**3GPP TSG RAN WG1 #110bis-e R1-22XXXXX**

**e-Meeting, October 10th – 19th, 2022**

**Title: Draft LS on interference modelling for duplex evolution**

**Response to:**

**Release: Rel-18**

**Work Item:** **FS\_NR\_duplex\_evo**

**Source: Moderator (CMCC)**

**To:** **RAN4**

**Cc:**

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**Send any reply LS to: 3GPP Liaisons Coordinator,** **mailto:3GPPLiaison@etsi.org**

1 Overall description

In RAN1#110bis-e, RAN1 made the following agreements.

**Agreement-1**

RAN1 assumes frequency isolation value in the overall RSI value ranges provided by RAN4 is based on the assumption of SBFD subband configuration with {DUD=40MHz:20MHz:40MHz} at least for FR1 and all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power.

* For SLS of SBFD in RAN1, the RSI is modelled as frequency flat within the UL subband.
* Using $α\_{SI}^{} $to denote the overall RSI value provided by RAN4, RAN1 makes the following assumption
	+ $I\_{SI}^{max}=\frac{P\_{tx}^{max}}{α\_{SI}^{}}\*\frac{N\_{ULRB}^{}}{N\_{DLRB}^{}}$
		- $I\_{SI}^{max}$ is the residual self-interference power on the UL subband when all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power (in linear scale).
		- $P\_{tx}^{max}$ is the maximum gNB DL Tx Power on the two DL subbands (in linear scale).
		- $N\_{DLRB}^{}$ is the total number of DL RBs in the DL subbands.
		- $N\_{ULRB}^{}$ is the total number of UL RBs in the UL subband.
		- Note: $α\_{SI}^{}$ is in linear scale
* RAN1 further makes a simple assumption that $α\_{SI}^{}$ doesn’t change when DL RBs are not fully allocated for DL transmission, and the residual self-interference power on one UL RB when DL RBs are not fully allocated for DL transmission is computed by
	+ $I\_{SI}^{per-RB}=\frac{P\_{tx}^{per-RB}}{α\_{SI}^{}}\*\frac{N\_{used-DL-RB}^{}}{N\_{DLRB}^{}}$
		- $P\_{tx}^{per-RB}$ is DL transmission power of gNB per RB, $P\_{tx}^{per-RB}=P\_{tx}^{max}/N\_{DLRB}^{}.$
		- $N\_{used-DL-RB}^{}$ is the number of DL RBs allocated for DL transmission.
* Send LS to RAN4 to confirm RAN1’s assumptions and the subband configuration assumed for FR1/FR2
	+ Also ask RAN4 if the above is applicable to other subband configurations

**Agreement-2**

For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for gNB-gNB co-channel channel model, the power of inter-site gNB-gNB co-channel inter-subband CLI experienced by the victim gNB on each receiver chain at one UL RB can be modelled as

* $I\_{Inter-Site-CLI}^{A^{'}\rightarrow A,per-RB}=P\_{tx}^{BS A^{'},per-RB}\*N\_{used-DL-RB}^{BS A^{'}}\*CL\_{}^{BS A^{'}\rightarrow BS A}\*\left(\frac{1}{ACLR\_{BS}^{}}+\frac{1}{ACS\_{BS}^{}}\right)\*$ $\frac{1}{N\_{DLRB}^{}}$
	+ $I\_{Inter-Site-CLI}^{A^{'}\rightarrow A,per-RB}$ is the power of inter-site gNB-gNB co-channel inter-subband CLI from gNB $A^{'}$ to gNB $A$ on each receiver chain at one UL RB (linear value)
	+ $P\_{tx}^{BS A^{'},per-RB}$ is DL transmission power of gNB $A^{'}$ across all transmit chains per RB (linear value). $P\_{tx}^{BS A^{'},per-RB}=P\_{tx}^{max}/N\_{DLRB}^{}$.
	+ $N\_{used-DL-RB}^{BS A^{'}}$ is the number of DL RBs allocated for DL transmission by gNB $A^{'}$
	+ $CL\_{}^{BS A^{'}\rightarrow BS A} $is the coupling loss between gNB $A^{'}$ and gNB $A$ (linear value), accounting for beamforming at the aggressor gNB and victim gNB.
		- FFS: the detailed definition of the coupling loss, which can be discussed later
	+ $N\_{DLRB}$ is the total number of DL RBs in the DL subbands
	+ Note: $ACLR\_{BS}^{}$ and $ACS\_{BS}^{}$ are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., $ACLR\_{BS}^{}$) is provided as the candidate for TX leakage, and gNB ACS (i.e., $ACS\_{BS}^{}$) is provided as the candidate for Receiver impairment.
	+ Note: the model is based on the assumption that the same transmission power across different DL RBs is used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS.
	+ Note: This model is not applicable to the RBs in the guardband.
	+ Note: This model is not applicable for some candidate gNB-gNB CLI handling schemes (for example, spatial digital beam coordination, advanced receivers)
* Send LS to RAN4 to confirm RAN1’s understanding

**Agreement-3**

For SLS in RAN1, if both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the inter-site gNB-gNB co-channel inter-subband CLI signal across all Rx chains at UL RB $n$ at victim gNB can be modeled as $I\_{Inter-Site-CLI}^{\left(n\right)}=I\_{leakage}^{\left(n\right)}+I\_{selectivity}^{},$ where,

* $I\_{leakage}^{\left(n\right)}=H\_{CLI}^{\left(n\right)}Wy^{\left(n\right)}$ is the first part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at UL RB $n$, caused by power leakage at aggressor gNB,
	+ $H\_{CLI}^{\left(n\right)}$ is the $N\_{R}×N\_{T}$ channel matrix between aggressor gNB and victim gNB at UL RB $n$, the beamforming of the aggressor gNB and the victim gNB can be taken into account by $H\_{CLI}^{\left(n\right)}$,
	+ $y^{\left(n\right)}=\left[\begin{matrix}y\_{0}^{\left(n\right)},&y\_{1}^{\left(n\right)},&\begin{matrix}…,&y\_{N\_{T}-1}^{\left(n\right)}\end{matrix}\end{matrix}\right]^{T}$ is the unwanted emission across all Tx chains at UL RB $n$ at aggressor gNB,
		- $N\_{T}$ is the number of Tx chains at aggressor gNB,
		- $y\_{k}^{\left(n\right)}\~N\left(0,σ\_{y,n}^{2}\right)$, $k=0,1,…,N\_{T}-1$, is modelled as white Gaussian noise,
		- $σ\_{y,n}^{2}=\frac{P\_{tx}^{per-RB}\*N\_{used-DL-RB}^{}}{ACLR\_{BS}^{}}\*$ $\frac{1}{N\_{DLRB}^{}}$ is the total leakage power at UL RB $n$ at aggressor gNB,
		- $P\_{tx}^{per-RB}$ is the DL power transmitted across all Tx chains at one DL RB at aggressor gNB,$P\_{tx}^{per-RB}=P\_{tx}^{max}/N\_{DLRB}^{}$,
		- $N\_{used-DL-RB}^{}$ is the number of DL RBs scheduled for DL transmission by aggressor gNB,
		- $N\_{DLRB}$ is the total number of DL RBs in the DL subbands
	+ $W$is the $N\_{T}×N\_{T}$ normalized identity matrix with unit norm, $\left‖W\right‖\_{F}=1$,
		- FFS whether $W$ can be other values and corresponding conditions
* FFS for $I\_{selectivity}$
* Note:$ACLR\_{BS}^{}$ and $ACS\_{BS}^{}$ are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., $ACLR\_{BS}^{}$) is provided as the candidate for TX leakage, and gNB ACS (i.e., $ACS\_{BS}^{}$) is provided as the candidate for Receiver impairment.
* Note: the model is based on the assumption that the same transmission power across different DL RBs are used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS.
* Note: This model is not applicable to the RBs in the guardband.
* Send LS to RAN4 to confirm RAN1’s understanding.

**Agreement-4**

For SLS of SBFD in RAN1, candidate values for $α\_{SI}^{}$ at least can be determined based on the assumption that UL receiver sensitivity degradation due to self-interference is 1dB.

* FFS: UL receiver sensitivity degradation due to self-interference is 0.8dB and 0.1dB
* The value of $α\_{SI}^{}$ can be calculated based on the UL receiver sensitivity degradation, noise floor of UL subband and maximum gNB DL Tx Power as below
	+ $α\_{SI}^{}=\frac{P\_{tx}^{max}}{I\_{SI}^{max}\*\left(\frac{N\_{DLRB}^{}}{N\_{ULRB}^{}}\right)}$
		- For example, for sensitivity degradation of 1dB, $I\_{SI}^{max}$ can be computed based on $10\*log10\left(\frac{I\_{SI}^{max}+N}{N}\right)=1dB$, where N is the noise floor over the UL subband given by $N(dB)=-174 + 10\*log10 (20e6) + 5 = -96 dBm$, assuming 20MHz UL subband and 5dB noise figure.
* Note: the feasibility of the determined $α\_{SI}^{}$ values can be discussed separately
* Companies shall report what values of the individual components are assumed in order to achieve the alpha\_SI value corresponding to 1 dB desense
* Other approaches of determining values for $α\_{SI}^{}$ are not precluded and can be used and reported by companies.

Send LS to RAN4 to confirm RAN1’s understanding.

2 Actions

**To: RAN4**

**ACTION:** RAN1 respectfully asks RAN4 to confirm RAN1’s understandings/assumptions in above agreements and provide feedback on them.

3 Dates of next TSG RAN WG1 meetings

TSG RAN WG1 Meeting #111 14th Nov – 18th Nov, 2022 Toulouse, FR

TSG RAN WG1 Meeting #112 27th Feb – 3rd Mar, 2023 Athens, GR