Licensing of Future Mobile Satellite Systems

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ABSTRACT

The regulatory process for licensing mobile satellite systems is complex and can require many years to complete. This process involves frequency allocations, national licensing, and frequency coordination. This paper describes the regulatory process that resulted in the establishment of the radiodetermination satellite service (RDSS) between 1983 and 1987. In contrast, each of these steps in the licensing of the mobile satellite service (MSS) is taking a significantly longer period of time to complete.

INTRODUCTION

Since the early 1970s, a major regulatory objective of the Federal Communications Commission (FCC) has been the establishment of competition in the provision of satellite services. The licensing of multiple systems has been a central feature of the domestic satellite industry in the United States. Moreover, the FCC has continued to adapt its licensing standards to minimize regulatory delay in the authorization of additional satellites as demand for service grows. The resulting competition has stimulated technical and service innovation, and reduced the price of equipment and service to the public.

RDSS has been established in the United States on a similar multiple entry basis. The establishment of the regulatory scheme for RDSS began in 1983, and was completed with the 1987 World Administrative Radio Conference (WARC) for the Mobile Services. Initial service began within the United States during 1988.

Establishing a regulatory framework for MSS has proven to be much more difficult and time consuming. This is due in large part to the different characteristics and service objectives of MSS systems. Nevertheless, competition between multiple MSS systems can produce the same types of innovation and economies that have been experienced in other areas of satellite communications.

THE REGULATORY PROCESS

The licensing of MSS systems involves three broad areas: the frequency allocation process, the licensing process, and the frequency coordination process. The frequency allocation and coordination processes can have both national and international components.

Frequency Allocations

Both the FCC and the International Telecommunication Union (ITU) establish tables which allocate specific bands of frequencies to various radiocommunication services. In each of these "tables of frequency allocations," separate bands of frequencies are allocated to RDSS and MSS, and each of these services is defined differently. RDSS is a satellite service for the "determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves." MSS is a radiocommunication service to earth stations "intended to be used while in motion or during halts at unspecified points." In addition, the mobile satellite service is subdivided into separately defined land, maritime and aeronautical mobile satellite services.[1]

Frequency allocations can be made on a primary basis or on a secondary basis not to cause interference to primary services. Bands may be allocated to one service on an exclusive basis, or bands can be shared between two or more services.

The allocations for RDSS are essentially the same in both the United States and the international tables. In the Western Hemisphere, RDSS shares its allocated frequencies with other radio services on a primary basis.

The situation regarding the MSS L-band frequency allocations is different, however. Prior to the 1987 Mobile WARC, the lower half of the MSS bands (i.e. 1530-1544 MHz downlink and 1626.5-1645.5 MHz uplink) was allocated only for maritime MSS. The upper half (i.e. 1545-1559 MHz downlink and 1646.5-1660.5 MHz uplink) was allocated only for aeronautical MSS, and there were no L-band allocations for land MSS. The 1987 Mobile WARC changed the international MSS allocations by allocating 3 MHz of the lower half of L-band for land MSS on a co-equal primary basis with maritime MSS, and re-allocating 4 MHz of the upper half to land MSS from aeronautical MSS. The United States domestic allocation of these bands does not, as a general matter, distinguish between land, maritime and aeronautical uses of MSS. However, 4.5 MHz in the upper half of L-band has been allocated domestically only for aeronautical safety MSS on a primary basis.

Licenses

Each operator of a satellite system must receive a formal license from a national telecommunications authority to construct and operate the system. Except for systems to be operated by the federal government, such licenses are issued by the FCC in the United States.

The FCC usually establishes a deadline, or "cut-off period", during which applications for licenses to operate satellites in the same frequency bands must be filed if they are to be considered at the same time. If more applications are filed by the cut-off date than can be granted because of mutual interference, the FCC must establish a policy or procedure to select which of the applications to grant.

Frequency Coordination

Since several satellite systems use the same spectrum, it is necessary to insure that their operation does not cause unacceptable interference between them. International frequency coordination procedures have been established by the ITU in Articles 11 and 13 of its international Radio Regulations.

Technical guidance is also available in the reports and recommendations of the International Radio Consultative Committee (CCIR). New reports will be adopted by the 1990 CCIR Plenary Assembly dealing with the derivation of MSS interference and sharing criteria, MSS inter-system frequency sharing and reuse, and technical aspects of MSS frequency coordination[2].

The technical aspects of coordination initially focus on the amount of discrimination or isolation that can be provided between transmissions carried over two satellite systems on the same frequency. A significant amount of isolation can be provided if the satellite antennas cover different geographical areas, or if directive earth station antennas with rapid sidelobe roll-off are used to discriminate between satellites at different orbital locations. For spread spectrum systems, isolation is provided by choosing pseudo random noise codes which have good cross-correlation properties. If sufficient isolation is not available from satellite and/or earth station antenna directivity, then frequency plans assigning different frequencies to each system can be used to eliminate interference.

RDSS LICENSING

The RDSS proceeding began in March 1983 when the Geostar Corporation filed a petition for rulemaking to allocate frequencies and establish licensing procedures for RDSS, together with an application for an RDSS system license. In its rulemaking Dockets 84-689 and 84-690, the FCC allocated domestic frequency allocations for RDSS[3] and an open entry licensing policy for this satellite service[4]. The feasibility of operating multiple RDSS systems in the same band relies on the use of different pseudo random noise spreading codes and coordination of power density levels.

The RDSS licensing procedures have been codified into Section 25.392 of the FCC's rules and regulations. These regulations include the following provisions:

(a) application content
(b) application procedures, including an automatic 60-day cut-off period
(c) blanket licensing of mobile units
(d) authorization of ancillary services
(e) frequency assignment techniques
(f) domestic inter-system coordination
(g) compliance with Docket 84-689 and 84-690 policies.

Initially, four companies were granted licenses to construct, launch and operate RDSS systems. However, only Geostar proceeded and has already begun initial operations.

Following these national decisions, frequency allocations were made for RDSS on a world wide basis at the 1987 Mobile WARC[5]. Moreover, the international Radio Regulations specify sharing criteria, such as EIRP density limits on mobile units and power flux density limits on RDSS satellites, as well as specified coordination distances for mobile RDSS earth stations, so that the conventional coordination procedures of Articles 11 and 13 can be directly applied to RDSS.

MSS LICENSING

The MSS licensing proceeding began with the filing of a petition for rule making by the National Aeronautics and Space Administration in November 1982. The FCC began its Docket 84-1234 rulemaking proceeding in late 1984 to allocate frequencies and issue the initial licenses for domestic MSS.

One of the major delays in the initial MSS licensing involved the controversy over whether to use UHF or L-band frequencies. Once the FCC allocated the upper half of the MSS L-band for domestic use[6], it then had to grant one or more of the twelve pending applications for initial MSS system licenses. The FCC had several options, such as comparative hearings to determine the best applicant, division of the available spectrum among each of the qualified applicants, a rigorous examination of the qualifications of each applicant, a lottery to randomly select a license, or an auction.

The FCC found various flaws with each of these approaches. In addition, the FCC recognized that virtually every applicant advocated a high capacity, multiple spot beam satellite design and that assigning frequencies to multiple satellites would be complicated by the division of the upper MSS L-band frequencies between aeronautical safety MSS and other non-safety MSS. As a result, the FCC established a consortium of the pending applicants to hold the initial domestic MSS system license in the upper half of the MSS L-band. The FCC also required each of the consortium members to make a $5 million cash contribution to fund the initial operations of the consortium.[7]

In selecting this approach, the Commission did not award the consortium a monopoly franchise for domestic MSS service within the United States, nor did it guarantee the economic viability of the system. The FCC stated that additional systems may be licensed in the future if the need arose, if additional allocations were made, or if technological developments made it feasible to divide the available spectrum.[7] The FCC recently began a proceeding to allocate the lower MSS L-band for domestic MSS systems.[8] The FCC will therefore have an opportunity to license one or more new MSS systems in the near future to compete with the initial domestic MSS system it licensed in 1989.

MSS COORDINATION

The initial United States MSS system of three satellites may be required to coordinate with up to 30 other domestic and international MSS satellites under the ITU procedures. The technical aspects of this coordination can be based on inter-system isolation and/or detailed frequency plans.

Inter-System Isolation

Coordination between domestic MSS systems with non-overlapping coverages should be relatively easy to achieve since the satellite antennas in each of the systems can, by themselves, provide enough inter-system isolation to reduce interference levels between co-channel transmissions to acceptable levels.

The more difficult cases involve coordination of domestic MSS systems with international MSS systems using global coverage antenna beams. Such systems provide no discrimination by the spacecraft antenna in the overlapping coverage areas. For spot beam domestic MSS systems, however, coordination of some of the spot beams can be coordinated on the basis that they do not overlap the global beam. For example, there is no geographical overlap between the western spot beams of a United States MSS system and the global beam of an Atlantic Ocean Region INMARSAT satellite.

Another method of achieving coordination is by means of mobile earth station directivity. Although omnidirectional antennas are desirable to avoid the reliability concerns associated with mechanically steered antennas or to reduce the high costs associated with electronically steered antennas, they provide virtually no antenna discrimination. Studies indicate that directive mobile earth station antennas may provide sufficient discrimination to allow co-channel transmissions on satellites spaced widely apart in orbit.[2] For example, the initial United States MSS system will employ three satellites separated by approximately 35° in longitude, and the same frequencies can be used on all three satellites by mobile earth stations with directive antennas. Initially, such directive antennas may also be employed to conserve limited satellite power.

Frequency Plans

In those cases where there is not enough inter-system isolation to permit co-channel transmissions, detailed frequency plans for each system can be developed to insure that the interfering transmissions do not use the same frequencies in both systems.

The impact of such frequency plans on current systems may not be exorbitant, since currently operational and planned systems appear to be power limited. In these MSS systems, the aggregate r.f. power available at L-band for transmission from the satellite is not sufficient to fully utilize the allocated band in an effective manner. Table 1 illustrates this condition.

Satellite Coverage	Global Beam (39 dBW Total EIRP)				Spot Beam (54 dBW Total EIRP)				
Channel Designation	Standard-A	Standard-B	Standard-M	Aero Voice	Omni Voice	Directional Voice	Fixed Voice	Aero Voice	Aero Data
Channel Bandwidth	28	20	8	17.5	5	5	20	17.5	2.5
Satellite EIRP Per Channel (dBW)	18	18	17	22	30.4	24.5	26.8	25	25
Number of Channels (includes VOX)	250	250	320	100	460	1785	1050	1590	795 no VOX
Frequency Re-Use	None	None	None	None	2X	2X	2X	2X	2X
Total Usable Allocated Bandwidth (MHZ)	7.0	5.0	2.5	1.8	1.1	4.5	10.5	13.9	1.0

Table 1. Total Allocated Downlink Bandwidth Usable with Aggregate Satellite EIRP Available

In Table 1, the amount of downlink bandwidth that can be actually used for the assumed aggregate available satellite power is calculated for several representative types of r.f. carriers. For ease of presentation, these calculations assume that the satellite is filled with only one type of r.f. carrier, rather than the more typical case where a mixture of different r.f. carriers are carried by an MSS satellite. The global beam parameters are representative of the INMARSAT II satellite, and the spot beam parameters are representative of a domestic, multiple spot beam satellite including multi-carrier back-off. It should be noted that several, lower EIRP satellites can be operated by different companies using the same bandwidth used by a single, high EIRP satellite.

As can be seen from Table 1, currently planned MSS systems have sufficient power to utilize only a small portion of 28 MHz of L-band spectrum currently allocated for downlink MSS transmissions, except for the case where directive antennas are used with a spot beam satellite. However, directive earth station antennas can permit the same frequencies to be used by both global and spot beams covering the same geographical area in the usual case where there is a large orbital separation between such satellites. These example calculations demonstrate that coordination of multiple domestic and global beam MSS satellites with overlapping coverage areas is feasible, if spectrum efficient modulation techniques are used in both types of systems.

CONCLUSION

Lengthy licensing processes create economic disincentives and conflict with the national commitment to increased competition and innovation. With the rapid development of new terrestrial services, it is necessary to improve the functioning of these regulatory processes to maintain the competitiveness of the satellite industry. Additional spectrum in the lower half of L-band is being allocated for domestic MSS, and multiple domestic MSS systems are feasible now at L-band.

The full cooperation of existing operators of global beam satellites will be required to accommodate domestic MSS systems. Moreover, both international and domestic MSS systems will have to be configured to minimize the amount of spectrum actually occupied in their systems.

Regulatory bodies will also have to adjust their standards and procedures to recognize the feasibility and desirability of licensing competing domestic MSS systems, just as was done earlier in the case of RDSS. Regulatory bodies will also have to address the long-term spectrum needs of a growing competitive MSS industry that requires allocations beyond those made at the 1987 Mobile WARC. This can be done at the upcoming 1992 World Administrative Radio Conference, which will be able to make additional allocations to MSS in the 1 to 3 GHz portion of the spectrum.

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