Recommendation ITU-R M.1041-3 (02/2025)

M Series: Mobile, radiodetermination, amateur and related satellite services

Future amateur radio systems



Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radiofrequency 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.

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	Series of ITU-R Recommendations
	(Also available online at <u>https://www.itu.int/publ/R-REC/en</u>)
Series	Title
во	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
ВТ	Broadcasting service (television)
F	Fixed service
Μ	Mobile, radiodetermination, amateur and related satellite services
Р	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.

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RECOMMENDATION ITU-R M.1041-3

Future amateur radio systems

(Question ITU-R 48-7/5)

(1994-1998-2003-2025)

Scope

This Recommendation provides the design objectives and characteristics that should be taken into account when developing future systems in the amateur and amateur-satellite services. It includes general, technical and operational considerations.

Keywords

Amateur, amateur-satellite, education, open access

Related ITU Recommendations

Recommendation ITU-R M.625 – Direct-printing telegraph equipment employing automatic identification in the maritime mobile service

Recommendation ITU-R M.1042-3 - Disaster communications in the amateur and amateur-satellite services

Recommendation ITU-R M.1043-2 - Use of the amateur and amateur-satellite services in developing countries

Recommendation ITU-R M.1044-2 - Frequency sharing criteria in the amateur and amateur-satellite services

Recommendation ITU-R M.1544-1 - Minimum qualifications of radio amateurs

Recommendation ITU-R M.1677-1 - International Morse code

- Recommendation ITU-R M.1732-3 Characteristics of systems operating in the amateur and amateur-satellite services for use in sharing studies
- Recommendation ITU-R M.2034-0 Telegraphic alphabet for data communication by phase shift keying at 31 baud in the amateur and amateur-satellite services
- Recommendation ITU-R M.2164-0 Guidance on technical and operational measures for the use of the frequency band 1 240-1 300 MHz by the amateur and amateur-satellite service in order to protect the radionavigation-satellite service (space to-Earth)

Recommendation ITU-T S.1 – International Telegraph Alphabet No. 2

NOTE – The versions referenced above represents the version of each document when this Recommendation was approved.

The ITU Radiocommunication Assembly,

considering

- a) Question ITU-R 48-7/5;
- *b)* that different future systems are under study;

c) that system compatibility is necessary for international operation;

d) the need for flexible systems capable of adapting to new developments and natural disasters;

e) that the amateur and amateur-satellite bands below 5 GHz are heavily used, and there is a need to reduce interference within these services;

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f) that the bands above 5 GHz are subject to increasing use;

g) that to communicate at distances beyond line of sight, propagation characteristics of the bands above 144 MHz usually require use of terrestrial or satellite radio-relays;

h) that there is increasing need for high-speed digital communications;

i) that commonality of hardware, software and protocols is desirable to achieve economies of scale, reduce the cost of systems and improve the ability to easily communicate with other amateur stations,

recognizing

that Radio Regulations No. **25.2A** provides 1A) Transmissions between amateur stations of different countries shall not be encoded for the purpose of obscuring their meaning, except for control signals exchanged between earth command stations and space stations in the amateur-satellite service. (WRC-03),

recommends

that future systems in the amateur and amateur-satellite services should consider incorporation of the following objectives and characteristics, and take into account the following frequency band considerations:

1 Objectives

Objectives for future systems in the amateur and amateur-satellite services should take into account:

1.1 General

1.1.1 Promote design of robust systems capable of providing communication during natural disasters.

1.1.2 Accommodate the needs of amateur operators in urban, rural and remote areas, including those in developing countries.

1.1.3 Make equipment and systems widely available to amateur operators at an acceptable cost, recognizing that amateur operators fund their own stations.

1.1.4 Develop compatible and interoperable terrestrial and satellite systems.

1.1.5 Provide a flexible architecture that will facilitate introduction of new technology.

1.1.6 Minimize radiated power consistent with establishing and maintaining satisfactory communication quality.

1.1.7 Encourage experimentation and learning with respect to the use of different transmission modes, and the propagation characteristics of different frequency bands.

1.2 Technical

1.2.1 Promote increased spectrum efficiency, e.g. through use of automatic power control, transmit signal predistortion, adaptive antennas, diversity reception, digital signal processing, software defined radio, channel coding and open access CODEC technology.

1.2.2 Ensure information integrity through error control techniques.

1.2.3 Encourage the development and use of common interfaces for the interconnection of radio and computing equipment, especially those based on the use of low-cost computing hardware and open access software.

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1.3 Operational

1.3.1 Provide for operational flexibility and self-organization.

1.3.2 Support international roaming within the amateur services.

1.3.3 Permit amateur stations to gain access to particular capabilities made possible by advances in technology, e.g. automatic protocol conversion, activity databases, remote transmitting and receiving stations, etc.

1.4 Methods of radiocommunication

Support, among others, the following:

1.4.1 Morse code

Morse code, in accordance with Recommendation ITU-R M.1677-1, is still widely used in the amateur and amateur-satellite services because of its technical simplicity and good performance in poor signal-to-noise ratio situations.

1.4.2 Narrow-band direct-printing telegraphy

International Telegraph Alphabet No. 2, as defined in Recommendation ITU-T S.1, and Recommendation ITU-R M.625 except for modified station identification. Newer systems based on "Varicode" are increasingly being used, see Recommendation ITU-R M.2034.

1.4.3 Telephony

Telephony of commercial quality, using both analogue and digital technology. Increasing use is being made of open access hardware and software which is enhancing the uptake of new digital voice technology.

1.4.4 Data transmission

Synchronous and asynchronous in accordance with appropriate ITU-T and ITU-R Recommendations, consistent with bandwidth limitations and propagation at MF/HF and higher frequencies.

1.4.5 Image transmission

Still image, slow and fast scan television using appropriate regional standards where applicable. Increase the use of digital technology to optimize the necessary bandwidth of the transmitted signal and provide increased quality of the received signal for the band being used.

1.4.6 Structured data modes

Structured data modes send the minimum amount of information necessary to complete a radio contact between amateur stations. The information is sent in a specific format and strong forward error correction allows information to be reliably exchanged with low radiated power or under low signal-to-noise ratios.

1.4.7 New transmission modes

Experimentation and development of new modes of transmission and communications applications in order to advance the state of the art.

2 Technical characteristics

Amateur and amateur-satellite systems should have technical characteristics that provide worldwide interoperability, and allow origination, relay and termination of communications independent of other

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radio services. Design emphasis should be placed on reliability, robustness and flexibility of reconfiguration for efficient emergency communications. Multiple access techniques (FDMA, TDMA and CDMA) should be selected for optimum spectrum efficiency and frequency reuse. The selection of modulation techniques should take into account resistance to interference and immunity to adverse propagation conditions. The use of forward error correction and structured data techniques (where the information content follows a precise format) based on digital signal processing using open access technology allows communications over propagation paths with low signal-to-noise ratios and/or low radiated power.

3 Operational characteristics

Systems should be capable of operation in urban, residential and rural areas, and should be suitable for use in fixed, portable and mobile applications. Systems may also enable the use of remote transmitting and receiving stations which will assist amateur operators residing in urban and residential areas who may have restrictions or technical limitations, particularly on antennas. Mobile systems should include personal pocket terminals and systems suitable for operation in vehicles. Small, inexpensive systems capable of being upgraded should be available for new users and those in developing countries. Satellite systems should be designed to serve both industrialized and developing countries. Systems should facilitate education of operators and technicians.

4 Frequency band considerations

4.1 Spectrum requirements

Worldwide common frequency bands facilitate international working, international roaming and commonality of equipment. Frequency bands allocated to the amateur and amateur-satellite services should cover a wide range having different propagation characteristics, in order to encourage experimentation.

4.2 Spectrum utilization

Frequency bands used by future amateur radio systems should be chosen for operations to carry out the desired communication with (a) minimum power, (b) maximum frequency reuse and optimal frequency sharing, (c) spectrum efficiency and (d) minimum interference to other services, in accordance with the Radio Regulations. The frequency bands above 5 GHz are being more widely used by the amateur service for various wide-band data applications.

5 Education and training

Noting that the amateur and amateur-satellite services provide a mechanism to train future technicians and engineers, which is useful in supporting the installation, operation and maintenance of national technology systems, it is desirable that linkages are established between education institutions and national amateur societies. The development of open-source amateur equipment and applications provides an ideal training opportunity for future communications professionals. Applying the technologies and techniques of amateur radio is also an ideal way to promote scientific, technical, engineering and math education for younger students in the classroom.