**3GPP T****SG-RAN WG4 Meeting #113 R4-241xxxx**

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

**Agenda item:** 7.14.3

**Source:** Moderator (Nokia)

**Title:**  Ad Hoc Minutes for [113][320] NR\_SCM

**Document for:** Information

# Introduction

This document captures the minutes for FS\_NR\_demod\_SCM (also known as NR\_SCM) under AI 7.14 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

## 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 Approacheso CDL model in 901o CDL model derivation in 38.827o TDL model with dual-beamsteering methodo TDL model with per-tap correlation methodChapter 6 Comparison of Spatial Channel Modelso SU-MIMO 8Tx8Rx PDSCH- Simulation comparison• Parameters per channel model approaches• Comparison aspectso Antenna configurationso BF implementationso Performance curveso Etc.• Observations- Testability comparison• Equipment• Feasibility and repeatability• Observationso SU-MIMO PMIChapter 7 Alignment of Spatial Channel Modelso Example: agreed CDL model approach• Scalable deterministic CDL model• Angle relevant parameters configurations.• Channel model profile.• Alignment simulation results collectiono 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

## 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:

|  |
| --- |
| **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 PMI4Rx: 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.

Online Discussion:

Nokia: We need to have random case for alignment. For comparison, we need either follow-PMI or fixed. Follow is difficult to use since implementations are different. We therefore suggest fixed. We can determine fixed from histograpm. Our prppose is random for alignment, and random and fixed for comparison.

MTK: Agree with Nokia:

Apple: Fixed requires at least two steps. Need to check histogram to see which PMI is selected. The fixed may not actually be used in a requirement. We propose to keep only the random PMI.

Huawei: For comparison, we are already comparing random and fixed PMI for PMI test.

Moderator: The agreement was for random and follow (not fixed).

ZTE: Share same view as Apple

Nokia: PDSCH we are interested in receiver performance. For PMI, we fix the receiver to be reference. The two cases are not comparable. To Apple, without fixed, cannot see the gain from SCM.

Huawei: To Nokia what gain are we seeking?

Nokia: What we are saying is the difference between SCM and non-SCM models for PDSCH vs. PMI. PMI we use a reference receiver while PDSCH we use the real receiver according to companies inputs.

Huawei: PMI and PDSCH are similar. We don’t understand what is meant by real receiver.

Nokia: Real receiver is the one used in a product.

Nokia: We could agree random precoder now. But we think we also need fixed.

Qualcomm: We would be interested in the difference between fixed and follow. We can include PMI statistics and “follow”.

Nokia: We saw results where fixed was better than follow. If follow is susceptible to short-term statistics in direction, it may not perform as well. We should not excnlude fixed based on most commonly selected PMI.

Apple: Assuing PDSCH throughput, not PMI test cases, we don’t see the need for follow PMI. We should include random and the question is whether we should also include fixed.

Huawei: How to align fixed PMI across different companies?

Nokia: Agree with Apple we should not have follow PMI. But Qualcomm was talking about statistics.

#### 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*)

Online Discussion:

BT: We have results for MU-MIMO. It is part of the SID. It needs to be included. We would like to align on specific cases. We presented a case last meeting and encourage companies to discuss this case.

Samsung: Understand MU-MIMO is common. It is too early for MU-MIMO cases. We are still discussing extension of TDL or use of CDL. We should spend the time talking about spatial channel modelling.

Nokia: We prioritize SU-MIMO, but don’t preclude MU-MIMO. We don’t need to extend channel model for single cell.

Orange: We need to include MU-MIMO.

Huawei: Same view as Samsung. We want to focus on SU-MIMO and channel model.

Qualcomm: First focus on SU-MIMO. We already have 10 different channel model candidates. MU-MIMO would be much more complex. It will take a very long time. We propose to first start with SU-MIMO. Can then decide on a subset for MU-MIMO.

Nokia: Agree with Qualcomm. We can partition the online time to prioritize SU-MIMO.

BT: The agreement on SU-MIMO also helps MU-MIMO case. We would like to ensure that agreements we make for SU-MIMO can also apply for MU-MIMO.

Apple: Why is MU-MIMO so important to SCM? We don’t need advanced receivers since MU-MIMO provides separation and reduces the interference level.

Nokia: Agree with Apple that MU-MIMO can use simpler receivers.

Qualcomm: At the last meeting, we spent a lot of time on MU-MIMO assumptions, parameters, and test setups. This doesn’t seem productive.

#### 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.
		- *Observation: 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.*
	+ 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 tentative agreement in RAN4#112-bis)
	+ Use 3-argument notation of (M,N,P) for ‘fully connected’
		- [(M,N,P) = (8,8,2) for 8Tx and 4Tx CSI-RS Ports]
	+ Use 5-argument notation of (M,N,P,Ms,Ns) for other configurations
		- [(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]

Recommended WF:

* For discussion at meeting whether to change the option for AAV notation captured in the WF 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

Discussions in Online

Huawei: Is this for 827 model?

Moderator: This is general, irrespective of model

Nokia: This is large scale analysis setup, independent of the spatial channel model

Huawei: Cannot agree

Nokia: Companies are encouraged to use these assumptions, but each company can choose according to their own assumption

Qualcomm: What does Huawei propose instead?

Huawei: Same height for BS and UE for 901

Apple: All of these parameters are a package. 25m seems to be a reasonabl assumption for BS. Does Huawei propose UE to also be at 25m?

Qualcomm: Same height for BS and UE was our original proposal. Based on offline discussion, there was understanding of 25m, 10deg downtilt as typical urban macro assumptions for BS according to ITU. These are already used in 827. The goal is to have assumptions for 901.

Nokia: What is Huawei’s concern?

Huawei: We would like to simplify. We prefer not to include downtilt.

Nokia: In 827 there was downtilt. In 901 we can either have both at the same height w/o downtilt or do the same as 827. Both are nearly the same. But for the future, it will be difficult to understand why 827 and 901 are different. Can we keep them the same?

Huawei: We are ok to compromise to 25m BS height with 10 degree downtilt.

**Agreement:**

* + 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)

Online Discussion

Samsung: Why do we need X=100m?

Nokia: Technically it’s not needed, but many companies asked for it.

Apple: For 901 it is needed. It’s good to have it.

Samsung: We understand it is useful for system evaluation. It is better to clarify it is only for Uma scenario.

Nokia: This is our comparison setup. It is not linked to Uma. We could indicate it is for Macro scenario.

Samsung: If not for Uma, does 100m make sense for other scenarios?

Nokia: It is not suitable for other scenarios, we are ok to indicate for macro, but Uma includes other parameters.

**Agreement**

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

Note: This set up is for the macro scenario

#### 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.

Samsung (from R4-2418620)

Select UE antenna orientation as (alpha = 0 degrees, beta = 90 degrees, gamma = 0 degrees) is a reasonable choice.

*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°

**Agreement:**

* + 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)

**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.

**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: UE Polarisation (0, 90) (*Nokia, Samsung, Qualcomm, MediaTek)*

Recommended WF

* Tentative Agreement: UE Polarisation (0, 90)

**Agreementt**

* 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.

Online Discussion

Apple: No virtualizer for the UE

**Agreement:**

* UE antenna radiation patterns are omnidirectional.

#### 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.

Online Discussion:

Nokia: Two intrepretations on 827. We don’t think ray-splitting is needed.

Apple: The subcluster correlation was the issue from the last meeting. The rays to subcluster mapping is different. The sub-cluster delays are not present.

Nokia: The procedure in 901 differs from 827.

Keysight: We are following the spec. There is no correlation.

R&S: Both options are the same

Moderator: Can we agree with option 2, with “no action required” added.

**Agreement:**

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). No further action 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 2: We propose to focus on 3.5GHz carrier frequency first but check other frequencies in the end of feasibility study. (*MediaTek*)
* Option 3: RAN4 to study if a scalable deterministic CDL model can be defined for all frequency bands in a given frequency range (Ericsson).

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 polarizationsMs 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,

(*The following observations and proposals were updated by Huawei during summary review period, but not captured in the submitted formal TDoc)*:

Observation 3 *For Rank4, the performance comparison is TDLC+Low>CDL-C with FixedSubArray> CDL-C withoutAAV>CDL-C with FixedArray >TDLC+Med B. Cases with all virtualization approaches have reasonable target SNR.*

Observation 4: *For Rank8, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C with FixedSubArray=CDL-C withoutAAV>TDLC+Med B. Cases with all virtualization approaches have reasonable target SNR.*

Observation 5: *For Rank4, the performance comparison is TDLC+Low= CDL-C with FullConnected> CDL-C with FixedArray> CDL-C with FixedSubArray=CDL-C withoutAAV>TDLC+Med B. Cases with all virtualization approaches have reasonable target SNR.*

Observation 6: *For Rank8, the performance comparison is TDLC+Low>CDL-C with FixedArray> CDL-C withoutAAV >CDL-C with FixedSubArray >TDLC+Med B. The peak throughput of case withoutAAV is unachievable.*

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.*

Proposal 7: RAN4 to use without AAV approach and random PMI for cases with up to 4layers. Use FixedArray approach and random PMI for cases with 8layers.

*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 |  |