**3GPP TSG-RAN WG4 Meeting #112 R4-2414299**

**Maastricht, Netherlands, 19th – 23rd August, 2024**

**Title:** WF on other issues (MIMO)

**Agenda Item:** 8.2.5

**Source:** Nokia, Spark

**Document for:** Approval

**Background**

System-level simulation results relating to implementation of IMT BS multiuser spatial beamforming techniques, such as zero-forcing (ZF) or minimum mean-square error (MMSE) based schemes, have been provided to RAN4#112.

There are different views on the assumptions, parameters and methodologies which should be used for such study, especially considering the various aspects on MIMO implementation. Such divergence in views is attributed to the fact that several aspects are implementation dependent (e.g., schedulig, BF weights calculation). In order to simulate the impact of MU MIMO via ZF/MMSE on over the horizon emissions, the underlying assumptions should reflect what is commercially used. Simulation results presented to this meeting show that MU MIMO via ZF/MMSE result in similar over the horizon emissions compared to the baseline case of using AAS beamforming – currently used by the ITU-R (i.e., M.2101 model).

RAN4 discussed some of the assumptions used to obtain the results and it was agreed that the system level results are sensitive to the assumptions and underlying model adopted, as discussed in the points below. Since companies have different views, it is currently challenging to agree on the assumptions and underlying models.

* To investigate MU-MIMO, characterization of the channel impulse response ought to be considered in the system lvel simulations, i.e., whether the UEs are lying in LOS or NLOS conditions, the value of Ricean K factor if both LOS and NLOS conditions exist. RAN4 system level simulations generally aim at studying RF parameters to enable coexistence between adjacent operators and thus, the focus has been only on modeling the large scale parameters owing to address simulations complexity.
* Several views on how to calculate the AAS beam array factor (**FR**F) specific to each UE in the ZF set (co-scheduled UEs) as well as the evaluation of the ZF/MMSE precoding matrix
* Clear representation of the system model and underlying components of the sumulation framework.
* RAN4 typically considers Round Robin scheduling in its system level simulations and thus, scheduling of UEs with given azimuth/ elevation separation might require additional discusson on agreeing on a single scheduling algorituhm which is implementation-dependent and vendor proprietary.

In addition, there are practical challenges in implementing MU MIMO that need to be considered in evaluating the co-existence conditions with and without ZF/MMSE based MU MIMO. These challenges can be summarized as:

* The selection of the SNR threshold to invoke MU MIMO, which is an implementation-dependent and vendor proprietary.
* ZF/MMSE BF evaluation is highly dependent on the estimated channel and errors in CSI estimation will result in inter-use interference and thus reducing the co-scheduled UEs SNRs.
* Given a threshold SNR for MU MIMO operation, the selection of UEs in a MU MIMO set is a scheduler feature and that there is no agreed scheduler within RAN4 as it is vendor proprietary.

**Agreements**

In the RAN4 LS reply to WP5D on “guidance on the process of deriving the necessary beamforming weights for the IMT AAS BS to compute its radiation pattern,”

* TSG WG4 can point out to ITU-R WP5D the complexities arising from practical issues in simulating ZF/MMSE based MU MIMO for co-existence and with this view RAN4 can recommend to ITU-R WP5D the use of current AAS beamforming model seems more appropriate.

In the TR 38.922, system-level simulation results provided to RAN4#112 and any further simulation study can be put into an annex for information.