**3GPP T****SG-RAN WG4 Meeting #113 R4-2419607**

**Orlando, Florida, USA, 18th – 22nd November, 2024**

**Agenda item:** 7.14.3

**Source:** Moderator (Nokia)

**Title:**  Topic summary for [113][320] NR\_SCM

**Document for:** Information

# Introduction

This document summarises the contributions for FS\_NR\_demod\_SCM (also known as NR\_SCM) under AI 6.14 at RAN4#113.

FS\_NR\_demod\_SCM was agreed at RAN Plenary, with the SID being under [RP-241610](https://www.3gpp.org/ftp/meetings_3gpp_sync/ran/Docs/RP-241610.zip).

This topic was introduced in RAN4 demodulation at RAN4#112 with a completion by RAN#108 in June 2025.

The proposals from the contributions are grouped into the following topics:

* Topic #1: General
  + Sub-topic 1-1: Technical Report Aspects
  + Sub-topic 1-2: Work Plan
* Topic #2: Spatial Channel Modelling Methodology
  + Sub-topic 2-1: Common for all Methodologies
  + Sub-topic 2-2: TDL Based Methodologies
  + Sub-topic 2-3: CDL Based Methodologies
  + Sub-topic 2-4: Comparison of methodologies
  + Sub-topic 2-5 Requirements and Other

# Topic #1: General

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Source | Proposals / Observations |
| [**R4-2417556**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417556.zip) | Nokia | **Observation 1:** During RAN4#112-bis significant progress was achieved on SU-MIMO scenarios, with some further down-selection required at RAN4#113  **Observation 2:** During RAN4#112-bis significant progress was achieved on spatial channel modelling methodologies, however there are several open issues.  **Proposal 1: RAN4 shall aim to consolidate the options presented for a SCM following RAN4#112-bis**  **Proposal 2: RAN4 shall attempt to finalise the SU-MIMO cases during RAN4#113**  **Proposal 3: RAN4 shall make reasonable progress on MU-MIMO cases during RAN4#113**  **Proposal 4: RAN4 shall carefully consider the extant TR Skeleton for 38.753 and whether further clauses are required.**  **Proposal 5: RAN4 shall agree a work split during RAN4#113 for drafting Text Proposals for TR 38.753 once the clauses are stable.** |
| [**R4-2419251**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419251.zip) | Ericsson | **Proposal 1 RAN4 could consider following section content for Chapter 5, 6, 7 of TR38.753 as starting point.**  • Chapter 5 Spatial Channel Modeling Approaches  o CDL model in 901  o CDL model derivation in 38.827  o TDL model with dual-beamsteering method  o TDL model with per-tap correlation method  • Chapter 6 Comparison of Spatial Channel Models  o SU-MIMO 8Tx8Rx PDSCH  - Simulation comparison  • Parameters per channel model approaches  • Comparison aspects  o Antenna configurations  o BF implementations  o Performance curves  o Etc.  • Observations  - Testability comparison  • Equipment  • Feasibility and repeatability  • Observations   * SU-MIMO PMI   • Chapter 7 Alignment of Spatial Channel Models   * Example: agreed CDL model approach   • Scalable deterministic CDL model  • Angle relevant parameters configurations.  • Channel model profile.  • Alignment simulation results collection   * Specific CDL model for a test case   • Other parameters configurations  • Channel model profile.  • Alignment simulation results collection |
| [**R4-2419338**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419338.zip) | BT plc, Ericsson | **Observation 1:** MIMO radio channels for stationary UE in typical deployments exhibit multiple long-term stable spatial directions of arrivals.  *This document also includes results of experimentation showing the impacts of a spatial channel.* |

## Open issues summary

### Sub-topic 1-1: Technical Report Aspects

#### Issue 1-1-1: Content of Technical Report 38.753

Proposals:

* Options: RAN4 consider the following content to be included in the TR
* Option 1 *(Ericsson)*

|  |
| --- |
| Chapter 5 Spatial Channel Modeling Approaches  o CDL model in 901  o CDL model derivation in 38.827  o TDL model with dual-beamsteering method  o TDL model with per-tap correlation method  Chapter 6 Comparison of Spatial Channel Models  o SU-MIMO 8Tx8Rx PDSCH  - Simulation comparison  • Parameters per channel model approaches  • Comparison aspects  o Antenna configurations  o BF implementations  o Performance curves  o Etc.  • Observations  - Testability comparison  • Equipment  • Feasibility and repeatability  • Observations  o SU-MIMO PMI  Chapter 7 Alignment of Spatial Channel Models  o Example: agreed CDL model approach  • Scalable deterministic CDL model  • Angle relevant parameters configurations.  • Channel model profile.  • Alignment simulation results collection  o Specific CDL model for a test case  • Other parameters configurations  • Channel model profile.  • Alignment simulation results collection |

* Option 2 *(Nokia)*
  + Option 2a: RAN4 shall carefully consider the extant TR Skeleton for TR38.753 and whether further clauses are required.
  + Option 2b: RAN4 shall agree a work split during RAN4#113 for drafting Text Proposals for TR 38.753 once the clauses are stable.

Recommended WF:

* For discussion at meeting regarding the content of the TR, noting an aim according to the work plan to agree a work split during RAN4#113.

### Sub-topic 1-2: Work Plan

#### Issue 1-2-1: Work Plan

Proposals:

* RAN4 shall aim to consolidate the options presented for a SCM following RAN4#112-bis *(Nokia)*
* RAN4 shall attempt to finalise the SU-MIMO cases during RAN4#113 *(Nokia)*
* RAN4 shall make reasonable progress on MU-MIMO cases during RAN4#113 *(Nokia)*

Recommended WF:

* There is no need to explicitly discuss these during the meeting, but all delegates are reminded to consider these in order to make good progress against the work plan.

# Topic #2: Spatial Channel Modelling Methodology

## Companies’ contributions summary

| T-doc number | Source | Proposals / Observations |
| --- | --- | --- |
| [**R4-2417801**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417801.zip) | MediaTek inc. | **Observation #1:** 8-layer demodulation with random precoding and LMMSE MIMO demodulation is challenging and not feasible for all evaluated CDL-C UMa AAV cases.  **Proposal #1: Instead of random precoding, we propose using a carefully chosen fixed precoder for 8-layer PDSCH demodulation testing in CDL channels.**  **Observation #2:** For 4L and 8L MIMO, R-ML demodulation can provide significant performance gains compared to LMMSE demodulation.  **Proposal #2: We propose that companies employ strictly LMMSE MIMO demodulation to enable alignment of the results.**  **Proposal #3: We propose RAN4 to consider the option of *multi-cluster TX-RX beam steering* with TDL model for spatial channel modelling as a much simpler and controllable choice than CDL.**  **Proposal #4: We propose to focus on SU-MIMO first but discuss potential MU-MIMO scenarios for study.**  **Observation #3:** CDL-C UMa with AAV via fixed TX-BF as specified in TR38.827, provides only modest gains for Type1/eType2 follow-PMI when compared to random precoding.  **Proposal #5: We propose that AAV via fixed TX-BF as specified in TR38.827 is not used for follow-PMI testing.**  **Observation #4:** CDL-C UMa without AAV, provides significant gains for both Type1 and eType2 follow-PMI when compared to random precoding.  **Proposal #6: We propose to consider no AAV for follow-PMI testing in CDL channels.**  **Observation #5:** eType2 precoding provides tput gain over Type1 precoding only when the UE speed (Doppler) is low, and only when the rank is low (2).  **Proposal #7: We propose that eType2 follow PMI testing should concentrate to low UE speed or Doppler, and rank 2.**  **Observation #6:** Simple multi-cluster TX-RX beam steering with TDL-C channel is well feasible for both Type1 and eType2 follow-PMI testing.  **Proposal #8: The upcoming TR should provide self-contained and focused descriptions of the agreed channel models.**  **Observation #7:** With different AAV TX beamforming options, the average power response of the CDL-C UMa FR1 is not equal to one.  **Proposal #9: Depending on each AAV and spatial CDL channel combination, a numerical transmit beamformer power normalization factor should be specified to ensure unit power response.**  **Observation #8:** There is a risk that the fading processes between the sub-clusters become correlated unless ray-splitting is performed.  **Proposal #10: To avoid inter-cluster correlation, RAN4 companies should make sure they are performing ray-splitting for the sub-clusters as specified by TR 38.827 and TR 38.901.**  **Proposal #11: We propose to use BS radiation pattern as defined in TR38.901 Table 7.3-1.**  **Proposal #12: We propose to use Omnidirectional antennas for UE.**  **Proposal #13: We propose to focus on 3.5GHz carrier frequency first but check other frequencies in the end of feasibility study.**  **Proposal #14: We propose to further evaluate the method for time variant beam directions in CDL model.**  **Proposal #15: We propose to evaluate proposed channel models in lower and higher doppler conditions.**  **Proposal #16: We propose to use BS (α, β, γ) = (0°, 0°, 0°).**  **Proposal #17: We are also fine with (α, β, γ) = (0°, 10°, 0°).**  **Proposal #18: We propose to use BS polarization slant = (45°, -45°).**  **Proposal #19: We propose to use UE (α, β, γ) = (180°, 0°, 0°).**  **Proposal #20: We propose to use UE polarization slant = (0°, 90°).**  **Proposal #21: We propose to use broadside antenna virtualizer.** |
| [**R4-2417802**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417802.zip) | MediaTek inc. | *Simulation Results* |
| [**R4-2417827**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417827.zip) | CATT | **Observation 1:** Define the radiation power pattern of a single antenna element for spatial filtering for TDL model extensions.  **Observation 2:** Use method in sub-clause 7.7.5.2 of TR 38.901 to generate correlation matrix for TDL model extensions.  **Observation 3:** For the purposes of CDL alignment, the isotropic pattern can be considered for aligning the parameters other than antenna element pattern.  **Observation 4:** Basic CDL channel model can be defined and used for all carrier frequencies/bands in given frequency range by scaling delays and angles.  **Proposal 1: Adopt Option 1 for generation of Angles of Arrival.**  Proposals:   * Option 1: Replace the mean angle  in the last position of departure and arrival angles generated equation by the desired angle as  . |
| [**R4-2418028**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418028.zip) | Qualcomm Incorporated | **Proposal 1: RAN4 to prioritize SU-MIMO PDSCH results collection and alignment with the agreed initial configuration for the purpose of SCM study and alignment. Baseline agreements for the configurations with Single User PMI and Multi-User MIMO can be postponed and reviewed once the PDSCH results are available and reviewed.**  **Proposal 2: RAN4 to agree on the following definition for an Antenna Subarray: One subarray is a unique set of co-polarized antenna elements mapped exclusively to one CSI-RS Port through a virtualizer (vector of complex values).**  **Proposal 3: RAN4 to capture the description below in the TR: The BS antenna panel is composed by antenna elements arranged in columns and rows, single or dual polarized, and can be split in subarrays. One subarray is a unique set of co-polarized antenna elements mapped exclusively to one CSI-RS Port through a virtualizer (vector of complex values).**  **The BS antenna panel configuration is defined as (M,N,P,Ms,Ns), according to the description below:**   * **M is the number of antenna elements with the same polarization in each column (vertical size)** * **N is the number of antenna elements with the same polarization in each row (horizontal size)** * **P is the number of polarizations** * **Ms is the number of Subarray Elements with the same polarization in each column (vertical size)** * **Ns is the number of Subarray Elements with the same polarization in each row (horizontal size)**   **Observation 1:** Existing methodology for Channel Modelling based on 38.901 in RAN4 is based on a simplified procedure to reduce the number of channel taps to a maximum of 12 taps for 5ns resolution or 16 taps for 2ns resolution.  **Proposal 4: RAN4 to discuss whether the existing simplification procedure in 38.901 Annex B.2.1 is applicable to SCM, and if not how to extend the existing simplification methodology to reduce the number of channel taps for CDL channels based on 38.901.**  **Proposal 5: Support the radiation power pattern defined in 38.901 Table 7.3-1 to be used for Antenna Element Pattern at the BS;**  **Proposal 6: RAN4 to agree that the UE applies no virtualizer at the RX and that each Antenna Elements (omnidirectional as per previous agreements) is connected exclusively with one RX Chain;**  **Proposal 7: For the gNB, use the following parameters for alignment with UMa CDL-C model:**   * **GCS Location Coordinates for the gNB:**    + **Height = 25 m**   + **Azimuth = 0 (placement on the x axis)**   + **X Coordinate = 0 m** * **GCS to LCS Conversion angles ( = bearing, downtilt, panel slant) for the gNB:**   + **Polarization Slant:**   **Proposal 8: For the UE, use the following parameters for alignment with UMa CDL-C model:**   * **GCS Location Coordinates for the UE:**    + **Height = 1.5 m;**   + **Azimuth = 0; (placement on the x axis);**   + **X Coordinate = 100 m; (Distance from gNB = 100 m);** * **GCS to LCS Conversion angles ( = bearing, downtilt, panel slant) for the UE:**   + **Polarization Slant:**   **Proposal 9: For the purpose of received signal power normalization and SNR definition, RAN4 to consider capturing in the TR the following understanding: Assuming constant total received signal power summed across all RX RF Chain, the sum of Signal Power across all TX Beams is normalized using the spatially filtered long-term average PDP.**  **Proposal 10: RAN4 should capture the detailed SCM approach used to generate simulation results for alignment in the TR according to one of the following options:**   * **Option 1: Copy/paste of the relevant portions of 38.827 and/or 38.901, adding extensions for RAN4 Demod Usage;** * **Option 2: (Self Contained?) Rewrite of the “randomness reduction” changes from 38.827, specific to RAN4 Demod Usage;** * **Option 3: (Self Contained) rewrite of the relevant portions of TR 38.901 including 38.827 Changes, specific to RAN4 Demod;** |
| [**R4-2418042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418042.zip) | Keysight Technologies UK Ltd | ***Observation 1:*** *There will be no correlation between subclusters for CDL based methodologies. Hence, there is no need to define mechanisms to avoid it.*  ***Proposal 1: Discussion on potential correlation between subclusters and the definition of mechanisms to avoid it for Rel-19 Demodulation spatial Channel model work item can be closed now. No action is required.*** |
| [**R4-2418043**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418043.zip) | Nokia | Chapter === CDL based SCM  == Virtualizers   1. Antenna Array Virtualisation defines the connections and weights between BB/RF ports (e.g., CSI-RS or SRS ports) and antenna elements of an antenna array or panel. 2. Both fully and partially connected virtualizer have precedence in TR 38.901 and TR 38.827.   == Precoder selection and DoA for 827 CDL  In 38.827 CDL the precoding vector selection impacts the spatial properties of the RE-domain channel matrix seen at the receiver, i.e., changing the precoding direction of a layer, changes its receive direction.  == Numerical stability for 827 CDL  Initial random seeds have a negligible impact on the TPUT performance scaling of 837 CDL.  Redrawing scalar random initial phase terms does have a systematic impact on 827 CDL, that reduces with less redraw frequency (not redrawing for 1000 slots starts to be fine).  == Spatially consistent MU extension for 827 (and 901) CDL   1. RAN4 to consider how SCM candidates can be modified to allow separately, but spatially consistently, correlated channels for different AODs, AOAs and ZODs corresponding to different multiple UEs.   Chapter === CDL comparisons and observations  == SU PDSCH  = Baseline: 2CW  For 2CW features, only 827 CDL can create the expected inter-CW performance difference at feasible SNR levels, which is needed to fully test a 2CW SDM receiver and correctly model performance scaling in deployment.  It is feasible to make a fixed PMI choice based on the most frequently chosen follow\_PMI under a given channel model.  All three evaluated virtualizer options (827 AAV, mech. downtilt AAV, no AAV) show the expected impact of a large-scale environment, with 827 AAV having the largest testable range/least SNR requirements, followed by no AAV at +6dB and downtilt AAV at +12dB.  Any SNR budget gains cannot stem from exploiting the gain of strong channel directions, as the RAN4 SNR definition normalizes average receive branch power, so SNR budget gains arise from the channel model (a) providing spatially diverse environments that the SDM receiver can efficiently equalize, and (b) providing a less uneven per layer signal quality.  For SU TPUT use cases, legacy TDL channel model-based demodulation performance requirements are neither fit to test receiver functionality, nor fit to set a stable minimum performance requirement. Functionally differing SDM receiver implementation show same performance under legacy TDL channel requirements, but SCMs with spatially typical properties (in this case 827 CDL) can meaningfully differentiate between implementations, even under random precoding.  == SU PMI  = Additional: PMI profiles  The capacity optimal TypeI PMI choice is random in TDL low, fixed to broadsight in TDL+antCorr, and following defined and stable strong directions in CDL. Thus, only SCM model-based requirements can provide evidence for correct algorithmic function and set reasonable minimum performance expectations.  It is possible to derive a reasonable fixed precoder setting for all tested channel models, by choosing the most frequent choice of the follow\_PMI histogram for each channel model.  = Baseline: 4Rx and 2/4 layer  For SU PMI requirements, both 827 CDL with and without fully connected AAV are feasible.  = Additional: eTypeI vs. eTypeII  In legacy TDL channel models TypeI and eTypeII PMI feedback performs nearly identical, raising serious concerns whether such performance requirements are reasonable from an implementation correctness pov and from the perspective of absolute values for performance requirements. Performance requirements based on CDL channels behave as expected.  == MU PDSCH  = Background: SU SDM reduces inter-UE interference in SCM  SU SDM receivers used in MU systems, indirectly reduce inter-UE interference coming from directions that are not aligned with the signal DoA.  = Baseline: 2+2 layers with IRC, E-IRC, and R-ML  For single cell MU TPUT is it expected that SU and MU MMSE perform about equally well in typical co-scheduling scenarios, and the R-ML to linear receiver gap is within a reasonable margin.  If a SCM was used in Rel-18 advanced receivers instead of TDL, RAN4 would not have needed to spend a lot of time unnecessarily analyzing and debating SU vs. MU MMSE in DL.  Using 827 CDL in MU TPUT scenarios significantly reduces SNR requirements for all advanced receivers and allows to introduce non-orthogonal precoder requirements, even for non-R-ML requirements.  == MU PMI  = MU interference mitigation via PMI choice  There are some environments, where the PMI selection algorithm shall take spatial information about interference via DM-RS and/or CSI-RS into account to achieve reasonable performance. The link between interference and PMI selection is given by the SDM receiver spatial selectivity towards signal arrival directions that are influenced by PMI selection in SCMs.  Chapter === Spatial Channel Modelling Methodology  == Common for all Methodologies  = Test cases for SU-MIMO   1. RAN4 shall allow each contributor to make a fixed PMI choice based on the most frequently chosen follow\_PMI under a given channel model. 2. RAN4 to agree one common PMI choice for each channel model and configuration, with the following starting point for discussion: - 8T8R-8Layer CDLC Uma 365-100 with 827 virtualizer: (i1\_1=6, i1\_2=0, i2=0) - 8T8R-8Layer CDLC Uma 365-100 no AAV: (i1\_1=6, i1\_2=0, i2=0) - 4T4R-4Layer CDLC Uma 365-100 with 827 virtualizer: (i1\_1=2, i1\_2=0, i2=0) - 4T4R-4Layer CDLC Uma 365-100 no AAV: (i1\_1=2, i1\_2=0, i2=0) 3. RAN4 to use TR 38.833 IRC as reference receiver with a common fixed precoder, to align SCM candidate implementations in. Different additional, and potentially undisclosed, receiver implementations to be useable in comparison test cases. 4. Request results for 4Rx / 4layer case with fixed precoding, to allow for receiver performance scaling to be evaluated without dependency on the PMI selection algorithm or the KPI equalizing effort of random precoding. 5. RAN4 to discuss whether random vs. follow PMI TPUT should overlap for low rank cases in a SCM, and how the gap is expected to scale with different numbers of layers and Rx branches. 6. RAN4 shall capture all comparison cases results (from all contributors and with respect to all legacy and SCM candidates) in the TR, to allow for evaluation of fitness for purpose of the channel models.   = Test cases for MU-MIMO   1. RAN4 to necessarily include MU SDM receiver algorithms in the comparison test cases and their evaluation, e.g., E-IRC and R-ML. PMI choices as in SU PMI. 2. RAN4 to include comparison cases for eTypeI vs. eTypeII in a MU PMI setup, at least for single cell MU. 3. RAN4 to aim to bring initial multi cell MU PMI results in RAN4#114. 4. RAN4 shall capture all comparison cases results (from all contributors and with respect to all legacy and SCM candidates) in the TR, to allow for evaluation of fitness for purpose of the channel models.   == CDL Based Methodologies   1. RAN4 to set CDL transmitter and receiver antenna related configuration as follows: BS  (α,β,γ = 0, 10, 0),   I.e., intent of 10deg mechanical rotation around the y-axis, downtilted with respect to the horizon, resulting in θ\_BS=100° and ϕ\_BS=0°.  Polarization slant (+45, -45).  AE radiation pattern from 38.901 Table 7.3-1  Informative: BS height is assumed 25m and d\_2D=100m. UE  (α,β,γ = 180, 0, 0),   I.e., intent is pointing towards BS along x-axis with no tilt, resulting in θ\_UE=90° and ϕ\_UE=180°.  Polarization slant (0, 90).  AE radiation pattern omnidirectional  Informative: UE height is assumed 1.5m and d\_2D=100m. 2. RAN4 to use “Max Receive Power” for standard 827 fully connected BS Antenna Virtualizers, and to use “Broadside” for 827 partially connected BS Antenna Virtualizers with 10 degrees of mechanical downtilt. 3. All CDL based approaches to use the 827 randomness reduction framework, i.e., small scale fading changes, fixed subpaths, weak clusters, etc.   == Comparison of methodologies   1. RAN4 to focus on the following SCM candidates (a) CDL (as defined in R4-2415283) with AAV using subarray configuration (partially connected with broadside steering+mechanical tilt),  (b) CDL (as defined in R4-2415283), i.e., with AAV without subarray (fully connected), and  (c) CDL (as defined in R4-2415283) without AAV. 2. RAN4 to consider expected SNR levels for selection of virtualizer, and hence to give priority to the 827 fully connected AAV. |
| [**R4-2418044**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418044.zip) | Nokia | *Simulation Results* |
| [**R4-2418550**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418550.zip) | Apple | **General aspects**   1. The best PMI would depend on the channel realization and is feasible to determine only in static channel without running 2 sets of simulations. 2. Finding a fixed precoder for CDL or TDL channel to align across all companies is not practical.   **Proposal #1: RAN4 employ random precoder for PDSCH TPut test cases for alignment and comparison study of different channel modeling methodologies.**   1. UE processing is tested sufficiently for cancelling inter-user interference in MU-MIMO scenarios with TDL channel model.   **Proposal #2: Further justification is needed for considering MU-MIMO for the study.**  **Proposal #3: In case MU-MIMO is agreed the test setup is limited with what RAN4 has used so far – single UE with random PMI for target UE.**  **Proposal #4: In case MU-MIMO is agreed the test setup shall not include PMI feedback and/or multiple UEs.**  **Proposal #5: If determined as necessary and feasible to introduce spatial channel model, RAN4 shall not define any new requirements with it in Rel-19 – for either Rel-19 WIs or earlier WIs.**  **TDL based methodologies**  **Proposal #6: RAN4 to also consider spatially filtered TDL channel models described in 38.901 in the study.**   1. Multi-cluster TX RX beam steering over TDL might be limited in modeling the spatial properties as observed. 2. Introducing per-tap correlation for TDL channel could be a feasible approach for TDL based methodology.   **CDL based methodologies**   1. Assuming directional antenna for BS might be practical and more relevant to this study.   **Proposal #7: Assume directional antenna with radiation pattern in 38.901 for CDL channel.**   1. The CDL channel models in the TR 38.827 are defined for specific scenarios, carrier frequency, with some assumptions of RMS delay spread and UE velocity.   **Proposal #8: RAN4 to study if the same channel model can be defined for all carrier frequencies/ bands in given frequency range – example FR1/ FR2.**  **Proposal #9: Use the ray to sub-cluster mapping in Table 7.5-5 of TS38.901 in UMa-CDL-C channel generation to avoid potential correlation between sub-clusters.**  **Proposal #10: Replace the mean angle  in the last position of departure and arrival angles generated equation by the desired angle as .**  **Proposal #11: Set based on the LOS direction between the TX and RX.**  **Proposal #12: BS and UE panels are in the Y-Z plane with the following parameters: Height of BS: 25m LCS to GCS for BS: α,β,γ=(0,10,0); Height of UE: 1.5 m LCS to GCS for UE: α,β,γ=(180,0,0);**  **Proposal #13: For BS antenna configurations with AAV use max receive power based BS antenna virtualizer.**   1. When there is no AAV and #TX ports= BS antenna elements, we don’t need 5-argument notation. 3-arg notation (M,N,P) is sufficient. 2. The 5-argument notation can be used for AAV without sub-array.   **Proposal #14: Use 3-argument notation of (M,N,P) for no AAV configuration.**  **Proposal #15: Use 5-argument notation of (M,N,P,Ms,Ns) for AAV with no sub-array config where Ms=M, Ns=N.**  **Proposal #16: RAN4 to study if the CDL channel models can be simplified to smaller number of clusters.**  **Comparison of methodologies**  **Proposal #17: RAN4 to discuss test metrics to compare the methodologies that help identify limitations in the current methodology that impacts MIMO performance.** |
| [**R4-2418620**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418620.zip) | Samsung | **Proposal 1: For CDL evaluation, prioritize the simulation assumption/results alignment of SU-MIMO scenario alignment and defer MU-MIMO scenario.**  **Observation 1:** CDL model introduces the correlation cofficient for polarizations between BS and UE side as , while TDLC with ULA Low, which neither include the correlations between polarizations nor the correlation coefficients for different layers (identity matrixs), is an unreasonable and unfair comparison object.  **Proposal 2: Prefer to use TDLC X-pol medium correlation as the comparison object for CDL performance comparision.**  **Observation 2:** Multi-cluster TX-RX beam steering with TDL model method could also achieve the target for introducing spatial property, which is easier than CDL model since no antenna patterns and antenna combining weight needed.  **Proposal 3: For BS antenna configuration, select cross Pol with +/- 450 polarization in order to promise both polarizations could receive signals successfully at UE side.**  **Proposal 4: For BS antenna configuration, the directional radiation power pattern per antenna element defined in 38.901 Table 7.3-1 should be used.**  **Observation 3:** Only one set of initial phases which indicating the correlation introduced by polarization are applied for each cluster in 38.827.  **Observation 4:** The technical effects of current departure and arrival angles generation equation in 38.827 is only scaling the ray offsets in addition to the mean angle of the original channel model table, the final scaled angle are still fixed due to fluctuating around the mean angle instead of desired angles.  **Proposal 5: Replace the mean angle  in the last position of departure and arrival angles generated equation by the desired angle as**  **Proposal 6: CDL based link level simulation should focus on predefined and fixed beam direction, i.e., no need to introduce time varying beam direction modelling for CDL based link level simulation.**  **Proposal 7: For BS side, frequency Fc=3.5GHz, BS height=25m, BS antenna orientation (alpha = 0 degrees, beta = 0 degrees, gamma = 0 degrees) should be assumed if no mechanical down tilt introduced. BS antenna orientation (alpha = 0 degrees, beta = 10 degrees, gamma = 0 degrees) should be assumed if 10-degree mechanical down tilt introduced.**  **Observation 5:** Three typical UE antenna distributions: The first one is Azimuth uniform deployment, in which UE antenna orientation could be (alpha = 0 degrees, beta = 90 degrees, gamma = 0 degrees). The second one is the distributed on the vertical plane (y-z plane), UE antenna orientation could be described as (alpha = 0 degrees, beta = 0 degrees, gamma = 0 degrees). The third one is spherical uniform deployment, in which UE antennas uniformly distributed on the sphere, this is the most complex one.  **Observation 6:** Considering user habits nowadays, people stare at the UE screen most of the time, which means UE antennas are distributed on the horizontal plane (x-y plane).  **Proposal 8: Select UE antenna orientation as (alpha = 0 degrees, beta = 90 degrees, gamma = 0 degrees) is a reasonable choice.**  **Proposal 9: For BS antenna virtualization, DFT combing weight is reasonable, but RAN4 need to clarify how to implement “panning” in link level simulation and if it’s needed.**  **Proposal 10: RAN4 should clarify if BS antenna down tilts is applied in CDL modeling and define the values of BS antenna down tilts if any.**  **Observation 7:** The AAV rule between BS antenna elements and CSIRS/Tx ports are transparent to UEs, subject to BS algorithm design, and different AAV rules may correspond to different throughput performance. Current 38.827 defines the co-polarized antenna elements of the array are combined to a single RF port.  **Observation 8:** Current AAV rule for the mapping between antenna elements and CSIRS/Tx ports defined in 38.827 is not suitable for 4T4R and 8T8R with high rank modes.  **Proposal 11: For RAN4 demodulation and CSI reporting simulation, option C (CDL without AAV with the configuration: (M,N,P,Ms,Ns) = (1,4,2,1,1) for 8Tx CSI-RS Ports and (M,N,P,Ms,Ns) = (1,2,2,1,1) for 4Tx CSI-RS Ports) is a good choice to avoid the AAV process which seems useless for RAN4 requirements definition.**  **Proposal 12: If AAV process is introduced in RAN4 CDL model, update SNR definition accordingly which should not account the virtualization gain.** |
| [**R4-2419166**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419166.zip) | ZTE Corporation, Sanechips | ***Observation 1.*** *The cross-correlation matrix is derived from statistical analysis of real measurement data and adheres to certain statistical characteristics.*  ***Observation 2.*** *The sub-clusters can be generated from the strongest clusters with different fixed delay offset, without exhibiting any statistical characteristics.*  ***Observation 3.*** *For the electronic downtilt approach, it is only applicable to URA or ULA antenna structures. Meanwhile, the method in 827 is more general, suitable for all antenna array structures.*  ***Proposal 1. The correlation between sub-clusters does not need to be considered.***  ***Proposal 2. To consider replacing the mean angle  in the last position of departure and arrival angles generated equation by the desired angle as***  ***Proposal 3. From evaluation purpose, maybe we can consider different approaches for BS virtualization, e.g. electronic downtilt and the method in TR 38.827.***  ***Proposal 4. Both sub-array and full connection models shall be considered at least in study item.*** |
| [**R4-2419252**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419252.zip) | Ericsson | [Observation 1 The existing TDL models used for demodulation requirement use fixed Doppler shift which leads the no performance difference per center frequency.](#_Toc181977844)  [Observation 2 CDL models in 38.901 are general but hard for results alignment. CDL models in 38.827 are dependent to center frequency and not general.](#_Toc181977845)  [Observation 3 It could be possible to derive a common CDL model with partial fixed variables (angle relevant and initial random parameters) which can be applied for different frequency bands, scenarios and both DL/UL directions.](#_Toc181977846)  [Observation 4 CDL FR1 Uma model profiles in 38.827 include 10o BS down tilt.](#_Toc181977847)  [Observation 5 Once the boresight of radiation between BS and UE is aligned, it is not critical for PDSCH link level simulation that CDL channel model capture down tilt or not, but down tilt will impact PMI index report.](#_Toc181977848)  [Observation 6 Full connection without subarray virtualization method is not typical for large antenna implementation in real network.](#_Toc181977849)  [Observation 7 Larger antenna array is helpful to have better beam shape and performance for multiple layer transmission.](#_Toc181977850)  [Observation 8 All layers are transmitted by strongest beams could have relative better performance than transmitted by different beam directions.](#_Toc181977851)  [Observation 9 More subarray in a certain plane (horizontal or vertical) would be needed to support more beam direction freedom on this plane.](#_Toc181977852)  [Observation 10 Subarray virtualization could be feasible for 8 layers transmission with CDLC Uma FR1 if there are enough subarrays to steer the beam.](#_Toc181977853)  [Observation 11 Similar as subarray virtualization method, all layers transmitted by the strongest beam direction could have better performance. The propagation condition of selected beam is more dominant for performance than inter-layer interference.](#_Toc181977854)  [Observation 12 One by one CSI port to AE mapping is not feasible for 8 layers performance verification with CDL Uma FR1 model in 38.827.](#_Toc181977855)  [Observation 13 To support higher layer transmission under CDL model, the large antenna array is necessary to have large spatial freedom.](#_Toc181977856)  [Observation 14 If set all desired transmission directions along a certain plane (i.e., all strongest beams are along horizontal plane as in CDLC Uma FR1 model), more antenna element is needed (i.e., at least 16 AE for 4 beam directions) to steer the beam to expected direction.](#_Toc181977857)  Based on the discussion in the previous sections we propose the following:  [Proposal 1 RAN4 to discuss if a new scalable deterministic CDL model is necessary from demodulation perspective. Following procedures could be considered.](#_Toc181977858)  [1. Derive scalable CDL models based on 38.901 model and 38.827 method for MIMO simulation:](#_Toc181977859)  [a. Reuse relative delay and power per cluster defined in CDL models in 38.901.](#_Toc181977860)  [b. Set UE is static as 38.901.](#_Toc181977861)  [c. Assume one isotropic antenna element for both BS and UE side.](#_Toc181977862)  [d. Set desired angles, desired angel spread, coupling patterns and initial phase of polarization matrix etc., as 38.827 have done.](#_Toc181977863)  [e. Derive channel model profiles (for example, call them “CDLM-A/B/C”) which can be considered as general model for a frequency range.](#_Toc181977864)  [2. Derive specific CDL models for demodulation requirements:](#_Toc181977865)  [a. Set desired delay spread, desired UE velocity vector (Doppler shift and directions) and proper BS and UE antenna configurations according to typical feature scenario.](#_Toc181977866)  [b. Derive specific model profiles on top of scalable channel model profiles from step 1 above.](#_Toc181977867)  [Proposal 2 It could be furtherly discussed that the necessary of having different subset of models per deployment (i.e., Uma, Umi, Indoor etc.) for demodulation requirements.](#_Toc181977868)  [Proposal 3 Consider subarray virtualization method for beamforming weight generation in CDL model derivation.](#_Toc181977869)  [Proposal 4 Choose typical BS antenna configurations and subarray virtualization (1 column per subarray) to have proper beamforming weight in CDL channel model.](#_Toc181977870) |
| [**R4-2419253**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419253.zip) | Ericsson | *Simulation Results* |
| [**R4-2419347**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419347.zip) | BT plc | *Simulation Results* |
| [**R4-2419403**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419403.zip) | Huawei, HiSilicon | Proposal 1: RAN4 shall preclude MU-MIMO test cases and only focus on SU-MIMO PDSCH and PMI test cases. For PDSCH cases, use random PMI rather than fixed PMI.  Proposal 2: RAN4 shall confirm simulation alignment as one of metric to justify the feasibility of new channel model  Proposal 3: To compare the channel models, the metric of PDSCH cases could be throughput or condition number, i.e, ratio of the absolute value of the maximum eigenvalue to the absolute value of the minimum eigenvalue of the channel. The metric of PMI cases could be reused from PMI test cases.  Proposal 4: RAN4 to introduce enhanced TDL channel with multi-beams as one of candidate solutions for R19 SCM.  Proposal 5: RAN4 to use CDL channel generation procedure defined in 38.827.  Observation 1: CDL-UMa-C in 38.827 is that the CDL parameter table is defined as band specific, e,g, parameters in CDL-UMa-C are based on 3.5GHz carrier frequency, which conflict with the tradition that requirements are defined as band agnostic.  Proposal 6: RAN4 to use CDL parameters table defined in 38.901 for study.  Observation 2: Beamforming changes receiving signal power but doesn’t change actual SNR since 38.101-4 defines SNR at receiving side.  Proposal 7: RAN4 to evaluate the performance of fixed array, fixed subarray and without AAV and preclude the full connected with beamforming,  Proposal 8: RAN4 shall specify the parameters of conversion from GCS to LCS. I.e. alpha, Beta and Gama and BS/UE antenna element coordinate in the LCS.  Proposal 9: If RAN4 agrees to use CDL parameters table defined in 38.901, RAN4 to configure for BS side and for UE side. I.e. UE and BS are facing to each other with same height.  Proposal 10: If RAN4 agrees to use CDL parameters table defined in 38.901, RAN4 to configure for BS side and for UE side. I.e. UE and BS are facing to each other with BS height=25m, UE height=1.5m and D2D=100.  **Proposal 11: RAN4 to generate the time varying beam direction CDL channel by referring the procedure of scaling of angles for CDL channel defined in clause 7.7.5.1 in 38.901, the making the desired mean angle changed slot by slot.**  **Proposal 12: RAN4 to discuss how to handle the changed SNR with the beam direction changed**  Observation 3: For Rank4, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C with FixedSubArray> CDL-C withoutAAV>TDLC+Med B.  Observation 4: For Rank8, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C with FixedSubArray=CDL-C withoutAAV>TDLC+Med B.  Observation 5: For Rank4, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C with FixedSubArray> CDL-C withoutAAV>TDLC+Med B.  Observation 6: For Rank8, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C with FixedSubArray=CDL-C withoutAAV>TDLC+Med B.  Observation 7: For Rank 2, digital beamforming gain for CDL channel is not sufficient, which means PMI test is problemtic since Rank2 is always used for legacy PMI test.  Observation 8: For Rank4, the digital beamforming gain is sufficient for CDL channel, legacy TDLC XPL High channel can’t work. However, with enhanced TDLC363-5 with 2beams, the Digital beamforming gain is quite higher than CDL channel. |

## Open issues summary

### Sub-topic 2-1: Common for all Methodologies

#### Issue 2-1-1: Cases for SU-MIMO

Previous agreements from the WF of RAN4#112-bis:

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| --- |
| **Agreement:**  Single-User PDSCH:  8Rx: 8 Layer, MCS 13 on both codewords (Table 1) (type I codebook) – PMI Choice (FFS Fixed, Random) *Companies encouraged to bring Fixed PMI choice to next meeting*  (*FFS Whether it is already covered in PMI*) 4Rx: 4 Layer, MCS 13 (Table 1) (type I codebook) – PMI Choice (FFS Fixed, Random) *Companies encouraged to bring Fixed PMI choice to next meeting*  4 CSI-RS Ports (2,1) for 4 Layer  8 CSI-RS Ports (4,1) for 8 Layer  Single-User PMI  4Rx: 4 Layer (type I) – Full Throughput Curves (PMI Follow, PMI Random)  4Rx: 4 Layer (eType II) – Full Throughput Curves (PMI Follow)  4Rx: 2 Layer (type I) – Full Throughput Curves (PMI Follow, PMI Random)  4Rx: 2 Layer (eType II) – Full Throughput Curves (PMI Follow)  *Interested companies can use initially 8 CSI-RS Ports, more ports can be used to identify and show relevant impacts.*  *Note: Several companies would prefer to focus on PDSCH until the modelling is stable* |

Companies Views:

*MediaTek* (from R4-2417801):

Proposal #1: Instead of random precoding, we propose using a carefully chosen fixed precoder for 8-layer PDSCH demodulation testing in CDL channels.

Proposal #7: We propose that eType2 follow PMI testing should concentrate to low UE speed or Doppler, and rank 2.

*Nokia* (from R4-2418043):

Proposal 2: RAN4 shall allow each contributor to make a fixed PMI choice based on the most frequently chosen follow\_PMI under a given channel model.

Proposal 3: RAN4 to agree one common PMI choice for each channel model and configuration, with the following starting point for discussion:

- 8T8R-8Layer CDLC Uma 365-100 with 827 virtualizer: (i1\_1=6, i1\_2=0, i2=0)

- 8T8R-8Layer CDLC Uma 365-100 no AAV: (i1\_1=6, i1\_2=0, i2=0)

- 4T4R-4Layer CDLC Uma 365-100 with 827 virtualizer: (i1\_1=2, i1\_2=0, i2=0)

- 4T4R-4Layer CDLC Uma 365-100 no AAV: (i1\_1=2, i1\_2=0, i2=0)

Proposal 5: Request results for 4Rx / 4layer case with fixed precoding, to allow for receiver performance scaling to be evaluated without dependency on the PMI selection algorithm or the KPI equalizing effort of random precoding.

Proposal 6: RAN4 to discuss whether random vs. follow PMI TPUT should overlap for low rank cases in a SCM, and how the gap is expected to scale with different numbers of layers and Rx branches.

*Apple* (from R4-2418550):

Proposal #1: RAN4 employ random precoder for PDSCH TPut test cases for alignment and comparison study of different channel modeling methodologies.

Proposals:

Keep the cases as agreed during RAN4#112-bis, the following are presented as options, specifically for PMI choice on PDSCH:

* Option 1: Employ random precoding (*Apple)*
* Option 2: Use carefully chosen precoders for 8 Layer PDSCH (*MediaTek, Nokia)*
  + Option 2a: Allow each contributor to make a fixed PMI choice based on the most frequently chosen follow\_PMI under a given channel model, using the following as a starting point for CDL-C UMa 365-100. (*Nokia)*
    - With TR 38.827 virtualiser (i1\_1=6, i1\_2=0, i2=0)
    - Without antenna virtualisation (i1\_1=6, i1\_2=0, i2=0)
* Option 3: (For 4 Layer) Allow each contributor to make a fixed PMI choice based on the most frequently chosen follow\_PMI under a given channel model, using the following as a starting point for CDL-C UMa 365-100. (*Nokia)*
  + With TR 38.8327 Virtualiser (i1\_1=6, i1\_2=0, i2=0)
  + Without antenna virtualisation (i1\_1=6, i1\_2=0, i2=0)
* Option 4 (For 2 Layer) eType2 follow PMI testing should concentrate to low UE speed or Doppler, and rank 2. (*MediaTek)*
* Option 5: For 4Rx/4 layer cases use fixed precoding, to allow for receiver performance scaling to be evaluated without dependency on the PMI selection algorithm or the KPI equalizing effort of random precoding. *(Nokia)*
* Option 6: RAN4 to discuss whether random vs. follow PMI TPUT should overlap for low rank cases in a SCM, and how the gap is expected to scale with different numbers of layers and Rx branches. *(Nokia)*

Recommended WF:

* For discussion at meeting, regarding choice of PMI for PDSCH and whether to use random or fixed.

#### Issue 2-1-2: Receiver Type

Proposals:

* Option 1: Companies employ strictly LMMSE MIMO demodulation to enable alignment of the results. *(MediaTek)*
* Option 2: Use TR 38.833 IRC as reference receiver with a common fixed precoder, to align SCM candidate implementations in (*Nokia*).
  + Option 2a: Different additional, and potentially undisclosed, receiver implementations to be useable in comparison test cases. *(Nokia)*

Recommended WF:

* Discuss during the meeting to attempt to achieve consensus on receiver type to be used for alignment.
  + Potentially agree that for comparison other receiver implementations may be used.

#### Issue 2-1-3: SU-MIMO and MU-MIMO Prioritisation

Companies Views:

*MediaTek* (from R4-2417801):

Proposal #4: We propose to focus on SU-MIMO first but discuss potential MU-MIMO scenarios for study.

*Qualcomm* (from R4-2418028):

Proposal 1: RAN4 to prioritize SU-MIMO PDSCH results collection and alignment with the agreed initial configuration for the purpose of SCM study and alignment. Baseline agreements for the configurations with Single User PMI and Multi-User MIMO can be postponed and reviewed once the PDSCH results are available and reviewed.

*Samsung* (from R4-2418620):

Proposal 1: For CDL evaluation, prioritize the simulation assumption/results alignment of SU-MIMO scenario alignment and defer MU-MIMO scenario.

*Apple* (from R4-2418550):

Proposal #2: Further justification is needed for considering MU-MIMO for the study.

*Huawei* (from R4-2419403):

Proposal 1: RAN4 shall preclude MU-MIMO test cases and only focus on SU-MIMO PDSCH and PMI test cases. For PDSCH cases, use random PMI rather than fixed PMI.

Proposals:

For background the latest SID (RP-241848) stipulates that the objective is as follows:

|  |
| --- |
| * Study practical spatial channel modelling methodology for both SU- and MU-MIMO demodulation requirements and CSI reporting requirements: |

Therefore, the following are for discussion during RAN4#113.

Options:

* Option 1: Prioritise SU-MIMO PDSCH
  + Option 1a: Baseline agreements for the SU-MIMO PMI and MU-MIMO to be postponed once PDSCH is reviewed (*Qualcomm)*
* Option 2: Prioritise SU-MIMO (PDSCH and PMI) *(MediaTek, Samsung)*
  + Option 2a: discuss potential MU-MIMO scenarios for the study (*MediaTek)*

#### Issue 2-1-4: Cases for MU-MIMO

Previous agreements from the WF of RAN4#112-bis:

|  |
| --- |
| **Agreement:**  Interested companies to bring to RAN4#113 views on the following cases:  PDSCH  2+2 layers with IRC (type I orthogonal and random precoding, to distinguish target and co-scheduled UE)  Interested companies are encouraged to assess 2+2 layers with R-ML / E-IRC (type I orthogonal and random precoding, to distinguish target and co-scheduled UE)  Proponents to highlight the difference between a SCM and TDL for MU-MIMO. |

Companies Views:

*Nokia* (from R4-2418043):

Proposal 8: RAN4 to necessarily include MU SDM receiver algorithms in the comparison test cases and their evaluation, e.g., E-IRC and R-ML. PMI choices as in SU PMI.

Proposal 9: RAN4 to include comparison cases for eTypeI vs. eTypeII in a MU PMI setup, at least for single cell MU.

Proposal 10: RAN4 to aim to bring initial multi cell MU PMI results in RAN4#114.

*Apple* (from R4-2418550):

Proposal #3: In case MU-MIMO is agreed the test setup is limited with what RAN4 has used so far – single UE with random PMI for target UE.

Proposal #4: In case MU-MIMO is agreed the test setup shall not include PMI feedback and/or multiple UEs.

Proposals:

Building upon the agreement from RAN4#112-bis, the following options are presented:

For PDSCH:

* 2+2 layers with IRC (type I orthogonal and random precoding, to distinguish target and co-scheduled UE)
* Interested companies are encouraged to assess 2+2 layers with R-ML / E-IRC (type I orthogonal and random precoding, to distinguish target and co-scheduled UE)
* **(NEW)** Option 1: PMI Choices as in SU PMI (*Nokia*)

Other MU-MIMO Test case aspects

* Option 2: RAN4 to include comparison cases for eTypeI vs. eTypeII in a MU PMI setup, at least for single cell MU *(Nokia)*
* Option 3: RAN4 to aim to bring initial multi cell MU PMI results in RAN4#114 *(Nokia)*
* Option 4: In case MU-MIMO is agreed the test setup shall not include PMI feedback and/or multiple UEs. *(Apple)*
* Option 5: In case MU-MIMO is agreed the test setup is limited with what RAN4 has used so far – single UE with random PMI for target UE. (*Apple*)

#### Issue 2-1-5: Ability for SCM candidates to be modified

Proposals:

* Option 1: RAN4 to consider how SCM candidates can be modified to allow separately, but spatially consistently, correlated channels for different AODs, AOAs and ZODs corresponding to different multiple UEs. *(Nokia*)

Recommended WF:

* For discussion at meeting

#### Issue 2-1-6: Capturing comparison cases and results in TR 38.753

Companies View:

*Nokia* (from R4-2418043):

Proposal 7: RAN4 shall capture all comparison cases results (from all contributors and with respect to all legacy and SCM candidates) in the TR, to allow for evaluation of fitness for purpose of the channel models.

Proposal 11: RAN4 shall capture all comparison cases results (from all contributors and with respect to all legacy and SCM candidates) in the TR, to allow for evaluation of fitness for purpose of the channel models.

*MediaTek* (from R4-2417801):

Proposal #8: The upcoming TR should provide self-contained and focused descriptions of the agreed channel models.

Proposals:

The following option and sub-options are proposed for discussion

* Option 1: TR 38.753 shall be self-contained and include the following:
  + Option 1a: Focussed descriptions of the agreed channel model
  + Option 1b: Comparison case results with respect to all legacy and SCM candidates

Recommended WF:

* For discussion during the meeting; noting that during the meeting Issue 1-1-1 will be discussed and any agreement there may overtake this issue.

#### Issue 2-1-7: Metrics for comparison

Companies Views

*Huawei* (from R4-2419403)

Proposal 3: To compare the channel models, the metric of PDSCH cases could be throughput or condition number, i.e, ratio of the absolute value of the maximum eigenvalue to the absolute value of the minimum eigenvalue of the channel. The metric of PMI cases could be reused from PMI test cases.

*Apple* (from R4-2418550)

Proposal #17: RAN4 to discuss test metrics to compare the methodologies that help identify limitations in the current methodology that impacts MIMO performance.

Proposals:

* Option 1: RAN4 to discuss test metrics to compare the SCM methodologies (*Apple)*
* Option 2: The metric of PDSCH cases could be throughput or condition number, i.e, ratio of the absolute value of the maximum eigenvalue to the absolute value of the minimum eigenvalue of the channel. (*Huawei)*

Recommended WF:

* RAN4 to discuss the test metrics to compare SCM methodologies during RAN4#113.

### Sub-topic 2-2: TDL Based Methodologies

#### Issue 2-2-1: Tap Delay Line Parameters

Proposals:

* Option 1: Use TDLC (X-Pol) medium correlation for comparison (*Samsung*)

Recommended WF:

* Needs discussion during the meeting, noting that no agreement was made during RAN4#112-bis on the TDL parameters for comparison. Therefore, this should be agreed during RAN4#113.

#### Issue 2-2-2: Tap Delay Line Correlation Matrix

Proposals:

* Option 1: RAN4 to consider spatially filtered TDL channel models described in 38.901 in the study *(Apple)*

Recommended WF:

* Discuss during the meeting, noting that as spatially filtered CDL may produce a ‘traditional’ TDL channel, so there may be overlap with Issue 2-2-1.

#### Issue 2-2-3: TDL Model Extensions

Proposals:

* Option 1: RAN4 to consider the option of multi-cluster TX-RX beam steering with TDL model for spatial channel modelling *(Mediatek)*
* Option 2: RAN4 to introduce enhanced TDL channel with multi-beams as one of candidate solutions for R19 SCM. *(Huawei)*

Recommended WF:

* For discussion at meeting, initially focussing on the question whether TDL model should be extended at all.

### Sub-topic 2-3: CDL Based Methodologies

#### Issue 2-3-1: Antenna Array Virtualisation Notation

Proposals:

* Option 1 (*Apple)*:
  + Use 3-argument notation of (M,N,P) for no AAV configuration.
  + Use 5-argument notation of (M,N,P,Ms,Ns) for AAV with no sub-array config where Ms=M, Ns=N.
* Option 2 (As per agreement in RAN4#112-bis)
  + Use 3-argument notation of (M,N,P) for ‘fully connected’
  + Use 5-argument notation of (M,N,P,Ms,Ns) for other configurations

Recommended WF:

* For discussion at meeting whether to overturn the agreement from RAN4#112-bis

#### Issue 2-3-2: Angles of Departure and Angles of Arrival

Proposals:

* Option 1: Replace the mean angle in the last position of departure and arrival angles generated equation by the desired angle as  . *(Samsung, CATT, Apple, ZTE, Sanechips)*
* Option 2: RAN4 to generate the time varying beam direction CDL channel by referring the procedure of scaling of angles for CDL channel defined in clause 7.7.5.1 in 38.901, the making the desired mean angle changed slot by slot (*Huawei)*
* Option 3: Set μ\_(ϕ,desired) based on the LOS direction between the TX and RX. (*Apple)*

Recommended WF:

* For discussion during meeting, it appears that there is a desire to replace the mean angle, but discussion needs to be had on how.

#### Issue 2-3-3: Time Varying Beam Direction

Proposals:

* Option 1: Further evaluate the method for time variant beam directions in CDL model. (*MediaTek*)
* Option 2: CDL based link level simulation should focus on predefined and fixed beam direction, i.e., no need to introduce time varying beam direction modelling for CDL based link level simulation. (*Samsung*)

Recommended WF:

* For discussion at meeting on the time varying beams in CDL

#### Issue 2-3-4: UE Speed

Proposals:

* Option 1: Evaluate the proposed channel models in lower and higher doppler conditions. (*MediaTek*)

Recommended WF:

* For discussion at meeting, proponents welcome to explain during meeting how to propose this is included.

#### Issue 2-3-5: GCS Antenna Coordinates for gNB

Companies Views:

*Qualcomm* (from R4-2418028):

GCS Location Coordinates for the gNB:

Height = 25 m

Azimuth = 0 (placement on the x axis)

X Coordinate = 0 m

*Apple* (from R4-2418550):

Height of BS: 25m

Proposals:

* Option 1: For the gNB, use the following parameters:
  + Height = 25 m
  + Azimuth = 0 (placement on the x axis)
  + X Coordinate = 0 m

Recommended WF:

* Potential Agreement on:
  + Height = 25 m
  + Azimuth = 0 (placement on the x axis)
  + X Coordinate = 0 m

#### Issue 2-3-6: LCS Antenna Coordinates for gNB

Companies Views:

*MediaTek* (from R4-2417801):

Proposal #16: We propose to use BS (α, β, γ) = (0°, 0°, 0°).

Proposal #17: We are also fine with (α, β, γ) = (0°, 10°, 0°).

*Qualcomm* (from R4-2418028):

* GCS to LCS Conversion angles (α,β,γ = bearing, downtilt, panel slant) for the gNB:
  + α,β,γ=(0,10,0);
  + Polarization Slant: ζ=(+45) deg

*Apple* (from R4-2418550):

LCS to GCS for BS: α,β,γ=(0,10,0);

*Nokia* (from R4-2418043):

BS

* (α,β,γ = 0, 10, 0),
  + I.e., intent of 10deg mechanical rotation around the y-axis, downtilted with respect to the horizon, resulting in θ\_BS=100° and ϕ\_BS=0°.
* Polarization slant (+45, -45).
* AE radiation pattern from 38.901 Table 7.3-1
* Informative: BS height is assumed 25m and d\_2D=100m.

*Samsung* (from R4-2418620):

Proposal 7: For BS side, frequency Fc=3.5GHz, BS height=25m, BS antenna orientation (alpha = 0 degrees, beta = 0 degrees, gamma = 0 degrees) should be assumed if no mechanical down tilt introduced. BS antenna orientation (alpha = 0 degrees, beta = 10 degrees, gamma = 0 degrees) should be assumed if 10-degree mechanical down tilt introduced.

Proposal 10: RAN4 should clarify if BS antenna down tilts is applied in CDL modeling and define the values of BS antenna down tilts if any.

*Huawei* (from R4-2419403):

RAN4 to configure α=0, β=0, γ=0 for BS side

RAN4 to configure α=0, β=13.2°, γ=0 for BS side

Proposals:

As BS antenna polarisation is covered in Issue 2-3-9, the following are proposed as options

* For α:
  + Option 1: 0° (*MediaTek, Apple, Qualcomm, Nokia, Samsung, Huawei*)
* For β:
  + Option 1: 0° (*MediaTek, Huawei*)
  + Option 2: 10° (*MediaTek, Apple, Qualcomm, Nokia, Samsung*)
  + Option 3: 13.2° (*Huawei*)
* For γ:
  + Option 1: 0° (*MediaTek, Apple, Qualcomm, Nokia, Samsung, Huawei*)

Recommended WF:

* Potential Agreement on:
  + α = 0°
  + γ = 0°
* Discussion need on β, but 10° may be agreeable.

#### Issue 2-3-7: GCS Antenna Coordinates for UE

Companies Views:

*Qualcomm* (from R4-2418028):

GCS Location Coordinates for the UE:

Height = 1.5 m;

Azimuth = 0; (placement on the x axis);

X Coordinate = 100 m; (Distance from gNB = 100 m);

*Apple* (from R4-2418550):

Height of UE: 1.5 m

Proposals:

* Option 1: For the UE, use the following parameters:
  + Height = 1.5 m;
  + Azimuth = 0; (placement on the x axis);
  + X Coordinate = 100 m; (Distance from gNB = 100 m)

Recommended WF:

* Potential Agreement on:
  + Height = 1.5 m;
  + Azimuth = 0; (placement on the x axis);
  + X Coordinate = 100 m; (Distance from gNB = 100 m)

#### Issue 2-3-8: LCS Antenna Coordinates for UE

Companies Views:

*MediaTek* (from R4-2417801):

Proposal #19: We propose to use UE (α, β, γ) = (180°, 0°, 0°).

*Qualcomm* (from R4-2418028):

* GCS to LCS Conversion angles (α,β,γ = bearing, downtilt, panel slant) for the UE:
  + α,β,γ=(180,0,0);
  + Polarization Slant: ζ=(0) deg

*Apple* (from R4-2418550):

LCS to GCS for UE: α,β,γ=(180,0,0);

*Nokia* (from R4-2418043):

UE

* (α,β,γ = 180, 0, 0),
  + I.e., intent is pointing towards BS along x-axis with no tilt, resulting in θ\_UE=90° and ϕ\_UE=180°.
* Polarization slant (0, 90).
* AE radiation pattern omnidirectional
  + Informative: UE height is assumed 1.5m and d\_2D=100m.

*Huawei* (from R4-2419403):

α=180°, β=0, γ=0 for UE side

Proposals:

As UE Antenna polarisation is covered in Issue 2-3-13, the following are proposed as options

* For α:
  + Option 1: 180° (*MediaTek, Apple, Qualcomm, Nokia, Huawei*)
* For β:
  + Option 1: 0° (*MediaTek, Apple, Qualcomm, Nokia, Huawei*)
* For γ:
  + Option 1: 0° (*MediaTek, Apple, Qualcomm, Nokia, Huawei*)

Recommended WF:

* Potential Agreement on:
  + α = 180°
  + β=0
  + γ = 0°

#### Issue 2-3-9: BS Antenna Polarisation

Proposals:

* Option 1: BS Polarisation slant (+45, -45) (*Nokia, Samsung, Qualcomm, MediaTek)*

Recommended WF

* Tentative Agreement: BS Polarisation slant (+45, -45)

#### Issue 2-3-10: BS Radiation Pattern

Companies Views

*Apple* (from R4-2418550):

Proposal #7: Assume directional antenna with radiation pattern in 38.901 for CDL channel.

*Samsung* (from R4-2418620):

Proposal 4: For BS antenna configuration, the directional radiation power pattern per antenna element defined in 38.901 Table 7.3-1 should be used.

*MediaTek* (from R4-2417801):

Proposal #11: We propose to use BS radiation pattern as defined in TR38.901 Table 7.3-1.

*Qualcomm* (from R4-2418028):

Proposal 5: Support the radiation power pattern defined in 38.901 Table 7.3-1 to be used for Antenna Element Pattern at the BS;

*Nokia* (from R4-2418043):

Extract from Proposal 12:

AE radiation pattern from 38.901 Table 7.3-1

Proposals:

* Option 1: BS radiation pattern as defined in TR38.901 Table 7.3-1. (*Apple, Samsung, MediaTek, Qualcomm, Nokia*)

Recommended WF:

* Tentative Agreement: BS radiation pattern as defined in TR38.901 Table 7.3-1.

#### Issue 2-3-11: BS Antenna Virtualiser choice

Proposals:

* Option 1: Down Tilt Virtualiser : -10 degrees (*ZTE, Sanechips)*
* Option 2: Broadside (*MediaTek)*
  + Option 2a: Broadside for 38.827 partially connected virtualisers with 10 degrees of Mechanical downtilt (*Nokia)*
* Option 3: Max Receive Power for standard fully connected (*Nokia)*
* Option 4: For BS antenna configurations with AAV use max receive power based BS antenna virtualiser (*Apple*)
* Option 5: For BS antenna virtualization, DFT combing weight is reasonable, but RAN4 need to clarify how to implement “panning” in link level simulation and if it’s needed. (*Samsung*)

Recommended WF:

* For discussion, some aspects potentially overtaken by issue 2-3-6

#### Issue 2-3-12: UE Antenna Polarisation

Proposals:

* Option 1: BS Polarisation (0, 90) (*Nokia, Samsung, Qualcomm, MediaTek)*

Recommended WF

* Tentative Agreement: UE Polarisation (0, 90)

#### Issue 2-3-13: UE Radiation Pattern

Companies Views

*MediaTek* (from R4-2417801):

Proposal #12: We propose to use Omnidirectional antennas for UE.

*Qualcomm* (from R4-2418028):

Proposal 6: RAN4 to agree that the UE applies no virtualizer at the RX and that each Antenna Elements (omnidirectional as per previous agreements) is connected exclusively with one RX Chain;

*Nokia* (from R4-2418043):

Extract from Proposal 12:

AE radiation pattern omnidirectional

Proposals:

* Option 1: UE antenna radiation patterns are omnidirectional (*MediaTek, Qualcomm, Nokia*)
  + Option 1a: No Vitualiser is applied to UE side (*Qualcomm*)

Recommended WF:

* Tentative Agreement: UE antenna radiation patterns are omnidirectional.
* To discuss during the meeting whether no virtualiser shall be applied to UE.

#### Issue 2-3-14: Subcluster Correlation

Proposals:

* Option 1: Discussion on potential correlation between subclusters and the definition of mechanisms can be closed now and does not need to be considered. No action is required. *(Keysight, ZTE)*
* Option 2: To avoid inter-cluster correlation, RAN4 companies should make sure they are performing ray-splitting for the sub-clusters as specified by TR 38.827 and TR 38.901 (Table 7.5-5). *(MediaTek, Apple)*

Recommended WF:

* For discussion during meeting whether the ray-splitting needs to be considered to avoid inter-cluster correlation; or whether no action is required.

#### Issue 2-3-15: Frequency Bands/Carrier Frequency

Background:

As described in the SID the following is defined as the priority:

|  |
| --- |
| The methodology shall include both FR1 (conducted) and FR2 (wireless cable), with first priority for FR1. |

Proposals:

* Option 1: RAN4 to study if the same CDL channel model can be defined for all carrier frequencies/ bands in given frequency range *(Apple)*
* Option We propose to focus on 3.5GHz carrier frequency first but check other frequencies in the end of feasibility study. (*MediaTek*)

Recommended WF:

* For discussion during meeting, noting the prioritisation as defined in the SID.

#### Issue 2-3-16: CDL Simplification

Proposals:

* Option 1 RAN4 to study if the CDL channel models can be simplified to smaller number of clusters. *(Apple)*
* Option 2: RAN4 to discuss whether the existing simplification procedure in 38.901 Annex B.2.1 is applicable to SCM, and if not how to extend the existing simplification methodology to reduce the number of channel taps for CDL channels based on 38.901. (*Qualcomm*)

Recommended WF:

* For discussion at meeting on whether the CDL model should be simplified.

#### Issue 2-3-17: SNR Definition with CDL

Companies Views:

*Qualcomm* (from R4-2418028):

Proposal 9: For the purpose of received signal power normalization and SNR definition, RAN4 to consider capturing in the TR the following understanding: Assuming constant total received signal power summed across all RX RF Chain, the sum of Signal Power across all TX Beams is normalized using the spatially filtered long-term average PDP.

*Samsung* (from R4-2418620):

Proposal 12: If AAV process is introduced in RAN4 CDL model, update SNR definition accordingly which should not account the virtualization gain.

*Huawei* (from R4-2419403):

Proposal 12: RAN4 to discuss how to handle the changed SNR with the beam direction changed

*MediaTek* (from R4-2417801):

Proposal #9: Depending on each AAV and spatial CDL channel combination, a numerical transmit beamformer power normalization factor should be specified to ensure unit power response.

Proposals:

* Option 1: RAN4 to discuss the issue of how to normalize received signal power and define SNR reference for CDL-based simulation results alignment
  + Option 1a: Define as the following: Assuming constant total received signal power summed across all RX RF chain; the sum of Signal Power across all TX Beams is normalized using the spatially filtered long-term average PDP. *(Qualcomm)*:
  + Option 1b: Do not consider virtualisation gain (*Samsung*)
  + Option 1c: Consider beam direction change (*Huawei*)
  + Option 1d: Use a normalisation factor based upon AAV and spatial CDL channel (*MediaTek)*

Recommended WF:

* For discussion during meeting, firstly whether to change definition (it seems that majority support), and then how to do so.

#### Issue 2-3-18: Definition of ‘Antenna subarray’

Proposals:

* RAN4 to agree on the following definition for an Antenna Subarray: One subarray is a unique set of co-polarized antenna elements mapped exclusively to one CSI-RS Port through a virtualiser (vector of complex values). (*Qualcomm*):

Recommended WF:

* Discuss during the meeting whether the definition is agreeable

#### Issue 2-3-19: TR wording for definition of BS Antenna Panel

Proposals:

* RAN4 to capture the description below in the TR (*Qualcomm*):

|  |
| --- |
| The BS antenna panel is composed by antenna elements arranged in columns and rows, single or dual polarized, and can be split in subarrays. One subarray is a unique set of co-polarized antenna elements mapped exclusively to one CSI-RS Port through a virtualiser (vector of complex values).  The BS antenna panel configuration is defined as (M,N,P,Ms,Ns), according to the description below:  M is the number of antenna elements with the same polarization in each column (vertical size)  N is the number of antenna elements with the same polarization in each row (horizontal size)  P is the number of polarizations  Ms is the number of Subarray Elements with the same polarization in each column (vertical size)  Ns is the number of Subarray Elements with the same polarization in each row (horizontal size) |

Recommended WF:

* Discuss during the meeting whether the wording is agreeable.

#### Issue 2-3-20: Reduction of Randomness

Proposals:

* Option 1: All CDL based approaches to use the 827 randomness reduction framework, i.e., small scale fading changes, fixed subpaths, weak clusters, etc. (*Nokia*)

Recommended WF:

* For discussion during meeting, potentially overtaken by Issue 2-4-1 if only 38.827 options are chosen.

### Sub-topic 2-4: Comparison of methodologies

#### Issue 2-4-1: TDL and CDL Methodologies

Previous agreements from the WF of RAN4#112-bis:

|  |
| --- |
| **Agreement:**  Interested companies to use the following candidate SCM options:   * (Option A) CDL (as defined in R4-2415283) with Antenna Array Virtualisation (AAV) using subarray configuration   + (M,N,P,Ms,Ns) = (8,8,2,8,4) for 4Tx CSI-RS Ports (option X)   + (M,N,P,Ms,Ns) = (8,8,2,8,2) for 8Tx CSI-RS Ports (option X)   + (M,N,P,Ms,Ns) = (8,2,2,8,1) for 4Tx CSI-RS Ports (option Y)   + (M,N,P,Ms,Ns) = (8,4,2,8,1) for 8Tx CSI-RS Ports (option Y) * (Option B) CDL (as defined in R4-2415283), i.e., with AAV without subarray (fully connected)   + [(M,N,P) = (8,8,2) for 8Tx and 4Tx CSI-RS Ports] * (Option C, for interested companies) CDL (as defined in R4-2415283) without AAV with the following configuration:   + [(M,N,P,Ms,Ns) = (1,4,2,1,1) for 8Tx CSI-RS Ports]   + [(M,N,P,Ms,Ns) = (1,2,2,1,1) for 4Tx CSI-RS Ports] * (Option D, for interested companies) CDL from 38.901 with AAV using subarray   + (M,N,P,Ms,Ns) = (8,8,2,8,4) for 4Tx CSI-RS Ports (option X)   + (M,N,P,Ms,Ns) = (8,8,2,8,2) for 8Tx CSI-RS Ports (option X)   + (M,N,P,Ms,Ns) = (8,2,2,8,1) for 4Tx CSI-RS Ports (option Y)   + (M,N,P,Ms,Ns) = (8,4,2,8,1) for 8Tx CSI-RS Ports (option Y) * (Option E, for interested companies) CDL from 38.901 with AAV without subarray (fully connected)   + [(M,N,P) = (8,8,2) for 8Tx and 4Tx CSI-RS Ports] * (Option F, for interested companies) TDL extensions as defined in R4-2412762) * (Option G for interested companies) TDL extensions as defined in R4-2415382)   *Where the BS antenna panel is composed by antenna elements arranged in columns and rows, single or dual polarized, and can be split in subarrays according to the following description: (M,N,P,Ms,Ns)*  *M is the number of antenna elements with the same polarization in each column (vertical size)*  *N is the number of antenna elements with the same polarization in each row (horizontal size)*  *P is the number of polarizations*  *Ms is the number of Subarray Elements with the same polarization in each column (vertical size)*  *Ns is the number of Subarray Elements with the same polarization in each row (horizontal size)*  Options on BS antenna configuration for Options A, D:   * Option X: Fixed array size 128 AE (8,8,2,8,Ns) * Option Y (*where most companies views are aligned*): Fixed sub-array size 16 AE (8,N,2,8,1)   Companies to clarify their assumptions used for radiation patterns of antenna elements. |

Companies Views:

*Nokia* (from R4-2418043):

Proposal 15: RAN4 to focus on the following SCM candidates

(a) CDL (as defined in R4-2415283) with AAV using subarray configuration (partially connected with broadside steering+mechanical tilt),

(b) CDL (as defined in R4-2415283), i.e., with AAV without subarray (fully connected), and

(c) CDL (as defined in R4-2415283) without AAV.

Proposal 16: RAN4 to consider expected SNR levels for selection of virtualizer, and hence to give priority to the 827 fully connected AAV.

*Huawei* (from R4-2419403):

Proposal 5: RAN4 to use CDL channel generation procedure defined in 38.827.

Proposal 6: RAN4 to use CDL parameters table defined in 38.901 for study.

Proposal 7: RAN4 to evaluate the performance of fixed array, fixed subarray and without AAV and preclude the full connected with beamforming,

*ZTE, Sanechips* (from R4-2419166):

Proposal 4. Both sub-array and full connection models shall be considered at least in study item.

Proposal 3. From evaluation purpose, maybe we can consider different approaches for BS virtualization, e.g. electronic downtilt and the method in TR 38.827.

*Ericsson* (from R4-2419253):

Proposal 1: RAN4 to discuss if a new scalable deterministic CDL model is necessary from demodulation perspective. Following procedures could be considered.

1. Derive scalable CDL models based on 38.901 model and 38.827 method for MIMO simulation:

a. Reuse relative delay and power per cluster defined in CDL models in 38.901.

b. Set UE is static as 38.901.

c. Assume one isotropic antenna element for both BS and UE side.

d. Set desired angles, desired angel spread, coupling patterns and initial phase of polarization matrix etc., as 38.827 have done.

e. Derive channel model profiles (for example, call them “CDLM-A/B/C”) which can be considered as general model for a frequency range.

2. Derive specific CDL models for demodulation requirements:

a. Set desired delay spread, desired UE velocity vector (Doppler shift and directions) and proper BS and UE antenna configurations according to typical feature scenario.

b. Derive specific model profiles on top of scalable channel model profiles from step 1 above.

Proposal 2: It could be furtherly discussed that the necessary of having different subset of models per deployment (i.e., Uma, Umi, Indoor etc.) for demodulation requirements.

Proposal 3: Consider subarray virtualization method for beamforming weight generation in CDL model derivation.

Proposal 4: Choose typical BS antenna configurations and subarray virtualization (1 column per subarray) to have proper beamforming weight in CDL channel model.

*Samsung* (from R4-2418620):

Proposal 11: For RAN4 demodulation and CSI reporting simulation, option C (CDL without AAV with the configuration: (M,N,P,Ms,Ns) = (1,4,2,1,1) for 8Tx CSI-RS Ports and (M,N,P,Ms,Ns) = (1,2,2,1,1) for 4Tx CSI-RS Ports) is a good choice to avoid the AAV process which seems useless for RAN4 requirements definition.

*MediaTek* (from R4-2417801):

Proposal #5: We propose that AAV via fixed TX-BF as specified in TR38.827 is not used for follow-PMI testing.

Proposal #6: We propose to consider no AAV for follow-PMI testing in CDL channels.

Proposals:

Through viewing all the options from the WF from RAN4#112-bis it appears that all have at least one company wishing to pursue it, so the options are presented as is:

* (Option A) CDL (as defined in R4-2415283) with Antenna Array Virtualisation (AAV) using subarray configuration (*Nokia, Huawei, ZTE)*
  + (M,N,P,Ms,Ns) = (8,8,2,8,4) for 4Tx CSI-RS Ports (option X)
  + (M,N,P,Ms,Ns) = (8,8,2,8,2) for 8Tx CSI-RS Ports (option X)
  + (M,N,P,Ms,Ns) = (8,2,2,8,1) for 4Tx CSI-RS Ports (option Y)
  + (M,N,P,Ms,Ns) = (8,4,2,8,1) for 8Tx CSI-RS Ports (option Y)
* (Option B) CDL (as defined in R4-2415283), i.e., with AAV without subarray (fully connected) (*Nokia (priority), Huawei, ZTE)*
  + (M,N,P) = (8,8,2) for 8Tx and 4Tx CSI-RS Ports
* (Option C) CDL (as defined in R4-2415283) without AAV with the following configuration: (*Nokia, Huawei, ZTE, Samsung, MediaTek)*
  + (M,N,P,Ms,Ns) = (1,4,2,1,1) for 8Tx CSI-RS Ports
  + (M,N,P,Ms,Ns) = (1,2,2,1,1) for 4Tx CSI-RS Ports
* (Option D) CDL from 38.901 with AAV using subarray : (*Huawei, ZTE)*
  + (M,N,P,Ms,Ns) = (8,8,2,8,4) for 4Tx CSI-RS Ports (option X)
  + (M,N,P,Ms,Ns) = (8,8,2,8,2) for 8Tx CSI-RS Ports (option X)
  + (M,N,P,Ms,Ns) = (8,2,2,8,1) for 4Tx CSI-RS Ports (option Y)
  + (M,N,P,Ms,Ns) = (8,4,2,8,1) for 8Tx CSI-RS Ports (option Y)
* (Option E) CDL from 38.901 with AAV without subarray (fully connected) (*Huawei, ZTE)*
  + [(M,N,P) = (8,8,2) for 8Tx and 4Tx CSI-RS Ports]
* (Option F) TDL extensions as defined in R4-2412762) (*Huawei*)
* (Option G) TDL extensions as defined in R4-2415382) (*Mediatek*)
* (Option H) New Scalable deterministic CDL model (*Ericsson*)

Recommended WF:

* As many options are open, companies are encouraged to present views during the meeting;
  + Initially focussed on high level 38.901, R4-2415283 CDL, R4-2412762 TDL Extension, R4-2415382 TDL Extension or other SCM options
  + Further focus on AAV options, potentially related to specific tests under Issue 2-1-1 or Issue 2-1-3.

### Sub-topic 2-5: Requirements and Other

#### Issue 2-5-1: Definition of New Requirements

Proposals:

* Option 1: RAN4 shall not define any new requirements with a spatial channel model in Rel-19 – for either Rel-19 WIs or earlier WIs. (*Apple)*

Recommended WF:

* Discuss during the meeting to views on whether or not to introduce new requirements in Rel-19 WIs, noting that the SID does not impact specifications or reports beyond TR 38.753.

# Recommended Disposition of TDocs

|  |  |  |
| --- | --- | --- |
| T-doc number | Suggested Status | Comments (Optional) |
| [**R4-2417556**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417556.zip) | Noted |  |
| [**R4-2419251**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419251.zip) | Noted |  |
| [**R4-2419338**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419338.zip) | Noted |  |
| [**R4-2417801**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417801.zip) | Noted |  |
| [**R4-2417802**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417802.zip) | Noted | *Simulation results* |
| [**R4-2417827**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2417827.zip) | Noted |  |
| [**R4-2418028**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418028.zip) | Noted |  |
| [**R4-2418042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418042.zip) | Noted |  |
| [**R4-2418043**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418043.zip) | Noted |  |
| [**R4-2418044**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418044.zip) | Noted | *Simulation results* |
| [**R4-2418550**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418550.zip) | Noted |  |
| [**R4-2418620**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2418620.zip) | Noted |  |
| [**R4-2419166**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419166.zip) | Noted |  |
| [**R4-2419252**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419252.zip) | Noted |  |
| [**R4-2419253**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419253.zip) | Noted | *Simulation results* |
| [**R4-2419347**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419347.zip) | Noted | *Simulation results* |
| [**R4-2419403**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_113/Docs/R4-2419403.zip) | Noted |  |