**Rel.17 NR-FeMIMO EVM Offline Discussion**

The offline discussion on EVM is divided into two phases:

1. Phase 1: Assessment on the need for additional EVM agreements beyond what we already have in Rel.16 for each item in the WID + a list of high-level aspects
2. Phase 2: Details of simulation assumptions for each item
3. Phase 1
	1. Summary: observation and proposal

The following observation can be drawn from companies’ views:

* Items 1, 2a, 2d, 3, and 4: the majority of, if not all, companies see the need for additional EVM agreements beyond Rel.16.
* Items 2b and 2c: the majority of companies do not see the need for additional EVM agreements beyond Rel.16
	+ It is pointed out that the antenna configuration for multi-panel UE, if used for 2b and 2c, can follow the outcome from item 1 discussion
	+ For item 2c, an assumption on pre-determined SNR offsets for emulating distances from the UE to the TRPs can be used for LLS

Based on companies’ views, the following proposal on how to proceed with Phase 2 is made:

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| **Proposal**: On the EVM for Rel.17 NR-FeMIMO, i.e. the need for additional EVM agreements beyond Rel.16: * Phase 2 of the EVM discussion comprises items 1, 2a, 2d, 3, and 4 only
* For items 2b and 2c, beyond the agreed Rel.16 EVM:
	+ Antenna configuration for multi-panel UE, if used, will follow the outcome from item 1 discussion
	+ For item 2c, the assumed pre-determined SNR offsets for emulating distances from the UE to the TRPs is to be stated if LLS is used
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* 1. Compilation of companies’ views

The following question was posed for Phase 1:

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| Please share your view on the questions below in the provided tables.1. Q1: If the respective item (cf. WID) requires some discussion on evaluation methodology **in addition** to what we already agreed in Rel.16 eMIMO
2. Q2: If the answer to Q1 is yes, potential aspects of evaluation methodology (initial and high-level assessment, i.e. tentative)
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The response from companies is compiled in the following table.

**Table 1 Item 1 – Multi-beam**

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| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | Item 1a specific: * SLS is the primary tool for evaluation at least for intra-cell mobility (typical BM).
* Inter-cell mobility may consider other (simpler) metrics such as dropped-call rate
* SLS layout to evaluate high-mobility scenarios @FR2 (e.g. highway, intra/inter-cell, HST cf. 2d): Reuse 38.913 and 38.802 as much as possible.
	+ Note: For HST, use the same model as item 2d

Item 1b specific:* SLS is the primary tool for evaluation for evaluating MPE issue
* MPE-specific assumptions need to be discussed: 1) panel blocking model, 2) EIRP

Common (1a and 1b):* UE multi-panel assumptions:
	+ 3-panel UE as a baseline should be evaluated (left, right, back), each panel is 1x4x2
	+ Beam direction per panel needs to be aligned or at least elaborated
 |
| ZTE | Y | * LLS and SLS assumptions to evaluate multi-beam operation (e.g., Spectral efficiency, UPT, outage), where most of them can be inherited from Rel-16 MB enhancements except for the following.
	+ High UE speed, e.g., 60km/h or 120km/h, for evaluating scenarios like high-speed vehicles/trains.
	+ UE mobility (physical trajectory with spatial consistency) and blockage modelling
	+ Details of TXRU mapping to antenna elements & antenna configurations of BS in indoor hotspot and Dense Urban.
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| Intel | Y | Beam Management for high mobility support:* SLS/LLS (HST-like) evaluations can be considered
* Evaluation methodology should be defined for SLS based beam management evaluation for mobility
	+ Consider UE trajectory within deployment
	+ Intra/inter-cell layout with or without handover
	+ Scenarios e.g., dense urban, Rural (highway) etc.
* KPIs for system level evaluation of beam tracking/indication with low overhead should be clearly defined

Uplink Multi-Panel for MPE mitigation:* Rel-16 SLS evaluations including multi-TRP scenario can be used as starting point
* MPE mitigation baseline and UE multi-panel assumptions should be defined
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| Huawei, HiSilicon  | Y | Considering that the objective is to support higher intra- and L1/L2-centric inter-cell mobility, at least medium mobility with 30/60 km/hour speed, in addition to random UE rotation and blockage models agreed in 38.901, shall be considered as the baseline of evaluations. Otherwise, the evaluation results may be overly optimistic for FR2 mobility. Considering how to support more efficient (lower latency and overhead) DL/UL beam management, the trade-off between latency/overhead versus UPT shall be studied in Rel-17. Therefore it is worth discussing how to estimate/define signalling latency and overhead among solutions, assuming realistic UE capability on beam measurement/tracking. RAN1 may need to consider additional metric/clarification of signalling latency/overhead in order to facilitate a fair comparison. In terms of multi-panel UE, it is preferred to consider the following in Rel-17: * Up to 4 panels per UE as the baseline, with potentially different panel size and number of beams on each panel. For example some commercial UEs are observed to have 3 or 4 panels, with different sizes of 1x4, 2x2, and 1x2 antenna elements, due to varying space limitations over the hand-held device.
* Autonomous panel selection by the UE as the baseline. For Objective 1, single active panel is determined by the UE based on P1 procedure for both DL reception and UL transmission.

Considering how to study UL coverage loss mitigation due to MPE, Rel-16 RAN4 solution (P-MPR reporting via PHR-MAC-CE) can be considered as the baseline solution. However, on top of that, RAN1 needs to consider how to model MPE events in SLS. Our preliminary preference is to model MPE events as a random drop of a UL transmission, [per UE or per panel basis], for simplicity of SLS whereas exact characteristics of MPE events are FFS.  |
| Apple | Y | Cell association scheme needs to be discussed. Currently the cell association is based on the best gNB-UE beam pair, however this is not practical since UE would not try all beams before it decides the cell to access. |
| CATT | Y | * SLS vs. LLS: SLS for mobility related EVM, LLS for non-mobility related items.
	+ LLS: existing Rel.16 methodology can be used as much as possible.
	+ SLS: additional modeling on UE movement, deployment scenarios, handover aspects could be further clarified.
* For MPE, agree with Samsung that antenna panel blocking and EIRP are needed.
* If panel selection is to include panel activation/deactivation, additional modeling of activation/deactivation is required, e.g. how often it occurs, panel activation/deactivation timing budget, panel switching timing budget.
 |
| InterDigital | Y | * Rel-16 EVM can mostly be re-used.
* Need a clear set of assumptions for MPE evaluation, e.g., panel configurations, incurred loss, persistency, etc.
 |
| Ericsson | Y | Some of the topics in Item 1 are not suitable for SLS, e.g., unified TCI. Care should be taken to be clear on how to use simulation results, before aligning simulation assumptions.Item 1a: * RS transmission scheme
* Tx beam selection method
* Rx beam selection method
* UE mobility model
* Handling of UEs crossing cell borders – with higher speeds, crossing cell borders will be common

Item 1b:* MPE-specific assumptions need to be discussed: 1) panel blocking model, 2) EIRP
* Handling of UEs out of coverage
* RAN4 MPE mitigation algorithms

Common (1a and 1b):* UE multi-panel assumptions:
	+ 4-panel UE as a baseline should be evaluated (left, right, top, bottom)
	+ Each panel is 1x4x2
 |
| LG | Y | On supporting intra- and L1/L2-centric inter-cell mobility, SLS and LLS assumptions may be needed to evaluate the performance (e.g. UPT performance/overhead tradeoff, outage etc.) of MB operation at least for medium mobility cases. As a baseline, considering UE mobility scenarios seems reasonable with adopting UE rotation and blockage models in 38.901 On uplink multi-panel, it is primarily required to define the UE multi-panel assumptions with heterogeneous antenna array configuration per panel as well as homogenous antenna configuration per panel, taking practical implementation aspects such as panel calibration error, PA structures across multi-panel into account. |
| Lenovo, Motorola Mobility | Y | Beam management can be evaluated with SLS and LLS. The following assumptions need to be agreed or clarified:* gNB/UE panel/antenna configurations
* deployment scenario (dense urban, indoor hotspot, HST)
* UE mobility model (speed and trajectory) and handover model (intra-cell and inter-cell)

For FR2, blockage should be modeled. For MPE study, SLS should be used with multi-TRP and orientation/blockage model. At least two-panel UE should be studied.  |
| FUTUREWEI | Depends | We agree that SLS simulation are the best tool to ensure thorough study and selection of solutions. However, the amount of efforts could be too high considering the time of the WID especially under the current situations and the potential complexity of evaluating mobility with beam management which involves both external dynamics of the system and internal dynamics of beam switching. In addition, with new/augmented assumptions and performance metrics, calibration and benchmarking may be need.SLS performance evaluation of high mobility scenario need to consider also blockage. Assumptions on common and correspondence beams need to be clearly stated. KPI of solutions may also include beam switching latency and BFR rate.UE multiple panel/operation assumptions along with MPE modeling need to be defined for MPE. |
| CMCC | Y | Item 1a:* To support higher intra- and L1/L2-centric inter-cell mobility, UE with medium speed (30km/h or 60 km/h) and UE with high speed (120km/h for highway or up to 500 km/h for HST) should be considered.
* Considering how to evaluate the performance of unified TCI.

Item 1b:* Details of multi-panel assumptions and MPE-specific assumptions need to be discussed.
 |
| vivo | Y | For intra- and L1/L2-centric inter-cell mobility, SLS and LLS can be considered for various evaluations: e.g.* SLS with rotation/blockage modelling is used to evaluate the variation of beam link quality.
* LLS is used to evaluate the impact of beam indication and beam switching delay on performance.

For multi-panel UE, rotation/blockage should be considered in SLS simulation for mobility case.* Multi-panel UE assumption should be considered, at least for MPE issue.
* UE panel selection and panel switching for uplink can be considered in conjunction with MPE. The panel blocking and the EIRP assumption should be considered.
 |
| OPPO | Y | For higher intra and L1/L2 centric inter-cell mobility: EVM of rel16 MB can be used as the baseline with the following updates: * Up to medium high mobility (60km/hr) UEs can be included. For high speed UEs, it is more feasible to simulate them under special scenario, for instance 2d.
* Inter-cell handover latency shall be considered as performance metric

For multi-panel UE:* SLS EVM of rel16 MB can be used as the starting point and UE power consumption shall be considered in the evaluation.

For MPE issue: use SLS EVM of rel16 MB is the baseline with the following updates:* UE power back off model shall be modeled：it is per beam direction? It is per panel or it is per UE? Please note RAN4 has agreed a MAC CE based PMPR reporting to resolve the MPE issue.
* Human body blockage shall be modelled in the simulation.
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**Table 2 Item 2a – mTRP PDCCH/PUSCH/PUCCH**

|  |  |  |
| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | PDCCH: LLS as primary tool for evaluation* Scenario and channel model: reuse 38.913 as much as possible. (@FR2, focus on IIoT scenarios with a certain blockage probability)
* PDCCH configurations: AL, interleaving, DCI format/size, # of symbols
* Repetition method, e.g., TDM as a starting point
* Decoding assumptions, e.g., whether to allow soft combining
* Reliability target for PDCCH

PUCCH and PUSCH: LLS as primary tool for evaluation* Scenario and channel model: reuse 38.913 as much as possible. (@FR2, focus on IIoT scenarios with a certain blockage probability)
* Resource configuration, e.g., targeted PUCCH format, # of RBs/symbols
* Repetition method, e.g., TDM only (intra/inter-slot, same/different resource configuration)
* Decoding assumptions, e.g., whether to allow soft combining for PUCCH
* Tx power control, e.g., per TRP
* Reliability target for PUCCH, PUSCH
 |
| ZTE | Y | LLS assumptions to evaluate PDCCH/PUSCH/PUCCH reliability. At least basic settings for PDCCH/PUSCH/PUCCH transmission need to be aligned among companies. Rel-16 methodology for PDSCH evaluation (e.g., modelling of blockage) can be a reference. |
| Intel | Y | Rel-16 EVM for MTRP URLLC [R1-1814008] can be re-used, we propose the following to be added:**PDCCH**:- Consider SFN as baseline scheme, consider single PDSCH reception - Determine realistic TRP power difference and timing difference to UE from SLS- Consider simple blockage model from Rel-16 (addition of x dB loss with probability p) for FR2**PUSCH**: - Consider Rel-16 mini-slot based repetition and specification transparent MTRP reception (URLLC) for baseline scheme.  - Determine realistic UE PSD due to power control based on uplink SLS evaluations(d) Determine realistic UE power difference and timing difference to 2 TRPs based on uplink SLS evaluations - Consider simple blockage model from Rel-16 (addition of x dB loss with probability p) for FR2 **PUCCH**: - Consider specification transparent MTRP reception for baseline scheme.  - Determine realistic UE PSD due to power control based on uplink SLS evaluations- Determine realistic UE power difference and timing difference to 2 TRPs based on uplink SLS evaluations |
| Huawei, HiSilicon | Y | For robustness/reliability estimation, link level simulation is preferred, Appendix A.3 in TR38.824 can be a start point. For PUSCH, gNB receiver should be modelled in simulations, e.g. joint detection, or soft-combining. The CDL channel modeling can be used, where the channel correlation among TRPs should be provided by companies. For PDCCH, the multi-TRP transmission behavior should be modelled, such as that each TRP transmits separate PDCCH candidate of the same DCI. Larger AL, e.g. 4 or 8 should be considered since multi-TRP transmission mostly benefit cell-edge UEs. TDL channel modeling can be used. Other detailed parameters including CCE-to-REG mapping, DCI payload, REG bundle, etc., should be aligned as well.For PUCCH, joint detection for UL should be included in the simulation. The PUCCH formats carrying HARQ-ACK can be used, which are more critical to system performance. And TDL channel modeling can be used. |
| Apple | Y | LLS assumption for PDCCH/PUCCH/PUSCH needs to be discussed, which is not included in Rel-16 assumption. |
| CATT | Y | * LLS as baseline.
	+ From our perspective it appears possible to reuse existing Rel.16 EVM on (1) channel models and (2) antenna panels configurations.
* On candidate enhancement schemes
	+ We think this discussion (if covered in this email thread) is valid for all Rel.17 items, not only 2a.
 |
| InterDigital | Y | * Rel-16 EVM to be used as the starting point for other channels.
* Should agree on a channel blocking model for better evaluation of transmission robustness.
 |
| Ericsson | Y | Agree that LLS should be the primary tool for PDCCH/PUSCH/PUCCH evaluations. Rel-16 multi-TRP EVM for URLLC can be the starting point. Pathloss difference between TRPs can be considered, blocking model used Rel-16 mTRP may be used to evaluate channel blocking effects. To reduce the number of cases to evaluate and to align among companies, some basic configurations such as RBs, symbols, code rates, etc. may be defined for each of PDCCH/PUCCH/PUSCH.  |
| LG | Y | LLS assumptions for PDCCH/PUSCH/PUCCH need to be discussed. Assumptions in Appendix A.3 in TR 38.824 can be considered as a starting point of further discussion.  |
| Lenovo, Motorola Mobility | Y | LLS can be used for PDCCH/PUCCH/PUSCH evaluation. The link level simulation assumption in TR38.824 can be used as a starting point for discussion. Deployment, channel model and panel/antenna configuration should be synchronized with Item 1. Pathloss difference, user orientation and blockage model should be included. Resource usage, repetition scheme, reception /decoding method should be clarified. Time domain repetition can be a starting point.  |
| FUTUREWEI | Y | Reuse the general framework of R16 EVM as much as possible and include new EVM for PDCCH/PUSCH/PUCCH.Since the scope of this agenda item is really broad, to ensure completion on time, too complicated EVM / too many evaluation options should be avoided if possible. Simplified performance analysis based on repetitions may be considered as a starting point. |
| CMCC | Y | LLS is the primary tool to evaluate PDCCH/PUSCH/PUCCH reliability. Rel-16 methodology for M-TRP URLLC PDSCH evaluation and the channel blocking model can be considered as a reference for R17. Besides, the configuration of PDCCH/PUCCH/PUSCH should be aligned among companies.  |
| vivo | Y | Channel model：* Prefer CDL since it can model the spatial relations between TRPs of gNB and panels of UE.
* Path-loss difference between two TRPs to be taken into account, e.g{0dB, 6dB, 20dB(similar to blockage)}

LLS assumption for PDCCH* SFN as baseline
* Some parameters should be determined, e.g.
* payload size, CORESET size, AL, interleaving enabled or disabled, repetition number, etc.
* REG bundle, CCE mapping may be considered.
* Receiver assumption: whether to introduce soft combining according to transmission scheme.

LLS assumption for PUSCH/PUCCH* Based on TDM scheme
* Both codebook and non-codebook transmission for PUSCH should be evaluated.
* Other assumptions:
* Number of transmission layers.
* Transmission related to full power scheme as low priority.
* Potential Receiver algorithms for ideal backhaul:
* Opt1: separate equalizer with soft combining between two TRPs.
* Opt2: joint equalizer, e.g., carrying out MRC between two TRPs.

Opt1 has higher priority. |
| OPPO | Y | * PDCCH: Additional evaluation parameters are needed for PDCCH, e.g. aggregation level, DCI size, number of symbols, bandwidth, REG bundling, soft combining or not etc.
* PUSCH: PUSCH repetition in Rel-16 eURLLC is used as baseline
* PUCCH: PUCCH repetition in Rel-15 is used as baseline
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**Table 3 Item 2b – inter-cell mTRP**

|  |  |  |
| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | No | -- |
| ZTE | N |  |
| Intel | Y | Rel-16 EVM for MTRP eMBB can be reused [R1-1814008], we propose the following KPIs to be included to understand the scope of specification changes:- Determine statistics of TRP power difference to UE from 2 TRPs- Determine statistics of propagation delay difference to UE from 2 TRPs |
| Huawei, HiSilicon | N | As agreed in early R16, multi-TRP supports both intra- and inter-cell cases, so R16 evaluation assumption can be a starting point. Our understanding is that Item 2b is about inter-cell M-TRP transmission where UEs are not expected to move and is performing M-DCI reception, while inter-cell mobility involving cross-cell movement is to be discussed in Item 1.  |
| Apple | N |  |
| CATT | N |  |
| InterDigital | N |  |
| Ericsson | N |  |
| LG | N |  |
| Lenovo, Motorola Mobility | N |  |
| FUTUREWEI | N | To clarify, we may need detailed descriptions of the deployment scenarios (ISD, backhaul assumptions, etc.). Analysis based on the agreed deployment scenarios may be sufficient and no actual LLS/SLS is needed. |
| CMCC | N |  |
| vivo | N |  |
| OPPO | N | This was discussed in rel16 and it seems we only need to specify inter-cell TCI state. So no additional is needed. |

**Table 4 Item 2c – mTRP beam management**

|  |  |  |
| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | LLS as primary tool for evaluationWe think the following assumptions, which had been agreed in Rel-16 can be reused:* Channel model (CDL-A)
* BS antenna configuration, i.e., (M, N, P, Mg, Ng) = {(4,8,2,1,1), (4,8,2,2,2)}

The followings should be further discussed in Rel-17* UE antenna configuration

e.g., for UE with 2-panels (M, N, P, Mg, Ng) = (2,4,2,1,2) and Ω0,1=Ω0,0+180°FFS, other practical UE implementation with >2 panels (e.g. from item 3)* Pre-determined SNR offset across each TRP-UE channel
 |
| ZTE | N | The evaluation assumptions of M-TRP set-up can be inherited from Rel-16. If there are any open issues, they can be discussed together with item 1. |
| Intel | N | Rel-16 EVM for multi-beam operation can be re-used from Rel-16 (R1-1814008) |
| Huawei, HiSilicon | Y | In R16, there was no enough discussion over UE multi-panel assumption. In R17, the detailed UE panel setup, status assumption etc., need to be discussed, which would impact simulation greatly. The outcome from item 1 discussion can be used as starting point, e.g., maximum 4 UE panels in one device. More specifically, assumption for multi-panel reception simultaneously should be further discussed, e.g., how many UE panels can be selected for simultaneous reception, whether/how to maintain the same set of UE panels to select for downlink reception and uplink transmission. We suggest to consider up to 2-panel reception simultaneously when the channel conditions are satisfied (e.g., RSRP differences less than certain threshold) and not exceeding a limited duration (e.g., less than certain percentage of the time). UE with single panel reception is assumed as baseline for comparison. |
| Apple | N |  |
| CATT | Y | * LLS as baseline.
	+ Reusing Rel.16 EVM on (1) channel models and (2) antenna panel configuration as a starting point.
* Introduce a pre-determined SNR offset to emulate UE distance to two different TRPs.
 |
| InterDigital | N | * Rel-16 assumptions can be re-used, specific details can be discussed on as-needed basis.
 |
| Ericsson  | Y | We think SLS should be the main tool for evaluation, where sDCI based NC-JT with the existing group-based beam reporting is the baseline. Any enhancement on group-based beam reporting is then compared with the baseline in terms of throughput gains. |
| LG | N | Rel-16 assumptions can be re-used, specific details can be discussed on as-needed basis. |
| Lenovo, Motorola Mobility | N | Rel-16 EVM for multi-beam operation can be re-used from Rel-16 (R1-1814008) |
| FUTUREWEI | N | Reuse R16 EVM |
| CMCC | Y | Rel-16 methodology for M-TRP can be considered as a starting point, however, considering multi-panel reception, the details of multi-panel assumptions discussed in Item 1b can be reused here. |
| vivo | N | SLS of R16 EVM for FR2 MTRP can be reused, assumptions in Item 1 can be included* UE antenna configuration with 2 or more Rx panels
 |
| OPPO | N | The EVM for M-TRP in rel1-6 can be re-used, where assumptions for FR2 (30GHz) and multi-panel UE was included.  |

**Table 5 Item 2d – HST**

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| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | LLS as primary tool for evaluation* Deployment scenarios: for both FR1 and FR2, reuse 38.913 as much as possible
* HST-SFN channel models: reuse the HST-SFN channel model agreed in RAN4 as much as possible
* Time-varying Doppler frequency modeling, e.g., as defined in RAN4
 |
| ZTE | Y | LLS assumptions should be discussed at least for the second bullet of 2d in WID.* Rel-16 MTRP LLS assumptions can be reused as much as possible. CDL channel model in 38.901 should be used. The simulation methodologies in R1-2003483 can be a starting point.
* FR1 should be prioritized.
* UE speed can be 350km/h, 500km/h.
 |
| Intel | Y | For FR1 current RAN4 simulation assumptions for HST can be reused.New simulation assumptions should be defined for FR2. |
| Huawei, HiSilicon | Y | Link level simulation is preferred.For HST scenario, CDL channel (multi-path) with different delay spread (e.g., 300ns for one TRP+ 100ns for another TRP) should be modeled, i.e. for UEs nearby one side of window, or on inside seats. The channel correlation among TRPs should be provided by companies.Moreover, multiple TRSs should be considered in the simulation, such as 2 TRSs. |
| Apple | Y | LLS assumption for HST/SFN needs to be discussed, which is not included in Rel-16 simulation assumption. The assumption should include both PDCCH and PDSCH. HST/TDL channel model is recommended. |
| CATT | Y | LLS as baseline* FR1 may be prioritized
* Channel model: reuse HST-SFN channel model agreed in RAN4 as much as possible
* Baseline transmission scheme: SFN transmission for both PDSCH and TRS
* UE speed: 500km/h mandatory.
 |
| InterDigital | Y | * Only LLS
* Reuse RAN4 agreements, as they have already concluded many assumptions for HST-NR evaluation
* Given the limited time, FR1 should be at least the priority, if not the only focus.
 |
| Ericsson | Y | * LLS is primary tool
* FR2 and FR1 of equal priority
* Reuse RAN4 simulation assumptions as much as possible for FR1
* Both unidirectional and bidirectional RRH deployments to be considered
 |
| LG | Y | * LLS is baseline
* Channel model and assumptions in TR 36.878 can be considered as a starting point of further discussion.
* HST-SFN channel model agreed in RAN4 should be reused as much as possible
* Both PDCCH and PDSCH should be considered
 |
| Lenovo, Motorola Mobility | Y | - Link level simulation is preferred- CDL model is used as in TR 38.901, with CDL model D/E used for window-seat users- FR1 should be prioritized for simulation- Reuse the HST layout in TR 38.913- Time-varying Doppler model is used |
| FUTUREWEI | Y | Reuse RAN4 simulation assumptions as much as possible. Only LLS for evaluation. |
| CMCC | Y | * LLS could be used as the primary tool
* High level evaluation assumptions: Reuse the agreements related to the simulation assumptions of HST-SFN in RAN4 Rel-16 WI NR\_HST as much as possible, but with some modification and update to the 4-tap channel model assumption to reflect the directional antenna pattern of gNB. Specifically,
	+ Deployment scenario: HST-SFN with bidirectional coverage, Ds=700m, Dmin=150m, as agreed in RAN4. We do not think further discussion on unidirectional RRH deployment is needed, given that this was also not considered in RAN4 HST-SFN agreement.
	+ Frequency range: FR1 should be prioritized, i.e., no optimization is need for FR2 but the enhancement can also be used in FR2, considering that up to 3.6GHz was considered in RAN4 HST, and we should not be too advanced compared with RAN4 in specification for this scenario.
	+ Channel Model: 4-tap LTE HST-SFN bidirectional channel model (see TR36.101 Annex B.3A as in Fig.1 below) was assumed in RAN4. However, some modification and update is needed to take into account the directional antenna pattern of each RRH. It should be noted that in real deployment, there are usually separate antennas covering one of two directions per site, similar to the Fig.2 below, which will impact the solution design and performance evaluation, e.g., two TRPs with opposite directions per site may use separate TRSs, etc. Therefore, we think that some combination of the CDL channel model in TR38.901 and the 4-tap channel model in TS36.101 Annex B.3A could be considered. One simple way could be similar to the suggestion of ZTE, as illustrated in figure 3 below, 2-tap channel model for simplicity could be assumed which is similar to RAN4’s 4-tap assumption in order to reflect the characteristic of SFN-based transmission, and for each tap, CDL channel model in TR38.901 could be used to model the effect of the directional antenna of gNB.
		- The delay for k’th TRP is modified as

where  is the delay of k’th TRP, which can be derived aswhere  is the delay of the n’th channel cluster as in Table 7.7.1-1~7.7.1-5 in 38.901, and assume the location of the k’th TRP is xk, and the UE’s location is y(t).The delay spread for different TRPs could be modeled as different as suggested by Huawei.* + - The normalized power for k’th TRP is modified as

* + - To generate the modified angle parameters, the scaling method mentioned in subclause 7.7.5.1 in TS 38.901 is used

where  could be assumed, and  of the k’th TRP is the AOD, AOA, ZOD and ZOA of LOS direction derived based on the locations and antenna heights of UE and TRPs.Fig. 1. Deployment of HST-SFN in TS36.101 Annex B.3AFig. 2. HST-SFN deployment in real networkFig. 3. Simplified and updated HST-SFN channel model for evaluation* Baseline transmission scheme for evaluation: For HST-SFN scenario, some companies may prefer that Rel.16 multi-TRP enhancement should be taken as the baseline. We are open to study the benefit of the HST-SFN enhancement in Rel-17 over Rel-16 multi-TRP transmission schemes. However, from our perspective, since the typical downlink transmission scheme in the first phase 5G commercial HST network is the SFN based transmission, the performance gain of the Rel-17 HST-SFN enhancement compared to the traditional SFN-based transmission is also important. Additionally, the Rel-16 multi-TRP transmission scheme is a very big and complicated feature, and it is uncertain that whether the Rel-16 multi-TRP transmission schemes will be introduced in the 5G commercial macro network or not. If the Rel-16 multi-TRP transmission schemes are not introduced in the 5G commercial macro network, then we need to further decide whether it is still cost efficient to introduce them only for HST scenario. In the contrast, if Rel-17 can provide a simple and dedicated enhancement for HST scenario compared to the commercialized the SFN-based transmission, it would still be promising for application in the commercial HST network. Therefore, we propose that both traditional SFN based transmission and Rel.16 transmission schemes could be used as the baseline for evaluation of the second objective of 2d.
 |
| vivo | Y | LLS is used primarily* Channel models: CDL-D/E channel model combined with the HST-SFN channel model agreed in RAN4
* Both FR1 and FR2 are considered, FR2 assumptions need further discussion
 |
| OPPO | Y | * LLS simulation is baseline.
* RAN4 SFN-HST scenario can be reused.
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**Table 6 Item 3 – SRS**

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| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | LLS as primary tool for evaluation* UL channel estimation and error modeling + UL Tx power
* SRS configuration (UL carrier frequency or UL-DL duplex distance, SRS BW, #symbols, comb, time-bundling and antenna switching)
* Practical UE implementation on antenna switching
	+ Omni-directional UE antennas for FR1
	+ Directional UE antennas for FR2, FFS angle between panels for UEs with >2 panels
* Performance metric: BLER of PDSCH and/or PUSCH, MSE of channel
 |
| ZTE | Y | LLS assumptions to evaluate SRS coverage and capacity (e.g., evaluation metrics, baseline, SRS setting, MIMO setting, etc.). |
| Intel | Maybe | * For aperiodic SRS triggering flexibility, simulation may not be necessary.
* For antenna switching with xTyR, some SLS simulations can be performed to analyze the benefit for different yR values.
* For coverage/repetition, the link level simulation assumption used for additional SRS enhancement in LTE Rel-16 can be re-used as much as possible.
 |
| Huawei, HiSilicon | Y | Evaluation metrics: DL throughput can be considered for both capacity and coverage evaluation, since downlink throughput is more sensitive to CSI accuracy than uplinkSRS capacity evaluation: * For the SRS capacity limited scenario, SRS capacity enhancement actually means SRS period reduction. So downlink throughput gain of SRS period reduction should be evaluated, and SLS should be used.
* TDD, 3.5GHz, 30K SCS and 20M/40M bandwidth can be considered as baseline, larger bandwidth up to 100M may be optionally considered.
* 64T64R (8,8,2,1,1,4,8) can be used for BS antenna configuration as baseline.
* High traffic load, e.g. 70% RU
* Long SRS periodicity, e.g. 40ms or 80ms should be assumed to simulate SRS capacity limited scenario.
* SRS error model in Table A.1-2 of TR 36.897 can be reused.

SRS coverage evaluation: * LLS to evaluate the throughput gain of SRS coverage enhancement.
* Frequency hopping and repetition can be considered for the evaluation.

TDD, 3.5GHz, 30K SCS, CDL channel and 64T64R (8,8,2,1,1,4,8) are used as baseline. |
| Apple | Y | LLS assumption for SRS needs to be discussed, and MSE could be the metric. |
| CATT | Y | LLS as baseline:* Clarify baseline scheme for performance comparison.

Parameters configuration, e.g., SRS and MIMO configurations* Evaluation metrics, e.g., UL BLER or DL BLER
 |
| InterDigital | Y | * LLS seems sufficient for coverage enhancement evaluation, but SLS may be a better means for SRS capacity evaluation.
 |
| Ericsson | Y | * PDSCH performance should be used to quantify benefit of ‘y’ values for xTyR antenna switching, and of increased SRS coverage.
	+ UL TPMI determination & link adaptation is expected to be less sensitive to SRS SINR than DL CSI determination.
* Realistic UE antenna configurations using both directional and omni antennas
* FR1: 2 Tx has one dual polarized omni, 4 Tx has 4 directional single polarized elements pointing in 4 directions
* FR2: 4-panel UE as a baseline should be evaluated (left, right, top, bottom). Each panel is 1x4x2
 |
| LGE | Y | LLS assumption can be discussed for enhancement on SRS. In addition to what we agreed in Rel-16 eMIMO LLS assumption, baseline of SRS configuration (including SRS BW, number of repetition, comb value..) needs to be discussed. Regarding SRS antenna switching, reciprocity based channel estimation error should be considered for performance evaluation, which had been discussed for LTE MIMO. For the performance metric, BLER of PDSCH(antenna switching)/PUSCH can be evaluated. |
| Lenovo, Motorola Mobility | Y | LLS as baseline. Antenna/panel configuration should be clarified. Impact to both DL and UL should be evaluated.  |
| FUTUREWEI | Y | LLS and SLS, depending on the specific proposals:• Sounding performance (per se), e.g., UL channel estimation: LLS, and SLS if needed• Flexible SRS triggering for DL CSI acquisition: SLS• Flexible SRS triggering for other purposes: LLS, SLS, or analysis• SRS capacity: LLS, SLS, or analysis• SRS coverage: LLS, SLS, or analysis |
| CMCC | Y | LLS assumption for SRS enhancement needs to be discussed:* Evaluation metric: DL BLER and UL BLER.
* SRS configuration: SRS BW, number of symbols, comb, repetition, frequency hopping.
 |
| vivo | Y | LLS is primarily used for SRS capacity and coverage enhancement and antenna switching* May not be necessary for flexible triggering

Realistic UE implementation* FR1: 2Tx and 4Tx with Omni-directional UE antennas
* FR2: UE with 2 Tx panels as a baseline, FFS for panel location and antenna configuration within a panel

Performance metric should be discussed* DL/UL channel BLER, throughput, or MSE of channel estimation
 |
| OPPO | Y for 3c | * For SRS capacity and coverage: use LLS to evaluate the performance: including e.g., Channel model, SRS resource configuration: Comb, offset, number of symbols, BW, freq hopping.
* For SRS switching: looks like simulation is not needed. Especially, antenna switching for up to 6 or 8 antennae is not needed to be considered/evaluated in FR2.
* For AP SRS triggering: looks like simulation is not needed.
 |

**Table 7 Item 4 – CSI**

|  |  |  |
| --- | --- | --- |
| **Company** | **Q1 (Y/N)** | **Q2** |
| Samsung | Yes | Item 4a: SLS as primary tool for evaluation* Deployment scenarios
	+ Rel-16 MTRP assumption as baseline
	+ Large # of TP antennas for both UMa and InH, e.g., Up to 256 antenna elements assumed in 38.913
	+ Focus on ideal backhaul assumption
* CSI report configuration and overhead: # of reports, periodicity, feedback delay
* IMR assumptions for NC-JT and inter-cell interference calculation, e.g., IMR for inter-cell interference only

Item 4b: modeling realistic system aspects such as (at least some of) the followings  * UL channel estimation and error modeling + UL Tx power (e.g. based on UL PC)
* SRS configuration (UL carrier frequency or UL-DL duplex distance, SRS BW, #symbols, comb, time-bundling and antenna switching)
* Frequency offset modeling (e.g. according to the FDD reciprocity model in 36.897
* PAPR issue modeling for >=8 CSI-RS ports
* UL/DL reciprocity errors (due to different Tx-Rx RF circuitry different UL-DL interference profile)
 |
| ZTE | Y | * Most of the SLS assumptions to evaluate M-TRP CSI can be inherited from Rel-16 M-TRP enhancements.
* SLS assumptions to evaluate CSI enhancements based on FDD reciprocity, incl. modelling of FDD reciprocity, baseline scheme, SRS channel estimation modelling, etc.
 |
| Intel | Y | * For CSI reporting enhancements for DL multi-TRP and/or multi-panel transmission, SLS evaluation assumptions for eMBB can be reused from Rel-16 mTRP enhancements. New modeling components for inter-cell mTRP scenario can be reused from the corresponding Rel. 17 feMIMO agenda item. Simulation methodology for URLLC enhancements can be discussed, if needed.
* For Type II port selection codebook enhancement, assumption of the modelling of the UL and DL channels should be agreed, other assumptions can be reused from Rel. 16 Type II CSI enhancements. For modelling of the UL and DL channels methodology from 36.897 can be reused.
 |
| Huawei, HiSilicon | Y | At least Item 4b may require following discussion on EVM, in addition to what RAN1 have already agreed in RAN1 94bis for Rel.16 CSI enhancement * Clarification of Channel model for FDD partial reciprocity

By reviewing existing MIMO channel modelling analysis and measurement campaigns from both academia and industry, multipath angle and delay are reciprocal between DL and UL channel in FDD system. For example, WINNER II channel model suggests that the multipath angle and delay are reciprocal between DL and UL in an FDD system. Therefore in order to utilizing FDD DL/UL partial channel reciprocity over angle/delay domains, a channel model including both Uplink and Downlink channel generation shall be clarified, especially for a FDD band, in order to align RAN1 simulation efforts and understanding. In our view, Section 7.5 of TR 38.901 with FDD reciprocity model elaborated by Section 5.3 in TR 36.897 can be sufficient for FDD CSI evaluation in Rel-17.* Frequency Range

Since Item 4b mainly targets at FDD FR1, 2.1 GHz can be considered with a duplexing distance of 200 MHz in the evaluation methodology. For example, China Telecom, the frequency range 2110MHz ~ 2130MHz is allocated for downlink, and the frequency range 1920MHz ~ 1940MHz is allocated for uplink. For China Unicom, the frequency range 2130MHz ~ 2155MHz is allocated for downlink, and the frequency range 1940MHz ~ 1965MHz is allocated for uplink. Moreover, China Telecom and China Unicom have agreed to share the spectrum of 2.1GHz and co-build 5G network for all customers from both China Telecom and China Unicom so that total 45MHz bandwidth (the frequency range 2110MHz ~ 2155MHz) will be available in FR1. In the future, another 5MHz bandwidth for DL may be distributed as well for co-building from adjacent 10MHz (e.g. 2155MHz ~ 2165MHz), which enables total 50MHz bandwidth to be shared. * Simulation bandwidth and BS Tx power

Many operators have a 20MHz BW, or even a 50MHz BW, for NR FDD deployment, including DOCOMO, China Telecom, China Unicom. So we prefer to consider both 20MHz and 50MHz BW with associated BS Tx power 44dBm/ 48dBm BS Tx power as the baseline. * UL sounding model based on SRS

CSI acquisition based on UL channel may be worth considering a certain channel estimation error related to SRS configuration, e.g. SRS periodicity 10ms and SRS error Modelling in Table A.1-2 in 36.897 can be sufficient or considered as the starting point of further discussion. * Baseline for performance evaluation

Since Item 4b is for Type II port selection codebook enhancement (based on Rel.15/16 Type II port selection), the baseline for performance evaluation in Rel-17 shall be revised accordingly. To be consistent with previous releases with a fair comparison, in our view, it is preferred to use Rel-16 port-selection eTypeII codebook as the baseline. (Type I Codebook can be considered at least for performance evaluation)[1] IST-4-027756 WINNER II D1.1.2 v1.2 WINNER II channel models |
| Apple | Y | FDD partial channel reciprocity modeling related needs to be discussed, as well as MSE modeling for SRS |
| CATT | Y | Most of SLS assumptions for Rel-16 Type II codebook could be reused, with the following additions.* Baseline for performance comparison
* SRS configuration (SRS BW, SRS frequency granularity, SRS period)
* Channel modeling (e.g. whether according to the FDD reciprocity model in 36.897 or 38. 901)
 |
| Ericsson | Y | **Item 4a SLS** Most of the SLS assumptions to evaluate M-TRP CSI can be inherited from Rel-16 M-TRP evaluation assumptions.**Item 4b SLS** **DL carrier/duplexing distance/SCS.** We have no strong opinion for evaluation purpose, however for the defined FDD band n1 for example (UL: 1920-1980 MHz, DL: 2110-2170 MHz), the duplex distance is 190 MHz, thus having a duplexing distance of 200 MHz is appropriate if 2GHz carrier frequency is used. If 4 GHz is selected, then 30 kHz SCS can be used, for 2 GHz, 15 kHz can be used. **Channel model.** We prefer the reciprocity model from 36.897 as it is more tailored for DL-UL reciprocity evaluations, while the reciprocity model in 38.901 is more general for multi-frequency evaluations (i.e . CA) where the duplexing distance could be much larger than what is used here for this evaluation. It is noted that 38.901 is inconsistent by saying that angles and delays are the same for all frequencies while the corresponding spreads are frequency dependent. **Antenna setup and port layouts at gNB.** Baseline options. Companies to report which option(s) are used between- (8,8,2,1,1,2,8), (dH,dV) = (0.5, 0.8)λ - (8,4,2,1,1,2,4), (dH,dV) = (0.5, 0.8)λOther configurations for antenna arrays are not precluded. Companies also describe the used down-tilt, e.g. 100 degrees.**Simulation bandwidth.** It is noted that choosing 10 MHz will only give 100 ns delay resolution. It could be difficult to resolve taps in delay domain with this resolution, better to use 40 MHz as the baseline. **MIMO scheme.** “MU-MIMO is enabled”. Companies can report actual fraction of SU and MU MIMO scheduling in their results. **CSI feedback.** Periodic CSI can be used for simplicity. Note that using a periodicity for CSI is a simplification in the simulator, it does not mean we are targeting enhancements using periodic CSI feedback only. **UL channel estimation error model.** The UL channel estimation can be up to company to decide, while what estimator/error model is used need to be disclosed when presenting results. SRS error model in Table A.1-2 of TR 36.897 can be used. **DL channel estimation error model.** The DL channel estimation (on CSI-RS and PDSCH DMRS) can be up to company to decide, while what estimator/error model is used need to be disclosed when presenting results. **UL/DL reciprocity error model** should be provided by each company. **Overhead.**  DL overhead needs to be considered when calculating the throughput, e.g. the overhead due to CSI-RS resource utilization (#ports) and periodicity should be reflected in the DL throughput**Traffic model load.**  20/50/70% (or the highest load before system is unstable). Full buffer, if used, can only be used for calibration purpose, it cannot be used for decision making and evaluation of schemes. **PAPR issue** for beamformed CSI-RS (since all CSI-RS ports pass through all PAs (for a given polarization)), the impact needs to be considered for realistic assumptions, see companies reported evaluation results on CSI-RS PAPR in R1-1811894. A power backoff/coverage loss of X dB for the CSI-RS transmission can be applied to model the effect where from R1-1811894, we can assume this value of X depending on how many CDM groups the configured CSI-RS resource use in an OFDM symbol (assuming no FDM with data)* + X= 0 dB for 1 CDM group/symbol (no PAPR issue)
	+ X= 2 dB for 2 CDM groups/symbol
	+ X= 4 dB for 3 CDM groups/symbol
	+ X=6 dB for 4 CDM groups/symbol
 |
| LG | Y | Most of SLS assumptions for Rel-16 mTRP and CSI enhancement can be reused. And the followings can be discussed for the additional aspects for Rel-17 Type II port selection codebook enhancement, e.g., modeling of FDD reciprocity, SRS configuration, and the CSI acquisition based on the SRS configuration, etc. |
| Lenovo, Motorola Mobility | Y | **CSI for mTRP:**- SLS are used for performance evaluation, similar to Rel. 16 mTRP enhancements- Discuss deployment scenarios to be considered (one indoor & one outdoor scenario) - Discuss CSI feedback error/delay modeling and inter-cell interference measurement**CSI under FDD Reciprocity:**- SLS are used for performance evaluation, similar to Rel. 15/16 CSI feedback WIs- Multi-frequency channel correlation modeling in TR 38.901 is used for deriving UL channel estimates from the DL channel- UL and DL channel estimation delays/errors are both modeled- FR1 is assumed with different duplexing distances, e.g., 50, 200 MHz |
| FUTUREWEI | Y | For mTRP CSI evaluation, reuse R16 EVM as much as possible.For Type II port selection codebook enhancement* SLS with R16 enhanced Type II port selection codebook as baseline.
* Assumptions for FDD channel reciprocity can use model from TR 36.897.
* Assumptions for SRS channel estimation can use SRS error model in TR 36.897.
 |
| CMCC | Y | Item 4a:Most of the SLS assumptions to evaluate M-TRP CSI can be inherited from Rel-16 M-TRP evaluation assumptions. |
| vivo | Y | Item 4a:SLS assumption for MTRP CSI* Deployment scenarios
* Reuse Rel-16 MTRP assumption
* Consider both non-ideal backhaul and ideal backhaul
* Consider both FR1 and FR2
* FR2 can be evaluated with MTRP beam enhancement
* IMR and CMR assumptions for NC-JT
* Dynamic switching between NC-JT and DPS

LLS is used for CSI enhancement in HST scenario* Reuse the model same as Item 2d, or can be evaluated in Item 2d.

Item 4b:SLS assumption for FDD partial reciprocity* UL/DL reciprocity modeling based on TR 36.897
* Numerology
* Carrier frequency for downlink and uplink is 2.1GHz and 2.3GHz respectively
* SCS: 15KHz/30KHz for both downlink and uplink
* Bandwidth: 10MHz/20MHz for downlink
* SRS assumptions
* SRS BW and density
* SRS estimation error modeling
* Misaligned RX timing assumption between UE and gNB
 |
| OPPO | Y | * For 4a，SLS can reuse Rel-16 EVM
* For 4b, eType II port selection codebook is used as baseline. Rel16 CSI enhancement simulation assumption can be reused. FDD reciprocity model in TR 36.897 can be used.
 |

1. Phase 2
	1. Summary: observation and proposal

The following observation can be drawn from ...

* 1. Compilation of companies’ views

Please ...