RECOMMENDATION ITU-R F.1766*

Methodology to determine the probability of a radio astronomy observatory receiving interference based on calculated exclusion zones to protect against interference from point-to-multipoint high-density applications in the fixed service operating in bands around 43 GHz

(2006)

Scope

This Recommendation provides a methodology which may be used to derive exclusion zones around radio astronomy sites for transmitting point-to-multipoint (P-MP) high density applications in the fixed service (HDFS) which may be used by administrations in national and bilateral discussions as method to protect radio astronomy sites from potential interference from P-MP HDFS stations.

The ITU Radiocommunication Assembly,

considering

a) that the frequency band 42.5-43.5 GHz is used or is planned to be used for continuum observations;

b) that the frequency bands 42.77-42.87 GHz, 43.07-43.17 GHz, and 43.37-43.47 GHz are used by radio astronomers to observe the spectral lines of silicon monoxide;

c) that these observations can be made from a single antenna or from a network of antennas using very long baseline array (VLBI) techniques;

d) that these observations employ very high-gain antennas and very low-noise amplifiers to receive extremely weak cosmic radio emissions over which astronomers have no control;

e) that point-to-multipoint (P-MP) high density applications in the fixed service (HDFS) could involve the deployment of a large numbers of terminals, for which individual coordination would not be feasible;

f) that administrations wishing to protect a Radio Astronomy (RAS) site from potential interference from P-MP HDFS stations may consider the use of an exclusion zone around the RAS site in their national and bilateral discussions;

g) that the determination of size of the exclusion zone could be improved by considering the topology and demographic data around RAS sites,

recognizing

1 that the frequency band 42.5-43.5 GHz is allocated to the radio astronomy service (RAS) on a primary basis worldwide;

2 that No. 5.149 of the Radio Regulations (RR) states that "in making assignments to stations of other services to which the bands 42.5-43.5 GHz, 42.77-42.87 GHz, 43.07-43.17 GHz, 43.37-43.47 GHz are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference";

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

3 that the band 42.5-43.5 GHz is also allocated to the fixed service (FS) on a primary basis;

4 that RR No. 5.547 notes that the band 42.5-43.5 GHz is available for high density applications in the fixed service, and that administrations should take this into account when considering regulatory provisions in relation to this band,

noting

a) that Resolution 79 (WRC-2000) calls for ITU-R "to conduct studies on the coordination distance between radio astronomy stations operating in the 42.5-43.5 GHz band and P-MP HDFS stations with a view to developing ITU-R Recommendations";

b) that Recommendation ITU-R F.1765 describes a methodology to calculate the aggregate equivalent isotropically radiated power (a.e.i.r.p.) from stations of the P-MP HDFS operating in bands around 43 GHz,

recommends

1 that Annex 1 may be used to determine the probability of an RAS observation receiving interference from the deployment of P-MP HDFS outside a specified exclusion zone (EZ) based upon a.e.i.r.p. distributions;

2 that Annex 2 may be used to determine the EZ around the RAS site, defined by a propagation loss from the RAS site, outside of which stations of the P-MP HDFS may be deployed without likelihood of causing unacceptable interference into the RAS, using the methodology in Annex 1 to calculate probability of interference.

Annex 1

Methodology to determine the probability of an RAS observation receiving interference from the deployment of P-MP HDFS outside a specified EZ based upon a.e.i.r.p. distributions

1 Introduction

In order to be in a position to offer the RAS the required level of protection, it is necessary to be able to predict interference levels at a RAS site from potential deployments of P-MP HDFS stations. This interference level will depend upon the characteristics assumed for each service and the terrain and clutter around the RAS site.

A number of the input parameters are not available as a numerical constant, but vary according to a distribution. For example the propagation loss between two points depends upon a number of parameters including the percentage of time. The methodology described in this Annex is based upon Monte Carlo techniques, whereby these input distributions are convolved using an interference equation to produce a distribution of interference against probability that these levels of interference are exceeded.

This approach allows comparison against RAS thresholds defined in Recommendation ITU-R RA.769, which are defined in terms of an interference threshold (mean power over observation) and probability of an observation being interfered.

The calculation requires three stages:

1 definition of RAS model;

2 definition of P-MP HDFS model;

3 calculation of interference.

Each of these stages are described in the sections below.

2 RAS model

2.1 Interference threshold

The basis of the RAS model is the protection criteria for radioastronomical measurements described in Recommendation ITU-R RA.769. In order to protect radio astronomy it is necessary that there be a $(100 - x)$% probability that an observation is interference free.

An observation is interference free if the mean interfering power over the integration period T is less than the levels specified in Annex 1 of Recommendation ITU-R RA.769. A value of $T = 2\,000$ s is typically used within this Recommendation and other analysis of sharing with the RAS.

This integration period also determines the sensitivity of the receiver, and hence the threshold or mean interference level. These vary depending upon the type of observation, whether continuum or spectral line observation. The continuum observations are more sensitive than those for spectral lines, and so require a lower threshold. Operation of a telescope as part of a VLBI system results in higher thresholds due to the low correlation of sources of interference.

The values in Table 1 of Recommendation ITU-R RA.769 specify mean interference thresholds in terms of spectral power flux-density, based upon an assumed receiver gain of 0 dBi. This corresponds to an antenna with side lobes as given in Recommendation ITU-R SA.509 at an off-axis angle of 19°. In order to be able to model RAS telescopes at lower elevation angles and to include other gain patterns for the telescope, it is necessary to define the threshold in terms of interference at the receiver, i.e. using ΔP_H as defined in equation (4) of that Recommendation.

As noted above there must be an $(100 - x)$% probability that an observation is interference free, i.e. that this threshold is not exceeded. Recommendation ITU-R RA.1513 identifies that for a single network, in this case for a P-MP HDFS deployment, a value of $x = 2$% should be used.

2.2 Location

The location of the RAS antenna is defined by its latitude, longitude and height above local terrain.

2.3 Gain pattern

The RAS antenna should be modelled by a suitable gain pattern, such as that specified in Recommendations ITU-R S.1238 or ITU-R RA.1630, or, where available, measured data. As noted above the interference threshold is based upon mean interference over an observation period, typically 2 000 s. Assuming that the propagation environment and P-MP HDFS deployment is constant over that period, then the mean interference will be that calculated using the mean gain over the observation.

The mean gain of an RAS telescope can be determined by:

– locating a number of test points (e.g. every 3°) on the horizon around the test RAS site;

– set the RAS antenna to the gain pattern selected as described above;