be used, and is used, for the same purpose. 2T2R can be used with 8Rx. 4T4R can be used for 8Rx. Why 3T3R cannot be used for 8Rx? We don’t mean to reinvent the wheel here. |

# Conclusions

TBD