**3GPP TSG RAN Meeting #104 RP-24xxxx**

**Shanghai, China, 17th – 20th June, 2024**

**Source: [BT, Nokia, AT&T, Bell Mobility, Bouygues Telecom, China Telecom, CMCC, Deutsche Telekom, Ericsson, Intel, KDDI, Keysight, KT Corp., MediaTek, Orange, Qualcomm, Rohde & Schwarz, Samsung, SK Telecom, Spark NZ, Telecom Italia, Telenor, Telia Company, Telstra, T-Mobile USA, Verizon, Vodafone]**

**Title:** **New SID: Study on spatial channel model for demodulation performance requirements**

**Document for: Approval**

**Agenda Item: X.X.X.X**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

# Title: Study on spatial channel model for demodulation performance requirements

## Acronym: [FS\_NR\_demod\_SCM]

## Unique identifier: XXXXXX

NOTE: For new WIs/SIs leave the Unique identifier empty and make a proposal for an Acronym.

 For a revised WI/SI: Take Unique identifier and acronym as shown in 3GPP workplan.

 If this is a RAN WID including Core and Perf. part, then Title, Acronym and Unique identifier refer to the feature WI.

 Please tick (X) the applicable box(es) in the table below:

 Either:

|  |  |
| --- | --- |
| **This WID includes a Core part** |  |
| **This WID includes a Performance part** | **X** |

 or:

|  |  |
| --- | --- |
| **This WID includes a Testing part** |  |
| **and it addresses the following 3GPP work area:** | **Radio Access** |  |
| **Core Network** |  |
| **Services** |  |

Potential target Release: Rel-19.

Note that this field above indicates the proposed Release at the time of submission of the WID to TSG approval. It can later be changed without a need to revise the WID. The updated target Release is indicated in the Work Plan. NOTE: In case of contradiction with the target dates of clause 5, clause 5 determines the target release.

## 1 Impacts *{ For Normative work, identify the anticipated impacts. For a Study, identify the scope of the study.}*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Affects:** | UICC apps | ME | AN | CN | Others (specify) |
| **Yes** |  | X | X |  |  |
| **No** | X |  |  | X | X |
| **Don't know** |  |  |  |  |  |

## 2 Classification of the Work Item and linked work items

### 2.1 Primary classification

This work item is a …

|  |  |
| --- | --- |
|  | Feature |
|  | Building Block |
|  | *Work Task* |
| X | Study Item |

### 2.2 Parent Work Item

|  |
| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
| N/A |  |  | N/A |

### 2.3 Other related Work Items and dependencies

|  |
| --- |
| Other related Work Items (if any) |
| Unique ID | Title | Nature of relationship |
| 830087 | RF requirements for NR frequency range 1 (FR1) | *relevant WI in Rel-16* |
| 890062 | RF requirements enhancement for NR frequency range 1 (FR1) | *relevant WI in Rel-17* |
| 950080 | Further RF requirements enhancement for NR frequency range 1 (FR1) | *relevant WI in Rel-18* |
|  | [MU-MIMO WIDs] |  |

**Dependency on non-3GPP (draft) specification**:

## 3 Justification

The motivation behind Spatial Channel Models (SCM), and specifically the Clustered Delay Line (CDL) model, is to enable the performance expectation of 5G NR features to be aligned with that experienced in deployment and/or field testing.

The existing method for channel modelling using the spatially agnostic TDL approach is commonly recognised in RAN1 and in Rel-15 RAN4 discussions as having significant limitations in MIMO use cases. This may be attributed to the fact that TDL channels on their own are spatially agnostic, i.e., any direction to transmit signals through the channel is as good as any other. Hence, the UE is not required to show that it can demodulate information across different MIMO layers of differing large environment dependent quality, which is contrary to the needs observed in a real deployment scenario. Such shortcomings are, for example, visible in 2-codeword requirements, where both codewords have the same performance requirements at the same time in Rel-18

Furthermore, spatially separating multiple users via MIMO receivers or MU precoding codebooks is only possible if the UEs’ channels are spatially separable. As a result, neither the Rel-16 NR\_eMIMO WI, nor the Rel-17 NR\_feMIMO WI were able to find a TDL based test setup suitable for the MU use case for which the newly introduced codebooks are designed.

Even if the UE conforms to the current minimum performance requirements, this does not guarantee that in the field the UE will make a reasonably efficient use of MIMO features specified since R15, e.g., providing appropriate channel state information to the network such that the network can make optimal use of the available MIMO layers. This could lead to suboptimal performance of mobile network operators’ (MNOs) networks or lead to sub-optimal investment in an operator’s network to optimise capacity performance.

MNOs have invested heavily in roll-out of 5G NR MIMO systems with enhancements specified since R15. They currently are unable to ensure a minimum performance of new 3GPP-specified functionality. If MNOs are unable to ensure minimum performance, it reduces confidence in investment into roll-out of 3GPP technologies. MIMO feature performance requirements need to be set under adequate test conditions that mimic MIMO effects observed in deployment as much as possible. The currently used TDL channels do not exhibit these effects nor match the expected statistics of a measured channel.

The ability to accurately model and predict MIMO performance in different spatial scenarios allows MNOs to take calculated judgements in deploying and optimising their networks for a given investment budget. Specified minimum performance requirements for the standardised features play an important role in deployment and planning of mobile networks that deliver services using 3GPP-specified functionality.

As such it is very important to add a spatial component to the channel model for RAN4 requirements, and RAN4 should in Rel-19 identify the most appropriate way to address such spatial differentiation. The same arguments apply for both uplink and downlink, including massive MIMO deployments. Therefore, a generic channel model with spatial differentiation can be helpful to emulate realistic network conditions and performance in conformance requirements.

Previous discussions of spatial channel modelling in RAN4 revolved around the TR 38.901 spatial channel model (CDL), which had challenges with complexity and repeatability when used for testing, and TDL based approaches. In Rel-16, the RAN4 testing session has developed a subgroup of 38.901 CDL, that is captured in TR 38.827, and which presents a tuned model that reduces randomness and implementation choices, to enable alignment between companies, implementation in test equipment, as well as straightforward repeatability.

## 4 Objective

### 4.1 Objective of SI or Core part WI or Testing part WI

None.

### 4.2 Objective of Performance part WI

NOTE: Leave empty if the WI proposal does not contain a RAN performance part.

The study item includes the following objectives:

* Study practical spatial channel modelling methodology for both SU- and MU-MIMO demodulation requirements and CSI reporting requirements:
	+ Identify the limitations of the current channel models and how they relate to UE MIMO performance
	+ Consider both CDL-based and TDL-based channel modelling approaches
		- For CDL-based channel modelling, use the tuned repeatable spatial channel model of TR38.827 as the starting point and identify any necessary changes.
	+ Verify test methodology feasibility including test complexity and achievable results uncertainty. The test complexity shall not be significantly increased.
	+ The methodology shall include both FR1 (conducted) and FR2 (wireless cable), with first priority for FR1.

### 4.3 RAN time budget request (not applicable to RAN5 WIs/SIs)

NOTE: For all new RAN related WIs/SIs which are not led by RAN WG5 the WI/SI rapporteur has to fill out the attached Excel table to request time budgets for corresponding RAN WG meetings.
The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI.
One time unit (TU) corresponds to ~ 2 hours in the meeting.
If no TU is needed, then leave the field empty otherwise enter a number >0 in the field.

 For revisions of already approved WI/SI descriptions: Please remove the Excel table from the WID/SID's zip file. The time budgets are already recorded. If you want to modify them, then this has to be done via the status report and not via a revised WID/SID.

 If this WID is covering Core and Performance part, then please fill out one line for each part in the attached Excel table.

**additional comments to the time budget request in the attached Excel table:**

## 5 Expected Output and Time scale

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| --- |
| **New specifications** *{One line per specification. Create/delete lines as needed}* |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Remarks |
| Internal TR | 38.xxx | Study on spatial channel model for demodulation performance requirements | RAN#107 | RAN#108 | Led by RAN4,rapporteur: Name, email |

*{Note 1: Only TSs may contain normative provisions. Study Items shall create or impact only TRs.
"Internal TR" is intended for 3GPP internal use only whereas "External TR" may be transposed by OPs.}*

NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
By default a new specs can only be new for one of both parts.

|  |
| --- |
| **Impacted existing TS/TR** *{One line per specification. Create/delete lines as needed}* |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
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NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
If an existing spec is affected by both (Core part and Perf. part), then it has to be listed twice with appropriate approval dates.

## Work item Rapporteur(s)

[TBD]

## 7 Work item leadership

Primary responsibility: RAN WG4

## 8 Aspects that involve other WGs

NOTE: For RAN WIs: Section 8 applies only toWGs outside of TSG RAN because RAN WG aspects have to be covered in section 4.

## 9 Supporting Individual Members

|  |
| --- |
| Supporting IM name |
| [BT] |
| [AT&T] |
| [Bell Mobility] |
| [Bouygues Telecom] |
| [China Telecom] |
| [CMCC] |
| [Deutsche Telekom] |
| [Ericsson] |
| [Intel] |
| [KDDI] |
| [Keysight] |
| [KT Corp.] |
| [MediaTek] |
| [Nokia] |
| [Orange] |
| [Qualcomm] |
| [Rohde & Schwarz] |
| [Samsung] |
| [SK Telecom] |
| [Spark NZ] |
| [Telecom Italia] |
| [Telenor] |
| [Telia Company] |
| [Telstra] |
| [T-Mobile USA] |
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