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| **Radiocommunication Study Groups** |  |
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| Received: 14 February 2022  Source: Document [6-1/43](https://www.itu.int/md/R19-TG6.1-C-0043/en) | **Document 6-1/99-E** |
| **15 February 2022** |
| **English only** |
| Saudi Arabia (Kingdom of), United Arab Emirates | |
| sharing Study From IMT To broadcasting For border area Scenario 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;

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 parameter values based on a practical deployment scenarios, which should be considered in the sharing and compatibility studies planned by Task Group (TG) 6/1. It should be noted that some of the practical deployment scenarios in-between different countries consider more conservative configurations that will result in less interference probability and less coordination distance results.

# 2 Proposal

This contribution proposes revision of earlier contribution (Doc. C-043) that was submitted by multi Administrations on the sharing and compatibility studies between IMT system under Mobile Service (MS) and Broadcasting Service (BS) for the scenario of IMT deployments in border areas. The parameters were selected from the ITU Recommendations and Reports, as relevant including Report ITU-R BT.2337, to 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 possible interference from IMT based MS transmitters (base-station and user equipment) into Digital Terrestrial Television Broadcasting (DTTB) receivers and into DTTB system receivers.

The attachment provides the initial modifications proposed to the Working document/material on sharing and compatibility studies in the frequency band 470-694 MHz in Region 1 (Annex 2 - Document [6-1/77](https://www.itu.int/md/R19-TG6.1-C-0077/en)).

**Attachment:** 1

Attachment

Proposed Revision to Annex 2 to Task Group 6/1 Chairman’s Report (Document 6-1/77-E) of Working document/material on sharing and compatibility studies in the frequency band  
 470-694 MHz in Region 1

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## 2.5 Calculation methods and assumptions

### 2.5.1 Propagation prediction methods

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### [2.5.3 Percentages of time for the propagation curves

Percentage of time for the propagation curve considered for the following studies of the impact on the broadcasting service varied from 1% to 10%. For GE06 agreement, the characteristics of 1% of time and 50% of locations are considered for the construction of the contours for the tropospheric case for the determination of the interference into the broadcasting receiver, and the characteristics of 10% of time and 50% of locations are considered for ground to ground calculations for the determination of the interference into the other primary terrestrial services]

[Ed. Note: Below section 2.5.3.1 is proposed to be shifted to the working document on the spectrum use and needs]

#### [2.5.3.1 Information on assignments in individual countries

Annex 2 provides the list of assignments that the administration of Iran (Islamic Republic of) had notified to the Radiocommunication Bureau and that are within the frequency bands subject to WRC-23 agenda items.]

# 3 Sharing and compatibility studies

[The baseline parameters for the studies are those supplied by the interested Working Parties 5A, 5D, 6A etc.

Adjusted parameters used in the studies, to study a specific deployment scenario, should be clearly stated together with description of the deployment scenario in question. The values of the parameters are adjusted to take into account deployments in border areas between the territories of concerned neighbouring countries.

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## 3.1 Impact from mobile to broadcasting/DTTB

### 3.1.1 Impact from IMT base stations to broadcasting in co-channel and adjacent channel

#### 3.1.1.1 Summary of past studies

Co-channel compatibility studies

Three generic studies are included in Section I of Report ITU-R BT.2337-1, all focus on the cumulative effect of interference from Mobile base stations into DTTB reception.

Two studies use Minimum Coupling Loss (MCL) method and I/N based protection criterion to assess the increment of interference level from single to multiple base stations and the related increase of the separation distance between the Mobile Base station(s) and the DTTB reference reception point.

A third study uses Monte Carlo simulation method with a protection criterion based on degradation of reception location probability and related degradation of *C*/(*N*+*I*). It also assesses the increase of the separation distance between the Mobile Base station(s) and the DTTB reference reception point from single to multiple interferers.

Two co-channel case studies in Annex 1 to Section I also focus on the cumulative effect of interference, they both use an MCL method.

A first study considers a hypothetical border between two countries and shows the distribution of the increase in field strength between single and multiple base stations.

The second study considers a real mobile network in France, in order to assess the potential impact of multiple sources of interference in terms of *C*/(*N*+*I*) at different points at the border between two countries and inside the victim country.

Adjacent channel compatibility studies

Section I of Report ITU-R BT.2337-1 includes one study on adjacent channel compatibility between the Mobile service, represented by a “wireless broadband access system”, and the broadcasting service. It shows laboratory and field trials in the frequency band 470-694 MHz. It covers only the case of User Equipment (UE) at fixed locations and the mutual impact between the two systems.

The study shows results of protection ratio measurements for different broadcasting receivers and separation distances required between the UE equipment and the broadcasting receiving antenna. The study also assesses the need and feasibility of mitigation measures to ensure compatibility.

Annexes 1 to 3 to Report ITU-R BT.2301-2 show National field reports on the introduction of IMT in the bands with co-primary allocation to the broadcasting and the mobile services for the case of the 800 MHz band in Germany, France and Netherlands, respectively.

These reports describe the method used by the national regulators in the three countries to assess the risk of interference from Mobile base stations into DTTB reception in adjacent channels before granting the authorisation to implement the Mobile base stations. In addition, the reports indicate the number of actual interference cases and describe the mitigation measures used to solve these cases.

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#### 3.1.1.3 New Study 2 - Interference from IMT Base-station to Broadcasting receiver

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 study 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 different configurations that will result in less interference probability and less coordination distance results.

##### 3.1.1.3.1 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 42 dBm for Channel bandwidth of 10 MHz in the given frequency band around 600 MHz band (with Tx power of 34 dBm including losses such as activity factor, polarization discrimination), Antenna height of 10 m, Antenna down tilt of -9 degrees, Cell Radius of 1.5 km and 8 km for urban and rural scenarios, respectively. For the UE 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](https://www.itu.int/md/R19-WP5D-C-0028/en)) for terrestrial component of IMT

The simulations cover the following scenarios:

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| Scenario | Area Type | Interference Type | Test Cases |
| IMT Base-Station into Broadcasting Rx | Urban | Co-Channel | 100% Outdoor Rx  100% Indoor Rx |
| Adjacent Channel  0 MHz Guardband |
| IMT UE into Broadcasting Rx | Urban  Rural | Co-Channel | 70% indoor / 30% outdoor for urban  50% indoor / 50% outdoor for rural |
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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  Rural: 38 |
| **Antenna Height (Tx) (m)** | Urban: 150  Rural: 300 |
| **Antenna Pattern (Tx)** | ITU-R BT.419-3 |
| **Antenna Gain (Rx) (dBd)** | 7 |
| **Antenna Gain (Rx) (dBi)** | 9.15 (Outdoor)  2.15 (Indoor) |
| **Antenna Height (Rx) (m)** | 10 |
| **Antenna Pattern (Rx)** | ITU-R BT.419-3 |
| **Bandwidth (MHz)** | 8 |
| **I/N (dB)** | -6 (and -10 in some cases) |







##### 3.1.1.3.2 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

##### 3.1.1.3.3 Results and Conclusions

The following results were obtained for the relevant scenarios:

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

**a Interference Probability for Urban Environment**

## a.1 BS outdoor

### a.1.1 Scenario 1: Single Interferer

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| I/N = -6 | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| 0 |  | 2.30% |
| 0.1 |  | 1.10% |
| 0.2 |  | 0% |
| 3 | 72.30% |  |
| 4 | 11.80% |  |
| 4.5 | 0% |  |

The above results indicate that the probability of interference is negligible at distance greater than 4 km for urban deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

**a.1.2 Scenario 2: Multiple Interferers**

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| **I/N = -6** | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| **0** |  | 2.10% |
| **0.2** |  | 0% |
| **4** | 69% |  |
| **5** | 9.20% |  |
| **5.5** | 0% |  |

The above results indicate that the probability of interference is negligible at distance greater than 5 km for urban deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference cases.

## a.2 BS indoor

### a.2.1 Scenario 3: Single Interferer

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| **I/N = -6** | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| 0 |  | 0% |
| 0.1 | 25.10% |  |
| 0.5 | 9% |  |

The above results indicate that the probability of interference is negligible at distance greater than 0.5 km for urban deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

### a.2.2 Scenario 4: Multiple Interferers

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| I/N = -6 | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| 0 | 31.60% | 0% |
| 0.5 | 9.40% |  |
| 1 | 0% |  |

The above results indicate that the probability of interference is negligible at distance greater than 0.5 km for urban deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference cases.

**b Interference Probability for Rural Environment**

## b.1 BS outdoor

### b.1.1 Single Interferer



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| **I/N = -6** | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| **0.2** |  | 1.3% |
| **7.5** | 93.2% |  |
| **8.5** | 35.7% |  |
| **9** | 7.4% |  |
| **9.2** | 0.7% |  |

The above results show that the probability of interference is negligible at distance greater than  9 km for rural deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

### b.1.2 Multiple Interferer

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| --- | --- | --- |
| I/N = -6 | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| **0.4** |  | 0.9% |
| **8.5** | 41.6% |  |
| **9** | 11.8% |  |
| **9.3** | 1% |  |

The above results show that the probability of interference is low at distances greater than 9 km for rural deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference cases.

**b.2 BS indoor**

**b.2.1 Single Interferer**



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| **I/N = -6** | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| 0.1 |  | 0% |
| 0.5 | 18.7% |  |
| 0.8 | 9.2% |  |
| 1 | 1.7% |  |

The above results show that the probability of interference is negligible at distance greater than 0.8 km for rural deployment environment in co-channel interference cases with single interferer and coordination distance further decreases in adjacent interference cases.

### b.2.2 Multiple Interferers



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| I/N = -6 | | |
| Coordination Distance (km) | Co-channel | Adjacent |
| **0.1** |  | 0% |
| **0.5** | 23.2% |  |
| **1** | 9.4% |  |
| **1.5** | 0.6% |  |

The above results show that the probability of interference can be negligible at distance greater than 1 km for rural deployment environment in co-channel interference cases with multiple interferers and coordination distance further decreases in adjacent interference.

###### 3.1.1.3.3.2 Interference from IMT User equipment to Broadcasting Receiver

The protection criteria of I/N with value of -10 dB is considered for the below evaluation since there is no probability of harmful interference in case of considering I/N of -6.

**a Interference Probability for Urban Environment**

## a.1 Outdoor IMT UE and Indoor BS Rx

### a.1.1 Single Interferer



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| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 0.7% |  |
| **20 m** | 0.4% |  |

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

### a.1.2 Multiple Interferers

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| **I/N = -10** | | |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 4.1% |  |
| **20 m** | 2.9% |  |
| **40 m** | 1.6% |  |

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 in terms of few meters.

### 4.2.2 Outdoor IMT UE and Indoor BS Rx

#### 4.2.2.1 Rural

##### 4.2.2.1.1 Single Interferer

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| **I/N = -10** | | |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 1% |  |

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 in terms of few meters.

##### 4.2.2.1.2 Multiple Interferers

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| **I/N = -10** |

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| --- | --- | --- |
| **Coordination Distance (m)** | **Co-channel** | **Adjacent** |
| **10 m** | 4.5% |  |
| **30 m** | 3.1% |  |
| **50 m** | 2% |  |
| **70 m** | 0.8% |  |

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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 in terms of few meters.

##### 3.1.1.3.4 Summary

This study analyzed the probability of interference occurrence and any potential coordination distance between IMT and Broadcasting systems to ensure no harmful impact 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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