RECOMMENDATION ITU-R F.1095

A PROCEDURE FOR DETERMINING COORDINATION AREA BETWEEN RADIO-RELAY STATIONS OF THE FIXED SERVICE

(Question ITU-R 129/9)

(1994)

The ITU Radiocommunication Assembly,

considering

a) that in some neighbouring countries the same frequency band may be shared by fixed radio-relay stations;

b) that the accuracy of interference considerations should be as high as necessary;

c) that not all of the data needed to be exchanged between concerned countries may be available;

d) that the concept of coordination area would be useful in avoiding undue interference between fixed terrestrial stations;

e) that some guidelines to determine such a coordination area would be useful;

f) that some existing procedures to determine the coordination area for fixed terrestrial services may identify stations for which detailed interference studies may not be required,

recommends

1. that with the agreement of administrations concerned:

- the procedure described in Annex 1 may be used as a guide to determine the frequency coordination area for interference studies between stations of the fixed service;
- the maximum level of interference and the achievable accuracy of coordination distances referred to in Annex 1 have to be assessed.

ANNEX 1

A procedure for determining coordination area between radio-relay stations of the fixed service

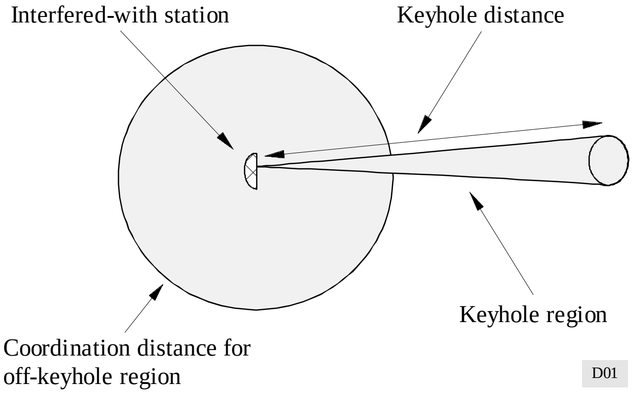
1. Introduction

This Annex describes a procedure for using the concept of coordination area for fixed radio-relay systems. It presents a methodology for determining the number of stations that need to be coordinated and the probability of interference that may exist between those stations.

Because of the directivity of microwave antennas, a keyhole concept may be used for the development of a coordination distance analysis procedure. The keyhole concept takes into account the larger distance along the main beam (keyhole zone) of a microwave station, and the probability of interference over this region. It then follows that the region outside the keyhole zone (the area off the main beam) requires shorter coordination distances as shown in Fig. 1. The specific numerical figures for coordination distances for the keyhole zones and off-main-beam regions depend on the types of antennas and the frequencies used.

FIGURE 1

Basic concept for keyhole coordination distance



2. Calculating coordination distance

The coordination distance can be obtained by solving the relation between the power of the interfering signal received by the victim station and the distance from the interfering station,

$$I = P_T + [G_R - D_R(\theta)] - L(d) + [G_T - D_T(\theta')] \tag{1}$$

where:

I: power at distance d originating from the interfering station (dBm)

P_T: the maximum transmitting power level (dBm) in the reference bandwidth at the input to the antenna of the interfering station

G_T: gain (dBi) of the transmitting antenna of the interfering station

G_R: gain (dBi) of the receiving antenna of the interfered-with station

D_T: antenna discrimination (dB) of the transmitting antenna (at different angles θ’)

D_R: antenna discrimination (dB) of the receiving antenna (at different angles θ)

$L(d)$: total path loss (dB) for the Earth’s curvature, with $K = 1.33$.

As an example for intersystem radio-relay interference analysis, a C/I ratio of greater than or equal to 65 dB can be assumed and expressed as follows:

$$C - I \geq 65 \quad \text{dB} \tag{2}$$

where:

C: nominal received desired signal power (dBm)

I: maximum tolerable interfering power (dBm)

$$C \geq P_T + [G_R - D_R(\theta)] - L(d) + [G_T - D_T(\theta')] + 65 \tag{3}$$

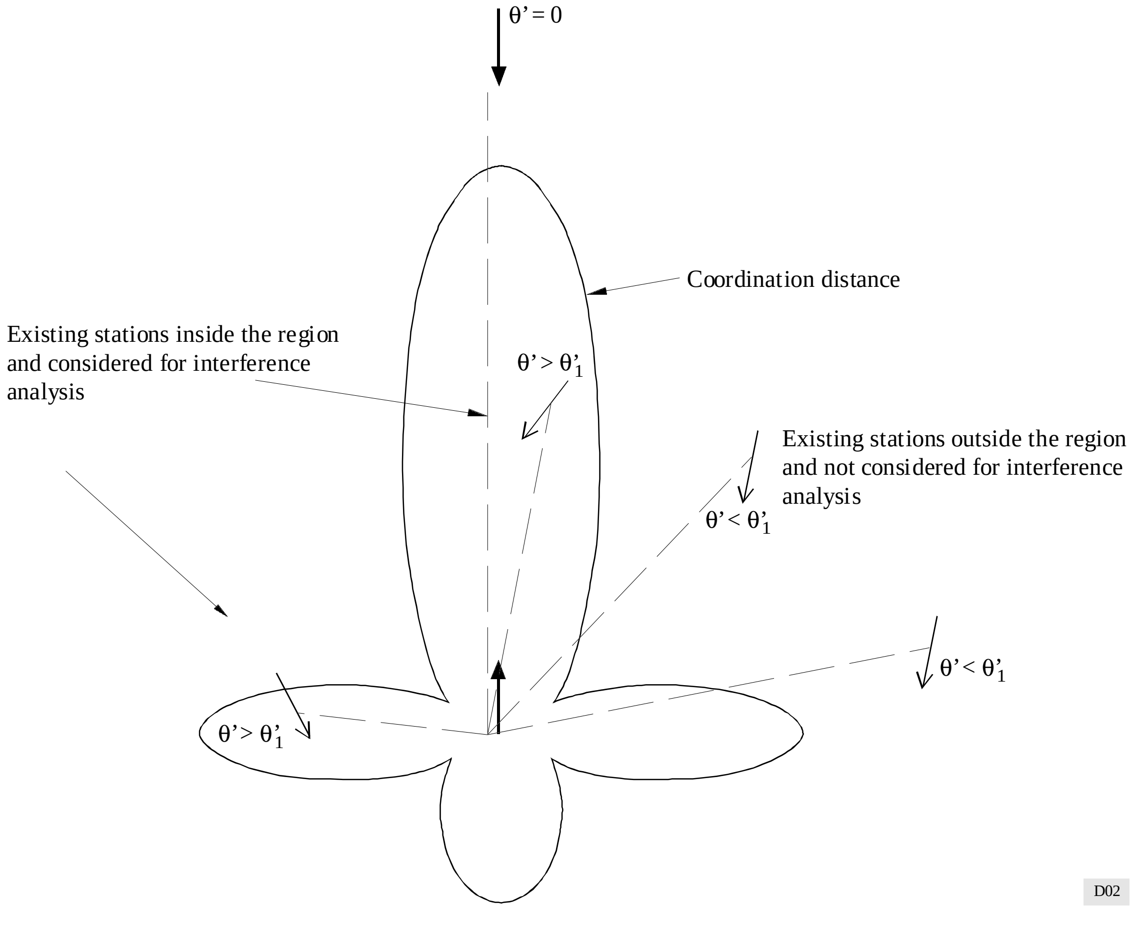
The coordination distance d, at different angles θ can be calculated for different values of discrimination pattern $D_T(\theta')$ of the interfering station. For $D_T(\theta') = 0$, equation (3) represents a situation where the interfering stations are directed toward the proposed station. Coordination distance calculated under this condition will specify a region within which all interfering stations will be located. However, on some occasion, the conservative coordination distance may include a large number of stations resulting in the coordination process being quite burdensome. Under this condition, the coordination region may be reduced with a certain probability of interference.

3. *Coordination distance versus reliability*

Here, the coordination distance can be obtained for $\theta' = \theta'_1$, which will include all interfering stations whose directions toward the proposed station will make angle $\theta' > \theta'_1$ with their main axes. However, the area specified by these coordination distances for $\theta' = \theta'_1$ does not include those stations whose directions toward the victim station make angles less than θ'_1. Thus there is a finite probability that the victim station will receive interference from a station located outside the region specified by the coordination distances as shown in Fig. 2.

FIGURE 2

Coordination of existing and proposed stations



Under this condition, the probability of alignment of the existing station with the proposed station located outside the region specified by the coordination distance will be as follows:

$$P(\theta') = N_1 / N_t \tag{4}$$

where N_1 is the number of existing stations located outside the region whose antenna axes make angles less than θ'_1 with beam direction towards the proposed station, and N_t is the total number of existing stations in the concerned area.

The above probabilities for different angles θ' can be calculated from a known database where station azimuths are known. Here, N_1 can be obtained by calculating the number of stations whose antenna axes lie within an angular window of width $2\,\theta'_1$. If the window is rotated in small increments, for example 0.1°, the number N_{1max} for that window size will give the maximum number of stations that can create interference caused by their alignment with the proposed station. Under the worst-case, all of these stations will be outside the region specified by the coordination distance obtained at $\theta' = \theta'_1$. Thus the probability of interference associated with the coordination distance can be expressed as:

$$P_i(\theta'_i) = N_{imax} / N_t \tag{5}$$

where i corresponds to the window of size θ_i. For the worst possible case of antenna alignment, a homogeneous distribution of the microwave stations, randomly oriented, is assumed. The probability of interference under this condition can be expressed as:

$$P_i(\theta'_i) = \theta'_1 / 180 \tag{6}$$

The reliability of the coordination distance that represents the accuracy of the coordination procedure can be defined as follows:

$$R_i(\theta') = 1 - P_i(\theta') \tag{7}$$

The distance along the main axis of the antenna can be considered to be the keyhole coordination distance. There may be several approaches to find the off-axis coordination distances. An example indicating the use of the procedure is given in Appendix 1.

APPENDIX 1
OF ANNEX 1

The following example illustrates the relation between reliability and coordination distance. These calculations are done for the 4 GHz band with a 150 m antenna height, using a database of about 2 000 stations. The off-axis coordination distances correspond to the first sidelobe peak of the antenna. Results are shown in Fig. 3.

FIGURE 3

Coordination distances, 4 GHz