**3GPP TSG- Meeting #**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  |
| *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 |  | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Correction of channel modeling enhancements for 7 - 24 GHz  |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** |  |  | ***Release:*** |  |
|  | *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)* |
|  |  |
| ***Reason for change:*** | (1) max subscript typo in Table 7.3-2 has been identified and it may lead to incorrect understanding of angle range.(2) incorrect copy of equation 7.3 to 7.3-3a has been identified and it may lead to incorrect implementation of antenna polarization model 1.(3) In TR38.901, for angle scaling of CDL models, the scaling factors of ZOA in Table 7.7.5.1-1 are the same as these of ZOD, which is not correct. In addition, there is an typo in Appendix A.5 for angle scaling.(4) incorrect section referenced in Note of Table 7..7.5.1-1.; (5) Typo of “antenna” in Table 7.8-2A.(6) In the current TR 38.901 [1], antenna element-wise angular-domain parameters are introduced to additionally model the antenna element-wise field patterns for the NLOS channel impulse response in the near-field channel model. However, the definitions of these antenna element-wise angular-domain parameters are missing, leading to ambiguity in their interpretation.(7) Ambiguous application of antenna polarization for the handheld UT antenna. |
|  |  |
| ***Summary of change:*** | (1) removal of max subscript from horizontal cut of radiation power pattern in Table 7.3-2.(2) correction of sin theta prime to cos theta prime in equation 7.3-3a.(3) In TR38.901, for angle scaling of CDL models, the scaling factors of ZOA in Table 7.7.5.1-1 are changed to correct values. In Appendix A.5, P\_m is changed to P\_n.(4) correcting section reference from Annex A.3 to A.5 in in Note of Table 7.7.5.1-1.(5) Correct typo for “antenna” in Table 7.8-2A.(6) Add definitions for the antenna element-wise angular-domain parameters in equation 7.6-49 of TR 38.901 [1], which are introduced for modelling the antenna element-wise field patterns.(7) Clarify the polarization equation for handheld UT |
|  |  |
| ***Consequences if not approved:*** | (1) ambiguous math notation for range of angles.(2) incorrect angle calculation for polarization model 1.(3) Incorrect scaling of ZOA for CDL models.(4) incorrect reference of the equations used to derivation of the scaling value for CDL model angle changes.(5) mis-spelled word in TR.(6) The expression for the angular-domain parameters in equation 7.6-49 of TR 38.901 [1] remains undefined, resulting in ambiguity and potential inconsistency in implementation.(7) Polarization application for handheld UT is ambiguous and can lead to companies with different implementation. |
|  |  |
| ***Clauses affected:*** |  |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

7.3.0 Antenna array structure

*<unchanged text omitted>*

**Table 7.3-2: Radiation power pattern of a single antenna element for handheld UT**

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| Vertical cut of the radiation power pattern (dB) |  |
| Horizontal cut of the radiation power pattern (dB) |  |
| 3D radiation power pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5.3 dBi |
| NOTE: For UT antenna modelling of handheld devices, optional antenna imbalance can be modelled. If modelled, randomized loss is applied per UT antenna port and randomized loss can be applied independently for the UL and DL directions. No imbalance is modelled by default. |

*<unchanged text omitted>*

7.3.2 Polarized antenna modelling

In general the relationship between radiation field and power pattern is given by:

 . (7.3-2)

The following two models represent two options on how to determine the radiation field patterns based on a defined radiation power pattern.

**Model-1**:

In case of polarized antenna elements assume is the polarization slant angle where degrees corresponds to a purely vertically polarized antenna element and degrees correspond to a pair of cross-polarized antenna elements. Then the antenna element field components in and direction are given by

 , (7.3-3)

where

 , (7.3-3a)

 . (7.3-3b)

Note that the zenith and the azimuth field components , , and are defined in terms of the spherical basis vectors of an LCS as defined in Clause 7.1. The difference between the single-primed and the double-primed components is that the single-primed field components account for the polarization slant and the double-primed field components do not. For a single polarized antenna (purely vertically polarized antenna) we can write and where is the 3D antenna radiation power pattern as a function of azimuth angle and zenith angle in the LCS as defined in Table 7.3-1 converted into linear scale.

**Model-2**:

In case of polarized antennas, the polarization is modelled as angle-independent in both azimuth and elevation, in an LCS. For a linearly polarized antenna, the antenna element field pattern, in the vertical polarization and in the horizontal polarization, are given by

 (7.3-4)

and

 , (7.3-5)

respectively, where  is the polarization slant angle and is the 3D antenna element power pattern as a function of azimuth angle, and elevation angle, in the LCS. Note that  degrees correspond to a purely vertically polarized antenna element. The vertical and horizontal field directions are defined in terms of the spherical basis vectors, and respectively in the LCS as defined in Clause 7.1.2. Also , and as defined in Table 7.1-1.

**Handheld UT Model:**

For cases when a candidate antenna placement location is used for one antenna field pattern:

- Reference radiation pattern of the UT antenna model is vertically polarized with all the gain in the theta field component, and , and referred to as the polarization direction along the axis.

For cases when a candidate antenna placement location is used for two distinct antenna polarization field patterns:

- Reference radiation pattern of the UT antenna model is,

- For first antenna field pattern: and .

- For second antenna field pattern: and .

Each polarized field component of the reference radiation pattern and should be rotated according to the orientation and polarization direction of the each of UT antennae to get , using equation

 , (7.3-6)

 , (7.3-7)

 , (7.3-8)

where , and are obtained according to the orientation and polarization direction of each UT antenna, and then rotated based on the orientation of the UT in the global coordinate system to get and using Clause 7.1.3 equation (7.1-11).

For cases when a candidate antenna placement location is used for one antenna field pattern (e.g., single polarization):

- The polarization direction is indicated by the arrow in Figure 7.3-7, which is parallel with the plane of the handheld UT and perpendicular to the direction from the UT center to the candidate antenna location.

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**Figure 7.3-7: Handheld UT antenna polarization directions for one antenna field pattern (top down view)**

For cases when a candidate antenna placement location is used for two antenna field patterns (e.g., dual polarization) (not intended for FR1):

- For the first antenna field pattern, the polarization direction is indicated by the arrows in Figure 7.3-7 but additionally rotated 45 degrees about the direction from the UT center to the candidate antenna location (i.e. rotated using the direction from the UT center to the candidate antenna location as the rotational axis).

- For the second antenna field pattern, the polarization direction is perpendicular to the polarization direction of the first filed pattern and perpendicular to the direction from the UT center to the candidate antenna location

- An example for candidate antenna location (6) is given in Figure 7.3-8.

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**Figure 7.3-8: Handheld UT polarization direction for two antenna filed pattern (side view)**

*<unchanged text omitted>*

7.6.13 Near-field channel model

The near-field channel model is to support the simulations that involve the impacts of the spherical wavefront from the perspective of antenna array.

To model the antenna element-wise channel parameters, in the Step 11 in Clause 7.5, the following updates are considered to generate the channel impulse response:

For the NLOS channel impulse response, determine the NLOS channel coefficient for the two strongest clusters, say *n* = 1 and 2, instead of the equation (7.5-28) and forthe N – 2 weakest clusters, say n = 3, 4,…, N, using instead of equation (7.5-22).

- To model the antenna element-wise phase at TRP side, the NLOS channel coefficient, , is given by:

 (7.6-47)

where, the is the spherical unit vector with azimuth departure angle and elevation departure angle for ray m of cluster n. is the vector pointing from reference point to transmit antenna element s, wherein the reference point is the physical center of the antenna array/center at Tx side. The is the distance calculated as:

 ,

where the refers to the 3D distance between reference point at TRP and UT side. The refers to the excess delay, which is only applicable when it’s not in LOS case, and generated according to the Clause 7.6.9, otherwise is assumed to be 0. The refers to the delay of *i*-th sub-cluster mapping to the rays defined in Table 7.5-5. The ray index, *m*, should be determined based on the sub-cluster information in Table 7.5-5. For the , if the nth cluster is one of the strongest cluster, 1, otherwise is generated according to the . The corresponding value of and Beta distribution is defined in Table 7.6-13-1, respectively.

**Table 7.6-13-1: Parameters for Uma, Umi, Indoor-Office and Indoor-Factory**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scenarios** | **UMa**  | **UMi**  | **InH**  | **InF** |
| *k1* | 2 | 2 | 4 | 4 |
| Beta distribution |  | 1.93 | 1.53 | 1.25 | 1.38 |
|  | 1.33 | 1.42 | 1.27 | 1.26 |

Optionally,

- To model the antenna element-wise phase at UT side additionally, the is given by:

 (7.6-48)

where is the spherical unit vector with azimuth arrival angle and elevation arrival angle for ray m of cluster n. is the vector pointing from reference point to receive antenna element u, wherein the reference point is the physical center of the antenna array/center at Rx side. The is the distance calculated as:

where , if the nth cluster is one of the strongest cluster, otherwise . Note that it is assumed that only single non-specular interaction along with specular reflection(s) is considered in the propagation channel and most of the sources of non-specular interaction are assumed to be a point scatterer or diffractions.

- To model the antenna element-wise antenna field patterns additionally, the is given by:

 , (7.6-49)

where and are the respective antenna element-wise elevation arrival angles and azimuth arrival angles for ray *m* of cluster *n* between the reference point at TRP side and receive antenna element *u*, and and are the respective antenna element-wise elevation departure angles and azimuth departure angles for ray *m* of cluster *n* between the transmit antenna element *s* and the reference point at UT side.

In the LOS channel impulse response, determine the LOS channel coefficient as:

- To model the antenna element-wise phase, the equation (7.5-29) in Clause 7.5 is replaced by:

 (7.6-50)

where, the refers to the vector determined by the location of the th antenna element at receiver and the th antenna element at transmitter. The refers to the 3D distance between reference point at TRP and UT side, wherein the the reference point is the physical center of the antenna array/center of the device.

Optionally,

- To model the element-wise antenna field patterns additionally, the equation (7.5-29) in Clause 7.5 is replaced by:

 (7.6-51)

where , , , are the respective antenna element-wise elevation arrival angles, azimuth arrival angles, elevation departure angles and azimuth departure angles of LOS path between the transmit antenna element s and receive antenna element u.

*<unchanged text omitted>*

#### 7.7.5.1 CDL extension: Scaling of angles

*<unchanged text omitted>*

**Table 7.7.5.1-1: Scale factor values for each CDL model**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CDL Type** | **Desired AOD Spread（°）** | **Scale Factor (AOD)** | **Desired AOA Spread（°）** | **Scale Factor (AOA)** | **Desired ZOA Spread（°）** | **Scale Factor (ZOA)** | **Desired ZOD Spread（°）** | **Scale Factor (ZOD)** |
| CDL-A | 5 | 0.0680 | 30 | 0.3531 | 5 | 0.2397 | 1 | 0.0352 |
| 10 | 0.1360 | 45 | 0.5268 | 10 | 0.4802 | 3 | 0.1056 |
| 15 | 0.2041 | 60 | 0.6981 | 15 | 0.7225 | 5 | 0.1761 |
| 25 | 0.3405 |  |  |  |  |  |  |
| CDL-B | 5 | 0.1238 | 30 | 0.5417 | 5 | 0.6519 | 1 | 0.1940 |
| 10 | 0.2475 | 45 | 0.8081 | 10 | 1.3018 | 3 | 0.5822 |
| 15 | 0.3710 | 60 | 1.0709 | 15 | 1.9480 | 5 | 0.9705 |
| 25 | 0.6168 |  |  |  |  |  |  |
| CDL-C | 5 | 0.1281 | 30 | 0.4307 | 5 | 0.6476 | 1 | 0.3643 |
| 10 | 0.2568 | 45 | 0.6447 | 10 | 1.2971 | 3 | 1.0929 |
| 15 | 0.3864 | 60 | 0.8585 | 15 | 1.9504 | 5 | 1.8219 |
| 25 | 0.6513 |  |  |  |  |  |  |
| CDL-D | 5 | 0.3231 | 30 | 9.8888 | 5 | 4.3268 | 1 | 0.4477 |
| 10 | 0.6652 | 45 | N/A | 10 | 8.8868 | 3 | 1.3469 |
| 15 | 1.0594 | 60 | N/A | 15 | 14.0344 | 5 | 2.2579 |
| 25 | 5.8637 |  |  |  |  |  |  |
| CDL-E | 5 | 0.3950 | 30 | 2.9733 | 5 | 6.9195 | 1 | 0.9714 |
| 10 | 0.8009 | 45 | N/A | 10 | 14.8378 | 3 | 2.9180 |
| 15 | 1.2330 | 60 | N/A | 15 | 27.2849 | 5 | 4.8774 |
| 25 | 2.3627 |  |  |  | 0.2397 |  |  |
| NOTE: Values of Table 7.7.5.1-1 were computed based on scaling factor calculation method described in Annex A.5. |

*<unchanged text omitted>*

7.8.2 Full calibration

*<unchanged text omitted>*

**Table 7.8-2A: Simulation assumptions for full calibration**

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| Scenarios  | UMa, UMi-Street Canyon, SMa |
| Carrier Frequency | 7 GHz,(optional) 15 GHz |
| BS antenna downtilting | Mechanical downtilt of 95 degrees for SMa for ISD = 1299mMechanical downtilt of 92 degrees for SMa for ISD = 1732mElectrical downtilt as in Table 7.8-1 for UMa and UMi-Street Canyon |
| BS antenna configurations | Config 3 for UMi, UMa, SMa at 7 GHz: Mg = Ng = 1, M = 8, N = 16, P = 2, dH = dV = 0.5λ … calibration metrics 1), 2), 3), 4) are calibrated(optional) Config 4 for UMa at 7 and 15 GHz: Mg = Ng = 1, M = 64, N = 16, P = 2, Mg = 1, Ng = 1, dH = dV = 0.5λ … calibration metrics 1), 2), 3), 4) are calibrated |
| BS Polarized antenna modelling | Model-2 in Clause 7.3.2 |
| BS port mapping | Config 3 for UMi, UMa, SMa at 7 GHz: Mp = 8, Np = 16, each antenna element is mapped to one port(optional) Config 4 for UMa at 7 and 15 GHz: Mp = 16, Np = 16Mp and Np are the number of vertical, horizontal TXRUs within a panel and polarization |
| BS Tx power | 49 dBm for SMa |
| Bandwidth | 20 MHz for 7 GHz(optional) 200 MHz for 7 and 15 GHz |
| UT attachment  | Based on RSRP (formula) from BS port 0 |
| UT distribution  | For SMa, 20% of UT outdoor, 80% of UT indoor. Among indoor UT, 90% of indoor UT are within residential buildings, and 10% of indoor UT in commercial buildings. Indoor UTs are uniformly distributed across all floors for a building type. |
| UT array orientation | Config B, C: Ω*UT,a* uniformly distributed on [0,360] degree, Ω*UT,b* = 45 degree, Ω*UT,g* = 0 degreeConfig D: Ω*UT,a* = 0 degree, Ω*UT,b* = 0 degree, Ω*UT,g* = 0 degree |
| UT antenna configurations | Config B for 7 GHz: 4 antenna port with single polarization for calibration based on handheld device antenna model using candidate antenna locations (1,7,3,5) as described in Clause 7.3(optional) Config C for 15 GHz: 16 antenna port with dual polarization based on handheld device antenna model using candidate antenna locations in (1,2,3,4,5,6,7,8) as described in Clause 7.3(only for metric 5) Config D: 8 antenna port with single polarization based on handheld device antenna model using candidate antenna locations in (1,2,3,4,5,6,7,8) as described in Clause 7.3 |
| UT antenna pattern | Config B, C, D: Based on directional antenna for handheld UT described in Clause 7.3 |
| UT Polarized antenna modelling | Config B, C, D: Based on directional antenna for handheld UT described in Clause 7.3 |
| O2I penetration loss | For SMa, low-loss A model |
| SCS assumption | 30 kHz |
| Additional metrics | 5) Antenna field pattern of handheld UT, and , in UT LCS using UT antenna configuration D  |

*<unchanged text omitted>*

A.5 Calculation of scaling factor for changing CDL model angular spread

The following expression for the computing scaling factor, , to achieve a specific angular spread, AS, in degrees is given by

 (A-5)

 (A-6)

where is the power for the *n*th cluster path, is the input cluster path angle (either AOA, AOD, ZOA, ZOD) given in degrees, is the power for the input LOS path, and is the input LOS path angle (either AOA, AOD, ZOA, ZOD) given in degrees. If input LOS path does not exist, is assumed.

*<unchanged text omitted>*