Title: Summary on SRS evaluation methodology

# Remaining issues on evaluation methodology

Prior to RAN1#102e, an offline discussion has been conducted in RAN1 NR reflector on the evaluation methodology for SRS enhancements [1]. The following three proposals are the outcome of this discussion.

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| ***EVM Proposal 1:*** *LLS is used to evaluate SRS enhancements in Rel-17 FeMIMO, while SLS can be used additionally for evaluating data throughput for a given SRS design.****EVM Proposal 2:*** *Adopt the following LLS assumptions at least for SRS enhancements on coverage/capacity in Rel-17.*

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| **Parameter** | **Value** |
| Metric | UL/DL BLER or throughputNote: Other metrics like MSE can be considered optionally.  |
| Baseline | Rel-15 SRS + FG 10-11. Companies to state the detailed configuration used as baseline scheme.FFS: converged baseline(s). |
| Carrier frequency, SCS, System BW | FR1: 3.5GHz or 4GHz, 30kHz, 20, 40 or 100 MHzFR2: 30 GHz, 120kHz |
| Channel model | CDL-B or CDL-C in TR 38.901 with 30ns or 300ns delay spread as baselineNote: other delay spread is not precluded. FFS: whether and how to define scenarioFFS: whether and how to use CDL in MU-MIMO |
| UE speed | 3km/h , 30km/h or 120km/h  |
| Number of UE antennas  | 1T4R, 2T4R or 4T4R |
| Number of gNB antennas | 32T32R or 64T64R |
| UE antenna configuration | FR1: omni as baseline* + FFS: whether direction can also be considered for more than 2 antennas

FR2: directional |
| Rank, precoder and MCS  | Precoder is adaptive. Rank/MCS can be adaptive or fixed. |
| Precoding granularity | Fixed: 2, 4 or wideband for DL, wideband for UL. |
| SRS periodicity  | Companies to state the used SRS periodicity.Note: SRS triggering may be aperiodic.  |
| SRS Comb | Comb 2 or 4 |
| SRS frequency hopping | Companies to state whether SRS frequency hopping is enabled and the hopping pattern if so. |
| DL SNR | Companies to state the used difference between DL SNR and UL SNR* + FFS detailed values
 |
| Phase coherency | Companies to state whether the phase coherency in time domain is modelled and if so, how. |

***EVM Proposal 3:*** *Adopt the following SLS assumptions at least for SRS capacity enhancements in Rel-17.*

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| **Parameter** | **Value** |
| Metric | DL throughput |
| Baseline | Rel-15 SRS + FG 10-11. Companies to state the detailed configuration used as baseline scheme.  |
| SRS error modelling | Table A.1-2 of TR 36.897 |
| SRS periodicity | Companies to state the simulated SRS periodicity.Note: SRS triggering may be aperiodic |
| Carrier frequency, SCS and system bandwidth | 3.5GHz, 30KHz and 20MHz/40MHz/100MHz as baseline |
| Number of gNB antennas | (*M*, *N*, *P*, *M*g,*N*g; *M*p, *N*p) = (8,8,2,1,1,4,8). (dH,dV) = (0.5, 0.8)λ |
| Number of UE antennas | 1T4R, 2T4R or 4T4R |
| Traffic model | FTP 1 or FTP 3 |
| Handover margin | 3dB |
| Scenario | UMi/UMa with 200m ISD.Note: UMa with 500m ISD can also be considered. |

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Several contributions submitted to RAN1#102e propose to refine the three proposals.

## EVM proposal 1

Qualcomm proposes to update EVM proposal 1 as

* *LLS is used to evaluate SRS enhancements in Rel-17 FeMIMO, while SLS can be used additionally for evaluating data throughput and utilized SRS resources for a given SRS capacity enhancement design*

***Proposal 1:*** *LLS is used to evaluate SRS enhancements in Rel-17 FeMIMO, while SLS can be used additionally for evaluating data throughput for a given SRS design.*

Companies’ views are collected as follows.

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| **Company** | **View** |
| Rapporteur’s assessment | In SLS, SRS resource utilization can be reflected in data throughput. For example, for a given number of UEs in a cell, a particular scheme with larger overhead reduces the number of UEs which can be multiplexed in a slot. Then to accommodate SRS transmission for all the UEs in a cell, a larger SRS periodicity is required, which reduces data throughput due to larger CSI latency. Hence to investigate the overall impact of SRS overhead/capacity, data throughput is critical and sufficient to be the metric in SLS. |
| Huawei, Hisilicon | Agree with Rapporteur. Resource utilization can determine the periodicity of SRS in the capacity limited scenario, while periodicity will impact throughput. So data throughput is sufficient for SLS. |
| Futurewei | Suggest keeping the original proposal 1, which has a broader scope. The original has “*for a given SRS design*” whereas the updated has “*for a given SRS capacity enhancement design*”. The updated seems to be limiting. |

## EVM proposal 2

The following updates are proposed by companies on EVM proposal 2.

* Baseline
	+ Samsung proposes to remove “FG 10-11” in baseline.
* Carrier frequency
	+ Qualcomm proposes to remove “3.5GHz” and “FR2”.
* DL/UL prioritization
	+ Qualcomm proposes to prioritize DL over UL.
	+ Nokia proposes to prioritize UL over DL.
* UE antenna configuration
	+ CATT proposes to consider directional antennas additionally for more than 2 antennas in FR1.
	+ Samsung and ZTE propose not to consider directional antennas for FR1.
* SRS periodicity
	+ Samsung propose to remove “Note: SRS triggering may be aperiodic.”
* Scenario and angular scaling
	+ ZTE proposes to add “Companies to state whether angle scaling is performed, and if so, the desired angle spread and mean angle”.
* Difference between UL SNR and DL SNR
	+ ZTE and Ericsson suggest to let companies to state one signal value. The value may depend on link budget analysis.
* Phase coherency modeling
	+ Alt 1 (Qualcomm): $|ϕ\_{p\_{i}}\left(t\_{2}\right)-ϕ\_{p\_{i}}(t\_{1})|\leq ϕ\_{max} $ for $ \left|t\_{2}-t\_{1}\right|\leq T\_{thresh}^{(1)}$ per SRS port
	+ Alt 2 (Qualcomm): $ϕ\_{p\_{i}}\left(t\_{2}\right)=ϕ\_{p\_{i}}\left(t\_{1}\right)+r\_{drift}⋅\left(t\_{2}-t\_{1}\right)+δ(t\_{2}) $ for $\left|t\_{2}-t\_{1}\right|\leq T\_{thresh}^{\left(1\right)}, \left|δ\left(t\right)\right|\leq Δ\_{model}$ per SRS port
	+ Alt 3 (CATT): Phase noise model as in R1-165685
	+ Alt 4 (Huawei, HiSilicon): Random phase rotation for each transmitted SRS in different slots follows a uniform distribution [-pi\*Δf\*x/Ts, pi\*Δf\*x/Ts], where Δf denotes the gap between central frequency and UE's SRS frequency position and Ts for sampling frequency. x can be 0.1, 0.2, 0.4.

***Proposal 2:*** *Adopt the following LLS assumptions at least for SRS enhancements on coverage/capacity in Rel-17.*

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| --- | --- |
| **Parameter** | **Value** |
| Metric | UL/DL BLER or throughputNote: Other metrics like MSE can be considered optionally.  |
| Baseline | Rel-15 SRS + FG 10-11. Companies to state the detailed configuration used as baseline scheme.~~FFS: converged baseline(s).~~ |
| Carrier frequency, SCS, System BW | FR1: 3.5GHz or 4GHz, 30kHz, 20, 40 or 100 MHzFR2: 30 GHz, 120kHz |
| Channel model | CDL-B or CDL-C in TR 38.901 with 30ns or 300ns delay spread as baselineNote: other delay spread is not precluded. Companies to state whether angle scaling is performed, and if so, the desired angle spread and mean angle.~~FFS: whether and how to define scenario~~~~FFS: whether and how to use CDL in MU-MIMO~~ |
| UE speed | 3km/h , 30km/h or 120km/h  |
| Number of UE antennas  | 1T4R, 2T4R or 4T4R |
| Number of gNB antennas | 32T32R or 64T64R |
| UE antenna configuration | FR1: omni as baseline* + ~~FFS: whether direction can also be considered for more than 2 antennas~~

FR2: directional |
| Rank, precoder and MCS  | Precoder is adaptive. Rank/MCS can be adaptive or fixed. |
| Precoding granularity | Fixed: 2, 4 or wideband for DL, wideband for UL. |
| SRS periodicity  | Companies to state the used SRS periodicity.Note: SRS triggering may be aperiodic.  |
| SRS Comb | Comb 2 or 4 |
| SRS frequency hopping | Companies to state whether SRS frequency hopping is enabled and the hopping pattern if so. |
| DL SNR | Companies to state the used difference between DL SNR and UL SNR* + ~~FFS detailed values~~
 |
| Phase coherency | Companies to state whether the phase coherency in time domain is modelled and if so, ~~how~~ the model can be chosen from the following* Alt 1: $|ϕ\_{p\_{i}}\left(t\_{2}\right)-ϕ\_{p\_{i}}(t\_{1})|\leq ϕ\_{max} $ for $ \left|t\_{2}-t\_{1}\right|\leq T\_{thresh}^{(1)}$ per SRS port
* Alt 2: $ϕ\_{p\_{i}}\left(t\_{2}\right)=ϕ\_{p\_{i}}\left(t\_{1}\right)+r\_{drift}⋅\left(t\_{2}-t\_{1}\right)+δ(t\_{2}) $ for $\left|t\_{2}-t\_{1}\right|\leq T\_{thresh}^{\left(1\right)}, \left|δ\left(t\right)\right|\leq Δ\_{model}$ per SRS port
* Alt 3: Phase noise model as in R1-165685
* Alt 4: Random phase rotation for each transmitted SRS in different slots follows a uniform distribution [-pi\*Δf\*x/Ts, pi\*Δf\*x/Ts], where Δf denotes the gap between central frequency and UE's SRS frequency position and Ts for sampling frequency. x can be 0.1, 0.2, 0.4.
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Companies’ views on the above are collected as follows.

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| **Company** | **View** |
| Rapporteur’s assessment | * Baseline
	+ Rel-16 UE capability discussion for NR-U has concluded FG 10-11 can also be applied on licensed band. Hence it should be included in the baseline.
* Carrier frequency
	+ FR2 or DL in 3.5GHz has global interest for operators’ deployment. It’s better not to disallow companies to conduct evaluation for them.
* DL/UL prioritization
	+ Based on offline discussion prior to RAN1#102e and the submitted contributions, it’s impossible to prioritize one link to another. There are good points on both sides. DL may have more gain based on accurate CSI, while UL has more urgent need to enhance coverage. Hence it’s better not to prioritize any link in evaluation.
* UE antenna configuration
	+ The current situation is to use omni antennas as baseline for FR1, as it is more useful for FR1. On the other hand, this does not preclude companies to evaluate directional antennas for FR1. Hence it is suggested to keep the current EVM proposal of having omni as baseline.
* SRS periodicity
	+ The intention of the note is not to preclude companies to evaluate the utilization of aperiodic SRS for capacity coverage enhancement. Hence it seems fine to keep it.
* Scenario and angular scaling
	+ Angle scaling reflects the angular spread and allows simulator to generate different angles for different UEs. Hence it is suggested to add “Companies to state whether angle scaling is performed, and if so, the desired angle spread and mean angle”. With this, we can remove the two FFS bullets in channel model.
* Difference between UL SNR and DL SNR
	+ We can keep the current proposal to let companies report the difference and remove the FFS bullet. The reported value may depend on gNB/UE Tx power, noise figure, number of antennas, bandwidth, etc..
* Phase coherency modeling
	+ It’s better to align the modeling of phase coherency if it is used. Companies’ input on the three alternatives are encouraged.
 |
| Huawei, Hisilicon | * Baseline
	+ Rel-15 can be baseline since no other enhancements on SRS in Rel-16.
	+ For the more SRS symbols introduced in NRU, the use case for FG 10-11 is still not clear yet, e.g., UL transmission, antenna switching, or BM. The UE capability will be further discussed in RAN2. So, we also fine to remove it in the baseline.
* Carrier frequency
	+ 3.5GHz is the most common band for operators’ deployment. So it should be used.
* DL/UL prioritization
	+ DL is more sensitive to SRS channel estimation accuracy, it’s better to focus on DL in LLS.
* UE antenna configuration
	+ It is not necessary to use directional antenna modes for FR1 in UE side (we agree to use directional antennas in FR2). Till now, have not any simulation based on UE side directional mode in FR1 case, the UE side antenna is not the same as gNB antennas. We also have no any definition of UE directional antennas in RAN4 for FR1
* SRS periodicity
	+ In our understanding, aperiodic SRS is usually used when burst traffic arrives. So the notation: “SRS triggering may be aperiodic.” can be removed, since LLS don’t have traffic model.
* Scenario and angular scaling
	+ We are fine with the moderator’s proposal “Companies to state whether angle scaling is performed, and if so, the desired angle spread and mean angle”.
* Difference between UL SNR and DL SNR
	+ It’s fine to keep the current values and some additional values also can be reported by companies.
* Phase coherency modeling

We have the following coherency modeling in the email discussion stage:* + For SRS time bundling, when the start of the corresponding downlink frame of timing advance (TA) is controlled by UE only (i.e., R16), random phase rotation for each transmitted SRS in different slots follows a uniform distribution [-pi\*Δf\*x/Ts, pi\*Δf\*x/Ts], where Δf denotes the gap between central frequency and UE's SRS frequency position and Ts for sampling frequency. x can be 0.1, 0.2, 0.4.
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## EVM proposal 3

The following update is proposed on EVM proposal 3.

* Traffic model
	+ Qualcomm proposes to add full buffer in the traffic model.

***Proposal 3:*** *Adopt the following SLS assumptions at least for SRS capacity enhancements in Rel-17.*

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Metric | DL throughput |
| Baseline | Rel-15 SRS + FG 10-11. Companies to state the detailed configuration used as baseline scheme.  |
| SRS error modelling | Table A.1-2 of TR 36.897 |
| SRS periodicity | Companies to state the simulated SRS periodicity.Note: SRS triggering may be aperiodic |
| Carrier frequency, SCS and system bandwidth | 3.5GHz, 30KHz and 20MHz/40MHz/100MHz as baseline |
| Number of gNB antennas | (*M*, *N*, *P*, *M*g,*N*g; *M*p, *N*p) = (8,8,2,1,1,4,8). (dH,dV) = (0.5, 0.8)λ |
| Number of UE antennas | 1T4R, 2T4R or 4T4R |
| Traffic model | FTP 1 or FTP 3Note: Full buffer can also be considered optionally. |
| Handover margin | 3dB |
| Scenario | UMi/UMa with 200m ISD.Note: UMa with 500m ISD can also be considered. |

Companies’ views on the above are collected as follows.

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| **Company** | **View** |
| Rapporteur’s assessment | * Traffic model
	+ Burst model like FTP is closer to what we have in real network, esp. considering interference, MU paring, etc. caused by on-demand scheduling. Hence it is suggested keep FTP models only.
 |
| Huawei, Hisilicon | * Traffic model
	+ We support QC’s proposal to add full buffer as well. SLS is supposed to be used for capacity enhancement evaluation. In the capacity limited scenario, high traffic load should be assumed. So, burst buffer with high RU, e.g. 70% or 80%, should be used, and Full burst buffer also can be used.
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| Futurewei | Support to add full buffer in the traffic model. |

# References

[1] Offline email discussion on FeMIMO evaluation methodology: Item 3