3GPP TSG-RAN WG4 Meeting # 111 R4-2410592

Fukuoka, Japan, 20 – 24 May 2024

**Agenda Item:** **10.3.4.1**

**Source: Nokia**

**Title:** **TP to TR 38.922: System level simulation methodology and assumptions for coexistence study for 14800 - 15350 MHz frequency range**

**Document for:** **Approval**

**1. Introduction**

The SI on IMT parameters for 4400 to 4800 MHz, 7125 to 8400 MHz and 14800 to 15350 MHz was approved at TSG RAN#103 [1]. One of the objectives of this SI is to study the IMT parameters relevant for sharing and compatibility for 14800 to 15350 MHz frequency range.

It is stated in the ‘Justification’ of the approved SID that:

|  |
| --- |
| Previous work e.g., SI outcomes on 7 to 24 GHz as captured in TR 38.820 or 6 to 10 GHz parameters as captured in TR 38.921 may be taken to account, as needed. |

This topic was discussed at TSG RAN4#110bis and the WF was agreed [2].

This contribution proposes the system level simulation methodology and assumptions for coexistence study for 14800 - 15350 MHz frequency range and provides a text proposal to record the simulation methodology and assumptions into TR 38.922 [3].

**2. Discussion**

The simulation methodology and assumptions are based on clauses 5.1 and 5.2 in TR 38.803 [4] for coexistence study in the NR SI, with modifications on inter-site distance, path loss, antenna and beam forming pattern modelling, channel bandwidth and noise figure for 14800 - 15350 MHz frequency range.

2.1 Inter-site distance

The inter-site distance in TR 38.803 was based on the agreement for 30 GHz and 45 GHz frequency ranges during the NR SI. The inter-site distance should be updated with the agreements for the 14800 - 15350 MHz frequency range, and thus they are TBD in the TP here.

2.2 Path loss

The path loss model in TR 38.803 was based on TR 38.900 [5] from the study on channel model for frequency spectrum above 6 GHz. The path loss model in TR 38.901 [6] from the study on channel model for frequencies from 0.5 to 100 GHz is used in the TP here, and it can be further updated with the results from the study on channel modelling enhancements for 7-24GHz for NR [7].

2.3 Antenna and beam forming pattern modelling

The BS and UE antenna and beam forming pattern modellings in TR 38.803 was based on the agreement for 30 GHz and 45 GHz frequency ranges during the NR SI. The BS and UE antenna and beam forming pattern modellings should be updated with the agreements for the 14800 - 15350 MHz frequency range, and thus they are TBD in the TP here.

2.4 Channel bandwidth

The channel bandwidth in TR 38.803 was based on the agreement for 30 GHz and 45 GHz frequency ranges during the NR SI. The channel bandwidth should be updated with the agreements for the 14800 - 15350 MHz frequency range, and thus they are TBD in the TP here.

2.5 Noise figure

The BS and UE noise figures in TR 38.803 was based on the agreement for 30 GHz and 45 GHz frequency ranges during the NR SI. The BS and UE noise figures should be updated with the agreements for the 14800 - 15350 MHz frequency range, and thus they are TBD in the TP here.

**3. Conclusion**

This contribution proposes the system level simulation methodology and assumptions for 14800 - 15350 MHz frequency range. It is proposed to approve the text proposal below into TR 38.922.

**4. Text proposal**

**<Start of change>**

## 6.1 Co-existence study

### 6.1.1 Co-existence simulation scenarios

Table 6.1.1 summarizes the proposed initial simulation scenarios for 14800 - 15350 MHz.

Table 6.1.1-1: Summary of initial simulation scenarios for 14800 - 15350 MHz

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Usage scenario | Aggressor | Victim | Direction | Simulation frequency | Deployment Scenario | Priority |
| 1 | eMBB | NR, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Indoor hotspot | Second |
| 2 | eMBB | NR, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Urban macro | First |
| 3 | eMBB | NR, TBD MHz | NR, TBD MHz | DL to DL | 15 GHz | Dense urban | Third |
| 4 | eMBB | NR, TBD MHz | NR, TBD MHz | UL to UL | 15 GHz | Indoor hotspot | Second |
| 5 | eMBB | NR, TBD MHz | NR, TBD MHz | UL to UL | 15 GHz | Urban macro | First |
| 6 | eMBB | NR, TBD MHz | NR, TBD MHz | UL to UL | 15 GHz | Dense urban | Third |

### 6.1.2 Co-existence simulation assumption

### 6.1.2.1 Network layout model

#### 6.1.2.1.1 Urban macro

Details on urban macro network layout model are listed in Table 6.1.2.1.1-1 and 6.1.2.1.1-2.

Table 6.1.2.1.1-1: Single operator layout for urban macro

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | hexagonal grid, 19 macro sites, 3 sectors per site with wrap around |  |
| Inter-site distance | | 450 m (first priority)  350 m (second priority)  Other (third priority) |  |
| BS antenna height | | 25 m |  |
| UE location | Outdoor/indoor | Outdoor and indoor |  |
| Indoor UE ratio | 20/0% |  |
| Low/high Penetration loss ratio | 50% low loss, 50% high loss |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | Same as 3D-UMa in TR 36.873 |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 35 m |  |
| Channel model | | UMa |  |
| Shadowing correlation | | Between cells: 1.0  Between sites: 0.5 |  |

Table 6.1.2.1.1-2: Multi operators layout for urban macro

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operators layout | coordinated/un-coordinated operation (0/100% Grid Shift) |  |

|  |  |
| --- | --- |
| Coordinated Operation: each network with co-location of sites | zero grade shift macro |

Figure 6.1.2.1.1-1: Coordinated operation

A diagram of a cell range

Description automatically generated

Figure 6.1.2.1.1-2: Uncoordinated operation

#### 6.1.2.1.2 Dense urban

Details on dense urban network layout model are listed in Table 6.1.2.1.2-1 and 6.1.2.1.2-2.

Table 6.1.2.1.2-1: Single operator layout for dense urban

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | Fixed cluster circle within a macro cell. | note1 |
| Number of micro BSs per macro cell | | 3 | 3 cluster circles are in a macro cell. 1 cluster circle has 1 micro BS. |
| Radius of UE dropping within a micro cell | | < 65.03 m (first priority)  < 50.58 m (second priority)  < other (third priority) |  |
| BS antenna height | | 10 m |  |
| UE location | Outdoor/indoor | Outdoor and indoor |  |
| Indoor UE ratio | 80 % |  |
| 50% low loss, 50% high loss | Low/high Penetration loss ratio |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | Same as 3D-UMi in TR 36.873 |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 3m |  |
| Channel model | | UMi |  |
| Shadowing correlation | | Between cite: 0.5 |  |
| Note 1: Micro BS is randomly dropped on an edge of the cluster circle. All UEs communicate with micro BS, i.e. macro cell is only used for determining position of micro BS. As a layout of macro cell, hexagonal grid, 19 macro sites, 3 sectors per site model with wrap around with ISD = 450/350/other m is assumed. | | | |

A diagram of a cell structure

Description automatically generated

Figure 6.1.2.1.2-1: Network layout for dense urban

Table 6.1.2.1.2-2: Multi operators layout for dense urban

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operator layout | Cluster circle is coordinated | Note 1 |
| Minimum distance between micro BSs in different operator | 10 m |  |
| Note 1: Macro cell is collocated. Micro BS itself is randomly dropped. | | |

#### 6.1.2.1.3 Indoor

Details on indoor network layout model are listed in Table 6.1.2.1.3-1 and 6.1.2.1.3-2.

Table 6.1.2.1.3-1: Single operator layout for indoor

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Values | Remark |
| Network layout | | 50m x 120m, 12BSs |  |
| Inter-site distance | | 20m |  |
| BS antenna height | | 3 m | ceiling |
| UE location | Outdoor/indoor | Indoor |  |
| LOS/NLOS | LOS and NLOS |  |
| UE antenna height | 1 m |  |
| UE distribution (horizontal) | | Uniform |  |
| Minimum BS - UE distance (2D) | | 0 m |  |
| Channel model | | Indoor Office |  |
| Shadowing correlation | | NA |  |

A diagram of a diagram

Description automatically generated

Figure 6.1.2.1.3-1: Network layout for indoor

Table 6.1.2.1.3-2: Multi operators layout for indoor

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Multi operator layout | Coordinated operation (0% Grid Shift) |  |

### 6.1.2.2 Propagation model

#### 6.1.2.2.1 Pathloss

The pathloss models are summarized in Table 6.1.2.2.1-1 and the distance definitions are indicated in Figure 6.1.2.2.1-1 and Figure 6.1.2.2.1-2. Note that the distribution of the shadow fading is log-normal, and its standard deviation for each scenario is given in Table 6.1.2.2.1-1.

|  |  |
| --- | --- |
|  |  |
| Figure 6.1.2.2.1-1: Definition of *d2D* and *d3D*  for outdoor UTs | Figure 6.1.2.2.1-2: Definition of *d2D-out*, *d2D-in*  and *d3D-out*, *d3D-in* for indoor UTs. |

Note that

 (6.1.2.2-1)

Table 6.1.2.2.1-1: Pathloss models

| Scenario | LOS/NLOS | Pathloss [dB], *fc* is in GHz and *d* is in meters, see note 6 | Shadow  fading  std [dB] | Applicability range,  antenna height  default values |
| --- | --- | --- | --- | --- |
| UMa | LOS | , see note 1 |  |  |
| NLOS | for |  | Explanations: see note 3 |
| Optional |  |  |
| UMi - Street Canyon | LOS | , see note 1 |  |  |
| NLOS | for |  | Explanations: see note 4 |
| Optional |  |  |
| InH - Office | LOS |  |  |  |
| NLOS |  |  |  |
| Optional |  |  |
| Note 1: Breakpoint distance *d*'BP = 4 *h*'BS *h*'UT *f*c/*c*, where *f*c is the centre frequency in Hz, *c* = 3.0×108 m/s is the propagation velocity in free space, and *h*'BS and *h*'UT are the effective antenna heights at the BS and the UT, respectively. The effective antenna heights *h*'BS and *h*'UT are computed as follows: *h*'BS = *h*BS – *h*E, *h*'UT = *h*UT – *h*E, where *h*BS and *h*UT are the actual antenna heights, and hE is the effective environment height. For UMi *h*E = 1.0m. For UMa *h*E=1m with a probability equal to 1/(1+C(*d*2D, *h*UT)) and chosen from a discrete uniform distribution uniform(12,15,…,(*h*UT-1.5)) otherwise. With C(*d*2D, *h*UT) given by  ,  where  .  Note that *h*E depends on *d*2D and *h*UT and thus needs to be independently determined for every link between BS sites and UTs. A BS site may be a single BS or multiple co-located BSs.  Note 2: The applicable frequency range of the PL formula in this table is 0.5 < *fc* < *f*H GHz, where *f*H = 30 GHz for RMa and *f*H = 100 GHz for all the other scenarios. It is noted that RMa pathloss model for >7 GHz is validated based on a single measurement campaign conducted at 24 GHz.  Note 3: UMa NLOS pathloss is from TR36.873 with simplified format and PLUMa-LOS = Pathloss of UMa LOS outdoor scenario.  Note 4: PLUMi-LOS = Pathloss of UMi-Street Canyon LOS outdoor scenario.  Note 5: Break point distance *dBP* = 2π *hBS* *hUT* *fc*/*c*, where *fc* is the centre frequency in Hz, *c* = 3.0 × 108 m/s is the propagation velocity in free space, and *hBS* and *hUT* are the antenna heights at the BS and the UT, respectively.  Note 6: *fc* denotes the center frequency normalized by 1GHz, all distance related values are normalized by 1m, unless it is stated otherwise. | | | | |

#### 6.1.2.2.2 LOS probability

The Line-Of-Sight (LOS) probabilities are given in Table 6.1.2.2.2-1.

Table 6.1.2.2.2-1: LOS probability

|  |  |
| --- | --- |
| Scenario | LOS probability (distance is in meters) |
| UMi – Street canyon | Outdoor users:    Indoor users:  Use *d2D-out* in the formula above instead of *d2D* |
| UMa | Outdoor users:    where    and    Indoor users:  Use *d2D-out* in the formula above instead of *d2D* |
| Indoor – Open office |  |
| Note: The LOS probability is derived with assuming antenna heights of 3m for indoor, 10m for UMi, and 25m for UMa | |

#### 6.1.2.2.3 O-to-I penetration loss

The Path loss incorporating O-to-I building penetration loss is modelled as in the following:

PL = PLb + PLtw + PLin + *N*(0, σ*P2*)

where PLb is the basic outdoor path loss given in Section 6.1.2.2.1. PLtw is the building penetration loss through the external wall, PLin is the inside loss dependent on the depth into the building, and σ*P* is the standard deviation for the penetration loss.

PLtw is characterized as:



 is an additional loss is added to the external wall loss to account for non-perpendicular incidence;

, is the penetration loss of material *i*, example values of which can be found in Table 6.1.2.2.3-1.

*pi* is proportion of *i*-th materials, where ; and

*N* is the number of materials.

Table 6.1.2.2.3-1: Material penetration losses

|  |  |
| --- | --- |
| Material | Penetration loss [dB] |
| Standard multi-pane glass |  |
| IRR glass |  |
| Concrete |  |
| Wood |  |
| Note: f is in GHz | |

Table 6.1.2.2.3-2 gives PLtw, PLin and σ*P* for two O-to-I penetration loss models. The O-to-I penetration is UT-specifically generated, and is added to the SF realization in the log domain.

Table 6.1.2.2.3-2 O-to-I penetration loss model

|  |  |  |  |
| --- | --- | --- | --- |
|  | Path loss through external wall: [dB] | Indoor loss: [dB] | Standard deviation: σ*P* [dB] |
| Low-loss model |  | 0.5*d*2D-in | 4.4 |
| High-loss model |  | 0.5*d*2D-in | 6.5 |

*d2D-in* is minimum of two independently generated uniformly distributed variables between 0 and 25 m for RMa, UMa and UMi-Street Canyon. *d2D-in* shall be UT-specifically generated.

Both low-loss and high-loss models are applicable to UMa and UMi-Street Canyon.

Only the low-loss model is applicable to RMa.

The composition of low and high loss is a simulation parameter that should be determined by the user of the channel models, and is dependent on the use of metal-coated glass in buildings and the deployment scenarios. Such use is expected to differ in different markets and regions of the world and also may increase over years to new regulations and energy saving initiatives. Furthermore, the use of such high-loss glass currently appears to be more predominant in commercial buildings than in residential buildings in some regions of the world.

The pathloss incorporating O-to-I car penetration loss is modelled as in the following:

PL = PLb + *N*(*μ*, σ*P2*)

where PLb is the basic outdoor path loss given in Section 6.1.2.2.1. *μ* = 9, and σ*P* = 5. Optionally, for metallized car windows, *μ* = 20 can be used. The O-to-I car penetration loss models are applicable for at least 0.6-60 GHz.

### 6.1.2.3 Antenna and beam forming pattern modelling

#### 6.1.2.3.1 General

A general antenna model is a uniform rectangular panel array, comprising MgNg panels, as illustrated in Figure 6.1.2.3.1-1.

- Mg is number of panels in a column

- Ng is number of panels in a row

- Antenna panels are uniformly spaced in the horizontal direction with a spacing of *dg,H* and in the vertical direction with a spacing of *dg,V*.

- On each antenna panel, antenna elements are placed in the vertical and horizontal direction, where N is the number of columns, M is the number of antenna elements with the same polarization in each column.

- Antenna numbering on the panel illustrated in Figure 6.1.2.3.1-1 assumes observation of the antenna array from the front (with x-axis pointing towards broad-side and increasing y-coordinate for increasing column number).

- The antenna elements are uniformly spaced in the horizontal direction with a spacing of *dH* and in the vertical direction with a spacing of *dV*.

- The antenna panel is either single polarized (P=1) or dual polarized (P=2).

The rectangular panel array antenna can be described by the following tuple .



Figure 6.1.2.3.1-1: General antenna model

For a uniformly distributed array (ULA) antenna, as shown in Figure 6.1.2.3.1-2, the radiation elements are placed uniformly along the vertical **z**-axis in the Cartesian coordinate system. The **x-y** plane constructs the horizontal plane. A signal acting at the array elements is in the direction of **u**. The elevation angle of the signal direction is denoted as (defined between 0° and 180°, 90° represents perpendicular angle to the array antenna aperture) and the azimuth angle is denoted as(defined between -180° and 180°).



Figure 6.1.2.3.1-2: Antenna Array Geometry

The linear phase progression based beamforming is assumed, as described in Table 6.1.2.3.1-1.

Table 6.1.2.3.1-1: Composite antenna pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Composite Array radiation pattern in dB | For beam i:    the super position vector is given by:    the weighting is given by: |

In this simulation, there is one beam formed using all the antenna elements. Each beam is directed to one scheduled UE.

Note the above gives the correct antenna array radiation pattern, however the correct gain is only achieved if the element pattern  is selected for the exact element spacing. For other element spacings, the element pattern  must be separately calculated such that it is correct for the element spacing (*dg,H and dg,V*). If  is not linked to the element spacing then the calculated absolute gain may diverge from the correct value in a manner that varies as the beam is steered.

The correct composite array radiation pattern directivity(D) is given by:

,

The composite array radiation pattern gain can then be calculated as:



Where L is the Loss associated with the antenna. This is currently included in the estimate for element gain , and is 1.8dB.

#### 6.1.2.3.2 BS Antenna modelling

##### 6.1.2.3.2.1 Urban macro scenario

Table 6.1.2.3.2.1-1: BS antenna modelling for Urban macro scenario

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 6.4 dBi |
| (Mg, Ng, M, N, P) note | (1, 1, 64 x 24 / 64 x 32, 2) |
| (dv, dh) | (0.7λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is horizontal. | |

##### 6.1.2.3.2.2 Dense urban scenario

Table 6.1.2.3.2.2-1: BS antenna element pattern for Dense urban scenario

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 6.4 dBi |
| (Mg, Ng, M, N, P) note | (1, 1, 64 x 24 / 64 x 32, 2) |
| (dv, dh) | (0.7λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is horizontal. | |

##### 6.1.2.3.2.3 Indoor scenario

Table 6.1.2.3.2.3-1: BS antenna element pattern for Indoor scenario

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5.5 dBi |
| (Mg, Ng, M, N, P) note | (1, 1, [8/4, 8/4], 2) |
| (dv, dh) | (0.5λ, 0.5λ) |
| Note: An additional 3dB gain is added to the total beamforming gain to account for the two polarization directions. Boresight direction is perpendicular to the ceiling. | |

##### 6.1.2.3.2.4 Array antenna model extension

To model an AAS BS equipped with a sub-array antenna geometry an extended antenna model is required. A sub-array antenna geometry is created by combining vertical elements to sub-arrays as indicated in Figure 6.1.2.3.2.4-1. The antenna model extension was created to model AAS base station operating within the frequency range 14800 - 15350 MHz required for sharing studies in ITU-R.



Figure 6.1.2.3.2.4-1: Sub-array structure

In Table 6.1.2.3.2.4-1, the parameters used by the parameterized array antenna model supporting sub-array geometries are described.

Table 6.1.2.3.2.4-1: Extended parameter definitions

| Level | Parameter | Symbol | Unit |
| --- | --- | --- | --- |
| Element | Front to back ratio | *Am* | dB |
| Side lobe suppression | *SLAv* | dB |
| Horizontal half power beamwidth | *3dB* | Degrees |
| Vertical half power beamwidth | *3dB* | Degrees |
| Array element peak gain | *GE,max* | dBi |
| Sub-array | Number of element rows in sub-array | *Msub* | Integer |
| Vertical element separation | *dv,sub* | m |
| Electrical pre-set sub-array down-tilt angle | *subtilt* | Degrees |
| Array | Number of elements/sub-array rows | *M* | Integer |
| Number of elements columns | *N* | Integer |
| Horizontal element separation | *dh* | m |
| Vertical element/sub-array separation | *dv* | m |
| Electrical down-tilt angle | *etilt* | Degrees |
| Electrical scan angle | *escan* | Degrees |

The parameterized antenna model is built around array antenna model where the element factor, array factor and linear phase progressing is characterized as described by equations in Table 6.1.2.3.2.4-2.

Table 6.1.2.3.2.4-2: Extended AAS model

| Description | Equation |
| --- | --- |
| Peak normalized element radiation pattern |  |
| Peak gain normalized element radiation pattern |  |
| Sub-array excitation |  |
| Sub-array radiation pattern | , where |
| Array excitation |  |
| Composite array radiation pattern | , where |

In Table 6.1.2.3.2.4-3, representable parameter sets relevant for an AAS base station operating within 14800 - 15350 MHz are provided.

Table 6.1.2.3.2.4-3: Antenna array parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Indoor | Urban macro | Dense urban |
| Element gain (dBi) (Note 2) | 5 | 6.4 | 6.4 |
| Horizontal/vertical 3 dB beam width of single element (degree) | 90º for H 90º for V | 90º for H 65º for V | 90º for H 65º for V |
| Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V |
| Antenna polarization | Linear ±45º | Linear ±45º | Linear ±45º |
| Antenna sub-array configuration (Row × Column)  (Note 4) | [8 x 8 / 4 x 4] elements | 64 x 24 / 64 x 32 elements | 16 x 24 / 64 x 32 elements |
| Horizontal/Vertical radiating sub-array spacing | 0.5 of wavelength for H, 0.5 of wavelength for V | 0.5 of wavelength for H, 2.8/5.6 of wavelength for V | 0.5 of wavelength for H, 2.8/5.6 of wavelength for V |
| Number of element rows in sub-array | N/A | 4/8 | 4/8 |
| Vertical element separation in sub-array () | 0.5 of wavelength of V | 0.5 of wavelength of V | 0.5 of wavelength of V |
| Pre-set sub-array down-tilt (degrees) | 3 | 3 | 3 |
| Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 |
| Conducted power (before Ohmic loss) per sub-array (dBm) (Note 3) | [-1] | 8/7 | -2/-3 |
| Base station horizontal coverage range (degrees) | +/-90 | +/-60 | +/-60 |
| Base station vertical coverage range (degrees) (Note 1) | 0-180 | 90-100 | 90-100 |
| Mechanical down-tilt (degrees) | 90 | 6 | 6 |
| Note 1: The vertical coverage range is given for the elevation angle θ, defined between 0° and 180°.  Note 2: The element gain includes the loss and is per polarization.  Note 3: The conducted power per sub-array assumes 64 x 24/32 x 2 sub-arrays (i.e., power per H/V polarized element).  Note 4: 64 × 24/32 means there are 64 vertical and 24/32 horizontal radiating sub-arrays.  Note 5: For the case of 4/8 elements per sub array, dv will be 2.8/5.6 wavelengths. | | | |

#### 6.1.2.3.3 UE antenna element pattern

Table 6.1.2.3.3-1: UE antenna element pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | [5] dBi |
| (Mg, Ng, M, N, P) | (1, 1, [1/2], [1/2], 2) |
| (dv, dh) | (0.5λ, 0.5λ) |
| UE orientation | Random orientation in the azimuth domain: uniformly distributed between -90 and 90 degrees\*  Fixed elevation: 90 degrees |
| NOTE: This is done to emulate two panels: the configuration is equivalent to 2 panels with 180 shift in horizontal orientation and UE orientation uniformly distributed in the azimuth domain between -180 and 180 degrees. | |

### 6.1.2.4 Other simulation parameters

Table 6.1.2.4-1: Other simulation parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | Indoor | Urban macro | Dense urban |
| **Channel bandwidth** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 MHz |
| **Scheduled channel bandwidth per UE (DL)** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 MHz |
| **Scheduled channel bandwidth per UE (UL)** | 100/200/400 MHz | 100/200/400 MHz | 100/200/400 MHz |
| **The number of active UE (DL)** | Same as the number of BS beam | Same as the number of BS beam | Same as the number of BS beam |
| **The number of active UE (UL)** | 1 UE per slot (first priority)  3 UE per slot (second priority) | 1 UE per slot (first priority)  3 UE per slot (second priority) | 1 UE per slot (first priority)  3 UE per slot (second priority) |
| **Traffic model** | Full buffer | Full buffer | Full buffer |
| **DL power control** | NO | NO | NO |
| **UL power control** | YES | YES | YES |
| **BS max TX power in dBm** | 23dBm | 43dBm | 33dBm |
| **UE max TX power in dBm** | 23/26dBm | 23/26dBm | 23/26dBm |
| **UE min TX power in dBm** | -40dBm | -40dBm | -40dBm |
| **BS Noise figure in dB** | 16 | 8 | 13 |
| **UE Noise figure in dB** | 11 | 11 | 11 |
| **Handover margin** | 3dB | 3dB | 3dB |

### 6.1.3 Co-existence simulation results

**<End of change>**

**References**

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[5] 3GPP TR 38.900 v15.0.0, “Study on channel model for frequency spectrum above 6 GHz”.

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