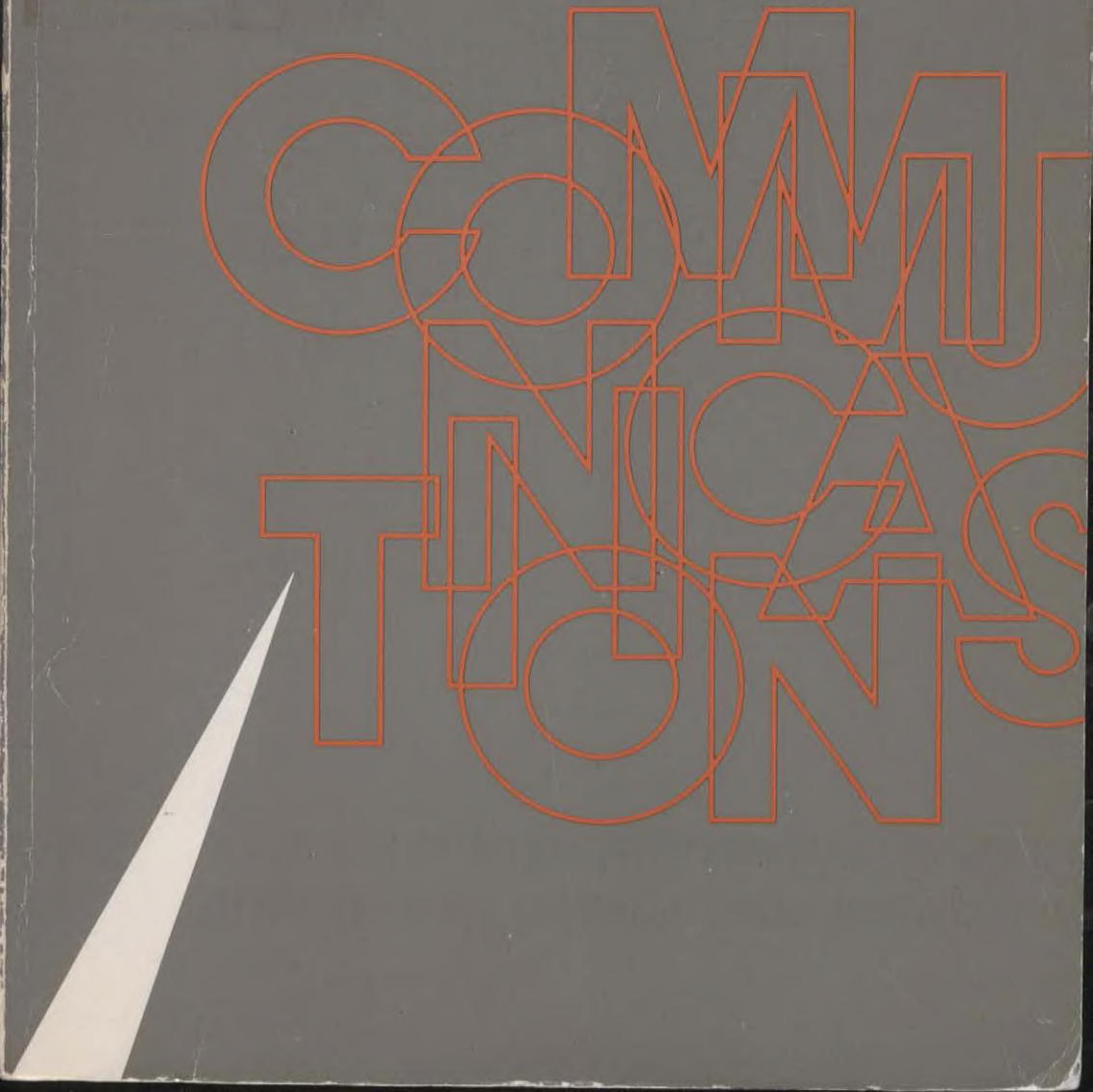
The Canadian Space Program; Five-Year Plan (80/81-84/85)



Canada. Dept. of Communications.

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

Gouvernement du Canada
Ministère des Communications

Cat. No. CO 22-23/1980

ISBN 0-662-50681-2

Contents

Foreword

This discussion paper was presented to the federal Cabinet by the Minister of Communications, as the Minister responsible for Space, in January, 1980. The document represents an analysis by the Inter-departmental Committee on Space of proposals made by several departments on space research and development programs for Canada over the next five years.

It has been reprinted here in full, in recognition of the importance of space research and development to Canada, and the need for medium-term planning in this area. This proposed five-year plan has not been fully considered by the Government, however decisions have been taken on three urgent projects, approval of which was announced on January 21 and 23.

This publication is also in keeping with the Government's determination to encourage public awareness of such internal documents as soon as possible.

Object

To report, as directed by Cabinet, on Canada's space research & development program and its effect on the Canadian space industry.

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Background

General

In 1963, the government began a policy of transferring space technology from government laboratories into Canadian industry to enable it to increasingly supply domestic requirements and to compete in export markets. This decision created a space manufacturing industry in Canada. Confirmed and strengthened by successive governments, the policy, restated in 1974 and implemented by operating departments within the coordinating framework of the Interdepartmental Committee on Space (ICS), is to utilize Canadian space technology to meet Canadian needs, through research and development programs, in which we seek the collaboration and contributions of other countries. The ICS was directed (224-78RD) "to provide (annually)....a list of proposed space programs in order of priority.... taking industrial loading into account".

Since the establishment of Telesat Canada in 1969, decisions have been taken on four series of ANIK communications satellites to extend telephone, television and radio services throughout Canada on a commercial basis. While it was necessary to rely on U.S. prime contractors for the construction of the first three of the series, the latest — ANIK-D — will be built in Canada. The government is contributing a grant of $19.4M to Telesat to cover the additional costs of procuring the ANIK-D series from the Canadian supplier. In addition, the government is spending $15M to upgrade the David Florida Laboratory as an integration and test facility for these and other satellites. All of Telesat's satellites to date have been launched by the U.S. National Aeronautics and

Space Administration (NASA).

In 1976, a Canadian-built experimental broadcast satellite, HERMES — the first of its kind in the world — was launched by NASA. NASA and the European Space Agency (ESA) both collaborated in this program.

In 1980, a Canadian-designed and built Shuttle Remote Manipulator System (SRMS) will be carried in NASA's Space Shuttle, a re-usable vehicle intended to replace expendable rocket launchers. As a Canadian contribution to the technological and industrial base of the Space Shuttle program, the objective is to assure Canada preferred access to launching services and to create a long-term market for related Canadian products.

Cloud pictures of weather over Canada from U.S. meteorological satellites have improved forecasting greatly since 1963. Since 1972, space receiving stations have been operated on Canadian soil to retrieve data from U.S. LANDSAT remote sensing satellites, for use by federal and provincial governments and the private sector in monitoring and managing resources and the environment. More recently, data also were received from SEASAT and NOAA satellites.

Canada has recently joined with the USA and France in a Search and Rescue Satellite program (SARSAT), to test and demonstrate the use of a satellite to detect and locate aircraft and marine disasters, with the objective of saving more lives and reducing the cost of rescue operations. The USSR is also participating in the SARSAT program and Japan is pressing to participate.

The decision was taken early in 1979 to participate in INMARSAT, an international undertaking to provide communications by satellite for ships on the high seas. Teleglobe Canada is our operating entity in this joint venture with all the major shipping nations of the world, as it is also in INTELSAT, an international commercial consortium providing international service amongst 100 nations of the world.

In 1978/79, the government's space budget (which does not include Telesat's expenditures) amounted to $95.7M, apportioned as follows:

- 9% to bilateral and multilateral cooperation including LANDSAT, SEASAT, ISIS and ESA programs;
- 23% to new communications services, including direct-to-home television, telemedicine, tele-education, via the HERMES and ANIK-B experiments;
- 43% to major programs and support of Canadian industry, including SARSAT, the SRMS, ANIKs-C and -D and the extension to the David Florida Laboratory (DFL);
- 25% to government operations support activities.

This breakdown of expenditures by program corresponds to the priorities defined by the Government and reflected in its Space Policy promulgated in 1974:

- the importance for Canada to gain access to the technology of space applications through cooperation with other countries and the contribution which Canada can make to the development of the world's scientific and technological knowledge through collaboration in international scientific satellite programs;
- the importance of communications to Canada and the role of satellites in improving such services, particularly in the rural and remote regions of the country;
- the economic importance of building a viable and competitive space industry;
- the need to optimize the use of talent and other resources, through improved coordination among government departments, by designating lead agencies for specific activities, and by planning, setting priorities, organizing and managing major programs on a interdepartmental basis.

Current Major Programs

These programs comprise a significant Research & Development element and are generally multidisciplinary both in terms of R&D content and potential user application. Each one is managed by a lead department, under the overall guidance of an interdepartmental program review board.

Space Science Program

Since 1955, Canada has operated a sounding rocket research program based at Fort Churchill, Manitoba, and developed the Black Brant series of rockets. In 1962 the scientific satellite program began with the launch of Alouette I, followed by Alouette II (1965), ISIS I (1969), ISIS II (1971). Scientists in Canadian universities and government laboratories have made major discoveries about the upper atmosphere over Canada using these satellites and rockets.

The National Research Council of Canada is the lead agency for space science, and coordinates the program through the Associate Committee on Space Research.

SRMS Development Program

The Shuttle Remote Manipulator System is an arm-like device which will be used to deploy payloads, satellites and other space devices from the cargo bay of the Space Shuttle Orbiter vehicle and to retrieve recoverable payloads. The SRMS operates under computer-assisted remote control and can manipulate objects with a mass of up to 29,500 Kg. Signature of a contract to supply NASA with additional assemblies is imminent.

The National Research Council of Canada (NRCC) is the lead agency and the Interdepartmental SRMS Review Board is chaired by NRCC's Vice-President (Laboratories and Scientific Services).

HERMES and ANIK-B Experimental Programs

HERMES is an advanced technology communications satellite launched in January 1976 which, for the first time, enabled the performance of communications and satellite broadcasting experiments in the 14/12 GHz frequency bands at very high power levels. The ANIK-B satellite, launched in December 1978, in addition to supplementing Telesat's operational capability in the 6/4 GHz bands, provides a continuing capability for a program of extensive and varied communications pilot projects in the 14/12 GHz band, at lower power than HERMES.

These programs are managed by the Department of Communications and the Direct Broadcast Satellite Review Committee is chaired by the Department's ADM (Space Program).

ANIK-C and ANIK-D Satellites, and DFL

The first of three ANIK-C satellites, each operating in the 14/12 GHz band, will be launched in the last quarter of 1981 and will form the backbone of east-west telecommunications by satellite in Canada in the 1980s. Two ANIK-D satellites, the first of which will be launched around 1982, will succeed the current ANIK-A satellites which provide mainly nationwide TV distribution and communications services with the North in the 6/4 GHz band; ANIK-D is the first commercial satellite for which prime-contractorship was awarded to a Canadian firm (SPAR).

The David Florida Laboratory at CRC is a national test facility for integration, assembly and environmental testing of space components and communications satellites, to determine, under simulated conditions (thermal vacuum chambers, vibration), their ability to survive the rigors of launching and the hostility of outer space. The facility is currently being expanded to support a Canadian prime contractor capability, including the integration and testing of complete spacecraft.

The Department of Communications has management responsibility for the ANIK C/D support programs as well as for the related extension to the DFL facility. The ANIK C/D Review Board is chaired by the Department's ADM (Space Program).

SARSAT Experimental Project

SARSAT is a joint Canada-France-USA experimental project which is intended to demonstrate the use of spaceborne technology for the detection and location of emergency beacon signals emanating from aircraft or ships in distress. The experiment will be carried aboard three U.S. weather satellites, and a 15-month period of evaluation is expected to begin with a first launch in 1982.

The Department of National Defence is the lead agency for Canada, and the Canadian SARSAT Review Board is chaired by the Department's ADM (Material).

Remote-Sensing Satellite Programs (LANDSAT, SURSAT, SEASAT)

The LANDSAT satellite system gives information about the earth's surface, which is being found to be increasingly valuable for crop inventory, forest and wildlife management, water resource management, land use mapping, ice reconnaissance, and mineral and petroleum exploration. LANDSAT-1 was launched in July 1972 and was followed by LANDSATs-2 and -3 in January 1975 and March 1978 respectively. LANDSAT-D, which is expected to be launched by NASA in 1981, will provide better color and spatial resolution (30 vice 80 metres) and, consequently, more detail and an improved identification capability, but will require the Canadian earth stations at Prince Albert, Sask, and Shoe Cove, Nfld. to be extensively modified.

SURSAT was established in 1977, as an interdepartmental project, to determine the feasibility of using satellites to assist in meeting surveillance needs forecast for the period 1980-2000 over the 200-mile coastal zone. These needs include daily all weather monitoring of sea ice, wind and sea state, ocean pollution, ships, oil rigs and navigational aids. The project included participation in the U.S. SEASAT-A experiment, conducting a complementary research and development program, and consulting with potential international partners regarding a joint operational system.

SEASAT was a U.S. program using a satellite to monitor the oceans and to provide continuously updated reports on weather and sea conditions. SEASAT-A was launched in June 1978 and provided extremely useful data, though it unfortunately failed after 4 months in orbit. One technique called Synthetic Aperture Radar (SAR) is of particular interest to Canada, within the SURSAT program, since it affords an all-weather 24-hour capability for surveillance and has proven its effectiveness for monitoring ice and sea conditions. It also demonstrated reasonable capability for monitoring shipping. McDonald, Dettwiler Company of Vancouver developed a unique capability in the computer processing of SAR data.

The Department of Energy, Mines & Resources is the lead agency for these programs and the Interagency Committee on Remote Sensing (IACRS) is chaired by the Department's ADM (Science & Technology).

Meteorological Satellites

Since 1963, Canada has acquired cloud pictures and other data from U.S. satellites, using its own earth stations. The meteorological services of USA, Canada and other members of the World Meteorological Organization operate data acquisition, communications, and processing networks to provide a truly global system for meteorological information. R&D activities are undertaken and coordinated both to meet national needs and to advance the global capability.

The Atmospheric Environment Service, operated by the Department of the Environment, is the responsible agency.

Status of Major Programs

Space R&D projects have a defined lifespan, usually two to six years. As indicated in the following table, current projects are reaching completion, and prudent planning requires that decisions be taken in good time, to pace departments' needs for new space R&D projects at a rate Canadian industry can absorb.

Major Space Projects Presently Approved
(Current-year $M)

	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85
Space Science	8.1	3.9	2.67	2.88	3.11	3.36	3.63	3.92
SRMS	22.30	28.50	11.12	3.62	—	—	—	—
Hermes	0.98	0.57	—	—	—	—	—	—
ANIK-B	9.00	21.40	2.72	2.92	—	—	—	—
ANIK-C/D, DFL	0.80	2.94	10.80	3.95	1.48	—	—	—
SARSAT	0.70	2.43	4.33	2.47	0.72	—	—	—
LANDSAT	4.08	2.95	2.87	2.69	3.10	3.38	3.50	3.50
SURSAT	1.74	3.43	1.18	—	—	—	—	—
Environmental Satellites	1.71	2.27	2.36	2.30	2.44	2.70	2.92	3.15
Total	**52.01**	**71.17**	**41.05**	**23.97**	**14.35**	**9.44**	**10.05**	**10.57**

Operations Support

Operations support for these programs comprises the total support expenditures provided by departments through their laboratories and technical centres. Such support will amount to about $22M in FY 79/80. There are three such centres:

- The *Communications Research Centre* (CRC) in Ottawa, where all the equiment and facilities necessary for satellite development are located, is connected to NASA's satellite tracking station network, controls Canada's scientific and experimental satellites, and operates telemetry and data processing facilities. CRC is operated by the Department of Communications, and the space component of its operating resources for FY 79/80 include 232 person years and an overall budget of about $10M;
- The *Canada Centre for Remote Sensing* (CCRS) in Ottawa processes LANDSAT and SEASAT data obtained at its Prince Albert (Sask.) and Shoe Cove (Nfld.) earth stations.
  CCRS is operated by the Department of Energy, Mines &

Resources and its resources for FY 79/80 include 106 person years and a budget of about $10M. This includes an airborne remote sensing R&D program as well as a satellite progam;

- The *Rocket Research Range* at Fort Churchill is the main launch range in Canada for rockets carrying Canadian and foreign experiments into the upper atmosphere in the auroral region.

  The range is operated by the National Research Council of Canada and its resources for FY 79/80, including those of the suport base at Gimli, Man., include 25 person years and a budget of $3M.

Industry Support

Direct support to industry, through grants and contracts to promote the development of new products by Canadian firms, is provided by the departments of Industry, Trade & Commerce; Supply & Services and Communications. These contributions, which totalled $6.5M in FY 78/79, can be broken down as follows:

- The Defence Industry Productivity (DIP) and the Industry Modernization for Defence Export (IMDE) programs of the Department of Industry, Trade & Commerce provided $3.1M in FY 78/79 for shared cost projects;
- The Unsolicited Proposal Program of the Department of Supply & Services supported 11 contracts during FY 78/79, with a value of about $1.4M;
- The Department of Communications has the responsibility for a program of spacecraft subsystems and components, which is executed through contracts with Canadian industry, with the objective of developing new products for which there is a perennial market. Expenditures in FY 78/79 totaled $2M.

Moreover, indirect support to industry is given by all federal departments under the Contracting-Out Policy.

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Factors

The Need for a Canadian Space Program

As may be gleaned from the preceding historical account, Canada's interest in, and use of, space systems have grown slowly but assuredly over the past two decades and, for reasons of geography and demography are expected to continue to develop in the foreseeable future.

Because of the high economic and social dividends which can result from the effective and rational use of space technology, the high cost of satellite systems and the need to keep abreast of a rapidly-developing technological field, it is important that a country like Canada ensure that its limited resources are utilized in an effective and opportune manner, that duplication of effort is avoided, that a technology base is developed continually to meet future needs, and that all activities in space are blended into a coherent program able to assist in meeting many national goals. This is particularly true in respect of government programs which must meet a wide variety of requirements with effectiveness and parsimony.

In order to meet its requirements for space systems, Canada could follow a number of approaches, ranging from complete foreign dependency to complete self-sufficiency. The former was rejected at the outset of the Canadian space program beginning with the construction in Canada of the first Alouette satellite and its successors, followed in 1963 by the Government's declared objective of developing technology in Canadian industry; then, in 1970, the decision to build the Communications Technology

Satellite (CTS) with the objective of further developing the industry as well as meeting future Canadian requirements; then, in 1975, the decision to establish a prime-contractorship in Canada for Canadian spacecraft. At the same time, it was recognized that Canada could not afford the development of a launching capability — which could cost several hundred million dollars per annum for many years to come — and would have to rely on launching services of other countries. To date, Canada has utilized the services of the U.S. National Aeronautics & Space Administration under conditions which can be considered reasonable. In order to increase her ability to obtain foreign launchers for her future satellite systems, Canada has sought participation in the national programs of supplier nations. Thus, the National Research Council decided upon the design and construction of the Remote Manipulator System as Canada's contribution to the Space Shuttle program of the U.S. At the same time, Canada has developed cooperative links with the European Space Agency, whose Ariane launcher could, in the early '80's, prove to be a viable alternative.

Current Government Policies

The sum total of events and decisions taken over the years, a few of which have been described in the preceding section, are elements of an evolving space policy which various Governments have consistently pursued. The principal policy statements made by Governments since 1963 can be paraphrased briefly as follows:

1963
- The Canadian Ionospheric Research program was approved, with the assumption that related R&D would be performed in Canadian industry;

1969
- Government space efforts should be diverted from ionospheric studies to satellite technology programs;
- The Interdepartmental Committee on Space was established to review Canadian space activity, recommend optimum use of resources, consider Federal policy for space activities and recommend appropriate plans and proposals;
- The Telesat Canada Act was passed directing the Company, inter alia, to utilize to the extent practicable and consistent with its commercial nature, Canadian research, design, and industrial personnel, techology and facilities in research and development connected with its satellite systems;

1970
- The Communications Technology Satellite (Hermes) program was authorized with the objective of further developing the Canadian space industry and of meeting future national needs;

1972
- A Memorandum of Understanding was signed by Canada and the European Space Research Organization for cooperation on Hermes in recognition of the entré this would provide Canadian industry into the markets developed

by Europeans;

1974 • "A Canadian Policy for Space" was adopted, stating:
- the government endorses the principle that a Canadian industrial capability for the design and construction of space systems must be maintained and improved through a deliberate policy of moving government space research and development out into industry;
- government purchasing policies should encourage the establishment of a viable research, development and manufacturing capability in Canadian industry;
- Canada will continue to rely on other nations for launch vehicles and services and we should enhance access to such services by participating in the supplying nation's space program;
- departments involved should submit plans to ensure that, to the fullest extent possible, Canada's satellite systems are designed, developed and constructed in Canada, by Canadians, using Canadian components;
- Canada's primary interest in space should be to use it for applications that contribute directly to the achievement of national goals;
- 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;
- 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 national sovereignty, and 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 future requirements for operational space systems.

1975 • The government should explore the setting-up of a prime contractor for Canadian spacecraft;

• The ICS was given the task of coordinating spacecraft procurement activities so as to maintain a viable spacecraft manufacturing industry in Canada;

1976 • Exploratory talks with the European Space Agency were authorized to determine satisfactory terms for upgrading Canada's relationship with the Agency;

1977 • Discussions with appropriate agencies of other nations,

or international bodies, were authorized with a view to possible international cooperation in the development of a surveillance satellite system;

- It was determined that a priority objective of Canada's space program be to demonstrate, as soon as feasible, the capability of SPAR Aerospace Ltd. to compete as a prime contractor for communications satellites.

1978
- The ICS was given the task of providing Treasury Board 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;
- The Minister of Communications was directed to apply more stringently the Canadian content provisions of the Telesat Canada Act as a means of implementing industrial policy;
- 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's David Florida Laboratory; and

1979
- The earlier policy of supporting the development of a Canadian prime contractor for satellites was reaffirmed.

Coordination of Government Activities in Space

Currently, the coordination of space activities amongst federal government departments is done through the Interdepartmental Committee on Space (ICS), which was established in 1969 and provided with a permanent secretariat in 1975. The following departments are members of the Committee:

Department of Communications
Department of Energy, Mines & Resources
Department of the Environment
Department of External Affairs
Department of Fisheries & Oceans
Department of Industry, Trade & Commerce
Department of National Defence
National Research Council
Ministry of State for Science & Technology

The Treasury Board and the Department of National Health and Welfare are observers.

The duties of the Committee are:

- To coordinate spacecraft procurement activities so as to maintain a viable space industry in Canada.
- To review Canadian space activities, including that of Federal Government departments and agencies, the universities, and industry, and to make recommendations concerning the optimum use of resources, the coordination of space activity, and the dissemination of information on such space activity.

- To consider Federal policy for space activity in relation to national interests, needs and opportunities and to formulate and recommend appropriate plans and proposals.
- To make recommendations concerning cooperation in the space activities of foreign and international entities in the best interest of Canada.
- To report annually on February 1st, or more often if desirable, to the Minister of Communications.

Pursuant to its mandate, the ICS is expected to prepare every Fall a global submission to Treasury Board constituted of all new space projects proposed by departments for the following year with a view to providing the Board with a full perspective of new space proposals, their justification and their impact on the health of the Canadian space industry. Such a submission has been prepared this year, but is being held in abeyance pending instructions from Cabinet on the proposed space program described in this paper and its parent Memorandum.

While it is not the intention of this paper to discuss the merits of the ICS as the coordinating mechanism for the government's space activities, it may be useful to point out that, as early as 1967, the Science Council of Canada recommended the establishment of a central agency for planning and implementing a Canadian space program. Since then, further suggestions with the same intent have been voiced both from within and outside government, the most recent consisting of a brief from the Air Industries Association of Canada; and about a year ago, comments by the Vice-Chairman of the Science Council were followed by a study performed by the Ministry of State for Science & Technology, entitled "A Review of the Effectiveness of the Present Approach to Implementing Canada's Space Program", which has been made available to Ministers in recent months. This is a question which the government may wish to address separately, as part of a broader objective of consolidating and strengthening Canada's capability in Space.

New Project Proposals

Several government departments have developed proposals in certain key areas of space activity which are intended to maintain and enhance the nation's access to the benefits of space technology. While, in the past several years, significant strides have been made in the area of satellite communications, in which the pace should be maintained, there are other areas, particularly in remote sensing, where to date Canada has had to rely on its southern neighbour for data about Canada gathered by U.S. satellites. In order not to be totally dependent on the goodwill of the U.S. for such data, it is being proposed that Canada put herself in the position of becoming an essential contributor to a proposed European remote sensing program, and also eventually contribute to the planning and implementation of similar U.S. and international programs. This will

guarantee to Canada, in the long-term, continued access to the data obtained by these systems and their successors and generate within Canadian industry an activity commensurate with her contribution to their costs. For a resource-based and trading nation like Canada, the value of such data cannot be overemphasized, particularly in view of the fact that other nations—many of them our competitors in world markets—will have such data to use to advantage.

The total number of new projects is 15. These can be categorized as R&D-intensive, which includes the majority of the proposals, and Operations-oriented. A secondary breakdown into activity areas produces the following classification:

Research & Development

Remote Sensing

- Technical studies prerequisite to a Canadian radar development program.
- A Canadian radar development program (subject to the above prerequisite).
- Utilization of new meteorological satellites.
- A joint Canada/U.S.A. meteorological satellite research program.

Space Science

- A joint NRCC/NASA Space Science Program.

Communications

- Engineering definition studies prerequisite to a multipurpose satellite system (MUSAT).
- Planning studies for a direct satellite broadcasting system (DBS).
- Extension of the ANIK-B experimental program.

Industry Support

- An increase of DOC's technology development program.
- Industry support in its bid for the NATO-IV satellite contract.
- Support of new international initiatives.

Operational

Remote Sensing

- Arrangements for receiving data from LANDSAT-D satellites.

Communications

- The construction of the MUSAT system (subject to the results of the Engineering Definition Study).

The individual projects are described in detail in the accompanying Annex B. However, the following four deserve to be high-lighted because of their special significance to governmental, industrial and commercial activity in Canada.

LANDSAT-D (EMR)

The LANDSAT-D satellite is scheduled to be launched by NASA in 1981, to replace LANDSATs 2 and 3 now in orbit.

LANDSAT-2 may cease to function anytime and LANDSAT-3 is expected to last at least until 1981. Through the use of a new thematic mapper covering a much broader spectrum of measurements, this satellite will provide better color discrimination and spatial resolution (30-metre, vice 80) and, consequently, greater detail and an improved identification capability over the present satellites. Extensive changes will be required to the Canadian earth stations so they can receive and process this improved data; this will cost $4.1M (1979 dollars). Further major station upgrading should not, however, be required during the 1980s, if announced U.S. plans to retain the LANDSAT-D technology throughout that period are followed. A new agreement with the U.S.A. will be required since the present agreement expires in 1980. The total cost to Canada for this program is estimated at about $13M (1979 dollars) over the period 1980 to 1983, including additional NASA annual charges of $U.S. 250,000 to read out the LANDSAT satellites with the Canadian ground stations. This project also includes an interdepartmental joint training and technology transfer activity with the Provinces to integrate effectively remote sensing technology into the nation's operational environment and resource management activities. If the government were to decide not to proceed with this program, approximately 1000 Canadian users would be forced to purchase data about Canada from U.S. sources beginning in 1981, possibly at higher prices. Canadian users could not expect to get faster service on data from the U.S. than any other nation of the world which does not have its own readout facilities.

Satellite Radar Development Program

While Canada is a user of remote sensing satellites and has developed a capability in receiving processing and utilizing data which has received world-wide recognition, she has not contributed to the actual design and construction of the satellites themselves. Developing the ability to do so is considered essential, and because of the high costs involved, collaboration with other countries appears as the most cost-effective and mutually beneficial course to follow. The European Space Agency, following a planning phase in which we have participated to the extent of having responded to the Agency's request for comment and criticism, has now embarked upon a "Preparatory European Remote Sensing Satellite Program". Participation in this program could be of significant benefit to Canada in acquiring the technological expertise needed to build in Canada the Synthetic Aperture Radar package, a technique particularly relevant to Canadian requirements, irrespective of which international partner may be chosen for further cooperation. Since the European program is already underway, the option for Canadian participation should be exercised as soon as possible. The cost of such participation would be $1.7M over FY 79/80 to 81/82. A decision not to proceed will result in the loss of an opportunity to influence the design to meet Canada's

satellite surveillance needs in the mid-80s and to embark her industry on the development of the technology required to build an actual follow-on operational system. This second phase, which would comprise the fabrication of equipment to be carried aboard ESA and/or NASA satellites, woud cost an estimated $81M in 1979 currency.

Multipurpose Satellite – MUSAT (DOC)

The Department of Communications has aggregated the needs of federal and provincial departments for press-to-talk voice communications with ships, aircraft and field parties in the Canadian North. Provision of these services over a common-user system would afford efficiency and cost-savings not available by other means; the Department of National Defence would use about half of the satellite's capacity. The ground stations working with MUSAT would be small, economical, flexible and easy to operate. A second-generation MUSAT could use ground stations small enough to fit an attaché case. The system would also be designed for system protection and message security when required.

The DOC proposes an engineering definition study phase (EDSP), leading to the construction of a satellite by Canadian industry during the 1981-84 period. The cost of the EDSP is $1.95M. Implementation could then be carried out, either by a capital investment by the Government at an estimated cost of about $158M in 1978 currency, or by the telecommunications carriers or Telesat Canada. In the latter case, government users would pay for service on receipt, under terms negotiated with the satellite owners.

Space Science Program (NRCC)

Canada's last scientific satellite, ISIS II, was launched in 1971. A new cooperative space science program has been negotiated with NASA. Its objectives are to sustain and improve Canadian research competence in the space sciences; to provide a significant fraction of new knowledge needed by Canada to base decisions on the future use of space and to provide access to the remainder of the knowledge generated by related NASA programs; to train young scientists and engineers in a variety of space disciplines of interest to Canada; and to provide opportunities for industrial innovation in Canada. The program will consist of three separate contributions to the Shuttle/Spacelab missions; two ground-based observational systems in support of a NASA study of the origins of plasma in the Earth's neighbourhood; the processing and storage of data from both ground-based and satellite observations; and a mechanism for funding future Canadian responses to NASA's "Announcements of Opportunity". The 7-year program is expected to cost about $32M, in 1979 dollars.

New Project Costs

Detailed costs for each project are given in the table of page 2

of Annex "B". For each area of activity identified earlier, the cost over the next five years are as follows:

Budget-Year Dollars $M

Activity	80/81	81/82	82/83	83/84	84/85	5-Year Totals
R&D						
Remote Sensing	2.95	8.57	15.63	33.74	43.74	104.63
(PY)	(4)	(8)	(10)	(11)	(11)	
Space Science	4.53	6.48	9.05	9.37	6.25	35.68
Communications	2.76	4.67	4.17	—	—	11.60
(PY)	(12)	(10)	(7)			
Industry Support	4.24	12.90	17.10	18.48	4.08	56.80
R&D Total	14.48	32.62	30.32	61.59	54.07	208.71
(PY)	(16)	(18)	(17)	(11)	(11)	
OPS						
Remote Sensing	3.61	5.48	4.94	1.93	2.09	18.05
(PY)	(2)	(12)	(12)	(12)	(12)	
Communications	—	—	25.56	71.68	77.82	175.00
OPS Total	3.61	5.48	30.50	73.61	79.91	193.11
(PY)	(2)	(12)	(12)	(12)	(12)	
Total Program	**18.09**	**38.10**	**76.45**	**135.20**	**133.98**	**401.82**
(PY)	(18)	(30)	(29)	(23)	(23)	

The additional person-years are above 79/80 levels and represent 35 actual positions, of which 12 are temporary.

Industrial Aspects

With the announcement of a Policy for Space in 1974, Canada joined other industrialized nations in formally acknowledging the economic, social and scientific benefits that derive from an active involvement in space. From an industrial vantage, the decision to develop an indigenous productive capability was primarily aimed at satisfying domestic space systems needs, providing high technology employment opportunities and enhancing the industry's ability to penetrate additional export markets.

Considerable momentum in achieving these industrial objectives has been gained over the past five years as a result of government support in the form of policy, program and investment decisions. These measures have enabled the industry to progressively increase its level of competence and responsibility, to develop new skills and products, and to gain in confidence, reputation and competitiveness. The Canadian space industry has advanced considerably from its origin as a supplier of components and as a build-to-print manufacturer. With the award of the ANIK-D prime contract to SPAR Aerospace, Canada is on the

threshold of having demonstrated a commercial space systems capability. Accompanying this evolution has been a rapid expansion of the industry's capacity in response to growing sales. For the current year, the Air Industries Association of Canada is projecting total industry sales of $138 million — a fourfold increase in five years. In addition, export business has steadily improved and is expected to account for approximately 40% of this year's sales volume. Employment within the industry now stands at 2,240, an increase of about 15% over last year.

Notwithstanding the above progress, space industries throughout the world are generally recognized as requiring continuing government support. Without exception, governments remain the largest single customer for their space industry's products and services. In Canada, approximately 60% of total industry sales have, over the past several years, been derived from government-sponsored programs. As the industry matures, it should be in a position to attract a greater proportion of international business, thereby reducing its dependency on government. Nonetheless, the cost to government of maintaining an indigenous capability in a highly advanced and competitive industrial sector implies both continuity of policy and stability of funding — particularly in relation to research and development. The concept of a five-year funding plan for space expenditures is one major step in this direction. This stability is required to enable the industry to align the development of its resources against market opportunities on a longer term basis. At the same time, the concept implies a greater degree of government/industry coordination to ensure that the collective efforts of both sectors are aimed at achieving the three industrial objectives cited earlier.

The project starts proposed for FY 1980/81, while mostly mission oriented, are largely R&D in nature and as such can be expected to contribute to maintaining the industry's technological base. Moreover, the bulk of the funds requested is destined to be spent in the Canadian space industry.

The Concept of a Space Budget

Most of the projects being proposed have limited life-spans of anywhere from two to six years. In industry, decisions related to marketing, investment and resource management also require reliable medium-term planning information. This is the main reason why industry has supported the suggestion that the coordination of governmental projects, particularly from the planning point of view, be strengthened, and has suggested that it might usefully contribute to the planning process. Because of the continued impact of government programs upon the industry's performance, the adoption of reasonably secure five-year plans by the government would be of immense value to the industry, as it would be to departments in managing their internal activities. Given the envelope management approach being implemented by the government,

it would seem opportune that the concept of a five-year space envelope or budget be examined.

Referring to figure 2 of Annex A, it can be seen that two budgetary levels, each of different composition, can be envisaged:

a) ALL new space-related expenditures, including the five-year commitments generated by 80/81 project starts, and the five-year Planning Envelope for potential expenditures which could arise from projects currently being examined but requiring definitive approval later than 80/81;
b) a five-year Committed Envelope which would include the five-year commitments generated by the 80/81 project starts;

These represent different levels of commitment by the government, the second (b) being essential if proposed 80/81 project starts are to be pursued to fruition, the maximum (a) providing a significant margin to accommodate current and future planning. It would naturally be assumed that the content of the Planning Envelope, above and beyond the commitments generated by the 80/81 starts, would be reviewed and approved annually, as dictated by new policy considerations, priorities and opportunities.

The concept of a space budget could usefully incorporate some or all of the following principles:

a) allocations within the budget would be made to specific departments by the Treasury Board in accordance with the cash-flow schedules shown in the accompanying Annex B;
b) the allocations would be controlled so that transfers of funds to non-space activities would not be permitted;
c) transfers of funds amongst space projects, within or between departments, would be allowed subject to the agreement of the departments concerned and Treasury Board;
d) an up-dated five-year plan would be submitted every year to the Economic Development Committee, showing proposed changes in allocations amongst projects and/or departments as well as new project proposals.

3

Alternatives

The fifteen projects proposed through this submission have been carefully reviewed and scrutinized by their sponsoring departments and the ICS Secretariat, and it is their opinion that the sum total of these projects represents a well-balanced program of activities. Project proponents are cognizant of the need to exercise restraint and maximum use of resources within current allocations will be made. Certain projects, like the utilization of LANDSAT-D and of meteorological satellites, are intimately linked to the services which departments have to provide to the public and industry; others, like the NATO-IV satellite bid, represent important opportunities which, if struck out or even deferred, will be completely lost; still others, like the space science program, have already been negotiated with NASA on the basis of a previous Treasury Board authorization. Coupled with the continued reliance of the industry's performance on governmental encouragement and assistance — a fact well-recognized in all technologically-advanced nations, including the U.S. — it is suggested that the new commitments proposed for 80/81, along with their consequential downstream commitments, constitute a minimum level of government-sponsored activity necessary to keep the nation moving ahead in space in the immediate future, i.e. 80/81 and 81/82. Beyond that, additional industrial activity may have to be encouraged, on one hand, through the capture of foreign contracts which cannot yet be counted on and; on the other hand, through additional domestic programs such as MUSAT and SAR. It was noted earlier that, even with projects such as MUSAT and SAR, the real growth rate in the performance

of Canada's space industry would be in the order of 12% over the five-year planning period.

In support of the aforementioned conclusion concerning the marginal adequacy of the proposed program, the following analysis is intended to evaluate the consequences of resource reductions or deferrals on each individual project.

1 *LANDSAT-D:* Non-approval of the project would negate the progress made in remote sensing in Canada since the introduction of this new technology in 1972, forcing Canada into a greater dependence on U.S. technology and data on Canadian terrain. It would mean that the many Canadian users of satellite data would have to purchase stale data about Canada at high cost from the U.S. Department of Commerce, rather than Canada providing her own technology and having direct access to these satellites, being thus able to provide more timely data. A delay in approval of the program could place Canada's main industrial supplier in a non-competitive position vis-àvis international customers for ground stations.

2 *Radar program preparatory studies:* Failure to proceed with the Preparatory Studies would eliminate the option of eventual cooperation in an ESA satellite program, deprive Canadian users of the resulting satellite data and also eliminate the possibility of Canadian industry contracts in this satellite development. That participation must be according to the schedule and funding formula previously agreed to by ESA member states. Delay or reduction of funding level beyond February '80 would prevent Canadian industrial participation.

3 *Radar development project:* International competition in developing a capability in Synthetic Aperture Radar (SAR) technology is intensifying; the U.S.A. already has the technology, Germany is attempting to capture the SAR component of the European remote sensing program, and Japan has plans of its own. Any cuts or serious delays in this project would result in Canada remaining a mere client of someone else's system and, without the possibility of being a significant contributor to an international system, will remain completely dependent upon others as to what data she will be allowed to obtain, and under what conditions. It should be noted, however, that the proposed $114M project would not begin until 81/82 and would, in any event, proceed only if the results of project number 2 above, including the negotiations with other countries, confirmed its desirability and feasibility.

4 *Information extraction system:* Delay in this program could result in the breaking up of experienced industrial teams which would set the program back several years and could result in

a lost opportunity for Canada to become involved industrially in the rapidly-developing technology of resource and environmental management information systems. The program can be kept alive with seed money by using existing A-level funding in 1980/81.

5 *Space Science program:* NRC obtained approval to negotiate a joint space science program with NASA, to replace activities which have already terminated. The joint program has been identified by both Parties and any cuts or serious delays would prove embarrassing to Canada. Moreover, since the components of the program are tied in to the schedules of another country, particularly with NASA's extremely tight launch schedule, delays would be difficult if not impossible to entertain. In addition, this program is needed to keep Canadian institutions active in new space technology, to give Canada access to the technology developed by her partner in other parts of the program and, more important in the long term, to provide opportunities for Canadian scientists and engineers to acquire new knowledge and to have it available to meet Canada's future requirements. In fact, this or some other comparable program is needed if space science is going to continue to be a viable activity in Canada.

6 *MUSAT project definition studies:* While the question of the most appropriate time to begin the construction of a MUSAT system itself cannot be answered precisely at this time, it may be necessary to take a decision to proceed in the near future, particularly if the timing of the construction were to be crucial to the loading of the industry, for which a lull in activity is currently foreseen for the mid-80's. Thus, to be in a position to move quickly, the remaining preparatory work, including the proposed detailed project definition studies, must be completed; any significant delay will place restrictions on future decision-making.

7 *The MUSAT system:* since the construction of the MUSAT system is dependant, inter alia, on the preceding project definition studies, the question of cuts or deferrals is not strategically relevant at this point in time. Definitive approval of this project need not be given before this time next year, or the following.

8 *DBS planning studies:* a fairly lengthy series of studies and experiments, by DOC, provincial government departments, universities and interested private groups tends to support the desirability and feasibility of a Canadian domestic broadcasting satellite system. Because of the legitimate expectations of both the public and the industry, it is necessary that specific

plans be drawn up as soon as possible to permit the government to respond on a timely basis to foreseeable demands in this area.

Moreover, a Regional Administrative Radio Conference of the ITU will be held in 1983, which will make spectrum allocations to direct broadcasting satellite systems. It is imperative that Canadian plans be well developed to support our claim for a reasonable share of the spectrum, which is a scarce and limited resource.

9 *Technology development program:* the fact that DOC's current program fund is practically all committed for 80/81 attests to the usefulness seen in it by the industry. A program increase to meet new requirements is indicated. Specifically for 80/81, a need exists to support the development of earth stations for use with the projected Australian domestic satellite system and Canadian domestic markets. Any delay in pursuing this development would have a negative impact on Canada's chances at capturing the Australian contract.

10 *NATO-IV bid support:* if preparation of the bid by SPAR does not proceed in 80/81, the opportunity to bid is lost forever. Thus, no cuts or delays can be entertained.

11 *ANIK-B experimental program:* any cuts in the program would reduce DOC's ability to carry out its mandate in this area and, moreover, would generate considerable public criticism. Any serious delay would not only upset the proposed program of experiments but would also result in costly inefficiencies in the use of the ANIK-B spacecraft.

12 *New international initiatives:* Past experience, and the observation of what happens in other countries, lies at the basis of the requirement in Canada for a secial fund permitting her to respond quickly to international opportunities so as to be able to compete on an equal footing with other countries. For 80/81, the potential use of the fund is beginning to materialize, with participation in the European L-Sat project as one candidate which could not be deferred. Thus, any total cuts or deferrals for 80/81 are likely to result in lost opportunities.

13 *DFL operations:* since approval is being sought to support the operation of the David Florida Laboratory beyond 82/83, there are no immediate 80/81 reduction or deferral implications.

14 *Meteorological satellite project:* since the proposed project relates to the government's ability to provide and improve

a service which is of great importance to the nation, any reduction or serious delay will have a definite impact on its ability to do so.

15 *Future atmospheric research:* since the proposed project involves collaboration in U.S. programs, its time-table is not independent and any reductions or deferrals in funding will result in lost opportunities.

In summary, it is the view of the members of the ICS that the proposed set of activities form a well-balanced program which will permit the nation to maintain what is considered to be a minimum acceptable level of activity in the space field and for which any significant reductions or deferrals in resource provisioning will have serious negative impacts on the buoyancy of the Canadian space industry.

4

Financial Considerations

The following table is intended to provide a global perspective of the proposed space program, and of its constituting elements.

A graphic presentation of levels A, B and C is given in figure 2 of Annex A.

It may be noted that the commitment created by approval of the 80/81 starts would result in a reduction of government activity, from $87.4M in 80/81 down to $64.4M in 84/85.

Budget-Year Dollars M, @ 8% inflation

	80/81	81/82	82/83	83/84	84/85	Total 5-Years
A) Approved program levels	69.3	52.4	50.6	49.6	50.7	272.6
B) New 80/81 activities (and 5-year downstream commitments thru 84/85)	18.09	31.16	36.53	31.01	13.72	130.51
C) New activities beginning after 80/81 (and downstream commitments thru 84/85)	—	6.94	39.92	104.19	120.26	271.31
New program totals (B+C)	18.09	38.10	76.45	135.20	133.98	401.82
Total commitments resulting from current programs and 80/81 starts (A+B)	87.4	83.6	87.1	80.6	64.4	403.1
Total Government Program (A+B+C)	87.4	90.5	127.1	184.8	184.7	674.5

5

Federal-Provincial Relations

The overall space research and development program which is being proposed offers many opportunities to further develop mutually-beneficial working arrangements with Provincial governments. Such relations already exist, particularly in the areas of broadcasting and new communications services and, indeed, several of the projects constituting the proposed program are being developed in consultation with provincial authorities; these include such major projects as the Multipurpose Satellite (MUSAT), the Technology Transfer element of the remote sensing projects, and the university-based research elements of the Space Science proposal. Moreover, the various projects will generate and further develop employment and economic activity in several Canadian provinces, notably, Ontario, Quebec, Saskatchewan, British Columbia, Newfoundland and Manitoba.

6

Other Considerations

As stated earlier, federal programs in the space field, particularly for the purpose of stimulating Canadian industrial activity as well as satisfying valid Canadian service requirements, have been tangible manifestations of official government policy ever since that policy was made explicit back in 1963. While industrial growth in such a novel, complex and competitive field is bound to be slow, the performance of the Canadian space industry is gaining considerable momentum and will soon reach a level, judged as corresponding to an annual sales level of about $150M minimum (1979 dollars) where it will have greater financial strength, technical competence and general resilience, be more self-sustaining, and better able to meet stiffening foreign competition. This level has not yet been achieved. It is, however, within grasp within the next few years and is deserving of continued government support in order to achieve it. The proposed program elements are consistent with such an objective, as they are with the Cabinet's recent decision (461-79RD, 17 September 1979) concerning its Research & Development policy in science and technology.

7

Interdepartmental Consultation

This document, as well as the companion Integrated Submission to the Treasury Board, has the support of the four departments which have contributed to the proposed Space Program and, through the consultative mechanisms of the Interdepartmental Committee on Space, the support of all of its ten members.

The ICS members are also favourable to the concept of a five-year financial envelope for space, which would provide both government departments and the industry the assurances needed to plan, develop and market new systems and services and thus maintain a strong capability in a field of increasing importance to Canada and to other nations as well.

8

Conclusions

The following conclusions emerge from this document and its companion Treasury Board Submission:

a) Canada's activities in space, spurred by timely governmental policies, have been instrumental in bringing to Canadians many new services which were not economically available by other means;

b) government programs have provided the necessary incentives and support to the development of a diversified and competitive space industry in Canada;

c) current performance notwithstanding, Canada's space industry requires further support to achieve a base of strength sufficient to meet evolving foreign competition;

d) the proposed space program will assist in meeting this industrial objective, as well as contributing to the realization of the government's policy objective of raising Canada's R&D capacity, particularly in private industry;

e) the cost of the proposed program, in fiscal year 80/81 is of the order of $18 million which, considering a $9M decrease in approved programs from FY 79/80 to FY 80/81, represents a net increase in government space expenditures of about $9M.

Annex A

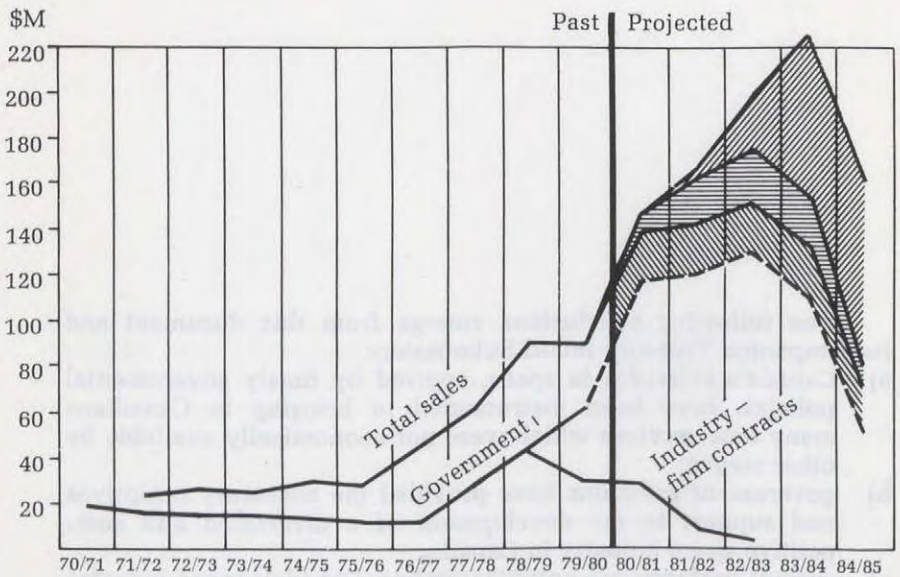

Figure 1
Canadian space industry sales

Planning envelope

5 year committed envelope

Government approved programs

Industry forecasts (TELESAT, SPAR, SED & MDA)

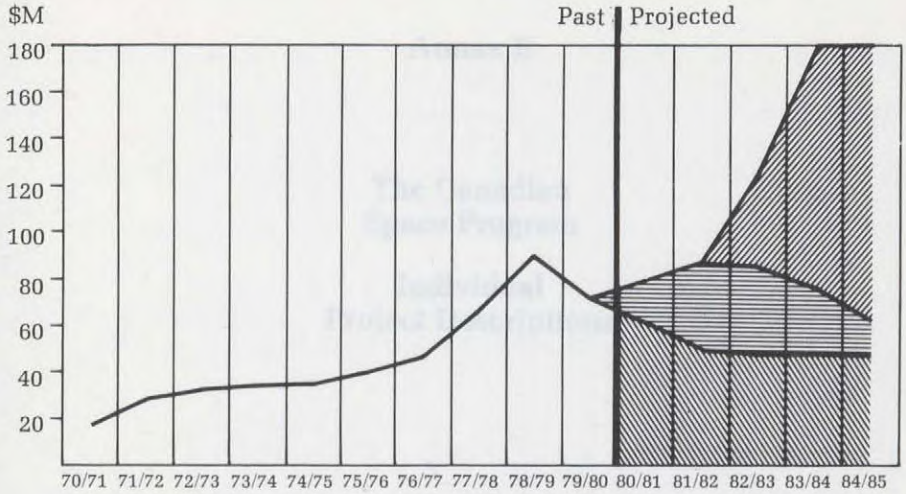

Figure 2
Government expenditures in space

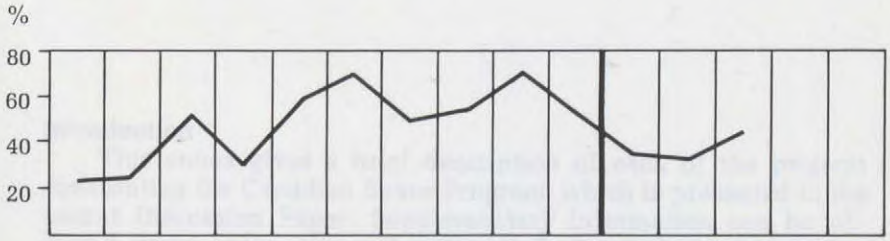

Figure 3
Sales to Government, as % of total sales

Planning envelope

Committed envelope

Approved program

All dollar values are in current (budget-year) dollars

Annex B

The Canadian Space Program

Individual Project Descriptions

Introduction

This annex gives a brief description of each of the projects constituting the Canadian Space Program, which is presented in the parent Discussion Paper. Supplementary information can be obtained from more comprehensive and detailed documentation prepared by sponsoring departments.

Summary

The projects proposed within the Space Program are the following:

1 renewal of the arrangements for receiving LANDSAT data from the U.S.A. and participation in the LANDSAT-D program (EMR, DOE, DOA, INA);
2 activities prerequisite to a Canadian radar development program (EMR);
3 participation in a satellite radar development program (EMR);
4 development of a remote sensing information extraction system (EMR);
5 participation in a joint Space Science Program with NASA (NRC);
6 Engineering Definition Studies prerequisite to the development and construction of a Multipurpose UHF satellite system, MUSAT (DOC);
7 support for the establishment of a MUSAT system (DOC);
8 planning studies for direct broadcasting by satellite (DOC);
9 increase DOC's technology development program (DOC);

10 support of Canadian industry in its bid as prime contractor for the next series of NATO satellites (DOC);
11 extension of the ANIK-B experimental program (DOC);
12 support of new international initiatives (DOC);
13 extension of operation of DFL satellite test facilities (DOC);
14 the utilization of new meteorological satellites (DOE);
15 participation in meteorological satellite research programs of the U.S.A. (DOE).

The following table shows the costs of the various projects and of the total program, as currently envisaged in budget-year dollars, assuming 8% inflation.

Cost of Proposed New Space Projects
($M @ 8% inflation p.a.)
(person years over 79/80 levels)

FY VOTE	80/81	81/82	82/83	83/84	84/85	Total to 84/85	Total to Completion
1-(a) EMR 45&50	3.57(1)	5.31(8)	4.74(8)	1.72(8)	1.85(8)	17.19	ongoing
(b) DOE 20	.04(1)	.09(2)	.10(2)	.11(2)	.12(2)	.46	ongoing
(c) DOA 5	—	.04(1)	.05(1)	.05(1)	.06(1)	.20	ongoing
(d) INA 25	—	.04(1)	.05(1)	.05(1)	.06(1)	.20	ongoing
2-EMR 50	2.41	0.62	—	—	—	3.03	3.03
3-EMR 50	—	6.47	12.60	27.20	36.70	82.97	113.82
4-EMR 45&50	—	—	—	3.40	3.68	7.08	ongoing
5-NRC 10&5	4.53	6.48	9.05	9.37	6.25	35.68	41.50
6-DOC 5	1.31(3)	0.87(3)	—	—	—	2.18	2.18
7-DOC 5	—	—	24.00	70.00	76.00	170.00	230.00
8-DOC 1&5	0.80(7)	0.80(7)	0.87(7)	—	—	2.47	2.47
9-DOC 5	1.0	1.24	3.50	3.78	4.08	13.60	ongoing
10-DOC 1&10	1.08(2)	—	—	—	—	1.08	1.08
11-DOC 1&5	0.65	3.00	3.30	—	—	6.95	6.95
12-DOC 5	2.16	11.66	13.60	14.70	—	42.12	42.12
13-DOC 1	—	—	1.56	1.68	1.82	5.06	ongoing
14-DOE 25	0.54(4)	1.01(8)	1.27(10)	1.23(11)	1.30(11)	5.35	ongoing
15-DOE 25&20	—	0.47	1.76	1.91	2.06	6.20	9.32
Total ($M)	18.09	38.10	76.45	135.20	133.98	401.82	
Total (PY)	(18)	(30)	(29)	(23)	(23)		

Project Descriptions

The following sections describe each project in the order they appear in the Summary.

Project No. 1 (EMR)
Canadian Participation in LANDSAT

Proposal:

a) Approval of the renewal of the Canada-USA Earth Resources Surveys (ERTS/LANDSAT) Agreement for a period of five years to allow continued Canadian participation in the NASA Landsat program.

b) Approval to upgrade the data reception, processing, dissemination, and image analysis capabilities of Canada in order to make full use of the data from the new, second generation, technology of NASA's LANDSAT-D series of operational satellites, the first of which will be launched in 1981.

c) Approval to negotiate Memoranda of Understanding with the Provinces and the Territories to implement technology transfer projects that will lead to the integration of remote sensing data into resource management operations.

Background:

The LANDSAT satellite system of the USA gives information about the earth's surface which is being found to be increasingly valuable for agricultural crop inventory, forest and wildlife management, water resource management, land use mapping, and mineral and petroleum exploration. Data from the LANDSAT satellite system is received in Canada under terms of the Canada-USA Earth Resources Surveys (ERTS/LANDSAT) Agreement. The agreement, last renewed in 1975, must be renewed again by May 1980 if Canada is to continue to receive data from the present LANDSAT satellites as well as the new LANDSAT-D satellites.

The new, second generation, LANDSAT-D technology will substantially improve earth resource survey capabilities by providing better colour and spatial resolution. However, in order to receive LANDSAT-D data, additional funds are needed to undertake extensive electronic changes at the two existing satellite receiving and data processing stations in Prince Albert, Sask. and Shoe Cove, Nfld. NASA intends to freeze the LANDSAT-D technology during the 1980's keeping at least one satellite in orbit during this time so that no station modifications in addition to those requested here will be required for at least a decade.

In order to ensure that maximum benefits of the data are achieved, Canada requires a strong training and technology transfer program jointly with the provinces to effectively integrate remote sensing technology into the nation's operational environmental and resource management information systems. Additional re-

sources for participating departments are required to implement this technology transfer program.

The above proposal is expected to maintain Canada's international prominence in export sales of satellite ground stations and associated data processing hardware and software.

Cost:

Additional financial and person-year resources (EMR, Earth Sciences Program, Votes 45 and 50) are requested as follows:

	80/81	81/82	82/83	83/84	84/85	Total
Capital						
Satellite Stations	2.25	2.38	0.50	—	—	5.13
Image Analysis	0.93	0.45	1.33	—	—	2.71
Technology Transfer	—	0.45	0.67	—	—	1.12
	3.18	3.28	2.50	—	—	8.96
Operating (On-Going)						
Satellite Stations	—	0.75	0.75	0.75	0.75	3.00
Image Analysis	0.08	0.12	0.12	0.12	0.12	0.56
Technology Transfer*	0.08	0.55	0.55	0.55	0.55	2.28
(Person Years)	(2)	(12)	(12)	(12)	(12)	
	0.16	1.42	1.42	1.42	1.42	5.84
	(2)	(12)	(12)	(12)	(12)	
Total Cost (1979 dollars)	3.34	4.70	3.92	1.42	1.42	14.80
(Person Years)	(2)	(12)	(12)	(12)	(12)	
Inflation @ 8%	0.27	0.78	1.02	0.51	0.67	3.25
Total Cost	**3.61**	**5.48**	**4.94**	**1.93**	**2.09**	**18.05**

Operating costs include an anticipated 1981/82 increase of U.S. $250,000 in the NASA charges above current charges in the same amount.

* Person-years will be allocated to participating departments as to:

a) DOE, Environmental Services Program, Vote 20, 1 P-Y in 80/81, 2 P-Y in subsequent years.
b) DOA, Research Program, Vote 5, 1 P-Y in 81/82 and subsequent years.
c) INA, Northern Affairs Program, Vote 25, 1 P-Y in 81/82 and subsequent years.

Projects 2 & 3 (EMR)
Satellite
Radar Development
Program

Proposal:

a) Approval for Canadian participation in the Preparatory European Remote Sensing Program of the European Space Agency.
b) Authority to negotiate a program of remote sensing satellites in cooperation with potential foreign partners in particular the U.S.A., ESA and Japan, which would incorporate a Canadian-designed and built Synthetic Aperture Radar package, as the Canadian contribution to a multi-national system, the cost of which to Canada could, as currently estimated, be of the order of $114M over a six-year period, probably commencing in 81/82.
c) Approval for technical studies and preliminary development activities to support these negotiations and to define in detail the elements, costs, and risks of possible cooperative undertakings.

Background:

Cabinet Document 6-77RD "Feasibility of a Canadian Surveillance Satellite System", 21 February 1977, directed that Canada move towards the utilization of a surveillance satellite system to assist in meeting forecast surveillance needs in the 1980-2000 time-frame. Further to this decision, the Canadian Surveillance Satellite (SURSAT) Program (TB749178) was approved in June 1977 to define Canada's options for participation in surveillance satellite systems in the 1980's. The Cabinet Document 6-77 RD also directed that "The Department of Energy, Mines & Resources, in cooperation with other departments be authorized to enter into discussions with appropriate agencies of other nations or international bodies, with a view to possible international cooperation in the development of a surveillance satellite system taking fully into account all of the elements contained in the recent Cabinet Decision (592-76RD) on possible cooperation with the European Space Agency". These activities have led to the conclusion that Canada should continue to move toward the utilization of surveillance satellite systems by supplying a Synthetic Aperture Radar (SAR) sensor as Canada's contribution to a cooperative, international, program.

Participation in the "Preparatory European Remote Sensing Satellite Program" (PERSSP) of the European Space Agency (ESA) would be of significant benefit to Canada in acquisition of the technological expertise needed to build a SAR in Canada, irrespective of which international partner may be chosen for further cooperation. Since the PERSSP is presently underway within ESA, the option of Canadian participation should be exercised as soon as possible.

A further step toward the utilization of a surveillance satellite system would consist in establishing a program to develop a spaceborne Synthetic Aperture Radar (SAR). It is proposed that conditions be negotiated with ESA, Japan and the USA to incorporate a SAR built in Canada in satellites of these agencies. Having established these conditions and selected an agency or agencies with which to cooperate, technical studies and preliminary development activities will be undertaken to define in detail the elements, costs and risks of this cooperative undertaking after which a detailed submission requesting approval of the program will be made. The SAR sensor is of great interest to Canada due to its capability to provide high resolution images of ocean and land areas, despite darkness or cloud cover. Such a program will ensure the future availability of spaceborne SAR data to Canada, and will develop a sovereign capability in a selected technological aspect of surveillance satellites and thereby permit Canada to be accepted as a strong contributing partner in international cooperative programs. In addition, the program would broaden the base of the Canadian space industry and develop opportunities for export sales in the surveillance satellite field.

Cost:

a) Funding totalling $1.7M over 3 years beginning in FY 79/80 is required for participation in ESA's PERSSP. $0.65M for FY 79/80 would be met within current allocations of DOC and EMR. Additional funding of $0.53M (EMR, Vote 50) is requested for each of FY's 80/81 and 81/82.

b) Additional funding of $1.7M (1979 dollars, EMR, Earth Sciences Program, Vote 50) is requested for technical studies prerequisite to the development of a satellite radar system.

c) Funding totalling $79.3M (1979 dollars) over 6 years for development of a satellite radar will be requested in 80/81, subject to the satisfactory negotiation of Canada's participation in a multinational program.

	80/81	81/82	82/83	83/84	84/85	85/86	86/87	Total
a) ESA PERSSP	0.53	0.53	—	—	—	—	—	1.06
b) Technical Studies	1.70	—	—	—	—	—	—	1.70
Cost (1979 (dollars)	2.23	0.53	—	—	—	—	—	2.76
Cost (8% Inflation)	2.41	0.62	—	—	—	—	—	3.03
c) SAR Development (1979 dollars)	—	5.55	10.00	20.00	25.00	10.00	8.75	79.30
SAR Development (8% inflation)	—	6.47	12.60	27.20	36.70	15.90	14.95	113.82

Project No. 4 (EMR)
Development of an Information Extraction System

Proposal:

Approval in principle, of the development of an information extraction system with Canadian industry which will integrate satellite and aircraft remote sensing data with other geographic data base information, and the operation of this system.

Background:

Achievement of the full economic benefits expected from remote sensing technology by the late 1980's requires the ability to integrate remote sensing data (such as the advanced Thematic Mapper data soon to be available from the LANDSAT-D series of satellites) with other geographic data bases. The system and methods developed are planned to serve as the basis for future resources and environmental management information systems in provincial agencies and in the resource exploitation industries. The design of this information extraction system, TOPAS, (Terra Observation Pattern Analysis System) will be developed from ongoing research activities of the Canada Centre for Remote Sensing and will respond to the needs of resource managers in Canada as identified in the technology transfer component of the "Canadian Participation in LANDSAT" project, described elsewhere in this submission. The proposal is expected to enhance Canada's international prominence in export sales and data processing systems as it will allow industry to offer a complete data reception, processing, and analysis package to the world market.

Cost:

Additional financial resources (EMR, Earth Sciences Program, Votes 45 and 50) are requested as follows:

(1979 $M)

	83/84	84/85	85/86	86/87	87/88	Total
TOPAS Development	2.30	2.00				4.30
Operating	.20	.50	.50	.50	.50	2.20
Total (1979 dollars)	2.50	2.50	.50	.50	.50	6.50
Total with 8% inflation	3.40	3.68	.80	.86	.93	9.67

Project No. 5 (NRC)
A Canadian
Space Science
Program

Proposal:

Approval of a cooperative space science program involving NASA and the National Research Council of Canada, to study certain physical processes in the area of space near the earth which are of importance to Canada and to involve the Canadian scientific and industrial communities in new areas of science and technology.

Background:

Canada has a long history of scientific research in high latitude phenomena in the upper atmosphere and magnetosphere and their relationship to the activity on the sun. This has been due to a policy to maintain a certain level of basic research in areas which have potential applications of interest to Canada. This research has been carried out using ground-based, rocket, balloon and satellite measurements and included the very successful Alouette and ISIS satellites. In fact, the high point in this work was reached with the launch of the ISIS II satellite in 1971 which produced a wealth of new knowledge related to the ionosphere and magnetosphere. The ISIS II program has been phasing down for a number of years and a follow-on program is required to maintain the scientific expertise that has been built up in Canada and to continue to produce a base of new knowledge for future applications. It is apparent that the most cost-effective way to continue this work would be through a cooperative scientific program with NASA. Such a program would allow for considerable interaction between US and Canadian scientists and would give Canada access to the Space Shuttle and to data from various US satellites.

The scientific background of the proposed Canadian Space Science Program was discussed in detail in an earlier submission (TB762487) which was considered and approved by the Treasury Board on March 8, 1979. It is therefore considered appropriate simply to summarize the objectives of the Program as:

a) to improve our knowledge of the physical processes that take place in the magnetosphere, ionosphere and atmosphere and the coupling mechanisms that act between these regions, particularly at high latitudes; and

b) to permit Canadian scientists and Canadian industry to participate in this particular field of space science through involvement on a cooperative basis in NASA programs as negotiated between NRC and NASA.

The following benefits to Canada are expected to flow from the program:

a) Canadian research competence in the area of space science will be sustained and enhanced;

b) a significant fraction of the new knowledge needed to make decisions relating to Canada's use of space will be obtained and access to the remainder of that knowledge will be possible through close association with a broader program;

c) training will be provided to young scientists and engineers in an area that will be the focus of much activity in the future; and

d) Canadian industry will receive a series of opportunities for industrial innovation.

Pursuant to the Treasury Board's approval for NRC to open negotiations with NASA to determine what role Canada might play in an international cooperative program, discussions took place and NRC sent a formal letter of intent to NASA dated July 12, 1979. Following further discussions with NASA officials, the proposals put forward by the NRC have been accepted in principle by NASA although some details remain to be resolved.

It is planned that the implementation of the proposed Space Science Program will be carried out using Canadian industrial expertise in planning, design, development, construction, testing and integration of hardware and in the development of software and data handling systems. The space-borne instruments are scientifically and conceptually at or near the state of the art and the successful design and manufacture of such devices will involve Canadian industrial performers in making innovations in a highly technological field. The scientists involved in the program are located in Canadian universities (about 60%) and in government laboratories (about 40%); it is planned to promote as much interaction as possible between university, industry and government scientists and engineers in an attempt to encourage technology transfer from both government and university laboratories to industry.

Cost:

	$M								
	79/80	80/81	81/82	82/83	83/84	84/85	85/86	Total	Current dollars at 8% p.a.
Capital Vote (10)	—	2.545	4.178	5.642	4.292	0.155	—	16.812	20.796
Operating (Vote 5)	0.401	1.647	1.378	1.539	2.596	4.095	3.670	15.326	21.099
Total ($ 1979)	0.401	4.192	5.556	7.181	6.888	4.250	3.670	32.138	—
Total (Current dollars at 8% p.a.)	0.401	4.527	6.481	9.046	9.371	6.245	5.824	—	41.895

Costs identified for the current year will be obtained from existing resources.

Projects 6 & 7 (DOC)
A Multipurpose Satellite (MUSAT)

Proposal:

Approval to conduct Project Definition Studies on a Multipurpose satellite system primarily for federal and provincial governmental communications with small mobile terminals on ships, aircraft, land vehicles and field parties, particularly in the Canadian North.

Background:

The Department of Communications has aggregated the needs of federal departments for voice and data communications with ships, aircraft, vehicles and field parties in the Canadian North and other areas of operations where mobile-satellite services are needed. Provision of these services over a common user system would create efficiencies and cost savings not possible by other means. The ground stations using the satellite would be small, economical, flexible and easy to use. Proceeding with the planning, definition, and implementation of such a Canadian-owned mobile satellite system would ensure that vital government communications are provided with a system under Canadian control.

The Department of National Defence would be the major user of the system for tactical and strategic communications, and *studies proposed in this submission would be carried out only if DND's Plan 2000 Statement of Requirement receives approval, including the satellite requirements.* Other departments and agencies which would plan to utilize the eventual system include

Environment; Fisheries and Oceans; Transport, External Affairs; Energy, Mines and Resources. Provincial government departments; police forces; and commercial shipping firms operating in the North could also utilize the system and their detailed requirements would be surveyed during the Project Definition Studies.

Based on feasibility studies carried out under the aegis of an interdepartmental MUSAT Steering Committee, it was agreed that the proposed Project Definition Studies should be undertaken as the next step with DOC as the lead department. The actual work would be contracted out to the Canadian space industry. The decision to proceed with the construction of an actual operational system would, in turn, depend on the conclusions of the Studies.

The proposed Project Definition Studies would provide DOC, DND and other interested departments with accurate technical, cost and other management information needed to decide on an eventual system. Studies covering such aspects as user needs, ownership and financing options; institutional arrangements for provision of services; international coordination; the involvement of Canadian industry; details on user requirements and design options; specifications and component costs; assessment of the technical risks involved; and a project implementation and management plan.

In view of the serious shortage developing for the limited orbit/UHF frequency resource for geostationary satellites, DOC has taken the first step in claiming an orbit position and frequencies for MUSAT by submitting Advance Publication information according to requirements of the International Frequency Registration Board. For this claim to be valid, MUSAT should be launched by 1985. To meet this schedule, the Project Definition Studies would have to commence in FY 80/81.

Cost: (including 8% inflation)

	80/81	81/82	Total
Vote 5 — Project Definition Studies	1.200	0.750	1.950
Salaries (PY term)	0.110(3)	0.120(3)	0.230
Totals	**1.310(3)**	**0.870(3)**	**2.180**

Following completion of the Project Definition Studies, a decision would be needed on whether to proceed with the construction of the MUSAT system. This system would consist of a satellite in orbit, several hundred user earth stations, and a spare spacecraft on the ground. An in-orbit spare satellite also would be needed to provide a fully operational service unless some other arrangements can be made to ensure service availability. The MUSAT satellite would be launched in orbit in 1985 and have an expected life of 7 years. The capital cost of the project without in-orbit spare is expected to be approximately $158M with the cash

flow as shown below. This amount includes approximately $37M for research and development. An in-orbit spare would cost an additional estimated $40M. These are preliminary cost estimates which are not supported by industrial proposals. The MUSAT system would be developed and manufactured in Canada and a decision would be needed on whether the system should be purchased by the government or leased from Telesat Canada or elsewhere. A full program submission required to proceed with the construction of the MUSAT system would be prepared after completion of the Project Definition Studies.

				($M)			
	82/83	83/84	84/85	85/86	86/87	87/88	Total
Cash Flow* for MUSAT construction, Vote 5 ($ 1979)	19.0	51.5	51.0	21.5	9.5	5.5	158
@ 8% inflation	24.0	70.0	76.0	34.0	16.0	10.0	230

*This cash flow is applicable only if the system is procured by the government. If the services were leased from Telesat, the capital would be provided by Telesat during the construction phase, lease payments would start in FY 85/86, and presumably would be part of the operating budgets of user departments, and not their space budgets.

Project No. 8 (DOC)
Direct Broadcasting by Satellite (DBS) Program Development

Proposal:

Approval of funding for studies required to prepare a proposal for a possible Canadian DBS system.

Background:

Approximately one-quarter of Canada's population lives in regions with population densities between 1 and 2,500 persons per square mile, which are defined as being rural areas. Cable systems, which are presently available to about 75% of Canada's population, together with over-air broadcasting, now provide a wide variety of radio and television programming in urban areas. Outside of these areas, however, the availability of programs falls off sharply. Moreover, the quality of reception in rural remote areas varies considerably. Even with such programs as the CBC's Accelerated Coverage Program, and the significant improvement in communications in Northern Canada made possible by Telesat Canada's satellite system, the disparity in level of service between the urban

and the rural and remote regions of Canada continues to grow. There are a number of technical options available for reducing this disparity; principally, increasing the number of cable and/or over-air systems, or the use of satellite systems to broadcast signals directly to home receiving units. The cable and over-air broadcasting options have been available for some time. The principal disadvantage of following this route exclusively is that these systems become very costly when used to service a widely dispersed population. As an illustration of the cost of this approach, the CBC Accelerated Coverage Program is forecast to expend about $75M to extend CBC broadcasting service to an additional 3.5% of the population, and this still leaves about 1% of the population with no television service.

A new approach that is becoming of increasing interest, even in countries with a much less dispersed population than in Canada, is the use of Direct Broadcast Satellite (DBS) systems. Such systems have the capacity to provide as many as ten or so channels of television as well as diverse choice of radio channels throughout Canada.

This proposal covers two areas of activity:

a) a direct-to-home pilot project on the ANIK-B satellite to provide potential program suppliers and system designers with data on the acceptability of the service as it might be provided, e.g., by the ANIK-C system;
b) planning studies required to document a proposal for a possible DBS system; and

Cost: (including 8% inflation)

	79/80	80/81	81/82	82/83	Total
Capital (Vote 5)	0.230	0.306	0.238	0.296	1.070
Operating (Vote 1) (includes salaries)	0.117	0.491	0.557	0.575	1.740
(PY)	(2.33)	(7.0)	(7.0)	(7.0)	
Totals	**0.347**	**0.797**	**0.795**	**0.871**	**2.810**

Costs identified for the current FY are not part of this submission.

Project No. 9 (DOC)
Increase in the DOC Technology Development Program

Proposal:

Approval of an increase in the level of funding from $2M in 1979/80 to $3M (1980 dollars) in 1980/81 and 1981/82; and of the maintenance of this level for subsequent years for contracts to industry for the development of space sub-systems and components.

Background:

DOC obtained approval in 1975 (TB 740025) for a program of contracts to industry for the development of space sub-systems and components in areas where DOC in-house expertise could be applied to the management of the contracts and could contribute to the success of the work. The level foreseen in TB740025 as being required by 1979/80 was $3M, and an increase from $2M to $3M was requested in the 1979/80 Program Forecast and was refused at that time. It is noted that the industry has developed rapidly since the original submission was made in 1975; and the prime contractor status of SPAR Aerospace has enhanced the general credibility of the Canadian space industry to such a point that there are now good prospects of competing strongly for selected international programs, e.g. an Australian domestic satellite system and earth stations for DBS and military systems. However, this, in turn, results in a much greater need for specific development work to back up such bids. While industry is picking up an increasing share of cost of such development, strong support from the government is also required to match similar support given to the industry of other countries.

Cost:

The increase requested for this program is $1M in 1980/81 and $1.24M in 1981/82. The approval requested for continuance of the program at an equivalent funding level including 8% inflation, results in a requested level of $3.5M for 1982/83 and similar levels adjusted for inflation thereafter.

($M)

80/81	81/82	82/83	83/84	84/85	85/86	86/87
1.00	1.24	3.50	3.78	4.08	4.41	4.76

Project No. 10 (DOC)
Support to SPAR Aeorospace in Bid Preparations for the NATO IV Satellite

Proposal:

Approval of funds to support SPAR Aerospace Ltd. in its bid as prime contractor for the next series of NATO satellites.

Background:

As a result of the government's decision to support SPAR as a prime contractor for satellite systems, and its encouragement of the company to seek out export business of this type (TB763342), SPAR is considering bidding, with support from the Hughes Aircraft Corporation, on the RFP for the NATO IV satellite system, scheduled to be issued in December 1980. The potential income to SPAR and Canadian Industry from this contract is estimated to be $83 million, out of a total target price of $207 million, including launch. This proposal is contingent on SPAR submitting a bid on NATO IV which they are assessing in relation to some uncertainties resulting from a UK proposal to increase the number of satellites, which is not expected to be resolved before February 1980.

SPAR is seeking support related to the bid proposal, as follows:

a) Preparations of the bid proposal; it is estimated by SPAR, based on previous experience, that the cost of this activity will be in the order of $3M.
b) Funding from the government to assist in the development of some of the specialized sub-systems required. For example, military satellites operate in the 7/8 GHz bands and include countermeasure techniques on which SPAR would need to do substantial development work.
c) Possible exemption from some David Florida Laboratory charges for integration and testing if a successful bid is made. Competitors are expected to receive similar support from their governments.

NATO has only released an incomplete first draft of the Performance Specifications for the NATO IV Communications Subsystem, with Annexes to be provided. Refined estimates of program costs are not possible using this document; however, it does define documentation that is necessary to support a bidder's proposal. Specifically it includes the necessary background work the bidder must carry out on the transponder and multi-beam antenna subsystems. In order for SPAR to meet these bid requirements, development work is necessary commencing in FY 80/81. The cost of transponder development in FY 80/81 is estimated at $1.8M, and antenna development is expected to cost $0.7. The requested $2.5M will permit these activities to be carried out in time for inclusion in the bid documentation.

In addition, technical support and advice will be needed from DOC personnel with experience in military satellite communications. It is estimated that 2 term PY will be required by DOC to be able to provide this support.

A Treasury Board submission will provide detailed information on costs and justification for the support.

Cost: (including 8% inflation)

	79/80	80/81	Total
Contribution (Vote 10) for part (a) only	—	2.500	2.500
Salaries (PY) (Vote 1)	0.020(0.5)	0.080(2)	00.100(2.5)
Totals	0.020	2.580	2.600
New Funds Required	—	1.08	1.08

Costs identified for the current FY are not part of this submission.

Project No. 11 (DOC)
ANIK-B
Experimental Program

Proposal:

Approval of an extension of the current ANIK-B communications program.

Background:

Telesat Canada began providing satellite communications services to DOC, through its ANIK-B satellite, in February 1979 pursuant to a 2-year service agreement negotiated, pursuant to Treasury Board's approval of the experimental program in December 1975. The experimental program involves a large number of Canadian users, both commercial and non-commercial, the former generally defraying a major part of the cost to DOC of their experiments, the latter obtaining free use of the ground stations working with the satellite. The program of pilot projects is consistent with DOC's objective of promoting the effective use of satellite communications systems to augment and improve the quality of communications available to all Canadians.

Cost:

		80/81	81/82	82/83	Total
	(Vote 5)	0.07	—	—	0.07
Initial follow-on	(Vote 1)	0.58	—	—	0.58
Extended program	(Vote 5)	—	2.8	2.8	5.60
Totals in 79 dollars		0.65	2.8	2.8	6.25
@ 8% inflation (81/82 onwards)		0.65	3.0	3.3	6.95

Project No. 12 (DOC)
New
International
Initiatives

Proposal:

Approval of funding in support of activities in pursuit of opportunities for Canadian involvement, particularly Canadian industrial involvement, in specific foreign and international space system market opportunities.

Background:

The extension of David Florida Laboratory facilities together with government support to Canadian industry in the ANIK-C and ANIK-D programs, will lead to a considerable enhancement of Canadian capability for the production of communications satellites. To maintain and exploit this capability, efforts must be made to ensure that industry loading is maintained and that export opportunities are developed through competitive bids on commercial systems and/or through cooperative programs with international or national agencies.

Opportunities exist for Canadian participation in a variety of projects now in the concept or early planning stages. Such programs involving international or national agencies require government action in the definition of opportunities; in the assessment of potential benefits to Canadian industry and their significance to planned domestic systems development; in the negotiation and implementation of international agreements; and in continued support to industry through operation of the David Florida Laboratory, the High Reliability Laboratory, etc.

Possible international initiatives which could be pursued by Canada include:

L-SAT (European Space Agency)

A recent ESA decision to undertake a Project Definition Phase (PDP) on a multi-purpose large platform design is expected to lead to the launch in late 1983 of a demonstration satellite (L-SAT) carrying a telecommunications payload, thereby to stimulate user interest and promote new markets. A considerable international market is foreseen for such a satellite, and Canadian participation in the development and demonstration phase of this proposed ESA optional program is under study as a means of increasing Canadian exports through consortium or teaming arrangements between Canadian and European industry. Such participation would likely involve Canada's supplying either a spacecraft sub-system or one or more payload elements: the probable cost would be of the order of several million dollars.

Surveillance Satellite

Canada's interest in surveillance satellite programs has led to a proposal by EMR which includes the development of space hardware — specifically, a Synthetic Aperture Radar (SAR) component — for inclusion in satellites of international partners. Although a non-Canadian satellite is currently assumed, Canadian industry now has a competitive capability in satellite sub-systems, and participation by Canada in the spacecraft design and construction would probably be negotiated into any agreement for a joint surveillance satellite program. Government costs related to satellite sub-system development (and excluding SAR) could be expected to be of the order of $5 million.

European Broadcasting Satellite

A number of broadcast satellite programs are under advanced study in Europe, including NORDSAT (decision expected in 1980 or 1981), and possible French or German domestic systems. Opportunities for Canadian industry to supply satellite sub-systems for such programs could require government support in the development phase, possibly in the order of $1-2 million.

CTS-2

The HERMES/Communications Technology Satellite has been highly successful in demonstrating new communications satellite applications both within the original joint Canada/NASA program and in external demonstrations — notably the telephony and TV broadcast demonstrations held in Australia in August, 1979. The satellite has exceeded its design lifetime and is now nearing the end of its operational life. Studies within DOC indicate that a satellite, having direct broadcast capability could be economically constructed using CTS design and, in many cases, existing CTS hardware. Such a satellite, launched as part of an international (probably Canada/NASA) program, could be used to demonstrate the potentialities of satellite communications to developing nations, and thereby to enable them to develop their operational requirements for domestic systems and to facilitate program decisions. From the point of view of Canadian industry, such a program would be a powerful aid to market development, enabling both space segment and earth terminal technology to be demonstrated. Costs for the satellite development and construction would be of the order of $10-15 million, with operational costs of approximately $1 million per annum following launch.

Costs:

A detailed cost proposal for the projects outlined above depends on the phasing of the projects; at any rate separate submissions will be made as individual proposals are developed. The overall cash flow required is estimated to be of the following order:

($M)

Fiscal Year	80/81	81/82	82/83	83/84	Total
Capital (Vote 5)	2	10	10	10	32
@ 8% inflation	2.16	11.66	13.6	14.7	42.1

Project No. 13 (DOC)
David Florida
Laboratory (DFL)
Operations

Proposal:

Approval of an extension of funding for David Florida Laboratory (DFL) Operations.

Background:

The David Florida Laboratory (DFL) at the Communications Resarch Centre is a national facility for the integration, assembly and environmental testing of space components and communications satellites. The facilities currently include provision for vibration, thermal vacuum, R.F. antenna testing and spacecraft integration at both the component and system levels.

The DFL facilities were originally intended for the testing of space hardware at the component and system level. They have been utilized in the past for the integration and testing of space hardware for Canadian industry for the HERMES (CTS) Satellite Program, the Shuttle Remote Manipulator System (SRMS) Program, the ANIK-B Satellite Program and the TDRSS Satellite Program.

However, it has been recognized since 1975 (589-75RD) that the development of a Canadian prime contractor for communications satellites is an essential prerequisite to capturing a greater share of the domestic and export markets for satellites. In 1977, Cabinet confirmed (242-77RD) as a priority objective of Canada's space program, the establishing of a capability in SPAR Aerospace Limited to compete as a prime contractor for satellites. In 1978, the Treasury Board (759298) approved the expenditure of $18.073 million for developing, maintaining and operating test facilities at the David Florida Laboratory.

The funding comprised $15.073 million in Capital (Vote 5), for expansion of the facilities; and $3 million in Operating (Vote 1), for maintenance and operations at a level of $1 million per annum from FY 79/80 through FY 81/82.

The expanded facilities will provide capability for integration and test of complete satellites, rather than components and subsystems. The laboratory will be a national facility, with equal access available to all Canadian companies.

The ongoing expansion will be completed during FY 81/82.

Following the period covered by the DFL Extension approval, in addition to continued Operating expenditures, Capital expenditures will be required to replace major items of equipment and to upgrade as necessary.

Costs: (including 8% inflation)

($'000)

Fiscal Year	82/83	83/84	84/85	85/86	86/87	87/88
Vote 5	300	324	350	380	410	440
Vote 1	1260	1360	1470	1590	1710	1850
Totals	1560	1684	1820	1970	2120	2290

Project No. 14 (DOE)
Meteorological Satellite Research and Development Program

Proposal:

a) Approval for a program of research and development to enable the Atmospheric Environment Service to make effective use in its operations of the capabilities of the current generation of meteorological satellites.
b) Approval of resources required for the maintenance of these programs in response to the evolving capabilities of meteorological satellites.

Note: This is part of a submission which also includes a program for improvements to the operational data reception and communications system.

Background:

The Atmospheric Environment Service of Environment Canada receives data and images of the earth and its atmosphere from operational and research meteorological satellites operated by the USA. In order to employ the data thus received in a quantitative way so as to improve the accuracy of the forecast of weather, ice, and other environmental parameters and to increase the effectiveness of the total data acquisition system of the Service, certain systems and techniques need to be developed. These include:

a) Completion, installation and verification of a system to combine satellite images with data from a weather radar to provide short-term precipitation and severe weather forecasts. The capital portion is being funded by DSS from U/P funds.
b) Research and development of methods to convert radiances measured by polar-orbiting satellites into information on the

structure of the atmosphere to reduce the dependence on sounding balloons.

c) Completion, installation, and verification of the ice status system, and extension of it to enable mapping of snow cover and sea surface temperature. Major capital equipment for this project has been funded by DOT.

d) Research to verify the capabilities of promising microwave space instruments to enable measurement of ice cover, snow cover, ocean surface wind, and surface temperature.

Cost:

($M)

	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
Capital Vote 25	0.15	0.20	0.21	0.17	0.17	0.20	0.20	0.20
O&M (PY) Vote 20	0.35(4)	0.67(8)	0.80(10)	0.73(11)	0.71(11)	0.71(11)	0.71(11)	0.71
Total ($M)	0.50	0.87	1.01	0.90	0.88	0.91	0.91	0.91
Total ($M) inc. 8% inflation	0.54	1.01	1.27	1.23	1.30	1.44	1.56	1.68

Project No. 15 (DOE)
Future
Atmospheric Research

Proposal:

Approval in principle for participation in certain meteorological research programs of USA.

Background:

Canada benefits from data provided by operational meteorological satellites built, launched, and operated by the USA. Some other countries have contributed to these operational programs by furnishing instruments and data processing services for the use of the global meteorological community. Participation in line with Canada's capabilities and interests could include contribution to space programs for studying the climate and the composition of the upper atmosphere. Preliminary discussions with the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration of USA have resulted in an invitation to propose participation in projects of common interest.

Topics which Canada would propose as a contribution to the upper atmosphere research program are participation on instrument development and validation teams, the use of balloons to make comparative measurements, and development and testing of instruments to measure atmospheric components from the Space Shuttle and from free-flying spacecraft. In this area, there is recog-

nized competence in Canadian industry and government. Approximately ⅔ of the proposed funding would be spent in Canadian industry. Canadian participation would count toward the global effort in atmospheric research.

Costs:

Approximate costs for the envisaged program are given below in millions of dollars:

	81/82	82/83	83/84	84/85	85/86	86/87	Total
Capital and O&M (Votes 25 & 20)	.400	1.400	1.400	1.400	1.100	.800	6.500
@ 8% inflation	.467	1.764	1.905	2.057	1.746	1.371	9.310