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Historical Development: The Alouette Program

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The Alouette Program

Introduction

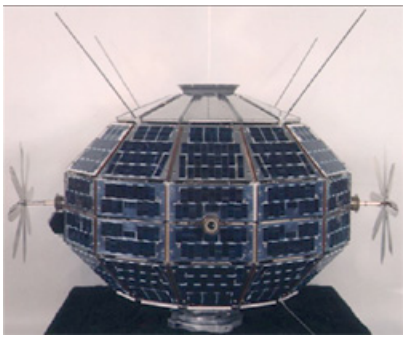
In the 1950's at the height of the Cold War, Defence Research Bureau (DRB) laboratories, located in Ottawa, were involved in research and development to keep Canadians abreast of leading edge technology and ensure that Canadian forces were adequately equipped for their defence role.

Research at the Defense Research Telecommunication's Establishment (DRTE) was directed at improving communications via various radio bands. In that era, prior to communications satellites, High Frequency (HF) or short wave radio was the main mode of communication, particularly over long distances. However, HF radio depends on reflections from the ionosphere, a layer of ionized gas high above the Earth. The ionosphere tends to be irregular, particularly at northern latitudes, and often causes severe difficulties in maintaining radio contact.

At DRTE, studies to improve such radio communications were a prime area of research. Although both theoretical and field studies were carried out, such studies were limited by the scarcity of Ionospheric data, available from only a few sites and from the lower layers of the ionosphere. Scientists had long dreamed of using a satellite to study the ionosphere from above.

The Americans and the Soviet Union had both announced plans to launch artificial satellites as part of the International Geophysical Year program in 1957-1958. The Space Age began with the launch of Sputnik 1 on October 4, 1957. The first American satellite, Explorer 1, followed on January 31, 1958. The Americans then solicited proposals for involvement of scientists from other countries in joint programs and Canada quickly responded.

Canada proposed to build a satellite that would place an ionospheric sounder in orbit (a top-side sounder) and in April 1959 signed an agreement with NASA whereby Canada would supply the satellite and NASA would lanuch it On September 29, 1962, Alouette I (the name of the satellite was suggested by Dr. Zimmerman, Chairman of the Defense Research Board) was launched from Vandenberg Air Force Base by a Thor-Agena-B rocket into a 1000 km, 80 degree inclined orbit. With this launch, Canada became the third nation in the world to have its own satellite in orbit.



A view of the Alouette satellite showing the four telemetry antennas and two of the four STEM (Storable Tubular Extendible Member) sounding antennas which were deployed on orbit. The satellite is about one metre in diameter. The satellite was spin-stabilized at about 1.4 rpm after antenna extension. After about 500 days, the spin slowed more than had been expected, to about 0.6 rpm when satellite spin-stabilization failed. It is believed that the satellite gradually progressed toward a gravity gradient stabilization with the longer antenna pointing earthward. Attitude information was deduced only from a single magnetometer and temperature measurements on the upper and lower heat shields. (Attitude determination could have been in error by as much as 10 deg.)

The Satellite

Alouette 1 was a small ionospheric observatory instrumented with an Ionospheric sounder, a VLF receiver, an energetic particle detector, and a cosmic noise experiment. Extended from the satellite shell were two dipole antennas (45.7- and 22.8-m long, respectively) which were shared by three of the experiments on the spacecraft.

There was no tape recorder, so data were available only from the vicinity of telemetry stations. Telemetry stations were located to provide primary data coverage near the 80 degree W meridian and in areas near Hawaii, Singapore, Australia, Europe, and Central Africa. Initially, data were recorded for about 6 hours per day. In September 1972, spacecraft operations were terminated.

The Program

The Alouette/IIS tracking antenna

The program objectives were twofold:

(a) Primary:

- To bring Canada into the Space Age by developing a space capability.
- To contribute to space engineering and technology.
- To improve the capability to use High Frequency communications by studying the ionosphere from above.

(b) Scientific:

- To measure the electron density distribution in the ionosphere at altitudes between 300 and 1000 kilometres.
- To study for a period of a year, the variations of electron density distribution with time of day and with latitude under varying magnetic and auroral conditions, with particular emphasis on high latitude effects.
- To determine electron densities in the vicinity of the satellite by means of galactic noise measurement, and to make observations of related physical phenomena, such as the flux of energetic particles.

Conclusions

With Alouette, Canada became a space faring nation, the third country after the USSR and USA to have built a successful satellite. Alouette was the cornerstone on which Canada became a leader in the peaceful uses of space and on which a competitive space industry has been built. Designed for a one-year lifetime, the spacecraft exceeded all expectations and was decommissioned on its tenth anniversary.

Canadian engineers acquired expertise in space technology and became known for the reliability of their products. It was one of the most successful scientific satellites ever and ushered in a new era of scientific co-operation. More than one

million ionograms were produced. Canadian scientists gained prominence as world experts on the upper atmosphere. In 1987, Alouette was designated one of the ten most outstanding achievements in the first 100 years of engineering in Canada. In May 1993, the global significance of the project was recognized when the Institute of Electrical and Electronic Engineers (IEEE), the largest technical organization in the world designated it as an International Milestone of Electrical Engineering.

Within a short time after the successful launch of Alouette 1, Canada initiated negotiations with NASA for additional cooperative scientific satellites. On 23 May 1963 those negotiations led to the creation of the International Satellites for Ionospheric Studies (ISIS) program, consisting of Alouette 2, ISIS 1 and ISIS 2. Alouette 2, launched November 29 1965, was a modified version of Alouette 1 and included a probe experiment and an expanded sounder frequency range. The two ISIS satellites, launched January 30 1969 and March 31 1971 respectively, incorporated additional equipment furnished by the United States.

In addition to its technological accomplishments, the Alouette-ISIS Program achieved a number of impressive accomplishments in the international arena:

- Alouette 1 was the first spacecraft completely designed and built by a nation other than the United States or the Soviet Union.
- The Canadian-built Alouette 1 was as complex as any previously launched U.S. or USSR satellite.
- The longevity of Alouette 1 was far greater than that of any previously launched satellite.
- Until the early seventies, Alouette 1 was the satellite that had led to the greatest number of scientific publications.
- The success of Alouette 1 was equaled, if not surpassed, by that of Alouette 2, ISIS 1, and ISIS 2, the other Canadian-built satellites of the program.
- The program, which started as a joint effort between Canada and the United States, grew steadily to include a total of 10 nations. All participating nations provided telemetry stations, many of which were built specially for the Alouette-ISIS program. The average length of this participation has been about 10 years.
- The program has led to an ISIS telemetry network (distinct from NASA's telemetry network).

Finally, the program has had an outstanding record in making the data available to the scientific community. The Alouette-ISIS program was the first satellite program to make extensive and well-documented contributions of data to international data centers. Approximately 100 Alouette-ISIS data sets are available at the National Space Science Data Center. The magnitude of these data holdings can be conveyed by pointing out that the one million Alouette 1 ionograms constitute only one data set. Because of its very early support of data center activities, the Alouette-ISIS Working Group also helped to develop some of the procedures and policies for submitting satellite data to the data centers.

Over 50 research groups and agencies have used data from the Alouette-ISIS program made available in this manner.

List of References:

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IEEE History Center: Alouette