**3GPP TSG-RAN WG4 Meeting #112bis R4-2417095**

**Hefei, China, October 14 – October 18, 2024**

**Title:** WF on 6Rx UE requirements

**Agenda Item:** 6.1.3

**Source:** AT&T

**Document for:** Approval

# Topic 1: REFSENS (delta RIB,6R)

## Sub-topic 1-1: Verification of 6Rx receiver requirements

**Issue 1-1-1: Verification of 6Rx receiver requirements when UE is equipped with six Rx antenna ports**

**Agreement**: Verification of 6Rx receiver requirements when UE is equipped with six Rx antenna ports will align with the following. The exact wording in the specification can be further aligned with the approaches taken for 4Rx and 8Rx.

- When the UE is equipped with six Rx antenna ports

- For single carrier REFSENS requirements, additional requirement for four Rx antenna ports and six Rx antenna ports shall be verified in operating bands;

- For Rx requirements other than single carrier REFSENS, the UE shall be verified with six Rx antenna ports and skip both two and four Rx antenna ports requirements in operating bands.

**Issue 1-1-2: Verification of 6Rx receiver requirements when UE is equipped with eight Rx antenna ports**

**Agreement**: Verification of 6Rx receiver requirements when UE is equipped with eight Rx antenna ports will align with the following. The exact wording in the specification can be further aligned with the approaches taken for 2Rx and 4Rx handling for 8Rx.

- Specifically focused on 6Rx verification as 2Rx and 4Rx handling is already specified. When the UE is equipped with eight Rx antenna ports

- For single carrier REFSENS requirements, additional requirement for six Rx antenna shall be verified in operating bands;

- For Rx requirements other than single carrier REFSENS, the UE shall skip six Rx antenna ports requirements in operating bands.

# Topic 2: SRS antenna switching and ΔTRxSRS

## Sub-topic 2-1: General considerations for SRS antenna switching and ΔTRxSRS

**Issue 2-1-1: Whether to consider an additional breakpoint for bands whose FUL\_high is higher than the FUL\_low of n104**

**Agreement**: RAN4 agrees to consider additional breakpoint for bands whose FUL\_high is higher than the FUL\_low of n104.

## Sub-topic 2-2: ΔTRxSRS values

**Issue 2-2-1: Proposed ∆TRxSRS values for t1r6, t2r6, and t1r6-t2r6**

**Agreement**: RAN4 agrees to adopt the values for Bands n79 and n104 as specified below.

Table: ΔTRxSRS values

|  |  |  |  |
| --- | --- | --- | --- |
| Operating Bands | ΔTRxSRS t1r6 (dB) | ΔTRxSRS t2r6 (dB) | ΔTRxSRS t1r6-t2r6 (dB) |
| Band n79 | 5.5 | 5.0 | 6.0 |
| Band n104 | 6.5 | 5.5 | 7.0 |

**Issue 2-2-2: Proposed ∆TRxSRS values for t3r6, t1r6-t3r6, t2r6-t3r6, and t1r6-t2r6-t3r6**

**Agreement**: As this is the first RAN4 meeting since the confirmation that RAN1 will consider t3r6, companies are encouraged to provide ∆TRxSRS values for t3r6, t1r6-t3r6, t2r6-t3r6, and t1r6-t2r6-t3r6 at RAN4#113 for further discussion with the Apple and Qualcomm proposals in R4-2415324 and R4-2416264, respectively.

# Topic 3: MIMO layer evaluation for 6Rx UE

## ~~Sub-topic 3-1: General considerations for MIMO layer evaluation for 6Rx UE~~

**~~Issue 3-1-1: Tx EVM assumptions for 6-layer performance evaluation~~**

**~~Way Forward~~**~~: RAN4 to further discuss the following options.~~

~~- Option 1: Further discuss the assumption of Tx EVM for 6-layer performance evaluation and decide during performance part of work~~

~~- Option 2: Use Tx EVM = 3% for all of modulation order in MCS Table 2 for performance evaluation~~

~~- Option 3: Consider TxEVM of 6% for 64QAM and TxEVM 3% for 256QAM~~

**~~Issue 3-1-2: 6-Layer Performance Evaluation Assumptions~~**

**~~Way Forward~~**~~: RAN4 to further discuss and align the 6-Layer MIMO performance evaluation assumptions considering realistic antenna correlation assumptions and deployment scenarios considering all proposals from RAN4#112bis and proposals from previous meetings and decide during performance part of work.~~

## Sub-topic 3-2: 6-layer Support

**Issue 3-2-1: 6-layer Support**

**Way Forward**: RAN4 to further discuss the following options (options are not necessarily mutually exclusive).

- Option 1: 6-layer support is feasible for handheld and FWA based on some company evaluations considering realistic antenna correlation assumptions and deployment scenarios.

- ~~Observation from company evaluations at this meeting show 6-layer provides gains over 4-layer for TDLA scenario, comparable DMRS overhead, Tx EVM = 1%, low BS correlation, and UE correlation matrix 1 or 2 with various crossover SNR levels. SNR would be discussed in the performance phase.~~

- Option 2: 6-layer support is feasible for FWA devices.

- Option 3: Companies to further discuss and align on the feasibility criteria and simulation assumptions by RAN4#113 to evaluate 6-Layer feasibility for handhelds using the following as a starting point.

- Feasibility criteria

- Consider 4-layer vs 6-layer throughput performance.

- Simulation assumptions

- Only consider link-level simulation for performance evaluations.

- Updated simulation assumptions are provided in Annex A for discussions on alignment at RAN4#113 and can be used by companies to provide simulation results at RAN4#113 for discussion. Companies to clarify and justify (e.g., where the number comes from) the settings used in the simulation assumptions for BS correlation matrix and Tx EVM. ~~Representative BS Tx EVM values for the feasibility study are requested from interested BS vendors for RAN4#113.~~

- Option 4: 6-layer support is not feasible for handheld UEs.

- Option 5: Companies to further discuss the following aspect of 6-layer support.

- If the handheld feasibility is confirmed, then the handheld and FWA devices will share the same 6-layer requirements.

- If the handheld feasibility is not confirmed, 6-layer requirements will be specified for FWA device only.

**Way Forward**: FFS on Tx EVM values to be used for feasibility evaluation.

- Option 1: Use Tx EVM = 1%

- Option 2: Use Tx EVM = 3% for all of modulation order in MCS Table 2 for performance evaluation

- Option 3: Consider TxEVM of 6% for 64QAM and TxEVM 3% for 256QAM

- Option 4: use the existing BS Tx EVM core requirement

- Option 5: The representative BS Tx EVM values provided by the BS vendors

**Issue 3-2-2: 6-layer Support as optional feature**

**Way Forward**: RAN4 to further discuss if 6-Layer support should be considered an optional feature per the following.

- Introduce 6 MIMO layers support as an optional feature, if 6-layer performance requirements are introduced for 6Rx.

# Topic 4: SRS IL imbalance issue

## Sub-topic 4-1: General considerations for SRS IL imbalance issue

**Issue 4-1-1: Whether to solve SRS IL imbalance issue in Rel-19**

**Way Forward**: RAN4 to further discuss the following options.

- Option 1: RAN4 should not continue the discussion on how to solve the SRS IL imbalance issue.

- Option 2: Continue to pursue a solution to the SRS IL imbalance issue based on compromised solutions for consideration with minimal impact to the specification and to indicate the specific impacts to RAN1, RAN2, and RAN4 specifications and performance gain based on the outcome of Issue 4-2-1.

**Issue 4-1-2: Initial Considerations for SRS IL imbalance issue**

**Way forward**: RAN4 to focus on the compromised solution proposals in Issue 4-2-1.

## Sub-topic 4-2: SRS IL imbalance issue solutions

**Issue 4-2-1: Candidate solutions for the SRS IL imbalance issue**

**Way forward**: Companies are encouraged to provide comments and indication of support for the solution proposals listed below by RAN4#113. Proponent companies (in parentheses) for the general solution and solution proposals below are encouraged to provide expected benefit/performance gains and draftCRs so that the impacts to RAN1, RAN2, and RAN4 specifications (for RAN1 and RAN2, a description of the necessary changes is sufficient if draftCRs are not possible) can be further discussed. Other proposals including expected performance gains and draftCRs are not precluded.

* Candidate solutions
	+ Option 1:
		- UE performs self-compensation of SRS IL up to its maximum Tx power capabilities
		- UE provides assistance to the network on SRS IL compensation (semi-static and/or dynamic), e.g.
			* Per SRS resource power headroom reporting
			* Configured maximum output power per SRS resource reporting
			* SRS insertion loss value reporting (per SRS resource or per UE)
			* Other
		- Details of SRS IL self-compensation and assistance framework are FFS
	+ Other options are not precluded
* Proposals
	+ Proposal 1: Only introduce UE compensation and new accurate SRS power headroom reporting for non-CA/DC scenarios can be a compromised solution. Further study the granularity of new SRS power headroom report (China Telecom)
	+ Proposal 2: IL imbalance reporting mechanism for SRS AS should include the configured maximum output power per SRS resource, the power headroom per SRS resource and ΔPPowerClass . The PH used for the SRS resource can be a Type 3 but used for a new MAC-CE “SRS resource power report” and can be used also for a carrier configured for PUSCH transmission (Ericsson).
	+ Proposal 3: Another way to resolve the SRS IL imbalance reporting issue would be to introduce two types of reporting for a UE: a “baseline” and an “advanced” reporting. The baseline reporting would not require any calibration at the UE and it could include e.g. the PHR and ΔPPowerClass information. The advanced reporting could in addition include the information on e.g. the configured maximum output power (Ericsson).
	+ Proposal 4: Solution for IL imbalance issue as identified below. Reporting power threshold needs to be considered for static and dynamic reporting. The granularity of reporting could be per band (Spreadtrum).
		- If UE reports statically, report the actual SRS insertion loss with no UE self-compensation
		- If UE reports dynamically, UE report the difference value of each diversity branch output power to NW according to the SRS period (including periodic, semi-persistent and aperiodic) in real time
	+ Proposal 5: Introduce semi-static UE assistance or capability signalling on the information on the UE SRS IL (∆TRxSRS,UE) (Intel).

**Adjust the existing equations on PCMAX\_L,f,c so that UE applies compensation up to UE-specific SRS IL**

**PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass – ΔPPowerClass + ΔPPowerBoost) – MAX(MAX(MPRc+∆MPRc, A-MPRc)+ ΔTIB,c + ∆TC,c +∆TRxSRS,UE, P-MPRc) }**

* + Proposal 6: Given that specification defines the Tx power should be equally distributed across SRS ports for each SRS transmission, per SRS resource IL reporting would be sufficient (Huawei, HiSilicon).
	+ Proposal 7: If dynamic reporting can be considered for SRS IL reporting, network configurable threshold related to e.g. historical change of PSRS can be considered in order to give the network authority for handling SRS IL reporting frequency (Huawei, HiSilicon).
	+ Proposal 8: To keep the current UE implementation untouched and avoid specification impact to most extent, following solution can be considered in Rel-19 (Huawei, Hi Silicon):
		- UE is allowed to indicate whether it enables self-compensation on the SRS IL once the network requests such information, which would benefit the network by adjusting expectation on the antenna switching SRS based PMI estimation.
	+ Proposal 9: Dynamic reporting for actual SRS IL reporting for each SRS-TxSwitch pattern, and several thresholds associated with capability class for the actual SRS IL reporting can be considered. (ZTE, Sanechips)
	+ Proposal 10: For Rel-19 UE, at least, optionally indicates self-compensation of SRS IL up to its maximum Tx power capabilities.

Annex A:
Feasibility Study Link-Level Simulation Assumptions

|  |  |
| --- | --- |
| Table: Feasibility Study Link-Level Simulation AssumptionsParameters | Values |
| Duplex mode | TDD |
| Bandwidth | 40MHZ |
| SCS | 30 |
| Antenna configuration  |  {8Tx, 6Rx} as baseline Interested companies can submit results with {32Tx, 6Rx} and specify the precoding type |
| Propagation channel | TDLA30-10 |
| Rank | Fixed rank {4,6}, interested companies can bring {5} |
| MCS | Adaptive MCS (target BLER 10%)MCS Table 2Interested companies can bring MCS Table 1 |
| PDSCH configuration | Mapping type | Type A |
|  | Starting symbol  | 2 |
|  | Length | 12 |
|  | PRB bundling size | 2 |
|  | VRB-to-PRB mapping type | Non-interleaved |
|  | Precoding | Random PMI (Rel-15 Type 1 codebook) for 8TxSVD based precoding for 32Tx; companies are encouraged to provide details on the SVD update periodicity |
| PDSCH DMRS configuration | DMRS Type | Type 1 [Rel-15] and eType-1 [Rel-18] |
|  | DMRS Configurations | Option 1: Rel-18 1+1(6L), Rel-15 1+1(4L)Option 2: Rel-15 1+1(4L), Rel-15 2+0(6L)Option 3: Rel-15 1+1(4L), Rel-15 2+2(6L)Option 4: Rel-15 2+2(4L), Rel-15 2+2(6L)[To be further discussed online] |
|  | Precoding | Random PMI (Rel-15 Type 1 codebook) for 8TxSVD based precoding for 32Tx, companies are encouraged to provide details on the SVD update periodicity |
| UE Correlation matrix | Option 1: A graph of numbers and letters  Description automatically generated with medium confidenceOption 2:$$\left[\begin{array}{c}\begin{matrix}1.00&0.10\\0.10&1.00\\0.30&0.10\end{matrix} \begin{matrix}0.30&0.15\\0.10&0.14\\1.00&0.12\end{matrix} \begin{matrix}0.13&0.12\\0.30&0.20\\0.20&0.12\end{matrix}\\\begin{matrix}0.15&0.14\\0.13&0.30\\0.12&0.20\end{matrix} \begin{matrix}0.12&1.00\\0.20&0.11\\0.12&0.30\end{matrix} \begin{matrix}0.11&0.30\\1.00&0.10\\0.10&1.00\end{matrix}\end{array}\right]$$Option 3:$$\left[\begin{matrix}\begin{matrix}\begin{matrix}1.00\\0.22\end{matrix}&\begin{matrix}0.22\\1.00\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.30\\0.58\end{matrix}&\begin{matrix}0.60\\0.15\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.15\\0.10\end{matrix}&\begin{matrix}0.05\\0.15\end{matrix}\end{matrix}\\\begin{matrix}\begin{matrix}0.30\\0.60\end{matrix}&\begin{matrix}0.58\\0.15\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}1.00\\0.15\end{matrix}&\begin{matrix}0.15\\1.00\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.15\\0.15\end{matrix}&\begin{matrix}0.15\\0.10\end{matrix}\end{matrix}\\\begin{matrix}\begin{matrix}0.15\\0.05\end{matrix}&\begin{matrix}0.10\\0.15\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.15\\0.15\end{matrix}&\begin{matrix}0.15\\0.10\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}1.00\\0.30\end{matrix}&\begin{matrix}0.30\\1.00\end{matrix}\end{matrix}\end{matrix}\right]$$Option 4:$$\left[\begin{matrix}\begin{matrix}\begin{matrix}1.00\\0.10\end{matrix}&\begin{matrix}0.10\\1.00\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.25\\0.35\end{matrix}&\begin{matrix}0.50\\0.10\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.10\\0.05\end{matrix}&\begin{matrix}0.05\\0.10\end{matrix}\end{matrix}\\\begin{matrix}\begin{matrix}0.25\\0.50\end{matrix}&\begin{matrix}0.35\\0.10\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}1.00\\0.10\end{matrix}&\begin{matrix}0.10\\1.00\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.10\\0.15\end{matrix}&\begin{matrix}0.10\\0.05\end{matrix}\end{matrix}\\\begin{matrix}\begin{matrix}0.10\\0.05\end{matrix}&\begin{matrix}0.05\\0.10\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}0.10\\0.10\end{matrix}&\begin{matrix}0.15\\0.05\end{matrix}\end{matrix}&\begin{matrix}\begin{matrix}1.00\\0.15\end{matrix}&\begin{matrix}0.15\\1.00\end{matrix}\end{matrix}\end{matrix}\right]$$Option 5: 3GPP MIMO correlation matrix with beta=0.00718 (Option 5 is parametric and to be justified since Options 1-4 are based on measurements)Note: For the feasibility analysis, antenna efficiency can be considered. Companies are encouraged to provide the antenna efficiency numbers. |
| BS correlation matrix | Option 1: 3GPP MIMO correlation matrix with Alpha = 0.1Option 2: 3GPP MIMO correlation matrix with Alpha = 0.0Other options are not precluded.Matrices requested from interested BS vendors for RAN4#113 |