**3GPP T****SG-RAN WG4 Meeting #116 R4-2511465**

**Bengaluru, India, 25 – 29th August**

**Agenda item:** 7.12.1

**Source:** Moderator (Nokia)

**Title:**  Topic summary for [116][320] NR\_SCM

**Document for:** Information

# Introduction

This document summarises the contributions for FS\_NR\_demod\_SCM (also known as NR\_SCM) under AI 7.12 at RAN4#116.

FS\_NR\_demod\_SCM was updated at RAN#107 with the new SID being [RP-241610](javascript:openTdoc('https://portal.3gpp.org/ngppapp/CreateTdoc.aspx?mode=view&contributionUid=RP-241610','RP-241610')).

This topic was introduced in RAN4 demodulation at RAN4#112 with a completion by RAN#109 in September 2025.

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

* Topic #1: General
* Topic #2: Common Parameters for all Methodologies
* Topic #3: TDL Based Methodologies
* Topic #4: CDL Based Methodologies
* Topic #5: Alignment of SCM implementations
* Topic #6: Comparison of Methodologies
* Topic #7: Other

# Topic #1: General

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Source | Proposals / Observations |
| [**R4-2509112**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509112.zip) | Nokia | **Proposal 1: RAN4 to include a singular CDL and Enhanced TDL channel respectively, shall be included in TR 38.753**  **Proposal 2: RAN4 shall achieve consensus on the ‘Comparison’ section and assessment to be include in TR 38.753 during RAN4#116**  **Proposal 3: RAN4 shall complete the TR 38.753 through a draft TR v1.1.0 during RAN4#116.** |
| [**R4-2510711**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510711.zip) | Ericsson | **Observation 1** The total normalized throughput could be similar when per CW normalized throughputs are quite different among different implementations.  **Observation 2** Rel-20 SCM study on MU-MIMO would start soon and it seems not necessary to capture MU-MIMO methodology without discussion in Rel-19 TR because the MU-MIMO part in Rel-19 TR will be removed in Rel-20 TR anyway**.**  **Proposal 1 Rename SCM model and antenna configuration with sorted numbers in the final TR to avoid confusion to readers.**  **Proposal 2 Adding total normalized throughput results for 8 layers PDSCH in alignment chapter.**  **Proposal 3 Companies to check if it is necessary to capture MU-MIMO methodology in Rel-19 TR. If companies think it necessary, capture it in a new Annex as informative information.** |
| [**R4-2509478**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509478.zip) | Apple | **General**  **Proposal 1: Focus efforts in RAN4#116 on drawing observations and conclusions based on the alignment and comparison aspects of the spatial channel model candidates.**  **Proposal 2: Capture items not discussed or concluded in the Rel-19 study to serve as a starting point for any further study in Rel-20.** |
| [**R4-2510437**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510437.zip) | Samsung | **Observation 1:** For TR38.753, the most important context of CDL-based spatial channel model are captured in Annex B, while only antenna modeling, parameters and UMa-CDLC1 table are described on the main body CDL approach section.  **Proposal 1: For TR38.753, merge Annex B to chapter 5.1 to enhance the TR logical consistency, readability and practicality.**  **Observation 2:** For TR38.753, sub-section 5.2.2.2 especially describes cluster model example. However, the contexts for annex C which named “Modelling execution for TDL Channel Models” but actually about two TDL examples.  **Proposal 2: For TR38.753, merge Annex C to chapter 5.2 to avoid cross-referencing.** |

## Open issues summary

### Sub-Topic 1-1: TR Scope Finalisation

#### Issue 1-1-1: Scope and Completion of TR 38.753

Options:

* Option 1: Finalise TR 38.753 with both CDL and Enhanced TDL channels included, producing draft v1.1.0 during RAN4#116 (*Nokia)*
  + Option 1A: Focus efforts in RAN4#116 on drawing observations and conclusions based on the alignment and comparison aspects of the spatial channel model candidates. (*Apple)*
* Option 2: Capture items not discussed or concluded in the Rel-19 study to serve as a starting point for any further study in Rel-20. (*Apple)*
* Option 3: Companies to check if it is necessary to capture MU-MIMO methodology in Rel-19 TR. If companies think it necessary, capture it in a new Annex as informative information. (*Ericsson)*

Recommended Way Forward:

* TR 38.753 draftTR v1.1.0 to be produced following RAN4#116, with both CDL and enhanced TDL included.
* Items not concluded should be captured into a Way Forward following RAN4#116, which may serve as support to Rel-20 activities.
* MU-MIMO aspects are already captured in Annex D, if updates are required a pCR will require developing during RAN4#116.

### Sub-Topic 1-2: Editorial Alignment

#### Issue 1-2-1: TR 38.753 Structure – Annex B

Options:

* Option 1: For TR38.753, merge Annex B to chapter 5.1 to enhance the TR logical consistency, readability and practicality. (*Samsung)*

Recommended Way Forward:

* Retain Annex B as separate unless strong views are presented during RAN4#116, noting that a previous decision was made to hold the details of Channel modelling execution in annexes. Companies are welcome to provide views.

#### Issue 1-2-2: TR 38.753 Structure – Annex C

Options:

* Option 1: For TR38.753, merge Annex C to chapter 5.2 to avoid cross-referencing. (*Samsung)*

Recommended Way Forward:

* Retain Annex C as separate unless strong views are presented during RAN4#116, noting that a previous decision was made to hold the details of Channel modelling execution in annexes. Companies are welcome to provide views.

#### Issue 1-2-3: Naming of SCM Model Parameters

Options:

* Option 1: Rename SCM model and antenna configuration with sorted numbers in the final TR to avoid confusion to readers. (*Ericsson)*

Recommended Way Forward:

* Common terminology will be agreed during RAN4#116, a single CDL and Enhanced TDL model shall be used for TR 38.753.
* Antenna configuration numbering shall be agreed and simplified when included in the TR, specifically with regards to Chapter 6, the following is proposed:
  + (TR 38.753) AAV Option 1 = (SCM SI working name) AAV Option 1Y
  + (TR 38.753) AAV Option 2 = (SCM SI working name) AAV Option 3
* Adopt final naming in TR v1.1.0; either through pCR revisions for Chapters 5–6 and Annexes, or via rapporteur edit, by end of meeting.

# Topic #2: Common Parameters for all Methodologies

## Companies’ contributions summary

**No contributions explicitly for this topic (Common Parameters for all Methodologies) at RAN4#116.**

## Open issues summary

**No open issues explicitly for this topic (Common Parameters for all Methodologies) at RAN4#116.**

# Topic #3: TDL Based Methodologies

## Companies’ contributions summary

**No contributions explicitly for this topic (TDL Based Methodologies) at RAN4#116.**

## Open issues summary

**No open issues explicitly for this topic (TDL Based Methodologies) at RAN4#116.**

# Topic #4: CDL Based Methodologies

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Source | Proposals / Observations |
| [**R4-2509856**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509856.zip) | Qualcomm Incorporated | **Proposal 1: RAN4 to use the updated angular scaling procedure in TR38.901, version 19.0.0, section 7.7.5.1.**  **Proposal 2: RAN4 to endorse the draftCR R4-2509115 that proposes to introduce a variable to capture the scaled and translated cluster angle. A mirror CR is submitted to RAN1 for approval.**  **Proposal 3:** **RAN4 should capture in TR38.753 that the latest version of the CDL cluster reduction procedure as submitted to RAN4#116 could result in a reduced CDL table with minor deviations with respect to the one used to generate simulation results, however no impact is expected to the conclusions.**  **Proposal 4: RAN4 to capture the qualitative observations included in this sections related to the autocorrelation function of the CDL clusters. In detail, we have observed its long duration and its high value between I/Q components.** |
| [**R4-2509395**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509395.zip) | Nokia | **=== TR38.753 CDLC**  **Observation 1:** A significant cluster of implementations of the RAN4#115 version of 38.753 CDLC, are well aligned and thus show the channel model proving a sound basis for performance requirements.  **Proposal 1: RAN4 shall declare that TR 38.753 CDLC is alignable and used implementations from a significant cluster of contributors are aligned.**  **Observation 2:** The RAN4#115 description of TR 38.753 CDLC is both stable and complete.  **Proposal 2: RAN4 to change the term “randomness reduction” framework to “convergence and alignment speedup framework”.**  **Proposal 3: RAN4 to recommend an additional AS scaling step (to AS\_desired) at the end of the cluster truncation procedure, for creation of tables to be used in future normative requirements.**  **Proposal 4: RAN4 to clarify that in the cluster truncation procedure, angular dependent gains stemming from the AAV and AE field patterns are to be calculated based on cluster mean angles.**  **Observation 3:** In MU-MIMO scenario related to two UEs, the CDL model #1 used by UE1 and the CDL model #2 used by UE2 should contain the same clusters. Then, it is considered reasonable to have some variation on cluster power, angle, and delay between those two CDL models.  **Observation 4:** The spatial consistency should be considered for MU-MIMO scenarios during the simulation. The channel model generated for both UE1 and UE2 should be based on the same clusters. One model can be generated first and the other model can be adjusted based on the first model.  **Observation 5:** Removing the clusters with same angular information from TR 38.901 CDL models may hurt the non-WSS channel characteristic in the frequency/delay domain for wide system bandwidth use cases. A non-truncated CDL model may be more suitable for high bandwidth MU-MIMO scenarios. |
| [**R4-2509153**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509153.zip) | Orange, Fraunhofer | **General observation 1**  The 38.753 CDL channel model can demonstrate the benefit of high-resolution compared to low-resolution codebooks for relevant scenarios, in contrast to the legacy TDL channel model, and contributor implementations have shown to be aligned in terms of SU-PMI performance.  **Proposal 1**  **RAN4 to agree to use and recommend usage of the 38.753 CDL channel model for PMI testing.**  **General Observation 2**  To improve performance requirements for high-resolution codebooks under the 38.753 CDL model, RAN4 may define specific CDL parameters as well as CSI-RS channel estimation assumptions to better differentiate the performance of high- and low-resolution codebooks, in the future.  **Proposal 2**  **RAN4 shall consider the following 38.753 CDL model and parameter configurations to improve differentiation of high- and low-resolution codebook performance:**  **Increase the number of antenna ports to at least 32.**  **Align the angular spread parameters of the 38.753 CDL model with those of 38.901, i.e., ASD=39.0949°, ASA=71.1175°, ZSD=4.0665°, ZSA= 10.4245°.**  **Apply power boosting for CSI-RS based channel estimation.** |
| [**R4-2509478**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509478.zip) | Apple | **CDL based methodologies**  **Observation 1:** RAN4 requirements are band agnostic  **Observation 2:** UMa-CDL-C1 channel is only for 3.5 GHz band and suitable for some TDD bands.  **Observation 3:** Options discussed in last meeting still need further study and evaluation  **Observation 4:** UMa-CDL-C1 is not a suitable candidate for defining requirements without further study on frequency generalization.  **Proposal 3: Further study frequency band generalization aspects of UMa-CDL-C1 prior to defining any demodulation performance requirements with it.**  **Observation 5:** For Uma-CDL-C1 channel we observe similar performance with different initial seeds.  **Observation 6:** For UMa-CDL-C1 the convergence time is comparable to legacy TDL channel models. |
| [**R4-2509652**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509652.zip) | MediaTek inc. | **Observation #1:** The spatial selectivity properties of CDL-C models A2 and A4 are very similar.  **Observation #2:** The frequency coherence properties of CDL-C models A2 and A4 are different due to the different channel power delay profiles.  **Observation #3:** The time coherence properties of CDL-C models A2 and A4 are similar.  **Observation #4:** The spatial selectivity properties of the multi-cluster TDL models depend on the cluster parameter setting**.**  **Observation #5:** The frequency and time coherence properties of the multi-cluster TDL models strictly follow the properties of the underlying legacy TDL model.  **Observation #6:** RAN1 has significantly changed the AS scaling process definition in TR 38.901 from version V18.0.0 to version V19.0.0.  **Observation #7**: In the scope of Rel-19 and TR 38.753, it is not possible for RAN4 to follow TR 38.901 V19.0.0.  **Observation #8:** Since AS process in TR 38.901 V18.0.0 was ambiguously written, it is not clear whether this SI has followed it or not.  **Proposal #2:** **TR 38.753 should include a detailed description of the AS process adopted in this SI.** |
| [**R4-2510437**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510437.zip) | Samsung | **Observation 3:** For TR38.753 sub-section 5.1.4.1, it seems the description of power weighted mean angle is independent with the angle scaling formula.  **Proposal3: For TR38.753 sub-section 5.1.4.1, the descriptions for power weighted mean angle should be updated to power weighted cluster mean angle defined in 38.901 Annex A.4.**  **Proposal4: For TR38.753 sub-section 5.1.4.1, the descriptions for mean angle and power weighted mean angle should be combined together in order to avoid ambiguous statement.**  **Observation 4:** For the AoA/AoD/ZoA/ZoD angles, it seems tables for CDLA/CDLB/CDLC/CDLD/CDLE are suitable for all carrier frequencies according the description in 38.901 section 7.7.1.  **Proposal 5: RAN4 to use the same CDL channel model/table for all FR1 FDD and FR1 TDD test assumptions.**  **Observation 5:** The scale factors for Azimuth angles we used in 38.753 seems larger than RAN1’s defination in 38.901 Table 7.7.5.1-1.  **Proposal 6: RAN4 to study if the CDL scale factors used in 38.753 should be updated.** |
| [**R4-2510712**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510712.zip) | Ericsson | **Observation 1** Large difference on preferred PMI among companies due to potential different implementations on PMI selection.  **Observation 2** eType-II codebook shows much better performance than type-I code book with 32Tx without SNR normalization.  **Observation 3** It would be more realistic to use smaller AE vertical HPBW when larger vertical separation is applied.  **Observation 4** The agreed CDL based model profile besides Doppler shift can be applied for whole FR1 bands.  **Observation 5** It is not suitable to compare throughput performance between different Tx antenna array sizes or different number of CSI ports no matter if a simple SNR normalization is applied or not.  **Observation 6** CDLC A4 and CDLC A2 model have almost same TC and FC properties.  **Observation 7** TDLC model shows a sharper peak in both TC and FC compared to CDLC models.  **Observation 8** The angular power distribution of CDLC A4 is aligned with expectation.  **Observation 9** The properties of long-term angular preference of CDL-based model is aligned with the observation from field measurement results.  **Observation 10** CDLC A2 (20 clusters) and CDLC A4 (12 clusters) show similar performance in most simulation cases.  **Observation 11** It would be better to further investigate how to create less variant truncation models for most typical antenna configurations.  **Proposal 1 Capture more descriptions on spatial filter creation in truncated CDL model generation in final TR.**  **Proposal 2 Only consider 3.5GHz for Doppler evaluation in Rel-19 and consider other values in future release for specific scenarios.** |
| [**R4-2510885**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510885.zip) | Huawei,HiSilicon | **Observation 1:** It has been agreed that PMI (4,0,0) is the optimal precoder for CDL-C-A4 channel and may be used as one parameter for PDSCH requirements definition in the further release. There is single CDL channel model for PDSCH and PMI tests, which means the best PMI has been informed to the tested UE**.**  **Proposal 1: Capture following wording on beam steering for CDL channel in TR:**   * **One contribution expresses the concern that the angular values of the agreed CDL mode is fixed, which is not suitable for PMI test for the reason that the PMI statistic is biased and a fixed precoder (for example, PMI (i1,1, i1,2, i2)=(4,0,0) for single-panel I codebook) performs better than channel adaptive precoders performed by PMI selection algorithm, leading that UE PMI selection may not be verified correctly. For example, UE constantly reporting PMI (i1,1, i1,2, i2)=(4,0,0), which has been revealed and can be pre-acquired without precoder selection may also past the PMI test. It is expected that the improvement could be made in the future release.**   **Observation 2:** Option 2 against the intention that introducing CDL channel to make the channel model for demodulation test more practical.  **Proposal 2:** **Capture following wording on frequency generalisation channel in TR:**   * **Some contributions express the concern that the agreed CDL channel is generalized according to certain frequency (3.5GHz), which may not be aligned with the FDD real deployment and may not be reasonably used for FDD demodulation test.** |

## Open issues summary

### Sub-topic 4-1: CDL Alignment

#### Issue 4-1-1: SU PDSCH CDL Alignment

Options:

* Option 1: RAN4 shall declare that TR 38.753 CDLC is alignable and implementations from a significant cluster of contributors are aligned. *(Nokia)*
* Option 2: There is good alignment in results with Uma-CDL-C1 for 4x4 4L PDSCH. There is large span for 8x8 8L (Apple)

Recommended Way Forward:

* Confirm during RAN4#116 whether the consensus view is that TR 38.763 CDL-C is alignable for SU PDSCH and that implementations from a cluster of contributors are aligned.

#### Issue 4-1-2: SU PMI CDL Alignment

Options:

* Option 1: RAN4 shall declare that TR 38.753 CDLC is alignable and implementations from a significant cluster of contributors are aligned. *(Nokia)*
  + Option 1a: RAN4 to agree to use and recommend usage of the 38.753 CDL channel model for PMI testing. (*Orange/Fraunhofer)*
* Option 2: There is good alignment with Uma-CDL-C1 for Type I CB, but larger span with eType II codebook.(Apple)

Recommended Way Forward:

* Confirm during RAN4#116 whether the consensus view is that TR 38.763 CDL-C is alignable for SU PMI and that implementations from a cluster of contributors are aligned.

### Sub-topic 4-2: CDL Configurations

#### Issue 4-2-1: Cluster Reduction/Truncation Procedure

Options:

* Option 1: RAN4 should capture in TR38.753 that the latest version of the CDL cluster reduction procedure as submitted to RAN4#116 could result in a reduced CDL table with minor deviations with respect to the one used to generate simulation results, however no impact is expected to the conclusions. (*Qualcomm)*
  + Option 1A: RAN4 to capture the qualitative observations included in this sections related to the autocorrelation function of the CDL clusters. In detail, we have observed its long duration and its high value between I/Q components. (*Qualcomm)*
* Option 2: RAN4 to clarify that in the cluster truncation procedure, angular dependent gains stemming from the AAV and AE field patterns are to be calculated based on cluster mean angles. (*Nokia*)
* Option 3: Capture more descriptions on spatial filter creation in truncated CDL model generation in final TR. (*Ericsson*)

Recommended Way Forward:

* Several companies would like to clarify the Truncation procedure, to optimise time during the final meeting of SCM SI in Rel-19, companies should focus on agreeing the content of Annex B and/or Section 5.1 – thus requiring revisions to R4-2509481 and R4-2509654.
* Discussion will be captured on specific details during RAN4#116 and any agreements as such noted in a Way Forward.

#### Issue 4-2-2: Angular Scaling

Options:

* Option 1: RAN4 to use the updated angular scaling procedure in TR38.901, version 19.0.0, section 7.7.5.1. (*Qualcomm)*
* Option 2: RAN4 to endorse the draftCR R4-2509115 that proposes to introduce a variable to capture the scaled and translated cluster angle. A mirror CR is submitted to RAN1 for approval. (*Qualcomm)*
* Option 3: RAN4 to recommend an additional AS scaling step (to AS\_desired) at the end of the cluster truncation procedure, for creation of tables to be used in future normative requirements. *(Nokia)*
* Option 4: TR 38.753 should include a detailed description of the AS process adopted in this SI. *(MediaTek)*
  + Option 4a: For TR38.753 sub-section 5.1.4.1, the descriptions for power weighted mean angle μ\_φ should be updated to power weighted cluster mean angle defined in 38.901 Annex A.4. (*Samsung*)
  + Option 4b: For TR38.753 sub-section 5.1.4.1, the descriptions for mean angle μ\_(φ,"model" ) and power weighted mean angle μ\_φ should be combined together in order to avoid ambiguous statement. (*Samsung*)

Recommended Way Forward:

* Several companies would like to update the Angular Scaling procedure, to optimise time during the final meeting of SCM SI in Rel-19, companies should focus on agreeing the content of Annex B and/or Section 5.1 – thus requiring revisions to R4-2509481 and R4-2509654.
* Discussion will be captured on specific details during RAN4#116 and any agreements as such noted in a Way Forward.

#### Issue 4-2-3: Alignment/Interaction with TR 38.901

Options:

* Option 1: RAN4 to endorse the draftCR R4-2509115 that proposes to introduce a variable to capture the scaled and translated cluster angle. A mirror CR is submitted to RAN1 for approval. (*Qualcomm)*
* Option 2: RAN4 to study if the CDL scale factors used in 38.753 should be updated, based upon 38.901 Table 7.7.5.1-1 (*Samsung)*

Recommended Way Forward:

* Discuss during the meeting whether the scaling factors from the updated TR 38.901 Table 7.7.5.1-1 should update those in TR 38.753.
* Companies invited to review ahead of time R4-2509115 for discussion during RAN4#116.

### Sub-Topic 4-3: General CDL Considerations

#### Issue 4-3-1: ‘Randomness Reduction’ vs ‘convergence and alignment speedup framework’

Options:

* Option 1: RAN4 to change the term “randomness reduction” framework to “convergence and alignment speedup framework” (*Nokia)*

Recommended Way Forward:

* Decision required during RAN4#116, consistent wording will then be applied to all revised pCRs to TR 38.753; double checked in submission of TR 38.753 v1.1.0 by rapporteur.

#### Issue 4-3-2: Frequency Band Generalisation

Options:

* Option 1: Further study frequency band generalization aspects of UMa-CDL-C1 prior to defining any demodulation performance requirements with it. (*Apple*)
* Option 2: Only consider 3.5GHz for Doppler evaluation in Rel-19 and consider other values in future release for specific scenarios. (*Ericsson*)
* Option 3: RAN4 to use the same CDL channel model/table for all FR1 FDD and FR1 TDD test assumptions. (*Samsung*)
* Option 4: Capture following wording on frequency generalisation channel in TR *(Huawei)*:
  + “Some contributions express the concern that the agreed CDL channel is generalized according to certain frequency (3.5GHz), which may not be aligned with the FDD real deployment and may not be reasonably used for FDD demodulation test.”

Recommended Way Forward:

* Future work item and demodulation requirements will be discussed during those future work items, noting that no requirements will be defined in Rel-19.
* RAN4 shall consider TR 38.753 CDL as suitable at least for 3.5 GHz, but due to opposing views regarding other carrier frequencies (and FDD/TDD) discussion and decision is required during the meeting as to TR wording.

#### Issue 4-3-3: Beam Steering

Options:

* Option 1: Capture following wording on beam steering for CDL channel in TR (*Huawei*):
  + “One contribution expresses the concern that the angular values of the agreed CDL mode is fixed, which is not suitable for PMI test for the reason that the PMI statistic is biased and a fixed precoder (for example, PMI (i1,1, i1,2, i2)=(4,0,0) for single-panel I codebook) performs better than channel adaptive precoders performed by PMI selection algorithm, leading that UE PMI selection may not be verified correctly. For example, UE constantly reporting PMI (i1,1, i1,2, i2)=(4,0,0), which has been revealed and can be pre-acquired without precoder selection may also past the PMI test. It is expected that the improvement could be made in the future release.”

Recommended Way Forward:

* If consensus can be achieved during RAN4#116, confirm that this wording can be included in the TR as an informative note.

#### Issue 4-3-4: Differentiation of high- and low-resolution codebooks

Options:

* Option 1: RAN4 shall consider the following 38.753 CDL model and parameter configurations to improve differentiation of high- and low-resolution codebook performance (*Orange*):
  + Increase the number of antenna ports to at least 32.
  + Align the angular spread parameters of the 38.753 CDL model with those of 38.901, i.e., ASD=39.0949°, ASA=71.1175°, ZSD=4.0665°, ZSA= 10.4245°.
  + Apply power boosting for CSI-RS based channel estimation.

Recommended Way Forward:

* If strong support is achieved for the proposed wording, confirm that this can be included in the TR, and if so where it should be included in the TR.

# Topic #5: Alignment of SCM implementations

## Companies’ contributions summary

| T-doc number | Source | Proposals / Observations |
| --- | --- | --- |
| [**R4-2509478**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509478.zip) | Apple | **Alignment**  **Observation 7:** There is good alignment in results with Uma-CDL-C1 for 4x4 4L PDSCH, PMI with Type I CB .  **Observation 8:** Large span is results is observed with UMa-CDL-C1 for 8x8 8L test case and PMI with eType II codebook – the targeted use cases for SCM.  **Observation 9:** It is not typical to align operating SNR for PMI reporting requirements**.** |
| [**R4-2510711**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510711.zip) | Ericsson | **Proposal 2 Adding total normalized throughput results for 8 layers PDSCH in alignment chapter.** |
| [**R4-2510885**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510885.zip) | Huawei,HiSilicon | **Observation 3:** Aligning SNR point with quite limited number of simulation cases (One MCS and one doppler) is not enough to confirm the alignment of channel implementation.  **Proposal 3: The alignment part of TR should cover not only SNR points collection but also channel properties if provided by companies such as power spectrum distribution, time coherent and frequency coherent.** |

## Open issues summary

### Sub-topic 5-1: Alignment Criteria

#### Issue 5-1-1: Addition of Normalised Throughput Results for 8 layer PDSCH

Options:

* Option 1: Adding total normalized throughput results for 8 layers PDSCH in alignment chapter. (*Ericsson)*

Recommended Way Forward:

* Keep per-codeword results for 8-layer unless strong reasoning presented, along with a cluster of companies simulation results, noting this is the last meeting of the study item in RAN4.

#### Issue 5-1-2: Alignment section in the TR

Background (from RAN4#115 Way Forward R4-2508624):

|  |
| --- |
| Comparison between TDL and CDL Agreement:  Channel Properties to be used for Comparison only, not for alignment.  Way Forward:  Utilise channel properties to compare across channel model candidates (Enhanced TDL and CDL) in each comparison case utilising the following properties, qualitative assessment discussions to be brought to RAN4#116 based on the following parameters:   * Power Angular/Phase Distribution in Tx and Rx Directions (including comments on stability and diversity) * Time Coherence as channel correlation between symbols * Frequency Coherence measured as channel correlation between subcarriers |

Options:

* Option 1: The alignment part of TR should cover not only SNR points collection but also channel properties if provided by companies such as power spectrum distribution, time coherent and frequency coherent. (*Huawei)*

Recommended Way Forward:

* The agreement from RAN4#115 states that channel properties should be captured in the comparison section of the TR. Therefore, they shall remain there, unless significant justification can be provided during RAN4#116.

# Topic #6: Comparison of Methodologies

## Companies’ contributions summary

| T-doc number | Source | Proposals / Observations |
| --- | --- | --- |
| [**R4-2511328**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511328.zip) | BT plc | **Observation 1:** Measurements reconfirm the existence of long-term stable spatial receive directions experienced by typical operational MIMO systems.  **Observation 2:** Channel experiences a shorter coherence time in urban conditions compared to suburban and rural. This translates in associated Doppler spread expected for these three operating environment classes.  **Observation 3:** Singular values of MIMO channel in operational network generally exhibit a span of several dB. Within that span, eigenmodes are spread with respect to specific operating conditions. |
| [**R4-2509652**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509652.zip) | MediaTek inc. | **Proposal #1:** **We propose the following chapter “Channel Statistics Comparison” to be included in TR 38.753.**  ***(See R4-2509652 for details of the text proposed)*** |
| [**R4-2509395**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509395.zip) | Nokia | **=== Comparison of methodologies**  **Proposal 5: To compare channel models, have each contributor set performance or channel property expectations for each comparison case. Then, each contributor compares their observations from simulations against their expectations, to subjectively decide whether channel models fit expectations. Context on importance of expectations for RAN4 minimum performance requirements is also given.**  **Proposal 6:** **RAN4 to capture the following observations on the TDL low channel model:**  **- Overly optimistic channel matrix condition values.**  **- Neither performance impact from PMI choice nor DoA nor related SDM receiver implementation.**  **Proposal 7: RAN4 to capture the following observations on the TDL nonLow channel model:**  **- Contradicting and non-consistent performance scaling behaviour and results (e.g., 1CW PMI).**  **- Unjustified channel condition degradation and SNR requirement increase.**  **- Needs heuristic correlation tuning to show expected performance scaling, hence unreliable for new features.**  **Proposal 8: RAN4 to capture the following observations on the CDL channel model:**  **- Highlights SDM receiver issues. - Reasonable SNR range.**  **- Matches etypeII vs. typeI deployment observations.**  **- Significantly different performance between random and follow precoding.**  **- Reliable performance scaling trends and explainable channel matrix condition numbers.**  **- Matches deployment observations on advanced receivers in MU adjacent setups.**  **Proposal 9: RAN4 to capture the performance curves all contributors in the TR, for (at least) the following use cases/configurations: SU 2CW MIMO PDSCH, SU 1CW MIMO PDSCH, SU PMI 4 layers.**  **Proposal 10: RAN4 to capture all Nokia contributed performance curves from this section in the TR.**  **Observation 6:** The convergence speed, and hence testing time, of TR 38.753 CDLC is on par with legacy TDL nonLow and well within the number of samples needed for requirement quality evaluations. Furthermore, CDL convergence speed is independent of starting seed.  **Proposal 11: RAN4 to capture above convergence properties results in the TR, along with the observation that TR 38.753 CDLC convergence speed, and hence testing time, is on par with legacy TDL nonLow.**  **Observation 7:** The spatial properties of legacy channel models do not match the measured typical deployment MIMO characteristics (“limited number of mid-term stable directions”), while TR 38.753 CDLC matches very well.  **Proposal 12: RAN4 to capture above spatial properties results in the TR, along with the observation that the spatial properties of legacy channel models do not match the measured typical deployment MIMO characteristics, while TR 38.753 CDLC matches very well.**  **Observation 8:** The PDSCH post-EQ SINR profiles, when using TDL channel models do not match measurements. SDM processing does not impact performance, when using TDL channel models. CDL both shows typical post-EQ SINR profiles and typical deployment spatial components.  **Proposal 13: RAN4 to capture above post-EQ SINR distribution results in the TR, along with the observation that TDL low channel models do not model mid-term stable per layer post-EQ SINR differences, and TDL nonLow do not model meaningful per layer post-EQ SINR differences at all.** |
| [**R4-2509478**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509478.zip) | Apple | **Comparison of methodologies**  **Proposal 4:** **Test metrics for performance comparison:**  **SU-MIMO PDSCH**  **SNR at 70% Max TP**  **SU-PMI**  **Gamma at 90% Max TP with follow Type I PMI**  **Gamma at 90% Max TP with follow eType TI PMI**  **SNR at 70% Max TP for follow Type I PMI**  **SNR at 70%Max TP for follow eType II PMI**    **Observation 10:** Comparing UMa-CDL-C1 with ULA antenna array configuration is not appropriate.  **Observation 11:** Correlation coefficient with TDL channel must be chosen based on number of TX/RX. There is no suitable MIMO correlation in RAN4 for 8x8 with ULA or XP.  **Proposal 5: Antenna array configuration and correlation coefficient of legacy channel model for comparison must be chosen to match UMA-CDL-C1 in some respects.** |

## Open issues summary

### Sub-topic 6-1: Metrics Definition

#### Issue 6-1-1: Test Metrics

Options:

* Option 1: Test metrics for performance comparison *(Apple*):

SU-MIMO PDSCH

SNR at 70% Max TP

SU-PMI

Gamma at 90% Max TP with follow Type I PMI

Gamma at 90% Max TP with follow eType TI PMI

SNR at 70% Max TP for follow Type I PMI

SNR at 70%Max TP for follow eType II PMI

* Option 2: RAN4 to capture the performance curves all contributors in the TR, for (at least) the following use cases/configurations: SU 2CW MIMO PDSCH, SU 1CW MIMO PDSCH, SU PMI 4 layers. (*Nokia*)
  + Option 2a: RAN4 to capture all Nokia contributed performance curves in Chapter 6 of the TR. (*Nokia*)

Recommended Way Forward:

* At minimum the following test metrics for performance will be used in the TR:

SU-MIMO PDSCH (4 Layer and 8 Layer)

SNR at 70% Max TP

SU-PMI (4 Layer)

Gamma at 90% Max TP with follow Type I PMI

Gamma at 90% Max TP with follow eType TI PMI

SNR at 70% Max TP for follow Type I PMI

SNR at 70%Max TP for follow eType II PMI

* Discussion on capturing performance curves and inclusion in TR 38.753 to happen during RAN4#116.

### Sub-topic 6-2: Channel Statistics for Comparison

#### Issue 6-2-1: Channel Statistics for Comparison

Options:

* Option 1: We propose the following chapter “Channel Statistics Comparison” to be included in TR 38.753. (*MediaTek)*

(See R4-2509652 for details of the text proposed)

Recommended Way Forward:

* Include as Chapter 6.3 if consensus text can be agreed during RAN4#116, noting other comparison aspects may wish to be included.

#### Issue 6-2-2: Comparison Methodology

Options:

* Option 1: To compare channel models, have each contributor set performance or channel property expectations for each comparison case. Then, each contributor compares their observations from simulations against their expectations, to subjectively decide whether channel models fit expectations. Context on importance of expectations for RAN4 minimum performance requirements is also given. (*Nokia*)
* Option 2: RAN4 to capture convergence properties results in the TR, along with the observation that TR 38.753 CDLC convergence speed, and hence testing time, is on par with legacy TDL nonLow. (*Nokia*)

Recommended Way Forward:

* Discuss during RAN4#116 regarding information required to capture in TR regarding convergence properties.
* Regarding channel or performance property expectations, revisions of pCRs to Chapter 6 of TR 38.753 will be required, and outstanding issues will be captured in a way forward.

### Sub-topic 6-3: Comparison with Legacy Channels

#### Issue 6-3-1: Comparison with Legacy TDL – Antenna and Correlation Coefficient

Background (from RAN4#115 Way Forward R4-2508624):

|  |
| --- |
|  |

Options

* Option 1: Antenna array configuration and correlation coefficient of legacy channel model for comparison must be chosen to match UMA-CDL-C in some respects. (*Apple*)

Recommended Way Forward:

* Appreciating the discussion raised by contributions, a brief discussion may occur during RAN4#116, but noting that a previous agreement has already been agreed on TDLC 300-10/100 with various correlations, and results have been brought to RAN4#116 with those parameters with, significant justification must be brought if another legacy TDL is to be proposed.

### Sub-topic 6-4: Specific Comparison Wording Proposals

#### Issue 6-4-1: Observations on TDL Low

Options

* Option 1: RAN4 to capture the following observations on the TDL low channel model (*Nokia*):
  + Overly optimistic channel matrix condition values.
  + Neither performance impact from PMI choice nor DoA nor related SDM receiver implementation.

Recommended Way Forward:

* If consensus is achieved for the proposed wording, confirm that this can be included in the TR, and if so where it should be included in the TR.

#### Issue 6-4-2: Observations on TDL nonLow

Options

* Option 1: RAN4 to capture the following observations on the TDL nonLow channel model (*Nokia*):
  + Contradicting and non-consistent performance scaling behaviour and results (e.g., 1CW PMI).
  + Unjustified channel condition degradation and SNR requirement increase.
  + Needs heuristic correlation tuning to show expected performance scaling, hence unreliable for new features.

Recommended Way Forward:

* If consensus is achieved for the proposed wording, confirm that this can be included in the TR, and if so where it should be included in the TR.

#### Issue 6-4-3: Observations on CDL

Options

* Option 1: RAN4 to capture the following observations on the CDL channel model (*Nokia*):
  + Highlights SDM receiver issues. - Reasonable SNR range.
  + Matches etypeII vs. typeI deployment observations.
  + Significantly different performance between random and follow precoding.
  + Reliable performance scaling trends and explainable channel matrix condition numbers.
  + Matches deployment observations on advanced receivers in MU adjacent setups.

Recommended Way Forward:

* If consensus is achieved for the proposed wording, confirm that this can be included in the TR, and if so where it should be included in the TR.

#### Issue 6-4-4: Post equalisation SINR Profile

Options

* Option 1: RAN4 to capture post-EQ SINR distribution results in the TR, along with the observation that TDL low channel models do not model mid-term stable per layer post-EQ SINR differences, and TDL nonLow do not model meaningful per layer post-EQ SINR differences at all. (*Nokia*):

Recommended Way Forward:

* Clarify during RAN4#116 if these observations present the consensus view, and discuss how they can be captured in TR 38.753.
* During the meeting it may be appropriate that this is merged with the discussion under Issue 6-2-1; as this proposal is similar to that in nature to the text proposed by MediaTek.

# Topic #7: Other

## Companies’ contributions summary

| T-doc number | Source | Proposals / Observations |
| --- | --- | --- |
| [**R4-2509395**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509395.zip) | Nokia | **=== Further topics for discussion**  **Proposal 14: The study TR shall contain a recommendation that any SCM requirements in 5GNR are recommended to be optional via optional UE capability/BS declaration and corresponding applicability rules.**  **Proposal 15: RAN4 to capture the following aspects about TR 38.753 CDLC as outcome of the FS\_NR\_demod\_SCM work:**  **- CDL covers typical spatial channel effects expected in deployment, as well as measurements, and is aligned with RAN1 assumptions for feature development.**  **- CDL implementations used to contribute to the study are majority wise aligned.**  **- CDL is aligned with TE implementation requirements.**  **- CDL is preferred SCM for the large majority of contributors.**  **- CDL is ready for use to specify normative demodulation and CSI performance requirements for SU MIMO cases in FR1.**  Additionally, for SCMs in general, specific use cases have been identified especially for setups with multiple codewords, advanced receivers, enhanced codebooks, and SDM reliant cases in general. |

## Open issues summary

### Sub-topic 7-1: Future Potential Requirements

#### Issue 7-1-1: Future Potential Requirements

Options:

* Option 1: The study TR shall contain a recommendation that any SCM requirements in 5GNR are recommended to be optional via optional UE capability/BS declaration and corresponding applicability rules. (*Nokia)*

Recommended Way Forward:

* Include optional recommendation for future 5G-Advanced requirements, if no immediate consensus can be achieved during RAN4#116 then this should be discussed as part of a potential Rel-20 WI.

### Sub-topic 7-2: Study Conclusions

#### Issue 7-2-1: Study Conclusions

Options:

* Option 1: RAN4 to capture the following aspects about TR 38.753 CDLC as outcome of the FS\_NR\_demod\_SCM work (*Nokia*):
  + - CDL covers typical spatial channel effects expected in deployment, as well as measurements, and is aligned with RAN1 assumptions for feature development.
    - CDL implementations used to contribute to the study are majority wise aligned.
    - CDL is aligned with TE implementation requirements.
    - CDL is preferred SCM for the large majority of contributors.
    - CDL is ready for use to specify normative demodulation and CSI performance requirements for SU MIMO cases in FR1.
  + Additionally, for SCMs in general, specific use cases have been identified especially for setups with multiple codewords, advanced receivers, enhanced codebooks, and SDM reliant cases in general.

Recommended Way Forward:

* Noting these conclusions are included in the Nokia pCR (R4-2509114) discussion during the meeting shall focus on that specific pCR rather than Issue 7-2-1.
* Comments regarding these conclusions can be captured during RAN4#116 to support the revision of R4-2509114 if there are opposing views.

# Recommended Disposition of TDocs

|  |  |  |
| --- | --- | --- |
| T-doc number | Suggested Status | Comments (Optional) |
| [**R4-2509112**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509112.zip) | Noted |  |
| R4-2511465 | TBD | *Topic Summary* |
| [**R4-2509113**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509113.zip) | Noted | *pCR* |
| R4-2509114 | Post-Meeting Approval | *Draft TR* |
| [**R4-2509115**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509115.zip) | TBD | *Draft CR for TR 38.901* |
| R4-2509413 | TBD | *Result Collection Table - Comparison* |
| [**R4-2509732**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509732.zip) | TBD | *pCR* |
| [**R4-2510711**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510711.zip) | Noted |  |
| [**R4-2510714**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510714.zip) | TBD | *pCR* |
| [**R4-2509153**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509153.zip) | Noted |  |
| [**R4-2509172**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509172.zip) | Noted | *Simulation results* |
| [**R4-2509193**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509193.zip) | Noted | *Simulation results* |
| [**R4-2509195**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509195.zip) | TBD | *pCR* |
| [**R4-2509395**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509395.zip) | Noted |  |
| [**R4-2509396**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509396.zip) | Noted | *Simulation results* |
| [**R4-2509478**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509478.zip) | Noted |  |
| [**R4-2509479**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509479.zip) | Noted | *Simulation results* |
| R4-2509480 | TBD | *Result Collection Table - Alignment* |
| [**R4-2509481**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509481.zip) | TBD | *pCR* |
| [**R4-2509652**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509652.zip) | Noted |  |
| [**R4-2509653**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509653.zip) | Noted | *Simulation results* |
| [**R4-2509654**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509654.zip) | TBD | *pCR* |
| [**R4-2509856**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509856.zip) | Noted |  |
| [**R4-2510437**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510437.zip) | Noted |  |
| [**R4-2510438**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510438.zip) | Noted | *Simulation results* |
| [**R4-2510712**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510712.zip) | Noted |  |
| [**R4-2510713**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510713.zip) | Noted | *Simulation results* |
| [**R4-2510885**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510885.zip) | Noted |  |
| [**R4-2510886**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510886.zip) | Noted | *Simulation results* |
| [**R4-2510887**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510887.zip) | TBD | *pCR* |
| [**R4-2510987**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510987.zip) | Noted |  |
| [**R4-2510988**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510988.zip) | TBD | *pCR* |
| [**R4-2511327**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511327.zip) | Noted | *Simulation results* |
| [**R4-2511328**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511328.zip) | Noted |  |
| [**R4-2511329**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511329.zip) | TBD | *pCR* |