Executive Summary. The Joint AEROSAT Evaluation Programme has been established by several European States, the United States and Canada in response to recommendations of the 7th Air Navigation Conference of the International Civil Aviation Organisation (IACO) held in April 1972 in Montreal. This group of 11 States has agreed to conduct a single international programme of experimentation and evaluation in order to facilitate the application of satellite technology to international civil aviation needs. The institutional arrangement devised for such a joint international programme is defined in a Memorandum of Understanding, which was executed in 1974 between the Federal Aviation Administration (FAA), the European Space Agency (ESA), representing the European States, and Canada, with provisions for participation by other countries in the future. An AEROSAT Council was established to oversee this international cooperative effort. The authority and responsibility for the day-to-day implementation of the Coordinated Programme rests with the AEROSAT Coordination Office (ACO), which was established in June 1975.

The joint international effort extending over the next ten years will consist of a programme of experimentation and evaluation comprising:

1. a Space Segment Capability of two geostationary satellites in orbit and a ground-based satellite control facility.

2. a Coordinated Programme consisting of ground facilities (Aeronautical Services Earth Terminals and Aeronautical Satellite Communication Centers), aircraft avionics and a coordinated test, evaluation and demonstration programme.

The Space Segment and the satellite control facility will be provided by COMSAT (for the U.S.) ESA and Canada as co-owners consistent with the performance specification attached to the M.O.U. The ground facilities and the avionics will be financed, developed and installed individually by each signatory of the M.O.U. on the basis of commonly developed and agreed interface specifications and selected system configurations. The test evaluation and demonstration programme will be conducted and financed by each signatory on the basis of an agreed joint programme under the direction of the ACO.
Although several aeronautical communication experiments have been conducted with
satellites, AEROSAT will be the first dedicated satellite capability to serve the interests of
Civil Aviation. The prime objective of this programme is to provide the data and
experience necessary to determine the merits of proceeding into an operational system. In
particular, the AEROSAT System will be used by the participating nations to evaluate
competitive technical and viable operational concepts for the avionics and ground
segments as well as to develop the technical and operational standards for an international
system. At the conclusion of the AEROSAT Programme there will exist sufficient
comparative system data for the sponsoring nations and the user community to reach a
decision in ICAO with respect to a future operational system capability, configuration and
other factors.

In order to achieve the objectives of the programme the following elements will be
provided to support the coordinated test, evaluation and demonstration programme:

1. A space segment capability of two satellites in geostationary orbit at 15° West and
40° West Longitude and a ground based satellite control facility.
2. A ground segment consisting of earth terminals, communication centers, ATC Centers,
test sets and interfaces with other users.
3. An avionics segment consisting of equipment for installation in experimental and
airline aircraft.

The essential characteristics of the system are:

1. Provision of air/ground voice and data communications service as well as dependent
and independent surveillance service. Independent surveillance is based upon ranging
through two satellites and pressure altitude data transmitted from the aircraft.
2. Provision of wideband (10 MHz) experimental channels for two-way ranging and
communication experiments.
3. Use of L-band and VHF-band for voice, data and surveillance service and L-band for
wideband experiments for the satellite-aircraft links. Use of C-band for voice, data,
surveillance and wideband experiments for the satellite-ground and use of C-band for
aircraft to satellite wideband experiments. (illustrated in figure 1)
4. Nominal gain of aircraft antenna 4 dB and a noise temperature of 1000°K for the
L-band avionics and -2 dB and a noise temperature of 1100°K for the VHF avionics.
5. Coverage for the L-band forward link subdivided in zones as given in figure 2. All other links are earth coverage.

The execution of the coordinated test, evaluation and demonstration programme using the aeronautical space segment capability and the other elements of the coordinated programme is the most complex part of the joint AERSAT programme.

The complexity comes from the fact that:

1. agreements have to be reached by the participants of this international cooperative programme in order to specify the ground facilities and the aircraft avionics in a manner that compatibility is assured.

2. the evaluation and test programme must be planned and carried out in a manner that the test results of the participants are directly comparable so that an objective assessment can be made to permit determination of the most attractive technical and operational solution leading to a proposal for standardization within ICAO.

The coordinated test, evaluation and demonstration programme is subdivided into communication experiments which are primarily of technical nature and relate to propagation effects, (e.g. multipath, scintillation), and channel performance (e.g. modulation, multiplexing, antenna performance) and operational system concept evaluations. For the execution of the programme it is highly desirable to reduce the number of candidate configurations which undergo evaluation under operational conditions. The following parameters will have to be taken into account when selecting operational system concepts for evaluation.

1. Potential requirements of a first generation operational system (e.g. number of simultaneous system users, geographic distribution of traffic, type of communication etc.).

2. Satellite Configurations (e.g. earth coverage, spot beams).

3. Ground System Configurations (e.g. number of ground facilities functioning as controlling ASET/ASCC’s).

4. Signal multiplexing (e.g. ranging + supervisory information/ data + voice).

5. Multiple access techniques (e.g. frequency division or time division multiple access).
6. Selection of Modems for voice, data and surveillance (e.g. quadraphase modulation, delta voice modulation etc.).

For the selection of candidate operational system concepts testing in the joint AEROSAT evaluation programme advantage will be taken of the results achieved by the ATS-5 and ATS-6 test programme, simulation studies and laboratory tests as well as theoretical studies. The aim is to limit the total number of operational system concepts requiring special provision on the avionics and ground facilities. In particular, the avionics installation in commercial aircraft must not be overly complex nor require frequent modifications but at the same time must be flexible enough to accommodate testing of all the candidate operational systems.

**Conclusion.** The joint AEROSAT Evaluation Programme is in an early stage of development. Because the programme is a joint programme of ESA, FAA and Canada it is necessary that the system be configured to satisfy the requirements of interest to each participant individually as well as collectively. It is generally recognized that there is little technical risk in designing and launching a satellite and to develop avionics equipment and ground facilities once appropriately specified. The complexity of the programme is associated with the selection of a system giving the flexibility to permit experimentation and evaluation of competitive technical approaches and usable operational concepts.

The complexity of the programme is furthermore associated with the requirement to achieve agreement by the signatories of the M.O.U. on technical characteristics to assure compatibility between the system elements and to select a limited number of system concepts to undergo evaluation. Finally the complexity of the programme is associated with the planning of the tests and evaluations in order to assure that the results obtained individually by the participants are directly comparable. This achievement is a fundamental requirement to reach the programme objective i.e. to arrive at one agreed proposal of technical characteristics and operational procedures for ICAO adoption.
Fig. 1 AEROSAT Frequency Plan

Fig. 2 Atlantic Coverage