SATELLITE COMMUNICATIONS IN CANADA: DEVELOPMENT AND APPLICATIONS

by

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A Thesis Submitted to the Institute of
Air and Space Law Faculty of Graduate
Studies in Partial Fulfillment of the
Requirements for the Degree of Master
of Laws

McGill University
Montreal, Quebec
July 31, 1981

SATELLITE COMMUNICATIONS IN CANADA

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ABSTRACT

The precise purpose of this thesis to to examine the scientific development and commercial application of satellite telecommunication technology in Canada. This thesis will be a study of the evolution of such satellite technology in Canada and the public and private institutions that have shaped and have been shaped by this technological explosion.

RESUME

Le but précis de cette thèse est d'examiner le développement scientifique et l'application commerciale de la technologie des télécommunications par satellite au Canada. Cette thèse sera une étude du développement de telle technologie des satellites au Canada et des organismes publics et privés qui ont développé cette évolution de la technologie des satellites et qui sont influencés par cette évolution.

PREFACE

This dissertation deals with the subject of the scientific development and commercial application of satellite telecommunications technology in Canada. This thesis will be a study of Canadian institutions in the space communications field and their relationship to the developing technology. The status of earlier and current scholarship has only dealt with this topic in a fragmentary manner. There is an urgent need for an updating of the material due to recent developments—especially in the field of 14/12 GHz technology. The proposed contribution of this thesis is to summarize and analyze all the recent satellite communications programs into a comprehensive whole in the light of the new wave of space communications technology.

While I alone am responsible for any shortcomings that remain, I have benefitted greatly from the assistance and counsel of certain individuals and organizations. I owe a vast debt to the people of Spar Aerospace Limited for their information in relation to satellite programs. I am also greatly indebted to the staff of the Department of Communications of the Canadian government for their excellent responses of my inquiries. I also express my thanks to Professor Nicolas M. Matte, OC QC., of the Institute of Air and Space Law at McGill University whose teaching materials and publications were of great assistance.

INTRODUCTION

At the dawn of the space age, scientific studies in Canada were already underway with the goal of applying space technology to the existing land-based telecommunications systems. At this time there was an active scientific research program in the physics of the upper reaches of the atmosphere, particularly the ionosphere.

The U.S.S.R. inaugurated the space age with the launching of Sputnik I on October 4th, 1957. Five years later, Canada became the third nation to own and operate a scientific experimental spacecraft when Alouette I was sent into orbit on September 29th, 1962.

Scientific experiments utilized Alouette I as well as Alouette II which followed in 1965 and ISIS I in 1969 and ISIS II in 1971. These scientific experimental satellites established Canada's capacity to design, build and operate satellites. These satellites also proved that satellite technology had a great potential to resolve problems in Canada's telecommunications systems.

Comprehensive studies beginning in the mid-1960's explored the potential of satellite technology to overcome specific problems peculiar to Canada's communications network, i.e. the long distances between communities, the variations in terrain and meteorological conditions, and the increase in consumer demand for telecommunications service. These studies were undertaken by the federal government and the telecommunications companies.

In the late 1960's the federal government was faced with an extremely important policy decision in relation to telecommunications by satellite. The federal government had to decide whether telecommunications by satellite should be the responsibility of a government agency or the responsibility of telecommunications companies in the private sector of the economy.

The solution was found in the creation of a company in which joint ownership was shared by the federal government and the Canadian telecommunications companies. Provision was also made for the participation of the general public. This company called Telesat Canada was incorporated by an Act of Parliament on September 1st, 1969 to establish and operate a domestic satellite telecommunications system.

Telesat Canada has implemented four major programs designed to provide Canada with an advanced communications satellite system. These programs consist of the Anik A program, the Anik B program, the Anik C program, and the Anik D program.

The role of the federal government has also been extremely strong in the area of the scientific research and development of communications satellites. The federal government has funded most of the major projects, provided scientific and technical advice and even initiated many technological concepts within their own laboratories.

The federal Department of Communications (DOC) is charged with promoting the development and the efficiency of communications in Canada, and with helping Canadian communications systems and facilities adjust to changing conditions. To help carry out this mandate, the Department undertakes research in many areas of communications.

Therefore, the federal government is involved in satellite communications on two levels. On the level of scientific research and development, the federal government has an extremely active role through the federal Department of Communications. On the level of commercial applications of satellite communications, the federal government shares joint ownership of Telesat Canada along with Canadian telecommunications companies.

It should be carefully noted that the federal government in the 1980's faces some important issues that need to be resolved in this decade. One current issue is the problem of earth station ownership and use by private citizens who illegally receive messages from satellites. Another current issue is the need for the federal government to set up a centralized space agency for Canada.

The main structure of the thesis is organized to provide an outline of the major scientific research and development programs of the federal government <u>as well as</u> the major commercial programs of Telesat Canada. The thesis is divided along these two lines. The first three chapters provide an overview of the major institutions in Canada in the scientific research and development of satellite communications technology from the 1950's to 1980. The last three chapters of the thesis deal with the commercial programs of Telesat Canada and the role of Spar Aerospace Limited as a prime contractor in the aerospace business.

Therefore, the goal of this dissertation is to provide an overview of the scientific development and commercial application of satellite communications technology in Canada from the 1950's until 1980. This evolution along these two parallel levels is the focus of the thesis. This involves an examination of the scientific technology and the major institutions that have played a role in the evolution of this technology. The conclusion to the thesis will summarize the scientific development and commercial application of satellite communications in Canada from the 1950's until 1980. The conclusion will also deal with two vital issues in the 1980's facing the federal government-earth station ownership and the need for a centralized space agency for Canada.

It should be noted that this dissertation places its emphasis upon two major themes— policy and technology. The legal aspect has received a minor emphasis due to this multidisciplinary approach of the thesis. Wherever possible, I have tried to include a legal aspect to the subject-matter which will be mostly in the contractual sphere.

Please note that the time period of this thesis only runs to the end of 1980. The delay is due to the difficulty in obtaining updated government documents in this field as well as pressing commitments on my time from other sources.

CHAPTER I

THE EARLY SCIENTIFIC PROGRAMS (1957-1969)

The most striking feature of Canadian activities in space during this period from 1957 to 1969 was the extreme fragmentation of space activities across the country and between various federal government departments. Scientists and technicians were at work in nearly every province of Canada. The technological infrastructure consisting of installations for launching vehicles by rocket or gun, radar facilities, tracking stations, radio stations for communicating with satellites, and laboratory facilities were widely distributed across the nation. The result was a complicated fragmentation of jurisdiction and functions resulting in an appearance of a "grass roots" activity.[1]

A profile of the Canadian space infrastructure in 1966, in terms of levels of expenditures, gives one an illustration of this fragmentation. In 1965-66, the total level of expenditure in Canada on space scientific research and development projects was about $30 million. The federal government spent $17.5 million on space projects, the United States government spent $4.5 million, and $6 million was spent by private industry. The total number of scientific, engineering, and technicians numbered about 1,500.[2]

The federal government had 15 major government-supported programs in operation at this time.[3] This jurisdiction was divided between the Defence Research Board, the National Research Council, the Department of Industry, the Department of Transport, and Atomic Energy of Canada Limited. Responsibilities for space programs were assumed by various government departments under their usual terms of jurisdiction.[4] Therefore, the Defence Research Board based its jurisdiction on defence research, the National Research Council through its university support program, the Department of Transport through its administration of the Radio Act and so on.[5]

Canadian activities in space during this period can be divided into three sectors. The first sector was the purely scientific interest in the upper atmosphere and space which had been undertaken from the ground and later from balloons, rockets and satellites. The second sector was the technical infrastructure which involves the provision of the rockets, small satellites and the launching facilities required with an emphasis on the development of a space industry and the new space technology involved. The third sector dealt with the combination of satellite technology with communications technology to develop satellite telecommunications. It should be noted that the federal government was deeply involved in each of these areas in terms of government programs.

The first sector of Canadian activities in space during this period was the purely scientific interest in the physics of the upper atmosphere, especially in the ionosphere. The federal government departments that took the lead in the development of scientific programs in this area were the Defence Research Board and the National Research Council. A brief summary of their activities will be outlined.

Beginning in 1947, the Defence Research Board conducted an active research program in the physics of the upper atmosphere and space. This began with ground-based radio measurements and by ground-level and balloon-borne optical measurements.[6] The launching of Sputnik I on October 4th, 1957 created a strong impression amongst scientists at the Defence Research Board. These scientists immediately realized the potential of this new space technology to extend present ionospheric research to high frequency communications in this region. A policy decision was made by the Defence Research Board to explore the possibilities of doing so.[7]

During the International Geophysical Year (IGY) in 1957, rockets were used by the Defence Research Board to investigate spectroscopic and ionic characteristics of the upper atmosphere. An important phase of this scientific research was directed towards improving communications through an understanding of the physics of the ionosphere. To this end, several ground-based measurements using radio wavelengths from a few mm to many km were made in conjunction with rocket and satellite measurements. These scientific experiments involved a study of the absorption, reflection, partial reflection, scattering, dispersion and polarization of radio waves emitted from a transmitter as well as those of natural origin. A parallel and complementary program of communications research also proceeded at the same time.[8]

The Defence Research Board built the Prince Albert Radar Laboratory (PARL) to carry out a specific program of ionospheric research with a defence orientation. The laboratory comprised a high-power ultra-high-frequency radar capable of being used for researches in radio propagation and to track rockets and satellites at long range. The Prince Albert Laboratory also had a number of accessory facilities for recording variations in ionospheric conditions and fluctuations in the earth's magnetic field.[9]

The key program that was undertaken by the Defence Research Board was the Alouette-ISIS program in which the satellites involved were built entirely in Canada. In 1959, an agreement was reached between the Defence Research Board and the National Aeronautics and Space Administration (NASA) in the United States.[10] The agreement stated that the Defence Research Board would build and NASA would launch a top side sounder in a satellite to obtain information on the upper side of the atmosphere, which could not be obtained by ground-based measurements.[11]

The Canadian content of the program was to design an ionospheric sounder for installation in a satellite and to construct three engineering models.[12] The Defence Research Board was also supposed to provide in Canada ground-based telemetry and recording apparatus for recording satellite sounding signals and to exchange copies of all ionograms with cooperating agencies as they were produced.[13] The American content of the program was to have NASA provide the launch vehicle.[14]

Following the formation of this agreement, work began at the Defence Research Board on the design of such a satellite in January 1960. The satellite, known as Alouette I was fabricated and integrated in the laboratories of the Defence Research Board which had program responsibility. The scientific satellite was launched on September 29th, 1962 into a 1000-km circular orbit at an inclination of 80 degrees. It contained four experiments consisting of the topside sounder, a cosmic-noise experiment, a very low frequency (VLF) receiver, and an energetic particle experiment.[15]

Alouette I was the first scientific satellite designed and built entirely by a nation other than the United States or the Soviet Union. It was also the first spacecraft to be equipped with the long extendible, storable, tubular, extendible member (STEM) antennas which have since become standard elements of the space programs of many other nations.[16] Alouette I had the task to measure and report on phenomena in the earth's upper atmosphere, providing a kind of radar map of the ionosphere from above.

Alouette I had a design life-expectancy of one year but the satellite lasted ten years. Alouette I contributed to the advancement of global information about the upper regions of the ionosphere.

Following the successful launch of Alouette I, agreement was reached in 1963 between the Defence Research Board and NASA to embark on a joint program of launching four more satellites, which would constitute the ionospheric research satellite program of both the United States and Canada.[17] This scientific program was to be known as the International Satellites for Ionospheric Studies (ISIS) program. The general objective of the ISIS program was to conduct comprehensive studies of the ionosphere by extending the scope of the Alouette I mission both in altitude coverage and in the number of ionospheric parameters investigated.

The approval of the Canadian government to the ISIS program was made contingent on the full participation of Canadian industry. The aim was that by the end of the program a skilled industry would exist in Canada for designing and building spacecraft. A special vote by the Canadian Parliament was provided to fund the ISIS program.[18] Therefore, funding of the program by the Canadian government in 1963 was contingent upon the creation of a space technological and industrial infrastructure in Canada.

Design work on Alouette II began at the Defence Research

Board in March 1963. Meetings were also held to inform Canadian industry with details of the program. The Defence Research Board and the Department of Defence Production also held meetings to select suitable companies for the manufacture and design of the satellite. The RCA Victor Company Limited in Montreal was selected as prime contractor, and the de Havilland Aircraft of Canada Limited in Toronto was selected as sub-contractor. Industrial personnel commenced design work with Defence Research Board personnel in September 1963.[19]

Alouette II was launched on November 29th 1965, into a 515-km by 2900-km orbit. A sister satellite, Explorer XXXI, was launched by the same launch vehicle and in nearly the same orbit as Alouette II. The purpose of the dual launch was to permit nearly simultaneous comparisons between the scientific data obtained by the sounder, VLF, and electrostatic probe experiments in Alouette II and the probes in Explorer XXXI, and to provide ion and electron temperature and ion composition data at the height of the satellite for use with the sounder data.[20]

Design work on ISIS I commenced in March 1964. The Defence Research Board retained responsibility for the spacecraft system design, command system design, and the spin maintenance and attitude control system design. The prime contractor, the RCA Victor Company Limited, was made responsible for the design of the other systems including sounder electronics, telemetry, power, spacecraft construction and ground support systems. The prime contractor was also responsible for the construction, integration and testing of the spacecraft. One engineering model had to be built for testing purposes.[21]

ISIS I was launched on January 30th, 1969 into a 90 degree inclination orbit of 575-km perigee and 3315-km apogee. ISIS I was designed to carry 10 experiments in the spacecraft. These experiments included a swept frequency sounder, a fixed frequency sounder, a very low frequency VLF receiver, a cosmic-noise experiment, energetic particle detectors, a soft electron spectrometer, a cylindrical electrostatic or Langmuir probe, an ion probe, an ion mass spectrometer, and a very high frequency (VHF) beacon.[22]

Design work on ISIS II commenced in December 1966 with the prime contractor selected to be the RCA Victor Company Limited. The prime contractor was made responsible to the Defence Research Board for all aspects of design, construction, integration, and testing of the spacecraft. Twelve experiments were to be carried on the spacecraft of which ten experiments were to perform the same measurements as those on ISIS I. The remaining two experiments dealt with the behavior of certain optical lines in the aurora.[23]

On April 1, 1971, ISIS II was launched into a near-circular orbit of 1356-km perigee and a 1423-km apogee. As the most advanced scientific ionosphere satellite, ISIS II expanded the frontiers of knowledge of the aurora borealis in its measurements of light radiation in the upper atmosphere.

The missions of Alouette I and II are now finished, since both satellites remained operational for nearly ten years. The missions of ISIS I and II were extended through and ended at the end of 1979. Specialized ISIS projects were undertaken at the University of Calgary in Alberta, as well as the Aerospace Products Division of SED Systems Limited, Saskatchewan.

Because of the increasing importance of communications satellites, the plans for ISIS III were cancelled. The plan for the ISIS III satellite was to put it into a highly eccentric orbit reaching out to between 6 and 10 earth radii in order to study the ionosphere out to the magnetospheric boundary.[24] The joint Canada-U.S.A. Hermes program took precedence over the final phase of the ISIS program.

As a direct result of the Alouette I and the ISIS programs, a team of scientists and engineers was developed at the Defence Research Board that was skilled in reliable spacecraft design in both its mechanical and electrical aspects, and that was accustomed to operating with private industry in Canada and the United States. Also, the Defence Research Board personnel became accustomed to dealing with NASA and to using advanced management systems in coordination with that body.[25]

In summary, the Alouette I and the ISIS programs made an extremely important contribution to the scientific knowledge of the environment in which radio communications takes place. These programs also set up the Canadian technological infrastructure that was required for advanced communications satellite technology.[26]

The National Research Council also had a long-standing interest in ionospheric physics, including meteor physics.[27] An early pre-Sputnik interest in cosmic-ray research was expanded into extensive measurements of energetic particle fluxes in the auroral ionosphere over Churchill, Manitoba, using rockets and satellites. A number of rockets containing instruments to study electron densities and temperatures, were flown. Other rocket experiments counted the number of micrometeorites encountered. In a related experiment, auroral radars were operated at a number of northern stations during the International Geophysical Year of 1957.[28]

One of the early National Research Council programs involved the reception of satellite telemetry transmissions. Beginning with a project undertaken for Professor J. Van Allen to record the transmissions from the Injun III and Injun IV satellites in 1961 and 1962 the work progressed through a series of measurements with the Alouette I satellite to later work with weather satellites.[29]

A major responsibility of the National Research Council during this era was in the provision of the engineering support necessary for the rocket experiments carried out by its own staff and by the universities. The National Research Council also operated the Churchill Research Range and gave financial support to university upper-atmosphere and space research.

The second sector of Canadian activities in space during this period was in the area of the technological development of rocket and satellite technology and the development of a specialized Canadian private industry to manufacture these products. This sector in Canadian space activity consists of rocket and satellite development and production activity.

The Alouette I and ISIS programs generated a considerable capability in satellite technology. General design and development work initially began in Defence Research Board laboratories but the bulk of the work was later contracted to the de Havilland Company in Toronto and the RCA Victor Company Limited in Montreal. The result was a satellite manufacturing capability that was capable of designing, constructing, and testing complex spacecraft of a moderate size. This result was due to a policy decision by the federal government in 1963 to transfer space technology from government laboratories to Canadian private industry. This policy decision was reflected as a condition of approval by the federal government for the ISIS program.

Since 1960, RCA Victor Company Limited made a progressively stronger commitment to space work. This industrial program covered 34 programs of space research, 7 programs of design and manufacture of satellite systems, and 16 programs of design and/or manufacture of earth station systems in support of satellites. This space activity was conducted mostly from 1961 until 1966. In this period, space work at RCA Victor was performed for 31 separate agencies for a total value of almost $29 million. Almost $9 million of space work was performed by RCA Victor in 1965. RCA Victor divided its space activities into three major areas: space research; satellite work; and earth-based facilities in support of satellites.[30]

Satellite work started at RCA Victor in 1961 with the development and manufacture of simulators, beacons and repeaters for the American Relay communications satellite. This was followed by the design, development and production of solid-state FM telemetry transmitters for the Alouette I and Explorer XX satellites.[31] Therefore, the foundation of satellite communications electronic development was established at a very early period in the space age at RCA Victor.

In September 1963, RCA Victor was granted the prime contractor role for the Alouette II and ISIS I satellites. Activities on the Alouette II involved the development and manufacture of telemetry and tracking transmitter equipment, as well as assisting the Defence Research Board in phases of design, construction, testing and launching of the spacecraft. On the ISIS I satellite, RCA Victor carried the management responsibility for spacecraft design, development, manufacturing, integration, test and launching of the spacecraft. Major portions of the contract were sub-contracted, but the final satellite was integrated and prepared for launching at RCA Victor facilities. The same method was involved in the ISIS II satellite.[32]

Facilities for the design and manufacture of satellite systems at RCA Victor included a special engineering office and laboratory, a "clean" spacecraft integration area, special test equipment, and a spacecraft component assembly area. In addition, there was an environmental test laboratory which contained equipment capable of testing components and systems through space environmental requirement.[33] Therefore, the Alouette I and ISIS programs helped generate the skills and facilities necessary for RCA Victor to meet the requirements of the space age.

Activities related to satellites began in 1960 at the de Havilland Aircraft of Canada Limited in Toronto. These activities began with the formation of the Alouette I satellite contract with the Defence Research Board. The contents of this contract involved the design, development, manufacture and test of the Alouette I spacecraft structure and its associated sounder antennas.[34] In the period from 1960 to 1966 this company carried out over \$6 million in space business, of which \$4.3 million was for export business.

One notable result of the Alouette I program was the development of a family of devices known as the Storable Tubular Extendible Member (STEM) which has been used on more than 100 satellites. The unique sounder antenna requirements of the Alouette I program led de Havilland to exploit a concept, originally devised by a Mr. George Klein of the National Research Council, for unfurling long over-lapped metal tubes stored as a flat tape on a drum in the satellite. STEM devices have been used for a broad variety of applications. Most notably, STEM devices have been used on the manned Mercury, Gemini, and Apollo programs.[35]

Beginning in 1963, de Havilland was the sub-contractor for the ISIS program, with RCA Victor as the prime contractor. The contractual responsibilities of de Havilland centered around the spacecraft structure (as in Alouette I), but were extended to complete spacecraft structural layout and design, thermal design, antenna design, orbit calculations and vehicle dynamic analysis.[36]

For the Alouette II spacecraft, de Havilland provided manufacturing services, sounder antennas and support personnel at the Defence Research Board and at the launching range. For the ISIS I spacecraft, the structure and mechanical devices, including handling and support equipment, were built, tested and integrated by de Havilland, and personnel were provided on a continuing basis in the Systems Management Office at RCA Victor. De Havilland also provided staff for the satellite payload terms which followed the spacecraft through assembly, integration, testing and launching.[37]

It should be noted that it was a specialized section of de Havilland that carried out all of the above space activities. This special group was known as the Special Products and Applied Research Division of de Havilland. This small group later formed the basis of SPAR Aerospace Limited which took its initials from the old de Havilland group dealing with aerospace matters.

Another notable company that was involved in space activities at this time was Bristol Aerospace Limited which was involved in the development of the Black Brant rockets. Bristol Aerospace Limited, in close cooperation with the Defence Research Board, developed a family of commercial sounding rockets to explore the upper atmosphere. Black Brant rockets were used for the Canadian research program for the upper atmosphere, and were sold to various organizations in the United States and West Germany. Over one hundred Black Brant rockets were sold covering an altitude range of between 100 and 600 miles and carrying payloads of 40 to 500 lbs.[38]

A number of companies became involved in space activities during this era. These companies which helped to form the nucleus of a growing Canadian aerospace industry included the following: Computing Devices of Canada Limited, Aviation Electric Limited, EMI Cossor Limited, Canadair Limited, CAE Industries

Limited, Canadian Westinghouse Limited, Sinclair Radio Laboratories Limited, Ferranti-Packard Electric Limited, Barringer Research Limited, Canadian Industries Limited, and the Bell Telephone Company of Canada Limited. Some of these industrial programs have been research and development cost sharing programs with the federal government, some have been on domestic space projects, some have been export sales, and others have been purely private domestic sales.[39]

The third sector of Canadian activities in space during this period dealt with the combination of satellite technology with communications technology to develop satellite telecommunications. The use of satellite communications, in order to improve Canada's telecommunications, came under a great deal of study by the federal government and private industry during this period. These organizations had an understanding, early in the space age, of the possibilities of using satellites to link Canada's isolated communities into the national telecommunications network.

The Canadian government department which took the lead in this area was the Department of Transport. The Department of Transport had legal jurisdiction for the administration of the Radio Act. The Department of Transport, under this Act, regulated and controlled radio transmission and reception in Canada, and assigned radio frequencies to users. Following the success of the American satellite communication projects, Telstar and Relay, the Department of Transport entered into an agreement with NASA in April 1963 to participate in the testing of experimental communications satellites launched by NASA.[40]

This Memorandum of Understanding of August 1963 included an obligation by the Department of Transport to build an earth station which was built near Mill Village, Nova Scotia, roughly 80 miles southwest of Halifax.[41] The technical design of this experimental communications satellite ground station was based on the use of the NASA Applications Technology Satellite to be launched in 1965. RCA Victor Company Limited was selected as the prime contractor for systems integration. One requirement of this program was a "significant" Canadian content and engineering involvement in the program. Construction and testing of the experimental communications satellite ground station was completed by RCA Victor in February 1966.[42]

The Canadian telephone industry also showed an early interest in the development of satellite technology for satellite telecommunications. This industry showed a precise interest in providing telephone, teletype and TV service to northern communities in Canada. In 1965, Bell Canada and Northern Electric agreed to undertake a technical and economic study to be made of a satellite telecommunications system in Canada's Far North.[43] This study culminated in a joint decision in mid-1966 to proceed on an experimental basis to develop an unattended Arctic earth station for field trial at Bouchette, Quebec. Bell Canada set down the design specifications for this earth station and Northern Electric was sub-contracted to make a design to meet these specifications and to manufacture an earth station prototype to be installed at Bouchette.[44]

The northern Canadian environment creates extremely unique conditions for the system design of a telecommunications system. This is due to the harsh weather conditions, the remoteness and the smallness of the communities to be served, and low circuit requirements. Bell Canada had an early appreciation of the capability of a communications satellite system for the Far North.

Beginning in late 1966, private industry and the federal government began to show an interest in a domestic satellite telecommunications system for Canada as a whole. The end result of this explosion of proposals and government preparatory studies was the creation of Telesat Canada as we know it today.

Private industry had an early interest in a satellite telecommunications system to serve domestic markets. In October 1966, at the hearing of the Board of Broadcast Governors on the use of ultra-high frequency television bands, an important proposal was made. Niagara Television Limited and Power Corporation of Canada Limited proposed to set up a satellite telecommunications system to distribute television programmes for a third television network.[45] In March 1967, the Trans-Canada Telephone System and Canadian National/Canadian Pacific

Telecommunications placed a specific proposal for a domestic satellite communications system before the federal government.[46]

In September 1967, the RCA Victor Company Limited of Montreal Issued a proposal setting up precise design requirements for a communications satellite within the capabilities of Canadian industry.[47] In January 1968, Northern Electric announced an agreement with Canadair Limited, of Montreal, P.Q. and Hughes Aircraft of Los Angeles, California, to form a group to design and build satellite communications equipment.[48]

The federal government undertook a number of preparatory studies in recognition of the growing possibilities of domestic satellite communications system. The Science Secretariat of the federal government's Privy Council Office commissioned in May 1966, a report entitled "Upper Atmosphere and Space Programs in Canada." This report was published in February 1967.[49] It was followed by a Science Council report entitled "A Space Program for Canada" in July 1967.[50] Both of these federal government reports urged action to secure the allocation of frequencies and orbital positions for a Canadian domestic communications satellite system. Both reports also endorsed the capability of Canadian private industry to undertake the manufacture and design of all of the important elements of such a communications system.[51]

Due to increasing interest in the subject matter of a domestic satellite telecommunications network, in July 1967. the Canadian Prime Minister, Lester B. Pearson, announced the creation of a special Task Force on this matter to be under the jurisdiction of the Science Secretariat of the Privy Council Office. The specific mandate of the Task Force was to advise the federal government on satellite policy in general and, in particular, on the use of satellite technology for domestic communications.[52]

The findings of the federal Task Force and its recommendations were submitted to the federal government early in November 1967. Finally, a White Paper entitled "A Domestic Satellite Communication System for Canada"[53] was published on March 28th, 1968. This White Paper as a policy paper helped form the legislation that created Telesat Canada.

To summarize this chapter, the federal government made several important decisions from 1957 to 1969 as part of this period of scientific programs. In 1963, the federal government approved the ISIS program with the implied condition that related space technology would be developed by Canadian industry instead of the government facilities.[54] In 1969, the federal government decided that Canadian space programs should be transferred from ionospheric research to satellite communications technology programs.[55]

In 1969, the federal government finally took a tentative step towards establishing some form of government machinery to coordinate space activity through the creation of the Interdepartmental Committee on Space. This was an effort to create a body to review and coordinate and review Canadian space activity, recommend plans and proposals, consider federal government space policy, and recommend the optimum use of resources. This ad hoc committee has a mandate to coordinate the various federal government interests in activities in relation to the upper atmosphere and space. However, this interdepartmental committee has limited powers and is not the equivalent to a centralized space agency.[56]

In 1969, the Telesat Canada Act was passed by the Parliament of Canada which marked the end of this period of scientific exploration of the ionosphere and the beginning of the era of satellite communications.[57] The Telesat Canada Act directed the company to utilize to the extent that is commercially practicable, Canadian research, design, technology and facilities in research and development connected with its satellite systems.

These four decisions from 1963 to 1969 helped bring Canada from its early stage of scientific exploration of the upper atmosphere to the threshold of commercial satellite communications. The federal government developed the space industry during this period and finally set up a government committee to coordinate Canada's activities in space. This government machinery was set up to deal with the growing participation of Canada in space activities.

The next chapter will trace the scientific research and development programs that followed the programs of the 1960's. One program was the Hermes program which demonstrated the capability of high-powered television transmission in the 14/12 GHz frequency bands. Scientific research and development programs had gone beyond the primitive and elementary stages of satellite communications to a more refined stage of direct broadcasting by satellite.[58] Clearly, more advanced forms of satellite communications were to be developed upon the basic knowledge of satellite communications acquired in the 1960's.

FOOTNOTES TO CHAPTER I

[1] A Space Program for Canada, Report No. 1, Science Council of Canada, O.M. Solandt, Chairman, (Ottawa, Canada: Queen's Printer, 1967), paragraph 56.

[2] Ibid., paragraph 62 for the expenditures and personnel numbers.

[3] Ibid., paragraph 63. Accompanying Table 1 in Appendix 1 of this thesis.

[4] These usual terms of jurisdiction were usually based on administrative powers derived from specific legislation or from the customary division of Cabinet departments. An example of specific legislation is The Science Council of Canada Act which requires the Council to make recommendations on scientific research and development according to Sections 11 and 13 of this Act.

[5] J.H. Chapman, P.A. Forsyth, P.A. Lapp and G.N. Patterson. Upper Atmosphere and Space Programs in Canada, Special Study No. 1, Science Secretariat, Privy Council Office, (Ottawa, Canada: The Queen's Printer,,1967), pp. 65-66.

[6] Ibid., p. 5. At first, the Defence Research Telecommunications Establishment (DRTE) which is part of the Defence Research Board carried out ground-based radio measurements. Then the Canadian Armament Research and Development Establishment (CARDE) also a part of the Defence Research Board carried out ground-level and balloon-borne optical measurements.

[7] Roy Dohoo, Canada's satellite policies and how they grew, In Search, Vol. VI, No. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring, 1979), p. 14. To be more precise, scientists at the Defence Research Telecommunications Establishment (DRTE) of the Defence Research Board were the group involved. The Defence Research Board then made a policy decision as a result of their inputs.

[8] J.H. Chapman et al., Upper Atmosphere and Space Programs in Canada, Special Study No. 1, Science Secretariat, Privy Council Office, (Ottawa, Canada: The Queen's Printer, 1967), pp. 5-6.

[9] Ibid., p. 6.

[10] J.H. Chapman. A copy of this agreement can be found in Upper Atmosphere and Space Programs in Canada, pp. 135-137.

This agreement actually was in the form of three Letter Agreements that were made between Dr. A. Hartley Zimmerman, Chairman of the Defence Research Board and Dr. T. Keith Glennan, Administrator of NASA. The three Letter Agreements were dated August 25th, 1959, November 18th, 1959, December 16th, 1959. Therefore, these international agreements were inter-governmental agreements on the department or agency level. Since November 13th, 1958, discussions were undertaken between personnel of DRTE, the Defence Research Board, the Office of the Canadian Defence Research Member in Washington, D.C., and NASA concerning an ionospheric topside sounder satellite project. On December 31st, 1958, NASA received a DRTE proposal on this subject-matter from the Office of the Defence Research Member in Washington, D.C. In answer, on March 11th, 1959, Dr. T. Keith Glennan, Administrator of NASA indicated approval of this project in general terms but the details were left to be worked out in the three Letter Agreements.

[11] J.H. Chapman. Upper Atmosphere and Space Programs in Canada, pp. 135-137. The letter Agreement of August 25th, 1959 from Dr. A. Hartley Zimmerman, Chairman, Defence Research Board contains a five-point summary of the Canadian contribution in paragraph two. The Letter Agreement of November 18th, 1959 from Dr. T. Keith Glennan of NASA contains a four-point summary of NASA's contribution in paragraph three.

[12] Ibid., p. 135. The Letter Agreement of August 25th, 1959 from Dr. A. Hartley Zimmerman, Chairman, Defence Research Board stated the Canadian content in paragraph two in items (a) and (b). It should be noted that one engineering model was for installation in the satellite, one engineering model was a spare, and one engineering model was for testing to destruction.

[13] Ibid., items (c), (d), (e).

[14] Ibid., p. 136. The Letter Agreement of November 18th, 1959, from T. Keith Glennan, NASA Administrator stated the NASA content in four points in paragraph three. NASA agreed to provide the launch vehicle in item 2. Item 1 dealt with sounding rockets to test and Canadian satellite prototype instrumentation. Items 3 and 4 dealt with the subject-matter of satellite ionograms.

[15] Ibid., p. 11 and pp. 42-43. General design work on the satellite initially began at the Defence Research Board between Government scientists and industry scientists and engineers in January 1959. The Alouette I satellite was built in the technical facilities of the Defence Research Board in Ottawa. De Havilland of Canada received an 'outside' contract to build the spacecraft structure and its associated sounder antennas but the entire satellite was integrated at the Defence Research Board.

[16]Ibid., pp. 43-44.

[17]J.H. Chapman et al., pp. 138-143. A copy of this document can be found in Upper Atmosphere and Space Programs in Canada. The agreement between the Defence Research Board and NASA was based on a Memorandum of Understanding concluded between the two government entities on December 23rd, 1963. The agreement was confirmed between the Canadian government and the United States government in an Exchange of Notes on May 6th, 1964. The legal reference for both agreements is the Canada Treaty Series 1964 No. 6.

The agreement to launch four more satellites is contained in article 2 of the Memorandum of Understanding of December 23rd, 1963.

In 1966, it was estimated that the Alouette I and ISIS programs would cost an estimated total of about $32,250,000 (CAN.) for the Defence Research Board of Canada, but this should be reduced by $7.5 million (CAN.) due to the cancellation of ISIS III - see p. 133 of J.H. Chapman et al.

[18]J.H. Chapman et al., p. 11. Upper Atmosphere and Space Programs in Canada. The provisions for Canadian content are contained in article 4 of the Memorandum of Understanding of May 23rd, 1963.

[19]Ibid., p. 12. The term "associate prime contractor" which is used in The Chapman Report in relation to de Havilland is incorrect. On page 43 of the Chapman Report, this term is replaced by "associate contractor". In an examination of what the contractual responsibilities of de Havilland were, it is obvious that the company merely had a sub-contract to build specified sub-systems that was awarded to them by the Defence Research Board. However, RCA Victor Company Limited in Montreal still had overall prime contractor responsibility. In none of the SPAR Aerospace materials does one find the terms "associate prime contractor" or "associate contractor". Indeed, on page 41 of The Chapman Report, the term "sub-contracted" is used in relation to the same subject matter.

[20]Ibid., p. 12.

[21]Ibid., p. 12 and p. 43.

[22]Ibid., p. 12.

[23]Ibid., p. 13.

[24]Ibid.

[25]Ibid.

[26]Ibid.

[27]This interest is longer than that of the activities of the Defence Research Board which places the National Research Council activities beginning at least in 1946.

[28]J.H. Chapman et al., <u>Upper Atmosphere and Space Programs in Canada</u>, pp. 7-8.

[29]<u>Ibid</u>., p. 8.

[30]<u>Ibid</u>., pp. 39-41. The RCA Victor Company Limited satellite work from 1960 to 1966 is valued at $10.8 million, of which about $2 million was for U.S. programs and the balance was for Canadian programs. Figures are not available for the period from 1967 onwards on the ISIS program.

[31]<u>Ibid</u>., pp. 40-41.

[32]<u>Ibid</u>., p. 41.

[33]<u>Ibid</u>.

[34]Ibid., pp. 42-43. Despite the confusion of The Chapman Report, this contract was a sub-contract in relation to the project. See Footnote 19 in relation to this point of confusion.

[35]<u>Ibid</u>., pp. 43-44.

[36]<u>Ibid</u>., p. 43.

[37]<u>Ibid</u>.

[38]<u>A Space Program for Canada</u>, Report No. 1, Science Council of Canada, O.M. Solandt, Chairman, (Ottawa, Canada: Queen's Printer, 1967), paragraph 88. To be more precise, the Defence Research Board acted through the Canadian Armament Research and Development Establishment (CARDE) as well as the Department of Industry, on the basis of commercial export potential.

[39]<u>Ibid</u>., paragraphs 96-97.

[40]J.H. Chapman et al. A copy of this document can be found in <u>Upper Atmosphere and Space Programs in Canada</u>, pp. 155-157. The agreement between the Department of Transport and NASA was in the form of a Memorandum of Understanding dated April 25th, 1963 and signed by J.R. Baldwin of the Department of Transport and H.L. Dryden of NASA. This agreement was formally confirmed by an Exchange of Notes between representatives of the Canadian and U.S. governments on August 13th, 1963 and August 23rd, 1963. The legal reference for both agreements is the Canada Treaty Series 1963 No. 13.

[41]J.H. Chapman et al. Upper Atmosphere and Space Programs in Canada, p. 157. A legal obligation to build "a ground station to receive and/or transmit television and multichannel telephonic or telegraphic signals" is contained in paragraph two of the Memorandum of Understanding of April 25th, 1963. The Department of Transport subsequently selected the site of Mill Village, Nova Scotia.

[42]Ibid., pp. 14 and 42. The total amount spent by the Department of Transport for the Mill Village project was about $13 million, according to a statement on page 133. The reference to Canadian content is not specifically stated in the inter-governmental agreement. Mr. J.H. Chapman is apparently referring to a policy objective of the Department of Transport.

[43]Ibid., p. 47.

[44]Ibid., pp. 45-46.

[45]C.M. Drury, Minister of Industry. White Paper on "A Domestic Satellite Communication System for Canada", (Ottawa, Canada: Queen's Printer, 1968), p. 38.

[46]Ibid. The TCTS/CNCP proposal is discussed in greater detail in Chapter IV of this thesis.

[47]Ibid.

[48]Ibid. The exact nature of this agreement is not detailed. This seems to be a consortium which is defined as an association of financiers or companies formed for a particular purpose. The companies retain their individual legal personality unless they form a new company which will be legally responsible for the common activities. Forming a separate company is the only way to avoid the individual responsibility of these companies.

[49]This report is also known as 'The Chapman Report'. This was a technical study which was commissioned by the Science Secretariat of the Privy Council Office in May 1966. The members of the technical study group were J.H. Chapman, P.A. Forsyth, P.A. Lapp and G.N. Patterson. The terms of reference of 'The Chapman Report' are stated on page v of its preface. Public hearings were held across Canada from June 30th to October 31st, 1966. A total of 112 briefs were received. The technical study was presented to the Science Council of Canada on January 16th, 1967. The technical study was published in February 1967.

[50] This report was submitted by O.M. Solandt, Chairman of the Science Council of Canada to Prime Minister Lester B. Pearson on July 4th, 1967. The terms of reference of this report are stated in paragraph 6 of the report. The basis of issuing this report are Sections 11 and 13 of the Science Council of Canada Act. This report took into account the comments and recommendations of 'The Chapman Report' but the Science Council did not formally endorse them in paragraph 7 of the Science Council Report. No reason was given.

[51] C.M. Drury, White Paper on A Domestic Satellite Communication System for Canada, p. 38.

[52] Ibid., p. 78. This page describes the precise terms of the Task Force. A government Task Force differs from a formal royal commission in several important respects. The federal Cabinet appoints a royal commission under the Inquiries Act which is usually composed of one or more members who are selected for their special qualifications and for their objectivity and detachment from politicians and public servants of the Canadian government. A Task Force is usually composed of outside experts as well as public servants and politicians. A Task Force does not have the strict standards of political objectivity and lacks the formal procedures of a royal commission. Usually a Task Force is the preliminary step towards a change of government policy whereas a royal commission will make a decision as to whether a change of policy is necessary.

[53] C.M. Drury, Minister of Industry. White Paper on A Domestic Satellite Communication System for Canada, (Ottawa, Canada: Queen's Printer, 1968).

[54] The Canadian Space Program; Five-Year Plan (80/81-84/85) Serial No. DOC-6-79DP Discussion Paper, Department of Communications, Government of Canada, January 1980, p. 16.

[55] Ibid.

[56] Nicolas Mateesco Matte, Space Policy and Programmes, Today and Tomorrow, Institute and Centre of Air and Space Law, (McGill University, Montreal, Canada: 1980), pp. 84-85. The membership of the Interdepartmental Committee on Space (ICS) consists of the following: the National Research Council; the Ministry of State for Science and Technology; the Department of Communications; the Department of National Defence; the Department of Industry, Trade and Commerce; the Department of Energy, Mines and Resources; the Department of Fisheries and Oceans; the Department of the Environment; the Department of External Affairs. The Treasury Board and the Department of National Health and Welfare are observers.

[57]The Canadian Space Program; Five-Year Plan (80/81-84/85) Serial No. DOC-6-79DP Discussion Paper, Department of Communications, Government of Canada, January 1980, p. 16.

[58]For a detailed legal analysis of the international regulation of direct broadcasting by satellites see Paul Fauteux, Pour une réglementation internationale de LA RADIO-DIFFUSION directe par SATELLITES, Annals of Air and Space Law, Volume V, Institute and Centre of Air and Space Law, McGill University, Montreal, Canada, 1980, pp. 427-447. One can also study his document prepared under a grant by the Social Sciences and Humanities Research Council of Canada in the Spring of 1980 entitled "La radiodiffusion directe par satellites: une impasse significative dans l'encadrement juridique des relations internationales".

CHAPTER II

HERMES—THE EVOLUTION OF 14/12 GHz TECHNOLOGY (1969-1979)

On January 17th, 1976 the Communications Technology Satellite (Hermes)[1] developed jointly by the United States and Canada, was launched into geostationary orbit in order to begin a series of user-oriented applications experiments. This launch culminated nearly seven years of intensive planning and preparation on the part of NASA and the Department of Communications of Canada (DOC).[2] The principal purpose of the program was to demonstrate the feasibility of high-powered television transmission in the 14/12 GHz frequency bands and to provide users with additional opportunities for experimentation. The spacecraft is viewed as the forerunner of the direct-to-home and direct-to-community satellites of the future.

Planning for the project began in 1969 when Canadian officials decided to focus space research and development in the field of direct broadcasting by satellite. Canadian officials contacted the Office of International Affairs of NASA about the possibility of conducting a joint communication satellite experiment to pioneer the use of the 14/12 GHz frequency bands, which had been recently allocated for satellite broadcasting experimentation. NASA agreed to the Canadian proposal and after two years of complex negotiations, a formal Memorandum of

Understanding was signed by the Department of Communications and NASA.[3] NASA readily accepted the Canadian proposal that the last satellite of the ISIS program be cancelled and that funding be placed into the development of the new experimental communications satellite.

The Memorandum of Understanding, signed on April 20th, 1971, outlined the responsibilities of NASA and the Department of Communications. The Department of Communications took on the responsibility to design, build and operate the spacecraft. The Communications Research Centre (CRC) of the Department of Communications was the design authority and the prime contractor for the Hermes satellite.[4]

NASA undertook to provide the launch vehicle, the high-power travelling-wave-tube amplifier, spacecraft environmental test support, and launch and operational support to place the satellite in geo-stationary orbit. NASA's Lewis Research Centre (LeRC) in Cleveland, Ohio, was designated as the responsible American agency.[5]

In May 1972, an agreement was signed between the Department of Communications and the European Space Research Organization, (ESRO) now the European Space Agency (ESA), under which ESRO agreed to develop an extendible solar blanket and associated solar cells as well as two 20 Watt travelling-wave-tube amplifiers and a parametric amplifier.[6]

Both the Department of Communications and NASA agreed to carry out an experimental program in satellite communications. As a consequence of this, NASA and the Department of Communications set up a procedure whereby invitations were sent to organizations in the United States and Canada respectively to tender communication experiment proposals.[7]

The objectives of the program in relation to the technical configuration of the spacecraft were as follows:

(1) Develop and flight-test a high power travelling-wave-tube amplifier (TWTA) having greater than 50% efficiency with a saturated power output of 200 Watts at 12 GHz.

(2) Develop and flight-test a lightweight extendible solar array with an initial power output greater than 1 kW.

(3) Develop and flight-test a 3-axis stabilization system to maintain accurate antenna boresight positioning on a spacecraft with flexible appendages.

(4) Conduct satellite communications experiments using the 12 and 14 GHz bands and low-cost transportable ground terminals.[8]

At the Fourth Communications Satellite Systems Conference, held in April 1972, three general technical objectives for the program were formulated. The first was to test the effectiveness of the 12 GHz band for downlink transmissions to small, low-cost earth stations. A second related objective was to demonstrate the feasibility of uplink television transmission at 14 GHz from transportable earth stations. The third objective was to test experimental spacecraft subsystems and components which could be used in possible future communication satellite systems.[9]

The United States and Canada devised their own methods for soliciting proposals for experiments. In the United States, NASA, specifically the Office of Applications, issued a notice of experimental opportunity to federal agencies, corporations, and universities, and invited interested parties to submit short letters indicating their intent to propose an experiment.[10]

Those parties indicating interest in the project were provided with information concerning prior experiments on ATS-1, 3, and 5, and were subsequently briefed concerning the specific requirements for experimentation with Hermes. Finally, those groups who wished to be considered for participation in the US portion of the program submitted proposals detailing their program plan, overall goals, terrestrial requirements and evaluation plans.[11]

To assess the merits of each experiment, NASA set up a screening mechanism consisting of an evaluation panel composed of specialists in the fields of space technology and social service satellite applications. Each experiment proposal was evaluated to determine whether the experiment was designed to contribute to the solution of a significant social problem and whether use of satellite facilities was essential to the objectives of the proposed experiment.[12]

The evaluation panel also reviewed the proposals to assess the financial credibility, technical capability, and general competence and experience of the experimenter, NASA offered to assist organizations submitting proposals in their efforts to develop a credible experimental concept by providing them with technical advice as well as the benefits of its prior experience with similar user activities.[13]

The experiment groups were responsible for obtaining their own funding for the program development, ground terminal procurement and installation, and related management costs. As with previous user satellite projects, NASA offered to provide free satellite transmission time.[14]

Canada, since 1973, had operated the Anik A satellite system, which provides many of its remote areas with reliable telephone, radio and television service with a frequency of 6/4 GHz. The Hermes program was not intended to supplement Anik A directly, but rather as an opportunity to determine ways in which advanced satellite technology could be used to meet a variety of specific public service needs at a frequency of 14/12 GHz. The focus of the Hermes program was on experimentation which would serve "as a catalyst to give new directions to the development of telecommunications systems for education and social services delivery".[15]

In relation to the Canadian experiment selection process, the Department of Communications sought public participation at all levels in order to devise a complementary program of technical and social service demonstrations. Thus, the Department of Communications informed potential user groups about the program by holding a series of meetings open to representatives from universities, federal and provincial government departments, and private organizations. Also, the Department of Communications organized various regional and national committees to coordinate the efforts of the prospective users with the overall Canadian Hermes program objectives. The Minister of Communications appointed an independent evaluation committee whose purpose was to select those experiments which would further Canadian social, cultural, economic and technological goals.[16]

To obtain the greatest advantage from the Hermes program, the Department of Communications decided to offer its facilities (at relatively low cost to the Department) for experimental use. The 49 proposals received were evaluated against criteria of scientific merit and social relevance by an independent evaluation committee under the chairmanship of Dr. Henry Duckworth, president of the University of Winnipeg and past-chairman of the Royal Society of Canada. The Minister of Communications accepted the recommendation that 33 experiments be approved. Nine of these experimental proposals were subsequently withdrawn and one new proposal was accepted, leaving a total of 25 accepted proposals. In addition, 15 new proposals were subsequently accepted resulting in a total of 40 experimental proposals.[17]

The 15 technical experiments related to the improvement of 14/12 GHz space communications technology and spacecraft technology. The technical experiments included evaluation of earth station performance, scientific experiments, and measurement of precipitation attenuation. The 25 social experiments related generally to improved methods of providing tele-health, tele-education, community communications, administrative and broadcasting services.[18]

The DOC's Communications Research Centre (CRC) offered to assist the committee in evaluating the technical requirements of each proposal. Contrary to the situation in the United States, where the experimenters built and owned their earth stations in the majority of cases, the Department of Communications constructed and retained ownership of all ground terminals installed in Canada for the experiments. Satellite time was also provided without charge, as in the United States. The additional financial obligations assumed by the Department of Communications were based, in part, from the fact that the Canadian experiments were of a shorter duration than the US experiments, thereby requiring more centralized management and coordination, as well as a sharing of some ground facilities for experiments involving the same geographic areas.[19]

Following two years of experimentation, the Department of Communications not only carried out its own internal assessments of the experiments but let a number of contracts for independent evaluations, and, with NASA, publicized the whole program in a symposium organized by the Royal Society of Canada. Responsibility for further analysis or evaluation rested with those active in the disciplines affected by the experiments.[20]

The Canadian user demonstration approach emphasized the experimental, rather than the quasi-operational nature of their activities. In this regard, the Department of Communications allowed various users to phase their experiments in shortened but intensive time slots, with opportunities for repeat experimentation if needed. This procedure permitted a sharing of ground terminal hardware amongst selected users. In addition to the technical experiments, the Hermes program investigated the possibility of using satellite and related ground technologies to deliver essential social, medical, and cultural services.[21]

The experiments concerned with tele-education were carried out by a variety of groups. For example, the Public Service Commission of Canada studied the possibility of training federal employees in their home offices via satellite. It is expected that such a procedure would reduce employee training costs and accelerate the educational processes. Lakehead University in Thunder Bay, Ontario, broadcast mathematics education programs in order to determine whether the instructional skills of teachers in remote areas could be improved by means of satellite communications.[22]

In the Province of Quebec, the University of Quebec was involved in a communications experiment from mid-October 1976 until March 1977. During the period of the experiment, campuses in Montreal, Quebec City, Trois Rivières, Hull, Rouyn, Rimouski, Chandler and 7 other locations in the Province were linked together by means of the transmission of courses and documents, tele-conferencing, and teacher training exercises. The use of 3m and 2m earth stations was a new step to linking together a modern university which has scattered campuses across a large territorial area.[23]

In British Columbia, Distance Education was involved in the transmission of educational programs from a 3m earth station from Vancouver to 2m earth stations at cable TV, linking points in Chilliwack, Kelowna, and Campbell River. Another 2m earth station was located at a community college in Dawson Creek and a television receive only (TVRO) was placed at a lumber camp at Pitt Lake. Between mid-October 1977 and mid-December 1977, these communities received educational broadcasts with such topics as job training, lumbering, earth physics and Indian culture. This experiment provided valuable experience in order to aid the planning of educational broadcasts to scattered mountain communities.[24]

One of the leading experiments was conducted between Carleton University in Ottawa, Ont. and Stanford University near San Francisco, California. These two universities exchanged courses during a full academic year from September 1976 to May 1977 with a two-way video system. This experiment was a valuable illustration of the exchange of expert information and lectures between two distant universities.[25]

The Ontario Educational Communications Authority (OECA) was engaged in an experiment using 2m earth stations in the communities of Fort Francis, Chapleau and Owen Sound in the period from June 1978 to August 1978. This experiment was supposed to extend the OECA educational broadcasting network to the cable systems in those communities.[26]

From September 1978 to December 1978, the University of Montreal used a 3m earth station in Montreal, P.Q. and 2m earth stations in Rimouski, Hauterive and Sept Iles to provide courses in nursing for students at the three locations, in order to compare the effectiveness of such methods with the extension courses normally given at those locations.[27]

Physicians and health professionals in remote communities in Newfoundland were part of a Hermes experiment from April 1977 to mid-June 1977 in important telemedicine communications. A 3m earth station situated at Memorial University in St. John's Newfoundland, was used to transmit medical education programs to physicians and other health care personnel to four hospitals in Stephenville, St. Anthony, Goose Bay and Labrador City. 2m earth stations were placed on the roofs of these hospitals to provide for TV reception and two-way voice communications. At one point, a medical discussion was undertaken among the five sites, led by medical staff from Memorial University. One lasting effect of this experiment was the development of greater cooperation between the hospitals which had been achieved before from other methods of communications.[28]

In addition to providing continuing education to medical professionals in remote areas, the Memorial University of Newfoundland experimented with the transmission of various medical data, including electrocardiograms, X-rays, and laboratory biomedical data. Equipment which allowed medical personnel to examine eyes and ears remotely and to monitor pregnancies was also tested.[29]

The University of Western Ontario conducted a similar experiment to ascertain the feasibility of utilizing satellite communications to assist nurses stationed at remote areas in the conduct of activities relating to patient examination, decision-making, and consultation. And the Rural Health Society of Victoria, British Columbia, attempted to determine the degree to which two-way television transmission between medical specialists located in urban areas and health officials in remote areas could raise the quality of basic health care services available to the inhabitants of rural communities.[30]

In the sphere of community communications, important exchanges were carried out during the Hermes program. The great size of Canada's territory with its extremes of geography, as well as the low density of its population, have long created strong barriers to the development of close links between separated communities in Canada. Thus, many of the experiments were designed to reduce barriers between Canadian communities and to aid in developing a spirit of cooperation between these communities.

One experiment in community communications involved the University of Saskatchewan, Regina and the Quebec Ministry of Education established a cultural exchange between two francophone communities, one in Zenon Park, Saskatchewan, and the other in Baie St. Paul, Province of Quebec. This experiment was conducted between February 1978 and May 1978 and the content of the programs included discussions of agriculture, recreation, education and government. The satellite utilized 3m earth stations to relay two-way audio and video communications.[31]

Another communications experiment was Project Ironstar, conducted by the Alberta Native Communications Society whose goal was to provide native people with information and to link native communities more closely with their representatives in the provincial capital of Edmonton, Alberta. A 3m earth station in Edmonton transmitted adult education, community interest and school programs to native communities in Wabasca-Desmarais, Fort Chipewyan and Assumption in northern Alberta. The content of these exchanges covered topics such as housing, health, roads, employment opportunities, legal aid, Indian councils, and firearms control. The experiment took place in two stages, from October 1976 to February 1977 and from August 1977 to December 1977.[32]

There were two important experiments designed to explore the utility of satellite communications for the development of cultural associations between native communities. One experiment was conducted from May 1978 to September 1978 by the Wa Wa Ta native communications association of northern Ontario. This experiment used 1m earth stations to link radio stations in the communities of Sioux Lookout, Fort Hope, Trout Lake and Sandy Lake with radio programs in the Cree language. In a parallel experiment, the Tagramuit Nipingat, an Inuit association used 1m earth stations to link radio stations in Inuit communities on the shores of the Hudson Strait, i.e. Sugluk, Payne Bay, Wakeham and Koartuk.[33]

Provincial governments and their entities in Canada were interested in the use of Hermes as a means for centralizing administrative and management operations. As an example, the establishment of high-quality telephone communication links among its various offices was the experimental objective of an activity that was conducted by the James Bay Development Corporation. The Hydro Quebec Research Institute tested the feasibility of using satellite technology instead of high-frequency radio to maintain contact with power stations in northern Quebec. The government of Ontario experimented with the delivery of governmental services to remote areas of the province; and finally, the Manitoba Government Centre initiated satellite-mediated teleprocessing experiments between government offices in Winnipeg and Ottawa.[34]

Mr. Delbert D. Smith stated: "The set of Canadian experiments has displayed, at times, a certain lack of planning and organization, but Canadian officials view their flexible experiment plan as an impetus to creative uses of the spacecraft".[35] The Canadian experiments have been more varied than those of the United States. It should also be noted that the primary evaluative responsibility was delegated to the individual experimenters, each of whom reported their conclusions to the Department of Communications. The Department of Communications then assessed the experiments for an overall determination of the feasibility of an operational application of broadband communication satellite technology.

For Canadians, the Hermes program was designed to assess the proposition that a communications satellite can be an effective mode for delivering public interest services to widely dispersed user groups operating small, low-cost ground transmit/receive terminals. For Canada, the experiments were a first venture into user experimentation, which shaped the future telecommunications policy of Canada.

The Hermes transponder and earth stations were capable of supporting TV or radio broadcast, educational TV with a voice or data return channel, TV origination from remote locations, two-way TV for teleconferencing, telephon (two-way voice) and digital communications, including experimental time-division multiple-access (TDMA) signals. The earth stations were located adjacent to the users premises; in school yards, on university campuses, near or on public buildings, on the roofs of hospitals or high rise buildings and on metropolitan parking lots.[36]

In Canada, the required earth stations were acquired by the Department of Communications, and were loaned to approved experimenters. There were five different types of terminals for a total of 24. There was one fixed 9m antenna located at the Communications Research Centre near Ottawa, Ont. and the rest of the earth stations were transportable. Prior to the commencement of each experiment, earth stations would be shipped to selected locations, installed, and checked out with the satellite and experimenter equipment and turned over to the experimenter for operations. Usually, these activities, for a given experiment, were carried out by 1-2 technicians and were completed in 2 to 3 weeks.[37]

The 3m terminals were installed and operated by DOC contract personnel. The 2m and 1m terminals were usually installed and tested by DOC contract personnel, but were operated by the experimenter. However, several experimenters successfully undertook installation and checkout in order to gain greater experience.[38]

During the experiments, all maintenance was performed by DOC contract personnel, usually on the basis of complete replacement of one of the electronic sub-units. At the end of each experiment, the earth stations were dismantled and prepared for shipment to the locations for the next experiment.[39]

The earth stations were divided into five different types. The largest earth station, with a 9m antenna, was located at the Communications Research Centre near Ottawa. This fixed terminal was capable of transmitting TV, data and telephone voice communications. There were also two transportable TV transmit 3m terminals which had the same communications capability as the fixed 9m antenna. These could be moved by road, rail or barge and one could be dismantled for air transportation. The 3m earth station was equipped with a 1.2 kW klystron power amplifier for transmission and a parametric amplifier for reception. These terminals were developed for the Department of Communications by a Canadian firm, SED Systems of Saskatoon.[40]

A 2m earth station which has a capability to receive TV and to transmit and to receive a telephone channel was also used. It was equipped with a tunnel diode amplifier for reception and a 20 W TWTA for transmission. The earth station consisted of the antenna and two outdoor electronic units plus three indoor units. Typically, the earth station was mounted on a wooden base weighted down with concrete blocks or stones. The 2m earth station could be erected or disassembled by two men in about 8 hours. When packaged for shipment, the terminal weighed 409 kg. Eight of these earth stations were developed in Canada for the Department of Communications by SPAR Aerospace Ltd.[41]

A lm telephony earth station with a capability to transmit and receive a telephone channel was also developed for the Hermes program. This earth station was also equipped with a 20 W TWTA for transmission and a tunnel diode amplifier for reception. The earth station consisted of the antenna and two outdoor electronic units plus two indoor units. When packaged for shipment, the earth station weighed 273 kg. Ten of these terminals were developed for the Department of Communications by SPAR Aerospace Ltd.[42]

To illustrate the capability of a satellite such as Hermes for TV broadcasting, several TV receive-only (TVRO) earth stations were developed by the Communications Research Centre. One of these had a 60cm antenna which was capable of receiving a good quality TV signal when located near the center of the 200 W beam. It had been demonstrated both outdoors and whole receiving signals through a window, when located within an office building. These small earth stations were sufficiently small that they could be carried as personal baggage on aircraft. They were assembled and put into operation to receive a signal from Hermes in less than 30 minutes.[43]

The social service experiments in the Hermes program demonstrated that 14/12 GHz communications technology was available to link individuals, organizations, and communities effectively in any part of Canada. More importantly, the experimental satellite links made potential users aware of the communications technology that could be used to meet social service delivery needs.[44]

The Hermes program also made groups available of the barriers that existed in relation to access to satellite transponders and earth stations. The Canadian government began to review the rigid regulations in relation to access to satellite technology. Other barriers to service delivery by satellites were inherent in the traditional organizational institutional, cultural, and professional structures. In these experiments, the barriers were successfully overcome.[45]

The Hermes communications experiments illustrated that although many of the groups did not have a requirement for full-time use of a satellite transponder, there were no technical or operational barriers to prevent time-sharing the use of one transponder amongst many geographically widely spaced groups. Although considerable flexibility in the time and duration of access to a transponder might be desired, it was found during the experiments that the experimenters always controlled their requirements to match the precise time periods that were allocated. A pre-emption to accommodate an emergency situation was exercised in Canada on only two occasions and by NASA of

Canadian time on only one occasion during three years, indicating that rigid definition of access was possible.[46]

The high power of the Hermes satellite and the frequency band of operation made it feasible to use small earth stations which could be installed in physically suitable locations without the need to coordinate these with terrestrial communications systems. Hence, it was possible to install complex video or other communications links in a matter of weeks without regard to difficulty of terrain or geographical separation. Once installed, it was shown that the relatively complicated earth stations could be operated by personnel who did not have specialist technical training.[47]

It was demonstrated that one technician with an assistant could routinely install and check out an earth station in either urban or difficult remote locations. The quality of the video reception and the voice links using Hermes in the remote locations was spectacular, taking into account the normal difficulty of access in these areas and making a comparative analysis with existing communications.[48]

It was found, particularly with respect to the social services applications, that multi-disciplinary approaches to solving problems were necessary. As a result of the Hermes experiments, "an improved awareness of the potential of telecommunications developed and the satellite program emerged as a catalyst that stimulated numerous spin-off benefits and development activities in other areas."[49]

The Hermes program met all of its initial objectives so successfully that additional objectives were established and three separate program extensions were authorized. The first extension (the third year of Hermes operation) was used to carry out longer-term experiments that could not be accommodated in the initial planning. The second extension, to September 1979, was arranged to meet a request for TV and telephony demonstrations at a variety of sites in Australia. A third extension, to January 1980, had been authorized to meet a follow-up Australian request for demonstrations during the rainy season.

However, on November 24th, 1979, contact was lost with the satellite due to an anomaly in the earth sensor of the satellite's attitude control system. Communications Research Centre officials stated that at 8:06 p.m. on November 24th, an anomaly re-occurred in the earth sensor of the satellite's control system, which in turn caused a loss in attitude control. At 8:11 p.m. all telemetry data ceased and at 8:14 p.m. virtually all radio frequency (r.f.) signals vanished because, it is believed, of a change in the satellite's orientation.[50]

Both the Communications Research Centre and NASA monitored the satellite for any sign of telemetry signals but none were ever received. Officials believed that the satellite was rotating slowly with its solar arrays or "wings" tipping sufficiently away from the sun to cause the loss of r.f. signals. All attempts to change the satellite's orientation were unsuccessful.[51]

At the time of the Australian experiments, Australia's Minister of Post & Telecommunications stated that, " . . . the recent experiments using the Hermes satellite could not have been contemplated without the facilities made available by the Department of Communications and the technological support of its senior officials. . . . The Canadian government is a world leader in the development of domestic satellite systems . . . "[52]

It should be noted that in the original plan for the Australian experiment, Hermes was only to be used in August and September of 1979. The Department of Communications and NASA had originally agreed to switch the satellite off in mid-October of 1979. When the Australian Post & Telecommunications Department requested an extension of the tests, the Department of Communications cautioned that the satellite was two years past its design life and that it could not guarantee that a satellite failure would not occur. The tests, involving earth stations in northern Queensland in rain attenuation tests, were to conclude in late January of 1980 when the satellite was to be shut down permanently. However, the failure on November 24th, 1979, cut short these planned experiments. Officials have stated that the satellite at that time was in such a high orbit, that there was no risk of it every falling to earth.[53]

The design of the Hermes satellite centred around three major advanced technology subsystems:

- A unique new transmitting tube, more powerful than any satellite has carried to date. It delivered 200 watts of power at about 50 per cent efficiency, compared with the roughly six watts and 30 per cent efficiency of the tubes in conventional satellites.[54]
- In order to provide enough electricity to operate the powerful transmitter, the satellite had two large but very light sails. These sails were studded with about 27,000 individual power cells to convert solar energy to electricity. The sails each measured about 22 feet long by four feet— roughly three times as long as the diameter of the satellite body. They remained packed, like accordions, on the side of the spacecraft until it attained operational orbit. Then, upon command from the earth, their protective covers were blown off and they unfolded.[55]
- Because the sails of the spacecraft had to rotate to face the sun and its antennas had to point accurately earthward, the satellite itself had to remain stable. Designers, therefore, had to develop a method of three-axis stabilization so that slight drifts could be continually corrected by small jets powered by hydrazine gas. Even slight movements of the satellite in space would critically affect the direction of signals. The antennas focused the signals of the satellite,

much like a flashlight beam, illuminating areas on earth about a time-zone wide. The stabilization system, therefore, had to maintain antenna pointing accuracy to within one-fifth of a degree.[56]

This feature was quite different from the spin-stabilization systems used by most present-day communications satellites. Spin-stabilized satellites remain stable by spinning like a top. Because their solar cells are on the outer body of the spacecraft, little more than a third of the cells are in sunlight absorbing energy at any one instant. The Hermes satellite could not afford the luxury of such a low-efficiency power source; hence the solar sails.[57]

In terms of communications capacity, the satellite provided the equivalent of two colour television channels, more than 2,000 voice circuits and over 4,000 audio FM channels for experimental use. However, only one of these television channels was powered by a 200 Watt TWTA (travelling wave tube amplifier) that allows television signals to be received at the earth station having an antenna diameter of two meters. The second television channel had only a 20 watt final amplifier. These two channels were transmitted from two satellite antennas, each with a 2.5 degree circular beam width and with a footprint on the earth of about 1840 km. in diameter.

Along with the 200-watt travelling wave tube and its power conditioner, the Hermes communications subsystem consisted of a high-sensitivity, high-gain receiver, 20 watt driver/ transmitter tubes (supplied by the European Space Agency, which also supplied the solar cells, prototype blanket and parametric amplifier), and two independently steerable 2.5 degree beam-width antennas.[58]

The transponder transmitted to earth on frequencies between 12.038 and 12.123 GHz and 11.843 to 11.928 GHz, receiving on frequencies between 14.205 and 14.290 and 14.010 and 14.095 GHz. The receive frequency band was 14 GHz to 14.3 GHz, in two 85 MHz pass bands. The transmit frequency band was 11.8 GHz to 12.1 GHz, in two 85 MHz pass bands. Communications consisted of colour television, two-way voice, FM broadcast, and data channels. The maximum output power was 200 watts on antenna 1 and 20 watts on antennas 1 and 2. The solar power system consisted of 2 solar sails measuring 7m x 1.29m each with an initial power output of 1300 watts. The spacecraft body solar power was 100 watts maximum, with 2 batteries with 5 amp-hour, 24 cells each.[59]

The precise specifications of the Hermes satellite were as follows. The launch weight was 676.1 kg and the launch vehicle was a U.S. Delta 2914 with Castor 11 strap-on motors. The usable weight in geostationary orbit was 346.0 kg. The height was 177.8 cm, the width was 200.6 cm and the depth was 167.6 cm. The position in synchronous orbit was 116° west longitude. The SHF antennas had a beamwidth of 2.5° and a gimballed, boresight steering range of 15°. The attitude control systems had a 0.1° accuracy in pitch and roll and a 1.1° accuracy in yaw (a side to side movement).[60]

The major participants on the Hermes program in Canada in the government sector included the Department of Communications which had Canadian program responsibility. The Department of Supply and Services had the responsibility for contracts management. The Department of National Defence had responsibility for inspection services and acted as storage battery consultants.[61]

The major industrial participants in Canada for this project included Spar Aerospace Limited in Toronto which manufactured the spacecraft structure and the mechanical subsystems. RCA Limited of Montreal which built the electrical and electronic subsystems and the earth stations. SED Systems Limited of Saskatoon also built earth stations as well as computer software for orbital maneuvers. Bristol Aerospace of Winnipeg built the electrical units.[62]

In the United States, the governmental agencies that were involved in the program were NASA which delegated U.S. program responsibility to the Lewis Research Centre and launch responsibility to the Goddard Space Flight Centre. The U.S. industrial corporations involved in the program consisted of TRW and Litton Industries which built the 200 watt transmitting tube and Thiokol built the apogee motor. Hamilton

Standard built the reaction control subsystem.[63]

The European governmental participant consisted of the European Space Agency which delegated European program responsibility to the European Space Technology Centre. The European industrial corporations consisted of Thompson/CSF of France which built the 20 watt driver/transmitter tubes and AEG Telefunken of the Federal Republic of Germany which manufactured the solar cells and blanket. FIAR of Italy built the power processor and GTE of Italy which built the parametric amplifier.[64]

The joint US/Canada Hermes program made a major contribution to the development of satellite communication systems. Due to Hermes' excellent performance, it was clear that Canada did have the technological capability to provide vastly improved— and relatively inexpensive— telecommunication services anywhere in the world, to meet needs for the transmission and reception of television, radio, two-way voice communication, data, graphics and many other types of information.

Hermes' operational time was shared 50:50 between US and Canadian experimenters, under the over-all control of the Ottawa ground station.[65] Fixed and mobile ground terminals of various sizes were used at literally hundreds of locations during the three and a half years of experimentation. In addition to the more routine experiments, Hermes also demonstrated its flexibility during the disastrous 1977 floods in Pennsylvania, the

1976 Olympics and, using a New York link, for the 1978 Third Inter-American Conference in Buenos Aires.

Although Hermes was experimental, operational direct broadcasting satellites could easily be common within a decade. Because of the international implications, discussions are proceeding in the United Nations which could lead to acceptable international rules for direct satellite broadcasting between nations.[66]

Therefore, the Hermes program was a major factor in proving the suitability of the 14/12 GHz band for satellite communications. The technology of the earth stations at 14/12 GHz frequency range proved to be no more difficult than at 6/4 GHz and the higher pointing accuracies required for antennas were not difficult in practice. Clearly, the Hermes program was a major step forward in putting communications technology at the service of humanity.[67]

The next chapter will explore the scientific research and development programs that followed the Hermes program. These contemporary programs have extended the knowledge acquired during the Hermes program to determine the capability of the new technology to fulfill advanced telecommunications needs.

FOOTNOTES TO CHAPTER II

[1]Once launched by the Communications Technology Satellite was named Hermes by the Canadian Minister of Communications, Hon. Jeanne Sauvé.

[2]The Department of Communications (DOC) was created by an Act of Parliament in 1969 to foster the orderly development and growth of telecommunications and to promote their accessibility to all Canadians. The Defence Research Telecommunications Establishment (DRTE) of the Defence Research Board was absorbed by the DOC. The communications research branch of the DOC is the Communications Research Centre (CRC) in Ottawa, which was also formed in 1969. The CRC is the public sector research and development arm of the DOC. More comments will be made on the DOC and the CRC in Chapter III of this thesis.

[3]The legal reference for the Memorandum of Understanding of April 20th, 1971 is the Canada Treaty Series 1971 No. 14.

[4]N.G. Davies, J.W.B. Day and M.V. Patriarche. The Transition from CTS/Hermes Communications Experiments to Anik B Pilot Projects, Abstract for the Department of Communications, CH 1352-4/178/0000-0324, (Ottawa, Canada, 1978), pp. 324-325.

[5]Ibid., p. 325.

[6]The agreement took the form of an Exchange of Notes between the Canadian government and ESRO with an attached Memorandum of Understanding both of which were dated May 18th, 1972. The legal reference is the Canada Treaty Series 1972 No. 19. The specific ESRO obligations can be found in article 3 of the Memorandum of Understanding.

[7]Ibid.

[8]Ibid., p. 324.

[9]Delbert D. Smith, Teleservices via Satellite, Experiments and Future Perspectives, (The Netherlands: Sijthoff and Noordhoff, Alphen aan den Rijn, 1978), p. 147.

[10]Delbert D. Smith, Teleservices via Satellite, p. 150.

[11]Ibid.

[12]Ibid.

[13]Ibid.

[14]Ibid. The first group of U.S. experiment proposals for CTS/Hermes included submissions from Comsat Laboratories; the Brazilian Space Research Institute; the Boeing Company; and New

Mexico Regional Medical Program; Pennsylvania State / University of Alberta, Canada; Stanford University / Carleton University, Canada; University of Colorado / State University of New York; University of Texas, Austin / University of California, Los Angeles.

[15] *Ibid.*, pp. 150-151.

[16] *Ibid.*, p. 151.

[17] N.G. Davies, J.W.B. Day and M.V. Patriarche. *The Transition from CTS/Hermes Communications Experiments to Anik B Pilot Projects*, pp. 328-329. Note that the authors list 40 projects in Table 2, although their writings on page 328 add up to a total of 39 projects. This table has been reproduced as Appendix 2.

[18] *Ibid.*, pp. 324 and 328.

[19] Delbert D. Smith, *Teleservices via Satellite*, Experiments and Future Perspectives, p. 151.

[20] The whole Hermes program is described in I. Paghis (ed.) *Hermes (The Communications Technology Satellite) Its Performance and Applications*, Proceedings of the Symposium, The Royal Society of Canada, Ottawa, Canada, 1977 in three Volumes.

[21] Delbert D. Smith, *Teleservices via Satellite, Experiments and Future Perspectives*, pp. 158-159.

[22] *Ibid.*, p. 159.

[23] N.G. Davies, J.W.B. Day, D.H. Jelly and W.T. Kerr, *CTS/Hermes - Experiments to Explore the Applications of Advanced 14/12 GHz Communications Satellites* in Astronautics for Peace and Human Progress, Edited by L.C. Napolitano, (Oxford, U.K. and New York, U.S.A.: Pergammon Press, 1979), pp. 331-332.

[24] *Ibid.*, p. 332.

[25] *Ibid.*

[26] *Ibid.*

[27] *Ibid.*

[28] *Ibid.*, p. 331.

[29] Delbert D. Smith, Teleservices via Satellite, Experiments and Future Perspectives, pp. 159-160.

[30] Ibid., p. 160.

[31] N.G. Davies, J.W.B. Day, D.H. Jelly and W.T. Kerr, CTS/Hermes - Experiments to Explore the Applications of Advanced 14/12 GHz Communications Satellites, p. 333.

[32] Ibid., p. 332.

[33] Ibid., p. 333.

[34] Delbert D. Smith, Teleservices via Satellite, Experiments and Future Perspectives, pp. 160-161.

[35] Ibid., p. 161.

[36] N.G. Davies, J.W.B. Day, D.H. Jelly and W.T. Kerr, CTS/Hermes - Experiments to Explore the Applications of Advanced 14/12 GHz Communications Satellites, pp. 321 and 324.

[37] Ibid., pp. 324-325 and 329.

[38] Ibid., p. 329.

[39] Ibid.

[40] Ibid., pp. 324-326.

[41] Ibid., p. 325.

[42] Ibid., p. 326.

[43] Ibid., p. 327.

[44] Ibid., p. 333.

[45] Ibid., pp. 333-334.

[46] Ibid., p. 334. It should be noted that a 50:50 time sharing system was set up between NASA and the Department of Communications. The basic division was by alternate day usage. Beginning in May 1976, the year was divided into four 13-week periods. For one given 13-week period, the Department of Communications had use of the satellite on Monday, Wednesday and Friday; NASA used the satellite on Tuesday, Thursday and Saturday. Sundays would alternate between the two organizations. The following 13-week period, the two organizations would exchange the order of the days.

[47]*Ibid.*

[48]*Ibid.*

[49]*Ibid.*

[50]Department of Communications News Release, November 27, 1979, p. 2.

[51]*Ibid.*

[52]INFOSPAR, volume XI number 4, December 1979, p. 1.

[53]Department of Communications News Release, November 27th, 1979, p. 2.

[54]Hermes: The Communications Technology Satellite, pamphlet published by the Department of Communications, No. CO 22-19/1978, (Ottawa, Canada: 1979), p. 18.

[55]*Ibid.*

[56]*Ibid.*, p. 20.

[57]*Ibid.*

[58]*Ibid.*, p. 26.

[59]*Ibid.*, the term "transponder" refers to the communications payload (receivers, filters, etc.) inside the satellite.

[60]*Ibid.*

[61]*Ibid.*, p. 27.

[62]*Ibid.* It should be noted that the federal government issued two policy statements in relation to Canadian private industry in the Hermes program. In 1970, the Hermes program was authorized with the objective of further developing the Canadian space industry and of meeting further national needs. In 1972 the Memorandum of Understanding was signed by Canada and the European Space Research Organization for cooperation on Hermes in recognition of the entrée this would provide Canadian industry into the markets developed by Europeans. These two statements are contained in The Canadian Space Program; Five-Year Plan (80/81-84/85) Serial no. DOC-6-79DP Discussion Paper, Department of Communications, Government of Canada, January 1980, pp. 16-17.

[63]*Ibid.*

[64]*Ibid.*

[65]See Footnote 48 of Chapter II of this thesis.

[66]See Paul Fauteux, *Pour une réglementation internationale de la radio diffusion directe par satellites*, Annals of Air and Space Law, Volume V, Institute and Centre of Air and Space Law, (McGill University, Montreal, Canada: 1980), pp. 427-447.

[67]This "major step" was undertaken at no small cost. The Hermes satellite cost the Communications Research Centre \$60.3 million (CAN.) for design and production. NASA contributed \$11.4 million (CAN.) during development and \$10.8 million (CAN.) for the launch vehicle. The baseline for the project is an estimated total of \$82.5 million (CAN.). The European Space Agency also provided several components. *Aviation Week & Space Technology*, December 13, 1976, p. 28.

CHAPTER III

CONTEMPORARY SCIENTIFIC PROGRAMS (1979-1980)

The Hermes program proved that there was great potential in 14/12 GHz communications technology. On December 15th, 1978, Canada's Anik B communications satellite was launched into geostationary orbit which led to the further exploration of the capacity of this new technology. This launch was the beginning of the execution of an agreement between the Department of Communications and Telesat Canada to lease six 14/12 GHz channels on the Anik B satellite, which also carries twelve 6/4 GHz channels to back up the aging 6/4 GHz Anik A satellites presently in operation.

The aim of the Anik B communications program of the Department of Communications was to advance national objectives in telecommunications and broadcasting. Specific goals of the program were:

(1) To determine the viability, on a pre-operational but continuing basis, of telecommunications services designed to meet identified requirements;

(2) To develop the knowledge and expertise to better utilize 14/12 GHz satellite communications technology;

(3) To develop expertise and create awareness in user institutions of the potential of telecommunications to deliver new services.[1]

The Anik B Department program represented an extension of the Hermes program with special emphasis being given to the requirements for satellite communications by the public services sector and the policy and jurisdictional considerations associated with provision of such services to this sector.

The Department of Communications planned to accommodate a number of pilot projects to meet the goals of the Anik B program. A pilot project is at the pre-operational level of development rather than at the merely experimental level. Based on the Hermes program, potential areas were identified for pilot projects in telemedicine, tele-education, community communications, commercial services, TV distribution, and technology development. The Department of Communications invited public and private entities to propose pilot projects.[2]

The Department of Communications received 35 Anik B pilot project proposals from 29 different groups and evaluated the proposals in terms of user requirements, technical feasibility and suitability, operational and policy considerations, the capability of the proposers to carry out the pilot projects, adequacy of funding, the degree of innovation in the proposals, the mandate of the proposer, and the probability that the pilot projects would foster transition to new or improved operational services. These proposals were evaluated and 15 pilot projects were accepted.[3]

The 15 pilot projects were sponsored by a variety of agencies including federal government departments and agencies, provincial government departments and agencies, telecommunications carriers, native communications associations, universities and hospitals. The Department of Communications cooperated with the sponsors in the planning, conduct and conclusion of the pilot projects. In particular, the Department provided a system of earth stations for use by the sponsors.

The duration of the pilot projects was dependent upon the duration of the lease with Telesat Canada. The Department of Communications service lease was for an initial period of two years, beginning in late March 1979. There was an option for an extension for an additional three years. The initial two year lease dealt with the rental of six 14/12 GHz channels at a total cost of $32 million.[4]

There was a wide variety in the pilot projects across Canada. In the Maritimes, Memorial University made available educational health programs and physician consultation services to seven remote communities of Labrador and Newfoundland. In the Province of Quebec, several provincial Departments and universities worked with the Quebec Ministry of Communications and the federal Department of Communications to deliver health care, education, and other government services to residents of the Province, including native peoples.[5]

In the Province of Ontario, the Ministry of Government Services made an evaluation of a satellite-based office communications network providing for the transfer of information for several provincial departments relating to voice, facsimile, teletype and video transmission. In addition, the Ontario Educational Communications Authority studied the viability of an extension of its video network, via satellite, to improve delivery of educational programming to remote communities in the Province.[6]

In the West, the Alberta Educational Communications Authority led a group of Alberta participants in a project to connect a program centre in Edmonton with several isolated northern communities in the province using one-way and two-way links for educational and community services aimed at both the native and non-native population. In British Columbia, the Ministry of Education coordinated the participation of several institutions in a project to implement an interactive satellite communications system to improve access to adult and community education programs, as well as courses of an academic and technical nature. Anik B was also used to feed community cable distribution systems in remote areas of British Columbia, complementing similar terrestrial feeds in the more populous parts of the province.[7]

In northern Canada, the Inuit Tapirisat of Canada carried out a project to implement an interactive satellite communications system to improve access to educational instruction and to permit tele-conferencing of meetings. It also tested the viability of an Inuit television broadcasting service designed to offset and reduce the cultural impact of southern television productions distributed to the Arctic.[8]

A highlight of the Anik B Department program was attained on September 26th, 1979 when Canada became the first nation in the world to transmit TV programming directly to earth stations installed in private homes. The Department of Communications had lent small, dish-shaped earth stations for receiving the programming to these private rural homes as well as to community centres and cable television systems. This pilot project continued until February 17, 1981.[9] Federal Communications Minister David MacDonald stated the following in relation to this pilot project:

> If this project is a success and if our government decides to develop the concept of direct-to-home satellite broadcasting a step further, millions of Canadians in remote and rural areas will benefit.[10]

The Department had purchased 100 earth stations from SED Ltd. of Saskatoon to be used in this direct broadcasting pilot project. Electrohome Ltd. of Waterloo, Ont. and Andrew Antenna Ltd. of Toronto, Ont. were major subcontractors. Engineers from the Department of Communications had also been working for several years to develop the technology of small low cost earth stations for direct-to-home satellite broadcasting.[11]

Users of the 1.2 metre and 1.8 metre dish antennas were situated in the Province of Ontario. These private home viewers were chosen by the project participants which included the Department, the Ontario Educational Communications Authority, the

Ontario Ministries of Transportation and Communications, Culture and Recreation, and Northern Affairs.[12]

Inauguration of the Ontario private home pilot project was marked by a special 10-minute broadcast on TV Ontario at 9:50 p.m. on September 26th, 1979 which featured interviews with the participants and a brief explanation of how the new technology worked. The first home users of the earth stations were the King family of Macdiarmid, Ontario, a village about 170 km northeast of Thunder Bay on the shores of Lake Nipigon. Ontario viewers were limited to programming supplied by TV Ontario.[13]

One of the interesting aspects of the Ontario pilot projects was the issue of the commercial possibilities of this 14/12 GHz satellite technology. Mr. MacDonald stated that the Department had undertaken this pilot project "not only to test the feasibility of using small, low cost earth stations for direct-to-home satellite broadcasting but also to stimulate an important high technology industry in Canada."[14]

A key to the commercial potential of this 14/12 GHz technology rests in the price for the earth stations used in this Ontario pilot project. The earth stations that were used cost about $3600 a unit plus about $200 a unit to install. The Department believes that such earth stations could cost as little as $500, or even less, if earth station manufacturers are able to sell to a mass market. Therefore, this isolated pilot project could have great commercial implications if a mass market can be successfully developed in the 1980's.[15]

The Ontario private home pilot project was extended on December 14th, 1979 to northern British Columbia, the Yukon and the Northwest Territories. The broadcasting transmissions consisted of the complete daily service of the CBC's Pacific TV network and Vancouver's CTV affiliate, CHAN. These transmissions were relayed via Anik B to private homes as well as small cable TV systems, community halls and low-power rebroadcasting stations in 45 remote locations which had limited or poor-quality reception with conventional broadcasting systems. The Western phase of the private home pilot project continued until February 17th, 1981.[16]

The participants in the Western phase of this pilot project were the Department of Communications, the British Columbia Ministry of Universities, Science and Communications, the CBC, the governments of the Yukon and Northwest Territories, and the CTV affiliate— British Columbia Television or BCTV. A committee composed of representatives of the Department, BCTV, the CBC and the Provincial and territorial governments involved, worked with community representatives throughout the region to finalize a list of homeowners and communities that eventually received the trial service in the pilot project.[17]

Private homes in the British Columbia communities of Cassiar, Dease Lake, Telegraph Creek, Anahim Lake and Tatla Lake were the first to be served, with earth stations going into operation almost immediately afterwards at Yellowknife, N.W.T., and Whitehorse, in the Yukon. Before the end of 1979, Department technicians also installed earth stations in private homes in the British Columbia communities of Atlin, Hazelton, and Stewart.[18]

The Department of Communications had purchased the earth stations used in the Western phase of this direct broadcasting pilot project. The 1.8 metre earth terminals were loaned free of charge to users for the duration of the Western phase of the pilot project by the Department. This pre-operational trial in the West allowed for a very broad evaluation of the viability of a direct broadcasting service on a commercial basis. The earth stations were given a thorough evaluation in a broad range of environmental and climatic settings. This new generation of Canadian-designed and manufactured earth stations were built by SED Ltd., of Saskatoon, Saskatchewan. The earth stations used in the Western phase of this pilot project were part of the original 100 earth station purchase which has just been described.[19]

The Western phase of this pilot project was not just an isolated event but a pre-operational trial which could have great commercial significance. Federal Communications Minister, David MacDonald, stated the following in relation to the consequences of this pilot project:

> Now that we have pioneered the technology, we in Canada must make the best possible use of our lead in it to bring more and better Canadian Television program services to people still not provided with basic levels of service that Southern Canada takes for granted.
>
> If this project is a success, and we decide to develop further direct-to-home satellite TV broadcasting, millions of Canadians stand to benefit.[20]

Pilot projects which were purely technical in nature included several applied propagation investigations as well as others intended to evaluate a terrestrial satellite digital link for the Anik C system and to evaluate the operational features of a medium capacity time-division multiple access (TDMA) system. Other technical pilot projects included the establishment of a pre-operational, phase-stable long baseline interferometer system to advance national and international geophysical studies and applications, as well as the delivery of remote sensing imagery analysis data from laboratories in Ottawa to distant users in Newfoundland, Quebec and Alberta.

On September 15th, 1980, the Anik B program marked another milestone with the inauguration of the world's first commercial telecommunications service in the 14/12 GHz band. The Anik B satellite is being used to transmit French language television programming on a daily 14-hour schedule for La Société d'Edition et de TransCodage T.E. (La Sette). The service which is being carried out on one of the 14/12 GHz channels of the Anik B satellite reaches 22 cities and towns in the Province of Quebec.[21]

This service is carried on TVFQ or Channel 99, which will relay television programs from a transmitting earth station in Montreal, P.Q. to TVRO stations at the head ends of 25 Quebec cable broadcasting companies throughout Quebec. In addition to this system of local cablecasting stations, the programming can also be received through 1.2 m earth stations on individual houses. The use of Anik B for this service was made possible through an agreement under which the Department of Communications released its lease of one 14/12 GHz channel to Telesat Canada to permit the distribution of Channel 99 programming in urban and rural Quebec.[22]

The content of Channel 99's television programs is made up of public affairs, music, drama, sports and variety programs broadcast by the three television broadcasting networks in France, TF-1, Antenna 2 and FR-3. The rights to transmit the television programming in Canada were granted under cultural agreements between the Province of Quebec, France and the Canadian Government.[23]

The Anik B 14/12 GHz channel will continue to be used by Channel 99 until early 1983 when the broadcasting service will be switched to a channel on Telesat's Anik C 1 satellite. At that time, each of the Anik C satellites will provide 16 high power 14/12 GHz channels. For video transmissions each channel will carry up to two simultaneous colour television programs and their associated audio signals. At that time mass production of small earth stations is expected to cost $500 each rather than the current $3,000. Therefore, one can see how the experimental aspect of the Anik B program merged into the commercial aspect by the fall of 1980.[24]

A total of 121 earth stations were used in the Anik B Department program. 100 of these earth stations consisted of the 1.2 and 1.8 metre television receive-only (TVRO) dish antennas that were purchased from SED Ltd. The other 21 earth stations were modified earth stations that were used in the Hermes program. There were three types of modified Hermes earth stations. The first type was one 9m earth station which was capable of transmitting video and operating duplex two-way video links. The second type was two 3m TV Transmit (TVTX) earth stations which were also capable of transmitting video and operating duplex two-way video links. The third type was eighteen 3m television reception and two-way telephony (TVRT) which could receive video transmission. All earth stations had at least one duplex telephony channel and all earth stations except the 9m earth station in Ottawa were transportable.[25]

The technical design of the Anik B satellite is a three-axis-stabilized satellite with deployable solar arrays. The satellite has two antennas, one to transmit up to 12 channels simultaneously at 4 GHz to the whole of Canada, and a second antenna to transmit up to 6 channels at 12 GHz into four fixed beams covering four contiguous regions. The four fixed 12 GHz beams each have a beamwidth of approximately 2 degrees. The Effective Isotropically Radiated Power (EIRP) of 45.5 dBw at the edge of each beam is considerably less than the power of the Hermes satellite but representative of satellites operating in point-to-point fixed services. The 14/12 GHz antenna coverage for the Anik B satellite comes from a geostationary location over the equator at 109 degrees West Longitude.[26]

With these high frequency 14/12 GHz beams,[27] Anik B can reach specific targets, even in urban areas, without danger of interference from other communications systems. Obviously, one of the most attractive features of the technical design of the Anik B satellite is that receiving 12 GHz antennas can be smaller and cheaper than those required for conventional 6/4 GHz communications satellites.

The Department of Communications spent $36 million (CAN.) on the Anik B program in the first two years. The two year lease cost $32 million (CAN.) and the cost of earth station conversion, administration and other Departmental costs ran to another $4 million (CAN.). Telesat Canada paid $19.1 million (CAN.) to RCA Corp. for the satellite and $20 million (CAN.) to NASA for the launch. Therefore, the financial baseline for the Anik B program which includes the use of the twelve 6/4 GHz channels is at least $75.1 million (CAN.).

Anik B was built by RCA Corporation in Highstown, New Jersey, U.S.A. Nearly 30 per cent of the contract for the satellite— $5.6 million (CAN.) — was subcontracted to the U.S. firm's Canadian branch, RCA Limited of Montreal. This subcontract to the Canadian subsidiary comprised the Anik B communications payload. The Montreal firm was responsible for much of the technological innovation in the satellite which included the development of the six 14/12 GHz channels. The communications payload consisted of two independent transponder systems providing dual-band capabilities. Therefore, the Montreal firm gained valuable experience in both 14/12 GHz and 6/4 GHz communications technology.[28]

The Anik B Department program was designed to produce sufficient advances in 14/12 GHz communications technology to bring Canadians closer to the day when they will be able to receive high-quality TV service directly at home from a satellite— regardless of where they live, or how far they may live from a conventional broadcast transmitter or cable TV system.[29] The Department of Communications clearly had its eye on the development of a commercial mass market for small earth stations in Canada. The Communications Minister, Jeanne Sauvé, stated the policy of the Department as follows:

> The role of the Department of Communications is that of a catalyst, and as such we will do our best to see that demands and expectations created in the Anik B program can be carried out in an operational system.
>
> The Anik B program will test a market that may be developing in the public services sector and we hope the carriers will investigate the kinds of options open for future systems developments.[30]

This concludes the description of the Anik B Department program. There will now be a description of the Department of Communications and its role in the development of satellite communications technology in Canada. The Department has had a dominating role in research and development in the field. A detailed examination of the Department's role will illustrate the leading role that the federal government has played in the field of satellite communications.

The Department of Communications is charged with promoting the development and efficiency of communications in Canada, and with helping Canadian communication systems and facilities adjust to changing conditions. To help carry out this mandate, the Department undertakes research in many aspects of communications. Cooperation between government and industry helps Canadian industry maintain and improve its standing in a sector fundamental to the national social, economic and cultural health. Technological research and development is also a vital part of the broader process of policy development within the Department, since technological advances tend to have social, economic and institutional impact.[31]

The objective of the Department of Communications is to foster the orderly development and operation of space communications for Canada in both the domestic and international spheres. The Department's mandate includes responsibility for ensuring optimum use of space technology to meet Canadian telecommunications needs. The Department seeks development of a viable industrial base and has responsibility for transferring space technology to Canadian industry and helping maximize participation of that industry in fast growing domestic and foreign space markets.[32]

The communications research branch of the Department is the Communications Research Centre (CRC) in Ottawa. The Communications Research Centre employs about 500 people—including 150 scientists and engineers and 150 electronic technologists and technicians. The CRC laboratories and support units cover 23,000 square metres with transmitting and receiving facilities and other facilities occupying an adjacent area.[33]

The Communications Research Centre is the public sector repository of scientific expertise in such fields as satellite communications systems and technology, radio propagation, electro-optics, radar, remote sensing and microwave technology.[34]

The functions of the Communications Research Centre are numerous. The CRC carries out research and development on new communications technology in both basic and applied research. The CRC provides advice and scientific support for the Department of Communications policy formulation and spectrum management responsibilities. The CRC also undertakes research for other government departments which include the Departments of National Defence; Energy, Mines and Resources; Environment; and Transport.[35]

The Communications Research Centre also helps the Department of Communications to analyse and evaluate the performance and prospects of the satellite telecommunications industry in Canada. The CRC can validate and supplement industrial data and evaluate the relative costs and effectiveness of alternative communications systems and methods. An illustration of this would be the determination of the appropriate mix of terrestrial and satellite-borne long-haul microwave transmission facilities.[36]

Communications Research Centre research and development work comprise five major programme areas:

. Remote communications, which aims to strengthen telephone, data, radio, live television and other links for education and entertainment among communities in Canada's remote areas and between people in the north and south of the country. Work under way in this area includes system studies of intra- and inter-community communications needs, an integrated HF/VHF communications system, and an investigation of the possibilities of ionospheric modification.[37]

. Rural communications, with priority programmes directed towards bettering Canada's rural networks through improved radio and guided-optical systems.[38]

. Urban communications,, to foster, develop and introduce new communications systems, facilities and resources. Image, broadband and computer communications are emphasized.[39]

. Spectrum management support, with major objectives in the study of interference and noise in the HF, VHF and lower UHF bands; development of propagation models from climatic and topographic data and of means for measuring and studying spectrum occupancy, automatically and at high speed.[40]

. Research in support of other departments, containing an important set of activities on behalf of half a dozen or more other departments and agencies of the Government of Canada.[41]

The key principle that lies behind the Department of Communications/Communications Research Centre research policy is that there is a presumption against research work being performed "in-house", if it is possible to perform the work "externally" in Canadian private industry or at a Canadian university. This comprises the Canadian Government's "make or buy" policy.[42]

This contracting-out principle is applied to the widest degree possible in Department of Communications programs. Industrial contracts totalled over 65 per cent of the 1977/1978 DOC space program budget. The corresponding figure for 1978/1979 was 85 per cent, amounting to about $33 million.[43]

The major aim of the Department of Communications space programmes is to promote technological developments in Canadian industry that will meet the Department's objectives, by demonstrating the technical feasibility of space components and techniques. This will have the ultimate goal of placing Canada in a position to manufacture marketable space products of advanced design for its own use and for export.[44]

One practical side effect of this promotion of Canadian industry has been an increased degree of Canadian industrial participation as the nation's space programme advanced. The success of each stage of the space programme has enhanced Canadian capabilities in the design and manufacture of spacecraft components and sub-systems. There has been a corresponding capacity for Canada to specify, assess and produce its own space communications systems.[45]

At present, this policy of increased industrial participation has placed Canada as a world leader in the space technology of 14/12 GHz transmission to small low-cost earth stations in private homes. The success of Hermes and the Anik B programs have also allowed experts and planners with an opportunity to assess the impact and the feasibility of the new broadcasting services such technology makes possible. The most pressing issue is the possibility of a commercial mass market for the new 14/12 GHz technology.[46]

The Department of Communications works with other government departments to ensure maximum industrial participation in space activities, consistent with industry capabilities and desires. There are, for example, ongoing efforts to foster a spacecraft prime contractor capability in Canada and a program is underway to expand the Department's David Florida Laboratory in Ottawa to include facilities for integrating and testing complete, large satellites. In addition, negotiations with Telesat Canada helped provide Canadian industry with the highest practical level of subcontract business for construction of the Anik C series.[47]

The Department of Communications also administers an industrial contract program, begun in 1976, to encourage industry to develop components and subsystems expected to be required for future Canadian satellite programs. Industry participation during the first two years of the program has been highly successful. More than $700,000 was contracted to Canadian firms during 1977/78, with program funds budgeted at $2 million for 1978/79.[48]

While the Department has contributed directly to a continuing program throughout the federal government to support Canada's industrial base (particularly in high-risk areas of advanced research), it has also provided various departments with expert advice in the evaluation of ongoing industrial assistance programs in the aerospace field. Technology developments have accelerated the general shift towards increased use of satellites for communications and other applications. Advances in both systems and earth terminal technology will affect Canadian industry. Current government programs that will aid application of domestic technology and industrial development include MUSAT, SARSAT, Hermes, and the Anik B communications program.[49]

MUSAT, the multi-purpose UHF satellite system, would provide a variety of mobile telecommunications services to remote areas of Canada. In the planning for several years, MUSAT would supply high-quality, 24-hour-a-day service to such users as the Department of National Defence, the Coast Guard and the Environment Department, in applications involving portable manpack stations, remote data platforms and voice, data and facsimile services for potentially hundreds of ships, aircraft and other mobile stations. The system proposed would use a UHF-SHF transponder aboard a three-axis stabilized satellite (with a second spacecraft as back-up). With development and testing of a technically feasible transponder, earth terminal channel unit and various system studies all but complete, the program entered the project definition phase later in 1979.[50]

Present MUSAT activities include planning, interpretation of user needs, preparation of communication system specifications, and definition of the communications control station for the system. Transponder studies and demonstrations under way will ensure viability of critical satellite subsystem components, within stringent passive intermodulation restraints. Development and production of a highly portable, low-cost earth terminal essential to the MUSAT system is also being planned.[51]

SARSAT is a Canada-US-France program to demonstrate an experimental search and rescue satellite system by 1981, using transponder packages designed, developed and built in Canada aboard polar-orbiting US weather satellites. A relatively simple satellite system could provide search and rescue authorities with quick alarm alerts and position fixes when aircraft or other emergency locator transmitters (ELTs) go off. Such a system would greatly reduce the time needed to locate and rescue survivors of air crashes and other disasters.[52]

The Department of Communications is providing technical management of the project and other major support to the defence department, which is responsible for aerial search and rescue in Canada. This country will also develop and specify a SARSAT ground station and participate in evaluation of the total system. Major impetus for the current project came with successful proof-of-concept demonstrations two years ago, during which the Communications Research Centre achieved accuracies as good as 2.5 km, using simulated "crash" signals and the Radio Amateur Satellite Corporation (AMSAT) Oscar-6 satellite.[53]

According to Canadian law, all non-scheduled commercial and private aircraft are required to carry Emergency Location Transmitters (ELTs). An aircraft flying at 10,000 feet can, in theory, detect an ELT signal within an area of 55,000 square miles since the aircraft has its horizon at 132 miles.[54]

In practice, the ELT system effectiveness has been hampered by errors caused by bad weather, magnetic disturbances and poor communications. Potential search areas can be extremely large and conventional search is usually undertaken at low altitudes by aircraft for the purpose of visual observations. Therefore, the conventional search process can be slow, especially as that there will usually only be aircraft in position to receive signals when a formal search has been initiated. Several hours may pass before an aircraft is even reported to be missing.[55]

Placing a SARSAT ELT receiver in a satellite at an altitude of 400 miles gives the receiver a horizon of 1700 miles and a signal reception area of nearly 9 million square miles. Also, the detection of an ELT signal in this area will be detected immediately, instead of with the time-lag that one has with conventional techniques.[56]

The location of the crash site is determined by a doppler analysis of the ELT signal received at the satellite as retransmitted to an earth station. Therefore, the signal provides the initial alarm and its doppler analysis then gives the location of the emergency within a few square miles of the 9 million square mile area. The frequency at which the SARSAT L-Band satellite transmitter operates is at 1543 MHZ or 1.543 GHz.[57]

The SARSAT system will feature three (3) Canadian-built transponders aboard U.S. satellites. Current Department activity includes systems definition work, development of a signal processor and curve-fitting algorithms for ground-based position detection, a look at a possible scanning receiver to process signals from more than one source at the same time and negotiations towards a Memorandum of Understanding. The Canadian electronics industry would benefit from the system through expenditures on space-borne repeaters and ground stations required to implement the system in Canada.[58]

SPAR Aerospace Limited on March 28th, 1979, received a $5.3 million contract from the Department of Supply and Services, acting for the Department of National Defence for the supply of three flight transponders for search and rescue satellites. The SARSAT Engineering Model is now in final testing. Flight 1 is well under way with slices being machined out, MFF assembly under way and some first module testing. Manufacture of the SARSAT transponder is being done at SPAR Aerospace Limited in Ste-Anne de Bellevue, P.Q.[59]

The Department of Communications is responsible for promotion and protection of Canadian telecommunications interests on the international scene. The departmental space program participates in several multi-national satellite communications projects, such as INMARSAT whose purpose is to deploy and operate satellites intended to improve maritime communications.[60]

The Department has been negotiating possible Canadian participation in a variety of European Space Agency (ESA) programs. Such cooperation with Europe would benefit Canadian industry, because procurement contracts placed by the agency in Canada would be proportional to this country's contribution. And a long-range objective of Canada/ESA negotiations was

establishment of industrial links to permit reciprocal arrangements for supply of components and subsystems.[61]
The ESA telecommunications program includes plans for an operational 14/12 GHz satellite system (OTS/ECS), a maritime satellite program (Marecs), a direct-broadcast program (Heavy Communications Platform) or H-Sat for short, an advanced systems and technology program (ASTP) and an aeronautical satellite program. During 1977, a detailed proposal was developed for Canadian industry to build a complete transponder and antennas for a high powered 12 GHz satellite.[62]

On December 9th, 1978, an agreement was reached between the federal government and the European Space Agency. This agreement establishes the framework for the cooperation of Canada in ESA activities. Article VI of the agreement states that Canada shall have a "fair industrial return" in relation "to the geographical distribution of work relating to the activities in which Canada participates."[63]

The Department has several projects under its "make-or-buy" policy and industrial contract fund program of special interest to Canadian industry. These include:

* an earth terminal technology development effort, aimed at stimulating technological advances and assuring highest possible levels of Canadian industrial participation;
* studies of digital communications systems for both low- and high-rate applications in advanced satellite systems;

* an SHF space technology effort, to help Canada maintain its competitive position in 14/12 GHz satellite components and sub-systems;
* definition of future requirements for devices and components for high-speed digital communications via satellite;
* work on spread spectrum modems, to improve reception of signals under poor signal-to-noise ratio conditions;
* a project to evaluate the feasibility to application of advanced devices in such circuitry components as band pass, programmable and coded filters, discriminators, demodulators and stable oscillators;
* provision of support to the military in advanced communication satellite studies;
* assessment of the technical and economic feasibility of unattended data retransmission platforms (DRPs) to transmit sensor-collected data through a satellite to a central ground facility;
* a project, aimed at establishment of a competitive Canadian industrial producer, to further the technology required for the highly-accurate antenna control and pointing capabilities future advanced satellites will need;
* a satellite and antenna structures development effort to help maintain Canadian capabilities in mechanical systems, satellite structures and related fields; and
* a spacecraft power sources project to develop new electronic battery-management systems, with the actual studies involved undertaken by industry.[64]

Two unique facilities, each situated at the Department's Communications Research Centre, just west of Ottawa, can assist industry in space systems research and development, including the design, testing and fabrication of satellite circuit components, subsystems and even the integration of entire spacecraft:

* The David Floridá Laboratory is well equipped for environmental testing assembly of satellites and space hardware. It has thermal/vacuum chambers of varying sizes and a range of systems for vibration, electromagnetic frequency, and RF interference testing.[65]

* The High Reliability Laboratory (HRL) in Ottawa is a unique national centre of expertise in development and application of techniques for assessing the reliability of electronic subsystems, components, devices and materials for space communications systems.[66]

A brief note should be mentioned in closing this chapter as to the contractual relationships that exist between the federal government and the research and development contractors in the satellite communications area. There is a highly complicated set of contracts that exists between the Department of Supply and Services of the federal government and these contractors. The Department of Supply and Services (DSS) is the procurement agency for the federal government and acts as the funding agent and the contract manager for government aerospace projects. The Scientific Authorities which are named in each contract are those government departments such as the Department of Communications which plan projects and oversee the design and development of government projects by private contractors. There is a highly complicated relationship that exists between the contractual Scientific Authorities, the Department of Supply and Services, and the research and development contractors.

There are two types of contracts which are used by the federal government. The first type is the Cost Reimbursable contract which is outlined in Form 1026 (S-100B) of the Department of Supply and Services. Cost reimbursable contracts are used for research and development projects where the costs are extremely difficult to foresee. The second type are fixed price contracts which are outlined in Form 1026 (S-100A) of the Department of Supply and Services. Fixed-price contracts are used for manufactured items of a standard type in which development costs are held to a minimum. In the fixed-price contract, the cost is easy to foresee because the product has been manufactured before and only slight modifications may be necessary to update the product.

The Department of Supply and Services cost reimbursable contracts are used in aerospace research and development projects as the primary type of contract. There contracts are not particularly complicated in themselves but rather in the pricing and financial aspects of these contracts. There is a highly complicated basis of payments for two types of costs called Labour Rates and General Administration Rates. These Rates go through three basic accounting cycles— the Rate estimate cycle, the approved Rate estimate cycle, and the audited Rate estimate cycle. All of these Rates require extensive adjustments for inflation and re-negotiations as the Rates go through the three cycles. The pricing, accounting and financing of these contracts thus involves an enormous amount of time.

This complicated Rate system operates within a "progress payment" system in which payment is made on a monthly basis, with the submission of a monthly progress report to prove that the work is being completed according to the program schedule. A certain percentage of each monthly payment will be withheld until the successful completion of the project as an incentive. These withheld payments are called "holdback payments."

The Department of National Defence has a parallel set of contracts. There are fixed-price contracts which are outlined in Form 1026A of the Department of Supply and Services. There are also cost reimbursable contracts which are outlined in Form 1026B of the Department of Supply and Services. These defence contracts are similar in content to the civil contracts.

Supplementary contractual documents deal with special areas. Form 1024 of the Department of Supply and Services deals with insurance. Form 1031 of the Department of Supply and Services deals with the pricing and cost structure of cost reimbursable contracts. Form 1031 is also known as the Costing Memorandum. Form 1036 of the Department of Supply and Services deals with research and development. Therefore, one deals with four major contractual forms and three supplementary forms of contracts.

The profit structure can vary depending on the type of contract that a company has made with the Department of Supply and Services. Fixed-price contracts are usually on competitive bids which, due to market constraints, usually have a profit ceiling of 10 to 15 per cent. Cost reimbursable contracts have a maximum profit ceiling of 7.5 per cent.

The US government has the target-price contract system which allows for a greater incentive for completion within the contractual schedule. The target-price contract allows for an increase or decrease in the profit levels which are related to the proximity of the time of completion. If a contractor finishes his project on time, the company will have a profit level of 10 per cent. If the contractor has not completed his program within the contractual schedule, the company will have a minimum profit level of 7.5 per cent as a penalty for late delivery. If the contractor completes the program before the scheduled completion date, the company could attain the maximum profit ceiling of 15 per cent. Therefore, the target-price contract system will vary the profit level from 7.5 to 15 per cent, in relation to the performance of the contractor.

There are sharp variations between Canadian procurement law and US procurement law. American procurement contracts are more equitable to the contractor with more of a commercial basis to the terms and conditions. Canadian procurement law is inflexible and gives the Canadian government most of the advantages in the terms and conditions. One obvious example of this is the target-price system which was just discussed. A Canadian procurement contract will not award a contractor who gives the Canadian government an early delivery of the product, which would lessen the contract price, due to reduced labour and administration costs in a cost reimbursable contract.

Therefore, in this chapter it has been shown that the Department of Communications has entered into an agreement with Telesat Canada to develop a pre-operational capability to provide satellite telecommunications services in the 14/12 GHz band. The research and development program of the Department in the Anik B program is almost on the verge of pure commercial applications of this new technology. The Department of Communications is also involved in a number of key advanced satellite telecommunications projects such as MUSAT and SARSAT. A complicated number of research and development programs have been established by the Department which will ensure that Canada will remain as a leader in the field of satellite telecommunications for several years to come.

The next three chapters of this thesis will be devoted to an examination of the commercial application of satellite telecommunication technology in Canada. This involves a study of Telesat Canada and the Anik satellite programs. A case study will also be made of SPAR Aerospace Limited as the only Canadian company to achieve prime contractor status in this nation for satellite programs.

FOOTNOTES TO CHAPTER III

[1]N.G. Davies, J.W.B. Day, M.V. and M.V. Patriarche. The Transition from CTS/Hermes Communications Experiments to Anik-B Pilot Projects, Abstract for the Department of Communications CH 1352-4/78/0000-0 324, (Ottawa, Canada: 1978), p. 331.

[2]Ibid., p. 332.

[3]Department of Communications News Release, June 19, 1978, p. 4.

[4]Department of Communications News Release, December 12, 1978, p. 2. Also note that the lease (no contract number) of March 9th, 1977 has a precise value of $31,892,000 (CAN.) for the first two years.

[5]N.G. Davies, J.W.B. Day and M.V. Patriarche. The Transition from CTS/Hermes Communications Experiments to Anik-B Pilot Projects, p. 333.

[6]Ibid., p. 333.

[7]Ibid., pp. 333-334.

[8]Ibid., p. 334.

[9]Department of Communications News Release, September 25, 1979, p. 1.

[10]Ibid.

[11]Ibid., p. 2.

[12]Ibid.

[13]Ibid.

[14]Ibid., p. 3.

[15]Ibid.

[16]Department of Communications News Release, December 13, 1979, pp. 1 and 3.

[17]Ibid., pp. 2-3.

[18]Ibid., p. 1.

[19]Ibid., p. 2.

[20]Ibid.

[21]Telesat Canada News Release, September 15th, 1980, p. 1.

[22] Ibid., p. 2.

[23] Ibid.

[24] Ibid., p. 3.

[25] N.G. Davies, J.W.B. Day and M.V. Patriarche. The Transition from CTS/Hermes Communications Experiments to Anik-B Pilot Projects, pp. 332-333.

[26] Ibid., pp. 331-332.

[27] The beams operate at 14.00-14.48 GHz and 11.70-12.18 GHz with a channel width of 72 MHz.

[28] Ottawa Citizen, December 11th, 1975, p. 6.

[29] Department of Communications News Release, December 12, 1978, pp. 3-4.

[30] Department of Communications News Release, June 19, 1978, p. 4.

[31] Preface, Research and Development 1977-1978. A review prepared by the federal Department of Communications, (Ottawa, Canada: 1979), p. 5.

[32] T.A. Eastland. "Satellite communications and related applications", Research and Development 1977-1978, a review prepared by the federal Department of Communications, (Ottawa, Canada: 1979), p. 17.

[33] S.N. Ahmed, R.W. Cant, G.F. Carleton et al. Telecommunication Journal,, Volume 44-III, 1977, p. 119.

[34] Ibid.

[35] Ibid.

[36] Ibid.

[37] Ibid.

[38] Ibid.

[39] Ibid.

[40] Ibid., pp. 119-120.

[41] Ibid., p. 120.

[42] Ibid., p. 120.

[43] T.A. Eastland, "Satellite communications and Related applications", p. 17.

[44] S.N. Ahmed, R.W. Cant, G.F. Carleton et al. Telecommunications Journal, Volume 44-III, 1977, p. 120.

[45] Ibid.

[46] Ibid.

[47] T.A. Eastland, "Satellite communications and related applications", p. 17.

[48] Ibid.

[49] Ibid., pp. 17-18.

[50] Ibid., MUSAT Stands for Multiple Purpose UHF Satellite, pp. 22 and 40.

[51] Ibid., p. 40.

[52] Ibid., SARSAT stands for Search and Rescue Satellite, pp. 22 and 42.

[53] Ibid.

[54] Dr. F. Osborne, "SARSAT Scannings", Issue 2, February 1980, SPAR Aerospace Limited technical bulletin, p. 1.

[55] Ibid.

[56] Ibid.

[57] Ibid., pp. 1-2.

[58] T.A. Eastland, "Satellite communications and related applications", p. 22.

[59] Dr. F. Osborne, "SARSAT Scannings", p. 2. MFF stands for micro-circuit fabrication facility.

[60] T.A. Eastland, "Satellite communications and related applications", p. 23. INMARSAT stands for International Maritime Satellite Organization.

61 *Ibid.*

62 *Ibid.*

63 The agreement was an Agreement between the Canadian government and ESA signed on December 9th, 1978 with effect from January 1st, 1969. The legal reference is the Canada Treaty Series 1978 No. 23.

64 T.A. Eastland, "Satellite communications and related applications", pp. 23-24.

65 *Ibid.*, p. 24.

66 *Ibid.*

CHAPTER IV

TELESAT CANADA'S COMMERCIAL PROGRAMS (1969-1975)

Communications satellites were first developed almost 20 years ago. From that time satellites have been used to supplement terrestrial telecommunications systems and have had an increasingly favourable impact on the cost and the quality of global telecommunications. In the last decade, operational commercial communications satellites have become cost-effective substitutes for existing terrestrial systems. There are now about 70 operational or pre-operational communications satellites in orbit; their estimated total capacity is equivalent to about one million telephone circuits.[1] This chapter will outline the formation and development of the Telesat Canada system in its first five years of operation as part of the world-wide increase in the use of satellite communications technology.

The roots of Telesat Canada can be traced to the mid-1960's when a number of important events were made in relation to the subject matter of implementing operational satellite communications in Canada. Beginning in 1966, the Board of Broadcast Governors (BBG) received several applications for domestic satellite systems in relation to broadcasting and telecommunications distribution. Therefore, Canadian industry was early to appreciate the capacity for a domestic satellite communications system in this nation.[2]

In 1967, the TransCanada Telephone System (TCTS) and Canadian National-Canadian Pacific Telecommunications (CNCP) proposed to "establish and maintain a Canadian communications satellite system, and to operate it in conjunction with radio-relay and other terrestrial facilities in meeting present and foreseeable Canadian domestic telecommunications needs" and "to accept financial responsibility for this satellite system— in full or to whatever degree national policy may suggest."[3]

The TCTS/CNCP proposal stressed complementarity in that the carrier's proposal was introduced to allow the telecommunications carriers to operate a satellite service as a complement to the terrestrial service and not as a competitor.[4] The TCTS/CNCP proposal had the following vision of the future in recommending the provision of service to the North, followed by full Canadian service and "the scientific and industrial research and development required to produce a new generation of satellites beyond 1975. These could be Canadian in concept and construction, designed to meet particular Canadian requirements in the late 1970's and beyond."[5]

The Science Secretariat of the Canadian government commissioned a study entitled "Upper Atmosphere and Space Programs in Canada" in 1966.[6] This was followed by a report of the Science Council of Canada.[7] In 1967 both reports were published which called for early action on a Canadian satellite communications system. These studies led to the formation of a Task Force under the Science Secretariat to study and advise the federal government on the subject matter of satellite policy and on the use of domestic satellite communications for Canada.

The Task Force report was published in 1968 as a government White Paper entitled "A Domestic Satellite Communication System for Canada".[8] One of the key conclusions of this report was that a Canadian domestic satellite communications system was of "vital importance to the growth, prosperity and unity of Canada and should be established as a matter of priority."[9]

This White Paper set the guidelines for the development of domestic satellite communications for the next 12 years. The government of Canada would "participate in an appropriate manner with private interests"[10] in the ownership of single system, comprising satellites and earth stations, which would "compete effectively in those areas where competition is appropriate".[11] It was foreseen that "the availability of as many competitive means of long distance transmission as possible is an advantage to the telephone companies, to the broadcasters and, consequently, to the customers".[12] The telecommunications carriers agreed to cooperate but reiterated their preference for a carrier-owned system which would be a supplement and not a competitor to the terrestrial telecommunications system.

The White Paper had a model for federal government and industry participation in the proposed Canadian domestic satellite communications system. The White Paper contained the following policy in relation to the proposed satellite system:

> The Government envisages a domestic satellite communications system which would offer a nationwide television service in both English and French. The system would permit the introduction of this same television service to any remote area, including the North, which cannot be economically served by conventional systems. It would also provide telephone service to many of the same areas, and it would supplement the transmission of television, telephone and data service over the long-distance routes covered by microwave networks.[13]

The core of the White Paper dealt with the creation of a corporation to own and operate the proposed communications system. The White Paper stated the following in relation to this subject matter:

> Having carefully considered the relative merits of public and private ownership of satellite facilities, the Government will propose that a corporation be formed by special statute of Parliament to develop, own and operate both the satellites and the earth stations of the system, consistent with relevant international agreements. The Government will propose to encourage private participation in the Corporation and to this end will initiate discussions with the interested parties. The pattern of ownership needed to maintain effective Government control in those matters involving national interest will emerge from these discussions. The proposed legislation would provide not only for the establishment of the Corporation, but would also indicate the general nature and scope of the regulation contemplated for the system, in the light of the general legislation for telecommunications.[14]

Legislation was drafted to create a corporation to plan, design, build and operate a Canadian system of communications by satellite. This draft legislation was introduced in the Canadian Parliament in 1968 as Bill C-184 and the statute, The Telesat Canada Act, was passed and received Royal Assent on June 27th, 1969.[15]

The Telesat Canada Act of 1969 followed the lines of the White Paper in specifying that the share capital should be divided between the government, the telecommunications carriers and the public, but the legislation retreated from the competitive aspects of the White Paper. In introducing the Act, the Hon. Eric Kierans, then the Minister of Communications, said, "The Corporation will operate as a complement, not as a competitor, to the common carriers."[16]

The proclamation of the Telesat Canada Act on September 1st, 1969, marked the first day of Telesat Canada's existence as a corporation. On September 2nd, 1969, Telesat Canada began official business on two small floors of a small building at 110 Argyle Street in Ottawa with a permanent staff of one consisting of Mr. D.A. Golden, Telesat President and former President of the Air Industries Association of Canada. The 30 other people working for Telesat Canada at this time were on loan from government and industry, and most had been involved in the field of satellite communications for some time.[17]

In mid-September 1969, a Board of Provisional Directors was appointed by Order-in-Council. The Provisional Board was made up of: A.G. Archibald, President and Chairman of the Board of Maritime Telegraph and Telephone Company Ltd.; Dr. J.H. Chapman, Assistant Deputy Minister, Department of Communications; Z.H. Krupski, Chairman of the Trans Canada Telephone System; J. Alphonse Ouimet, former President of the Canadian Broadcasting

Corporation; L.A. Picard, Executive Vice-President of the CBC; R.D. Southern, President of ATCO Industries Limited; Telesat President D.A. Golden was also a member of the Board. Mr. Ouimet was elected Chairman of the Board.[18]

During these first four months to the end of 1969, Telesat Canada began to set up an organizational structure with a permanent staff. By the year's end, Telesat Canada had a permanent staff of 45 which had been recruited from government and industry. The establishment of an effective organization was the primary function of Telesat Canada at this time.[19]

During this time period, Telesat Canada negotiated a contract with RCA Limited, of Montreal, to define a Program Definition Phase of the Canadian domestic telecommunications satellite project. Telesat Canada also was financed during this period by loans from the Government of Canada in the amount of $9.8 million. Finally, the Department of Communications, in November 1969, announced the winner in a contest to name Telesat Canada's new satellite. A panel of judges, which included Dr. Marshall McLuhan, selected the name Anik, which means "brother" in Inuit which had been proposed by one Mary Frances Czapla, a supermarket employee in St. Leonard, in the Province of Quebec.[20]

Early in 1970, Telesat Canada moved from its temporary offices in the centre of Ottawa to two full floors in a new office complex at 333 River Road on the Rideau River in the suburban city of Vanier. The first full operation year of Telesat Canada was marked by a number of important events. One milestone was the conclusion of the pre-implementation contracts and studies for a Canadian domestic satellite communications system coupled with the award of the first spacecraft contract for three Anik satellites to the Hughes Aircraft Company of Los Angeles. There had been fierce competition between Hughes Aircraft and RCA Limited and an element of Canadian nationalism had played a role, due to the intense interest of the media.[21]

The $31 Million (U.S.) contract for three Anik A Series spacecraft named Hughes Aircraft Company as the prime contractor for the project in September 1970. Major Canadian subcontractors included Northern Electric Company of Lucerne, Quebec, and SPAR Aerospace Products Ltd. of Malton, Ontario. Canadian content in the building of the Anik A contract amounted to approximately 20 per cent of the contract price, with a contractual provision for Canadian content of similar value in future Anik A-type satellites sold by Hughes Aircraft Company in the world market.[22]

The permanent staff of Telesat Canada (which numbered 96 at the end of 1970) was deeply involved in several functions. One group was involved in converting customers' requirements into technical specifications for the earth stations in the terrestrial segment of the Anik A system. Another group was involved in negotiations with the National Aeronautics and Space Administration (NASA) in the United States for the launch vehicle for the first Anik A satellite. A third group was involved in supervising the construction of the satellite and its components in plants in Canada and the United States.[23]

The year 1970 was also notable in that Telesat Canada completed the year in a debt-free situation due to the initial issue of common shares to the federal government and the major Canadian telecommunications common carriers. These public and private interests subscribed for a total of 6,000,001 common shares in the company. The common shares, without nominal or par value, were issued at $10 a share. One third of the total allotment was acquired in 1970 and the remaining 4,000,000 shares were purchased at intervals to March 1st, 1972, which provided Telesat Canada with $60 million of the projected $90 million financing required to the commencement of commercial operations in 1973.[24]

During the year 1970, the original Provisional Board of Directors was re-structured. The new structure, which is the present structure, consists of an 11-member Board of Directors. The composition of this Board contains five members which are appointed by the federal government; five members, which are elected from the common shareholders' telecommunications common carriers; and the President of Telesat Canada who holds one common share representing "persons who fulfill the statutory conditions."[25]

The common shareholders' telecommunication common carriers hold 3,000,000 of the total allotment of shares issued between 1970 and 1972. The federal government holds 3,000,000 common shares and the Telesat President, D.A. Golden, holds one common share. The telecommunication common carriers which divide these 3,000,000 common shares are the following: Alberta Government Telephone, Bell Canada, British Columbia Telephone Company, Canadian National, Canadian Pacific, Maritime Telegraph and Telephone Co. Ltd., Newfoundland Telephone Co. Ltd., Ontario Northland Transportation Commission, Quebec-Telephone, Saskatchewan Telecommunications, the Island Telephone Company Ltd., The Manitoba Telephone system, the New Brunswick Telephone Co. Ltd.[26]

The year 1971 for Telesat Canada dealt with preparation for the launch of the first Anik A satellite, as well as planning for the earth station system. In May 1971, a launch agreement was signed between Telesat Canada and NASA for the first two Anik A satellites. The Satellite Control Centre was installed on the 12th floor of Telesat Canada's Ottawa headquarters. Service agreements were also being negotiated between Telesat Canada and its first customers such as Bell Canada, the Canadian Broadcasting Corporation, CNCP Telecommunications, and the Canadian Overseas Telecommunication Corporation which is now Teleglobe Canada.[27]

In 1971, the initial plans for the earth stations were completed. Three contracts for the construction of 37 earth stations in Telesat Canada's system with a combined value of $16 million (CAN.) were awarded in May 1971 to RCA Limited, Montreal, Que., Raytheon Canada Ltd., Waterloo, Ont., and Philco-Ford Corporation of Canada, Toronto, Ont. The master station in the earth station system was being built at Allan Park near Hanover, Ontario, so that the site would be ready for the installation of the earth station antennas the following year. At Lake Cowichan, B.C., another major earth station site was being made ready for the following year.[28]

All across Canada, groups of surveyors and engineers were preparing the network of earth stations. These groups travelled to such isolated points as Yellowknife and Frobisher Bay in the Northwest Territories, as well as Faro and Dawson City in the Yukon Territory. Therefore, tangible signs of a network of earth stations began to appear from a world of paper plans and contractual specifications.[29]

The year 1972 was marked by the successful launch of Anik A 1 at 8:14 p.m. EST on November 9th at Cape Canaveral, Florida. This spectacular achievement was the climax to 39 months of effort by the permanent staff of Telesat Canada which now numbered 212 employees. Twenty-six minutes after the lift-off of Anik A 1, controllers in the Satellite Control Centre of Telesat Canada in Ottawa assumed command of the communications satellite and spent the next 15 days maneuvering the satellite to its geostationary position at 104 degrees West Longitude.[30]

The Anik A 1 satellite, as part of the Anik A series, is a spin stabilized satellite with despun antenna designed to give Canadian coverage by microwave communications in the 6/4 GHz bands. Each Anik A series satellite has 12 high capacity microwave channels and uses 10 channels continuously with two channels for standby purposes. More technical details on the Anik A series satellites will be given later on in this chapter.

The successful launch of Anik A 1 was the key achievement of Telesat Canada in 1972, but several other developments took place during this year which were noteworthy. By the early fall of 1972, the system of satellite earth stations was tested and ready to receive signals from the Anik A 1 satellite. At Lake Cowichan, B.C., and Allan Park, Ont., the 30 m dish antennas of the Heavy Route stations had been lifted into their pedestals. The large Network Television and Northern Telecommunications earth stations had been established at their points in the satellite system. Finally, the smaller earth stations had been delivered by Raytheon Canada of Waterloo, Ont., in their containers all across Canada and subsequently assembled for operational use.[31]

During the summer and fall of 1972, Telesat Canada and its customers, TCTS and CNCP Telecommunications, Bell Canada, and the Canadian Broadcasting Corporation signed a series of service agreements which covered satellite message and broadcast services on seven Anik A-1 channels in eight provinces and the Yukon and the Northwest Territories. Each of the contracts was for a five-year term with one-year option clauses. These contracts produced some $127 million in revenues for Telesat Canada over the contract and option periods.[32] There were three basic agreements which were as follows:

(1) Telesat Canada and the Canadian Broadcasting Corporation (CBC) signed a five-year contract at $45 million with a one-year option clause to provide satellite distribution of national English and French television networks over three Anik A-1 channels.[33]

(2) Telesat Canada and TCTS, CNCP Telecommunications signed a five-year contract at $30 million with a one-year option clause to provide for Heavy Route trunk message service between Vancouver and Toronto over two Anik A-1 channels.[34]

(3) Telesat Canada and Bell Canada signed a five-year contract at $30 million with a one-year option clause for Medium Density and Thin Route message services in the Eastern Arctic using two Anik A-1 channels. In December 1972, Bell Canada announced its intention to expand its service in the Eastern Arctic with an additional 15 Thin Route message stations.[35]

Another key event in 1972 occurred in December when Telesat Canada and RCA Global Communications/RCA Alaska

Communications and American Satellite Corporation signed a Memorandum of Agreement to provide domestic service between Alaska and the lower 48 states in the continental United States. This agreement would only last until this American service could be transferred to American owned satellites. This lease covered up to five channels on the Anik A series satellite system.[36]

The Memorandum of Agreement dealing with the Alaskan satellite service was subject to the condition of approval by the governments of both countries, as well as approval by the Parliament of Canada to an amendment to the Telesat Canada Act permitting it to provide services outside Canada. All of these procedures had to be fulfilled in order for the agreement to enter into force. The Canadian Parliament considered amendments to sections 5 and 6 of the Telesat Canada Act to allow for satellite services outside of Canada under inter-governmental agreements.[37]

The year 1973 began with the historic inauguration of commercial service on the Anik A-1 communications satellite on January 11th. On this date Communications Minister Gérard Pelletier and Resolute Bay Settlement Manager, Ludi Pudluk, inaugurated this commercial service by a telephone call between them. This telephone conversation was carried on the Bell Canada Northern Service channel. In February 1973, the first Bell Canada Thin Route Service was inaugurated at Pangnirtung and Igloolik in the Northwest Territories. In the same month, an interim CBC network television service was inaugurated in seven Arctic communities.[38]

On April 20th, 1973, Anik A-2 was launched into orbit from Cape Canaveral. The communications satellite was launched into geostationary orbit at 109 degrees West Longitude. Anik A-2 was used to provide U.S. television services between the lower 48 states and Alaska for RCA Global Communications and RCA Alaska Communications. The American services were transferred to the first American domestic commercial communications satellite, Western Union's Westar 1 in June 1975.[39]

At the beginning of 1973, the Telesat Canada satellite system began commercial operations with one satellite and four earth stations. By the end of 1973, the satellite system comprised two satellites and 34 earth stations which were providing television, radio and telephone services for five major Canadian customers. There was an extremely high reliability in the satellite system from the beginning of commercial operations. By the fourth quarter of 1973, the satellite system was operating effectively for 99.99% of the message services. Similar levels were being achieved for television services.[40]

The year 1973 was also marked by an expansion of the Telesat Canada system along territorial lines. In February 1973 Telesat Canada's application for changes to its letters patent was approved by the Parliament of Canada which allowed the satellite company to serve points outside the territory of

Canada. In December 1973, a service agreement was signed between Telesat Canada and the Canadian Overseas Telecommunication Corporation (now Teleglobe Canada) for a satellite link between the CANTAT II Atlantic cable terminal at Harrietsfield, N.S. and Toronto, Ont.[41]

Therefore, 1973 was an extremely successful year for Telesat Canada in relation to its commercial operations on a technical level. On the financial level, Telesat Canada's revenues in its first year of commercial operations amounted to $19 million. The net earnings or the the profit was $1.6 million or about 26 cents per common share.[42]

The year 1974 was marked by a very strong growth in the Telesat Canada satellite system. The operating revenues in the second year of commercial operations increased from $19.0 million to $28.0 million by the end of 1974. Net earnings or profit increased by $2.0 million from the previous year to a final profit of $3.6 million by the end of 1974. The earnings per common share increased from 26 to 61 cents. On the technical side, the number of satellite channels in commercial service increased by 44% and the number of earth stations in service increased by 40%. In addition, there was a significant increase in the capacity of existing earth stations which were upgraded to provide additional satellite services.[43]

Major contributions to this increased financial and technical growth included the utilization of the Telesat Canada system by RCA Global Communications and RCA Alaska Communications on an interim basis until service by U.S. domestic satellites. Another factor was the expansion of the Thin Route service of Bell Canada in the Eastern Arctic as well as the service provided to the Canadian Overseas Telecommunications Corporation. Another important element in the growth of Telesat Canada was the Canadian Broadcasting Corporation's Accelerated Coverage Plan in which television and radio service was to be provided to all Canadian communities of over 500 and 200 population respectively. In relation to the CBC Plan, Telesat Canada placed a $1.2 million contract with RCA Limited, Montreal, for radio receiver equipment at 16 projected earth stations.[44]

One promising technical development that took place in 1974 was the development by Telesat Canada of the AniKom transportable earth stations with a 3.6 m antenna. These small earth stations can be transportable on an aircraft of the Twin Otter class and may be erected within a few hours of delivery. The AniKom earth stations opened up a new market to provide for reliable communications between isolated communities such as drilling and mining exploration sites and their parent headquarters in southern Canada. In February 1974, a successful three-month trial of these earth stations began at the MacKenzie Delta oil exploration camps. The first such station that went into actual operational service was at the Panarctic Oil

Company's main base at Rea Point on Melville Island at 75 degree 21' North Latitude-Telesat Canada's most northerly point of service.[45]

One key event in 1974 which had an obvious impact on Telesat Canada was the adoption by the federal government of "A Canadian Policy for Space".[46] This was a policy statement which had a wide-ranging impact on all sectors of Canada's space community. The federal government policy statement consisted of the following items:

(1) The federal government endorsed the principle that a Canadian industrial capability for the design and construction of space systems should be maintained and improved through a deliberate policy of moving government space research and development out into private industry.[47]

(2) Federal government purchasing policies should encourage the establishment of a viable research, development and manufacturing capability in Canadian industry.[48]

(3) Canada would continue to rely on other nations for launch vehicles and services and Canada should enhance access to such launch services by participating in the supplying nation's space program.[49]

(4) The federal government departments involved should submit plans to ensure that, to the fullest extent possible, Canada's satellite systems would be designed, developed and constructed in Canada, by Canadians, using Canadian components.[50]

(5) Canada's primary interest in space should be to use it for applications that would contribute directly to the achievement of national goals.[51]

(6) Utilization of space systems for the achievement of specific goals should be through activities proposed and budgeted by departments and agencies within their established mandates.[52]

(7) At the international level, Canada's ability to use space should be furthered by participating in international activities for the use and regulation of activities in space, negotiating agreements for the continuing access to science, technology and required facilities, and maintaining knowledge of foreign space activities in order to respond quickly to potential opportunities and threats to Canada's national sovereignty.[53]

(8) At the national level, Canada's ability to use space should be furthered by the support of research appropriate to the need to understand the properties of space, the potentialities of space systems, and the search for potential applications, and technology programs to develop the industrial capability essential to meeting further requirements for operational space systems.[54]

This policy statement entitled "A Canadian Policy for Space" clearly set down parameters which would affect Telesat Canada directly and indirectly. The provisions dealing with the "Canadianization" of the space industry would have an influence upon the procurement policies of Telesat Canada.

Obviously, the federal government, as part owner of Telesat Canada, would seek to apply its policies to Telesat Canada.

It should be carefully noted, however, that section 5 (2) of the Telesat Canada Act of 1969 already had specific directives in relation to the utilization of Canadian resources and capabilities in relation to the Telesat Canada satellite system. One can conclude that the policy stated in the Telesat Canada Act of 1969 was repeated and more sharply emphasized in the general policy statement of 1974. Clearly, Canada was moving in the direction of a prime contractor role for Canadian industry as the next step in the "Canadianization" of the space industry.

The year 1975 for Telesat Canada was marked by the successful launching of the last of the Anik A series satellites. Anik A-3 was launched on May 7th, 1975, and went into geostationary orbit at 114 degrees West Longitude. In November 1975, Anik A-3 went into service as Telesat Canada's primary service satellite. In June 1975, the interim service that Telesat Canada had been providing between Alaska and the American mainland was terminated. The United States Federal Communications Commission (FCC) ordered RCA Global Communications and RCA Alaska Communications to switch to an American domestic satellite. The FCC order exempted the service provided by RCA on the Telesat Canada system for the U.S. Defence Department between Thule, Greenland and the United States mainland.[55]

Despite the loss of the lucrative lease to the RCA companies, Telesat Canada maintained its profit margin in 1975 at $3.6 million or 61 cents per common share. In July 1975, Telesat Canada declared and paid its first dividend of 10 cents per common share. Therefore, the financial situation of Telesat Canada remained stable in 1975 despite the loss of a customer of up to five channels on the Anik A series satellites.[56]

A key event in December 1975 occurred when Telesat Canada awarded the Anik B contract worth $19.1 million (U.S.) to RCA Astro-Electronic Division of Hightstown, New Jersey, as the prime contractor. Anik B was planned as the second generation satellite for the Telesat Canada system. Anik B was to be the world's first domestic satellite providing commercial services in both the 6/4 GHz and the higher 14/12 GHz frequency bands.[57]

The hybrid nature of Anik B rested in a mixture of Telesat Canada's requirements and those of the Department of Communications of the federal government. The federal government would have a satellite for experiments in the higher frequency range following the end of the Hermes program. Telesat Canada would have a satellite to replace the first of the Anik A series satellites that would come to the end of their design life-expectancy of seven years.[58]

Therefore, Anik B marked a fusion of the requirements of Telesat Canada and the Department of Communications. The Anik B payload was planned to contain six 14/12 GHz channels which would be leased by the Department of Communications at commercial rates. The Anik B communications payload would also carry twelve 6/4 GHz channels for commercial communications. The result was a hybrid satellite which would have purely experimental and commercial functions.[59] In the next chapter, a more detailed description will be given of the Anik B program.

The Anik A series satellites are technically interchangeable. Each satellite has 12 microwave channels at 6/4 GHz frequency of which 10 channels are continually operational and two channels have a standby function. Each 6/4 GHz channel can carry one television program or 960 voice circuits. All three Anik A satellites were placed into geostationary orbit from Cape Canaveral, Florida, by three-stage Delta launch vehicles. The Anik A-1 and the Anik A-2 were each launched by a Delta 1914 and the Anik A-3 was launched by a Delta 2914.[60]

Anik A-1 was launched on November 9th, 1972, and was the world's first domestic geosynchronous communications satellite. Anik A-2 was placed into geosynchronous orbit on April 20th, 1973, and Anik A-3 was placed into the same type of orbit on May 7th, 1975. The Anik A series satellites have geosynchronous orbital speeds of 11,062 kilometres per hour. They are placed 36,000 kilometres above the equator of the earth at 104 degrees, 109 degrees, and 114 degrees West Longitude in numerical order.[61]

Originally, Anik A 2 and Anik A 3 were orbited to provide back-up support in space for Anik A 1. With this support, there was an assurance of reliable, uninterrupted communications service as well as the capacity to meet requirements for increases in service. At this time, Anik A 3 is the primary operational communications satellite, and Anik A 2 and Anik A 3 provide the back-up and additional microwave channel capacity. The design-life of an Anik A series satellite is seven years. At the present rates of consumption, fuel reserves for Anik A 1, Anik A 2, and Anik A 3 are estimated to be sufficient for operational capacity until 1980, 1981 and 1983 respectively.[62]

The Anik A series satellites are spin stabilized satellites with despun antenna which weighed approximately 560 kg at the time of launch. The Anik A series satellites are 1.78 metres in diameter and are 3.4 metres high. Telesat Canada had a $31 million (U.S.) contract with Hughes Aircraft Company for the three Anik A series satellites. Each launching of the Anik A series satellites has been fixed at $7 million (CAN.) per launch for a total launch cost of $21 million (CAN.) for the three satellites.[63]

A brief note should be added as to the technical specifications of the 48 earth stations that were in existence in 1975. The Heavy Route ~~stations~~ ions at Allan Park, Ont., and Lake Cowichan, B.C., have 30 metre antennas to deal with high-density service links. Earth stations also carried 10 metre and 8 metre antennas to carry network television and handle northern communications.. Earth stations also carried 4.6 metre antennas to handle Thin Route services, remote television reception, and message service. The smallest earth station antenna in the Telesat Canada system were the 3.6 metre transportable Anikom antennas. These are mobile, semi-permanent earth stations which were developed by Telesat Canada to meet the demand for telecommunications services in remote regions. Weighing 953 kilograms, these earth stations can provide voice, facsimile, teletype and data services in isolated Northern communities.[64]

Therefore, Telesat Canada by the end of 1975 had achieved a great success. The organization was turning in strong annual profits and in 1975 this young organization had enough earnings to pay a dividend. In 1969, Telesat Canada was merely a paper organization with no permanent staff, no corporate income, no assets, no contracts, no customers, and no satellite experience. However, within five years, Telesat Canada was an efficient profitable organization which was managing a system of satellite communications covering the second largest nation in the world.

The authorized capital stock that is defined in section 10 of the Telesat Canada Act is comprised of 10,000,000 common shares without nominal or par value and 5,000,000 preferred shares with a nominal or par value of $10 per share. The only issue of shares was 6,000,001 common shares for a stated value of $60,000,010 or $10 per common share. This issuance of shares between 1970 and 1972 remains the only issued capital stock of Telesat Canada to this date. Therefore, the financing structure of Telesat Canada has been one of initial financing through capital stock followed by financing from loans from the federal government and commercial banks as well as cash derived from earnings.

By 1975, Telesat Canada had achieved the success required to operate a 6/4 GHz communications system at a profit. On May 7th, 1975, Telesat President D.A. Golden stated the following: "Virtually every objective of the program Telesat devised during 1970 and 1971 to create a satellite system for Canada has been attained."[65] In an address to the American Institute of Aeronautics and Astronautics on January 29th, 1974, the Telesat President also stated that "With a year of operational experience of Anik A-1 and some eight months on Anik A-2, the overall performance of the system has exceeded expectations . . . we have been able to translate theory into practice."[66] Therefore, Telesat Canada had achieved a baseline success in the operation of a domestic satellite communications system for Canada.

Greater challenges would lie in the future for Telesat Canada after 1975. The technological explosion in the late 1970's as well as the 1980's has forced and will continue to force Telesat Canada to adapt to changing conditions. Several technological possibilities were already on the horizon which the Hon. Eric Kierans, Canada's first Minister of Communications, predicted in 1969. He stated the following:

> Telesat Canada may orbit just a single satellite, it may serve its primary function of service to the North and supplementary East-West traffic, but never grow substantially beyond those limits. At the other end of the scale, Telesat may accomplish a great deal more, (referring to such technological applications as satellite-linked data banks in universities and libraries, nationwide electronic newspaper publishing, tele-medicine and tele-education services, electronic funds transfer and direct-to-home satellite signal reception). This is the spectrum of possibilities. At the lower end . . . we know what the satellite can do and what the demand for its services is. At the upper end, we get into Buck Rogers' territory, the difficulty being that these days science fiction has an uncomfortable habit of becoming fact.[67]

Coupled with these technological pressures to adapt to changing conditions, the federal government adapted a series of policy positions which would form a framework within which Telesat Canada would be forced to operate. In 1969, the Telesat Canada Act was passed directing Telesat Canada to utilize Canadian research, design, and industrial personnel, technology and facilities in research and development connected with its satellite systems.[68]

This "Canadian content" was to be used to the extent practicable and consistent with the commercial nature of Telesat Canada. This provision is contained in section 5 (2) of the Telesat Canada Act. Section 8 of the Telesat Canada Act also calls for the approval of the Minister of Communications to all Telesat Canada tenders for contract. This approval is based on the criteria that the tender for contract would result in a proposal from the contractor with a reasonable amount of "Canadian content" in the design and engineering skills as well as components and materials. Therefore, the federal government legislated a specific policy into the Telesat Canada Act to achieve a reasonable "Canadianization" of the space industry.

In 1974, the federal government issued a major policy statement entitled "A Canadian Policy for Space" which stated that federal governments should "to the fullest extent possible"[69] ensure that Canada's satellite systems are designed, developed and constructed in Canada, by Canadians, using Canadian components. This was a re-affirmation of the principle stated in the Telesat Canada Act as well as a stronger affirmation of the need to "Canadianize" the space industry through a preference in procurement policies by the federal government. As the owner of 3,000,000 of Telesat Canada's 6,000,001 common shares, it is fairly obvious that the federal government could bring an enormous amount of pressure on Telesat Canada to follow its policies in a very strict sense.

In 1975, the federal government issued a policy statement that the government should explore the setting-up of a prime contractor for Canadian spacecraft.[70] Also in 1975, the Interdepartmental Committee on Space (ICS) was provided with a permanent secretariat and given the task of coordinating spacecraft procurement activities so as to maintain a viable spacecraft manufacturing industry in Canada.[71] Also in 1975, the procurement of Anik B marked a fusion in the experimental requirements of the Department of Communications as well as the commercial requirements of Telesat Canada.

Therefore by 1975, Telesat Canada was an unqualified success in forming Canada's domestic communications satellite system. There were, however, severe challenges in the future, due to the extreme rapidity of technological change in this specialized marketplace. The next few years, as well as the future in general, would call for a quick adaption to new technological changes. Coupled with these technical changes, the federal government created a specific policy position which would greatly influence the behavior of Telesat Canada. The federal government holds a major block of the shares in Telesat Canada, as well as being a major consumer of Telesat Canada, through such entities as the Department of Communications, the Canadian Broadcasting Corporation, and Canadian National. The federal government and its policies obviously play an enormous role in the decision-making process of Telesat Canada.

The next chapter of this dissertation will deal with Telesat Canada from 1976 to 1980. In this chapter, I will deal with the subject matter of Anik B in greater detail. The commercial programs of Anik C and Anik D will also be dealt with. The bulk of the discussion deals with the development of 14/12

GHz technology on a commercial basis. This is the new frontier of technological development and Telesat Canada has played a pioneer role in the field in the late 1970's and the 1980's. There will also be a discussion of the critiques that have been made of the Telesat Canada system, as well as the defenders of this system.

FOOTNOTES TO CHAPTER IV

[1]T.A. Eastland, Satellite Communications and Related Applications, Research and Development 1977-1978, a review prepared by the federal Department of Communications, (Ottawa, Canada, 1979), p. 14.

[2]Telesat Canada, 1979 Annual Report, Ten Years and Counting, Prologue, p. 4.

[3]Roy Dohoo, Canada's Satellite Policies and How They Grew, in Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring, 1979), p. 16.

[4]Ibid., pp. 16-18.

[5]Ibid.

[6]J.H. Chapman, P.A. Forsyth, P.A. Lapp and G.N. Patterson, Upper Atmosphere and Space Programs in Canada, Special Study No. 1, Science Secretariat, Privy Council Office, (Ottawa, Canada: The Queen's Printer, 1967).

[7]A Space Program for Canada, Report No. 1, Science Council of Canada, O.M. Solandt, Chairman, (Ottawa, Canada: The Queen's Printer, 1967).

[8]Hon. C.M. Drury, Minister of Industry, White Paper on A Domestic Satellite Communication System for Canada, (Ottawa, Canada: The Queen's Printer, 1968).

[9]Ibid., p. 8.

[10]Ibid., paragraph 19, p. 58.

[11]Ibid., paragraph 16, p. 46.

[12]Ibid.

[13]Ibid., paragraph 25, p. 70.

[14]Ibid., paragraph 26, p. 70.

[15]The official reference is the Telesat Canada Act. 1968-69, c.51,s.1. This Act came into effect from and after September 1st, 1969 by proclamation of the federal Cabinet. The reference to the proclamation is The Canada Gazette No. 34 Vol CIII Part I on page 2049 dated August 23rd, 1969.

[16]Roy Dohoo, Canada's Satellite Policies and How They Grew, in Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring, 1979), p. 18.

[17]Anikdotes (Telesat Canada Internal Bulletin), Special Anniversary issue, Vol. 7, No. 17, September 5th, 1979, p. 2.

[18]Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 6. Also Order-in-Council P.C. 1969-1757 dated September 11th, 1969 (unpublished).

[19]Ibid., pp. 6-7.

[20]Ibid.

[21]Ibid., pp. 8-9.

[22]Ibid., p. 9. Also note that the contract reference number is Telesat Canada No. SP70SP004 September 30th, 1970 with a value of $31 million (U.S.).

[23]Ibid., p. 8.

[24]Ibid., p. 9.

[25]Ibid.

[26]Telesat, Symphonie, edited by N.M. Matte and M.M. Matte, Institute and Center of Air and Space Law, (McGill University, Montreal, Canada, 1978), p. 13.

[27]Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 10. Also note that the contract reference number for the launch agreement is Telesat Canada No. PDC1SPO024 May 10th, 1971 with no price that could be obtained by the public.

[28]Ibid.

[29]Ibid.

[30]Ibid., p. 12.

[31]Ibid.

[32]Ibid., pp. 12-13.

[33]Ibid., p. 13.

[34]Ibid.

[35]Ibid.

[36]Ibid., pp. 12-13. Also note that the Memorandum of Agreement (no contract number) of November 22nd, 1972 had a baseline rate of $100,000 (CAN.) per hour per channel. The lease had an annual revenue of approximately $9 million (CAN.).

[37]*Ibid.* Also it should be noted that the amending procedure to the company's objects is contained in section 33 of the Telesat Canada Act.

[38]*Ibid.*, pp. 14-15.

[39]*Ibid.*, p. 14.

[40]*Ibid.*

[41]*Ibid.*, pp. 14-15.

[42]*Ibid.*, p. 15.

[43]*Ibid.*, p. 16.

[44]*Ibid.*, pp. 16-17.

[45]*Ibid.*, p. 17.

[46]*The Canadian Space Program; Five-Year Plan (80/81-84/85)*, Serial no. DOC-6-79DP Discussion Paper, January 1980, Government of Canada, Department of Communications, pp. 7 and 17.

[47]*Ibid.*, p. 17.

[48]*Ibid.*

[49]*Ibid.*

[50]*Ibid.*

[51]*Ibid.*

[52]*Ibid.*

[53]*Ibid.*

[54]*Ibid.*

[55]Telesat Canada 1979 Annual Report, *Ten Years and Counting*, pp. 18-19.

[56]*Ibid.*, p. 19.

[57]*Ibid.*, p. 18. Also note that the contract reference number is Telesat Canada No. PDC5SP7505 December 9th, 1975 with a value of $19.1 million (U.S.).

[59] *Ibid.*

[60] Telesat Canada, *A Technical Description*, TC-79-001, September 1979, pp. 13-14 and 27-28.

[61] *Communications Satellites: The Canadian Experience*, External Affairs, Government of Canada, March 1979, p. 4.

[62] *Ibid.*

[63] Telesat Canada, *A Technical Description*, TC-79-001, September 1979, p. 1. The launch cost estimate was supplied by Nicolas Mateesco Matte, *Aerospace Law*, from Scientific Exploration to Commercial Utilization, The Carswell Company Limited, Toronto, Canada, 1977, p. 88, Footnote (27).

[64] Communications Satellites: *The Canadian Experience*, External Affairs, Government of Canada, pp. 4-7.

[65] Telesat Canada 1979 Annual Report, *Ten Years and Counting*, p. 18.

[66] *Ibid.*, p. 16.

[67] *Ibid.*, Message from the President, p. 2.

[68] *The Canadian Space Program; Five-Year Plan (80/81-84/85)*, Serial no. DOC-6-79DP Discussion Paper, Department of Communications, Government of Canada, January 1980, p. 16.

[69] *Ibid.*, p. 17.

[70] *Ibid.*

[71] *Ibid.*

CHAPTER V

TELESAT CANADA'S COMMERCIAL PROGRAMS (1976-1980)

1976 was an important year for Telesat Canada due to two important events. In 1976, the Summer Olympic Games were held in Montreal, Canada, which involved an enormous concentration of broadcasting facilities in Canada for that event. Telesat Canada carried out its normal functions of distributing the Canadian Broadcasting Company's national French and English television and radio services across the nation using satellite technology. Telesat Canada also played a key role in terms of international communications. Special transportable television transmitting stations at the various Olympic event sites relayed special programming for broadcasting companies in the competing nations direct by satellite to the Teleglobe earth stations near Halifax, N.S., and Victoria, B.C. These signals were then re-transmitted to Europe and the nations on the Pacific rim via the Atlantic and Pacific INTELSAT satellites.[1]

In late December 1976, after months of negotiations, an association agreement was reached between Telesat Canada and the TransCanada Telephone System (TCTS) under which Telesat Canada would become a member of the TCTS. The agreement was to become effective on January 1st, 1977. The association of Telesat Canada with the TCTS member companies would allow for joint planning of the development of the terrestrial and satellite systems. The association agreement would also allow for joint planning for the integration of the two types of technologies into a unified national system. The fusion of the terrestrial and the satellite telecommunications carriers would allow for a comprehensive national plan that would integrate all aspects of Canada's telecommunications technology.[2]

Parallel to these integration activities, detailed studies and plans were being developed to determine customer requirements in the 1980's by Telesat Canada as well as the TCTS member companies. Once customer requirements were determined for an integrated telecommunications system, these requirements would be incorporated into the design of the Anik C 14/12 GHz satellites which were then planned for service in 1981.[3]

The Telesat Canada system in 1976 grew to 72 earth stations in operation. This technological growth was due largely as the result of a program of the Province of Ontario to expand and improve communications services in a number of small communities in the NorthWest part of the province. In July 1976, an interesting development was the use of a Telesat Canada earth station situated directly at the Banff Springs Hotel in Alberta. This earth station distributed live television coverage of the Provincial First Ministers' Conference to the national CBC network.[4]

The year 1977 was largely dominated by the issue of the association agreement between Telesat Canada and the TCTS member companies. On August 24th, 1977, the Canadian Radio-television and Telecommunications Commission (CRTC) ruled that the association agreement was disallowed by the CRTC since it was contrary to the public interest. This adverse interest was based on the assumption that the association agreement would limit normal competition to a certain degree.[5]

The adverse ruling of the CRTC created an immediate legal obstacle to the comprehensive plans of Telesat Canada and the TCTS member companies to integrate a national system of terrestrial and satellite telecommunications. Telesat Canada appealed this decision to the federal government, and more precisely, the Minister of Communications. The grounds for this appeal was a belief that the association agreement would be beneficial to the public interest due to more efficient planning. The Minister of Communications, Jeanne Sauvé, conducted interdepartmental discussions and brought the matter to the federal Cabinet.[6]

On November 3rd, 1977, the federal Cabinet approved the association agreement of Telesat Canada and the TCTS member companies. The federal Cabinet reversed the decision of the CRTC by virtue of section 64 (1) of the National Transport Act which gave the Cabinet this specific power.[7] The Communications Minister, Jeanne Sauvé, stated the following in relation to this federal Cabinet decision: "Accordingly, the government decided that the agreement already reached between Telesat and TCTS was the most appropriate means whereby government policy could be implemented".[8] This simply meant that integration would result in a truly national system of effective telecommunications. This obviously was the policy of the federal government.

Following the federal Cabinet decision, there was a resumption of the integration activities between Telesat Canada and the TCTS member companies. There was also a resumption in negotiations for the procurement by Telesat Canada of three 14/12 GHz Anik C satellites, which would be designed to carry the bulk of the satellite message traffic in the integrated system. Therefore, the Anik C satellites would be the product of joint planning of the terrestrial and satellite common carriers.[9]

The financial picture of Telesat Canada in 1977 continued to be healthy. In February 1977, Telesat Canada paid the final installment of interest and principal on a $25.5 million loan from the federal government. This loan was retired on schedule and had been a loan obtained from the federal government in 1972 and 1973 under section 41 of the Telesat Canada Act. Corporate income in 1977 rose to $34.1 million and the company declared its third consecutive annual dividend of 10 cents per common share.[10]

The Telesat Canada satellite system was expanded to 85 earth stations in operational service by the end of 1977. Additional earth station orders were placed with manufacturers to fulfill two programs. One program was the Eastern Arctic Program which would provide satellite service to 13 Northern Quebec and Northwest Territories communities. The other program was the Frontier Television Program which was designed to provide a basic satellite-carried network television service to isolated communities of less than 500 population. In 1977, the Frontier Television Program had reached 10 communities which were mainly situated in the Yukon Territory. There were also extensive experimental programs in which military, resource exploration, remote sensing, and environmental protection applications of satellite telecommunications were being carried out.[11]

A final noteworthy event in 1977 was a federal government policy decision that a priority objective of Canada's space program would be to demonstrate, as soon as feasible, the capability of SPAR Aerospace Ltd. to compete as a prime contractor for communications satellites.[12] This followed a 1975 policy decision that the federal government should explore the setting-up of a prime contractor for Canadian spacecraft. Clearly, the federal government had the objective for a complete integrated Canadian manufacturing industry, as well as an integrated system for terrestrial and satellite telecommunications carriers.

The leading event in 1978 was the launching of Telesat Canada's fourth satellite, Anik B, on December 15th, 1978. This was the launching of the first satellite in the world to provide commercial services in both the 14/12 GHz and 6/4 GHz frequency bands.[13] A more detailed description of Anik B and the other later generation satellites of Telesat Canada will be given later on in this chapter.

The year 1978 was marked by an increase in the use and demand for Telesat Canada's facilities. During this year, negotiations were underway with the Speaker of the House of Commons, Canadian broadcasters and cable TV operators, in relation to the satellite distribution of House of Commons debates to communities across the nation. In other areas, there was an increase in the amount of use of the occasional use channels by the Canadian Broadcasting Corporation and other broadcasters. The Global Television network and Canadian Television (CTV) also made considerable use of transportable TV-transmit earth stations to distribute live coverage of sports events and special programming to their network production centres. There was also an over-all increase in message traffic requirements that resulted in the installation of additional voice circuits in 21 existing earth stations.[14]

In March 1978, Telesat Canada was involved in the aftermath of the crash of the nuclear-powered Russian satellite Cosmos 954 in the Northwest Territories. Within hours of the crash in this emergency situation, a transportable Telesat earth station was flown to Cosmos Lake and erected on the lake ice. For a month, this earth station was effectively utilized to coordinate the activities of the search and recovery operation of the radioactive remains of the satellite. The use of the transportable earth stations, especially the Small Antenna Transportable Earth Stations (SATES) provides customers with an exceptional degree of flexibility, whether for emergency communications or for live broadcast feeds from areas where terrestrial telecommunications facilities are inadequate.[15]

The financial condition of Telesat Canada in 1978 continued to be excellent in the area of net revenues or profits. The profits of Telesat Canada increased by 24% to a total of $5.6 million, representing earnings per common share of 93 cents. In the previous year 1977, the net earnings had been $4.5 million and the earnings per common share were 75 cents. Two dividends of 10 cents per common share were paid out to stockholders in 1978. This was double the level of dividends paid out in 1977, 1976, and 1975.[16]

In April 1978, the Hughes Aircraft Company of Los Angeles, Ca., was awarded a $53.6 million (U.S.) contract for the construction of three Anik C satellites, the first of which was scheduled at that time to enter service in 1981. Four Canadian companies were selected as major subcontractors to Hughes Aircraft Company under subcontracts valued at $24 million (U.S.) or approximately 40% of the value of the total Anik C contract. The four Canadian subcontractors that were selected were SPAR Aerospace Ltd. of Toronto, Ont.; SED Systems Ltd. of Saskatoon, Sask.; COMDEV Ltd. of Cambridge, Ont.; and Fleet Industries of Fort Erie, Ont.[17]

In August 1978, Raytheon Canada Ltd. of Waterloo, Ont. was awarded a $12.3 million (CAN.) contract to manufacture the first ten 14/12 GHz earth stations to be used with the Anik C satellites. In late October 1978, a Request for Proposal (RFP) on the Anik D program was issued to SPAR Aerospace Ltd., of Toronto, Ont. The Anik D program was planned to replace the last of the Anik A satellites (as well as Anik B) which would be reaching the end of their design life in the 1980's.[18]

During 1978, the federal government made three important policy statements that would have a direct influence on the Canadian space community which obviously includes Telesat Canada. The first policy statement by the federal government was that the Interdepartmental Committee on Space (ICS) was given the function of providing the Treasury Board of Canada each year with a list of proposed space programs, in order of priority, with an implementation schedule and cash flow, and that in assigning priorities, the ICS must take industry loading into account.[19] This type of space policy would encourage experimental space programs that would have a feasible commercial application, rather than abstract experimental programs with a minimal industrial impact. Therefore, hybrid programs such as Anik B would have a high priority, due to the high industrial loading factor.

The second federal government policy statement was that the Minister of Communications was directed to apply more stringently the Canadian content provisions of section 5 (2) of the Telesat Canada Act as a means of implementing industrial policy.[20] Therefore, the federal government made another strong indication that the "Canadianization" process must be speeded up in order to build a complete Canadian space industry.

The third federal government policy statement was that the Department of Communications was directed to provide as a service to all Canadian space companies, access to the integration and test facilities of the Department of Communication's David Florida Laboratory.[21] Once again, the federal government was adopting a policy of strong government support for Canada's space industry.

These policy statements by the federal government underlined the strong presence of the federal government behind the Canadian space infrastructure which included manufacturers, satellite common carriers, and terrestrial common carriers with links to satellite systems. Telesat Canada was not only directly influenced by the federal government in many ways, but also indirectly, by these federal government policies. Federal government support of Canadian private space companies would obviously lead to pressure on Telesat Canada to give, not merely a preference, but prime contractor status to a Canadian company in the near future.

Therefore, Telesat Canada, despite its commercial function, could become involved in supporting, if not subsidizing, the development of a Canadian space company despite higher prices for the satellite products. It is interesting to note how an organization, designed for a commercial function, can become directly and indirectly influenced by government policies which may have public goals that conflict with the private goals of that organization. This is the perennial problem of organizations that are partially owned and/or have a strong dependence on a government. Public and private goals tend to conflict, and one goal may dominate the other.

The year 1979 marked the tenth year of the incorporation of Telesat Canada and the seventh year of satellite operations. Telesat Canada had launched and was operating four satellites in the Anik A series and the Anik B series. Telesat Canada also had plans to operate the Anik C series and the Anik D series to provide services in the 1980's. Telesat Canada was also not only a leader in providing 6/4 GHz communications services, but was also a leader in the development of services in the 14/12 GHz frequency range with Anik B. Therefore, the ten-year old company would be a world leader in the high technology space and communications industry.[22]

The most important event in 1979 occurred on May 15th, which was the awarding of a $78.6 million (CAN.) procurement contract for the Anik D series of satellites to a Canadian prime contractor, SPAR Aerospace Limited, of Toronto, Ont. The procurement contract called for the delivery of two Anik D satellites in the 1980's. Canadian content in the Anik satellite procurement contracts has progressively increased from 20 per cent in the Anik A series; 30 per cent for the Anik B series; 40 per cent for the Anik C series; and 50 per cent, with a Canadian prime contractor, for the Anik D series.[23] More details will be given of the procurement contracts for the last three series later on in this chapter, along with a technical description of the satellites.

The year 1979 was marked by an over-all increase in satellite services. In January, the 100th earth station in the Telesat Canada system went into service at Manouane, Que. At the end of 1979, (the last year of statistical records), there were 109 permanent earth stations in operation in the system. There were also up to 19 transportable earth stations in service during the year which provided temporary broadcast, message and data services at periodic times during the year.[24]

In 1979, the financial situation of Telesat Canada continued to be excellent. Net earnings or profits for 1979 were $9.3 million, which was an increase of $3.7 million, or 66 per cent over the figure of $5.6 million in 1978. The earnings per common share were $1.54 in 1979 from 93 cents in 1978. The main factor in the increase in profits was a change in tax treatment as well as profitable lease that the federal Department of Communications held in six 14/12 GHz channels of Anik B. During 1979, Telesat Canada paid a dividend of 40 cents per common share in four quarterly instalments. This is compared to 20 cents per common share paid in 1978 and 10 cents per common share paid in 1977, 1976, and 1975.[25]

Corporate income derived from operating revenues in 1979 were $49.8 million, which was an increase of $16.1 million from the figure of $33.7 million in 1978. $15.1 million of this increase of $16.1 million was due to the new services provided to the federal Department of Communications for Anik B. Operating expenses in 1979 were $38.4 million, which was $11.5 million greater than the 1978 operating expenses of $26.9 million. This increase in operating expenses was largely due to the provision of new 14/12 GHz services.[26]

The financing requirements of Telesat Canada in 1979 were supplied by commercial bank financing of $37.0 million and funds derived from operations of $35.4 million. The total of bank financing drawn under a $140 million credit agreement with the Toronto-Dominion Bank stood at $41.0 million on December 31st, 1979.[27]

The composition of the Board of Directors of Telesat Canada was the following on December 31st, 1979: J. Alphonse Ouimet, Chairman and former President of the CBC; D.A. Golden, President and Chief Executive Officer of Telesat Canada; R.G. Ades, Peesident of Alberta Government Telephones; W.M. Auld, President of Bristol Aerospace; J.C. Carlile, Vice-President of British Columbia Telephone Company; J.V.R. Cyr, Executive Vice-President of Bell Canada; Pierre DesRoches, Executive Vice-President of the CBC; J.T. Fournier, Senior Assistant and Deputy Minister (Policy) of the federal Department of Communications; A.J. Kuhr, President & General Manager of CN Telecommunications; W.S. Robertson, President & Chief Executive Officer of Maritime Telegraph & Telephone Company Limited; A.S. Rubinoff, Assistant Deputy Minister, Economic Programs and Government Finance Branch of the federal Department of Finance.[28]

At the end of 1979 Telesat Canada had a total permanent staff of 387 employees concentrated mainly in Ottawa, Ont., Allan Park, Ont., Lake Cowichan, B.C., Harrietsfield, N.S. and Frobisher Bay in the Northwest Territories. The assets of Telesat Canada, as of December 31st, 1979 were $186,061,000.00 as compared to assets of $150,848,000.00 at the end of 1978. In ten years Telesat Canada had grown enormously to become a world leader in satellite telecommunications.[29]

In the year 1980, no official figures are available at present, in relation to the economic and technical growth of the Telesat Canada system. There were no launchings of any Telesat Canada satellites during this year. Nevertheless, two key events occurred during this year. On September 15th, 1980, the world's first commercial service in the 14/12 GHz frequency was inaugurated on Telesat Canada's Anik B satellite. On October 23rd, 1980, for the first time in Canada, a complete daily newspaper was transmitted from Toronto, Ont. to Montreal, Que. via Telesat Canada's Anik A-3 satellite beginning the National Edition of The Globe and Mail. Both of these major developments will be reviewed below.

At 9:30 a.m. on Monday September 15th, 1980, the world's first commercial telecommunications service in the 14/12 GHz band came into operation. Telesat Canada's Anik B satellite is being used to relay a group of French language television programming to 22 cities and towns in the Province of Quebec on TVFQ or Channel 99. This service is done on a 14-hour daily schedule for La Societé d'Edition et de TransCodage T.E. (la Sette). Contents of the service is made up of a selection of the best in public affairs, music, drama, sports and variety programs broadcast by the three television broadcasting networks in France.[30] More details of this event have been given in Chapter III of this dissertation.

On October 23rd, 1980, the first complete daily newspaper in Canada was transmitted at the speed of light from Toronto, Ont. to Montreal, Que. launching the National Edition of the Toronto-based The Globe and Mail. At the end of the same month, the National Edition was simultaneously received, via the Anik A-3 satellite, for printing in Calgary, Alta. At present, all of the circulation of The Globe and Mail outside of the Province of Ontario is the National Edition printed either in Montreal or in Calgary.[31]

The National Edition of The Globe and Mail is dominated by national, international and business news, including the complete Report on Business section. Local news is limited to those events which have national significance. The publishers of The Globe and Mail stated that the National Edition will average 32 to 40 pages during the working week and up to 48 pages on Saturday. In using this system, The Globe and Mail will gain the advantage of providing more regular service and it will gain savings in shipping costs as circulation expands. Expanding circulation also will provide increased coverage for advertisers.[32]

The inauguration of Canada's first satellite transmission of daily newspaper was a demonstration of Telesat Canada's capacity to offer cost effective telecommunications services for the Canadian business community all across the nation.[33] The new President of Telesat Canada, Eldon Thompson, stated the following in relation to this subject matter:

> We are quite naturally delighted that The Globe and Mail is using the data transmission services on Telesat's communications systems. Satellite telecommunication is ideally suited for data transmission of all kinds over long distances. Telesat anticipates increased demand from several sections of the Canadian business community. . . . The company will continue to welcome the opportunity to respond to new challenges and changing business requirements and to demonstrate the flexibility and cost advantages of Telesat Canada's satellite telecommunications system.[34]

The general organizational activities of Telesat Canada have been reviewed from 1976 to 1980. The satellite technology and the procurement contracts of the Anik B series, the Anik C series, and the Anik D series satellites will now be dealt with in greater detail. These programs place Telesat Canada on the frontier of satellite technological development.

Anik B was launched on December 15th, 1978, at the Kennedy Space Centre at Cape Canaveral, Florida at 7:21 EST. The launch vehicle was a Delta 3914 which was upgraded from previous Delta rockets through the use of a larger Castor IV strap on boosters. The Anik B satellite was placed at a geo-stationary location over the equator at 109 degrees West Longitude. Anik B weighed approximately 920 kilograms at the time of launch and is a three-axis-stabilized satellite with deployable solar arrays. Anik B is 3.28 metres in height and has a diameter of 2.05 metres. When the solar panels are extended, the satellite has a height of 11.3 metres.[35]

The original concept of Anik B was to have the satellite operate only in the 6/4 GHz frequency band. It was intended to replace one of the Anik A series satellites and back up the other two Anik A 6/4 GHz satellites which would reach the end of their design lives in the 1980's. However, in 1975, when Telesat Canada was preparing the final specifications for Anik B, the federal Department of Communications as a potential customer, expressed a desire for 14/12 GHz service, and so Anik B became a dual band hybrid satellite, to fill both the needs of the federal government and Telesat Canada.[36]

At that time in 1975, it looked doubtful that the existing 14/12 GHz satellite technology could meet the seven year design life expectancy in space that was required. Nevertheless, with the experience drawn from developments in the Hermes program, coupled with the experience on the Anik A series, Telesat Canada pooled its resources with the supplier RCA Astro-Electronics Division of Hightstown, N.J. and the new requirement was met in the design.[37]

Anik B can provide 12 channels in the 6/4 GHz frequency band. The 6/4 GHz antenna has three feed horns and provides full Canadian coverage on the uplink and the downlink segments. Anik B can also provide six channels in the 14/12 GHz frequency band. The 14/12 GHz antenna has four feed horns and provides full Canadian coverage on the uplink and four elliptical spot beams on the downlink segment. Essentially, this means that on the 14/12 GHz band frequency, Anik B receives on a broad antenna pattern from anywhere in Canada, and transmits via contiguous spot beams that overlap and cover Canada, from coast to coast.[38]

A maximum of six 14/12 GHz frequency channels are available on the Anik B series satellite and by ground control, are switched in various power-sharing combinations through four transmit travelling wave tube amplifiers (TWTA's). The 20 Watt

TWTA's provide at least 46.5 dBW within the elliptical spot beams to overcome higher rain attenuation in this band. Whenever there is snow or rainfall, there is greater interference in the 14/12 GHz frequency band than at the 6/4 GHz frequency band. Therefore, more concentrated power is required at the 14/12 GHz frequency band than at the 6/4 GHz frequency band.[39]

It should be noted that one of the important features of the Anik B satellite operating in the 14/12 GHz frequency bands is the use of small earth stations for individual home television reception in remote areas not otherwise covered by television broadcasting. Reception of these Anik B 14/12 GHz signals is obtainable on a 1.2 or 1.8 metre earth station that is directly connected to a television set.[40] This has been done on an experimental basis with the Department of Communications pilot projects and is now a viable commercial operation for the Quebec company La Sette.

Telesat Canada signed a $19.1 million (U.S.) with RCA Astro-Electronic Division of Hightstown, N.J. for the Anik B series satellite in December 1975. Approximately 30 per cent of the procurement contract for the satellite— $5.6 million (CAN.)— was subcontracted to the American firm's Canadian branch, RCA Limited of Montreal, Que. The Montreal firm was responsible for much of the technological innovation in the satellite. This included development of equipment capable of transmitting and receiving the special high frequency 14/12 GHz channels that the

Anik B series satellite carries. The $19.1 million procurement contract came with provisions for up to $2.25 million in extra performance incentives payments.[41]

The Anik C series of satellites will be the world's first communications satellites operating exclusively in the 14/12 GHz frequency band. The Anik C series satellites are designed to operate with earth stations situated in the heart of urban centres, in order to distribute an appreciable amount of the heavy message traffic between major cities in southern Canada. The Anik C series of satellites is planned for launch from the U.S. Space Transportation System (The Space Shuttle) commencing with the Anik C 1 launch on September 30th, 1982 followed by the Anik C 2 launch on February 8th, 1983 and the Anik C 3 launch on December 3rd, 1985.[42]

Three Anik C series satellites are being built for Telesat Canada. These satellites, like the Anik A series, have a spin stabilized cylindrical configuration, but with the despun section containing the whole communications payload. Each satellite will provide sixteen 14/12 GHz channels. Each channel can carry 1344 one way voice circuits or two simultaneous television programs.[43]

Each Anik C series satellite will have a launch weight of 1080 kilograms and will have a height of 6.43 metres with its solar panel and antenna deployed. The diameter of the satellite will be 2.16 metres. Anik C has an uplink or receiving antenna coverage from across southern Canada. The downlink antenna coverage area is divided into four regions across southern Canada provided by spot beam antennas. On command, the beams providing regional coverage in either the west or the east may be linked to provide half country coverage. Designed for high density telecommunications traffic between major cities in southern Canada, the northern limit of Anik C's antenna coverage pattern coincides roughly with the 60th parallel.[44]

Initial planning calls for 10 Anik C earth stations in major cities across Canada. Telesat Canada has identified Vancouver, B.C., Calgary, Alta., Edmonton, Alta., Toronto, Ont., Montreal, Que., and Halifax, N.S., as earth station sites for Anik C. The majority of the messages distributed between these cities will be long distance telephone traffic but provision is also being made for the establishment of video-teleconferencing links between these cities.[45]

Planning also calls for the addition of 250 Anik C earth stations by the end of 1985 for a total of 260 Anik C earth stations. These additional 250 earth stations will be added to provide additional broadcasting services, such as pay-TV, educational TV, telecasts from the Parliament of Canada, as well as cable-TV. Therefore, a comprehensive system of urban Anik C earth stations is in the planning stage.[46]

The Anik C earth stations will have eight metre antennas and will be located in places like the roofs of high-rise office buildings in southern Canadian cities. In the 14/12 GHz frequency range, existing interference with existing telecommunications equipment is eliminated, and with it the need to locate satellite earth stations in rural areas. In the southern cities, skilled telecommunications will be available locally as maintenance agents. No longer will weather prolong breakdowns in the equipment because men and equipment cannot gain access to a site. Earth station equipment not repaired locally can more rapidly be cycled through central repair depots. Finally, prime electrical power, often a problem at remote sites, is reliable in the cities.[47]

On April 14th, 1978, Telesat Canada awarded a procurement contract worth $53.6 million (U.S.) to Hughes Aircraft Company of Los Angeles, Ca., for the manufacture of three Anik C series satellites. Telesat President D.A. Golden stated that the contractual agreement between Telesat Canada and Hughes Aircraft Company takes the form of two separate contracts. The first contract encompasses the manufacture of the satellites and the provision of launch support services and ancillary equipment. The second contract covers certain ground control equipment and the Eastern Hemisphere telemetry, tracking and control facilities required during the launching and the orbital positioning of the satellites.[48]

The agreement signed also called for the payment to Hughes Aircraft Company of in-orbit performance incentives over and above the baseline figure $53.6 million (U.S.) which is the value of the firm, fixed-price (FFP) agreement. To earn these performance incentives, Hughes Aircraft Company guaranteed that each satellite will perform to contractually agreed upon specifications over its entire planned eight-year minimum mission life in orbit. The potential maximum value of these performance payments would be $13.7 million (U.S.).[49]

Four major Canadian subcontractors gained approximately $24 million (U.S.) in subcontracts worth approximately 40 per cent of the value of the Anik C series contract. The four major subcontractors are SPAR Aerospace Ltd. of Toronto, Ont.; SED Systems of Saskatoon, Sask.; COMDEV Ltd. of Cambridge, Ont.; and Fleet Industries of Fort Erie, Ont.[50]

SPAR Aerospace Limited received a subcontract valued at $19.9 million (U.S.) for the design, fabrication and testing of the spacecraft communications and control antennas and the communications receivers for the three Anik C satellites. SPAR Aerospace Limited will also provide the digital telemetry and command systems, signal interface units, power and control electronics and communications components. The remainder of the subcontract required SPAR Aerospace Limited to supply spacecraft structures, thermal hardware, solar panel positioners and antenna positioning antennas.[51]

SED Systems Ltd. of Saskatoon, Sask. received a $2 million (U.S.) subcontract to refurbish the Eastern Hemisphere telemetry tracking and control earth station which will be stationed on the island of Guam during the launch period of the Anik C satellites and will provide certain ground control and system test equipment. COMDEV Ltd. of Cambridge, Ont., received a $1.2 million (U.S.) subcontract to provide the input and output multiplexers for the three Anik C series satellites. Fleet Industries of Fort Erie, Ont., received a $500,000.00 (U.S.) subcontract to manufacture the solar panel substrates and mechanical aerospace ground equipment (MAGE).[52]

On August 2nd, 1978, a procurement contract for the first 10 Anik C earth stations was awarded by Telesat Canada to Raytheon Canada Limited, of Waterloo, Ont. The procurement contract has a value of $12.3 million (CAN.) which includes almost $1 million in special test equipment, spares and ancillary equipment. The contract has a delivery schedule that begins in March, 1980, and continues through to June, 1981. The first Anik C series satellite will now be launched on September 30th, 1982, creating ample time for ground testing of the Anik C earth stations.[53]

The beginning of commercial service on the Anik C series system in 1982 will mark the beginning of the full integration of the Canadian satellite system with the terrestrial common carrier systems across Canada. The new Anik C earth stations will form the interconnection point between Telesat Canada and the TCTS member companies. The integration of the satellite and terrestrial telecommunications systems will further establish Canada as a world leader in communications in 1982. The Anik C satellite system will place Canada on the vanguard of technological change.[54]

On May 15th, 1979, Telesat Canada awarded the largest single procurement contract in its history and its first for a spacecraft from a Canadian prime contractor. On this date, Telesat President D.A. Golden announced the award of the $78.6 million (CAN.) for the Anik D series communications satellites to SPAR Aerospace Limited of Toronto, Ont. The contract contains stipulations calling for the delivery of two 24-channel satellites operating in the 6/4 GHz frequency band. The Anik D series satellites will replace the 6/4 GHz services that are now provided on the Anik A series and the Anik B series satellites when the latter reach the end of their useful service lives in the 1980's.[55]

The procurement contract awarded to SPAR Aerospace Limited calls for a fixed price and provides for incentive payments for satisfactory performance over the planned minimum mission life of eight years in orbit. The total in-orbit incentives payable over the mission life of the Anik D satellites would be $10.8 million (CAN.) and is part of the total $78.6 million (CAN.) contract price. The major portion of the work by SPAR Aerospace Limited, including program management, will be carried out at the company's facilities at Ste-Anne-de-Bellevue, Que.[56]

The total Canadian content of the Anik Series contract is approximately 50 per cent. The largest subcontractor is Hughes Aircraft Company of Los Angeles, Ca. Significant Canadian sub-contractors are SED Systems Ltd. of Saskatoon, Sask., COMDEV Ltd. of Cambridge, Ont., and Fleet Industries of Fort Erie, Ont. It is anticipated that the spacecraft integration and tests will be carried out at the Department of Communications David Florida Laboratory just outside of Ottawa, Ont. Telesat President D.A. Golden stated that the company sought to obtain the maximum Canadian content consistent with its statutory mandate to operate as a commercially viable company. In previous spacecraft procurements, Telesat Canada sought competitive bids internationally, giving preference to bidders who selected major Canadian subcontractors and which provided maximum Canadian content.[57]

The relatively large start-up costs for facilities and personnel virtually precluded a Canadian prime contractor from bidding competitively against long-established foreign manufacturers. Several months of negotiations between Telesat Canada and the federal government led to a contractual agreement under which the federal government will absorb a portion of the Canadian content premium required to have the satellites manufactured by a Canadian prime contractor.[58]

On April 17th, 1979, federal Communications Minister, Jeanne Sauve, announced that the federal government would pay some $20 million (CAN.) of the difference between the SPAR Aerospace Limited bid price and the cost to Telesat Canada of the same type of satellites built by a U.S. prime contractor associated with Canadian subcontractors. The money will be paid to Telesat Canada which will channel it to SPAR Aerospace Limited in installments, as various milestones in the Anik D series program are successfully completed.[59] Telesat President, D.A. Golden, stated the following in relation to the prime contract with SPAR Aerospace Limited:

> I am very pleased that we have been able to work out a commercially acceptable contract with SPAR Aerospace Limited, and we look forward to working closely with that company. Of course, we already know them well, since they have over the years been a major supplier of earth stations to us, and also a major subcontractor to our spacecraft suppliers.[60]

Federal Communications Minister, Jeanne Sauvé, said she was pleased that SPAR Aerospace Limited will be the prime contractor for the Anik D series satellites. She said that "It demonstrates that we in Canada have developed a strong capability in the high-technology, rapid growth areas of satellites, which is appropriate since Canada is the second largest user of domestic satellite communications in the world, after the U.S.A."[61] The Communications Minister also added "With this step, we are assuring a market base from which this developing Canadian company can pursue export sales in a rapidly expanding world marketplace for satellites and related hardware."[62]

Federal Communications Minister, Jeanne Sauvé, also noted that SPAR Aerospace Limited would be building upon the expertise developed from procurement subcontracts for the Hermes, Anik A series, Anik B series, and Anik C series satellites. The federal Communications Minister stated that "I'm also pleased to see the extremely beneficial effects on Canadian industry of transfers of technology from government laboratories. I think the fact that we will now have a Canadian prime contractor is a dramatic example of government-industry cooperation of lasting value to our country, in this high technology area."[63]

The Anik D series' fourth generation satellites will introduce a new era of 6/4 GHz satellite services to provide for heavier Canadian satellite telecommunications needs expected in the 1980's. The two Anik D satellites will eventually replace the 6/4 GHz services of the Anik A series satellites as well as the 6/4 GHz services of the Anik B series satellite. Technical applications of the Anik D series satellites will be for long-distance telephone traffic as well as pay-TV, telecasts from the Parliament of Canada, cable-TV and educational television.[64]

The Anik D series satellites are designed for launch by NASA's Space Transportation System (STS) which is more commonly known as the Space Shuttle. However, like the Anik C series satellites, the Anik D series satellites can also be launched on a Delta 3910 rocket. Due to the delays in the launching of the Space Shuttle, Anik D 1 will be launched on a Delta 3910 rocket on August 5th, 1982. Anik D 2 will be launched on the Space Shuttle on April 1st, 1984.[65]

The Anik D series satellite is derived from the design of its forerunners, the Anik C series satellites. The Anik D series satellite will also have a spin stabilized cylindrical configuration but will be heavier, weighing 1128 kilograms at launch. The Anik D satellite will be 6.57 metres in height with a diameter of 2.16 metres.[66]

The Anik D series satellite will have a 6/4 GHz communications payload of 24 channels, each with a bandwidth of 36 MHz. Each channel will be able to carry up to 960 one way voice circuits or one television program with associated audio and cue and control capability. The Anik D spacecraft antennas will give all Canada coverage on the uplink and the downlink segments by means of the technique of frequency reuse and orthogonal polarization. There is one feed horn for vertical polarization and one feed horn for horizontal polarization. The satellite antennas have dual aperture orthogonally gridded reflectors of 60 inch focal length. The Effective Isotropic Radiated Power (EIRP) for each channel will be 36 dBW.[67]

Despite the unqualified success of Telesat Canada in the last decade, there have been notable criticisms of the Telesat Canada system and federal government policies in the field of satellite communications. One outspoken critic is Professor William Melody, Chairman of the Communications Studies Department at Simon Fraser University, Burnaby, B.C. Professor Melody has described satellites as "20th century pyramids"[68] as well as "the ultimate professional tinker toys."[69] Professor Melody has also stated that "few of the many potential advantages of satellites have been developed and applied in the service of the public and society."[70]

Professor Melody bases his criticisms on the fact that the effective operation of satellite common carriers have been "restrained by the need to accommodate the vested economic interests of the carriers that own and control the landline microwave and cable technologies."[71] He sums up the history of satellites as one of "wasted technological potential and outrageous economic inefficiency, in order to preserve the near monopoly market dominance of the established telecommunications carriers."[72]

A much milder form of criticism has emanated from Mr. Roy Dohoo who is a space communications consultant and former Director General of Space Programs at the Department of Communications. He states that the "large scale use of communication satellites depends on the enthusiastic cooperation of the TransCanada Telephone System (TCTS)."[73] However, he notes that one should not draw an immediate inference that the terrestrial carriers will only use satellites for services that cannot be served by landline technologies. Mr. Dohoo states that "What the carriers are likely to do is to combine space and terrestrial facilities to provide good service while maximizing the return on capital."[74] His major criticism is against the federal government in relation to the slow growth in Canadian content in the space programs.[75]

Both critics have limited remedies for the defects that they perceive in the Canadian telecommunications system. Professor William Melody advocates a general policy of the removal of "the restrictive shackles that prevent Telesat from developing satellite services that reflect the potential economic and social efficiencies of the technology."[76] More specifically, he advocates user ownership of earth stations as well as changes in the channel leasing policy, so that less than full satellite channels would be made available by Telesat Canada directly to potential users.[77] Subsequently, the federal government has announced a liberalized earth station ownership policy which allows user ownership of receive-only earth stations. This government change in policy will be dealt with in the Conclusion of this dissertation.

Mr. Roy Dohoo proposed that the federal government should maintain its present insistence on a larger and more meaningful role for Canadian industry in meeting demands for more satellites. He feels that the present policy (which he feels should have been taken in 1969 rather than the late 1970's) should "improve the chances of industry developing the necessary capability."[78] He supports the present government policy (announced in policy statements in 1975, 1977, 1978 and 1979) of creating a Canadian prime contractor for satellites as well as expanding government assembly and test facilities for use by industry in the integration of satellites. Mr. Roy Dohoo concludes by stating that "it will still require vigilance, especially by the Department of Communications, to ensure that exploratory investigations and the provision of needed services using Canadian-developed equipment are not stifled by institutional rigidity."[79]

Telesat Canada responded to the criticisms of Professor William Melody on August 29th, 1979, in the form of an anonymous press release. The press communiqué dealt with the 10th anniversary of the incorporation of Telesat Canada and stated the following in relation to the success of Telesat Canada:

> Along the way, Telesat has earned for itself, and for Canada, an international reputation for excellence and leadership in the field of communications by satellite. Its space and terrestrial hardware requirements over the years have provided much, if not most, of the impetus for the development of a Canadian space manufacturing industry in Canada. . . . The real benefits of communications by satellite are in the extension of the ability of Canadians anywhere in the 9,850,000 square kilometers of Canada to communicate instantly and reliably with each other. No community, however

> remote, need any longer be isolated from the mainstream of Canadian telecommunications for information, for entertainment, for resource exploration and development, for industry and commerce, for defence and in emergency.[80]

Mr. Mohammed Mili, Secretary General of the International Telecommunications Union in an editorial in the ITU's Telecommunication Journal stated the following in relation to the Telesat Canada system:

> . . . it was impossible to remain indifferent to the Canadian success, which is a source of both inspiration and technical know-how. . . . In the first place, it (Canada) has succeeded in establishing a telecommunication network remarkable in all respects despite formidable natural obstacles.
>
> Isn't Canada the first country to set up national digital data transmission systems and a national geostationary telecommunications satellite for commercial use? These facts alone would justify its reputation as a leader in the telecommunication field.
>
> Finally— and this may well be the most important facet of the Canadian experience— we should emphasize the attitude adopted by the operating companies to their customers: their objective has been to offer top quality service at reasonable cost— and this is certainly the key to their success.[81]

The late Dr. John Chapman, who was Assistant Deputy Minister, Space Program, in the federal Department of Communications, was a strong proponent of the existing Telesat Canada system. He believed that Canada had too small a market for unrestricted competition between terrestrial and satellite common carriers. The association of Telesat Canada with the TCTS member companies was necessary to allow for access to the telephone market.[82] Dr. Chapman also noted that governments in all countries have played a "direct role" in the development of satellite systems because of the high development costs involved as well as the need to protect the interests of the public.[83] Dr. John Chapman had the following opinions of the Telesat Canada system:

> It is in this context of a smaller market and industry and of particularly Canadian communications problems that we must plan the communications satellite system in Canada. It is a context in which the satellite must be a complementary factor, contributing to the opportunity for all Canadians to obtain modern telecommunications services, but at the same time, not setting off an explosion that might demolish one of the best telecommunications services in the world.
>
> Regardless of the tenets of existing theories on efficiency, and even though it is a mixed public/private structure, our system has the merit of working extremely well![84]

To conclude this discussion of the merits of Telesat Canada, as well as this chapter, I would like to state that I am in agreement with the proponents of the Telesat Canada system for the reasons given above. Telesat Canada has, on the record, been a successful, profitable organization for the past ten years. The argument for a purely competitive system can be rebuffed by the fact that the telephone service industry and other forms of telecommunications, tend for the most part, to form a "natural monopoly".[85] This is especially true in an industry with such high development costs and high capital expenditures.

It is also difficult to understand why the Canadian Radio-television and Telecommunications Commission (CRTC) was opposed to Telesat Canada joining an association of terrestrial communications carriers. Since the TransCanada Telephone System association was a legal organization without Telesat Canada, it is difficult to understand why the addition of a tenth member to the TCTS system would suddenly make this contrary to the public interest. If an association of terrestrial communications common carriers is not monopolistic to begin with, then what difference would it really make to allow a satellite common carrier to join this system? To be perfectly consistent, one would have to abolish the initial 'monopolistic' association of terrestrial common carriers on public interest grounds. The addition of a tenth member which is a satellite common carrier only changes the membership of the association, as well as increasing the technological resources of the association. The nature of the original 'monopolistic' association with links across Canada remains unchanged.[86]

The next chapter will examine the growth and development of SPAR Aerospace Limited as a case study of a Canadian aerospace company. SPAR Aerospace Limited has achieved prime contractor status in the satellite business in Canada. SPAR Aerospace Limited has close ties to the federal government and Telesat Canada in a symbiotic relationship with these organizations. Therefore, the next chapter will examine SPAR Aerospace Limited as an integral part of the Canadian space infrastructure.

FOOTNOTES TO CHAPTER V

[1] Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 20.

[2] Ibid., pp. 20-21. Also note that the official name of the association agreement is The TransCanada Telephone System Connecting Agreement (no contract number) of December 31st, 1976.

[3] Ibid., p. 21.

[4] Ibid., pp. 20-21.

[5] The official reference to the CRTC decision is Telecom Decision CRTC 77-10 contained in The Canada Gazette No. 36 Vol III Part I on page 4838 dated September 3rd, 1977.

[6] Telesat, Symphonie, edited by N.M. Matte and M.M. Matte, Institute and Center of Air and Space Law, (McGill University, Montreal, Canada, 1978), p. 15. Also it should be noted that the formal legal procedure applied here was the submission of petitions by interested parties under section 64 (1) of the National Transportation Act.

[7] The official reference to this federal Cabinet decision is Order-in-Council P.C. 1977-3152 dated November 3rd, 1977. This decision refers to the public interest as the basis of the federal Cabinet decision without any detailed explanation in this unpublished Order-in-Council.

[8] Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 22.

[9] Ibid.

[10] Ibid.

[11] Ibid., p. 23.

[12] The Canadian Space Program; Five-Year Plan (80/81-84/85), Serial no. DOC-6-79DP (Discussion Paper, Department of Communications, Government of Canada, January 1980, p. 18.

[13] Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 25.

[14] Ibid., p. 24.

[15] Ibid. Also Telesat Canada 1978 Annual Report, p. 4.

[16] Ibid., p. 25.

[17] Ibid. Also note that the contract reference number is Telesat Canada No. PDC8SP12008 April 14th, 1978 with a value of $53.6 million (U.S.).

[18]Telesat Canada 1978 Annual Report, pp. 1-2. Also note that the contract reference number is Telesat Canada No. PDC8SP12008 April 14th, 1978 with a value of $53.6 million (U.S.).

[19]The Canadian Space Program; Five-Year Plan (80/81-84/85), Serial no. DOC-6-79DP (Discussion Paper, Department of Communications, Government of Canada, January 1980, p. 18.

[20]Ibid.

[21]Ibid.

[22]Telesat Canada 1979 Annual Report, Ten Years and Counting, p. 28.

[23]Ibid.Also note that the contract reference number for the Anik D satellites is Telesat Canada No. PDC9SP12282 May 15th, 1979 with a value of $78.6 million (CAN.).

[24]Ibid., p. 32.

[25]Ibid., pp. 28-30.

[26]Ibid., p. 28.

[27]Ibid., p. 30.

[28]Ibid., p. 49.

[29]Ibid., pp. 38 and 47.

[30]Telesat Canada News Release, September 15th, 1980, pp. 1-2.

[31]Telesat Canada News Release, October 23rd, 1980, p. 1.

[32]Ibid., pp. 1-2.

[33]Ibid., p. 2.

[34]Ibid., p. 3.

[35]Telesat Canada, A Technical Description, TC-79-001, September 1979, pp. 9 and 28. Also, Communications Satellites: The Canadian Experience, External Affairs, Government of Canada, March 1979, p. 10.

[36]Jack W. Crawford, Canada and the Anik System, Satellite Communications, (Denver, Colorado, U.S.A., August 1978), p. 34.

[37]Ibid.

[38]Ibid., pp. 34-35.

[39]Ibid.

[42]Telesat Canada news release, May 15th, 1979, p. 2.

[43]Telesat Canada news release, April 14th, 1978, p. 3.

[44]Telesat Canada, A Technical Description, TC-79-001, September 1979, pp. 9 and 21-23.

[45]Jack W. Crawford, Canada and the Anik System, Satellite Communications, (Denver, Colorado, U.S.A., August 1978), p. 35.

[46]Ibid., pp. 35-36.

[47]Ibid., p. 36.

[48]Telesat Canada news release, April 14th, 1978, pp. 1-2.

[49]Ibid., p. 2.

[50]Ibid.

[51]Ibid.

[52]Ibid., pp. 2-3.

[53]Telesat Canada news release, August 2nd, 1978, pp. 1-2.

[54]Ibid., p. 1.

[55]Telesat Canada news release, May 15th, 1979, p. 1.

[56]Ibid., pp. 1-2.

[57]Ibid., p. 2.

[58]Ibid., p. 3.

[59]Ibid.

[60]Ibid.

[61]Department of Communications news release, May 15th, 1979, p. 2.

[62]Ibid.

[63]Ibid., p. 3.

[64]Telesat Canada news release, May 15th, 1979, p. 1.

[65] *Ibid.*, p. 2.

[66] Telesat Canada, *A Technical Description*, TC-79-001, September 1979, pp. 9 and 24..

[67] Telesat Canada news release, May 15th, 1979, p. 2.

[68] William Melody, *Are Satellites the Pyramids of the 20th Century?* In Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring, 1979), p. 8.

[69] *Ibid.*

[70] *Ibid.*, p. 4.

[71] *Ibid.*

[72] *Ibid.*

[73] Roy Dohoo, *Canada's Satellite Policies and How They Grew*, In Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring 1979), p. 18.

[74] *Ibid.*

[75] Ibid., pp. 20 and 22.

[76] William Melody, *Are Satellites the Pyramids of the 20th Century?* In Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring 1979), p. 8.

[77] *Ibid.*

[78] Roy Dohoo, *Canada's Satellite Policies and How They Grew*, In Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring 1979), p. 22.

[79] *Ibid.*

[80] Telesat Canada press release, August 29th, 1979, p. 2.

[81] *Ibid.*, pp. 3-4.

[82] Dr. John Chapman, *Why Satellite Communications in Canada?* In Search, Vol. VI, no. 2, Information Sercices of the Department of Communications, (Ottawa, Canada, Spring 1979). p. 12.

[83] Ibid., p. 10.

[84] Ibid., p. 12.

[85] Ibid., p. 10.

[86] It should be noted that membership in the TransCanada Telephone System consists of the following entities:

Telesat Canada
Alberta Government Telephones
Bell Canada
British Columbia Telephone Company
Manitoba Telephone System
Maritime Telegraph and Telephone Company Limited
Newfoundland Telephone Company Limited
Saskatchewan Telecommunications
The Island Telephone Company Limited
The New Brunswick Telephone Company Limited.

CHAPTER VI

SPAR AEROSPACE LIMITED

SPAR Aerospace Limited of Toronto is a Canadian corporation formed in 1967 to supply the aerospace, maritime and ground transportation and communications markets. Its sales volume grew from $5 million in 1967 to $80 million in 1978.[1] In less than 13 years, SPAR Aerospace Limited has grown from a small corporation to become one of the leading suppliers in North America of advanced technology systems. This remarkable growth has been due to a series of opportune mergers as well as the development of a highly skilled engineering and technical team.

SPAR Aerospace Limited has grown through a process of mergers and acquisitions. In 1967, its first step after incorporation was the purchase of the Special Products and Applied Research Division of the de Havilland Aircraft of Canada Ltd. In 1970, SPAR Aerospace Limited bought the technically bankrupt York Gears Limited for one dollar. In 1972, SPAR bought Astro Research Corporation of Carpinteria, Ca. In 1974, the federal government forced SPAR, RCA Limited, and Northern Telecom to make inter-company agreements in order to create joint industrial planning for the space industry as a whole.[2] In 1976, SPAR acquired the Space Division of Northern Telecom.

In 1977, SPAR purchased the Government & Commercial Systems Division of RCA Limited in Montreal, P.Q. In late 1978, SPAR purchased a Calgary-based repair and overhaul facility called The Copter Shop. On March 13th, 1980, SPAR purchased the Northway-Gestalt Corporation which is the largest mapping company in Canada.

At present, there is a very precise division of labour that exists between the five locations in Canada and the United States that employ a total of just over 2000 people. In Toronto, SPAR deals with mechanical and electrical engineering; the manufacture of gears and transmissions for turbine engines, helicopters and rail vehicles; the development of remote manipulator systems; and the repair and overhaul of aircraft instruments and equipment. In Ste-Anne-de-Bellevue, P.Q., it develops and manufactures satellite electronic subsystems, terrestrial microwave relays and satellite earth stations. In Kanata, Ont., SPAR "builds-to-print"[3] communications satellite and other electronic components and refurbishes military radar equipment. In Carpinteria, Ca., Astro Research designs and builds lightweight expansible structures for spacecraft, some of which make use of Canadian developed STEM technology pioneered by the National Research Council.

At present, SPAR Aerospace Limited has the capacity to design, produce, assemble and test electronic components, complete subsystems and satellite transponders. In other words, SPAR has a prime contractor capacity which makes it unequalled in Canada for space telecommunications systems. This capacity is recent and is the result of a combination of favourable circumstances which include opportune agreements with space giants such as Hughes Aircraft, RCA Limited, General Electric, and Sikorsky.[4]

One of the major steps towards this prime contractor capability was the purchase in January 1977 of the former RCA Government & Commercial Systems Division in Ste-Anne-de-Bellevue, P.Q. In March 1976, the American firm of RCA Limited was apparently dissatisfied with its financial statements on a number of business ventures, as well as with the situation which existed in several divisions of its Canadian subsidiary at Ste-Anne-de-Bellevue. RCA Limited decided to reorganize its division at Ste-Anne by eliminating its digital systems division and selling the research and development division to an independent firm called MPB Technology.[5]

After this re-organization, the Government & Commercial Systems Division of RCA Limited was continued. This corporate division had produced the payload for the ISIS program satellites which were ionospheric research satellites. However, in 1972, this RCA division had lost the important contract for the first three Anik A communications satellites to Hughes Aircraft of California. This division <u>did</u> make a favourable reputation as the contractor of electronic subsystems for Hermes, the communications technology satellite. It provided the 14/12 GHz transponders, antennas, telemetry systems, tracking and command systems, and the attitude control system. But the American parent RCA Limited decided to sell its Government & Commercial Systems division and to abandon all but its electro-optics division in the Montreal area.[6]

SPAR Aerospace Limited acquired the division in January 1977 and it is now known as the Electronic Group of the company. The agreement concluded with RCA Limited guaranteed the transfer of all of the highly qualified Canadian RCA personnel to SPAR and dealt with the protection of patent rights, the provision of parts, and the division's location until the end of 1979. Therefore, SPAR acquired an RCA division which had contractor experience with experimental communications satellite technology.[7]

SPAR has subsequently acquired satellite technology experience through its direct associations with RCA Limited and Hughes Aircraft. SPAR has worked with RCA Limited on the Anik B satellite, on the American Satcom satellites, and the Intelsat and Comsat satellites. SPAR has provided Hughes Aircraft with parts for Anik A and the Westar satellites as well as the network of Indonesian satellites, called Palapa.[8]

Mr. L.D. Clarke, Chairman of the Board of SPAR Aerospace Limited, made the following comments in relation to the capacity and the limitations of SPAR as a prime contractor for communications satellites:

> SPAR is already technologically capable of the design and construction of complete networks of communications satellites. This capability is the obvious sign of technical leadership in the field in this country. But we are also aware of our limits. The role of prime contractor requires important financial and material resources, expansion of workshops and personnel and the ability to make diverse elements work together as a team. And a prime contractor must be able to meet his contractual obligations, which provide for substantial financial penalties in cases of delay.[9]

SPAR presently has the responsibility as the prime contractor for the Anik D satellites. The company also has an interest in being the prime contractor for the Musat satellite, which the federal government is planning for 1985, and which will use ultra high frequencies.[10] SPAR is also bidding as prime contractor for the ARABSAT satellite system in 1981, for which SPAR is planning to build three Anik D type satellites.

SPAR also has prime contractor responsibility for the Remote Manipulator System (RMS) for the NASA Space Shuttle orbiter vehicle. The Americans struggled for two years with the mathematical model of the RMS mechanical arm, which SPAR is now manufacturing under contract with the National Research Council which has assumed costs of development and production of the first unit, amounting to some $75 million over three years. At the same time, SPAR is seeking to develop new markets for the RMS system in the nuclear industry and for underwater welding.[11]

SPAR's position as a prime satellite contractor is key to its future. It will enable SPAR to serve future requirements for satellite technology in Canada and will provide a national base from which to pursue opportunities in the rapidly growing international market for satellite communications. SPAR's anticipated participation, along with other Canadian companies, in the new multi-national L-SAT communications satellite being developed by ESA is an example of such opportunities.[12]

When the Space Shuttle becomes operational in the 1980's, SPAR management has anticipated a rapid increase in the use of satellites for a variety of commercial applications in the fields of communications, navigation, search and rescue services, mapping, and weather and resource evaluation. An extensive re-organization is under way to be completed by January 1981, when the re-organization will begin to take effect. SPAR will have a Space & Electronics Group, consisting of four divisions, called the Satellite Systems Division, the Aerospace & Communications Systems Division, the Remote Sensing Systems Division, and the Remote Manipulator Systems Division. It should be noted that these expansive market ambitions are tempered with caution. Mr. L.D. Clarke states that "There is no point replying to calls for tender where American or European powers have large markets and dominant influence."[13]

The responsibility of prime satellite contractor has forced SPAR to acquire advanced systems management technique for its Anik D and RMS project. A brief commentary will be made on the advanced systems management structures that have been set up by SPAR Aerospace Limited, in order to manage complicated aerospace projects. A company must have such a system in order to survive the demands of time and money which are integral to the aerospace industry.

The Satellite Systems Division (SSD) was formed on December 29th, 1978, and is based at SPAR's plant at Ste-Anne-de-Bellevue, P.Q. SSD's basic responsibility is for executing contracts for complete satellites by co-ordinating all of the resources of SPAR. SSD's primary functions are the following: proposal preparation, program management, subcontracts to suppliers, system engineering, product assurance and integration and testing for complete satellites.[14]

At present, the major responsibility of SSD is for the Anik D program, for which SPAR is the prime contractor. This was the first time that a Canadian company was awarded prime contractor status for a commercial communications satellite. SSD program management formulated an implementation plan for Anik D which defined the activities and functions of four project groups in supplying technical services and space equipment. A comprehensive logistics plan was set up to cover the movements of every item for the satellite to ensure accurate program schedule control. A product assurance team within SSD was also set up to conduct quality assurance for Anik D supported by product assurance staff from other SPAR groups.[15]

The Mechanical & Electrical Group of SPAR supplies the satellite structure, thermal subsystems, test fixtures, wiring harness, electronic units and other elements of the spacecraft bus. SPAR Electronic Group will supply the communication payload system and will do integration and test work at Ste-Anne. After components and subassemblies are manufactured and tested, SSD will integrate and test the complete satellite at the expanded David Florida Laboratory, which is a federal government facility near Ottawa.[16]

New space equipment has been supplied at the David Florida Laboratory by the federal government for Anik C and Anik D and future programs in line with the government's policy for a "self-determined space capability". This new equipment includes a 25-ft by 60-ft high vacuum chamber with thermal capabilities, anechoic chamber and separate vibration tables, both used to simulate launch and in-orbit conditions.[17]

At this level of testing and final integration, all components and subsystems are fully checked and tested, as integral parts of the satellite. Tests will be made for the thermal balance of the spacecraft, the ability of all spacecraft components to withstand stress and vibrations of launch conditions, and the ability of these components to function in the vacuum of space. Integration and testing also includes the use of computerized test equipment to simulate in-space operation of the communications payload. Once Anik D is completed, a specialized crew from SSD will participate in launch operations at Cape Canaveral.[18]

As prime contractor for Anik D, SPAR Aerospace Limited has complete responsibility for overall design definition, but also for integration of subcontractor's subsystems and their performance testing in simulated operational environments. Therefore, specification writing must be done for all subcontractor's subsystems; and quality control assured for these subsystems by test and analysis to verify that at the moment of launch, all systems and subsystems on Anik D will work. It should be noted that about 50% of the total value of a satellite like Anik D is for electronics payload; systems integration and testing are about equal in value for the remaining 50%.[19]

At the beginning of the Anik D project, the needs of Telesat Canada were well defined. SPAR made a very detailed response to the Telesat specifications that are contained in the Request for Proposal made by Telesat Canada to SPAR Aerospace Limited.[20] The satellite specifications are very well defined from the outset. However, not everything works out according to the original plans and specifications. Telesat Canada's requirements and specifications may change; the theoretical plans do not always work out in reality; and subcontracted parts, materials or processes do not conform to quality control standards imposed by the prime contractor. In a situation like this, extensive re-negotiation of complex technical matters may be necessary and contract amendments will have to be issued with the consent of both parties.[21]

In relation to the Remote Manipulator System (RMS), different sets of circumstances have resulted in different systems management techniques. RMS work does not have a base-line of well-established systems having predictable performances. Instead, much of the work is experimental, so there is more exchange between the customer and the prime contractor when requirements change during the development phase of the program. Therefore, SPAR has made a commitment to have all of its resources made available to the RMS Division because the final product, the areas of management responsibility, and the company financial risk are all very different from those of a satellite program.[22]

The core of RMS systems management is a control centre where program status is displayed in terms of costs, schedules, and performance at program, subsystem and work-package levels. Another control room shows detailed subsystem status in the areas of electronics; integration and testing; display and control; and the mechanical arm. The level of subsystems displayed and tracked cover the NASA program, SPAR management, and working levels, whether at SPAR or at a subcontractor.[23]

The major RMS contract-management areas are authorization and budget setting at company, program and detail levels; performance and reporting against schedule and budget; and review and control. Systems for management information were greatly improved for RMS program management, with every stage visible between receipt of the contract to the launch date.[24]

SPAR Aerospace Limited has received support from the federal government, in order to attain the capability of acting as a prime contractor for space programs. When plans were announced for a $20 million (CAN.) expansion of the David Florida Laboratory, the Minister of Communications stated that this would further a priority objective which was " . . . that of developing and demonstrating a Canadian capability to act as a prime contractor for the supply of complete satellites for both domestic and export markets".[25]

There are more aspects to being a prime contractor in a space program other than just having the contractual responsibility for a complete program. One aspect is maintaining in Canada an engineering team that would otherwise have to emigrate to the United States to find greater career opportunities. A second aspect is the sense of national pride that is generated by participating in such an important program as the NASA Space Shuttle. A third aspect is the fact that a prime contractor for space programs in Canada will generate a complete infrastructure of subcontractors in Canada to support this company.

A final aspect is the fact that a prime contractor in Canada will be able to compete internationally with other American and European prime contractors in certain cases such as the ARABSAT contract.

What is the corporate philosophy of the leaders of SPAR Aerospace Limited at this time? SPAR's Chairman of the Board, Mr. L.D. Clarke, has outlined his concepts for an industrial strategy for Canada in the 1980's. At the Empire Club in Toronto he stated the following:

> We should encourage the growth of manufacturing activities in such advanced technology areas as transportation and communications, . . . industries which have substantial domestic and export markets.[26]

Mr. Clarke also called for the following:

> . . . training programs . . . to produce a work force able to respond competitively to the demands of today's global marketplace.[27]

Therefore, the SPAR leadership contends that it is through expertise that Canada can compete internationally in areas in which Canadians have become leaders through national necessity and national conditions. Examples of industries in which Canadian national needs have forced Canadians to become leaders include telecommunication systems, nuclear energy, machine-finished wood products and ice-breaking technology. In these areas, Canada can compete on the basis of brainpower and expertise rather than through manufacturing and labour costs. Therefore, SPAR management believes that an industrial policy should encourage Canadian industries based on expertise and on Canadian products based on our geographical demands and national requirements.[28] Mr. L.D. Clarke stated the following in relation to this selective industrial strategy:

> We are old-fashioned in Canada. We have no philosophers in industry and technology like Marshall McLuhan in communications. And it is perhaps this absence of philosophy which largely explains our inability to provide leadership in fields of endeavor other than those in which we have traditionally been major customers. Perhaps it is time for the Canada Council to give bursaries for studying the situation of Canadian industry in the context of its economic environment while considering our resources and our social and political aspirations. But acquiring our own advanced technology implies considerable expenditures which only a large and stable market can justify. An indigenous technology is not warranted if our major markets are aboard and we are not the major consumers of our own products. We cannot be leaders everywhere, only in what we need and what we use most of.[29]

The leaders of SPAR Aerospace Limited believe that major obstacles stand in the way of a coherent industrial strategy based on engineering and scientific genius and specialization based on Canadian conditions. Mr. L.D. Clarke believes that Canada's fiscal policy in relation to corporate enterprise does not encourage individual initiative and thus inhibits technological leadership by Canadian companies. At SPAR's annual general meeting in May 1977, Mr. L.D. Clarke stated the following:

> Our industries must become competitive in the world market, and the only inducement that ultimately will achieve this is the expectation of a reasonable return on investment. Our governments must create policies that offer 'carrots' to induce industry to become more productive,

> and must cease the 'big stick' approach all too often used to cause industry to fall into line. Canada's corporate tax policies have placed a premium on mediocrity, both for entrepreneurs and corporations. . . . Canada needs to establish as a prime element of its industrial strategy the encouragement of its most efficient, productive and profitable enterprises. Our welfare depends on our productivity. Increasing our productivity is the only way we can, in the long run, improve our standard of living and achieve our social goals.[30]

A special note should be made of the relationship between SPAR and the federal government. Although the federal government (including Telesat Canada) is SPAR's best customer and provides a great deal of direct and indirect financial assistance, SPAR management would prefer changes in the tax system to allow SPAR to develop its internal growth through internal company funding. SPAR would like to see less dependence on the issuance of government grants and more reliance on private investment. SPAR management would prefer to have tax policies that would develop an autonomous capability for technological innovation for Canada's manufacturing industry.[31] This viewpoint was summarized by Mr. L.D. Clarke in an address to the company at its annual general meeting on June 12th, 1980, as follows:

> SPAR believes it is infinitely preferable for the Canadian government to contract for goods and services on a basis which provides industry with its own funds for reinvestment, rather than having to rely on government grants and other forms of financial assistance, which is often too little and too late. If government implements this change in policy, as we sincerely hope it will, SPAR can reasonably anticipate enhanced profit margins on work performed for the Canadian and United States governments, and increased control of its own destiny.

> As in the past, SPAR's greatest opportunities for internal growth will continue to flow from its engineering activities. For this reason and in order to maintain the desired balance within activities, we will continue to look for opportunities to acquire established profitable businesses that are engaged in providing services or manufacturing in the high technology field.[32]

Therefore, the challenge of the 1980's will be establishment of a precise industrial strategy by the federal government to enhance the capability of Canadian companies like SPAR Aerospace Limited to compete effectively on the international markets. This industrial policy must be formulated in the 1980's for Canada to compete with some success on the global markets.

The commercial satellite manufacturing business has a number of features that deserve a detailed examination. The major participants in this market are small in number, consisting of a handful of organizations. Major manufacturers in this market are SPAR Aerospace Limited, RCA Corporation, Hughes Aircraft Co., TRW Co., British Marconi Ltd., Thomson-CSF, and AEG Telefunken. In this highly technical market, it is essential that a company devote a great deal of its financial resources to research and development, or the company will quickly lose its competitive advantages in this fast-changing market. A small company will have difficulty in competing with giants such as Hughes Aircraft Co. which has vast pools of capital for research and development budgets.

The formation of a commercial satellite contract is a highly complex process which may take 6 months to 1 year to complete. Most commonly, the initial contact is made with the customer through a salesman from the seller. This salesman usually maintains contact with a few companies in one geographical area of the world and through personal links and travel will be continually alert to plans for a new satellite project which will be at a rudimentary stage. After this initial sales contact, the prospective customer will approach the seller for a bid called a Request for Proposal (RFP). The Request for Proposal may be at the prime contract level for a complete satellite or for a narrow, precisely defined sub-system of a satellite such as the receivers.

The Request for Proposal which is issued by the prospective customer is much more than a simple letter or telex. The RFP may be hundreds of pages long, containing thousands of detailed customer specifications, as well as the legal terms and conditions of the proposed contract from the customer's negotiating viewpoint. At this stage, the prospective vendor will set its internal company machinery in operation through the issuance of a proposition notice, which will authorize internal funding and the allocation of time for the preparation of a proposal.

Proposal work can be enormously complicated since this involves preparing and publishing detailed responses which may run into hundreds of pages. Complicated legal and technical issues become interwoven in the drafting of the proposal documents. An understanding of the technical terms is essential in order to prepare legal responses which protect the best interests of the seller. Usually, the satellite seller will issue a response which differs significantly from the customer's RFP because the customer's terms and conditions are too onerous. The technical specifications may contain requirements which contain significant legal liabilities behind a maze of technical language.

Once the seller has issued the proposal (which contains legal, pricing, and technical sections) the real negotiations begin. Obviously, major points of disagreement will be the price, the scheduled delivery dates, excusable delays, limitation of liability, and transfer of title. These are points of disagreement to all commercial contracts for the sale of complicated technical goods. This period of intense negotiations will create a strain in the seller's organization, between the sales branch which is always willing to close a "deal" and other branches, such as the program management and contract management groups, which do not want an agreement which is costly to the vendor.

Eventually, the period of negotiations comes to an end, and assuming that an informal compromise has been reached, the actual satellite project will begin through the process of "advance funding" of the project. Advance funding is done in satellite contracts before the formal contract is signed, to allow the seller to initiate the satellite project and to fund subcontractors. It should be carefully noted that advance funding is a separate legal contract and not part of the formal contract. If the formal contract is unsigned and is cancelled, these advance funding contracts remain as viable contracts for the raw materials purchased, and the other costs associated with the project. The seller will still have the right to demand full payment, based on these preliminary contracts, and subsequently deliver the unfinished raw materials to the customer.

Product Assurance is a major component of any commercial satellite contract. Product assurance has developed into a separate branch of engineering, with its own separate technical vocabulary and remains as one of the fastest growing fields in the 1980's. There are three major facets to modern product assurance engineering which are Reliability Assurance (RA), Quality Assurance (QA), and Quality Control (QC).

Reliability Assurance deals with the reliability of the electronic components of a satellite transponder such as transistors, resistors and capacitors. Since the design life of a satellite will be specified for a period of seven to ten years, it is essential that the electronic parts be able to survive for this period in conditions of great heat and cold. To this end, electronic components will be carefully screened to determine their reliability by running tests that may last hundreds of hours.

Electronic parts are destroyed by being burned out or cut open in these extensive and extremely costly tests. Complicated mathematical calculations are made to determine the probable life of the satellite. The RA staff must meet the RA technical specifications that were agreed in the contract.

Quality Assurance deals with the quality of those parts of the satellite which do not comprise the electronic parts of a communications payload, such as the raw material that forms the outer shell of the spacecraft. Quality Assurance engineers have an overview of the satellite designs, non-electronic parts, engineering changes, and all procured parts and materials that arrive at the seller's plant from subcontractors and suppliers. The QA staff must maintain the technical specifications that were agreed upon in the formal contract and like the RA engineers, act as an internal "watchdog" for the seller and the customer. In order to fulfill this function, millions of dollars must be priced into a satellite contract to support an expensive professional staff.

Quality Control (QC) fulfills the mundane function of testing the product as it passes through the part fabrication and integration stages. QC work involves measurements, taking sample tests and searching the material for flaws during the production process. Quality Control was the origin of modern day Product

Assurance since industrial companies long had internal inspection controls before they began to assign engineers to the fulltime tasks of Quality Assurance. Reliability Assurance really only became a separate sub-group with the commercial production of communications satellites.

The terms of payment form another major component of the commercial satellite contract. These contracts are on a fixed-price basis, so that the price agreed upon cannot be varied, despite an unexpected increase of costs, even from an independent source. Therefore, the seller will seek to avoid an extra financial liability by including a broad excusable delay clause in the company's favour, which will provide for an equitable adjustment to the contract price, and the delivery schedule, in case of fire, flood, epidemic, quarantine restriction, strike, walkout, freight embargo, an act of God or failure by the customer to meet his contractual obligations.

The procedure for payment is a payment milestone system whereby compensation is made according to a series of actual scheduled events in the satellite project, i.e. placing of procurement orders to subcontractors. There are usually 50 to 150 payment milestones, depending on the size of the satellite project. This system allows for a continual cash flow to the seller in order to finance his own expenditures for the satellite project.

Another important feature of the commercial satellite contracts is performance warranty on incentive payment clauses which will grant additional payments to the seller based on the duration of time that the satellite operates successfully. These in-orbit incentive payments comprised $10.8 million (CAN.) in the Anik D contract price of $78.6 million (CAN.) or 13.7 per cent of the total price.[33] The seller will seek to eliminate performance warranty clauses because the delays in payment may run up to ten years of successful operation after launch. The seller will usually settle for a performance warranty clause which gives him a sizable proportion of these incentive payments within one to two years of successful performance.

The converse to performance warranty clauses are price reduction clauses for late delivery which usually are drafted into the contract. The seller will seek to limit the price reduction clause (if it cannot be eliminated completely in negotiations) to a small fixed percentage of 1 to 2.5 per cent of the total contract price. Liability for the breach of other contractual obligations will usually exclude any damages for economic loss or loss of profits.

Conventional and legal warranties are always a major negotiating point in the commercial satellite contract. The unique feature of conventional warranties in these contracts is that commonly, the seller will never agree to any conventional warranty applying to any flight spacecraft after the launch. These conventional warranties usually only apply to defects in design, material or workmanship that are discovered before launch. The impossibility of access to a satellite in orbit to determine the cause of a malfunction has led to this limitation of conventional warranties. Legal warranties are commonly excluded by the terms of the contract.

Therefore, there has been a brief description of SPAR Aerospace Limited, as well as the nature of the type of commercial satellite contracts that the company is involved in. The major challenge of the 1980's for SPAR Aerospace Limited will be its ability to compete in the export market with technical giants like Hughes Aircraft Co. The commercial satellite business is highly costly and competitive. Extensive research and development is always one essential condition for success. An aggressive marketing staff and first rate scientific and engineering group are other conditions for a successful satellite company.

This advanced technology market may have a limited oligopolistic structure but the major commercial satellite manufacturers face a period of intense competition in the 1980's as rapidly rising labour and administrative costs place a squeeze on already low profit margins. The enormous amount of paperwork that is required in every commercial satellite project, due partly to Product Assurance requirements, will pose a growing bureaucratic drag on the efficient operation of a commercial satellite manufacturer in the next decade as satellite systems grow more complicated and more sophisticated. Private companies may be on the threshold of a new era in terms of the commercial development of direct broadcasting satellites and other technological advances, but serious financial and administrative problems remain to be resolved in the 1980's.

FOOTNOTES TO CHAPTER VI

[1] SPAR Aerospace Limited brochure, reprinted from "A New Dynamic SPAR has its Eye on a Star". Staff Report, Canadian Electronics Engineering, March 1978, p. 1.

[2] Ibid. pp. 4-5 for a description of this SPAR/RCA/ Northern Telecom arrangement.

[3] "built-to-print" means that the customer company sends its own technical blueprints to the contractor and the contractor builds the product according to those blueprints. The contractor does no independent design work under the contract. The customer supplies his own design.

[4] André Chenier, "Taking the Lead", In Search, Vol. VI, no. 2, Information Services of the Department of Communications, (Ottawa, Canada, Spring 1979), p. 34. These agreements are contracts for the supply of technical products.

[5] Ibid., pp. 32-34.

[6] Ibid., p. 34.

[7] Ibid., p. 36.

[8] Ibid., p. 36. Associations mean contracts.

[9] Ibid., p. 36.

[10] Ibid., p. 36.

[11] Ibid., p. 36.

[12] SPAR Aerospace Limited is now engaged in the initial development phase of the European L-SAT communications research satellite which involved preparing a technical contract proposal.

[13] André Chenier, "Taking the Lead," p. 36.

[14] INFOSPAR, volume XII, number 1, March 1980, p. 3.

[15] Ibid.

[16] Ibid.

[17] Ibid., an anechoic chamber is a chamber which is free from external vibrations.

[18]Ibid.

[19]INFOSPAR, volume XI, number 2, July 1979, p. 1.

[20]Telesat Canada Request for Proposal SP-27-47-1-3, dated October 27, 1978. SPAR Aerospace Limited submitted in response SPAR proposal No. 6512-F, dated January 22nd, 1979. It should be noted that the Minister of Communications pursuant to Section 8 of the Telesat Canada Act, indicated that the Minister was satisfied that such a Request for Proposal issued to SPAR would result in a proposal that specifies a reasonable ulilization of Canadian design and engineering skills and the incorporation of an appropriate proportion of Canadian components and materials. This declaration was contained in writing by letter from the Minister to Telesat Canada, dated October 13th, 1978.

[21]INFOSPAR, volume XI, number 2, July 1979, p. 1. Complex contract amendments have not, in fact, been issued to this date.

[22]Ibid.

[23]Ibid.

[24]Ibid.

[25]Ibid.

[26]INFOSPAR, volume XI number 2, July 1979, p. 2.

[27]Ibid.

[28]André Chenier, "Taking the Lead", pp. 32-34.

[29]Ibid.

[30]SPAR Aerospace Limited brochure, reprinted from "A New Dynamic SPAR has its Eye on a Star", staff report, Canadian Electronics Engineering, March 1978, pp. 3-4.

[31]Ibid., pp. 3-6.

[32]Address by Mr. L.D. Clarke, Chairman & Chief Executive Officer, SPAR Aerospace Limited at the Company's 13th Annual General Meeting, (Toronto, Ontario, Canada, June 12th, 1980), p. 4 of the speech.

[33]Article 15 Telesat Canada Contract with SPAR Aerospace Limited for Anik D. Contract Number PDC9SP12282 May 15th, 1979.

CONCLUSION

In this thesis I have examined three of the leading institutions in the Canadian space complex. The first institution is the Canadian government as represented by the Department of Communications (DOC). This is a purely public body which has funded key development projects and has helped found Canada's space industrial infrastructure. The Department of Communications is presently involved in a number of key advanced telecommunications projects such as Anik B, MUSAT, and SARSAT.

The role of the Department of Communications has been extremely positive and beneficial to Canada's space interests. Its research and development programs will allow Canada to remain a leader in the field of satellite telecommunications, as well as supporting and developing Canada's industrial base in this field. The only major caveat that one can add is that the lack of a centralized space agency in the federal government has resulted in a lack of a cohesive space policy that would encompass Canada's interests in satellite communications, remote sensing, and other new areas in space technology. The fault does not lie within the DOC but rather with the federal government's refusal in the 1970's to create a national space agency. This subject will be dealt with in greater depth later on.

The second type of institution that was examined was Telesat Canada which mixes public and private interests in this organization. As I have outlined, the Telesat system has come under a great deal of criticism for what is viewed as an inefficient use of its system capacity. There has also been related criticism to federal restrictions on earth station ownership, requirements of whole channel leasing and system interconnection. There has been a limited liberalization in relation to earth station ownership which will be examined in greater detail in this chapter. Telesat Canada clearly faces major challenges in the 1980's in relation to such issues as the requirements of whole channel leasing, restrictions against system interconnection, pay-TV, and the whole area of providing direct broadcasting services to residents in rural and remote areas. The federal government will have to decide in the 1980's whether to change and/or extend Telesat Canada's responsibility in such matters. Clearly, difficult decisions will have to be made in relation to the commercial technological explosion in this area.

The third type of institution examined was that of SPAR Aerospace Limited which is a purely private body. This Canadian corporation has had a remarkable success in the past 13 years. SPAR has attained prime contractor status and now has the capability to bid on major projects on the international market. However, it should be noted that SPAR has developed an extremely complicated systems management process in order to meet the exacting specifications of its major customers (especially in the field of Product Assurance). This could result in a cumbersome internal bureaucracy that is at variance with its innovative free enterprise philosophy. Private entities in the aerospace industry always run the risk of becoming "bureaucratized" due to the extensive paper-work required to manage, monitor, and detect defects in the final product. Also, the aerospace industry is extremely cyclical in nature due to its reliance on a small number of expensive government contracts to survive. For example, SPAR has experienced financial difficulties in the first nine months of 1980, due to the fact that no new major contracts have been signed recently.

Therefore, all three institutions face challenges in the 1980's and extensive changes will probably be required by these institutions to meet the new technological advances in satellite telecommunications. In this conclusion to my thesis, I will examine two key issues that will deeply influence the space complex in Canada in the 1980's. One is the problem of centralized management of Canada's space program by the federal government through a space agency. The other key issue is the policy of the federal government towards earth station ownership. Earth station ownership and the right to receive transmissions from satellites have become a "hot" issue and the subject of much controversy.

In the 1960's, the issue of national space agency for Canada was raised by the technical study which was commissioned by the Science Secretariat of the Privy Council entitled "Upper Atmosphere and Space Programs in Canada". This study (informally called the Chapman Report) published in February 1967 called for the creation of a national space agency for the following reasons:

> Several reasons were given to support the need for a central responsibility for space activities. In the absence of any central direction or central agency, there has been no delineation of Canada's objectives in space, from scientific, technological, social or economic viewpoints. There has been no central responsibility for the development of applications of space technology to communications satellites, resource surveys and other specific Canadian needs. There has been no unified planning for, nor coordination of, special facilities such as vibration and thermal vacuum test facilities, central data acquisition or processing facilities, or tracking facilities . . .
>
> Problems of organization and administration will grow as Canadian use of space technology grows without some form of central organization and assignment of responsibility within the Government.
>
> We consider that a central agency with responsibilities for space research and development for operation of major government facilities is necessary, and would recommend its establishment.[1]

In July 1967, the Science Council endorsed the recommendation of the Chapman Report in the form of a paper entitled "A Space Program for Canada". The Science Council of Canada in this report recommended the creation of a "broadly conceived"[2] central agency which would encompass the following functions: (1) Advance the Canadian capability in the science and technology of the upper atmosphere and space. (2) Further the development of Canadian industry in relation to the use of the upper atmosphere and space. (3) Plan and implement an overall space program for Canada. This wide mandate would have included the following activities:

> There is some difficulty in defining initially the full extent of the role that may be played by a central agency. Certainly, the primary role is to advise upon, coordinate, and, where necessary, initiate projects that collectively would constitute the national space research and development program. The agency should be competent to enter into contracts with government or other research establishments, or with industry, for the performance of specific research or development assignments.[3]

The federal government did not respond to these recommendations to create a national space agency along the lines proposed. The only response was in the limited form of committee management in the form of the Interdepartmental Committee on Space (ICS). This committee has a membership of seven departments, one Ministry of State, and the National Research Council. The ICS is responsible to the Department of Communications.[4]

Considerable criticism began to develop in relation to the effectiveness of the Interdepartmental Committee on Space to manage Canada's space activities. For example, the Air Industries Association of Canada believed that a central agency was necessary and must be independent from regular federal government departments. The association proposed that the space program be managed by an expanded Science Ministry or preferably, by a corporation along the lines of NASA. The association believed that the fault rested in the divided jurisdictions between government departments which creates a tangle of bureaucracies.[5] Another recommendation for a central space agency came from John J. Shepherd, Executive Director, Science Council of Canada, in a report entitled A Space Agency for Canada.[6]

In response to this rising level of criticism from several quarters, the ICS requested one of its members, the Ministry of State for Science and Technology, to conduct an internal review of the ICS as the coordinating organization for the Canadian space program. This review was to be undertaken in order to find out if the criticism of its functions was correct, i.e., that committee management was inadequate to meet the technological challenges arising from new areas such as resource-surveillance, remote-sensing, remote-manipulation, search and rescue, and navigation and meteorology. There was a common belief that the ICS could not handle these areas developing outside the traditional interest in satellite telecommunications.[7]

The internal review of the Ministry of State for Science and Technology was issued in July, 1979, which stated that: "The current approach to implementing the Canadian space program has several deficiencies which limit the scope and benefits of the space program in Canada."[8] The report confirmed the criticism that committee management was not enough in order to develop a coherent space program for Canada. It observed that the committee management system had difficulties in dealing with the current demands and to future needs.[9]

The main weakness of the committee system was stated by the report as follows:

> In practice, the establishment of priorities by the ICS is more an exercise in inter-departmental bargaining than a detached rational evaluation.[10]

The report also noted that Canada did not have a proper national presence at international discussions on space matters and "the right kind of business environment necessary to permit long-term stable investment by the Canadian space industry."[11]

The internal review of the Ministry of State for Science and Technology stated three possible options to this management problem:

(1) Create a Space Agency to develop and promote space technology. It could be given control over the Department of Communication's space-related laboratories; Energy, Mines & Resources' Canada Centre for Remote Sensing; the data-receiving facilities and research and development facilities of the Atmospheric Environment Service and the National ~~Research~~ Council's Space Research Facilities Branch. The Space Agency would be given the power to make international agreements and "would be more able than a government department to direct purchases to maximize industrial development."[12]

(2) Create a Space Branch within a current government Department that would oversee all aspects of the space program and take charge of all the government's space research facilities.[13]

(3) Set up a small staff for the ICS to facilitate communications between government and industry, follow activities in Canada and abroad, and play a major role in negotiating with international and foreign space agencies.[14]

The recommendations of this internal review did not receive any response from the ICS until January, 1980, when the ICS released a discussion paper on space programs for the next five years. The ICS discussion paper contained a $300 million five-year space plan and recognized formally that "in industry, decisions related to marketing, investment and resource-management also require reliable, medium-term planning and information."[15] The ICS discussion paper also made a note of the widespread advocacy of a national space agency.

There was no immediate decision by the federal government in relation to the ICS discussion paper regarding a national space agency. The federal government was more concerned with implementing parts of the five-year space plan such as the decision on January 21st, 1980, to invest $2 million in the European space industry's development of a large multi-purpose satellite called L-Sat, scheduled to be launched in 1983.[16] The Conservative government was also involved in an election campaign which was an obvious obstacle to a detailed decision, in relation to a new national space agency. When the Liberal government came to power on February 18th, 1980, the decision-making process was also slowed down due to the priority placed on winning the Quebec referendum. Politics was probably a major factor in delaying a decision on a new space organization for Canada.

Finally, on October 21st, 1980, Science Minister John Roberts outlined a new space program organization. The new organization will have its own budget with authority to recommend program priorities, scheduling and spending. The new space organization will centralize the efforts of the 10 departments and agencies of the federal government which have space programs.[17] The new space program organization will have the following functions:[18]

(1) The responsibility and authority to define, develop and direct a national space development program.

(2) The responsibility to ensure the continued development of a healthy space manufacturing and service industry.

(3) The responsibility to provide a focus for participation in international space programs.

(4) The responsibility to stimulate markets for Canadian space technology.

Science Minister John Roberts emphasized that the space organization would consult with Canadian industry which involves more than $140 million annually and provides 2,500 jobs. Reaction from Canadian industrial leaders in this field was favourable.[19]

Therefore, the federal government, after 13 years of pressure from within its own ranks and from outside sources finally set up a central space program organization to rationally plan Canada's space program as a whole. Canada will finally join the ranks of other space powers, such as the United States which have centralized space agencies to provide the necessary rational planning and direction to this growing industrial sector of the advanced industrial nations of the world.

The new space program organization will provide for greater direction and coordination of policies, financial resources, and development programs for all space related activities. Obviously, the satellite telecommunications sector (as one of the largest areas of space activities) will greatly benefit from a central space agency. Decisions as to the future development of this area of space technology will not suffer from the conflicting jurisdictions of the past. There should be a cohesive space program in the field of communications in the 1980's along with cohesive space programs in the other areas of space technology.

The establishment of Telesat Canada in 1969 created a restrictive earth station ownership policy. As a matter of policy, it was decided that Telesat Canada would be the only body that would be able to develop, own and operate communications satellites and licensed earth stations used in relation to Canada's domestic satellite telecommunications system. Therefore, the only licensed organization in Canada that could own and operate earth stations was Telesat Canada, except for

Teleglobe Canada which operates international telecommunications services. This restrictive earth station policy was the focus of a great deal of pressure brought by cable companies and conventional broadcasters who resented the monopoly that Telesat Canada possessed.[20]

In November 1977, Telesat Canada became a member of the Trans Canada Telephone System (TCTS). This occurred when the Federal Cabinet ruled that this association was in the public interest. The Cabinet decision overruled an adverse decision by the CRTC which felt that the commercial interests of the common carriers would outweigh the public interest goals of Telesat Canada in such a contractual arrangement. It should be noted that in the contractual arrangement, Telesat Canada continues to own all earth stations, but that the TCTS members control earth station locations in relation to their business.[21]

Political pressure to this contractual arrangement resulted in an announcement by the Minister of Communications, Mme. Jeanne Sauvé, on November 3rd, 1977, that the federal government would review its restrictive earth station ownership policy "with the objective of encouraging the fullest access to new satellite services".[22] This was a political move designed to dampen the public criticism of broadcasters and cable operators to the Telesat Canada-TCTS contract which was viewed by these non-TCTS members as being anti-competitive and resulting in common carrier domination of Telesat Canada's decision-making abilities.[23]

During this policy review, there was a predictable polarization of opinions. Telesat Canada and ten common carriers submitted briefs which recommended preservation of the restrictive status quo or recommending that only Telesat and the regulated common carriers be licensed to own and operate earth stations. The major arguments in favour of this restrictive policy were related to the need for systems integrity, the need to maintain a separation of carriage from content, cross-subsidization, new carrier entry, economics of scale, and ease of integration of satellite with existing terrestrial facilities.[29]

Opposition to the restrictive ownership policy was received in briefs from the Canadian Association of Broadcasters, the Canadian Broadcasting Corporation, the Ontario Educational Communications Authority, the Canadian Cable Television Association and a dozen cable television operators. These arguments were in favour of earth station ownership by customers of satellite channels leased from Telesat Canada. The arguments were based on the belief that customer ownership would increase operational flexibility, stimulate new earth station design, and ultimately result in lower costs. A strong argument was made that service to remote communities in Canada could be improved if broadcasters and cable companies could own inexpensive earth stations such as television receive-only (TVRO) satellite earth stations.[25]

A number of other organizations submitted briefs which asked for earth station ownership by customers of the satellite services. Seven industries or industrial organizations, including resource based companies, asked that earth station ownership belong to them, especially in remote locations. Canadian manufacturers of earth stations made detailed comments as to their capability to manufacture competively priced earth stations. The Consumers' Association of Canada, various community associations and a number of interested private citizens all made the case for consumer owned TVRO earth stations with the goal towards a more flexible system and an increased utilization of Telesat satellite channels.[26]

The end result of this extensive policy review process was an important policy change by the federal government. On February 27th, 1979, Communications Minister, Jeanne Sauvé, announced that Canadian broadcasters, cable TV companies and common telecommunications carriers could own and operate television receive-only (TVRO) satellite earth stations. Secondly, the Canadian common carriers would be able to own and operate transmit/receive earth stations for use in relation to the 14/12 GHz Anik C satellite system when it would go into operation on September 30th, 1982.[27]

This liberalized earth station ownership policy contains a number of important qualifications. The most important qualification is that TVRO licenses will only be issued for authorization reception of program-carrying signals originating in Canada and transmitted by Telesat Canada satellites. The authorization for reception of such program-carrying signals must be obtained both from the originators of those signals and the CRTC. The result of this qualification is that Canadian cable companies will not be able to use their TVRO stations to receive programs from American satellites. The revised policy will still restrict the further reception in Canada of foreign signals.[28]

Another important qualification to the revised policy is that although common carriers will be permitted to own transmit/receive stations, they will not be authorized to use such earth stations in relation to Canada's existing 6/4 GHz satellite system. This system, consisting of Anik A satellites and the hybrid Anik B satellite was said by the Minister to be "already well established under full Telesat ownership and management" and that "there was little evidence that such a change would significantly increase carrier utilization of those satellites or result in improved service to subscribers".[29]

An important exception has been created for users requiring an earth station for temporary use for operation "in remote off-shore locations".[30] In this case, the Minister will accept license applications "on a case-by-case basis"[31] from a telecommunication carrier or a user. This concession by the federal government allows a private citizen or a private company in a place like an off-shore drilling rig in the Arctic waters to operate an earth station that will receive signals from a Telesat Canada satellite subject to the approval of the originator of the program and the CRTC. This exception is designed for those situations in which ownership by Telesat Canada or another common carrier or a cable operator would be unrealistic.[32]

Communications Minister, Jeanne Sauvé, stated that the new liberalized policy would be particularly advantageous in remote and rural areas, where community groups that obtain broadcasting licenses could now apply for licences for receive-only earth stations. The Communications Minister also stated that the new policy would lead to the fuller use of Canadian satellites, and would increase opportunities for Canadian manufacturers.[33] Mme. Sauvé stated the following in relation to broadcasting services:

> Extension of ownership—made possible through this policy—opens the way to extension of basic services and choice in TV programming for all Canadians. I understand some initiatives are already being discussed by broadcasters, cable television companies and the telecommunications carriers. My department will do all it can to encourage these developments.[34] . . . I am confident that the new policy, in greatly improving access to satellite service, will provide new opportunities for the extension of TV programming in Canada.[35]

The February 27th, 1979, decision to liberalize earth station ownership policy has already been widely challenged by the proliferation of the illegal use of dish antennas to receive satellite signals. There are 100 television channels on eight different satellites that are transmitting signals into Canada and the illegal reception of these signals is growing and growing across the nation. These 100 television channels include six American pay-TV channels, four American sports channels, three cultural channels from the American PBS network, several Spanish channels, several religious channels, as well as the debates of both the Canadian House of Commons and the United States House of Representatives. An illegal operator can also tune in on private corporate business meetings and surgical operations. Obviously, many of these channels require paid subscribers which nobody in Canada on these illegal receivers has paid for.[36] These operations violate the Intelsat Treaty of August 20th, 1964 which forbids either Canada or the U.S.A. from taking signals from the other's satellites.[37]

The illegal reception of these transmissions also violates Canadian law since the Department of Communications cannot license such an earth station that intends to pick up such broadcast signals and the CRTC will not license an operation that intends to feed the signals to a cable system or to another transmitter. The maximum penalty is a $2500 fine and one year in prison, under the Radio Act and $1000 a day for relaying the signals under the Broadcasting Act.[38] Despite these legal sanctions, industry and government officials estimate that there are about 700 to 1000 parabolic dish antennas operating illegally in Canada.[39]

The illegal use of dish antennas gained considerable popularity in the Arctic areas and Western Canada as well as Northern Ontario. For example in Hinton, Alberta, the Rocky Mountain Cable company has been experimenting with its $30,000 dish antenna since October 1979. The president of that company stated publicly that the Hinton-area residents have enjoyed the experiments and he predicted that a "minor rebellion"[40] would occur if the government tried to penalize the station. In British Columbia, the provincial Communications Minister, Pat McGeer, installed an illegal earth station TV satellite receiver on the lawn of the provincial legislature building in Victoria in order to pressure the federal government into changing the law.[41] At Tofino, on the west coast of Vancouver Island, a community group formed a cooperative and placed a dish antenna on top of a local mountain as a protest against receiving only one TV channel with a bad signal through existing means of conventional broadcasting.[42]

This behavior on the part of operators and users of illegally-received television signals has resulted in a mixed reaction by federal government authorities. John Meisel, chairman of the CRTC in June 1980 promised to "commence prosecutions"[43] against operators who rebroadcast illegally-received American television signals. Mr. Meisel said at the annual convention of the Canadian Cable Television Association that the CRTC "intends to fulfill its duty with regard to the Broadcasting Act"[44] in order to stop the unlicensed broadcasting through the proliferating use of dish antennas. Mr. Meisel stated that the CRTC is concerned about the effect the illegal earth stations would have on the development of the Canadian broadcasting system, especially its licensees. Mr. Meisel also stated that "In addition, certain licensees are themselves transmitting or distributing illegally broadcast signals. Therefore, the commission has asked the Department of Communications to investigate certain allegations of illegal operations."[45]

On October 22nd 1980, Communications Minister, Francis Fox, announced that the federal government was starting a hard-line policy on illegal earth stations in urban areas by shutting down a dish antenna in Burnaby, British Columbia. However, the federal government would continue to ignore dish antennas set up in northern and remote communities in Canada that receive television broadcasts from American satellites until more programming is provided on Canadian satellites. The Communications Minister stated in a press interview that his department hopes that prosecution against six illegal operators in urban areas will deter others from receiving and distributing American satellite signals.[46]

An official for the Communications Minister stated that federal communications officials shut down a dish antenna on top of an apartment building in Burnaby, B.C., by seizing electronic components. The dish antenna was being used to distribute signals to television sets in the building. The seized equipment would be turned over to the Justice Department, which would decide whether to bring charges against the operators.[47]

The Communications Minister justifies this uneven approach in that the proliferation of such dish antennas would flood Canadians with American programming, but that he was not worried about antennas set up by individuals or by remote communities which would otherwise receive little or no television broadcasting. In essence, the Communications Minister is worried that the illegal reception of American programming "would threaten the Canadian broadcasting system"[48] in areas where the Canadian network already exists, but that residents in remote areas would be allowed to receive broadcasts on a temporary basis until the Canadian broadcasting network can supply services to these areas.

This uneven approach is designed to suppress entrepreneurs in urban areas who want to resell the signals to subscribers while showing an appreciation for the broadcasting problems of private citizens in remote communities. Unfortunately, this policy tends to breed confusion as to the line between legal and illegal behavior. This policy also means that American producers of pirated programming will not be compensated for the use of their property by these remote communities.[49]

In the long run, what is required is the extension of Canadian broadcasting services to these remote communities by satellite in order to protect Canadian culture as well as dealing with the entertainment needs of private citizens in remote areas. On October 23rd, 1980, Communications Minister, Francis Fox, announced that licensing hearings on extending television services to rural and remote communities by satellite would begin in February 1981 and that new "foundation" legislation governing telecommunications was planned.[50] The Communications Minister also announced that he would authorize transmission of CTV network programs and TVA, the network's French-language service, by satellite as a first step towards expanded service to remote areas of the country.[51]

The Communications Minister stated that he wished to make it easier to receive licenses for the dish antennas needed to receive Canadian television programming and other forms of communication by satellite. However, the Communications Minister said that the illegal reception from satellites of American programs for distribution in urban areas "will not be tolerated" and that operators of such programming would be prosecuted and have their equipment seized.[52]

Therefore, satellite communications in Canada stands at the threshold of a new era of development. The extension of Canadian broadcasting services to the remaining 3% of the Canadian population in remote areas remains as a challenge for this new technology. The challenge is not only to provide one of two channels of television service but at least a rough equivalent to what an urban resident can expect to receive. The field of Canadian satellite telecommunications will be extremely exciting in the 1980's, since new legislative rules must be drafted and new administrative regulations must be written in order to comply with the demands of the new technology.

The new space program organization of the federal government will be formulating policies for the 1980's in relation to satellite communications. Telesat Canada will be trying to implement the Anik C system as one of the world's first operating 14/12 GHz systems. Canadian private industry in the satellite communications field will be seeking to expand into the world markets and to formulate a Canadian industrial strategy with the federal government. All in all, the 1980's will be a fertile area for active participants and academic observers of the evolving Canadian satellite telecommunications domain.

FOOTNOTES TO THE CONCLUSION

[1]J.H. Chapman, P.A. Forsyth, P.A. Lapp and G.N. Patterson, Upper Atmosphere and Space Programs in Canada, Special Study No. 1, Science Secretariat, Privy Council Office, (Ottawa, Canada: The Queen's Printer, 1967), pp. 101-102.

[2]A Space Program for Canada, Report No. 1, Science Council of Canada, O.M. Solandt, Chairman, (Ottawa, Canada: The Queen's Printer, 1967), paragraph 16.

[3]Ibid., paragraph 17.

[4]John J. Shepherd, Canada's Pressing Need for a National Space Agency, The Globe and Mail, April 3rd, 1980, p. 7. Participants in the ICS include the following:

the Department of Communications
the Department of Energy, Mines & Resources
the Department of the Environment
the Department of External Affairs
the Department of Fisheries & Oceans
the Department of Industry, Trade & Commerce
the Department of National Defence
the National Research Council
Ministry of State for Science & Technology
the Treasury Board (observer status)
the Department of National Health and Welfare (observer status)

[5]Editorial, Which Way is up? The Globe and Mail, p. 6.

[6]John J. Shepherd, Executive Director, Science Council of Canada, in a Report entitled A Space Agency for Canada, File 7220-3, September 1, 1978.

[7]John J. Shepherd, Canada's Pressing Need for a National Space Agency, The Globe and Mail, April 3rd, 1980, p. 7.

[8]Ibid.

[9]Ibid.

[10]Robert Steklasa, Space Program Control Blasted, The Financial Post, May 24, 1980, p. 9.

[11]Ibid.

[12]Ibid.

[13]Ibid.

[14] Ibid.

[15] John J. Shepherd, Canada's Pressing Need for a National Space Agency, The Globe and Mail, April 3rd, 1980, p. 7.

[16] Editorial, Which Way is up?, The Globe and Mail, p. 6.

[17] Canadian Press, Canadian Space Agency on Launch Pad, The Montreal Gazette, October 22nd, 1980, p. 73.

[18] Ibid.

[19] Ibid.

[20] Robert J. Buchan, Canada's Earth Station Ownership Policy Liberalized, Satellite Communications, (Denver, Colorado, U.S.A., May 1979), p. 53.

[21] Ibid.

[22] Ibid.

[23] Ibid.

[24] Ibid., pp. 53-54.

[25] Ibid., p. 54.

[26] Ibid., p. 54.

[27] Department of Communications news release, February 27th, 1979, p. 1.

[28] Robert J. Buchan, Canada's Earth Station Ownership Policy Liberalized, Satellite Communications, (Denver, Colorado, U.S.A., May 1979), pp. 52-53.

[29] Statement by Minister of Communications, Jeanne Sauvé, on the New Policy for Licensing Satellite Earth Stations, Department of Communications, Information Services, p. 2.

[30] Ibid., p. 3.

[31] Ibid.

[32] Robert J. Buchan, Canada's Earth Station Ownership Policy Liberalized, Satellite Communications, (Denver, Colorado, U.S.A., May 1979), p. 53.

[33]Department of Communications news release, February 27th, 1979, p. 2.

[34]Ibid.

[35]Ibid., p. 1.

[36]Blaik Kirby, 100 TV Channels Free for Asking, The Globe and Mail, March 21st, 1980, pp. 1-2.

[37]This legal obligation is contained in article 2 of the Intelsat Treaty of August 20th, 1964 as well as articles 7 to 9 of the attached Special Agreement. The legal reference for the Intelsat Treaty including the Special Agreement is the Canada Treaty Series 1964 No. 24.

[38]These penalties are in Section 11 (1) of the Radio Act and Section 29 (3) of the Broadcasting Act.

[39]Canadian Press, Illegal TV Reception Dishes Popular in Alberta, The Montreal Gazette, June 17th, 1980, p. 82.

[40]Ibid.

[41]Canadian Press, B.C. Satellite 'Theft' Old Hat in the Wild, The Montreal Gazette, June 4th, 1980, p. 41.

[42]Jim Lyon, Meisel Message: Stop Poaching TV, The Financial Post, June 7th, 1980, p. 3.

[43]Ibid.

[44]Ibid.

[45]Ibid.

[46]Canadian Press, Ottawa Gets Tough on Illegal Antennas, The Montreal Gazette, October 23rd, 1980, p. 44.

[47]Ibid.

[48]Ibid.

[49]Editorial, Serving Notice on TV Pirates, The Montreal Gazette, November 25th, 1980, p. 6.

[50]United Press Canada, Francis Fox Endorses Pay TV Within a Year, The Montreal Gazette, October 23rd, 1980, p. 68.

[51]Ibid.

[52]Ibid.

APPENDIX 1

GOVERNMENT PROGRAMS (1966)

Program	Responsible Agencies	Expenditures $ Thousands Internal*	External**	Total	U.S. Expenditures in Canada $ Thousands
1. Alouette-ISIS***	Defence Research Board	1,018	3,204	4,222	—
2. Churchill Research Range	National Research Council	—	2,170	2,170	2,170
3. Missile Re-entry	Defence Research Board	1,895	105	2,000	600
4. Engineering Support, Rockets	National Research Council	310	1,440	1,750	—
5. HARP/McGill****	Department of Industry	—	1,500	1,500	1,150
6. Upper Atmosphere Research	Defence Research Board	1,237	—	1,237	—
7. Rocket Development	Department of Industry and Defence Research Board	600	370	970	—
8. Aerology	Defence Research Board	703	115	818	—
9. University Support	Defence Research Board and National Research Council	—	740	740	410
10. Satellite Communications	Defence Research Board and Department of Transport	731	—	731	—
11. NCR Space Research	National Research Council	612	—	612	—
12. P.A.R.L.*****	Defence Research Board	458	60	518	—
13. Industrial Research Support	Defence Research Board	—	225	225	—
14. St. John's Tracking Station	National Research Council	—	200	200	—
15. Cosmic Ray Research	Atomic Energy of Canada Ltd.	80	—	80	—
		7,644	10,129	17,773	4,330

*This subdivision is only approximate, due to the lack of precise information

*Internal = in-house government expenditures
**External = expenditures made through private industry, industry, universities, research institutes
***ISIS = International Satellites for Ionospheric Studies
****HARP = High Altitude Research Program
*****PARL = Prince Albert Radar Laboratories

Reprinted from A Space Program for Canada, Report No. 1, Science Council of Canada, O.M. Salandt, Chairman, Queen's Printer, Ottawa, Canada 1967, p. 18.

APPENDIX 2

HERMES EXPERIMENTS (July 1978)

NO	EXPERIMENTERS	SUBJECT	STATUS
F-1-1	Communications Research Centre	Propagation	U
-2	Communications Research Centre	TDMA*	C
-3	Communications Research Centre	FDMA**	C
-4	Communications Research Centre	High Rate Data	C
-5	Communications Research Centre	Terminal Evaluation	U
3F-1-6	CRC/NASA/COMSAT	Digital TV	P
F-2-1	Canadian Broadcasting Corporation	Urban Reception	C
-2	Canadian Broadcasting Corporation	Radio Broadcast	C
-3	Canadian Broadcasting Corporation	TV (Olympics)Broadcast	C
F-3	Public Service Commission	Tele-education	C
3F-4	Kash Connection	Telemedicine	C
3F-5-1	National Research Council	Time Transfer	U
3F-5-2	NCR/NASA/DOC	SRMS***	C
P-1	Memorial University	Telemedicine	C
P-2-3	Quebec-University of Quebec	Tele-education	C
-4	-James Bay Development	Remote Camp Communication	C
-5	Hydro Quebec	Clock Synchronization	C
P-3	Government of Ontario	Government Administration	C
-3B	Government of Ontario (Extension)	Government Administration	C
3P-3	Government of Ontario	Government Administration	U
3P-4-1	Ontario Educational Communications Auth.	Summer Academy	U
3P-4-2	Ontario Educational Communications Auth.	Teleconferencing	P
P-5	Government of Manitoba	Computer Communications	C
P-6	B.C. Distance Education	Tele-education	C
U-1	Carleton University	Tele-education	C
U-3	University of Toronto	Radio Interferometry	C
3U-3	University of Toronto (Extension	Radio Interferometry	U
U-4	McMaster University	Digital Modems	C
U-6	University of Western Ontario	Telemedicine	C
-6B	University of Western Ontario (Extension)	Telemedicine	C
U-7	Waterloo University	Data Communications	C
U-9	Regina University	Community Interaction	C
3U-10	University of Montreal	Nursing Education	P
3U-11-1	University of Quebec	Intercommunity Communications	P
-11-2	University of Quebec	Tele-education	P
3U-12	University of Quebec (Trois Rivières)	Teacher Education	P
I-1	Bell/Telesat	Terminal Evaluation	C
E-2	Alberta Native Communications Society	Community Interaction	C
3E-4	Taqramiut Nipingat	Community Communications	P
3L-5	Wa Wa Ta	Community Communications	U

C - Completed   U - Underway   P - Planned

All of the Canadian experiments have now been completed. This Appendix does not include the Australian experiments which were undertaken in the fall of 1979

*TDMA = Time Division Multiple Access
**FDMA = Frequency Division Multiple Access
***SRMS = Shuttle Remote Manipulator System

Reprinted from N.G. Davies, J.W.B. Day and M.V. Patriarche.

The Transition from CTS/Hermes-Communications Experiments to Anik B Pilot Projects
Department of Communications, Ottawa, Canada,
CH1352-4/78/0000-0324, 1978, p. 329.

APPENDIX 3

RESUMES OF

ANIK-B PILOT PROJECTS

AUGUST 1980

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

ANIK-B PILOT PROJECTS

TV BROADCASTING DISTRIBUTION

B-1 PROGRAM DELIVERY

COMMUNITY COMMUNICATIONS

C-1 ALBERTA EDUCATIONAL COMMUNICATIONS AUTHORITY/ACCESS
C-2 INUIT TAPIRISAT OF CANADA
C-3 TAQRAMIUT NIPINGAT INC.

TELE-EDUCATION

E-1 BRITISH COLUMBIA MINISTRY OF EDUCATION
E-2 ONTARIO EDUCATIONAL COMMUNICATIONS AUTHORITY
E-3 MINISTRY OF EDUCATION OF QUEBEC

TELE-HEALTH

H-1 MEMORIAL UNIVERSITY OF NEWFOUNDLAND
H-2 UNIVERSITY OF MONTREAL

PUBLIC SERVICE

P-1 ONTARIO MINISTRY OF GOVERNMENT SERVICES

ADVANCED TECHNOLOGY

T-1 TELESAT CANADA/TCTS
T-2 DEPARTMENT OF COMMUNICATIONS/CNCP
T-3 UNIVERSITY OF TORONTO
T-8 TELESAT CANADA/DOC

The Anik B satellite, owned by Telesat Canada, is located in the geostationary satellite orbit at 109°W longitude. It was launched on 15 December 1978. The satellite provides operational services at 6/4 GHz with 12 transponders and experimental services at 14/12 GHz with 4 transponders. The Department of Communications (DOC) leased the 14/12 GHz services for two years to February 1981 with a minimum availability of two transponders and the option to extend the lease. A brief résumé of each of the Pilot Projects in the two-year Anik B Communications Program is included below:

B-1 Program Delivery Pilot Project

The objectives of this pilot project are to demonstrate, to evaluate and to gain field experience with a direct-to-home and small community program delivery service and to provide information to contribute to policy development and plans respecting the future operational use of broadcasting satellites. The project is being carried out with transmissions to the central eastern region using one TV signal in a 20 Watt transponder and in the western region using two TV signals in one 20 Watt transponder. Receiving terminals are located at homes, schools, community centres, cable head-ends and at low power rebroadcast units.

East

The programs of the Ontario Educational Communications Authority (OECA) are transmitted for 94 hours each week to low cost TVRO terminals with antennas of 1.2 metres and 1.8 metres diameter in 39 communities in Northern and Northwestern Ontario and to four 3 metre TVRO terminals (designed for operation with cable systems) in communities in the Georgian Bay area. The project commenced on 25 September 1979 using a 9 metre terminal in Ottawa to uplink an off-air OECA signal. This arrangement was discontinued in August 1980 when a 4.5 metre TV uplink terminal was installed on the roof of the OECA building in Toronto where it is operated by OECA. The project will continue to 17 February 1981.

West

The programs of the Canadian Broadcasting Corporation (CBC) and B.C. Television Broadcasting System (BCTV) are transmitted daily, with two TV channels per transponder, for 154 hours/week. The project commenced on 14 December 1979 using a 3 metre and a 3.7 metre transportable TV uplink terminal in Vancouver. The 3.7 metre transportable terminal was replaced in May 1980 with a 3.7 metre fixed uplink terminal on the roof of the CBC building in Vancouver, which is operated by the CBC. 1.8 metre low cost TVRO terminals have been installed in 33 communities in B.C., the Yukon and N.W.T. Additional installations to a total of 36 are to be made in August/September 1980. The project will continue to 17 February 1981, but after mid-September, three TV signals will be carried by one transponder to meet program commitments to Projects B-1, C-1, C-2 and E-1.

C-1 Alberta Educational Communications Authority/ACCESS

The objective of this pilot project is to gain experience with satellite technology as it applies to educational TV in Alberta and to assess the potential audience and costs. A TV uplink terminal located at Burnaby, B.C., for Project E-1 is used to transmit packaged educational programs to 3 metre TVRO terminals at Medicine Hat and Fort McMurray and to 1.2 metre or 1.8 metre TVRO terminals at High Level, Peace River, Grouard, Grande Prairie and Edmonton. The project commenced on 10 March 1980 and is scheduled to continue to 17 February 1981. Project activities were suspended during school holidays in the Summer of 1980 when DOC 1.2 metre TVRO terminals were replaced by terminals purchased by the project sponsor.

C-2 Inuit Tapirisat of Canada

The objective of this project is to investigate the provision in the Northwest Territories of TV programming for the Inuit by the Inuit and the utility of intercommunity teleconferencing for educational, cultural and social purposes. A 3.7 metre TV uplink is installed at Frobisher Bay and 3 metre interactive TV receive and voice return terminals are installed at Cambridge Bay, Baker Lake, Pond Inlet, Eskimo Point and Igloolik. The project is scheduled to commence in early September and to continue until 17 February 1981.

C-3 Tagramiut Nipingat Inc.

The objective of this project is to investigate the comparative acceptability of Inuit TV programming and "southern" TV programming to the Inuit of Arctic Quebec, and to investigate the value of intercommunity satellite communications in that region. A 3.7 metre uplink terminal in Sugluk will transmit TV programs to George River, Great Whale River, Inujjuaq and Fort Chimo where 3 metre interactive TV terminals are located. The terminals were installed in August 1980. The project is scheduled to commence in September 1980 and to continue until 17 February 1981.

E-1 British Columbia Ministry of Education

The objective of this project is to test and to assess the potential for future use in British Columbia of "Interactive Instructional TV" over vast distances using satellite communications to overcome obvious geographical problems. Using a 3 metre TV transmit terminal at South Burnaby, credit courses of the B.C. Institute of Technology as well as special programs from other institutions are transmitted to community colleges in Port Alberni, Terrace, Prince George, Cranbrook and Dawson Creek in B.C. and Whitehorse in the Yukon with satellite audio return via 3 metre interactive TV terminals. Associated colleges in Gold River, Prince Rupert, Mackenzie, Fort St. John, and Fort Nelson receive the programs with TVRO terminals. The project began on 1 October 1979. In May 1980, the six interactive terminals were exchanged for four TVRO terminals (some site changes were necessary) and the project is scheduled to continue to 17 February 1981.

E-2 Ontario Educational Communications Authority

The objective of this project was to test the use of satellite distribution to serve four remote communities in Ontario to offer learning opportunities of the Tele-Academy which were not otherwise available. The programs were transmitted from the 9 metre station in Ottawa and received by 3 metre TV receive terminals at Geraldton, Marathon, Owen Sound and Manitouwadge with interconnection to the local cable systems. The project took place between 1 April and 30 June 1979. Audio feedback, as required, was by terrestrial means.

E-3 Ministry of Education of Quebec

The objective of this project is to test the use of satellite communications to improve the availability of high quality education in the northern school districts of Kativik and Nouveau Québec. During the period 9 April-30 August 1979, 3 metre TV transmit terminals installed at LG-2 (James Bay Development Region in Nouveau Québec) and Montreal were used for two-way video teleconferencing. The TV transmit terminals were replaced by 3 metre telephony terminals and the project was continued until June 1980 using audio teleconferencing. In September 1980, the terminal facilities installed for Project C-3 will be used to distribute educational programming (with interaction) to Inuit communities in the Kativik area of Arctic Quebec.

H-1 Memorial University of Newfoundland

The objective of this project is to assess the value of audio teleconferencing in a variety of health care activities and to provide data on efficiency and effectiveness of satellite links to remote areas in order that decisions may be made on the operational future for tele-medicine applications. In July 1980, a 3 metre telephony terminal was installed at St. John's and a 0.9 metre terminal was installed on a drill ship operating off Labrador. Additional 3 metre telephony terminals are to be installed at Labrador City and Goose Bay in August and at Makkovik after the close of the offshore drilling season. The project is scheduled to commence early in September 1980 and to be completed 17 February 1981.

H-2 University of Montreal

The objective of this project is to determine the operational viability for an audio telemedicine system to provide support for health service delivery in "Complexe La Grande" (LG-2). The terminal facilities installed at Montreal and LG-2 for Project E-3 were shared for this project. Two-way video teleconferencing trials took place from 9 April-30 August 1979 followed by two-way audio teleconferencing trials which continued until 30 August 1980.

P-1 Ontario Ministry of Government Services

The objective of this project was to design, implement, and evaluate on a pre-operational but continuing basis, a basic multi-purpose satellite-based common service telecommunications network for administrative and operational use of Ontario Government Ministries. 3.7 metre modular TV transmit terminals were installed at Thunder Bay and Toronto in July 1979 to provide for two-way video teleconferencing and a 3 metre interactive TV terminal was installed at Sault Ste. Marie. In January 1980 the latter terminal was removed. In May 1980, the TV uplink terminal at Thunder Bay was replaced with a TVRO and the project continued using combined satellite and terrestrial facilities. The project will continue until 17 February 1981.

T-1 Telesat Canada/TCTS

The objective of this project is to evaluate the performance of a 91 Mbps digital transmission link using a 14/12 GHz satellite and two earth stations that have been developed for commercial operation with Anik C. The integration of this link with the terrestrial network will also be tested. The tests are scheduled to take place from September 1980 through February 1981.

T-2 Department of Communications/CNCP

The objective of this project is to investigate the potential of a "slim" TDMA system, to establish its parameters and to test the suitability of the system for data, voice, video and innovative business services. New terminals have been developed and are being tested at Ottawa commencing in June 1980. Terminals are to be installed in Ottawa, Toronto, Montreal and Kitchener for tests of the TDMA system which will continue through February 1981.

T-3 University of Toronto

The objective of this project is to maintain a known phase relationship between three high-precision atomic frequency standards at Radio Observatories at Algonquin Park, Penticton and Washington. This will permit very accurate geodynamical measurements using extra-galactic radio sources and Very Long Baseline Interferometer (VLBI) techniques. Low-level pilot tones are transmitted continuously over many days during the periods of observation. The project commenced in June 1979 and will continue at intervals through February 1981.

T-8 Telesat/Department of Communications

The main objective of this project is to measure the depolarization of linearly polarized 12 GHz satellite signals due to rainfall in order to evaluate the margins that will be required for the use of dual polarization for radio spectrum conservation. A low-level signal will be monitored by receiving terminals at Halifax, Winnipeg, Toronto and Ottawa. The project commenced in August 1980 and will continue through February 1981.

APPENDIX 4

STATEMENT OF FINANCIAL POSITION

as at December 31, 1979 with comparative figures for 1978

Assets	1979 (thousands	1978 of dollars)
Property		
Satellites	$133 653	$ 74 451
Earth stations	75 186	66 161
Other	1 431	1 416
	210 270	142 028
Accumulated depreciation (note 1)	111 693	85 404
	98 577	56 624
Construction in progress (note 2)	83 730	90 419
	182 307	147 043
Current assets		
Cash and short term investments (note 3)	1 082	2 608
Receivables	2 039	491
Other	633	706
	3 754	3 805
	$186 061	$150 848

Shareholders' Equity and Liabilities		
Shareholders' equity		
Capital stock (note 4)	$ 60 000	$ 60 000
Retained earnings	28 962	22 101
	88 962	82 101
Deferred income taxes (note 5)	27 224	22 862
Long term liabilities (note 6)	42 950	4 500
Deferred revenue (note 7)	1 420	16 064
Current liabilities		
Accounts payable and accrued liabilities	8 474	10 587
Current portion of deferred revenue	16 414	14 317
Current portion of long term liabilities	617	417
	25 505	25 321
	$186 061	$150 848

from pages 38, 40, 47 Telesat Canada 1979 Annual Report, Ten Years and Counting

STATEMENT OF EARNINGS

for the year ended December 31, 1979 with comparative figures for 1978

	1979	1978
	(thousands of dollars)	
Operating revenues	$49 842	$33 745
Operating expenses		
Operations and administration	11 893	9 365
Depreciation (note 1)	26 504	17 515
	38 397	26 880
Earnings from operations	11 445	6 865
Other income—net (note 8)	2 178	3 998
Earnings before income taxes	13 623	10 863
Income taxes—deferred (note 5)	4 362	5 268
Net earnings	$ 9 261	$ 5 595
Earnings per common share	$ 1.54	$ 0.93

STATEMENT OF RETAINED EARNINGS

for the year ended December 31, 1979 with comparative figures for 1978

	1979	1978
	(thousands of dollars)	
Balance, beginning of the year	$22 101	$17 706
Net earnings for the year	9 261	5 595
	31 362	23 301
Dividend	2 400	1 200
Balance, end of the year	$28 962	$22 101

STATEMENT OF CHANGES IN FINANCIAL POSITION

for the year ended December 31, 1979 with comparative figures for 1978

	1979	1978
	(thousands of dollars)	
Financial resources provided by:		
Operations	$35 423	$25 637
Bank loan	37 000	—
Deferred revenue	—	18 860
	72 423	44 497
Financial resources used for:		
Property additions (note 2)	52 946	57 260
Current portion of deferred revenue	16 414	14 317
Dividend	2 400	1 200
Reduction of long term liabilities	898	344
	72 658	73 121
Decrease in working capital	(235)	(28 624)
Working capital (deficit), beginning of the year	(21 516)	7 108
Working capital (deficit), end of the year	$(21 751)	$(21 516)

STATISTICAL SUMMARY

	1979	1978	1977	1976	1975	1974	1973**
Financial Positions Items* (thousands of dollars)							
Investment in property	294 000	232 447	170 772	145 824	126 639	114 245	100 665
Accumulated depreciation	111 693	85 404	67 967	50 653	33 981	20 510	8 512
Shareholders' equity	88 962	82 101	77 706	73 784	71 925	68 868	65 220
Long term liabilities (including current portion)							
— loans	41 000	4 000	4 000	4 500	12 500	20 500	25 500
— other	2 567	917	1 551	3 976	9 792	7 456	7 837
Deferred income taxes	27 224	22 862	17 594	13 486	11 379	7 985	4 794
Deferred revenue (including current portion)	17 834	30 381	9 593	—	—	—	—
Earning Statement Items (thousands of dollars)							
Operating revenues	49 842	33 745	34 053	29 580	31 129	28 049	18 975
Operating expenses (excluding depreciation)	11 893	9 365	9 401	8 427	7 956	7 073	5 497
Depreciation	26 504	17 515	18 009	18 006	16 891	14 677	11 689
Other income	2 178	3 998	1 987	1 419	769	539	921
income taxes	4 362	5 268	4 108	2 107	3 394	3 190	1 142
Net earnings	9 261	5 595	4 522	2 459	3 657	3 648	1 568
Financial Statistics							
Common shares outstanding*	6 000 001	6 000 001	6 000 001	6 000 001	6 000 001	6 000 001	6 000 001
Earnings per common share	$1.54	$0.93	$0.75	$0.41	$0.61	$0.61	$0.26
Dividends per common share	$0.40	$0.20	$0.10	$0.10	$0.10	—	—
Return on common equity	10.8%	7.0%	6.0%	3.4%	5.2%	5.4%	2.5%
Return on total invested capital	11.4%	7.2%	6.1%	3.8%	5.4%	5.7%	3.4%
Equity per common share*	$14.83	$13.68	$12.95	$12.30	$11.99	$11.48	$10.87
Other Statistics*							
Number of employees*	387	360	333	311	312	282	236
Salaries and wages (thousands of dollars)	8 716	7 350	6 504	5 983	5 202	4 158	3 239
Number of earth stations in service*	109	99	85	72	58	49	34

*At year-end
**First year of operations

APPENXIX 5

THE
SPACECRAFT
SYSTEM

Telesat A Technical Description
Document No. TC-79-001
September 1979, page 9.

Introduction

The Telesat space segment consists of four satellites in geostationary orbit, three Anik A and one Anik B. A further three spacecraft of the Anik C series and two of the Anik D series are currently under construction.

All the Anik series communications spacecraft are designed to operate in the 6/4 GHz and/or the 14/12 GHz bands designated for fixed satellite services. A comparative Table of Characteristics is shown in Table 2.

Table 2 Comparison of Anik Series Spacefraft

	UNIT	ANIK A	ANIK B		ANIK C	ANIK D
Transfer Orbit Weight	kg	560	920		1080	1128
Height (On-station)	m	3.4	3.28		6.43	6.57
Body Width	m	1.78	2.05		2.16	2.16
Max.Dimension (On-station)	m	3.4	9.54		6.43	6.57
Stabilization		Spun	3 Axis		Spun	Spun
Frequency Band	GHz	6/4	6/4	14/12	14/12	6/4
Number of Channels		12	12	6	16	24
Number of TWTA's		12	12	4	20	24
Channel Bandwith	MHz	36	36	72	54	36
Antenna Coverage		All Canada	All Canada	4 Spot Beams	4 Spot Beam+ switching (S.Canada)	All Canada
Saturation Flux Density	dBW/m^2	-80	-81	-86 (-81)	-81	-81
Receive G/T	dB/K	-7.0	-6.0	-1.0	2.0	-3.0
EIRP	dBW	33	35.7	46.5	46.5	36
TWT Rated Power Output	W	5	10	20	15	11
Power						
Battery: Nominal Capacity	AH	7	17		17.3	17.3
Number		2	3		3	3
Array Capacity	W	235	620		800	800
Design Life	yrs.	7	7		10	10
Mission Life (Minimum)	yrs.	—	—		8	8
Launch Dates						
F1		Nov.72	Dec.78		1981	1982
F2		Apr.73	—		1982	TBA
F3		May 75	—		TBA	—

APPENDIX 6

Consolidated Balance Sheet December 31, 1979

Assets	1979	1978
Current:		
Accounts receivable	$20,100,000	$20,368,000
Inventories, less advance payments	16,912,000	8,668,000
Prepaid expenses	269,000	163,000
Total current assets	37,281,000	29,199,000
Fixed, at cost:		
Building and leasehold improvements	1,531,000	1,317,000
Machinery, tooling and equipment	15,587,000	11,262,000
	17,118,000	12,579,000
Less accumulated depreciation and amortization	6,060,000	4,689,000
Net fixed assets	11,058,000	7,890,000
Deferred development costs less accumulated amortization	151,000	59,000
	$48,490,000	$37,148,000

SPAR Aerospace Limited

1979 Annual Report pp. 10, 12, 24.

Consolidated Statement of Income and Retained Earnings

SPAR Report (cont'd.)

For the year ended December 31, 1979

	1979	1978
Revenues	$108,813,000	$91,869,000
Cost of sales including all expenses except items shown below	91,331,000	76,793,000
Administrative and selling expenses	10,637,000	8,572,000
Research and development costs	2,408,000	1,842,000
Deferred development amortization	97,000	137,000
Depreciation and amortization	1,399,000	1,120,000
Interest expense (income) (net)	549,000	(40,000)
	106,421,000	88,424,000
Income before income taxes	2,392,000	3,445,000
Income taxes — current	417,000	714,000
— deferred	370,000	547,000
	787,000	1,261,000
Net income for the year	1,605,000	2,184,000
Retained earnings, beginning of year	4,263,000	2,905,000
	5,868,000	5,089,000
Cash dividends on:		
Common shares	577,000	339,000
Preferred shares	441,000	479,000
Deferred shares	13,000	8,000
Stock dividend on common shares	928,000	
Retained earnings, end of year	$ 3,909,000	$4,263,000
Earnings per common share:		
Basic	$0.61	$1.05
Fully diluted	0.56	0.80

Basic earnings per share are calculated on net income after deducting dividends on preferred and deferred shares, divided by 1,872,231 shares being the weighted average number of common shares outstanding during the year (1978— 1,614,544)

Fully diluted earnings per share in 1979 are based on 2,876,588 shares assuming the conversion of all issued preferred shares on the basis of 2.08 common for each preferred share, the conversion of all issued special shares on the basis of one common for each 50 special shares, and the recognition of imputed earnings after tax at the rate of 8.2% in 1979 ($13,000) on cash that would have been received therefrom (note 6).

Ten-year Review

	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
Earnings (loss) per share:										
Basic										
before extraordinary items	$ .61	$1.05	$ .82	$ .60	$ .41	$ .28	$ .28	$ .49	$ .27	($ .30)
net income (loss) for the year	$ .61	1.05	.82	.60	.41	.28	.28	.63	.54	(.30)
Fully diluted										
before extraordinary items	$ .56	.80	.71	.55	.37	.25	.24	.38	.20	
net income for the year	$ .56	.80	.71	.55	.37	.25	.24	.48	.41	
Cash dividends paid per										
common share	$ .30	.21	.14	.13	.11	.08	.08	.02		
preferred share	$1.08	1.06								
deferred share	$ .05	.03								
Shareholders' equity per common share fully diluted	$5.12	$5.14	$4.65	$3.16	2.73	$2.41	$2.23	$2.03	$1.54	$1.14

	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
					($000)					
Revenues	108,813	91,869	70,089	37,347	28,716	26,444	18,490	15,843	12,205	9,124
Income (loss) for the year:										
before extraordinary items	1,605	2,184	1,311	956	638	419	407	652	334	(371)
net income (loss) for the year	1,605	2,184	1,311	956	638	419	407	830	671	(371)

	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
					($000)					
Capital expenditures (net of governmental grants)	4,567	2,851	4,000	751	664	898	890	132	280	390
Long-term debt	945	710	1,272	2,280	2,538	2,565	1,392	1,272	610	848
Shareholders' equity	14,730	13,854	12,441	5,616	4,860	4,317	4,002	3,591	2,707	2,035
Working capital	6,089	7,979	7,621	4,759	4,248	3,862	2,760	2,737	728	314

Ratio of current assets to current liabilities	1.2	1.4	1.6	1.8	1.9	1.9	1.8	1.8	1.2	1.1

	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
Number of employees	1,900	1,670	1,400	730	700	750	650	560	460	510
Number of shareholders										
common	2,690	2,150	2,060	2,120	2,150	2,170	2,190	2,200		
preferred and special	780	744								

APPENDIX 7

Telecom Decision CRTC 77-10 contained in The Canada Gazette No. 36 Vol III Part I on page 4838 dated September 3rd, 1977

CANADIAN RADIO-TELEVISION AND TELECOMMUNICATIONS COMMISSION

DECISION

Ottawa, August 24, 1977

Following a public hearing held in Ottawa in the period from April 25 to June 2, 1977, the Canadian Radio-television and Telecommunications Commission announces the following decision:

Telecom. Decision CRTC 77-10

Telesat Canada, Proposed Agreement with Trans-Canada Telephone System

Summary

1. In view of the considerations and conclusions set out in the decision, the Commission has decided that the proposed Agreement, under which Telesat would have become a member of the Trans-Canada Telephone System, would not be in the public interest. Accordingly, the Commission does not approve the Agreement.

2. The Commission's basic jurisdiction under section 320(11) of the Railway Act is limited to that of approving or withholding approval of agreements submitted under that section. The criterion for approval under section 320(11) is the public interest, viewed in a broad sense. In a case of this type, both applicants and interveners bear an onus to demonstrate where the public interest lies.

3. The Commission divided what it considered to be the appropriate public interest considerations into two broad categories. The first category embraced certain regulatory issues arising out of the Commission's jurisdiction under the Railway Act; namely, the effect of the Agreement on the requirement for effective regulation of rates and the prohibition of unjust discrimination or undue preference. The second category embraced a number of questions of general public policy.

4. In regard to the first regulatory issue, the Commission concluded that approval of the Agreement would compound the difficulties of identifying the costs and economics of satellite facilities offered to the public, would create obvious problems for effective intervention in Telesat rate cases, and would significantly reduce

incentives to efficiency which normally arise in rate proceedings. The Commission has therefore concluded that the Agreement if approved would substantially prejudice the process of effective rate regulation, contrary to the public interest.

5. Approval of the Agreement would also raise a substantial likelihood of undue preference to TCTS and would significantly prejudice the capacity of the Commission to adjudicate complaints of unjust discrimination under the Railway Act. This the Commission also finds to be contrary to the public interest.

6. While the Commission is prepared in this case to test its decision on the regulatory issues alone, it has also given considerable weight to public policy issues raised in this case. These included the effect of the Agreement on the powers and autonomy of Telesat under the Telesat Canada Act, on the availability and expansion of satellite services in Canada, and on competition in telecommunications services.

7. In regard to the first matter, the Commission concluded that while the Agreement was not illegal under the Telesat Canada Act, the erosion of Telesat's decision-making capacity which would be caused by the Agreement would not be consistent with the intent of the statute to create an independent autonomous corporation providing satellite services on a commercial basis.

8. With respect to satellite services via ANIK A satellites employing 6/4 GHz technology, the evidence indicated that these would continue to be offered with or without Telesat membership in TCTS. In respect to the 14/12 GHz satellite system proposed, the Commission does not wish to substitute its judgment for that of others more qualified either as to the advantages of it to Telesat, to its users or to Canada, or as to other possible arrangements. As to whether the Agreement was necessary to achieve the proposed system, the evidence was not conclusive.

9. The Commission also concluded that competition policy was an appropriate public interest concern to take into account in exercising its jurisdiction under the Railway Act. After reviewing the terms of the Agreement and the arguments and evidence, the Commission concluded that there were grounds for concern that a potentially competitive situation in the long-haul data and video or other private line services would be restricted by the Agreement, in a manner that does not appear to be justified.

from pages 4838-4840.

3. Impact of the Agreement on Competition

A number of the interveners argued that the Agreement would result in control over the satellite system passing from Telesat to TCTS and in the consequent merging of satellite and terrestrial communications technologies into a monopoly. It was argued that this would reduce competition, both as between Telesat and TCTS, and between TCTS and non-members of TCTS, and that this would bring about an irreversible change in the overall structure of the telecommunications industry contrary to the public interest.

The Commission considers that competition is an appropriate public interest concern to take into account in exercising its jurisdiction under the Railway Act, since this policy is expressed specifically in the Combines Investigation Act. Section 27.1 of that Act further provides that the Director may make representations to any federal regulatory tribunal respecting the maintenance of competition whenever he considers it appropriate. At the same time, the Commission is conscious that in the telecommunications industry there are many areas and services in which competition would not be appropriate.

Many of the arguments on the question of competition focused on restrictions in the Agreement which also relate to the question of undue preference under section 321(2) of the Railway Act. Thus there was some overlap with arguments discussed at pp. 34-42 above.

In brief, the interveners argued that restrictions on leasing r.f. channels on the construction, ownership or operation of terrestrial transmission facilities in TCTS members' territory, and on providing satellite services separately from the Agreement except for specialized space activities unrelated to the business of TCTS, were examples of provisions which tended to put Telesat in a position where it could not effectively compete with TCTS. With respect to competition between TCTS and non-members of TCTS, it was argued that non-members, who were not listed carriers in the Agreement (e.g. cable television companies) and could therefore not deal directly with Telesat for satellite services but only with the listed carriers, would be in the position of not only having their choice of suppliers of long distance services reduced but also of having to discuss service plans with potential competitors.

While the interveners conceded that there had been no real competition between Telesat and TCTS in the 6/4 GHz technology because of its cost disadvantages and certain marketing restrictions, it was claimed that the 14/12 GHz technology offered a real possibility of competition for long distance non-telephone traffic that would be virtually foreclosed by the Agreement.

In response to these points, the applicants argued that there was no evidence to support contentions that these restrictions would impair Telesat's ability to market its services. The applicants claimed that the major inhibiting factor for Telesat to date had been the high cost of satellite services which had no realistic prospect of being overcome without the benefits of the Agreement.

In connection with the position of non-members of TCTS, it was argued that there were no grounds for believing that those who are not listed carriers will suffer any competitive disadvantage through being required to deal with one of the listed carriers rather than directly with Telesat. It was noted that so far the only such user has been the CBC. With respect to CN/CP as well as users which are not listed carriers, the applicants contended that all users will have equal and complete access to satellite capacity under the Agreement at prices that are required to be the same for both members and non-members of TCTS.

As to the question of the merging of competing technologies and the foreclosing of competition between them, the applicants contended that existing satellite technology had not been competitive with terrestrial technology and that the Agreement offered the only reasonable and foreseeable prospect of competition. It was contended that unless the existing satellite system were extended to include the 14/12 GHz technology with the assurance of TCTS business, it would not be able to compete with terrestrial systems. The Agreement, it was said, would fulfill both conditions of success. In so doing it would be creating not lessening competition where none presently exists.

The Commission considered these arguments carefully. It is clear from the evidence that as a result of the Agreement, instead of there being three separate alternative carriers for long-haul traffic across Canada there would be two, one of whom, CN/CP, as has been concluded earlier, would be under certain disadvantages.

What appears clear also, however, is that Telesat has thus far not been "competitive" in the sense of offering an alternative service between the same points that could be obtained at a price as good as or better than that offered by the other carriers. This appears to be due to the combined effect of cost disadvantages in the 6/4 GHz technology and certain Telesat marketing policies.

In evaluating Telesat's competitive potential, a distinction must be drawn between traffic which is generated by TCTS's monopoly services (i.e. telephone toll traffic) and other traffic for which TCTS does not have a monopoly. In the former case, there does not appear to be any likelihood that Telesat will ever provide a competitive threat to TCTS since the use of the satellite for such services is wholly within the control of the telephone companies. On non-telephone traffic, however, and particularly the transmission of data and video communications over substantial distances and of TV signals from single point to multi-point, the potential for satellite competition is greater.

It appears from the evidence in this proceeding in fact that one of the considerations for certain members of TCTS in deciding to enter into the Agreement was the effect it would have on reducing competition in these areas. This is particularly reinforced by the provision in the Agreement itself whereby Telesat is prohibited from constructing or operating any terrestrial linking facilities in the operating territory of TCTS members.

The Commission thus has certain concerns that a potential competitive situation in long-haul data, video and other private line services may be restricted by the Agreement, in a manner that does not appear to be justified.

Conclusion

In view of the considerations and conclusions set out above, the Commission has concluded that the proposed Agreement would not be in the public interest. Accordingly, the Commission does not approve the Agreement.

LISE OUIMET

Secretary General

from pages 4865-4867

APPENDIX 8

P.C. 1977-3152
3 November, 1977
unpublished

WHEREAS, on 24 August 1977, the Canadian Radio-television and Telecommunications Commission, following public hearings, rendered Telecom Decision CRTC 77-10 in which it did not approve the Telesat Canada Proposed Agreement, made as of 31 December 1976, with the Trans-Canada Telephone System.

WHEREAS the Governor in Council has received petitions under subsection 64(1) of the National Transportation Act and has given due consideration to the petitions and views of interested parties and to the views of the Canadian Radio-television and Telecommunications Commission as expressed in the said Decision;

WHEREAS the Governor in Council has concluded that the public interest will be better served if the Telesat Canada Proposed Agreement is approved;

WHEREAS the approval of the said Agreement will not, in the opinion of the Governor in Council, affect the power of the Canadian Radio-television and Telecommunications Commission, under subsection 320(2) of the Railway Act, to approve or not to approve rates charged by Telesat Canada or the power of the Commission under subsection 320(7) of the Railway Act, to order Telesat Canada to provide access to its facilities upon such terms and conditions as the Commission deems just and expedient;

WHEREAS the approval of the said Agreement will not, in the opinion of the Governor in Council, affect the powers of the Minister of Communications under the Radio Act with respect to the operations of earth stations and associated terrestrial radio relay facilities.

AND WHEREAS the Agreement provides that nothing therein shall be binding which may override or conflict with any Act of the Parliament of Canada or any province thereof:

THEREFORE, HIS EXCELLENCY THE GOVERNOR GENERAL IN COUNCIL, pursuant to subsection 64(1) of the National Transportation Act, of his own motion, hereby varies the Telecom Decision CRTC 77-10 of the Canadian Radio-television and Telecommunications Commission, dated 24 August 1977, so as to provide for the approval of the Agreement between Telesat

Canada and the Trans-Canada Telephone System, that is to say, that the Decision will now read as follows:

> "The Agreement between Telesat Canada and the Trans-Canada Telephone System, made as of 31 December 1976, is in the public interest and is hereby approved."

APPENDIX 9

L E T T E R S   P A T E N T

Varying, amending and
extending the objects
and powers of

TELESAT CANADA

pursuant to the
provisions of the
Telesat Canada Act

DATED................15th November, 1972

By the Minister of Consuner
and Corporate Affairs.

To all to whom these presents shall come, or whom the same may in anywise concern,

Greeting:

WHEREAS section 33 of the Telesat Canada Act provides that the Member of the Queen's Privy Council for Canada charged with the administration of the Canada Corporations Act may issue letters patent for the purpose of varying, amending and extending the objects and powers of the Company;

AND WHEREAS TELESAT CANADA (hereinafter referred to as "the Company") was incorporated by special Act of Parliament R.S. c. T-4, as amended by R.S. (1st supp;), 10, 16;

AND WHEREAS the capital of the Company was by the said special Act fixed at ten million (10,000,000) common shares without nominal or par value and five million (5,000,000) preferred shares with a nominal or par value of ten dollars ($10) per share, and of the said shares, six million and one (6,000,001) common shares have been issued and allotted and are now outstanding as fully paid;

AND WHEREAS the Company has applied by petition to the Minister of Consumer and Corporate Affairs for the issue of letters patent confirming By-law Nineteen, which by-law was duly enacted by the directors and sanctioned in the prescribed manner by the shareholders of the Company, varying, amending and extending the objects and powers of the Company as hereinafter set forth;

AND WHEREAS the Company has satisfactorily established the sufficiency of, all proceedings by the Telesat Canada Act required to be taken and the truth of all facts by the said Act required to be established previous to the granting of such letters patent;

NOW KNOW YE that the Minister of Consumer and Corporate Affairs, by virtue of the power vested in him by section 33 of the Telesat Canada Act, does by these letters patent confirm the said By-law Nineteen of the Company, duly enacted and sanctioned as aforesaid, varying, amending and extending the objects and powers of the Company as recited in sections 5 and 6 of the special Act incorporating the Company by

(i) deleting therefrom sub-section (1) of section 5 which reads:

> "The objects of the company are to establish satellite telecommunication systems providing, on a commercial basis, telecommunication services between locations in Canada."

and substituting therefor the following:

> "The objects of the Company are to establish satellite telecommunication systems providing, on a commercial basis, telecommunication services
>
> (a) between locations in Canada; and
>
> (b) subject to the appropriate inter-governmental arrangements to and between other locations."

(ii) deleting from paragraph (c) of subsection (1) of section 6 thereof the words "between locations in Canada" so that the said paragraph (c) is to read:

> "the power to enter into contracts on such terms and conditions as it considers reasonable for the provision of telecommunication services by satellite;"

(iii) deleting therefrom paragraph (d) of subsection (1) of section 6 which reads:

> "the power to conduct research and developmental work in all matters relating to telecommunication by satellite;"

and substituting therefor the following:

> "the power to conduct research and developmental work and to provide managerial, engineering and other services in all matters relating to telecommunication by satellite and satellite systems."

The present letters patent shall be laid before Parliament not later than fifteen days after their issue, or if Parliament is not then sitting, on any of the first five days next thereafter that Parliament is sitting, and the letters patent shall become effective on the thirtieth sitting day after they have been laid before Parliament unless before that day either House of Parliament resolves that the letters patent shall be annulled whereupon the letters patent are annulled and of no effect.

GIVEN under the seal of office of the Minister of Consumer and Corporate Affairs at Ottawa this fifteenth day of November, one thousand nine hundred and seventy-two.

APPENDIX 10

ANIKDOTES (Telesat Canada Internal Bulletin), Vol. 9, No. 14, June 26th, 1981, p. 1.

Following the post-FMOF (First Manned Orbital Flight) Shuttle (STS) Users' Conference on 28 May 1981. Telesat has informed NASA that it will fly all the Anik C and the second Anik D satellites on the Shuttle. Telesat had already committed to fly the first Anik D on a Delta 3920 launch vehicle.

Commencing on launch plans, Vice-President Engineering John Almond said: "The first STS flight was declared by NASA as an unqualified success. They have, however, eliminated 14 of the 48 planned flights through to the end of 1985.

"Because of Telesat's early booking date with NASA, this did not substantially change our planned launch dates, but we did move to earlier STS shuttle flight numbers.

"The elimination of the 14 flights allows a longer turn-around time between flights, thus reducing the risk of further schedule slips," he said.

page 152, 156, 160	Anik D1-5 Aug. 1982	C1	- 30 Sept. 1982
210	Anik D2-1 April 1984	C2	- 8 Feb. 1983
		C3	- 3 Dec. 1985

TELESAT'S PRESENT PLANNED LAUNCH ACTIVITIES

Spacecraft	Launch Vehicle Assignment	Current Launch Date Date
Anik D1	Delta 3920	5 Aug. 1982
Anik C1	STS—5	30 Sept. 1982
Anik C2	STS—7	8 Feb. 1983
Anik D2	STS—15	1 April 1984
Anik C3	STS—34	3 Dec. 1985

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