

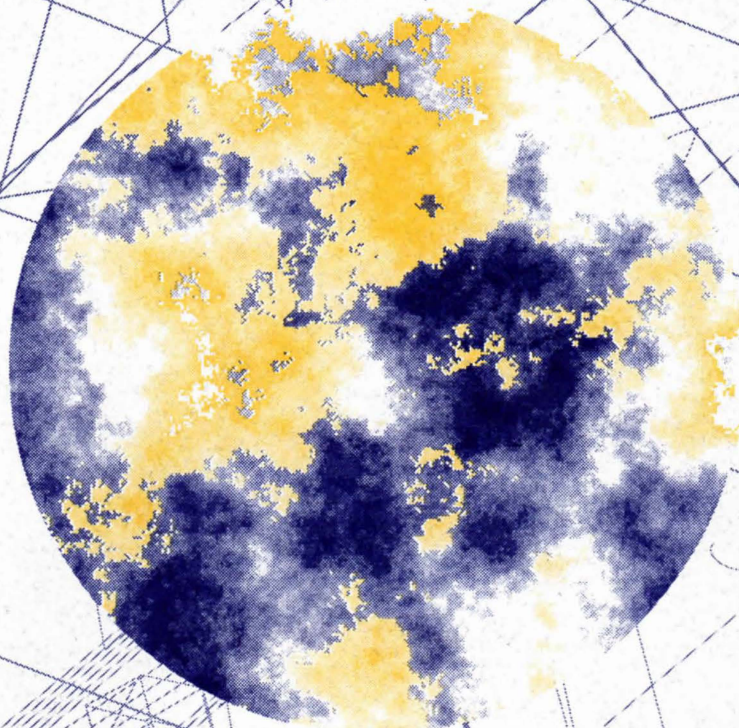


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LTSP II



The Canadian Space Program **A New Horizon**

Canada

THE CANADIAN SPACE PROGRAM

A NEW HORIZON

CANADA IN SPACE

Canada became interested in space because of its geography which spreads over half a continent. The need to communicate over large distances and manage a broad range of natural resources was paramount.

The most obvious practical application of space technology in a vast country like ours was and remains communications. The combination of widely separated settlements, rugged terrain, and harsh climate means that conventional methods of communications prior to the Space Age were unreliable, or prohibitively expensive. In less than a generation, all that has changed. Technological innovation in satellite telecommunications in Canada led to a comprehensive state-of-the-art satellite communications system that meets Canadian needs. As a result, Canadian satellite communications systems have become a model for other countries sharing similar geographical characteristics.

The development of a remote sensing sector is also a priority for Canada. The country's immense size, the environmental concerns, and an economy traditionally based on natural resources are among the many reasons why remote sensing is crucial to the nation. Canada thus began early on to equip itself to receive and use images transmitted by foreign remote sensing satellites; these images are being received at the Gatineau and Prince Albert ground stations. Canadian firms have also acquired expertise in remote sensing data interpretation, enabling them to market their equipment and services worldwide.

Canada has developed international excellence in certain space science disciplines, notably solar-terrestrial relations, to learn more about the natural

phenomena in space affecting life on Earth, such as the impact of solar storms on telecommunications or aurora borealis on power transmission lines.

Today, these motivations remain as valid and important as ever. Indeed, the requirement for even more advanced and versatile communications capabilities, in particular mobile services to remote regions of the country, the demand for new remote sensing capabilities to respond to the heightened concern in Canada and abroad for the environment, and the constant need for new insights into scientific phenomena for benefits on Earth, continue to serve as strong priorities for the Canadian Space Program (CSP).

Further, Canada's space program is a building block of the new knowledge-based economy providing the type of high-quality jobs required in technologically-advanced nations. As such, it is an important engine for social and economic progress in the 21st century and will play an important role in securing a prominent place for Canada at the leading edge among technologically-advanced nations.

SPACE AT A TURNING POINT

At the time of the February 1994 Budget, the CSP was at a turning point. Federal funding was expected to decrease rapidly over the next two to three years, due to the completion of major projects such as MSAT and RADARSAT. Moreover, it was recognized that, as a result of the substantial cost increases that have occurred in the International Space Station, important decisions had to be made regarding Canada's continued participation in this program.

The February 1994 Budget stated that the Government was committed to establishing a new Long Term Space Plan that would be affordable and yield the most benefits for Canada. The Budget provided \$800M in incremental funding over and above the \$1.7B currently approved funding for the next ten years to establish a Space Plan that would focus on Canadian needs and areas where Canada has developed competitive international advantages such as Earth observation and Satellite Communications. As part of the Budget, the Government announced also that Canada would undertake an orderly reduction in our current commitments to the International Space Station Program. Later,

an additional \$200M was made available to allow Canada to maintain its participation in the Program and protect the \$700M investment made in Space Station to date.

THE NEW CANADIAN SPACE PROGRAM

Major orientations and objectives

The initiatives for the new Space Plan have been selected from the more than four billion dollars worth of proposals received after extensive consultations with all stakeholders across Canada in the CSP. Its formulation has been guided by the following principles :

- focus on Canada's commercial and technological strengths to meet our ongoing needs in the areas of Earth observation and communications;
- contribute to economic growth and employment;
- contribute to increasing Canadian industrial competitiveness and export capabilities;
- contribute to the advancement of knowledge;
- maximize leverage through private sector partnership and financing;
- contribute to improving the efficiency and effectiveness of Government operations;
- balance the distribution of funds among space sectors, as well as between short-term and long-term initiatives; and
- ensure flexible formulation of program content and the allocation of funds.

The Canadian Space Station Program

In 1985, Canada agreed to join international partners to build a permanently-habited Space Station. Canada's contribution was to design, manufacture, and operate a robotics system, called the Mobile Servicing System (MSS), for assembly and maintenance tasks on the Space Station. The MSS includes the Space Station Remote Manipulator System designed to handle large loads on-board the Station and a second robot, the Special Purpose Dexterous Manipulator (SPDM) to take care of more delicate work. The Intergovernmental Agreement among Space Station partners also gave Canada the right to three percent utilization of on-board laboratories and of crew opportunities. Finally, the Canadian Space Station Program (CSSP) includes two complementary programs : the Strategic Technologies for Automation and Robotics (STEAR) and the User Development Program (UDP). The CSSP, as defined prior to the Budget, was estimated at \$1.3B to year 2000; more than \$700M were spent by March 31, 1994.

Revised Canadian Space Station Program

As a result of the Budget decisions on Space Station, intensive discussions with NASA and industry have led to a revised CSSP including the following elements :

- completion of the design and manufacture of the MSS, including the Mobile Base Servicing Unit and the Advanced Vision Unit;
- responsibility for MSS operations, including engineering support and crew training, to be located at the future MSS Control Centre at the Space Centre in St.Hubert, Québec;
- provision of spares required for the maintenance of the MSS;
- completion of the design of the SPDM over the next three years and first right of refusal on its manufacturing;
- continuation of the STEAR program.

Enhanced Canada/US Space Cooperation

Canada remains an active partner in the International Space Station Program along with the U.S., Japan, and nine member states of the European Space Agency; Russia is in the process of joining the program as part of a major initiative bringing Russia into the Western world economy. Canada is no longer committed to utilizing its share of Space Station. However, it will be possible to use Space Station on a case-by-case basis under normal terms of NASA cooperative science programs. Canada could also purchase exclusive use of other partners' utilization resources.

Canada retains the majority of the industrial, economic, and regional benefits foreseen in the original program and maintains its position as the world leader of space robotics. The completion of SPDM design places the Canadian industry in a strong position to win SPDM manufacturing contracts from NASA, should Canada decide not to build it. Retaining responsibility for operating the MSS in Canada ensures that Canadian technology is protected.

Earth observation

Canada has recognized the growing worldwide emphasis on global environmental monitoring and protection. The new Space Plan includes programs designed to ensure Canadian leadership in emerging Earth observation international markets.

RADARSAT I

RADARSAT is a satellite that will be equipped with leading-edge Synthetic Aperture Radar (SAR) rather than optical cameras like those found in conventional remote sensing satellites. Instead of gathering images formed by reflected sunlight, the radar «lights up» the surfaces it targets as it receives the echo of its own signal. It can thus operate in total darkness. Its microwave signal also easily penetrates the layers of cloud that periodically obstruct the view of other remote sensing satellites. The satellite will provide data for a number of applications, including the monitoring of ice and sea conditions in the Canadian Arctic and the management of Canada's natural resources. When launched in early 1995, RADARSAT I will permit Canada to enter the emerging

commercial marketplace for satellite data. Privately-owned RADARSAT International Inc. of Richmond, B. C., has the exclusive right to market RADARSAT data worldwide. The development and the operations of the satellite are estimated to cost \$620M; contributions from provinces and the private sector are valued at \$120M.

RADARSAT II and Beyond

The new Space Plan includes the provision of a second satellite (RADARSAT II) to be launched by the end of the century to ensure continuity of radar data for at least ten years, a requirement essential to the commercial success of the RADARSAT program. Further, a RADARSAT Technology Development program will be implemented to maintain Canadian leadership in advanced SAR technology for possible satellites beyond RADARSAT II.

The CSA will invite proposals from the Canadian private sector for an arrangement with the Government for the development and operation of RADARSAT II and beyond. The government will invest up to \$280M in the implementation of the program, including advanced technology development. The private sector will have to arrange for the remainder of the necessary funding.

Ground Infrastructure Development

The new Space Plan provides for the upgrading of Canada's receiving, archiving, and calibration facilities at a cost of \$40M to accommodate data from new satellites. As a result, Canada will be able to receive and use the expanding range of satellite data that will be available in the coming decade. Furthermore, this program will enable Canadian industry to maintain its dominance of the world market for remote sensing ground stations and equipment.

Applications Development and Technology Transfer

Programs fostering the development of Earth observation satellite data and their integration into commercial systems are essential to the development of a Canadian value-added industry. The new Space Plan provides for the following

Application Development and Technology Transfer programs at a cost of \$80M :

- the development of a Canadian Earth Observation Network (CEONET) to provide users with direct access to data through the use of the existing domestic electronic network infrastructure;
- Pilot Projects Program to develop and test new applications in a real world environment prior to implementing them operationally;
- a RADARSAT User Development Program to develop value-added products and services based on RADARSAT data;
- an Earth Observation Data Sets Program to provide data to Canadian researchers for global environmental research; and
- a User Training Program to provide on-the-job training methods developed at the Canada Centre for Remote Sensing.

Satellite Communications

The availability of a competitive communications infrastructure is the «nervous system» of a knowledge-based economy. Satellite communications is the most mature area of space applications with the greatest potential for immediate economic returns. It is one of the major strengths of the Canadian space industry. The CSP ensures that Canadians will continue to benefit from the many new communications services made possible by advanced satellite communications technologies and that Canadian industry will maintain its share of the expanding international market for these new services.

MSAT

MSAT is currently Canada's major development in satellite communications. To be launched early in 1995, MSAT will be Canada's first mobile communications satellite, allowing anyone to communicate anywhere south of the Arctic Circle even in the most remote regions of Canada. It will provide mobile radio, telephone, data, vehicle tracking and paging services. A Canadian company, TMI Inc. owns and will operate MSAT. The Company will spend about \$400M on the satellite and the federal Government will invest \$200M on pre-paid service lease, market trials and industry support.

Advanced Satellite Communications Program

The new Space Plan initiatives in this area would ensure that Canadians would continue to benefit from the many new services now possible with advanced technologies and that Canadian industry would be able to maintain its share of the expanding international market for these new services.

The Plan provides for the arrangement, with the private sector, of an Advanced Satellite Communications Program, including the development of leading-edge satellite technologies and innovative ground terminals and services. This program will provide Canada with advanced technologies required for future commercial delivery of multi-media services, high definition TV, and high data rate information highways. The government will invest up to \$160M to support this initiative. In order to maximize commercial success, industry will be asked to supplement federal funding and submit proposals for implementing the program.

International Mobile Program

The new Space Plan also includes an International Mobile Program aimed at positioning Canadian industry in the fast-growing market for mobile/personal satellite communications services, both as a supplier of sub-systems to international consortia operating constellations of small satellites and as a service provider to Canadians. The Government will invest \$30M in this program, and it is expected that substantial additional funds will come from the private sector.

Space Science

Space Science has been a cornerstone of the Canadian space program from the very beginning. It includes the traditional disciplines of upper atmospheric research, solar-terrestrial physics, and astronomy, as well as microgravity sciences for the study of the effect of weightlessness on living organisms and materials. Based on international cooperation, the Canadian Space Science program supports over forty major projects through contracts awarded to Canadian industry and universities.

In addition, the program manages more than 30 projects in microgravity materials within the User Development Program.

The CSA is mandated to ensure that Canada maintains a position of excellence in the worldwide scientific exploration and utilization of space. The new Plan will help the Canadian space science community contribute to the global knowledge base, to the Government's environmental monitoring and protection objectives, and to the enhancement of the Canadian space industry technological base.

Traditional Space Sciences

As a major new initiative, the new Space Plan includes a Scientific Smallsat Program that will see two small Canadian scientific satellites launched over the next ten years. By combining new resources (\$20M plus two smallsat launches with an equivalent value of \$40M) with existing resources, the program will provide the Canadian scientific community with control over a major scientific program (all other major science projects are cooperative ventures under the control of other nations) that could produce results in a time frame consistent with normal graduate programs.

The new Plan includes an increase of \$29M in the space science program for atmospheric science research, in response to the worldwide concern for the environment. It also provides \$16M for a Space Science Enhancement program that will involve the CSA and other funding agencies, notably Natural Sciences and Engineering Research Council of Canada (NSERC). This program is designed to provide "end to end funding", to ensure that there is continuity between the concept development of experiments, the instrument design, building and operation, and the data analysis/dissemination of the results of each project.

Microgravity Science

The new Space Plan includes the establishment of an extended microgravity materials program. By combining the remaining resources of UDP plus new resources, \$32M will be available over the next five years to support the Canadian research community in research and development that exploits the

unique environment of microgravity, continuing to use drop tubes, parabolic flights and orbital flights, both shuttle and possibly MIR.

Space Technology Development

An ongoing research and development effort in strategic technological areas (\$145M) is at the core of a successful space program and is required to stay abreast of, and fully benefit from, rapid developments worldwide. Working in close cooperation with industry, a small space technology team carries out in-house research and manages a contracting out program that ensures the development by Canadian industry of technologies needed to meet Canadian needs, and significantly contribute to the growth of the industry and its competitiveness.

The CSP includes programs to help companies develop strategic technologies in specific niches, establish links with foreign firms, improve access to foreign markets and benefit from technological transfer to Canada.

Strategic Space Technology Development Program

The new Space Plan allocates \$26M for a Strategic Space Technology Development Program. This program, designed to develop emerging space technologies, includes three components: the Industry Partnerships Program, to share technological development costs with industry; the International Cooperation Program, to allow Canadian industry participation in cooperative ventures with foreign partners; and the Technology Diffusion Program, to support the development of applications of space technologies in non-space sectors. It is expected that industry contributions will complement the federal funding.

ESA Programs

Canada is the only non-European country participating in the European Space Agency (ESA). Our participation in ESA programs, which amounts to \$193M over the next ten years, supports Canadian activities in the fields of Earth observation and satellite communications.

The new Space Plan provides resources to fund Canadian participation in several ongoing programs (\$58M for ENVISAT I, ERS Phase E extension) and to permit Canadian industrial participation in new ESA programs in the areas of satellite communications and Earth observation (\$51M). This additional funding will ensure that Canadian industry continues to have the opportunity for strategic technology and product development in conjunction with European industries and that Canada continues its special partnership agreement with ESA.

Canadian Astronaut Program

The Canadian Astronaut Program contributes significantly to public awareness of the importance of science and technology to Canada's future competitiveness and prosperity. Since its inception in 1983, the Astronaut program has been an important element of the CSP providing operational support to several of the CSA's scientific and technical programs. Three Canadian astronauts have participated in Space Shuttle missions : Dr. Marc Garneau in 1984 for the Canex-1 mission on space life sciences, Dr. Roberta Bondar in 1992 for the IML-1 mission on effects on microgravity environment on humans and Dr. Steve MacLean in 1992 for the Canex-2 mission on testing of the Canadian-designed space vision system.

Currently the Canadian astronaut corps is composed of eight individuals, including two astronauts training at the NASA Johnson Space Centre in Houston as Mission Specialists.

The new Plan includes \$10M over the next five years to cover the mission preparation costs associated with accepting NASA's offer to provide for a flight per year on the U.S. Space Shuttle over a period of five years. This offer will allow Canadian astronauts to participate fully in the early on-orbit assembly of Space Station and conduct microgravity, Earth observation, and other experiments for the Canadian industrial and scientific communities.

Space Awareness Program

A sum of \$13M is allocated to a Space Awareness Program in response to concerns voiced by many stakeholders in Canadian industry and research

institutions about the future Canadian competitiveness in the science and technology sectors. The program will use the unique appeal of space as a medium for improving scientific literacy among the general public and for promoting careers in science and technology among students and educators.

The program will include two elements that will be undertaken in cooperation with provinces and specialized institutions. The first element, Youth Awareness, will support production of space-related materials, ensure appropriate dissemination of materials to schools, and encourage youth to undertake careers in science and technology through rewards and recognition activities.

The second element, Advanced Space Studies Sponsorship, will provide, in cooperation with existing programs of the NSERC and the Medical Research Council of Canada, financial support to graduate students interested in pursuing advanced studies in space science and engineering. Also, the Program supports the International Space University.

David Florida Laboratory and St. Hubert Space Centre

The David Florida Laboratory (DFL) provides competitive environmental test facilities for the Canadian space community. It is a world class facility used for the assembly, integration and testing of spacecraft systems and sub-systems. Services offered are : large clean rooms, thermal vacuum chambers, infrared testing, vibration testing, evaluation of antennas and radio frequency payloads. DFL operating budget is estimated at \$50M over the next ten years. The new Space Plan includes a program to carry out a mid-life refit of the building and upgrade laboratory equipment at an estimated cost of \$10M.

Funds in the new Plan are also provided for maintenance and upgrades of the Space Centre at St. Hubert, and upgrades of laboratory equipment for the Space Science, Space Technology, and Canadian Astronaut programs within a strategy assuring efficient utilization of public and private sector facilities.

Contingency Reserve

The new Space Plan includes a Contingency Reserve of \$146M to be managed by the CSA in consultation with major stakeholders in the CSP. This reserve will ensure that the new Plan programs will be completed within approved resources. It will be used for the following purposes:

- unforeseen cost increases to the Government for approved space programs;
- future program opportunities that cannot be foreseen at this time;
- future decisions on continuation of existing programs (e.g. ESA, microgravity sciences); and
- cash management of the Canadian Space Program.

IMPLEMENTATION OF THE CANADIAN SPACE PROGRAM

The CSP is a complex set of projects and activities involving stakeholders from several Federal Government departments, provincial governments, industries across the country and the academic and research communities. Success of the Program will be enhanced by the implementation of the following space policy framework :

- space is of strategic importance to Canada's transition to a knowledge-based economy, and to the social, scientific, sovereignty, security and foreign policy objectives of the Federal Government. The CSP is a chosen instrument for the implementation of the new objectives of the Government in research and development, science and technology, economic and industrial development, export expansion and employment, improved efficiency and effectiveness of Government operations, and the maintenance of Canada's sovereignty in the new world economic order;

- the CSA, in addition to the management of its direct responsibilities, will coordinate all policies and programs of the Federal Government in civil space-related research, science and technology, industrial development and international cooperation;
- the CSA will chair and act as secretary to a new Canadian Space Program Consultative Committee, which will provide the President of the CSA with advice on the implementation of the CSP. Membership of this Committee and of its Sub-Committees will include, as appropriate, representatives from all stakeholders, including federal departments and agencies, the provinces, the Canadian space industry and the university community;
- the CSA will prepare, with the full support of all interested federal departments, an overall evaluation framework indicating how success will be measured and accountability ensured for all approved activities of the CSP, for the consideration of the Treasury Board before the end of 1994/95;
- programming of the CSP will be designed to lever the maximum possible funding from other interested parties, including the industry and the provinces. Innovative and flexible financing mechanisms will be required for that purpose on a program by program basis. The relative contribution of industry and provinces will be expected to increase as programs evolve toward the application phase. The federal share will be greater on the more risky and longer term elements of the Program;
- building on areas of industrial and technical competency, implementation of the CSP will seek to foster an internationally competitive, export-oriented Canadian space equipment and services sector, open to a growing number of firms, often small and medium-sized enterprises;
- federal programs affecting the Canadian space industry will be coordinated so as to avoid duplication and overlap within the Federal Government and, with the collaboration of provinces, between the Federal Government and Provincial Governments. These programs will

be managed so as to optimize the effectiveness of federal funds towards the achievement of this policy framework;

- a policy of sustainable industrial regional development will be pursued in order to maximize benefits from the CSP to all Canadians, with the current regional distribution targets being used as an implementation guideline for that purpose;
- the exploitation of the strategic environment of space is also deemed essential to protect national security and to enhance Canada's sovereignty in the new political and economic world order. A growing degree of synergy will be promoted between civil and non-aggressive defence space activities with a view to contributing to world peace and security, and to optimizing the effectiveness of federal funds;
- federal departments are expected to take advantage of the opportunities provided by space-based technology and services to improve their short and long-term operational efficiency and effectiveness in meeting their mission objectives, and will work with the CSA to maximize the degree to which these needs can be met from cost-competitive domestic sources;
- the unique appeal of space will serve to improve scientific literacy among students and educators, to encourage youth to undertake careers in science and technology; and to promote the diffusion of space knowledge to enhance the interest and awareness of the general public for science and technology.

CONCLUSION

Several factors have come together to reshape space activities : a new world order, a nascent global economy characterized by the importance of innovation and technology, environmental protection, and a constrained fiscal framework.

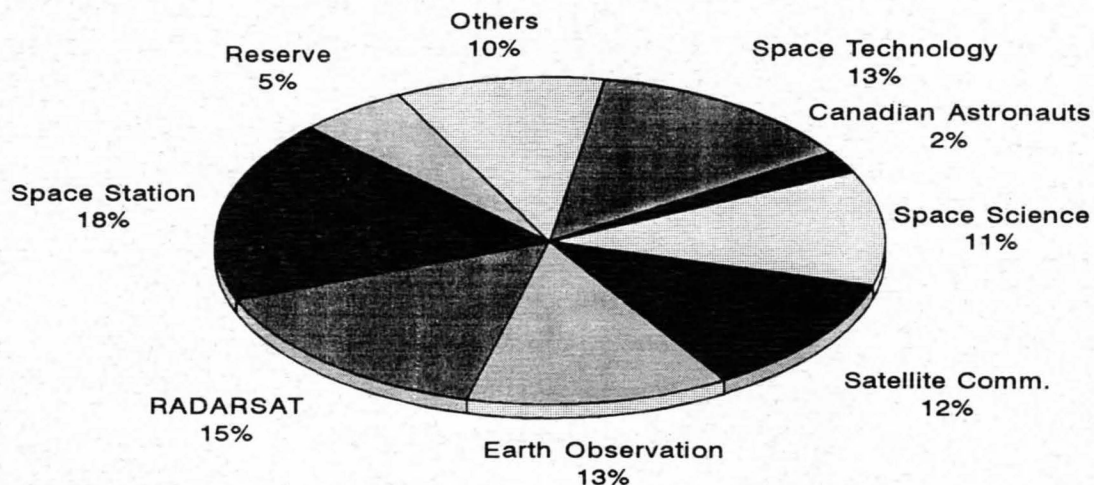
These factors require that governments all over the world re-examine their strategies for industrial, economic, and social development. This has led Canada to review its funding priorities and select initiatives to facilitating the

shift toward the new prevailing world conditions. The new Space Plan reflects the Government's priorities for the benefit of Canadians and ensures the sustainable development of the Canadian space industry and scientific community into the next century.

The following pie chart summarizes the allocation of the \$2.7B to be spent on space by the Government over the 1994-95 to 2003-04 period.

CANADIAN SPACE PROGRAM

\$2.7 Billion
1994/95 to 2003/04



Space Station	\$496M
RADARSAT	\$421M
Earth Observation	\$350M
Satellite Comm.	\$330M

Space Technology	\$364M
Space Science	\$311M
Canadian Astronauts	\$61M
Others	\$278M
Reserve	\$146M