The FAA Satellite Communications Program

Karen L. Burcham
Federal Aviation Administration
800 Independence Avenue NW, Washington DC 20591
Telephone (202) 267-7676
Fax (202) 267-5793

ABSTRACT

The Federal Aviation Administration is developing satellite communications capabilities to enhance air traffic services, first in oceanic and remote regions, and later for United States domestic services. The program includes four projects which develop technical standards, assure adequate system performance, support implementation, and provide for research and development for selected areas of U.S. domestic satellite communications.

The continuing focus is the application of automated data communications, which is already permitting enhanced and regular position reporting. Voice developments, necessary for non-routine communications, are also included among the necessary activities to improve ATC communications.

OBJECTIVES

The FAA Satellite Communications Program Plan objective is to provide for and facilitate operational use of Aeronautical Mobile Satellite (Route) Service (AMS(R)S) communications, where (R) stands for "Route" denoting the safety service, to meet civil aviation needs in oceanic and offshore areas, and possibly in U.S. domestic airspace as well. The FAA Plan concentrates on implementing the concept developed by the International Civil Aviation Organization's "Future Air Navigation Systems" (FANS) committee during recent years, at first for oceanic regions.

In the interest of improved air traffic management, the Program assists in developing national/international AMS(R)S standards, ensuring adequate system performance, supporting implementation, and providing research and development for U.S. domestic satellite communications. The general connectivity of the system is illustrated in Figure 1.

PROJECT AREA DESCRIPTIONS

There are four defined projects in the FAA Satellite Communications Program. The first three develop satcom capabilities and provide for operations in oceanic and remote regions where the FAA has current responsibility: the first developing data, the second developing voice, and the third supporting operations; and the fourth area will develop selected U.S. domestic applications.

Project 1: Oceanic/Remote Data

The development of satellite data communications for aircraft entails the generation of agreed-upon standards that permit aircraft flightworthiness and operational certification, and bring assured interoperability between aircraft and controllers by means of various service providers.

MOPS

Minimum Operational Performance Standards (MOPS) are developed jointly by the supplier/user industry and the FAA in an AMSS Special Committee (SC-165) provided for by RTCA, Inc. (formerly the Radio Technical Commission on Aeronautics). This independent body reacts to needs to define architectures, standards for signals and interfaces, and recommended tests that will bring uniformity and

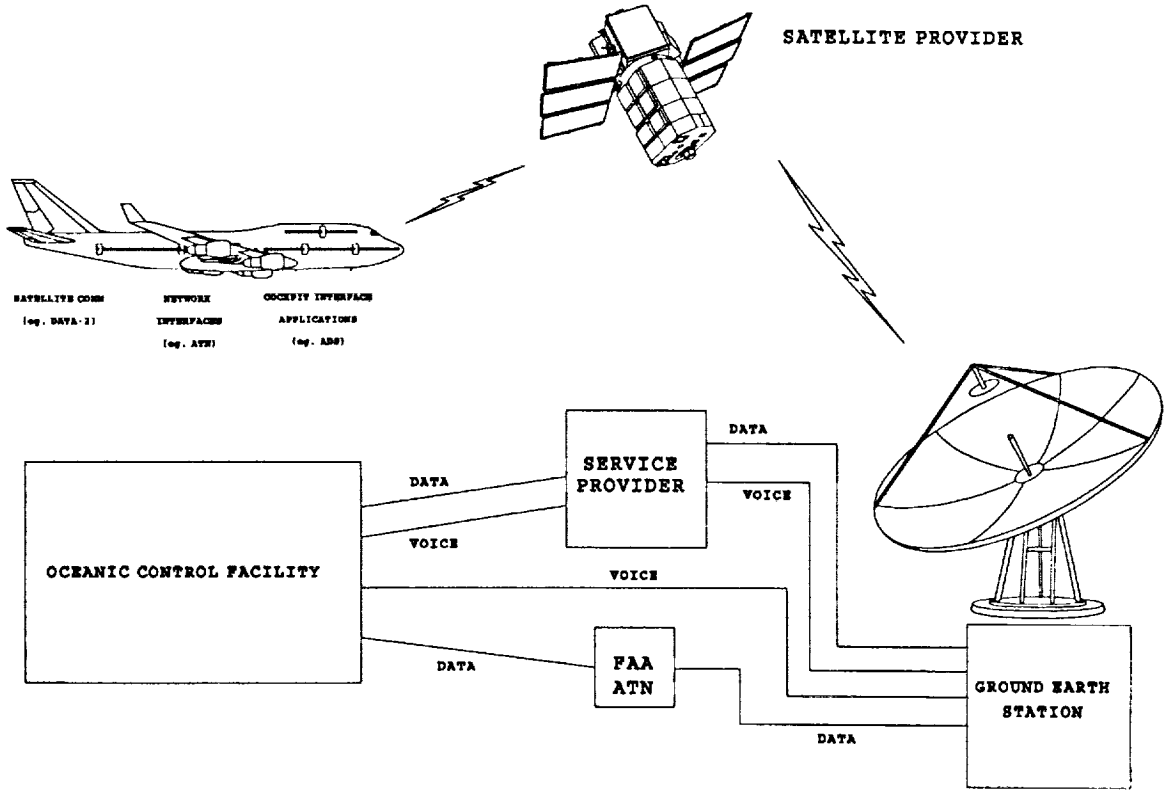

Figure 1. FAA Oceanic Air Traffic Control Operational Concept

interoperability for avionics used in aeronautical safety services.

While the MOPS focuses on describing only the Aeronautical Earth Station (AES) and its air-ground protocols, the committee also has developed a System Guidance document which permits understanding of end-to-end, pilot-to-controller service performance.

While not mandatory, the MOPS serves several purposes. It provides a published guide for manufacturers, operators, and users to implement the AMSS system in a coordinated way. Based on signal-in-space rather than on equipment design, the MOPS gives considerable freedom to design and innovation, while the standardization of signal characteristics provides for competitiveness and coordinated operations.

The MOPS also is a basis for manufacturers' acquisition of an FAA Technical Standards Order (TSO), which constitutes an FAA technical approval for equipment installation. It can assist as a basis for the installing facility's acquisition of Type Certification, which authorizes actual air traffic service applications.

The AMSS MOPS recently has been completed and is available through the RTCA. The next stage--modifications from knowledge gained during manufacturing, installation, and operation--is under way. The next MOPS edition is expected to be available early in 1994. FAA Program Plan support to this effort is focused within the Satellite Communications Program on oceanic and remote regions.

Needs of the Federal Communications Commission (FCC) to assure efficient and effective use of the radio spectrum

and non-interference were also supported by SC-165 in developing necessary changes to the Code of Federal Regulations, Part 87.

SARPs

Standards and Recommended Practices (SARPs), developed by member states' Civil Aviation Authorities within the International Civil Aviation Organization (ICAO), ultimately become treaty-level agreements among the member states that assure universal interoperability for international flight safety services. They define generally the AMS(R)S signal-in-space characteristics and protocols necessary for AES operation with its Ground Earth Station (GES).

Since 1989, the FAA has been a principal participant and architect in the development and validation of the AMSS SARPs. Similarly to the MOPS, these standards closely follow the system architecture defined in the Inmarsat System Definition Manual (SDM), but focus on describing signal characteristics rather than the specifics of design.

Under the International Telecommunications Union (ITU) Radio Regulations, the AMS(R)S designation denotes services which are afforded additional protection against interference. Similarly to the need to adapt FCC Rules to properly include aeronautical mobile satellite communications, the SARPs Working Group is supporting the efforts to establish non-interference and other performance standards for mobile satellite communications within the ITU's International Radio Consultative Committee (CCIR).

The AMSS SARPs are in the final stages of completion. They are expected to be validated through tests and modelling presently under way, and are scheduled to be presented to the ICAO Air Navigation Council for approval in mid-1994.

Following a circulation and agreement period to permit member-nation acceptance and aircraft implementations, the SARPs will facilitate worldwide AMSS operations. They should enable the realization of concepts held for many years, wherein air traffic operations would reap the full benefits of the integrity and timeliness of satellite services.

Oceanic Performance Analysis

Simulations are being developed and validated using projected AMSS traffic to ascertain effects on system performance and responsiveness. The outcome should permit estimates of operational capability, and should uncover areas where specific approaches could be implemented to enhance AMSS safety services. When complete in October 1993, the simulation model will be coordinated with developments in the Oceanic Development Facility (discussed below).

Develop SARPs-Compliant Capability

This project activity will acquire an AES and install and test it in an FAA-owned Boeing 727 aircraft at the FAA Technical Center (FAATC) near Atlantic City, NJ.

The AES interface with aircraft avionics, and through the satellite through the GES to end users, will employ the ISO 8208 standard as defined in both MOPS and SARPs. "Data-3," an Inmarsat definition, describes such an AES that can operate within the full Open Systems Interconnect (OSI) protocols. Use of this standardized protocol enables end-to-end interconnectivity advantages of the Aeronautical Telecommunications Network (ATN), now under design.

The principal objective of this project element is to validate the SARPs requirements by demonstrating and testing an in-flight AES using the SARPs-defined, ISO 8208 data protocol as the avionics interface. However,

because no Data-3 or SARPs-compliant AES will be available to meet the ICAO approval schedule, the present AES will be augmented by external software to emulate the additional SARPs-defined capabilities.

The AES installation on the FAA aircraft will then be able to operate as a complete ATN- and SARPs-compliant user terminal. The tests are scheduled for late 1993.

Optimize for Periodic Reporting

In the late '80s, ICAO Future Air Navigation Systems (FANS) study reports defined the need for an integrated Communications, Navigation, and Surveillance (CNS) capability to enhance safety services using satellites.

Within this capability is the requirement for periodic position reporting to controllers using aircraft-derived information, called Automatic Dependent Surveillance (ADS). Over oceanic and remote areas where conventional communications means are unreliable, satellite communications can be used instead for this purpose.

The use of existing signal architectures for regularly-spaced, short data messages is inefficient. Over the past few years, several schemes have been proposed for more efficient use of the communications channel to improve spectrum effectiveness and reporting timeliness.

Presently, simulations are being developed; and now, proceeding in coordination with Inmarsat, the completion of new reporting protocols for inclusion in the SARPs and implementations is scheduled for September 1993.

In its ultimate form, the Global Navigation Satellite System (GNSS), which will include both the US Global Positioning System (GPS) and the CIS Global Orbital Navigation Satellite System (GLONASS), will supply aircraft position information that is relayed from the aircraft through AMSS satellites, and through the ground network to air traffic controllers.

Equip FAA Aircraft for Trials

Development of worldwide standards for safety services expected to be useful for decades requires thorough testing in order to be assured that the requirements are correct, thorough, and unambiguous. The FAATC Boeing 727, now equipped for tests using a low-gain antenna and an early AES, will have installed a high-gain antenna and other capabilities to provide an effective AMS(R)S testbed.

A direct interface from the Comsat earth station at Southbury, CT, to the FAATC will be in operation to permit the real-time interaction necessary for these tests.

Project 2: Oceanic/Remote Voice

While ordinary and routine information is transmitted by voice in today's aeronautical communications, the use of data message services is becoming more pervasive. Although this trend will continue for AMS(R)S routine services, voice communications will still be very important. There are non-routine and emergency situations when controller and aircraft crew need direct and rapid access. The FAA is now developing a policy that will clarify the user selection of data or voice transmissions under various circumstances.

The Program Plan focus in this project area is on development of satellite voice capability for oceanic and remote regions. Aircraft that are fitted for AMS(R)S voice will enjoy the benefits of greatly improved reliability and connectivity with controllers anywhere in the satellite coverage areas.

Three activities are relevant, as follows.

Revise MOPS for Voice

The current MOPS (RTCA/DO-210) covers very minimally the voice circuit-mode services, relying on the Inmarsat SDM to support call setup and release definition of protocols and interfaces. The specific standards for these are now under accelerated development in SC-165, with the goal for completion early in 1994.

Controller Voice Architecture

Requirements are under development to provide the necessary interfaces for air traffic controllers to integrate AMS(R)S voice, to be used for non-routine needs, with routine data services.

Conduct Voice Trials

Northwest Airlines has installed an AES in a Boeing 747-400 equipped for aircrew and passenger use of satellite voice services. The airline, with Aeronautical Radio, Inc. (ARINC), and the FAA have drawn a joint test plan for using the system for AMS(R)S during Northwest's regular service in the Pacific area.

This trial of end-to-end AMS(R)S voice will be conducted first through connections from the aircraft's flight deck to the ARINC Comm Center, and patched through to the FAATC; and later, with direct connection from the aircraft to the FAATC. The trials are expected to begin in the second quarter of 1993 and will extend for six months.

Project 3: Oceanic/Remote Operations

This part of the Program Plan supports FAA elements that comprise a Satellite Operational Implementation Team. The Team was formed to treat several interrelated satellite programs that are in various stages of development. Its mission is to assure implementation of AMS(R)S for improved air traffic services according to a coordinated and scheduled plan. The target for completion of implementation for the oceanic area is late 1996.

Define Requirements

Initial activities in this project area include definition of requirements in support of an overall Satellite Operational Implementation Plan, now in draft form and scheduled to be completed by late 1993.

Conduct Engineering Trials

The FAA aircraft will continue to be used to collect data on AMS(R)S trials in the North Atlantic area. For a period from 1993 through 1995, trials will be run in coordination with the United Kingdom's Civil Aviation Authority.

Starting in 1994, the trials will operate with a full end-to-end ATN capability using AMS(R)S to handle Automatic Dependent Surveillance (ADS, or periodic position reports) and other messages. This will be the first exercise of the fully SARPs-compliant capabilities of these three systems.

Results will be integrated for analysis with data resulting from the continuing Pacific Engineering Trials. This activity, which began in 1992 prior to an ATN capability, provided ADS reports using an interim AES-equipped United Airlines aircraft in commercial service.

Integrate Oceanic Systems End-To-End

The next step in this project area will be to integrate AMS(R)S into the FAA's Oceanic Development Facility (ODF). This facility is under construction at the FAATC, and will serve as a principal test bed for all FAA oceanic communications and surveillance operations. Discussions have begun on schedule and goals, working with the oceanic program to ensure end-to-end function and performance. The final step will include the passage of

AMS(R)S directly between the Air Route Traffic Control Centers (ARTCCs) and the aircraft.

Project 4: Domestic Service Applications

The U.S. domestic applications project for AMS(R)S communications will focus first on the use of satellite communications in selected areas where it now is difficult to contact aircraft. Also within this area are investigations of satellite alternatives that could bring service advantages to the FAA such as reduced cost and improved availability.

Domestic/Offshore Helicopter Test

This project area will provide for the conduct of U.S. domestic area tests using an FAA helicopter with a loaned, interim AMSC AES and Marisat satellite capacity currently under lease to the American Mobile Satellite Corporation (AMSC). The test's three phases, scheduled from late 1992 through mid-1995, will move from Loran-C position reports to the use of the Global Positioning Satellite (GPS) capabilities reported through the AMSC's spot-beam satellite. Analyses of the results should support further developments in the FAA's domestic and offshore services.

In a second part of this project, the Jet Propulsion Laboratory (JPL) is under contract to the FAA to develop and test a low-cost, light-weight AES for helicopter use. The terminal should also be adaptable for use by fixed-wing aircraft.

Develop Applications and Equipment

This future planning project will investigate low-cost satellite communications alternatives for future domestic use, and will identify candidate systems for research. Coordinated work with the FAA's System Engineering service will identify where future needs are not yet being actively planned for.

Investigations will include use of the AMSC/TMI and next-generation Inmarsat satellite systems, possibilities for using future Low-Earth Orbit (LEO) and Medium-Earth Orbit (MEO), and store-and-forward terminals such as the "Aero-C" Inmarsat terminal.

Future R&D:

This project area will support selection, analyses, and testing of candidate systems; and provide for engineering trials and necessary revisions of the RTCA MOPS and ICAO SARPs. After surveying potential improvements to AMS(R)S, viable candidate architectures will be identified for further investigation and inclusion in planning.

CONCLUSION

The FAA Program Plan for satellite communications provides a basis for developing operational services to enhance air traffic control. It is an integral part of many ongoing improvements to the air traffic control system. Moving first from today's high-frequency radio to use of satellite communications through a service provider, the final step is envisioned to be direct AMS(R)S between flight deck and controller.

The Plan supports standards development; provides for coordinated domestic and international plans, tests and trials leading to integration with other automated FAA systems; and surveys and prepares for future improvement possibilities.

Availability of benefits should be accelerated by this activity for aircraft users equipped to these standards and interfacing with the ATN. The FAA R&D and operational activities to complete standards and integrate satellite communications will enable users to enjoy a level of communications integrity and availability not available by any other means.