

RECOMMENDATION ITU-R SM.1536

Frequency channel occupancy measurements

(2001)

The ITU Radiocommunication Assembly,

considering

- a) that some administrations assign the same frequency to more than one user for shared use;
- b) that it is desirable to compare measurement results from different countries in border areas or for instance in aeronautical or maritime mobile services bands;
- c) that spectrum management only can satisfactorily proceed if the monitoring service provides the radio spectrum planners with adequate high-quality information about the actual usage of the spectrum;
- d) that information obtained from frequency assignment databases does not reveal the degree of loading on each frequency channel;
- e) that results of frequency channel occupancy measurements would provide important inputs into:
 - frequency allotments and assignments;
 - verification of complaints concerning channel blocking;
 - establishment of the degree of efficiency of spectrum usage;
- f) that measurement procedures and techniques should be harmonized to facilitate the exchange of measurement results between various countries;
- g) that several new communications systems, requiring advanced measuring techniques, are and will be put in place in the near future,

recognizing

that various principles and methods of frequency channel occupancy measurements are in use in the different countries,

recommends

- 1** that the measurement procedures and techniques specified in Annex 1 should be used;
- 2** that frequency channel occupancy measurements should be repeated at regular intervals to enable achieving trends from historical data.

NOTE 1 – More relevant information on frequency channel occupancy measurements can be found in the spectrum monitoring handbook.

NOTE 2 – Channel occupancy measurements may not be the appropriate mechanism to evaluate the need for a specific assignment or the efficiency of spectrum usage for some operators (i.e. emergency communications).

ANNEX 1

1 Introduction

This Annex describes frequency channel occupancy measurements normally performed with a receiver. Many emission parameters can be stored such as its signal strength and the percentage of time that the signal is above a certain threshold level.

2 Requirements

2.1 Equipment

A suitable system capable of making frequency channel occupancy measurements will consist of a PC/controller, suitable software with interface adaptor, radio receiver, appropriate antenna, calibrated cable, and possibly a communications modem.

2.2 Site considerations

Various factors should be taken into consideration when selecting a site for frequency channel occupancy measurements.

2.3 Relationship between several parameters

2.3.1 There is a strong relationship between observation time, number of channels, average transmission length and the duration of monitoring.

2.3.2 The *revisit time* is directly dependent on the observation time and the number of channels

$$\text{revisit time} = \text{observation time} \times \text{number of channels}$$

2.3.3 The *observation time per channel* depends on the scanning speed of the monitoring equipment. In order to maintain a reasonably short revisit time with relatively slow equipment, the number of channels to be measured must be reduced.

2.4 Transmission lengths

2.4.1 The monitoring system needs to scan at an acceptable speed in order to detect individual short transmissions.

2.4.2 The optimum revisit time is equal to half of the minimum expected transmission length based on the Nyquist theory.

2.5 Duration of monitoring

2.5.1 The *duration of monitoring* is a combination of the revisit time, typical transmission lengths expected, number of frequencies to be scanned and the wanted accuracy of the results.

2.5.2 If a fast scanning system is used and the average transmission length is greater than a few seconds and the number of channels is relatively small then a short monitoring duration is sufficient.

2.5.3 The duration of monitoring should be at least one week.

2.6 Resolution of measurements

The monitoring software should be capable of producing occupancy information with a choice of resolutions. The default resolution of the measurements should be 15 min but should include the option to provide data in other resolutions.

2.7 Statistical confidence level

2.7.1 There is a linear relationship between the occupancy and the number of samples required. The lower the occupancy, the more samples will be needed to achieve a desired confidence level.

2.8 Limitations on monitoring

2.8.1 Simple automatic monitoring is not able to discriminate between wanted and unwanted emissions. Both types of emissions, if they are above the chosen threshold value, are treated as channel occupancy.

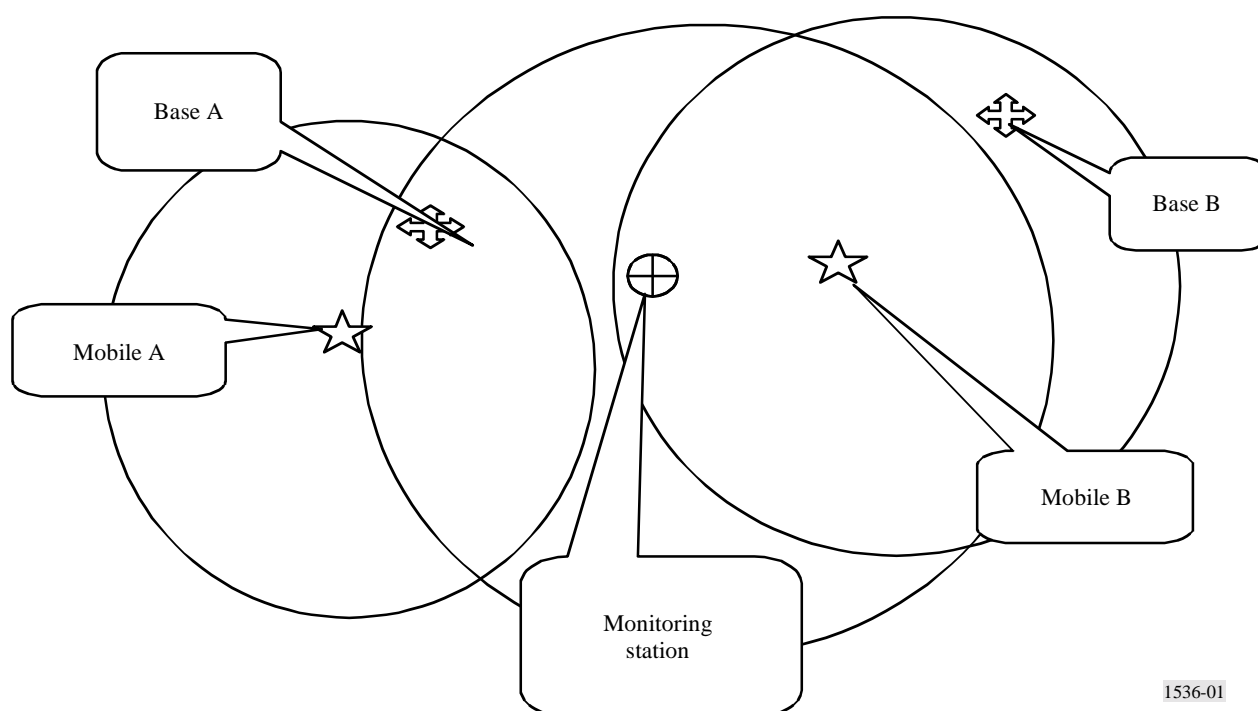
2.8.2 If more than one user is active on a frequency within the coverage area of the monitoring system, the occupancy recorded will be a combination of the radio traffic from each user.

2.8.3 Monitoring mobile transmissions (see Fig. 1)

2.8.3.1 It is possible that a wanted mobile unit (Mobile A) will be located significantly further from the monitoring site than the users own base site (Base A). Therefore the received signal strength may be less than the monitoring threshold value set, although strong enough at the intended base site to be useable.

2.8.3.2 Conversely, a mobile unit from an out-of-area co-channel user (Mobile B) may be received at the monitoring site but not heard at the main users base site.

FIGURE 1
Monitoring mobile transmissions



2.8.3.3 Either of the above situations would lead to uncertainty in the information being recorded. It is for this reason that occupancy results recorded on mobile emissions must be treated with caution.

2.8.4 Propagation

Propagation conditions should also be considered when setting receiver threshold levels.

2.9 Presentation and analysis of collected data

2.9.1 After the desired information is extracted from the sampled data, the sampled data can be discarded. The results can be stored every 5, 15, 30 or 60 min as required. From this data it is possible to generate presentations based on tables, textual graphs, line/bar graphs and maps.

2.9.2 The presentation system should, as a minimum, contain the location of monitoring site, date and period of measurement, frequency, type of user(s), threshold level used, occupancy in the busy hour and revisit period.

2.10 Exchange of data

2.10.1 Data format

A common data format, which can be read by any database and/or spreadsheet program used in most countries is comma-delimited ASCII (CSV).

2.10.2 Choice of data

The basic data fields, which should be exchanged between countries, including their format, are:

Header information

- Location (text: 40 characters maximum)
- Revisit time (numeric: integer, seconds)

Data

- Date (date format: YYYY-MM-DD)
- Frequency (numeric: real)
- Threshold used (numeric: signed integer, dB(μ V))
- Percentage occupancy values, for example 96×15 min or 288×5 min (numeric: unsigned integer 0-100)

2.11 Example of transfer file

There follows an example file containing the basic data fields necessary to exchange information between departments.

TABLE 1

Date	Frequency (MHz)	Threshold used	Percentage occupancy values
1998-10-02	163.2125	18	11, 4, 3, 8, 4, 0, 0, 0, 15, 4, 23, 0, 0, 13, 49, 49, 48, 47, 48
1998-10-03	163.2125	18	17, 31, 0, 0, 0, 15, 0, 0, 0, 0, 15, 0, 2, 0, 0, 0, 0, 0
1998-10-04	163.2125	18	41, 41, 36, 39, 20, 17, 2, 0, 2, 4, 0, 0, 0, 0, 0, 16, 3, 12
1998-10-02	163.2250	18	34, 14, 0, 27, 10, 24, 0, 4, 49, 30, 0, 0, 0, 1, 0, 0, 0, 0, 0
1998-10-03	163.2250	18	22, 6, 0, 0, 0, 0, 26, 48, 50, 48, 47, 35, 0, 0, 0, 0, 0, 0
1998-10-04	163.2250	18	39, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
1998-10-02	163.2375	18	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
1998-10-03 etc.	163.2375	18	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

TABLE 2

Definition of terms used in this Annex

Frequency channel occupancy measurements	Measurements of channels, not necessarily separated by the same channel distance, and possibly spread over several different frequency bands to determine whether the channel is occupied or not. The goal is to measure as many channels as possible in a time as short as possible
Revisit time	The time taken to visit all the channels to be measured (whether or not occupied) and return to the first channel
Observation time	The time needed by the system to perform the necessary measurements on one channel. This includes any processing overheads such as storing the results to memory/disk
Maximum number of channels	The maximum number of channels which can be visited in the revisit time
Transmission length	The average length of individual radio transmission duration
Duration of monitoring	The total time during which the occupancy measurements are carried out
Erlang	The unit of traffic intensity. The maximum traffic a single frequency can carry is 1 E
Preset threshold level for measurement	If a signal is received with a strength above the threshold level, the channel is considered to be occupied
Busy hour	The highest level of occupancy of a channel in a 60-min period