**3GPP TSG- Meeting #**

**Bengaluru, India, 25th - 29th Aug 2025**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  | **38.753** | **CR** | **TBD** | **rev** | **1** | **Current version:** | **1.0.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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| ***Title:***  | pCR to 38.753 Annex B and Section 5 |
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| ***Source to WG:*** | Qualcomm Incorporated, Apple Incorporated |
| ***Source to TSG:*** | RAN4 |
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| ***Work item code:*** | FS\_NR\_demod\_SCM |  | ***Date:*** | 2025-12-08 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-19 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
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| ***Reason for change:*** |  |
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| ***Summary of change:*** |  |
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| ***Consequences if not approved:*** |  |
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| ***Clauses affected:*** |  |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  |  |
| ***affected:*** |  | **x** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

### CHANGE #1

# Annex B: Modelling execution for CDL Channel Models

## B.1 Introduction

Unless otherwise specified, the procedure below is applied to all CDL models studied in this TR.

Parameters including for example as:

- CDL Tables

- Antenna Panel Configuration

- Antenna Array Virtualizer

are left up to the CDL model configuration.

## B.2 Common Execution steps to all CDL models

All the definition, indices, coordinate systems used in this section, unless otherwise specified, follow the relative definition as included in 3GPP TR 38.901 v19.0.0.

**Step 0: Set environment, network layout, antenna array parameters**

a) Give number of BS and UT. 3D location in the GCS of UT and BS are not necessary as LOS information are already included in the CDL table (see step d).

b) Give speed and direction of motion of UT in the global coordinate system

c) Specify system centre frequency  and bandwidth 

d) Specify CDL Table (includes already Angular spread and scaling)

**Step 1: Scaling and Translation of Angles**

The predefined angle values in the CDL models can be generalized by introducing angular translation and scaling. By translation, mean angle can be changed to and angular spread can be changed to match by scaling. The translated and scaled ray angles can be obtained according to the equations 7.5-5 and related (a, b, c, d) in TR 38.901 v19.0.0.

**Step 2: Spatial Filtering: use Antenna Array Virtualization procedure to obtain the BS and UT antenna field patterns *Frx* and *Ftx* in the global coordinate system and array geometries**

The 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 antenna port through a virtualizer (set of complex values), and can also be identified with the name of AAV.

The antenna panel configuration is defined as (M, N, P, Ms, Ns), according to the description below:

* M is the number of antenna elements per panel with the same polarization in each column (vertical size)
* N is the number of antenna elements per panel with the same polarization in each row (horizontal size)
* P is the number of polarizations
* Ms is the number of antenna elements per subarray with the same polarization in each column (vertical size)
* Ns is the number of antenna elements per subarray with the same polarization in each row (horizontal size)

Subarray/AAV, according to the convention above, can be uniquely described in a short form defined as AAV().

E.g. when the NR BS Antenna implements an antenna panel of size (8,1,2,8,1), the subarray can be identified as AAV(8,1). In this example, the Antenna Panel is composed of 8 cross-polarized antenna elements arranged in a single column, and each column of 8 elements with the same polarization belongs to one subarray/AAV.

Elements of each AAV are combined to form a beam by setting certain weights per element. Weight vector for the first polarization and for the second polarization is

Where

* is the location vector of each transmit antenna element in the subarray
* is a spherical unit vector denoting the virtualizer direction

If no virtualizer direction is specified, it is customary to consider broadside-emission at the AAV, thus the weight vector is real valued and all the elements are equal, e.g. [1,1 … 1]. Scaling factors can be applied only if they are consistent and equal for all AAVs in the panel.

The procedure to apply spatial filtering to CDL channels is also illustrated in Section 7.7.4.2 in TR 38.901 v 19.0.0, where it is used to generate TDL channel models. The same computation can be used to spatially filter the CDL profile using the AAV spatial response as specified in this section, retaining the cluster angles information (unlike when generating TDL profiles) for the next steps.

**Step 3: Couple rays within the cluster for both azimuth and elevation according to fixed coupling**

The AOD angles are coupled to AOA angles within a cluster *n*. The coupling is performed using the fixed coupling pattern specified in Table 5.1.4.2-1. The same fixed coupling pattern is applied for all clusters *n.*

**Step 4: Compute cross polarization power ratio**

The linear cross polarization power ratios (XPR) ** are calculated for each ray *m* of each cluster *n* as

,

where *X* is the per-cluster XPR in dB from Tables 7.7.1-1 – 7.7.1-5 of TR38.901.

**Step 5: Set the fixed initial phases for each ray in the cluster**

The set of fixed initial phases is same for all clusters, i.e. etc. for all four polarization combinations. These 20×4 initial phase values are specified in Table **5.1.4.2-**2.

**Step 6: Generate channel coefficients for each cluster *n* and each receiver and transmitter element pair *u, s*.**

Note: that the patterns are given in the GCS and therefore include transformations with respect to antenna orientation.  is the spherical unit vector with azimuth arrival angle *ϕn,m,AOA* and elevation arrival angle *θn,m,ZOA*, given by

 ,

where *n* denotes a cluster and *m* denotes a ray within cluster *n*.  is the spherical unit vector with azimuth departure angle *ϕn,m,AOD* and elevation departure angle *θn,m,ZOD*, given by

 ,

where *n* denotes a cluster and *m* denotes a ray within cluster *n*. Also, is the location vector of receive antenna element *u* and is the location vector of transmit antenna element *s*, *n,m* is the cross polarisation power ratio in linear scale, and is the wavelength of the carrier frequency. If polarisation is not considered, the 2x2 polarisation matrix can be replaced by the scalar  and only vertically polarised field patterns are applied.

The Doppler frequency component depends on the arrival angles (AOA, ZOA), and the UT velocity vector with speed *v*, travel azimuth angle *ϕv*, elevation angle *θv* and is given by

 

## B.3 Derivation of CDL Models for RAN4 Demod

### B.3.1 CDL Cluster Reduction

The Clustered Delay Line (CDL) profiles used in this study are simplified from the TR 38.901 CDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created.

**Step 0**: The CDL profile from TR 38.901 is the starting point. If the profile includes set of sub-clusters (defined in TR 38.901 as clusters generated from the two strongest clusters) with the same angle and fixed delay offsets, each sub-clusters set is combined(Note 1) in a single cluster with the minimum delay among the sub-clusters and power equal to the sum of the sub-clusters.

**Step 1**: Angle spread scaling (to match the ) and angle translation (to match the ) is applied to the CDL profile after sub-cluster combining, in order to extract the new cluster angles () according to the procedure specified in TR 38.901 v19.1.0 Section 7.7.5.1.

- The values for can be extracted from the table 7.7.5.1-1 according to the input desired (AoD, AoA, ZoA, ZoD) spreads or computed using the scaling factor calculation method described in 38.901 v19.1.0 Annex A.5

- Angle translation is effectively a rotation of the cluster from the point of view of the UE.

**Step 2**: Apply spatial filtering to the CDL profile generated in Step 1. This step ensures that the power-based reduction of the clusters considers the combined effect of the spatial channel and the AAV spatial response, and it is achieved by scaling each cluster average power with the AAV gain computed towards the respective mean cluster angle (see Annex B.3 for a detailed breakdown of the spatial filtering computation)

- The AAV gain assumes single AAV (subarray or single element) is used at the transmitter and/or at the receiver (where applicable).

- In the computation of the AAV gain the AAS orientation (downtilt, bearing, slant if applicable) needs also to be considered to obtain the correct AAV Gain

**Step 3**: Re-normalize cluster powers in the spatially filtered profile generated in Step 2 such that the strongest cluster is at 0dB.

**Step 4**: Find the clusters in the spatially filtered profile generated in Step 3 with power below [-30] dB, and remove the corresponding cluster index from the CDL profile generated in Step 1.

**Step 5**: If the number of clusters in the spatially filtered profile after Step 4 is larger than 12, find the cluster with the lowest power, and remove the corresponding cluster index from the CDL profile generated in Step 1. Repeat this step until the number of clusters equals 12.

Do not consider the spatially filtered profile generated in Steps 2-3 further after this step. The following modifications are to be applied on the surviving clusters (Note 2) in the CDL profile after Step 5.

**Step 6**: Calculate the effective delay spread of the CDL profile generated in Step 1 based only on the surviving clusters after Step 5, (ns), to be used in the next step by computing the root mean squared (rms) delay spread of the remaning clusters, using the following expressions:

Where:

* is the normalized delay value of the *i-*th cluster in the CDL profile
* is the power value of the *i-*th cluster in the CDL profile

**Step 7**: Perform delay scaling according to the procedure described below, based on the scaling procedure from clause 7.7.3 in TR 38.901 v19.1.0 but considering the impact of truncation using .

Where:

* is the delay value of the *i-*th cluster in the truncated CDL profile
* is the wanted delay spread in ns

**Step 8**: Apply the quantization to the delay resolution of 5 ns (for FR1) and [TBD] ns for FR2. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution. - To ensure that there is reduced impact from the use of a regularly spaced grid in the delay position, further improvements to delay quantization (e.g. dithering) can be considered

**Step 9**: If the delay spread has slightly changed due to the delay quantization, adjust the final delay spread by increasing or decreasing the power of the last cluster so that the delay spread matches the pre-quantization value.

**Step 10**: Round the amplitude of the last cluster to one decimal (e.g. -8.78 dB 🡪 -8.8 dB).

**Note 1:** Combining the clusters with the same AoD, AoA, ZoD, ZoA in CDL may impact the wide sense stationary (WSS) assumption of very large system bandwidth.

**Note 2:** The angular spread of the CDL Model after cluster reduction may not correspond to the value used to scale in step 1. That is because the removal of lower energy clusters might lead to minor differences in the final angular spread.

## B.4 Information on RAN4 CDL model derivation

### B.4.1 CDL Cluster Reduction results for validation

This section contains an overview of the intermediate result of the step by step cluster reduction procedure included in section 5.1.4.2 , with the purpose to allow cross-validation of the CDL cluster reduction algorithm implementation.

The example provided here is computed assuming the Receiver NR UE is using a single omnidirectional antenna with polarization slant of 0 deg, while the Transmitting NR BS is using an antennal panel of size = (8,1,1,8,1) with polarization slant of -45 deg.

The virtualizer used for AAV(8,1) is the one below (up to a scaling factor) and correspods to a broadside emission (no subarray level electrical steering)



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cluster #** | **Input cluster power** | **Element Gain** | **AAV Gain (Array Factor)** | **Output Cluster Power** | **Normalized Output Cluster Power** | **Cluster retention flag**  |
| After combining, downtilting, polarization slant | Computed based on scaled and translated cluster angle () in TR 38.901 7.7-5d |
| 1 | -7.4792 | 3.88 | 8.9504 | 5.35 | -11.50 | Yes |
| 2 | -1.2668 | 6.64 | 8.9874 | 14.36 | -2.49 | Yes |
| 3 | -5.5704 | 4.75 | 8.5662 | 7.75 | -9.11 | Yes |
| 4 | 0 | 7.86 | 8.9925 | 16.85 | 0.00 | Yes |
| 5 | -10.495 | 2.58 | 2.3295 | -5.58 | -22.44 | Yes |
| 6 | -10.208 | 0.79 | 8.7867 | -0.63 | -17.48 | Yes |
| 7 | -13.807 | 1.32 | -1.3293 | -13.81 | -30.67 | No |
| 8 | -14.25 | -7.05 | 9.0026 | -12.29 | -29.15 | Yes |
| 9 | -8.1939 | 2.60 | 4.9713 | -0.63 | -17.48 | Yes |
| 10 | -9.9091 | 0.99 | 3.0401 | -5.87 | -22.73 | Yes |
| 11 | -11.829 | -2.35 | 8.2854 | -5.89 | -22.75 | Yes |
| 12 | -16.341 | -3.44 | -1.1187 | -20.90 | -37.75 | No |
| 13 | -17.033 | -2.93 | 8.998 | -10.97 | -27.82 | Yes |
| 14 | -17.018 | -0.72 | 7.9434 | -9.79 | -26.65 | Yes |
| 15 | -18.954 | -8.53 | 8.8396 | -18.65 | -35.50 | No |
| 16 | -20.228 | -1.08 | -7.9129 | -29.22 | -46.08 | No |
| 17 | -19.125 | -1.71 | 8.1326 | -12.70 | -29.55 | No |
| 18 | -18.842 | -4.93 | 8.677 | -15.10 | -31.95 | No |
| 19 | -24.762 | -7.92 | -16.988 | -49.67 | -66.52 | No |
| 20 | -25.979 | -14.98 | -4.2836 | -45.25 | -62.10 | No |