



Recommendation ITU-R BT.2136-0
(12/2020)

**Assessing interference into digital
terrestrial television broadcasting
from other services by means
of Monte Carlo simulation**

BT Series
Broadcasting service
(television)



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Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.2136-0

**Assessing interference into digital terrestrial television broadcasting
from other services by means of Monte Carlo simulation**

(2020)

Scope

This Recommendation defines the methodology to be used to assess interference into digital terrestrial television broadcasting (DTTB) from other services, when Monte Carlo simulation is employed. It also provides guidance on how the results of such Monte Carlo simulation can be interpreted against guideline protection criteria given in Recommendation ITU-R BT.1895.

Keywords

DTTB, Monte Carlo, Quality of Service, Time Window, Probability of Interference, Probability of Disruption

The ITU Radiocommunication Assembly,

considering

- a) that Article 5 of the Radio Regulations (RR) allocates frequency bands to the terrestrial broadcasting service on a primary basis;
- b) that the terrestrial broadcasting service is planned on a noise-limited basis, taking into account intrinsic receiver noise and external radio noise;
- c) that broadcasting services may also be planned on an interference-limited basis;
- d) that Recommendation ITU-R P.372 describes levels of external radio noise, which are applied to planning of broadcasting services;
- e) that Recommendation ITU-R SM.1757 and Report ITU-R SM.2057 provide guidance on the protection requirements for the various radiocommunication services in respect of the aggregate emissions from devices using ultra-wideband technology;
- f) that Recommendation ITU-R BT.1895 recognises the principles above and provides guidelines to ensure that total interference at the broadcasting receiver from all radiations and emissions from radiocommunication services and other sources of radio-frequency emissions should not exceed specific limits of the total receiving system noise power thus degrading the performance of terrestrial broadcasting systems beyond acceptable levels;
- g) that protection criteria for intra-service broadcasting applications have been specified in ITU-R Recommendations (for example Recommendations ITU-R BT.1368, ITU-R BT.2033) and Regional Agreements, e.g. GE-06;
- h) that two approaches, “deterministic” and “probabilistic” can be used to assess interference into DTTB. Deterministic approaches, while being simple, do not always provide a complete assessment of the interference scenarios that may arise;
- i) that Monte Carlo simulation is increasingly being used within some services specifically to assess their compatibility with other radiocommunication systems;
- j) that the Monte Carlo simulation methodology, used to assess the compatibility between radiocommunications systems, provides the average probability of interference or the average loss of throughput, at any one instant in time, and does not account for interference that may occur within a

time window due to changes with time, for example in the relative position and/or power of transmitters within the interfering network;

- k) that unlike some radiocommunications systems, the broadcasting service cannot re-send data that has failed to be received and cannot adapt the bit rate to suit the state of the RF channel, so the quality of service (QoS) is therefore strongly dependent on the signal quality at the reception point;
- l) that the criterion for satisfactory reception of DTTB is that the received service is Quasi-Error Free (QEF) and that the probability of disruption to a DTTB service derived by a Monte Carlo simulation is the probability that one or more interference events occur to the received signal (e.g. picture) in an hour;
- m) that, for the above reasons (j, k, l), in the case of DTTB the outcome of Monte Carlo simulation may need to be post-processed to take into account state changes occurring in the interfering network within a time window;
- n) that sharing and compatibility studies between radiocommunications services are usually required in cases where new allocations are being considered;
- o) that in such studies values of technical system parameters for both services under study need to be supplied,

recognizing

the obligations incumbent on administrations through Articles 42 and 45 of the ITU Constitution (Nos. CS 193, CS 197, CS 198 and CS 199) to ensure the continued availability of the RF spectrum and guard against harmful interference,

noting

- a) that Report ITU-R SM.2028 – Monte Carlo simulation methodology for the use in sharing and compatibility studies between different radio services or systems, describes a Monte Carlo radio simulation methodology;
- b) that Report ITU-R BT.2469 – Characteristics of digital terrestrial broadcasting systems in the frequency band 174-230 MHz, and Report ITU-R BT.2383 – Characteristics of digital terrestrial television broadcasting systems in the frequency band 470-862 MHz, contain parameters for the broadcasting service for the purpose of use in sharing and compatibility studies;
- c) that Report ITU-R BT.2470 – Use of Monte Carlo simulation to model interference into DTTB, provides additional information and examples on the use of Monte Carlo simulation to model interference into DTTB reception for use in sharing and compatibility studies between DTTB systems and other radiocommunications services;
- d) that Report ITU-R BT.2265 – Guidelines for the assessment of interference into the broadcasting service, outlines possible approaches for protecting broadcasting from interference originating from other services and interference originating from devices/applications without a corresponding frequency allocation and provides guidance to assist administrations in planning the use of the spectrum in an efficient manner;
- e) that Recommendation ITU-R M.1634 – Interference protection of terrestrial mobile service systems using Monte Carlo simulation with application to frequency sharing, is a source of information on the use of the Monte Carlo method of analysis and recommends the use of a probabilistic approach when assessing potential interference;
- f) that Recommendation ITU-R M.2101 – Modelling and simulation of IMT networks and systems for use in sharing and compatibility studies, contains the methodology for modelling and simulation of IMT networks for use in sharing and compatibility studies between IMT and other systems and/or applications. As such, it does not make any assumptions on the system parameters or

modelling of these other systems and/or applications and is strictly limited to providing information for the IMT systems,

recommends

- 1 that the methodology outlined in Annex 1 of this Recommendation should be used in studies, based on Monte Carlo simulation, that assess interference into DTTB from other services;
- 2 that the parameters in Annex 2 concerning the broadcasting service should be used in such studies.

This Recommendation contains the following Annexes:

Annex 1 – Methodology to be used in Monte Carlo simulation.

Annex 2 – DTTB Parameters to be used in Monte Carlo simulation.

Annex 1

Methodology to be used in Monte Carlo simulation

1 Introduction

Monte Carlo simulation is a statistical method widely used to solve complex mathematical problems, to model physical phenomena or to understand complex real-life problems that cannot be easily modelled by analytical methods. Monte Carlo simulation is based on random sampling to generate a large number of events (experiments), according to the model implemented to describe a physical phenomenon.

Monte Carlo simulation is increasingly being used as the method for assessing interference in compatibility studies between mobile, fixed and broadcast services. The Monte Carlo simulation methods used to assess interference into and from bidirectional systems, provide information on the average probability of interference for any one moment in time. Usually, in bidirectional systems, this probability is mapped onto a loss of data throughput. Such simulations are ideal for assessing interference (blocking) in bidirectional systems that can re-send data not received. A method is required that suits assessing interference into broadcast systems of unidirectional design.

Modelling the probability of interference into DTTB using Monte Carlo simulation¹ poses some unique problems as quality of service is measured in a one hour time window and Monte Carlo simulation provides a probability of interference at one moment in time.

If the network being modelled does not change with time, i.e. the interferer position is fixed, and the transmitted power is constant, then there is a single event and the calculated probability of interference using a Monte Carlo simulation is valid for any time window. If, however, the network varies, in the case of fixed interferers the power varies between off and fully on, or there is movement or change in position of the interferers in the network, then the calculated probability of interference is only

¹ Report ITU-R SM.2028 provides background information on Monte Carlo simulation methodology for assessing compatibility between radio communication systems and their application in the Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) software.