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Spectrum Sharing between AMSS(R) and MSS

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INTRODUCTION

Generic satellite systems will serve aeronautical, land and maritime users in the United States and Canada. One important service, Aeronautical Mobile Satellite (Route) Service (AMS(R)S), pertains to the safety and regularity of flight. The North American systems are designed to assure that this vital safety service is not impaired in any way as it shares the spectrum and satellites with a large number and great variety of other users in other services.

AMS(R)S has priority and preemption rights over all other communications, including aviation non-safety, in the shared band. Internationally, those rights are in the band 1545-1555/1646.5-1656.5 MHz and in the United states 1545-1559/1646.5-1660.5 MHz. The lower portions are the satellite-to-aircraft links, the upper portions the aircraft-to-satellite links.

Safety related aeronautical communications impose stringent requirements on the design and operation of aeronautical mobile satellite systems. A pilot must have reliable, near instantaneous communication with an air traffic controller. There must be smooth transitions from one sector or flight information region to another. An aircraft must be able to fly anywhere in the world and communicate with its one set of equipment through any satellite that provides aeronautical communications.

The satellite service providers and the aviation community are working together to assure that the stringent requirements will be met. Minimum Operational Performance Standards are being developed by the Radio Technical Commission for Aeronautics. Standards and Recommended Practices are being developed by the Aeronautical Mobile Satellite Service Panel of the International Civil Aviation Organization. Avionics standards, "form, fit, and function", are specified by the Airlines Electronic Engineering Committee. The engineering bases for radio frequency regulations are developed by the International Radio Consultative Committee (CCIR).

All of the organizations are concentrating their efforts on AMS(R)S which consists of Air Traffic Services (ATS) and Aeronautical Operational Control (AOC). ATS, which includes air traffic control, is the responsibility of civil aviation authorities. AOC is the responsibility of the airlines and other users of the service. In addition to the AMS(R)S safety related communications, there are non-safety Aeronautical Administrative Communications (AAC), primarily airline business operations, and Aeronautical Public Correspondence.

Aeronautical mobile satellite communications will also be provided through the satellites of global systems, such as INMARSAT, which serve oceanic and continental areas that do not have regional systems. Regional systems, such as those of the American Mobile Satellite Corporation (AMSC) in the United States and of Telesat Mobile Inc. (TMI) in Canada, will provide the satellites for high traffic density areas.

In the United States AMS(R)S will be served by a network separate from all other uses of the AMSC satellites. The architecture of the system will interconnect the AMSC Network Control System and the AMS(R)S network to assure real time access to all the spacecraft power and bandwidth that will be needed. Coordination with other satellite systems will facilitate the air traffic handover between flight information regions and enhance efficiency in the use of the spectrum. The bandwidth and linearity of the satellite transponders will assure that every kind of communication signal and protocol used by aviation will be accommodated.

AMS(R)S REQUIREMENTS

The first use of satellites for AMS(R)S will be over the oceans. Automatic Dependent Surveillance (ADS) will provide automatic, frequent position reports to air traffic controllers. They can then track aircraft, thus supporting separation reduction and allowing more aircraft to follow the most fuel efficient routes. The position fixes are derived from on-board navigation systems, such as the aircraft inertial navigation system, Loran-C, or the Global Positioning System. The transmissions of the reports to the ground will be short data packets sent at timed intervals.

ICAO has specified the use of digital techniques for all voice and data communications. The minimum "core" capability requirement is duplex data communications between aircraft and ATS earth stations at 600 bits per second with aircraft equipped with 0 dBi omni-directional antennas. A signal power density at the aircraft of -165 dBW/Hz/m^2 is specified. Assuming global beam satellites, the international airlines have considered that digital communications at bit rates high enough to provide toll quality voice would require 12 dBi aircraft antennas with steerable beams.

The Airlines Electronic Engineering Committee has prepared ARINC Characteristic 741 describing the avionics equipment to be used on transport aircraft. Several manufacturers are building equipment according to this specification, and some aircraft that fly oceanic routes are being equipped. Aeronautical administrative and air passenger telephone communications are being introduced using the INMARSAT satellites. Oceanic air traffic services will be tested, but will not be operational until they have been qualified by the traffic control authorities.

There is no current plan to introduce AMS(R)S service in U.S. domestic airspace. However, studies by the Federal Aviation Administration are postulating the use of Automatic Dependent Surveillance as an alternative to the present en route radar surveillance for the time period circa 2010. A peak instantaneous aircraft count in North America may then be between 17,000 and 34,000. If those numbers of aircraft participate over North America and each aircraft transmits its location every ten seconds, the spectrum needed to handle the ADS and associated ATS and AOC communications would be between 8 and 13 MHz assuming that there is a frequency reuse factor of 3. The traffic load would have a large variation during the course of the day as well as seasonally. It would also vary with weather conditions.

Service areas of the INMARSAT, USSR and possibly other satellites overlap the service area of the AMSC satellites. International coordination according to International Telecommunication Union rules will be necessary to avoid interference between the systems. That coordination will be the responsibility of AMSC.

As aircraft move from the service area of one satellite to another, or between beams of a single satellite, and as they move from the region of one traffic control authority to another, a dynamic handover coordination procedure must be followed. That coordination is primarily the responsibility of the AMS(R)S network operator.

AMS(R)S OPERATION THROUGH AMSC SATELLITES

Each earth station in the AMS(R)S network will be interconnected with the Aeronautical Telecommunications Network that will use Open Systems Interconnection protocols. AMS(R)S authorities, through their network operator, will specify the portion of AMSC satellite power and bandwidth needed for AMS(R)S. The amount may vary diurnally and seasonally due to characteristic patterns of aviation traffic. A factor influencing the amount is the low blocking rate required for the service. AMSC will insure that no other traffic is allowed in the spectrum assigned to AMS(R)S.

The AMS(R)S authorities will operate an Aviation Priority Demand Assigned Multiple Access (AV PDAMA) facility that controls the communication traffic flow between the aircraft and the ATS and AOC authorities. The Network Control Center of AMSC will contain a Priority Demand Assigned Multiple Access (PDAMA) facility that has a robust interconnection with the AV PDAMA.

The ATS and AOC authorities will monitor the blocking rates of AMS(R)S traffic through the AMSC satellites. When they exceed acceptable limits AMSC will be notified and required to immediately preempt additional bandwidth and power for reassignment to AMS(R)S.

The AMSC system design complies with the preemptive access requirement. Every Mobile Earth Terminal that uses the AMSC satellites will be type approved and individually commissioned. All of them will be under positive control of the Network Control System (NCS). Positive control means that the NCS can issue commands at any time to one or groups of mobile terminals that must be acted upon immediately.

The aviation community, through the organizations listed in the Introduction, have defined in great detail the performance requirements, the operating procedures, and the equipment specifications for AMS(R)S. It is an ongoing process, and an important one because it is the introduction of new technology and capability into one of the world's major industries. The plans must anticipate developments over the next several decades in aviation and in mobile satellite technology.

Whenever it can play an appropriate role, AMSC participates actively in all of the aviation fora involved in the process. Members of the AMSC ownership consortium have participated in experiments and in the planning process since aeronautical communications by satellite were first suggested. Through that participation AMSC has contributed to the process, developed its system to be fully compliant with AMS(R)S requirements, and laid the groundwork for future system growth in capacity and performance that will keep pace with aviation's advances.