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| **Radiocommunication Study Groups** |  |
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| **28 June 2021** |
| **English only** |
| Egypt (Arab Republic of), Saudi Arabia (Kingdom of), United Arab Emirates | |
| Results of IMT and broadcasting for sharing and compatibility studies in preparation  for WRC-23 agenda item 1.5 | |
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**1 Introduction**

ITU-R Resolution **235 (WRC-15)** calls for review of the spectrum use and needs within the frequency band 470-960 MHz in Region 1, and to take appropriate regulatory actions including potential allocation to Mobile Service and/or identification of IMT within the whole band, or parts thereof. It resolves to invite ITU-R, after the 2019 World Radiocommunication Conference and in time for the 2023 World Radiocommunication Conference:

1. to review the spectrum use and study the spectrum needs of existing services within the frequency band 470-960 MHz in Region 1, in particular the spectrum requirements of the broadcasting and mobile, except aeronautical mobile, services, taking into account the relevant ITU Radiocommunication Sector (ITU-R) studies, Recommendations and Reports;

2. to carry out sharing and compatibility studies, as appropriate, in the frequency band 470-694 MHz in Region 1 between the broadcasting and mobile, except aeronautical mobile, services, taking into account relevant ITU-R studies, Recommendations and Reports;

This contribution provides sharing and compatibility studies between IMT system under Mobile Service (MS) and Broadcasting Service (BS). The parameters were selected from the ITU Recommendations and Reports, as relevant including ITU R-REP-BT.2337, to best simulate systems under study. Co-channel and adjacent channel scenarios are considered in urban and rural scenarios, as well as variations in many technical and non-technical parameters, including indoor and outdoor systems in urban areas. The coexistence studies are conducted to evaluate any possible interference from IMT based MS transmitters (base-station and user equipment) into Digital Terrestrial Television Broadcasting (DTTB) receivers and into DTTB system receivers.

In accordance with ITU Working Party (WP) 5D liaison statement (LS) (Doc. [5D/28](https://www.itu.int/md/R19-WP5D-C-0028/en)) on the characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 agenda item 1.5, IMT deployments in border areas between the territories of concerned neighbouring countries considers adjustments of base station configurations (e.g. larger antenna down tilts, lower antenna heights, sector azimuth restrictions, and other aspects to reduce emissions into a neighbouring country as well as lower user density).

This contribution provides specific parameters’ values based on a practical deployment scenario, where real deployment scenarios should be considered in the sharing and compatibility studies planned by Task Group (TG) 6/1 for such studies. It should be noted that some of the practical deployment scenarios in-between different countries consider more conservation configurations that will result in less interference probability and less coordination distance results.

**2 Parameters, Deployment Scenario, and Propagation Models**

The sharing and compatibility studies are carried out using the relevant ITU-R propagation models in the simulation including Recommendations ITU-R P.1546-6, ITU-R P.1812-4 for outdoor Tx/Rx, clutter models of Recommendations ITU-R P.2108-0 for outdoor and ITU-R P.2109-1 for indoor including building entry loss.

Monte Carlo simulations were conducted to evaluate interference probability using the given parameters for each of the mentioned systems, propagation models, and overall simulation events are given taken into account practical deployment scenario for the border areas between the territories of concerned neighbouring countries, to evaluate the probability of any possible interference. The values of some parameters include BS e.i.r.p of 44 dBm for Channel bandwidth of 20 MHz in the given frequency band around 600 MHz band, Antenna height of 10 m, Antenna down tilt of -9 degrees, Cell Radius of 1.5 km and 5.5 km for urban and rural scenarios, respectively. For the US parameters, average user terminal output power is considered. The values of other parameters for sharing and compatibility studies are considered in accordance with the characteristics provided by concerned ITU Working Parties such as ITU WP 5D LS (Doc. 5D/28) for terrestrial component of IMT. In addition,

The simulations cover the following scenarios:

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| Scenario | Area Type | Interference Type | Test Cases |
| IMT Base-Station into Broadcasting Rx | Urban  Rural | Co-Channel | 100% Outdoor Rx  100% Indoor Rx |
| Example for Adjacent Channel with 2 MHz separation |
| IMT UE into Broadcasting Rx | Urban  Rural | Co-Channel | 70% indoor / 30% outdoor for urban  50% indoor / 50% outdoor for rural |
| Example for Adjacent Channel with 2 MHz separation |

The DTTB systems’ characteristics are summarized in the following table.

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| --- | --- |
| Broadcasting System Parameters | |
| **EIRP (Tx) (kW)** | Medium: 5 |
| **Coverage Radius (km)** | Urban: 12.6  Rural: 32.1 |
| **Antenna Height (Tx) (m)** | Urban: 300  Rural: 150 |
| **Antenna Pattern (Tx)** | ITU-R BT.419-3 |
| **Antenna Gain (Rx) (dBd)** | 9.15 |
| **Antenna Gain (Rx) (dBi)** | 9.15+2.15 = 11.3 (Outdoor)  2.15 (Indoor) |
| **Antenna Height (Rx) (m)** | 10 |
| **Antenna Pattern (Rx)** | ITU-R BT.419-3 |
| **Noise Figure (Rx) (dB)** | 7 |
| **Bandwidth (MHz)** | 6 |
| **I/N (dB)** | -10 |

# 3 Interference Analysis

The analysis was conducted on the following interference cases:

* Interference from IMT Base-station to Broadcasting receiver in urban and rural environments.
* Interference from IMT User equipment to Broadcasting receiver.

In addition, the following scenarios are considered:

* Single Interferer
  + Scenario 1: IMT outdoor – BS outdoor
  + Scenario 3: IMT outdoor – BS indoor
  + Scenario 5: IMT UE outdoor – BS indoor
* Multiple Interferer
  + Scenario 2: IMT outdoor – BS outdoor
  + Scenario 4: IMT outdoor – BS indoor
  + Scenario 6: IMT UE outdoor – BS indoor

# 4 Results and Conclusions

The following results were obtained for the relevant scenarios:

## 4.1 Interference from IMT Base-station to Broadcasting receiver

### 4.1.1 Interference Probability for Urban Environment

#### 4.1.1.1 BS outdoor

##### 4.1.1.1.1 Scenario 1: Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **1.5** |  | 6.2 |
| **3** |  | 0% |
| **12** | 11.5% |  |
| **13** | 7% |  |
| **15** | 0% |  |

The above results indicate that the probability of interference is negligible at distance greater than 13 km for urban deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

##### 4.1.1.1.2 Scenario 2: Multiple Interferers

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **2.5** |  | 0.5% |
| **4** |  | 0% |
| **17** | 11.3% |  |

The above results indicate that the probability of interference is negligible at distance greater than 17 km for urban deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference cases.

#### 4.1.1.2 BS indoor

##### 4.1.1.2.1 Scenario 3: Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **2** | 8.4% | 0% |
| **4** | 0% |  |

The above results indicate that the probability of interference is negligible at distance greater than 2 km for urban deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

##### 4.1.1.2.2 Scenario 4: Multiple Interferers

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **0.2** |  | 3.9% |
| **3.5** | 3.9% | 0% |

The above results indicate that the probability of interference is negligible at distance greater than 3.5 km for urban deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference cases.

### 4.1.2 Interference Probability for Rural Environment

#### 4.1.2.1 BS outdoor

##### 4.1.2.1.1 Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **2.5** |  | 3.6% |
| **4** |  | 0% |
| **15** | 6% |  |
| **17** | 0% |  |

The above results show that the probability of interference is negligible at distance greater than 15 km for rural deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

#### 4.1.2.2 BS indoor

##### 4.1.2.2.1 Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **1** |  | 0% |
| **3** | 5% |  |

The above results show that the probability of interference is negligible at distance greater than 3 km for rural deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

##### 4.1.2.2.2 Multiple Interferers

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (km)** | **Co-channel** | **Adjacent** |
| **0.5** |  | 0.4% |
| **4** | 2.2% |  |

The above results show that the probability of interference can be negligible at distance greater than 4 km for rural deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference.

## 4.2 Interference from IMT User equipment to Broadcasting Receiver

### 4.2.1 Urban

#### 4.2.1.1 Outdoor IMT UE and Indoor BS Rx

##### 4.2.1.1.1 Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 1.6% |  |
| **50 m** | 1.4% |  |

##### 4.2.1.1.2 Multiple Interferers

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **30 m** | 7.2% |  |

The above results indicate that coordination distance is negligible between IMT UE’s and indoor broadcasting receivers, as the probability of interference for all cases is sufficiently low.

### 4.2.2 Outdoor IMT UE and Indoor BS Rx

#### 4.2.2.1 Rural

##### 4.2.2.1.1 Single Interferer

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 2.8% |  |
| **50 m** | 1.8% |  |

##### 4.2.2.1.2 Multiple Interferers

|  |  |  |
| --- | --- | --- |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **70 m** | 8.3% |  |

The above results indicate that coordination distance is negligible between IMT UE’s and indoor broadcasting receivers (in terms of meters), as the probability of interference for all cases is sufficiently low.

**5 Summary**

This study analyzed the probability of interference occurrence and any potential coordination distance between IMT and Broadcasting systems to avoid interference on broadcasting receivers within the co-channel and adjacent channel scenarios. The results showed that the required coordination distance can range from few meters in case of IMT UE’s to nearly few kilometers in case of IMT base-station, depending on the interference scenario and deployment environment.

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