RECOMMENDATION ITU-R SM.1133*

SPECTRUM UTILIZATION OF BROADLY DEFINED SERVICES

(Question ITU-R 205/1)

(1995)

The ITU Radiocommunication Assembly,

considering

a) that the Radio Regulations (RR) define over 40 different radio services;

b) that, narrowly defined services can unnecessarily restrict flexibility and limit spectrum utilization;

c) that the RR defines some radio services as subsets of others;

d) that the factors with respect to the utilization of broadly or narrowly defined services need to be delineated,

recommends

1 that, when considering the utilization of broadly defined services in a specific frequency band, administrations should consider the factors in Annex 1.

ANNEX 1

A guide to utilization of broadly defined services

1 Introduction

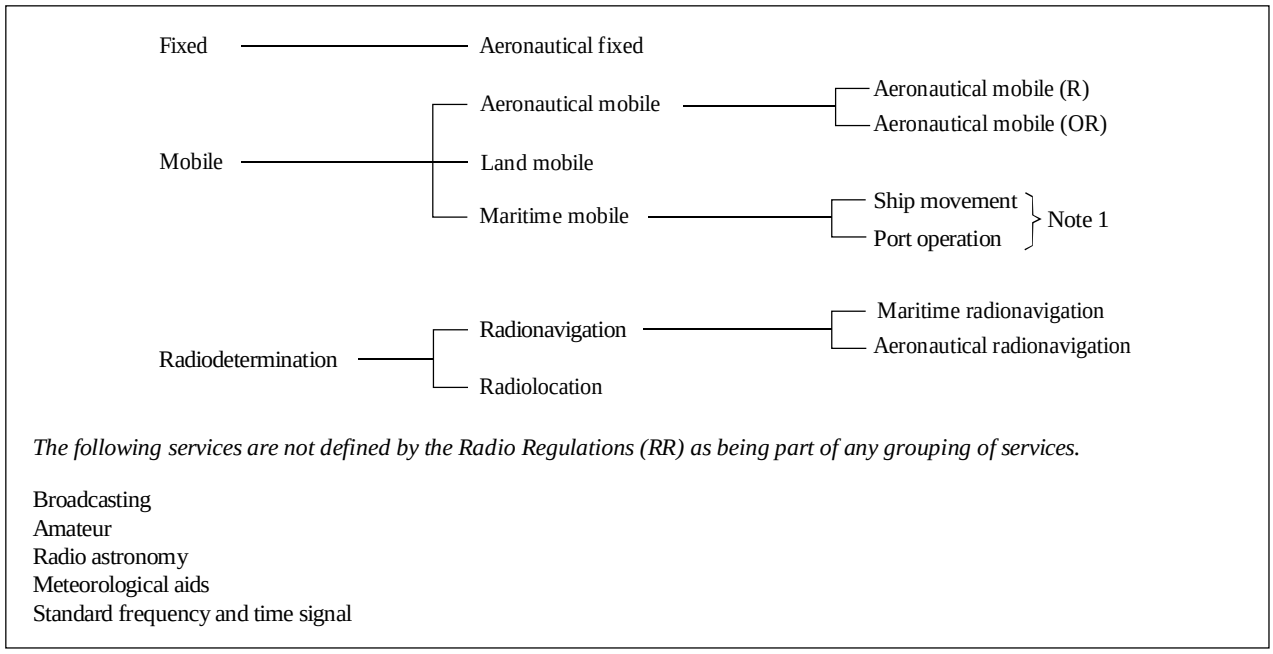
This Recommendation considers the technical requirements for the utilization of more broadly defined services. The relationship between radio services in terms of broader and narrower definitions is shown in Fig. 1. The objective of using broadly defined services is to increase the flexibility of allocations. The concept of using broadly defined services in this context does not necessitate the elimination of narrowly defined or subset services, but involves the use of the most broadly defined service possible, given the factors discussed below.

* This Recommendation should be brought to the attention of Telecommunication Development Study Groups 1 and 2 (ITU-D).

FIGURE 1

Relationship between radio services in terms of broader and narrower definitions

Terrestrial services

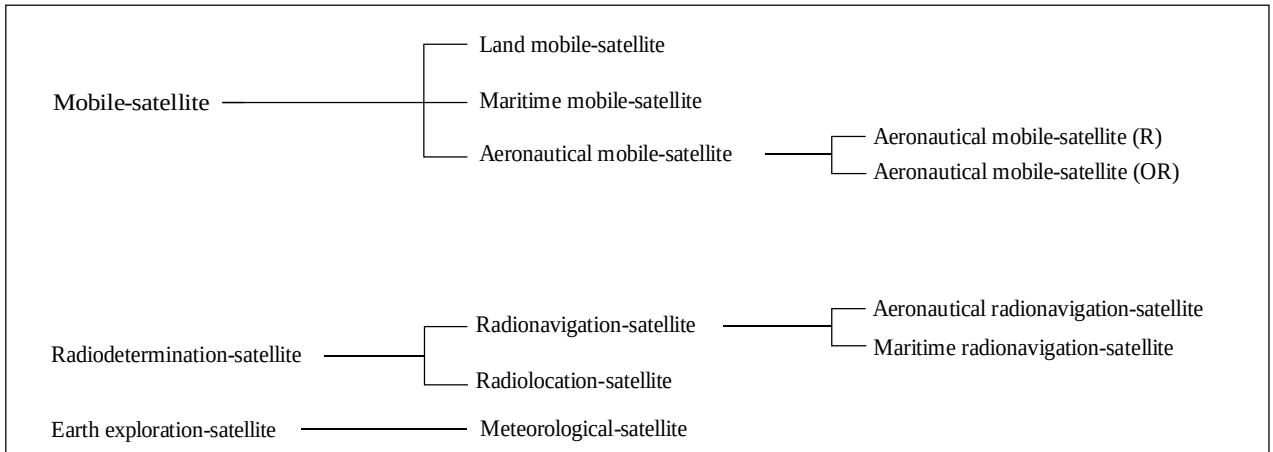


The following services are not defined by the Radio Regulations (RR) as being part of any grouping of services.

Broadcasting
Amateur
Radio astronomy
Meteorological aids
Standard frequency and time signal

Note 1 - The ship movement and port operation services are not subject to any table allocations. They are referred to in RR Appendix 18.

Space services



The following services are not defined by the RR as being part of any grouping of services.

Fixed-satellite
Broadcasting-satellite
Amateur-satellite
Radio astronomy
Standard frequency and time signal-satellite
Space operations
Space research
Inter-satellite

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2 In considering the use of the broadly defined services, the following should be noted:

– broadly defined services can provide a simpler allocation process;

– the complexity of sharing and coordination is related to the number of services and the kind of services that are subsets of a broadly defined service;

– while use of broadly defined radio services increases the flexibility of the allocation process, it may introduce more complex sharing within a particular frequency band. Hence there exists a trade-off between the flexibility and the complexity of sharing;

– use of broadly defined services may not result in higher spectrum efficiency. Especially when subset services with very different technical parameters (such as large difference in transmitter power) are together, degradation of efficiency may result;

– the safety aspects of services should be considered;

– it is possible that broadly defined radio services may be applicable in some bands and not in others (e.g. HF vs SHF);

– services which are expected to be phasing out due to the use of old technology, and emerging services could be identified so as to facilitate a process of using broadly defined services;

– in considering whether broadly defined services should be used as opposed to subset services, the concerns of developing countries, such as access to the spectrum and orbit, should be addressed;

– where broadly defined services are allocated, sharing criteria, conditions to address the exclusive worldwide or regional use of certain bands, etc. will be necessary.

In studying the use of broadly defined services, a number of factors should be considered. These include at least the economical, social, political, technical and operational factors.

In this Recommendation, technical and operational criteria or principles are outlined.

3 Technical factors

The technical factors which have a major impact on the viability of utilizing broadly defined radio services are:

– RF radiated power,

– necessary or permitted bandwidth,

– interference protection characteristics,

– service range or coverage,

– coordination factors,

– introduction of new technology (e.g. digital modulation and digital signal structure).

3.1 RF radiated power

Generally, different radio services require different RF radiated power levels in order to provide the quality and level of service required.

Using radio services which are incompatible in transmission power requirements will introduce severe limitations upon the service with the lower power requirements.

3.2 Necessary bandwidth

The bandwidth requirement of a particular radio service depends upon the type of information to be carried and the modulation technique employed. Generally, different radio services require different transmission bandwidths.

If subset radio services which use widely different bandwidths are used together, spill-over and wideband noise from wideband transmissions would cause inter-service interference to narrow-band services unless these were separated by

the same guardband as normally applicable to the wideband service. The introduction of such large guardbands to the narrow-band service would tend to reduce the efficiency of spectrum usage, and severely reduce the possible benefits of using the broadly defined service.

3.3 Interference protection

The protection ratio may be expressed as the ratio of the required signal power to all interference power. The level of interference tolerance for a particular radio service is dependant upon the level or performance requirements provided or required by that service. The level of protection required by one type of service, may not be suitable for another type of service.

Using a broadly defined service where its subset radio services have widely different protection ratios may result in a degradation of performance requirements.

3.4 Radio service range or coverage

Transmitter RF power, characteristics of electromagnetic wave propagation, frequency of operation and other system factors determine the range or coverage of a radio service.

The coverage requirement has a significant possessive bearing upon the frequency band that is used to provide that coverage. Homogeneity of subset services' ranges or coverage types should be a major consideration to ensure spectrum usage efficiency of the broader service. The broadly defined service should not be used where operations of subset services have widely differing ranges of coverage.

3.5 Coordination factors

Radio services are evaluated, with respect to their harmonious operation with other services operating in the same, similar or dissimilar frequency bands. Ideally, system performance and service types should be of a similar nature to simplify and smooth the coordination process. It is very necessary that coordination be equitable or at least similar between bordering nations, to ensure improved spectrum usage.

Using more broadly defined services may in some situations increase the complexity of sharing and coordination and result in a lower spectrum efficiency. If as a result of using a broadly defined service, the permissible level of interference is exceeded for any of the subset services or excessive reuse distances result, then such a change would not be technically advisable.

3.6 Introduction of new technology

The advance of technology in the area of digitization brings digital signals from various services together resulting in similar technical characteristics. One strategy that could be adopted is to introduce using more broadly defined services in a natural and progressive manner. Furthermore, services (such as land mobile, mobile satellite, etc. which are related to personal communications) also tend to converge. This opens up a new possibility of using broadly defined services in the future.

4 Operational factors

The operational factors that are considered to exert the most significant influence are:

– type of service,

– nature of service,

– coverage and service area requirements,

– performance requirements,

– priority of service.

4.1 Type of service

Existing radio services may be grouped under the following general headings according to the types of service:

– land (fixed, broadcast, mobile, etc.),

– maritime (navigation, mobile, etc.),

– aeronautical (navigation, radiolocation, mobile, etc.),

– satellite (fixed, mobile, broadcast, navigation, etc.),

– specialized (radioastronomy, amateur, scientific, standard time signals, etc.).

The operational aspects of service types are dependent to a large extent upon other operationally related factors that include the nature and amount of information or traffic to be carried by the service, the distance or area over which it is required to provide service and the performance requirements expected or required. The combined effect of these factors tends to create a uniqueness for many service types. Because of this uniqueness, it could require certain service types to be used on the basis of individual narrowly defined subset services.

4.2 Nature of service

From an operational point of view, the nature of a radio service can be defined in terms of the characteristics that describe the intent of the service, and includes user aspects. Within the context of the definition, a use and user general grouping might include the following:

– private,

– public,

– broadcast,

– aeronautical,

– maritime,

– transportation.

4.3 Coverage and service area requirements

The operational coverage requirements of radio services can and do differ considerably, depending upon the particular service employed.

However these aspects are dealt with in § 3 under the considerations on technical factors.

4.4 Performance requirements

Ideally, the performance requirements for subset services within a broadly defined service are compatible, or at least similar.

4.5 Priority of service

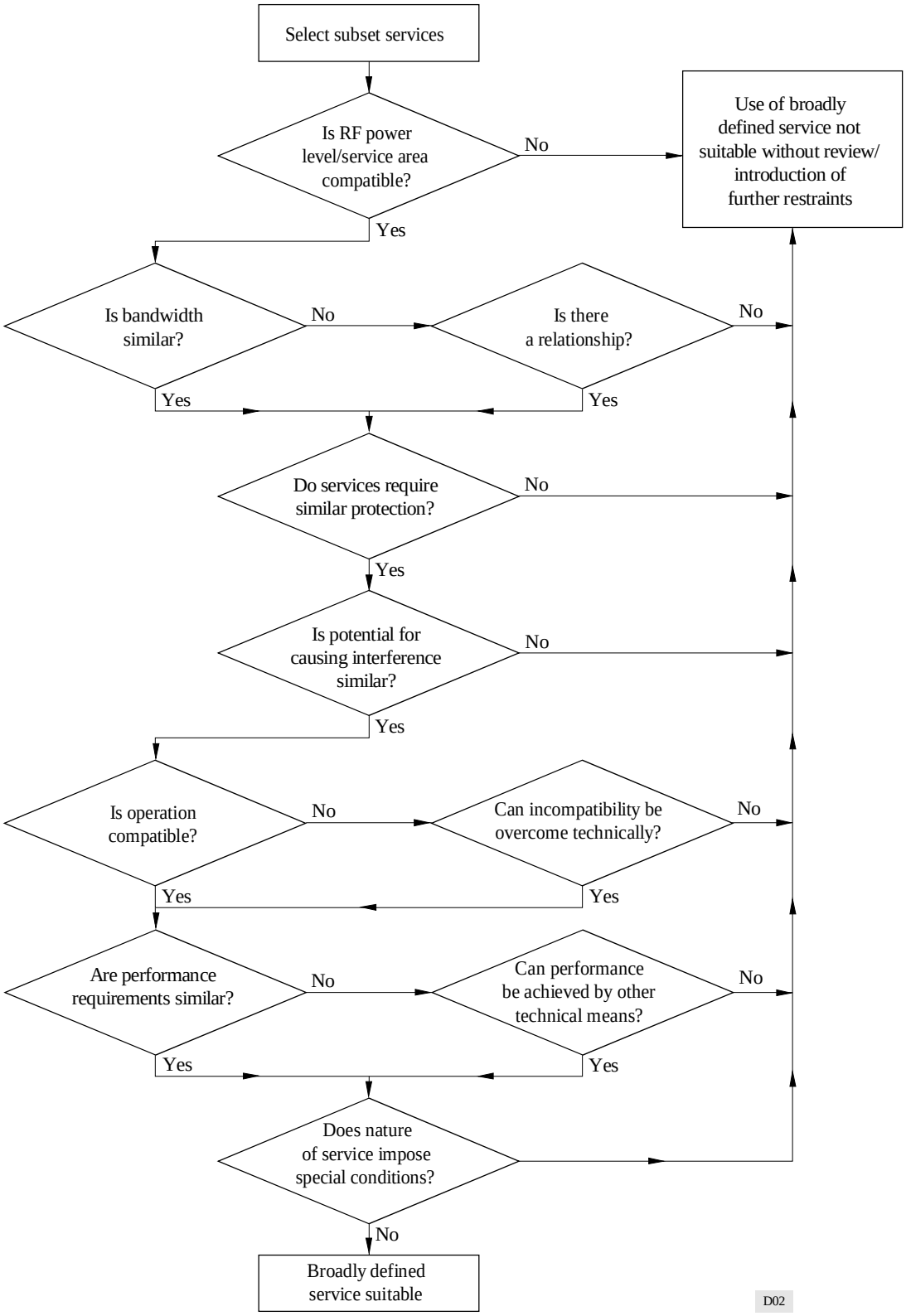
The priority status of radio services can be arranged in almost any manner, depending upon a particular point of view. Priority status ranks respective services in terms of the importance of their operational requirements or the importance of the use of the service. An example of a proposed and particular ranking of priority for services might be represented as follows: safety services, essential services, governmental services, military services, common carrier services, restricted common carrier services, end-user services, broadcast services, and research services. As a further breakdown, and within the ranking of safety services, there might be included, for example, life, rescue and health services, etc. and within essential services police, fire, utilities such as electricity and gas, etc.

5 Process of utilizing broadly defined services

In the previous sections, the factors which must be considered in using a broadly defined service are discussed. In Fig. 2 a flow-chart guide is provided to a process that can be used in developing a list of merged services. It should be recognized that subjective judgement must be exercised in determining the “Yes” or “No” answer.

FIGURE 2

Guide to utilizing broadly defined radio services



The “box” containing the “using a broadly defined service not recommended without review/introduction of further restraints” is intended to indicate that the process should be iterative. If, after first examination, a more broadly defined service is not suitable, then the situation should be reviewed to establish if it could be achieved by the imposition of some technical constraints which would not impact on the operational effectiveness of subset services.

To determine the ability to use a broadly defined service in a given frequency band, it will be necessary, when using the flow-chart, to compare specific quantitative values to assess similarity or compatibility.

The discussion above notes that many radio services are not grouped into broadly defined and narrowly defined or subset services. This fact necessarily limits the application of this concept. Further study is needed to determine whether some or all of the remaining services can be related to one or more broadly defined services. New services and service definitions may be required.

6 Special considerations on satellite services

Certain satellite services are not suitable at present for using within a broadly defined service, based on the technical characteristics given in the RR and ITU-R Recommendations. However, technical and technological changes may reduce the incompatibility of these services and may lead to their convergence even in the near future, as can be seen in the case of a general-satellite service (GSS) discussed below.

6.1 Examples – issues concerning the merging of satellite services

6.1.1 Present difficulties in the merger of FSS, BSS and MSS

A technical study concerning the effect of a merger between FSS and BSS, FSS and MSS or all three together into one broadly defined service indicates that this could result in a significant reduction in orbit/spectrum utilization efficiency, based on the present technical characteristics of the three services.

6.1.2 Merger of FSS and BSS

In general, the FSS is used to provide large capacity, high quality and high availability links. Most such systems employ moderate to large size earth station antennas. Even though small and very small earth station antennas are being introduced for specific applications, their use is accompanied by specific frequency planning measures or by modulation and access techniques which serve to enhance homogeneity.

The BSS service is a signal distribution service to the general public which requires the use of very small receive earth station antennas with considerable effort being made to reduce their sizes even further.

Although FSS earth terminals are being progressively reduced for the specific applications referred above, the earth terminal sizes are, and will remain, significantly larger, in general, than the earth terminals for BSS.

These facts make the downlinks of the two services significantly inhomogeneous. Analyses that have been performed and which were based on the parameters of an operating FSS system and a planned BSS system in the 14/12 GHz band indicate that in order to achieve compatibility between the two services in a common frequency band, orbital separations of the order of 25° may be required. Therefore, joint use of common spectrum by systems in the FSS and BSS could result in an inefficient use of the frequency spectrum and the GSO.

6.1.3 Merger of the FSS and MSS

Earth stations in the MSS, due to their requirement for mobility, use very small antennas. This results in a large inhomogeneity with FSS in both uplinks and downlinks. An example from the above-mentioned study based on the FSS system parameters similar to the INTELSAT digital IBS service and a recently proposed MSS system employing CDMA modulation and operating in 20/30 GHz band shows that orbital separations in excess of 40° may be required to facilitate sharing between the FSS and MSS. Such large orbital separations are not conducive to efficient use of frequency spectrum and the GSO.

6.1.4 Conclusions

The use of the FSS with either BSS or MSS, or the use of all the three services, could lead to increased inhomogeneity of the systems sharing a common frequency band and, consequently, might result in less efficient use of the frequency spectrum and the GSO. Thus, their combination as part of a more broadly defined service might not be accomplished in many situations without compromising an important objective of the RR; efficient use of the frequency spectrum and orbital space, and this should be carefully studied.

6.2 The concept of a future multipurpose-satellite service

6.2.1 Use of a generic general-satellite service to achieve flexibility

The concept of the general-satellite service (GSS) is one where satellite services with mutually acceptable technical criteria could be used within a single new broadly defined service. New applications would also be permitted as long as they conform to compatible technical criteria. Access to frequency bands would be determined not by the service application of the satellite network but by a set of technical criteria which would ensure a level of compatibility between networks. In this way, efficient use of the orbit/spectrum resource can be maintained while accommodating multi-service satellites and introduction of innovative new satellite services.

6.2.2 Criteria for use of a GSS frequency band

A set of technical standards would be required to determine if a proposed satellite system met the criteria for use of a GSS frequency band. Standards would be needed to maintain efficient use of the orbit/spectrum resource when the resource might be shared by a mix of uses including fixed, point-to-point, mobile and personal communications.

There are technical factors that make frequencies above about 20 GHz particularly attractive for introduction of the GSS. In particular at frequencies above about 20 GHz a mix of code division multiple access and frequency division multiple access could permit the operation of personal, mobile and fixed communication terminals without harmful interference and without the need for development of conservative interservice sharing criteria. Limits on the range of permissible user and satellite antenna gains and on the range of permissible e.i.r.p. values would also contribute to ensuring that the orbit/spectrum resource is used efficiently.

6.2.3 Sharing and orbit/spectrum utilization

Earth station antenna discrimination alone is insufficient to permit satellite spacings of 2° to 3° for mobile and personal communications, since antenna beamwidths for personal communications will be on the order of 18° at 20 GHz.

Additional measures are needed to obtain efficient use of the orbit/spectrum resource when personal and mobile communications are among the services to be provided. One key to achieving the objective would be to adopt a standard that mobile and personal communications would use code division multiple access. Traditional fixed satellite users could continue to use any modulation scheme of their own choosing.

Studies have shown that satellite capacity which approaches that achievable within the fixed-satellite service through use of large earth station antennas is achieved while accompanied by a flexibility to accommodate a wide mix of service applications that can vary over the life of the satellite networks.

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