International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R F.1110-3

(02/2003)

Adaptive radio systems for frequencies below about 30 MHz

F Series

Fixed service

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

RECOMMENDATION ITU-R F.1110-3*

Adaptive radio systems for frequencies below about 30 MHz

(1994-1995-1997-2003)

Scope

This Recommendation provides the general functions of HF adaptive systems.

The ITU Radiocommunication Assembly,

considering

a) that HF sky-wave links allow communication over large distances;

b) that, up to now, natural ionospheric variations and interference resulting from spectral congestion and propagation anomalies have made HF links difficult to operate and demanded highly-skilled operators;

c) that technological progress in recent years has led to the development of adaptive systems which can be used to automate HF links and enhance their quality;

d) that adaptive systems make it possible:

– to achieve a higher quality of service by combining an ability to exploit modern radio-frequency technology with advanced real-time control software; the result is a system which is reliable, robust, cost-effective and easy to use;

– to establish extensive HF networks with flexible, less hierarchical architecture;

– to reduce transmission times thereby:

  – securing more efficient use of the spectrum,

  – reducing the interference between users,

  – providing the ability to increase traffic density,

– to reduce the reliance on skilled operators;

e) that adaptive automatic link establishment (ALE) systems are now in operation;

f) that additional information on adaptive HF systems and networks can be found in the ITU-R Handbook on "Frequency-adaptive communication systems and networks in the MF/HF bands",

recommends

1 that adaptive HF systems should have the general functions given in Annex 1.

---

* Radiocommunication Study Group 5 made editorial amendments to this Recommendation in December 2009 in accordance with Resolution ITU-R 1.

Annex 1

General functions of HF adaptive systems

1 Introduction

Frequency-agile, adaptive HF systems may be used for any type of fixed or mobile service, but have a greater applicability for digital technologies where a high quality of service is required.

An adaptive system automates the processes involved in establishing, maintaining and terminating HF links or networks. It dispenses with the need for skilled operators and improves the quality of service and the efficiency of the link.

Basically, an adaptive system has a triple function:

– automatic selection of the frequency and of other system parameters to be used;
– automatic operation as regards calling, establishing the communication (with possible switch-over to the peripheral equipment needed for the type of service to be provided), and disconnecting;
– adaptivity during the communication so as to optimize at all times the quality of service according to the ionospheric conditions and spectrum congestion.

2 Automatic selection of the frequency to be used

The selection of the frequency to be used should utilize some or all of the following information:

– list of assigned frequencies;
– a stored ionospheric prediction schedule for predicting link quality at different frequencies as a function of the time, the season and the year;
– data on the quality of previous links, which may reduce the ALE time if the ionospheric duct is sufficiently stationary (short-term) or sufficiently reproducible during the same time interval on successive days;
– passive real-time analysis of channels in order to sort out free channels from channels suffering interference (reducing spectrum congestion);
– possibly, information provided by another device, e.g. ionospheric-sounding system.

On the basis of all this information, a preferential list can be drawn up, when required, of the frequencies to be used for a given link.

3 Automatic calling, link establishment and disconnection

3.1 Common calling/traffic channels

The calling sequence should contain the following information provided by the user:

– identification of calling station;
– identification of called station;
– type of service;
– possibly, mode of operation for those cases where this is not imposed by the link and where there is not a one-to-one correspondence between the mode of operation and the type of service.

The frequency selection unit or function lists the frequencies in order of expected service quality.

The calling sequence is carried out on the frequency classified as No. 1 by the frequency selection unit.

This frequency is retained for the link if:

– a reply is received from the called station;
– this reply indicates that the measured quality of the link in the calling-called direction is sufficient to provide the required service (the quality might be sufficient for establishing the link, which is always done at a low bit rate, but it might be insufficient for a service requiring a higher quality, for example analogue telephony or high bit rate transmission);
– the measured quality of the link in the called-calling direction is sufficient to provide the required service.

A call on the frequency classified as No. 2 will be reinitiated if one of the above three conditions is not met, etc.

As soon as an adequate frequency has been found, the system switches over automatically to the peripheral equipment corresponding to the type of service to be provided.

After disconnection, stations return to the watch-keeping mode.

NOTE 1 – By frequency classified as No. 1, No. 2, …, the following is meant:

– one single frequency for simplex operation;
– a pair of frequencies for half-duplex and duplex operation.

It is highly advisable to employ procedures allowing independent selection of the frequencies for each direction of the link in the following cases:

– presence of local interference;
– when the same frequencies are not available at the two ends of the link.

3.2 Separate calling and traffic channels

For networks or systems where the traffic density or number of stations is large, the use of separate calling and traffic channels may be preferred. In such cases the call establishment will generally follow the pattern of § 3.1, except that the initial contact is made on one of a set of calling channels, which are monitored by all stations when watch-keeping. After this, a combination of passive channel assessment and active channel sounding is used to determine the most suitable traffic frequency.

4 Adaptivity during a communication

Due to its adaptivity, the system automatically maintains the quality of an HF transmission during a communication by varying the main transmission parameters in accordance with the changing state of the channel.

These parameters are, for example:

– radio equipment:
  – frequency;
  – transmitter power;
  – choice of modulation;

– data terminal or telegraph peripheral equipment and their associated modems:
  – bit rate;
  – type of coding;
  – shift excursion;
  – sub-carrier frequency.

In setting up an adaptive process, it is necessary to:

– determine a measurable criterion representative of the quality of the link for a given type of service (for example, number of repetitions for an automatic repeat request (ARQ) telegraph link – error rate for a digital transmission measurement of *S*/*N* ratio-jitter);
– decide on a value for this criterion below which the quality is regarded as inadequate (threshold value);
– arrange for regular repeated measurements of the value of this criterion during the communication process;
– if this value drops below the threshold set for a specific time, vary one (or more) of the link parameters so as to obtain the required quality again;
– regular monitoring of the selected channels for occupancy from both ends of each link, so as to avoid causing interference.

This clearly presupposes that these parameters are programmable and that the various discrete values adopted may be modified remotely.

When the parameters are modified, the two terminals concerned have to be informed by a special signal that an adaptive process is in progress.

NOTE 1 – In analogue telephony, the criterion which is representative of the link quality can only be subjective; the user must therefore be able to take the decision to change the parameter. For example, a "restart" command activated by a user who is not receiving properly might tell the system that the adaptivity procedure needs to be triggered.