

RECOMMENDATION ITU-R M.1316-1*

**Principles and a methodology for frequency sharing in the
1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz bands
between the mobile-satellite service (Earth-to-space)
and the radio astronomy service**

(Question ITU-R 201/8)

(1997-2005)

Scope

This Recommendation provides the principles and methodology that may be applied for the protection of the radio astronomy observations from emissions of land and maritime mobile earth stations in the 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz bands. Annex 1 describes the three steps to be followed, with Annex 2 describing the calculation of the “separation distance by default” using the Monte Carlo methodology based on the principle of sampling random variables. Annex 3 calculates the restriction zones. Step 3 is the calculation of exclusion zones using the specific characteristics of the systems involved.

The ITU Radiocommunication Assembly,

considering

- a) that the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) (WARC-92) allocated the band 1 610-1 626.5 MHz on a primary basis to the mobile-satellite service (MSS) in the Earth-to-space direction, and the band 1 610.6-1 613.8 MHz on a primary basis to the radio astronomy service (RAS);
- b) that the frequency band 1 610.6-1 613.8 MHz is used by radio astronomers to observe the spectral line of the hydroxyl molecule near 1 612 MHz;
- c) that No. 5.372 of the Radio Regulations (RR) states that “Harmful interference shall not be caused to stations of the radio astronomy service using the band 1 610.6-1 613.8 MHz by stations of the radiodetermination-satellite and the mobile-satellite services (No. **29.13** applies)”;
- d) that the mobile-satellite systems operating in the 1 610-1 626.5 MHz band are likely to be utilizing mobile earth stations (MESS) with omni-directional antennas;
- e) that the 1 660-1 660.5 MHz frequency band is allocated to the RAS on a shared, primary basis with the land-mobile satellite service (LMSS) in the Earth-to-space direction;
- f) that the importance of the allocation at 1 660-1 660.5 MHz to the RAS was confirmed by Resolution 6 of the 20th General Assembly of the International Astronomical Union (IAU) (Baltimore, United States of America, August, 1988) and reconfirmed at the 21st General Assembly of the IAU (Buenos Aires, Argentina, July, 1991) and at the 22nd General Assembly of the IAU (The Hague, The Netherlands, 1994);
- g) that Recommendation ITU-R RA.1031 does not fully take into account the statistical nature of the interference caused by mobile transmitters,

* This Recommendation should be brought to the attention of Radiocommunication Study Group 7.

recommends

- 1 that principles and methodologies similar to those described in Annex 1 may be used in coordination between radio astronomy stations and land and maritime MESs in the bands 1 610.6-1 613.8 MHz and 1 660-1 660.5 MHz;
- 2 that further studies are needed by ITU-R, including studies for aircraft earth stations, in order to review the applicability of this Recommendation for detailed coordination between the MSS and the RAS;
- 3 that in any application of a methodology the input parameters should be agreed by the parties concerned during coordination;
- 4 that the ITU-R should, in cooperation with the Radiocommunication Bureau, jointly develop a computer program to implement the methodology given in Annexes 1 to 4.

Annex 1

Assessment of the interference from MES/MSS into radio astronomy observations

The protection of radio astronomy observations can be provided through three different steps:

Step 1: by setting a **separation distance by default** between an RAS site and an MES, which defines an area around an RAS site outside of which no restriction applies to the operation of MESs.

Step 2: by setting a **restriction zone** around an RAS site, which defines an area within which there may be some restriction to the operation of MESs. These restrictions should be defined by the regulator and agreed by the radio astronomy community and MSS operator.

Step 3: by setting an **exclusion zone** around an RAS site, defined by means of detailed assessment of the characteristics of the systems involved and measurements if necessary, within which no operation of MESs should be allowed.

Annex 2 and Annex 3 describe methodology which should be used for the calculations respectively for Step 1 and Step 2. Precise details for the conditions for the operation of the mobiles in the restriction zone need to be agreed by the concerned parties, in order to arrive at an exclusion zone, following the definition above in Step 3.

Annex 4 provides the list of the set of characteristics which are necessary for running a simulation.

Step 1 calculation is intended to provide separation distances by default. Annex 2 describes a general methodology of calculation which can be used for that purpose, using Monte Carlo methodology.

The basis of this model is to calculate the statistics of the interfering power produced at an RAS site by MESs in operation.

In order to protect radio astronomy observations, it is stated that:

“a 2000 second integration taken at any time of the day should have at least $(100 - x)\%$ of being interference free, i.e. the mean interference power is below the levels specified in Recommendation ITU-R RA.769.

The figure of 90% ($x = 10$) has its origin in propagation calculations (ITU-R Handbook on Radio Astronomy, § 4.2.4. See also Recommendation ITU-R RA.1031). The wider interpretation of this figure is under consideration within ITU-R”.

Thus, Annex 2 methodology should be used with the following assumptions:

- 2 000 s integration time (constant for all trials);
- peak traffic assumption;
- $x\%$ of time maximum interference criteria for the RAS (10% is the current value subject to revision by the ITU-R).

In the case where different sources of interference are identified for the radio astronomy observations, further studies are required on the possible splitting of the maximum interference power level.

Annex 2

Step 1 methodology: Calculation of separation distances by default between RAS sites and MESs

1 Introduction

This Annex describes a general methodology which can be used for the calculation of separation distances by default between RAS sites and the areas where MESs are allowed to transmit.

These separation distances, based on calculations using a Monte Carlo methodology, should ensure the protection of radio astronomy observations.

2 General principles used in the methodology

2.1 Monte Carlo methodology

In order to calculate the separation distances by default between RAS sites and MESs, it is necessary to evaluate the probability function of the interfering power produced by the mobiles and experienced by the RAS receivers.

This can be done by using statistical modelling of interference, such as a Monte Carlo methodology.

The Monte Carlo methodology is based on the principle of sampling random variables from their defined probability distributions.

The variables to be sampled are often various and numerous, as the accuracy of the model usually increases with their number.

In the particular case of the determination of separation distances by default, these variables may include the number of mobiles, the location of the mobiles, the propagation condition.

The statistics of the interfering power produced at an RAS site by MESs in operation is then derived from the calculation of interfering powers experienced for each sample.

2.2 Protection of radio astronomy observations

Radio astronomy observations are performed by using time averaging, to significantly reduce noise fluctuations.

In order to reflect such practice, statistics of received interfering power are based on integration time samples used during the observations.

The interference power coming from the MSS population is acceptable provided that no more than $x\%$ of the 2 000 s integration periods have mean interference power above the RAS detrimental level.

The following is based on this definition.

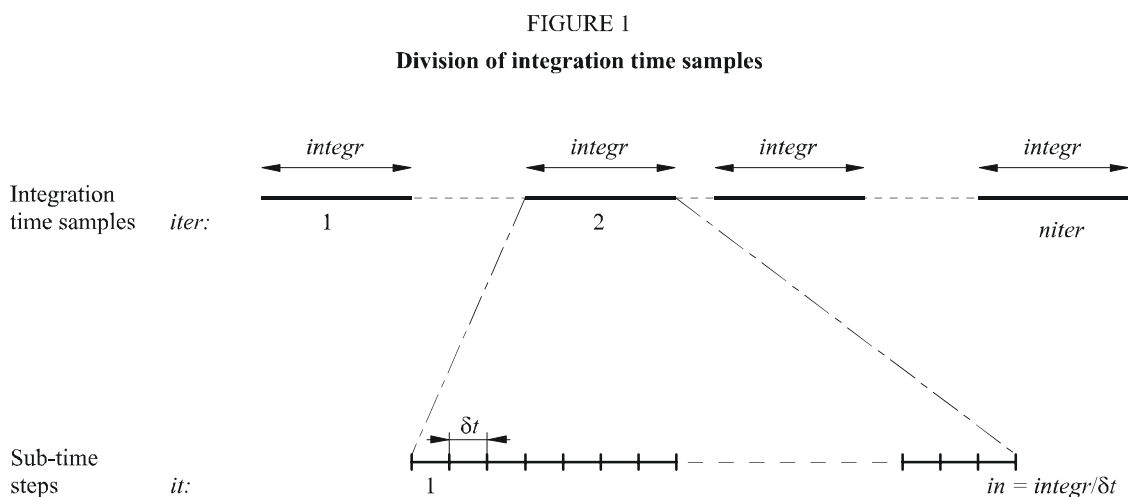
3 Presentation of the methodology of calculation

As stated in § 2, statistics of interfering powers are based on integration time samples:

niter: number of integration time samples needed for the statistic.

integr: duration of the integration time sample. In the following, *integr* is supposed to be constant.

During each integration time sample *integr*, the mean interference power produced by MESs is calculated by averaging “instantaneous” interfering powers produced within sub-time steps of δt seconds duration.



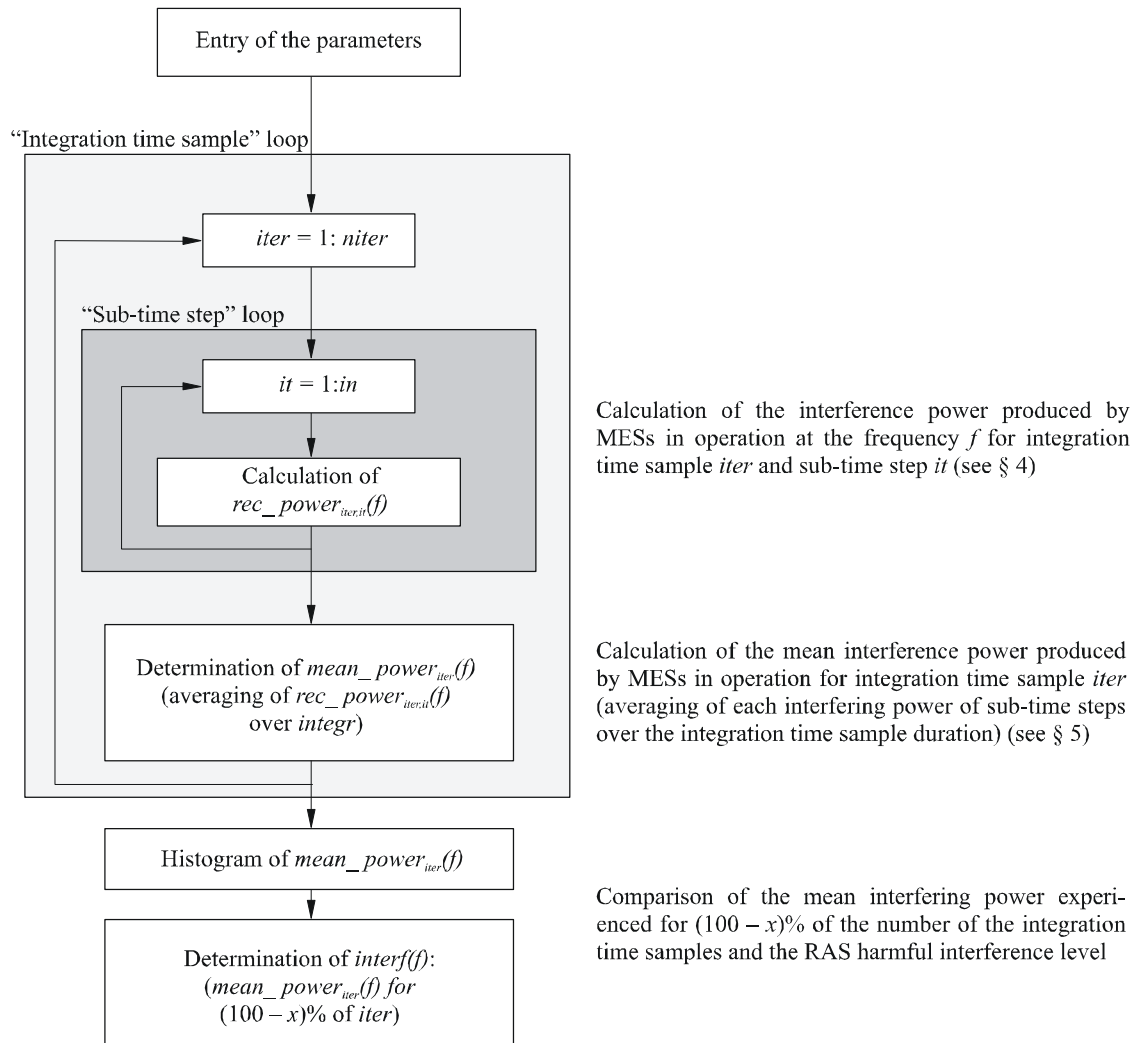
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During each of the sub-time steps, interfering powers are determined by making random trials on the traffic load of the MSS system under consideration and on the location of each MES in operation.

The outline flow chart of the calculation is given in Fig. 2:

FIGURE 2

General flow chart of the calculation



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4 Calculation of the interfering power experienced during a sub-time step – modelling of traffic

The interfering power experienced during each sub-time step at the frequency f is calculated by summing power produced by each mobile in operation during this time step.

For each time step it , it is thus necessary to determine:

- the number of mobiles in operation during it (derived from a given traffic law);
- the channels the active MESs are using;
- the location of the mobiles around the RAS site distance, azimuth, etc.

In order to keep the correlation between each sub-time steps, the number of mobiles in operation for sub-time step it is derived from the number of mobiles in operation for $it - 1$, by taking into account the number of calls dropped and initiated in-between.