



**Recommendation ITU-R M.1469-2**  
(01/2010)

**Methodology for evaluating potential for interference from time division multiple access/frequency division multiple access (TDMA/FDMA) mobile-satellite service (MSS) Earth-to-space transmissions into line-of-sight (LoS) fixed service receivers in the frequency range 1-3 GHz**

**M Series**  
**Mobile, radiodetermination, amateur and related satellite services**

## 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.

## Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://www.itu.int/ITU-R/go/patents/en> where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

### Series of ITU-R Recommendations

(Also available online at <http://www.itu.int/publ/R-REC/en>)

Series	Title
<b>BO</b>	Satellite delivery
<b>BR</b>	Recording for production, archival and play-out; film for television
<b>BS</b>	Broadcasting service (sound)
<b>BT</b>	Broadcasting service (television)
<b>F</b>	Fixed service
<b>M</b>	<b>Mobile, radiodetermination, amateur and related satellite services</b>
<b>P</b>	Radiowave propagation
<b>RA</b>	Radio astronomy
<b>RS</b>	Remote sensing systems
<b>S</b>	Fixed-satellite service
<b>SA</b>	Space applications and meteorology
<b>SF</b>	Frequency sharing and coordination between fixed-satellite and fixed service systems
<b>SM</b>	Spectrum management
<b>SNG</b>	Satellite news gathering
<b>TF</b>	Time signals and frequency standards emissions
<b>V</b>	Vocabulary and related subjects

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

Electronic Publication  
Geneva, 2010

© ITU 2010

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

## RECOMMENDATION ITU-R M.1469-2\*

**Methodology for evaluating potential for interference from time division multiple access/frequency division multiple access (TDMA/FDMA) mobile-satellite service (MSS) Earth-to-space transmissions into line-of-sight (LoS) fixed service receivers in the frequency range 1-3 GHz\*\***

(Questions ITU-R 201/4 and ITU-R 118/5)

(2000-2005-2010)

**Scope**

This Recommendation provides a methodology that may be used to assess the potential for interference from deployments of mobile earth stations (MES) that use non-directive antennas into line-of-sight (LoS) fixed service (FS) receivers in the 1-3 GHz range. This method provides predictions of the probability of interference into fixed service receivers in areas where there is co-frequency sharing between the two services.

The ITU Radiocommunication Assembly,

*considering*

- a) that the frequency band 1 626.5-1 660.5 MHz is allocated to the mobile-satellite service (MSS) (Earth-to-space) on a primary basis in all Regions;
- b) that the frequency bands 1 626.5-1 645.5 MHz and 1 646.5-1 660 MHz are also allocated to the fixed service on a primary basis in some countries;
- c) that the frequency band 1 668.4-1 675 MHz is allocated to the MSS (Earth-to-space) and the fixed service on a co-primary basis in all Regions;
- d) that the frequency bands 1 980-2 010 MHz in all Regions and 2 010-2 025 MHz in Region 2 are allocated to the MSS (Earth-to-space) and the fixed service on a co-primary basis;
- e) that mobile earth stations (MES) may potentially interfere with LoS fixed service receivers operating in the 1 626.5-1 645.5 MHz, 1 646.5-1 660 MHz, 1 668.4-1 675 MHz, and 1 980-2 025 MHz MSS bands within the MES coordination area, as determined using the methods in Radio Regulations;
- f) that the nature of such interference would be time-varying;
- g) that there is a need for detailed analysis tools to facilitate coordination between administrations operating MES and affected administrations operating fixed service receivers,

---

\* This Recommendation should be brought to the attention of Radiocommunication Study Group 3.

\*\* This is a joint Radiocommunication Study Groups 4 and 5 Recommendation, and any revision shall be undertaken jointly.

*recommends*

1 that when assessing the potential for interference from MES to fixed service systems, account should be taken of the time-varying nature of MES signals received by fixed service stations, including the effects of predicted diurnal and geographic distributions of transmitting MES, and the temporal variations of the power level of desired signals in fixed service systems;

2 that the methodology in Annex 1 may be used in bilateral coordination for detailed assessment of the potential for interference to fixed service receivers from a population of MES using non-directive antennas (see Notes 1 and 2).

NOTE 1 – The application of the methodology in this Recommendation will require the development of algorithms or calculation procedures to address the implementation of the considerations described. The use or adaptation of these algorithms or procedures in any bilateral coordination would be subject to agreement by the concerned parties.

NOTE 2 – That in territories where a large number of fixed service systems are in operation, it may suffice to apply the methodology of Annex 1 with respect to a representative set of fixed service systems using their actual parameters, taking care to include fixed service systems that are likely to be most susceptible to interference by virtue of their locations and characteristics.

## **Annex 1**

### **Methodology for detailed assessment of the potential for interference to FS receivers from MES**

(see Note 1)

NOTE 1 – The methodology presented herein is applicable to fixed service systems, which enables a somewhat simplified approach that addresses the interfering signal power and the associated performance levels in an individual hop of a multihop radio-relay system. A similar methodology addressing a single hop of a multihop analogue radio-relay system can be developed and applied with respect to appropriate performance criteria (i.e. end-to-end performance criteria for a multihop analogue system that has been appropriately pro-rated according to the number of hops).

#### **1 Introduction**

This Annex presents a detailed simulation method that may be used to assess the potential for interference from realistic deployments of MES using non-directive antennas into LoS fixed service receivers. The method provides detailed predictions of the probability of interference into fixed service receivers in areas where there is co-frequency sharing between the two services.

#### **2 General description**

A simulation is executed over a large number of time steps. At each time step the following calculations are performed:

2.1 The level of the desired signal at the fixed service receive station within a 1 MHz reference bandwidth is calculated using the fixed service transmission characteristics in conjunction with the model of multipath fading given in Recommendation ITU-R P.530 (see § 3 for more details).

2.2 The aggregate interfering signal power in the reference bandwidth from all active MES deployed within a defined area is calculated at the input to each fixed service receiver. Digital terrain data is used to derive terrain profiles for the interference paths from each MES to each fixed service receiver. The basic transmission loss for each interference path is calculated using the methods in Recommendation ITU-R P.452 (see § 4 for more details).

2.3 The  $C/(N + I)$  at each fixed service receiver is calculated (see § 5 for more details). In calculating the value of  $N$ , the effects of all fixed service system degradations should be included (for example, see Recommendation ITU-R M.1319).

By running the simulation for a sufficiently long time (i.e. a very large number of time increments), statistically significant results can be gathered. This process is applied to various realistic deployments of MES in order to eliminate the sensitivity of the results to the particular deployments considered, which can be particularly important in cases where the number of simultaneously-transmitting MES located within line-of-sight of an fixed service station may vary substantially over time. The cumulative probability distribution of  $C/(N + I)$  can then be compared with the performance objectives of the fixed service system (expressed in terms of equivalent  $C/(N + I)$  thresholds within the reference bandwidth).

### 3 Fixed service modelling

#### 3.1 Fixed service parameters

The deployment, equipment and performance characteristics of the fixed service system should be modelled using the parameters listed in Table 1. The fade depth should be calculated from Recommendation ITU-R P.530, which together with the free-space-loss is used to determine the basic transmission loss on the desired signal path.

TABLE 1  
List of required fixed service parameters

Parameter
Antenna gain, $G$ (dBi)
Antenna pattern, $G(\theta)^{(1)}$ (dBi)
Antenna noise temperature, $T$ (K)
Transmission frequency, $f$ (MHz)
e.i.r.p. <sub>FS</sub> (dBW)
Feeder loss, $L_s$ (dB)
Feeder noise temperature (K)
Receiver occupied bandwidth (MHz)
FS station position (° N, ° E)
Antenna height above mean sea level (m)
Geoclimatic factor, $K$
Receiver noise temperature (K)

<sup>(1)</sup> Fixed service antenna gain in the direction of the interferer.

### 3.2 Calculation of the power level of the desired signal

The first step is to calculate the received power level of the desired signal at an instant in time,  $C(t)$ . This is done with a random number generator to predict the fade depth,  $A$ , consistent with the distribution given in § 2.3 of Recommendation ITU-R P.530. The received signal level at each time step is calculated at the input of the fixed service receiver in each receiving station under consideration using the following equation:

$$C(t) = e.i.r.p.FS - L_{bf} + G - A(t) - L_s \quad (1)$$

where  $L_{bf}$  is the free space basic transmission loss. It may be possible in some cases, (e.g. based on measured data), to take account of diurnal and/or seasonal variations in multipath fading propagation behaviour.

## 4 MES modelling

### 4.1 MES geographic distribution

The MES geographic distribution is defined inside an area of interest (AoI), which has to be sufficiently large so that all significant interference contributions are taken into account. The AoI is overlaid with a grid of latitude/longitude points, which represent possible MES locations. The MES traffic profile is defined by two basic parameters:

- the number of active MES carriers at the local busy hour;
- a time of day profile.

The AoI can be subdivided into smaller cells, to enable variation of the above parameters.

At each time step the number of MES that are transmitting within a cell is determined from the MES traffic profile and the time of day. An MES at each point in the AoI will then be selected as being either transmitting or idle. This is determined by first determining the probability that an MES is transmitting,  $p(\text{active})$ , at this moment of time. A random number is then generated, and if the random number is less than  $p(\text{active})$  the MES is assumed to be transmitting; otherwise, the MES is assumed to be idle.

The MES geographic distribution is assumed to be independent from time step to time step. This assumption can be made since the purpose of the method is to derive long-term interference statistics, not the time evolution of interference.

### 4.2 MES signal propagation

A terrain database is required to accurately predict the basic transmission loss on the interfering signal paths between the MES and the FS receiver. A terrain profile is generated for the great circle path between each transmitting MES and each fixed service receiver under consideration, and the basic transmission loss at each time step is calculated using the clear-air interference prediction method in Recommendation ITU-R P.452. Because this propagation model predicts basic transmission losses exceeded for time percentages of 50% or less (rather than a complete cumulative distribution), it is necessary to appropriately extend the predicted cumulative time distribution of loss to higher time percentages in order to encompass the relatively high losses that may occur (rather than assume that the 50% value is the maximum level of basic transmission loss). Likewise it may be appropriate to extrapolate the basic transmission loss to very small percentages of time (e.g. less than 0.001%), by assuming a suitable small value for a minimum basic

transmission loss. Even with an extrapolation, this propagation model may underestimate the basic transmission loss in some situations (e.g. as a result of local phenomena not addressed by the model, such signal blockage due to intervening buildings not included in the terrain data and user “head blockage”). This leads to overestimation of interfering signal power levels.

### 4.3 The interference calculation

The interference power at each time step at the input of the fixed service receiver is calculated as follows:

$$I(t) = e.i.r.p.MES - L_b(t) + G(\theta) - L_s \quad (2)$$

where:

*e.i.r.p.MES*: equivalent isotropically radiated power of the MES within the reference bandwidth (dBW)

$L_b$ : basic propagation loss for the interfering signal (see § 4.2).

For deployments involving multiple transmitting MES, the aggregate interfering signal at each time step is taken as the sum of all single-entry levels of interfering signal power.

$$I_{agg}(t) = 10 \log \left( \sum_i 10^{I_i(t)/10} \right) \quad (3)$$

where:

$I_i(t)$ : single-entry interfering signals (dB).

## 5 Outputs

Each time step of the simulation will produce  $C/(N + I)$  values for each fixed service receiver considered in the simulation. These values are suitably quantized (e.g. 1 dB intervals) and stored (e.g. as the number of occurrences of a quantized value). At the end of the simulation, the cumulative distribution functions can then be computed and compared to relevant fixed service performance objectives, e.g. from Recommendations ITU-R F.634 or ITU-R F.697, converted to equivalent  $C/(N + I)$  thresholds.

---