

REPORT ITU-R BS.2002

**INTRODUCTION OF SATELLITE AND COMPLEMENTARY
TERRESTRIAL DIGITAL SOUND BROADCASTING
IN THE WARC-92 FREQUENCY ALLOCATIONS**

(Questions ITU-R 93/10 and ITU-R 107/10)

(1994)

Note - This Report addresses the necessary planning elements associated with satellite and complementary terrestrial digital sound broadcasting and should be read in conjunction with the latest versions of Report ITU-R BO.955 and Report ITU-R BS.1203.

1. Introduction

Arising from the WARC-92 Conference, the following frequency allocations were made to the broadcasting-satellite service (sound) (BSS(S)):

- Worldwide (Regions 1, 2 and 3) except United States: the band 1 452 - 1 492 MHz is allocated for BSS(S) and complementary BS(S) on a primary basis, although some countries (mainly in Europe and Africa) have chosen to maintain this allocation on a secondary basis until 1 April 2007.
- For the United States and India, the band 2 310 - 2 360 MHz is (in a footnote) allocated for BSS(S) and complementary BS(S) on a primary basis.
- For some countries in Asia and the Russian Federation, the band 2 535 - 2 655 MHz (note that the bandwidth is 120 MHz), is by means of a footnote, allocated for BSS(S) and complementary BS(S) on a primary basis.

Associated with the allocations in Article 8 of the RR, there are footnotes restricting the dates of introduction and the level of service in some countries. The worldwide allocation is therefore not available in all countries as the Regulations are now phrased. In particular, the United States has an alternative allocation and (in a footnote) the band 1 452 - 1 492 MHz is allocated to fixed and mobile services on a primary basis.

In addition to the allocation in Article 8, there were several procedures for introduction of new sound services.

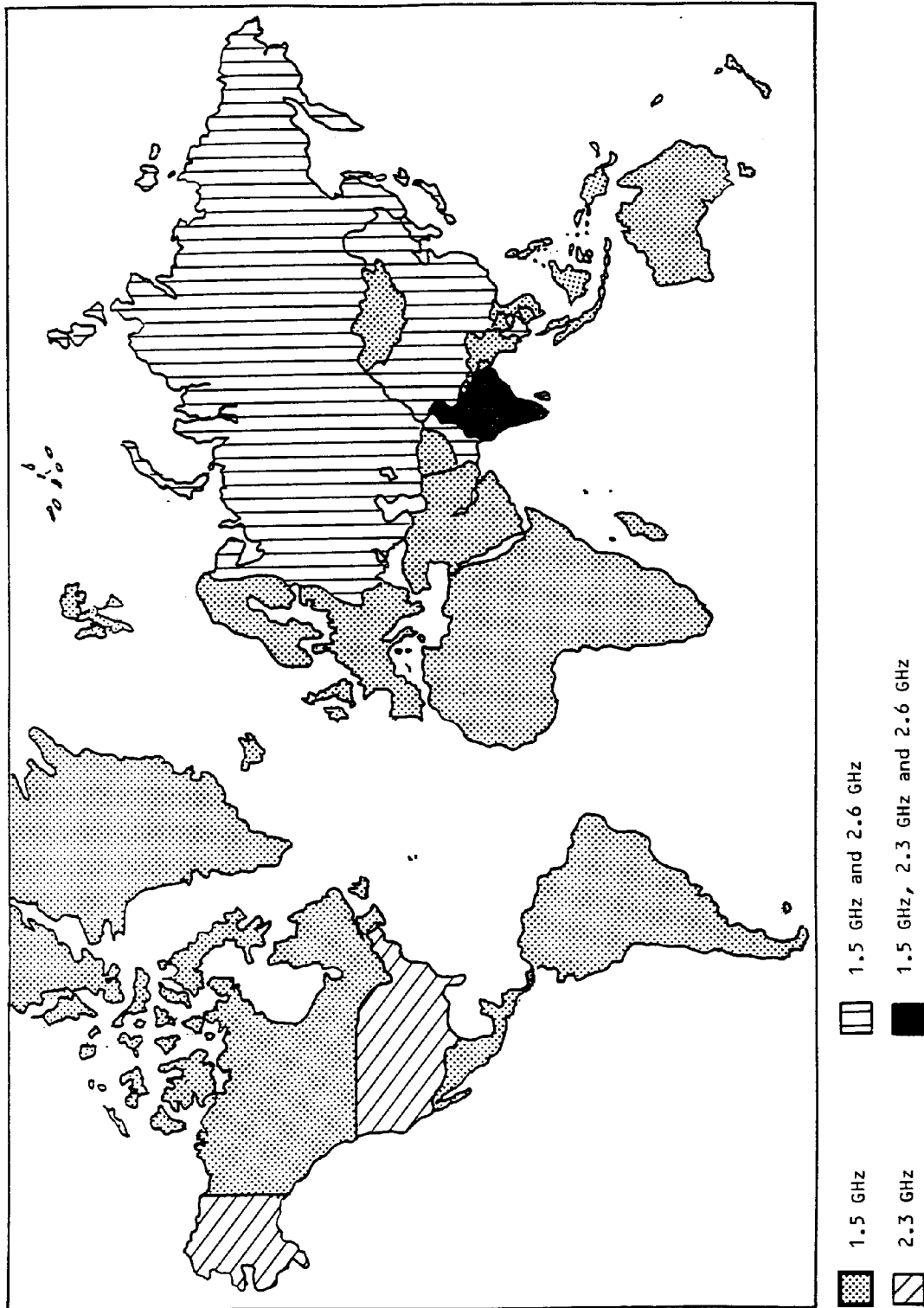
Resolution No. 527 (WARC-92) recognized that it may be possible to introduce new digital services in the terrestrial VHF broadcasting bands and opened the door to a more detailed consideration.

Resolution No. 528 (WARC-92) gives details of the introductory procedures. It discusses the need for a planning conference, restricts the range of frequencies that may be used before the planning conference to the upper 25 MHz of the appropriate band, and details the method of calculating interference criteria (these are determined by means of Resolution No. 703 (Rev. WARC-92) procedures, and so there are as yet no formal technical procedures that can be applied).

Resolution No. 522 (WARC-92) gives details of the types of orbit that can be used and the future work that is necessary before non-GSO systems can be deployed.

Figure 1 shows the differences in allocations throughout the world.

FIGURE 1
Simplified world map of WARC-92 BSS (sound) and BS (sound) frequency allocations



2. Service requirements

2.1 Service goals

There are a number of possible goals in introducing digital sound broadcasting services:

- to replace current AM/FM broadcasting in order to provide better quality and more reliable services and to better compete with other distribution media that can bring "CD" quality audio services to the listener;
- to provide the listener with a new service that can compete with the current AM/FM broadcasting service;
- to provide a service with conventional quality grade to large service areas for reception by very low cost receivers.

There is a recognized need for new sound broadcasting services to provide a better service to vehicular receivers (see Recommendation ITU-R BO.789). Furthermore, some services may also be directed to portable receivers for use inside buildings.

Currently, several administrations and commercial organizations have proposed sound-broadcasting satellite systems having different audio quality levels (CD, "Near-CD", FM stereophonic, FM monophonic and AM). Service to different kinds of receiver installations has been proposed (vehicular, portable and fixed), as well to a variety of environments (indoor, outdoor, rural, urban and suburban). All of these system approaches are technically feasible. One or more of them may be cost-effective and attractive to administrations depending on their state of development, the extent of their existing terrestrial systems and their broadcasting requirements.

There is a need to provide digital sound broadcasting services having a wide range of subjective audio quality. There may be substantial demand, particularly in developing countries and in sparsely settled countries having little terrestrial broadcasting infrastructure, for the digital equivalent of standard monophonic FM, and even for the digital equivalent of double-sideband AM.

2.2 Service objectives

The objective of new sound broadcasting services is to improve the availability, quality and diversity of programme services to listeners. Wide area coverage will bring programme service to many listeners for the first time and advanced digital techniques will allow high-quality sound equivalent to the quality available from other sound media (e.g., compact discs). Advanced digital techniques will also make possible a wide range of new programme-related and independent services with minimal impact on spectrum and power requirements. The BSS (sound) and BS (sound) is aimed at fixed, vehicular and portable reception. The technical system objectives are determined by two factors: quality and availability.

Quality

The service objectives for digital sound broadcasting may play an important role in determining the type of system to be used and the overall system design and cost. Careful consideration needs to be given to the interaction between performance and economic factors. Digital sound broadcasting has been under consideration now for over 25 years, and during that time the reproduction and transmission of sound has undergone considerable development.

The expectations of the listeners have also increased considerably. Most people in urban areas now expect high-quality stereo sound, even from portable or vehicular radios. The enormous advances in the performance of domestic "hi-fi" equipment, culminating in the extensive use of compact discs, has conditioned many people to expect sound quality greater than that which even fixed FM receivers can give. Even in remote areas, similar expectations often exist, owing to the wide availability of good quality cassette recorders and compact disc players.

Much of the wide-area coverage is currently achieved by long-, medium- and short-wave ionospheric transmissions. Even though the population of those areas may prefer to receive entertainment broadcasts of the highest technical quality, it may be more economical for this type of service to accept monophonic service of medium quality provided it was reliable, and could be received on portable/vehicular receivers.

For these reasons, quality objectives can range from grade 3 on the 5-point ITU-R scale for a simple monophonic system to grade 4.5 for an advanced digital system. For the advanced digital systems, the objective is to provide a high-quality stereophonic service, comparable to compact disc quality. These distinct grades of service quality may lead to different system trade-offs.

Availability

Traditional methods of planning for terrestrial broadcasting have used an availability criterion which requires 50% of the locations within the coverage area to meet the quality objectives for at least 50% of the time. It can be expected that the service availability objective for all services will be increased; and, particularly for the high-quality grade service, it will need to be substantially increased from the criterion stated above.

Some possible techniques for increasing service availability under certain conditions include time diversity, frequency diversity, and space diversity at the receiver, in addition to the use of on-channel terrestrial repeaters allowed by some modulations, to fill in shadowed areas which translates into space diversity at the transmission end.

2.3 Service concepts

2.3.1 BSS (sound) concept

The concept of satellite sound broadcasting is well described in Report ITU-R BO.955. Service areas are covered by satellite beams. The extent of the beam coverage needed on the Earth determines the size of the satellite transmit antenna. The transmission power at the satellite has to be large enough to compensate for propagation losses and to provide adequate fixed, portable and vehicular reception on the Earth. This concept can be used for covering sub-national, national, supra-national, and even global service areas.

2.3.1.1 Hybrid BSS (sound) concept

The satellite coverage can be improved through the use of low-power repeaters ("gap-fillers") using the same carrier frequency to cover shadowed areas produced by large buildings, tunnels, valleys, etc. This hybrid BSS concept is a special application of the new advanced digital modulation schemes which can make constructive use of echoes and therefore are well suited to operate in a multipath environment. In such cases, active echoes deliberately introduced by co-frequency repeaters to fill the shadowed areas appear to the receiver as if they were passive echoes. This results in a reduction of the needed satellite power to the level typically needed to cover rural

areas. The retransmitted power can be very low, of the order of a few watts, depending on the size of the shadowed area to be covered.

2.3.2 BS (sound) concept

The concept of terrestrial digital sound broadcasting is well described in Report ITU-R BS.1203. In the case of conventional AM and FM broadcasting, service areas are covered by one or more transmitters operating on different frequencies. The transmission power and the effective height of the antenna above average terrain (EHAAT) for terrestrial digital sound broadcasting stations need to be large enough to compensate for propagation losses and to provide adequate fixed, portable and vehicular reception. This concept can be used for covering local service areas with a single transmitter, or sub-national and national service areas using the single frequency network (SFN) concept described later.

2.3.2.1 Distributed emission concept for digital terrestrial sound broadcasting

Normal terrestrial broadcasting can also be augmented with the use of co-channel repeaters receiving the signal from the main transmitter and rebroadcasting it on the same frequency in the vicinity of the repeater. On-channel "gap-fillers" within the service area can be seen as a special localized case of the distributed emission concept. This requires that, as in the case of the hybrid concept, the type of modulation used allows operation in a multipath environment and makes constructive use of passive as well as active echoes.

The use of repeaters either as gap-fillers or coverage extenders to improve the terrestrial coverage allows a decrease of the required terrestrial transmitter power and, in addition, create a sharper discrimination towards a service area using the same frequency for satellite reception. The same sharper discrimination could be used to reduce the separation distance between two coverage areas using the same frequency, thus allowing greater frequency of reuse.

There exists an upper limit on co-channel repeater separation (several kilometres), and this limit is set by intersymbol interference occurring when two signals reach a receiver with a time difference which exceeds the guard interval between data symbols. Other concepts using spread spectrum signal structures, which could allow repeaters to transmit on a common channel and place fewer constraints on repeater separation, are under study.

An alternative concept utilizing frequency translating repeaters, each transmitting at a different frequency to fill shadowed areas for extended coverage, would not be constrained by the distance between repeater transmitters, but would require more channels.

2.3.2.2 Single frequency network concept (SFN)

In this concept, ideally, regularly spaced transmitters are fed synchronously by the same signal and broadcast on the same frequency. As in the previous case, there is a limit on the separation distance between these transmitters and this limit is set by the intersymbol interference produced at the receiver by the active echoes generated by these multiple transmitters.

This concept can be used to extend the reach of terrestrial broadcasting to national and even supra-national service areas.

2.3.3 Mixed satellite/terrestrial sound broadcasting service concept

The concept of a "mixed" satellite/terrestrial sound broadcasting service is based on the use of the same frequency band by both satellite and terrestrial broadcasting services. It can maximize the spectrum use by allowing these two broadcasting services to closely coordinate their service development rather than attempting sharing of the frequency band by totally unrelated services. The