

SPACE COMMUNICATIONS TO AIRCRAFT: A NEW
DEVELOPMENT IN INTERNATIONAL SPACE LAW
(PART I)⁺

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Introduction

Largely unnoticed by the international legal community, an important development has been taking place in space law: the creation of an international institutional framework for aeronautical satellite telecommunications. At the Fourth Session of the INMARSAT Assembly, held in October 1985, various amendments were adopted to the INMARSAT Convention and Operating Agreement. The effect of these amendments is to confer on INMARSAT the competence to provide aeronautical satellite telecommunications on a global basis.

In order to discuss this development it is necessary to provide certain background information. First, an outline will be given of INMARSAT, its structure and present operations. Secondly, there will be a description of the potential applications of aeronautical satellite telecommunications. Thirdly, an account will be given of the origin of INMARSAT's involvement in this field and of earlier attempts to establish an aeronautical satellite system.

INMARSAT

The International Maritime Satellite Organization (INMARSAT) came into existence in 1979. Its original purpose was "...to make provision for the space segment necessary for improving maritime communications, thereby assisting in improving distress and safety of life at sea communications, efficiency and management of ships, maritime public correspondence services and radiodetermination capabilities."¹ The origins and nature of the Organization have already been described in

+ Part II of this article will appear in a later issue of this JOURNAL.

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1. INMARSAT Convention, Art. 3(1).

detail in the pages of this Journal.² For present purposes an updated summary will be sufficient.

The decision to establish INMARSAT was taken at the International Conference on the Establishment of an International Maritime Satellite System, 1975-76. The Conference, which had been convened by the Inter-Governmental Maritime Consultative Organization (now the International Maritime Organization), adopted the texts of two international instruments. These were the Convention on the International Maritime Satellite Organization (INMARSAT) and the corresponding Operating Agreement. Both instruments entered into force on 16 July 1979, and the Organization commenced operations in 1982.

Forty-eight States have now joined INMARSAT by becoming Parties to the Convention. Each Party must either itself sign the Operating Agreement or designate a public or private entity within its jurisdiction to do so.³ The present Signatories to the Operating Agreement are extremely varied, including national PTT organizations, private commercial corporations, State enterprises, government departments and, in a few cases, the Member State itself. The Signatories invest in INMARSAT in proportion to the relative use made by their countries to the INMARSAT system.⁴ In return they receive compensation for use of capital at a rate fixed from time to time by the Council.⁵

The Organization levies charges for the use of its space segment. These charges are established at a level sufficient to cover operating expenses, amortization and compensation for use of capital.⁶ These are within the discretion of the various entities which operate coast earth stations through which communications are routed. End-user charges typically include the relevant space segment utilization charge as well as charges for the use of coast earth station facilities and terrestrial connections. INMARSAT receives its revenues from the coast earth station operators, not from end-users.

Although the Organization is required to operate in accordance with commercial principles,⁷ it has no power or obligation to earn profits

2. See Stephen E. Doyle, *INMARSAT: The International Maritime Satellite Organization - Origins and Structure*, 5 J. SPACE L. 45 (1977); and H.H.M. Sondaal, *The Current Situation in the Field of Maritime Satellite Communication Satellites: "INMARSAT"*, 8 J. SPACE L. 9 (1980).

3. INMARSAT Convention, Art., 2(3).

4. INMARSAT Convention, Art. 5(2); INMARSAT Operating Agreement, Arts. III and V.

5. INMARSAT Convention, Art. 5(2); INMARSAT Operating Agreement, Arts. III and VIII.

6. INMARSAT Convention, Art. 19(1).

7. INMARSAT Convention, Art. 5(3).

for its Signatories. It follows that, if the Organization starts to generate a surplus of revenues, after allowing for operating expenses, amortization and compensation for use of capital, it must stabilize or reduce its space segment utilization charges. A reduction was in fact made in January 1986.⁸

The Organization presently offers maritime satellite telecommunications services on a near-global basis, including telephone, telex, data, slow-scan television and compressed video. Among the most recent introductions are the SafetyNET and FleetNET enhanced group call services. Future service offerings are likely to include various navigational aids and the use of emergency position-indicating radio beacons (EPIRBs). INMARSAT services will also be an important element in the International Maritime Organization's Global Maritime Distress and Safety Service.⁹

At present the Organization leases operational and spare satellite capacity in each of its three ocean regions. However, the Organization has placed contracts to purchase a second generation of satellites, also a ground control system.¹⁰

The market for maritime satellite telecommunications services has grown considerably since INMARSAT commenced operations. The Organization's total revenues for 1986 were in excess of US\$60 million, to which maritime services made by far the largest contribution. About 5,500 vessels are currently equipped to operate via the INMARSAT systems, and this number is increasing at an average rate of 80 per month.

The Organization has three organs: the Assembly of Parties, the Council and the Directorate.¹¹ The Assembly meets once every two years and is responsible for the general policy and long term objectives of the Organization. The Assembly also decides upon questions concerning formal relationships between the Organization, States and other international organizations.¹² The Council meets three times a year. It consists of representatives of those eighteen Signatories with the largest investment share in the Organization and also of the representatives of four further Signatories elected in order to ensure just geographical representation.¹³ The Council is responsible for detailed policy and

8. COUNCIL/21/SR/FINAL/sec. 17 (this is an internal document).

9. See GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM, INTERNATIONAL MARITIME ORGANIZATION (London, 1987).

10. 5 OCEAN VOICE 2 (NO.2, April 1985); and 6 OCEAN VOICE 7 (No. 2, April 1986).

11. INMARSAT Convention, Art. 9.

12. INMARSAT Convention, Art. 12.

13. INMARSAT Convention, Art. 13(1).

approves the Organization's annual budget. The Directorate consists of an international staff of approximately 200, headed by the Director General, who is responsible to the Council for the day-to-day management of the Organization.¹⁴ The Directorate is located at the Organization's Headquarters in London.

Aeronautical Satellite Telecommunications

Although, as indicated above, the shipping industry has been quick to take advantage of the possibilities offered by satellite telecommunications, there is as yet no operational system for aeronautical satellite telecommunications. The historical explanation of this belongs in the next section of this Article. At this point it is necessary to describe the demanding requirements of the aviation industry for radio telecommunications and to illustrate how satellites can offer improvements over existing systems in meeting those requirements.

There are three broad categories of aeronautical communications. The first is Air Traffic Services (ATS). This type of communication is safety-related. Its purpose is to prevent collisions between aircraft in the air or in terminal areas; to ensure an orderly flow of air traffic; to provide advice and information for the safety of flights; and to notify appropriate authorities of aircraft in need of search and rescue aid. This is achieved by providing aircraft with meteorological information; and instructing or advising them in whatever way is necessary to avoid collisions, overcrowding of airspace or any other potentially dangerous situation. ATS communications occur in both directions, between pilots and the controllers in charge of air traffic control regions. Typical types of ATS messages are as follows:

(a) Position Reporting: currently done by voice;

(b) Air Traffic Control (ATC): this includes clearance of an aircraft to its planned destination via the route, altitude and speed which it planned to fly. Such clearances may be revised en route in order to prevent collisions with other aircraft;

(c) ATC Advisories: these messages provide information to the pilot about other traffic or runway conditions, data allowing the setting or resetting of an aircraft altimeter and other safety related information;

(d) Meteorological Reports: these include requests for and reports of weather conditions at particular locations, for example, the airport for which an aircraft is heading; and also weather forecasts broadcast for entire regions.

14. INMARSAT Convention, Art. 16.

Some aircraft report on the specific weather conditions that they encounter, to assist in the production of weather forecasts and to warn other aircraft of potentially hazardous situations, such as wind shear and thunderstorms.

The second broad category of communications is Aeronautical Operational Control (AOC). This relates to the safety, regularity and efficiency of flights. Such communications may be between an aircraft and its airline, an operating agency, a maintenance facility or the destination airport. The types of messages are as follows:

(a) Flight Operations: these may report the fact of departure or arrival, or their estimated time; the progress of the flight; or internal and external conditions. Such messages may also be used to advise the assignment of an airport gate to the aircraft; or to check the aircraft's passenger or cargo manifest;

(b) Maintenance Support: this covers reports on the aircraft's physical and technical condition; requests for and reception of engineering assistance from experts on the ground; and the automatic monitoring of engine performance parameters;

(c) Communications Management: this includes messages to check that the aircraft's communications equipment is functioning properly.

The third category of communications is Aircraft Passenger Communications. These are, in general, data messages and may include the transmission of business or personal messages by aircrew; the reception for distribution to passengers of news, weather and financial information; or special services such as medical or interpreter assistance. In addition, it is sometimes possible for passengers to make their own telephone calls from aircraft; although at present such a service is largely confined to the North American continent.

At present, all the above types of communication are made through terrestrial radio systems, operating mostly in the VHF and HF bands. VHS provides high quality but has a limited range. HF suffers from propagation difficulties, depending in particular on ionospheric conditions and the time of day, resulting in unreliable links of low quality. There are substantial areas of the world's airspace in which aircraft cannot be in contact with ATC centres or receive information from radio navigational beacons. In addition, to meet these needs, there

is a requirement for a large number of costly communications facilities.¹⁵

Satellite systems can provide reliable telecommunications of high quality over any distance on a near-global basis. The implications of this for ATS are dramatic. The speed and reliability of communications will enable ATC centres to reduce the spacing between aircraft, allowing more efficient use of crowded airspace. Routing can be optimized, leading to fuel savings, shorter flight times and reduced workloads for flight crew and air traffic controllers. Of particular importance is Automatic Dependent Surveillance (ADS), which will allow the position of an aircraft, as determined by its instruments, to be reported automatically or on request to an ATC centre without any action on the part of the flight crew.

History of Aeronautical Satellite Communications

In the early 1960's, NASA and Pan American Airlines conducted experiments to demonstrate the feasibility of satellite telecommunications for aircraft. A major development occurred in 1969, when the International Civil Aviation Organization (ICAO) formed a panel of experts to consider and make recommendations concerning the Application of Space Technology Relating to Aviation. This is the derivation of the name given to the Panel: ASTRA.

ASTRA met between 1970 and 1972. The first oil crisis had not yet occurred, and many forecasters predicted that there would be rapid growth over two decades in the demand for air travel. At the same time, many failed to foresee that there would be rapid growth in the use of wide-bodied jets, which would lower the number of aircraft needed to cope with any given level of demand. As a result, it seemed that there would be a great increase in the overall number of flights, straining the capacities of existing communication and air traffic services systems.¹⁶

It was in the light of such assumptions that ASTRA approached one of the fundamental questions of aeronautical satellite telecommunications: whether international civil aviation should have an exclusively dedicated satellite system, or should share the system with other users. ASTRA decided in favor of the first alternative. In the words of Mr. Duane Freer:

"The Panel felt that the paramount aviation safety considerations precluded any other options. Thoughts of shared usage of satel-

15. See D. W. Freer, *Applications of satellite communication technologies to international civil aviation*, 53 TELECOM. J. 710 at 712 (XII/1986).

16. *Id.* at 711.

lites or of a system which was not totally at the beck and call of the aviation community were dismissed as being unthinkable."¹⁷

The ASTRA recommendations came at a time when the airlines were experiencing a slackening of business, and were at the same time committed to investing in new inertial navigation systems and transponders for secondary surveillance radar. The costs of establishing a dedicated satellite system were considered totally unacceptable, and ASTRA was disbanded. However, at about this time the idea of a dedicated aeronautical satellite system was maintained in the context of the AEROSAT programme. Following a recommendation of an Air Navigation Conference, held by ICAO in 1972, the United States Federal Aviation Administration and the European Space Research Organization (ESRO) agreed to launch an experimental satellite. The objective was to perform a variety of experiments to determine the desired characteristics of an operational aeronautical satellite for mobile communications and position reporting. The satellite was never ultimately launched, and the airlines remained unwilling to invest in an expensive dedicated satellite system.

The AEROSAT programme resulted in one development of lasting importance. A Committee of the AEROSAT Council concluded in the early 1980s that civil aviation might be able to share satellite systems operated for other purposes. It urged ICAO to explore this possibility. The AEROSAT Council suggested that the INMARSAT system might be suitable for such a sharing arrangement.¹⁸

The origins of the idea of a shared satellite system, however, date back to at least the early 1970s. At this time the ITU, IMCO and ICAO were all considering the desirability of shared radio frequencies for aeronautical and maritime services. The position of the ICAO Council was stated in a recommendation approved on 11 December 1970:¹⁹

"(a) That, since from an operational and frequency management viewpoint general sharing of frequency bands between the aeronautical mobile and the maritime mobile services is considered undesirable, any proposals to this effect should be opposed;

(b) nevertheless, that provision should be made to permit the possible future allocation of a frequency channel(s) in appropriate bands for joint use by the aeronautical and maritime services, for a SAR [Search and Rescue] system employing satellite techniques,

17. *Id.* at 711.

18. *Id.* at 711-2.

19. Quoted in IMCO doc.MARSAT II/6, 25 January 1973, p. 2.

for application in the event that the requirement for such a system should emerge in the future."

The ICAO Council approved certain comments on this recommendation which explain the underlying concerns. The following extracts are of particular interest:

"Any curtailment of the flexibility now available to the international civil aviation interests in the organization of the aeronautical infrastructure would have an unacceptable stifling effect..... Experience over the last 25 years has shown that the coordination of frequency requirements within the aeronautical environment alone has been, and still is, a delicate and difficult undertaking. If the coordination has to include other than aeronautical interests, particularly where there are no common practices and requirements, it is feared that unacceptable delays will be suffered in the implementation of systems to meet the aeronautical needs."²⁰

The position of ICAO was summarized by the IMCO Secretariat in the following terms:

"Until recently the interpretation given to sharing, particularly by the CCIR, had been wholly on the use of common radio frequencies with an emphasis on technicalities and spectrum conservation..... ICAO would prefer to regard the question of radio frequency economy as being only one factor so as not to preclude the possibility of other forms of sharing, for example, a common space vehicle or common launcher even if the two Services use separate transponders operating on exclusive frequency bands. So far the ICAO position on the examples quoted is not defined."²¹

In the same document the IMCO Secretariat noted that the ITU Conference of 1971 had altered the frequency allocations so as largely to give effect to paragraph (b) of the ICAO Council Recommendation referred to above:

"Thus, for example, in the bands between 1535 MHz and 1660 MHz exclusive allocations are made to both [aeronautical and maritime] Services for communications in the upward and downward direction, in both cases separated by a contiguous band of

20. *Id.* Annex, at 2-3.

21. *Id.* at 1-2.

frequencies available to both maritime and aeronautical mobile Services on a shared basis."²²

The IMCO Panel of Experts on the Establishment of a Maritime Satellite System was also cautious on the question of sharing. The Panel reported in 1974 its view that the first phase of a maritime satellite service should be confined to meeting maritime needs. However, the Panel shared the views of ICAO and CCIR that consideration should be given to the possibility of suitable forms of sharing, particularly with respect to distress and to search and rescue, in the frequency bands which had been allocated to both aeronautical mobile- and maritime mobile-satellite services.²³

A more far-reaching proposal was introduced by the representatives of the United States at the International Conference on the Establishment of an International Maritime Satellite System. The proposal was as follows:

"The United States believes that the international telecommunications community should study seriously the question of ultimately combining maritime and aeronautical communications capabilities, so far as is compatible with sound technical, economic and institutional planning. We believe substantial advantages might well accrue from joint maritime and aeronautical capabilities. Preliminary United States studies suggest that combining these capabilities is technically feasible and might well result in substantially reduced total financial requirements and increased revenue."²⁴

In the result the Final Act of the International Conference on the Establishment of a Maritime Satellite System included the following recommendation:

"THE CONFERENCE RECOMMENDS that arrangements should be made to undertake at an early date the study, without prejudice to programmes in planning, of the institutional, financial, technical and operating consequences of the use by INMARSAT of multi-purpose satellites providing both a maritime mobile and an aeronautical mobile capability. In connection therewith, the

22. *Id.* at 3.

23. MARSAT/CONF/5, October 1974, Attachment, p. 21.

24. MARSAT/CONF/WP. 14, 19 February 1976, p. 1.

advice participation and cooperation of the appropriate aeronautical authorities should be sought."²⁵

It was in the light of this recommendation that INMARSAT began to study the requirements of the aeronautical community for satellite communications. The results and consequences of that study will be the subject of the second part of this Article.

25. FINAL ACT OF THE INTERNATIONAL CONFERENCE ON THE ESTABLISHMENT OF AN INTERNATIONAL MARITIME SATELLITE SYSTEM, INTER-GOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION, 69 (London 1976).