
CSA ASC
NATIONAL PAPER
The Canadian Space Program
Canada
Prepared by
the Canadian Space Agency
July 19, 1999
Canadian Space Agency
Agence spatiale canadienne
Canada

NATIONAL PAPER

The Canadian Space Program

Prepared
by
the Canadian Space Agency
July 19, 1999

"Humanity has always been confronted by frontiers. In early historical times the desert and the sea were the barriers to further expansion. But the domestication of the camel and the construction of seaworthy ships enabled us to cross those obstacles and both the desert and the sea became a means of livelihood and a way of communication, opening up rich lands beyond. The frontier today is the even greater vastness of outer space…The technological advances which are the outcome of space spill over into the more normal activities of the Western world and have put new power into the hands of citizens at all levels of society."

John H. Chapman, 1967

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Canada has a proud history in space. In 1962, Canada became the third country in space with the launch of Alouette-1. In 1972, Canada became the first nation to have a domestic, commercial, geostationary telecommunications system and, in 1976, the first to use direct broadcast satellite television. Having developed the Space Shuttle's Canadarm during the 1980s and the International Space Station's Mobile Servicing System during the 1990s, Canada has become the world's leader in space robotics. With the 1995 launch of RADARSAT-1, Canada developed the world's most advanced commercial radar remote sensing satellite system. Moreover, Canada is home of an experienced astronaut corps which undertakes world-class space science research and space technology development.

Canada has pursued a bold and balanced vision of space. The dual objectives of the Canadian Space Program are (i) to develop and apply space science and technology to meet Canadian needs, maximizing the practical benefits Canadians derive from space-based products and services, and (ii) to foster the development of an internationally-competitive space industry and thereby contribute to Canadian prosperity.

The Canadian Space Program pursues these objectives by:

- Strategically targeting Canadian space investments towards niche sectors and capabilities in areas such as space robotics and automation, radar remote sensing, and advanced satellite communications, which maximize industrial return and the public good and in which Canada can maintain global leadership;

- Working through innovative partnerships with the private sector as part of an industrial commercialization strategy that balances the roles of the public and private sectors;

- Structuring Canadian programs around co-operative international partnerships that create synergies between Canada's space investments and those of other countries;

- Fostering excellence and creativity within our scientific community to advance knowledge for the benefit of all Canadians; and

- Promoting scientific literacy among Canada's youth and supporting a science and technology culture in Canada through a national communications and space awareness program.

Canada's future in space will be equally distinguished. Building on the achievements of the past, the Canadian Space Program has recently been organized around five program areas: Earth and Environment, Space Science, Human Presence in Space, Satellite Communications, and Generic/Enabling Space Technologies. The new space program will expand Canadian capabilities in niche areas of remote sensing (through follow-on RADARSATs and applications development), space robotics (e.g. through planetary robotics missions), satellite communications (through advanced communication technologies), and space science (through a number of ground-breaking programs). The new plan will extend further Canada's space partnerships between government and industry and between Canada and its international space partners. And it will lay the groundwork for bold and promising advances in space science and technology while broadening the use of space applications for the benefit of Canadians and the broader human family.

CANADA'S SPACE OBJECTIVES

The values underlying Canada's vision of space are straightforward. In terms of the utility it provides to address society's needs for space-related products and services and the opportunities it presents for generating economic benefits, space is a theatre for serving the public good. The dual objectives of the Canadian Space Program are "to develop and apply space science and technology to meet Canadian needs and to foster an internationally-competitive space industry."

The objective of developing and applying space science and technology to meet Canadian needs was the original impetus behind Canada's space efforts. Consequently, two areas traditionally targeted for investment have been satellite communications and satellite remote sensing, both corresponding to the country's enormous size and traditionally resource-based economy. Likewise, Canada's investment in space robotics and the International Space Station has been motivated in large part by the promise of spin-offs in related terrestrial niches and what the use of the ISS will mean as laboratory for Canadian microgravity researchers attempting to solve practical problems.

The objective of fostering an internationally competitive space industry is based on the recognition of the enormous economic potential of space and the role the country's space program can play and is playing in nurturing the Canadian knowledge economy. In this, the Government of Canada recognizes that space serves the broader public good indirectly as well as directly and that Canadians benefit economically and socially from space-related research and economic activities in Canada. Hence, the Canadian Space Program emphasizes those activities deemed to have the greatest economic and industrial potential and ensures that Canada's investments in space are made in consultation and partnership with Canadian industry and other stakeholders.

The emphasis Canada places on the utility of what it does in space precludes neither the importance of conducting leading edge space research nor the adventure of space. From the beginnings of its space program Canada has reserved some of its space investments for scientific research with no immediate promise of generating applications, spin-offs or industrial return. The Canadian Space Agency and its partners in government, academia, and industry recognize that our ability to generate future benefits from space depends on our making continued investments at the cutting edges of space science research, edges where the principal objective is to advance the frontiers of human knowledge and experience. For it is at the frontiers where the adventure of space is greatest.

CANADA'S HISTORY IN SPACE

Canadian space pioneers began the Canadian space adventure shortly after the historic launch of Sputnik in 1957. They began to dream about launching a Canadian satellite to better understand natural phenomena occurring in the upper atmosphere. They began to pursue innovative ideas about linking Canadians from coast to coast via space. They began to envision a country observed from orbit, allowing us to better explore and manage our coastline, forests and crops. And they began to foresee a day when Canadian men and women would fly among the stars.

For over 35 years, Canada has pursued a national vision of space that has brought many of these dreams to reality. It is this vision that has developed Canadian leadership in niche areas such as robotics and automation, environmental monitoring from space, atmospheric studies, and advanced satellite communications. It is a vision that addresses fundamental needs of a modern Canadian society in constant evolution.

Through partnerships with the Canadian Space Agency, our industry, universities and government labs have become important players on the world stage. Our space sector has become the most export-oriented space industry in the world. Our astronauts have become a source of pride for the entire nation. And our employees work to bring the benefits of space to more and more Canadian institutions, homes and classrooms, inspiring the ideas and aspirations of the next generation of Canadians-our future pioneers in space.

From Science to Space Flight

Observers of the sky have long known about Canada's unique geographical position for studying the atmosphere. Scientists wanted to understand auroras, natural phenomena that sparked explanations from folklore to the scientific, and how it impacted radio communications. In fact, this knowledge was crucial to any attempts to assert Canadian sovereignty over the Arctic.

As early as 1839, a magnetic observatory was established at the University of Toronto to advance studies of Earth's upper atmosphere. By the 1930s, Canada had gained recognition as a leader in this field by means of measurements made by ground stations in the Arctic and launches of high-altitude balloons.

The launch of the Russian Sputnik 1 in 1957 thrust the world into the space era. With the Americans and Soviets competing for leadership in space, Canadian scientists and engineers envisioned space differently, as a peaceful route to solving problems on Earth while meeting Canadian needs. A young scientist by the name of John H. Chapman boldly proposed a Canadian satellite, a "topside sounder" that would explore the ionosphere from space. This space science would contribute to solving the mysteries of the Northern Lights and the radio disturbances associated with these auroral outbursts.

Canada's first satellite, Alouette-I, became a model of Canadian ingenuity, advancing space technology as a tool in support of scientific discovery. Launched in 1962, Alouette-I made Canada the third nation into space. Designed to last for a year, Alouette-I went on to function perfectly for ten. It was followed three years later by Alouette-II. International Satellites would undertake more studies of the ionosphere for Ionospheric Studies (ISIS-I), launched in 1969, and ISIS-II in 1972.

Space science had only begun. The Canadian designed and built Wind Imaging Interferometer experiment would set international standards in the field of upper atmospheric R&D. Canadian space astronomers would place in orbit the world's largest radio telescope for use in the study of distant galaxies. Our scientists would embark on advanced studies on the depletion of the ozone. And new images from space instruments would give us new insight into unpredictable space weather.

As successful protein crystalization experiments made their way back to Earth from Mir, the Russian Space Station, Canada was off to Mars as part of a Japanese satellite mission to sample the atmosphere. Further, American Astronaut John Glenn was back to the future in 1998 on a mission carrying three Canadian experiments that offered new insight into health care and medical issues such as osteoporosis and bone marrow transplants.

Connecting Canadians

As space science advanced, so did our ability to communicate. John Chapman, head of the Alouette project and now considered "Father of the Canadian Space Program", was asked to draw up a blueprint for Canada's future in space. The 1967 Chapman Report proposed the creation of a national space agency. Chapman also went on to declare that a domestic satellite communications system would be of vital importance for the growth, prosperity and unity of Canada and should be established as a matter of national priority.

The result was Canada becoming the first nation to have its own domestic communications satellite in geostationary orbit-forming the first national television service via satellite. The Anik satellite system, beginning with Anik A1 in 1972, brought quality telephone service to northern communities and television programs to every point in the country. In 1976, the most powerful communications satellite of its time, the CTS-Hermes experimental technology satellite, introduced the world for the first time ever to direct-to-home broadcasting.

Many more Anik satellites would follow, including MSAT in 1996, Canada's first Mobile Communications Satellite system. Today, our industry is bringing the world tele-health and tele-education, virtual reality entertainment, wireless Internet, and mobile communications services. Canada, through space, is connecting Canadians to each other and to the world.

Enabling Space Technologies

Our space pioneers also recognized that if space were the new route to finding solutions to problems on Earth, then advanced research and development of enabling space technologies would be critical to generating knowledge and prosperity. Equally important was exhaustive testing, ensuring that the technology would work flawlessly once launched beyond our reach.

To perform such work, a spacecraft assembly, integration and testing centre was officially opened in 1972. Named the David Florida Laboratory (DFL), in honour of one of Canada's foremost pioneers in space research, DFL has become a world-class facility in support of major space projects involving telecommunications, Earth observation, and robotics technologies.

Through the 1970s, with the media focussed on the American and Soviet race into space, Canada's vision to develop strategic niches in space science and technology continued to mature. Robotics was one such area. In 1973, Canada began pursuing the development of a robotic arm designed for complex on-orbit operations such as satellite deployment and retrieval. Under the direction of the National Research Council, and the expertise of Spar Aerospace, the construction of a 15-metre Remote Manipulator System for NASA's space shuttle was initiated. Eight years later, on November 12, 1981, Columbia would launch the most widely recognized space robot-the Canadarm.

The Canadarm, having celebrated its 50th successful flight in 1998, proved itself time and again as a reliable, useful and versatile instrument for performing complex space operations. It resulted in technological innovations and economic spin-offs in fields of agriculture, nuclear waste management and human-machine interfacing. Moreover, for Canada's future in space, it was the impetus behind an invitation from NASA for a greater participation by Canada in the space shuttle program.

Every effort was made to support the evolution and commercialization of technological thrusts which included communications satellite technologies, robotics, remote sensing payloads and applications, and smart structures in the realm of spacecraft engineering. Canada pursued new opportunities in promising markets for Canadian industry, as in the case of Canada's long-standing collaborative agreement with the European Space Agency, first signed in 1978.

Canadian Presence in Space

By the early 1980s, with Alouette, Hermes, Anik and the Canadarm, Canada was well into space. As a result of our close relationship with NASA, and the notable success of the Canadarm, realizing the dream of sending a Canadian into space was only a matter of time.

An extensive selection process resulted in Canada's initial team of six - Roberta Bondar, Marc Garneau, Steve MacLean, Ken Money, Robert Thirsk, and Bjarni Tryggvason. The lucky one would be Marc Garneau who in 1984 became the first Canadian to fly in space. Roberta Bondar and Steve MacLean led off the 1990s with flights in 1992, respectively conducting neurological and space vision system experiments.

In 1992, Chris Hadfield, Julie Payette and Dave Williams joined the astronaut corps, following a rigourous recruiting campaign that brought in over 5000 applications. In 1995, on STS-74, new recruit Chris Hadfield would become the first Canadian to operate the Canadarm and the only Canadian to board Space Station Mir. In 1996, Marc Garneau returned to space on STS-77 to perform experiments in material processing and biology. Close on his heels was Robert Thirsk who on STS-78, one month after Garneau's flight, conducted a series of 43 life and microgravity experiments aboard Spacelab, helping scientists find cures for such ailments as motion sickness and morning sickness during pregnancy.

In 1997, Bjarni Tryggvason was a crew member of STS-85, performing experiments on MIM, a cutting-edge technology that isolates unwanted vibrations in the microgravity environment. Barely a year later, in April 1998, Dave Williams participated on the Neurolab flight of STS-90. Soon after, he became the Director of the Space and Life Sciences Directorate at NASA's Johnson Space Center in Houston, the first non-American to hold this post.

Later in 1998, flights for Julie Payette (STS-96) and Marc Garneau (STS-97) were announced for assembly missions of the International Space Station. Julie Payette's mission in May and June of 1999 made her the first Canadian to board the Station. And at the turn of the century, Chris Hadfield will mark a new milestone in this country's history in space by performing Canada's first space walk to assemble the Mobile Servicing System, Canada's advanced robotics system for the Space Station.

Earth & the Environment

As calls for reliable management of our environment grew louder, Canada's scientific community quickly recognized the advantages of using satellites to survey natural resources, conduct weather surveillance, monitor forest fires and guide our ships through ice-plagued Northern passageways. Through the Canada Centre for Remote Sensing (CCRS), Canadians developed strategic competencies in receiving and analyzing images from satellites, beginning with the U.S. Landsat satellite in 1972.

Our industrial expertise in Earth observation would surge via Canada's collaborative agreement with the European Space Agency, in particular our involvement in their Earth observation satellites ERS-1 and -2. It would culminate in the construction of Canada's first EO satellite system, RADARSAT-1. Launched in 1995, RADARSAT-1 was designed to provide images of the Earth's surface any time of the day or night and in any climate condition, to clients around the world.

By 1998, the satellite system had imaged the entire planet, responded to over 50,000 requests from clients in more than 40 countries, and reduced its data delivery time to as little as one-hour, as in the case of ice conditions. For the first time in history RADARSAT-1 provided a complete high resolution mapping of Antarctica that is now helping scientists better understand and protect this environmental-sensitive region which houses 70% of the world's fresh water.

Undoubtedly, RADARSAT-1 has strengthened Canada's lead in Earth observation. A world-wide network of ground stations now enables real-time downloading of data to clients seeking solutions to exploration, navigation, agriculture, and disaster management operations such as floods and oil spills. It is allowing Canada to fulfill its international commitments to managing and protecting our precious environment. Scheduled for launch in 2002, a follow-on satellite - RADARSAT-2 - will ensure that Canada's Earth observation success story continues.

A Permanent Presence in Space

A national vision to further secure Canada's place in space was enriched with Canada's decision in 1988, a year prior to the creation of the Canadian Space Agency, to join the leading space-faring nations in the realization of the largest scientific project in history - the International Space Station. For Canada, the Space Station project was, and remains, a window of unprecedented opportunity.

Building on our expertise in space robotics, Canada is contributing the Station's robot, the Mobile Servicing System (MSS) which is designed to assemble and maintain the Station throughout its anticipated ten-year life in orbit. From CSA headquarters, Canada will also be providing extensive ground support including astronaut training and day-to-day operations of the MSS.

For the scientific community, Canada's main partnership role affords us access to the world's largest microgravity laboratory. For all Canadians, the Station spawns a new era of discovery in areas of biotechnology, genetic engineering, Earth observation, telecommunications, and space exploration. It is the next logical step in our space adventure.

A New Space Agency

John Chapman's call for a national space agency was realized in 1989. Mandated to promote the peaceful use and development of space - an undertaking that this nation had performed for many decades - the Canadian Space Agency soon developed into the centre of excellence for the Canadian Space Program.

In 1999, ten years into its mandate, the Canadian Space Agency builds on a past brimming with achievements. It enriches a vision that uses space to overcome the challenges of living in a vast landscape, precious environment, harsh climate and demanding global community. It applies space to seek solutions, equip Canadians and enlighten our youth. It works with and through space to advance our knowledge, generate wealth and strengthen niche technologies.

In just three decades, Canada has taken space from a dream and instilled it into the daily routine of the average Canadian. Developments during the next thirty years will be just as dramatic.

THE NEW GLOBAL ENVIRONMENT FOR CANADA'S SPACE ACTIVITIES

However successful the Canadian Space Program has been in the past, Canadians recognize that its success in the future will depend on our ability to respond to the enormous forces of change in global space activity. In recent years, the global space sector has witnessed the convergence of a number of important geopolitical, economic and technological trends: the ever-increasing globalization of the economy, the growing economic importance of so-called knowledge-based industries, growing concern for the global environment, and the changing role of government, to name a few. Some of the most important trends within the space sector are the following:

· The end of the Cold War has inaugurated a new era of international cooperation and partnership in space, providing new opportunities and creating a new sense of urgency for addressing long-neglected global problems.

· Overall government expenditures on space have diminished in recent years. Part of the observed reduction in world space activity is due to post Cold War reductions in military space procurement in both the United States and Russia, but fiscal constraints in many of the world's civil space programs have also reduced or levelled-off expenditures.

· The global space market is becoming increasingly commercialized and governmental activity in space is being privatized. Although governments remain the primary space markets (both civil and military), the private sector's role in space is growing, particularly in the areas of telecommunications, Earth observation, and launch services. This trend, which originated in the US and can now be witnessed in Europe, in Canada and elsewhere, extends to the definition, financing and implementating of projects on international markets. In satellite communications, for instance, traditional government-supported monopolies are spinning-off new private entities, which must compete with new or existing private sector players. More and more, governments consider purchasing their communications services on the commercial markets, even for some defense purposes.

· The global space market is growing quickly, driven by massive consumer demand for space-related services and applications. Satellite telecommunications revenues, for example, are expected to double by 2005, supported by an expected $40 billion investment during that timeframe. (Source: Space Publications and the International Space Business Council, State of the Space Industry, 1999)

· The global space industry is undergoing a process of massive restructuring and consolidation, to the point where only a handful of global, vertically-integrated space companies now dominate the world space market for complete systems.

· Important new players are entering the global space market and industry. These include companies from the defence and communications sectors that have enormous development capacities and very advanced technology. It also includes countries, such as those of the former Soviet Union, with whom many of the Cold War trade restrictions have been reduced in recent years, and countries such as India, China, and Brazil, which can increasingly offer world-class space-related products and services on the global market place.

· Important new geographic markets for space-based services are developing, of which Asia-Pacific and Latin American markets have been the fastest growing. Several countries in these regions have recently created new space agencies and adopted space programs to address their development needs. In doing so, these countries often attempt to leapfrog over terrestrial-based communications systems towards space-based systems.

· Space sector market forces, the life cycle for space products and the introduction of new services for consumers are accelerating, driven by greater competition, ever-improving and converging technologies and the growing role of capital markets in financing projects.

· Governments and industries world-wide are pursuing a "smaller, faster, cheaper" approach to space projects as a result of increasing cost and competitive pressures, leading to the development of small (and micro) satellites and launchers.

It is to this challenging new environment that the Canadian Space Agency and its partners in government, academia and industry are responding in the development and implementation of the next generation of our space programs.

CANADA'S SPACE POLICIES

The Goals of Canadian Space Policy

In 1994 the Government of Canada adopted the Space Policy Framework to guide the implementation of the Canadian Space Program. The Space Policy Framework flowed from the mandate assigned to the Canadian Space Agency when it was created in 1989, namely:

To promote the peaceful use and development of space, to advance the knowledge of space through science, and to ensure that space science and technology provide social and economic benefits for all Canadians.

The Space Policy Framework identified space as an area "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 Canadian Space Program is an important instrument for achieving the Government's objectives 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.

These policy objectives for Canada's space program evidence the bold and balanced nature of Canada's space vision:

· Maintain and expand Canadian expertise in traditional areas of activity:
  - · Space science
  - · Satellite telecommunications
  - · Earth observation and remote sensing
  - · Space robotics

· Derive maximum social and economic benefit from Canada's activities in space:
  - · Development of new applications
  - · Development of a knowledge-based industry
  - · Foster the growth of Canadian industry
  - · Open participation in the Canadian Space Program to Small and Medium Sized Enterprises (SMEs)
  - · Contribute to Canadian prosperity

· Foster regional development
    · Build on regional strengths and capabilities
    · Share the economic benefits of space in all regions of the country

· Develop and use Canada's space infrastructure:
    · Mobile Servicing System and the International Space Station
    · RADARSAT remote sensing satellites
    · Satellite communications
    · The David Florida Laboratory

· Private sector infrastructure
    · Contribute to the advancement of knowledge and expertise in:
    · Space science
    · Space technology

The Instruments of Canadian Space Policy

Niche Strategy

Perhaps the most impressive distinctive of the Canadian Space Program to international observers is its high degree of specialization. Canada has not only made specific strategic choices about what it will do in space, it has also made choices about what it will not do. The Canadian Space Program, for example, makes no investment in a national launcher program or a domestic satellite navigation system. In these and other areas, Canada relies heavily on partnerships with other countries.

Canada's strategy of focussing on specific niches is the result of practical considerations as well as programmatic vision. As noted above, Canada's space niches have been chosen in accordance with the country's needs and policy objectives. But they have also been chosen according to the country's economic realities. A nation that spends US$250 million annually in public sector space activities and that borders a country that spends more than US$28 billion annually needs to choose its activities carefully. Those responsible for the development Canadian space policy long ago recognized that Canada could not possibly compete against the United States along the full spectrum of space activity. The solution was niche specialization.

Thus, the four main areas of Canadian space activity are space robotics and automation, radar remote sensing, advanced satellite communications, and space science. In these areas Canada excels.

Industrial Commercialization Strategy

The most dramatic change in the space sector in recent years has been the growth of commercial space activities, a development that in Canada has been as much the result of deliberate strategy as natural economic forces. A key legacy of the last quarter century of Canadian space activity is its space commercialization objective, which as articulated by the Space Policy Framework is "to foster an internationally competitive, export-oriented Canadian space equipment and services sector."

The CSA pursues this objective through a variety of strategies and policies:

At a funding level, the Canadian Space Agency, which manages all federal civil space expenditures, out sources some 75-80% of all the monies it receives. Virtually all that the Canadian Space Agency does in space it does through procurement, mostly from industry but also from universities and specialized

research institutes. In this the Agency aims to ensure that key locus of space capability in Canada resides not in government labs or with public servants but in the private sector, which has a greater ability and propensity to commercialize that capability and the Canadian tax payer's investment.

At a policy level, the Canadian Space Agency has established a variety of guidelines for fostering the growth of industry. These include an emphasis on providing contracts to SMEs, a goal of ensuring that Canada's space investments are made in all regions of the country, and, most importantly, wide consultation with industry during the development of Canada's space programs and projects.

At a program level, the Canadian Space Agency supports space commercialization at virtually all stages of the development cycle. Technological development programs support everything from advanced (leap-frog) to near-market technologies-and always in partnership with Canadian industry. In addition, the Agency maintains a Commercialization Office that is mandated to support the commercial exploitation of space capabilities, technologies, facilities, and systems with the aim to maximize the social and economic benefits of the Canadian Space Program. Its main functions are to provide intellectual property management and to support technology transfer.

But the most important element in Canada's space commercialization strategy is the Government's long-term strategy of balancing public and private sector roles in a given sector of space activity in accordance with that sector's level of commercial maturity. The Government's objective is to privatize and commercialize space activities as they become commercially self-sustainable, leaving to industry the task of leading Canada's activities in commercially mature sectors and leaving to Government the responsibility for commercially immature sectors. Thus, in satellite communications, a commercially mature sector, the Government's role is limited to advanced technology and applications development and regulatory activities. In satellite remote sensing, a still maturing sector, the Government's role is greater, as investor, anchor tenant, and partner with the private sector. And in space robotics and infrastructure servicing, a very young sector, the Government's role is much greater, covering all procurement and technology development.

Partnership Strategy

Partnership is the cornerstone of Canadian activity in space. Canada's space partnerships serve the country's political, economic, scientific and technological interests. They symbolize the spirit of cooperation on which the peaceful use of space depends and serve broader Government of Canada foreign policy interests. They expand the commercial opportunities for Canadian industry, creating synergies between Canadian and international industrial partners. And they leverage the government's space expenditures by giving Canadian researchers access to programs and technologies from which they would otherwise be excluded.

Canada's domestic partnerships are extensive, involving some 350 companies, dozens of academic and research institutions, and numerous provincial and federal government departments. Canadian space activities are developed through broad and extensive consultation with the country's space stakeholders. Similarly, given that some 75-80% of Canada's space budget is outsourced, Canadian space activities are implemented through extensive partnership between the Canadian Space Agency, industry, academia, and other government departments.

Canada's international partnerships are also extensive. Virtually all of Canada's space activities entail some kind of international partnership or collaboration. Canada's commitment to being a full partner in the largest and most complex international science and technology project in history, the International Space Station, is evidenced in Canada's contribution to the project, the Mobile Servicing System designed to assemble and maintain the Station in orbit. Similarly, Canada's RADARSAT-1 Program involved close cooperation with NASA, as does the Canadian Astronaut Office. Our Space Technology

development activities are undertaken in extensive collaboration with ESA, with which Canada has for twenty years enjoyed a unique status as the only non-European Cooperating State. And our Space Science activities are pursued in collaboration with countries such as Russia, Japan, the United States, Sweden and other ESA member countries.

International cooperation will be equally important in Canada's future space activities. Canada anticipates developing further and stronger international partnerships in space under the aegis of our new space program, approved in 1999. The plan provides for five broad areas of activity in space: Earth & Environment, Space Sciences, Human Presence in Space, Satellite Communications, and Generic/Enabling Space Technologies. Each program area will involve extensive international cooperation.

Fostering Excellence in Science

Space science has been a cornerstone of the Canadian Space Program from the very beginning. It includes space life sciences, atmospheric sciences, space astronomy, microgravity sciences, and solar-terrestrial physics. Established as the focal point of Canadian space science activities, the Canadian Space Agency's Space Science Program is mandated to advance the knowledge of space through science and to ensure that space science and technology provide socio-economic benefits to Canadians.

The Science Program is responsible for planning, coordinating and implementing Canada's space science activities. It provides opportunities for scientists and engineers to participate in state-of-the-art science and technology projects that are usually international in scope. These projects enable technology transfer and advance our understanding of space for the benefit of humanity. Research activities are selected through announcements of opportunity and policies are developed with the support of advisory committees in these noted disciplinary areas.

The Space Science Program is still primarily based on international cooperation. Canada builds scientific instruments to fly on a variety of space platforms and international satellites. By so doing, Canadian space scientists collaborate in complex experiments that are beyond the resources of an individual space agency or nation.

Nurturing a Science Culture

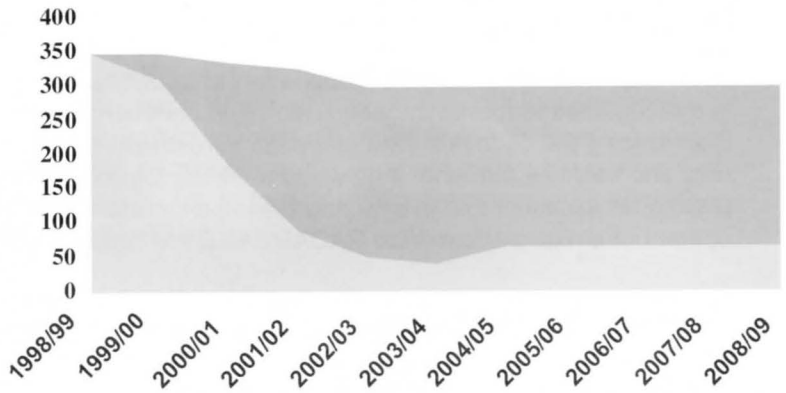
The Space Policy Framework also assigned the Canadian Space Agency the task of implementing a "country-wide communications and space awareness program," creating the Agency's Space Awareness Program. The Program uses the unique appeal of space to improve scientific literacy among students and educators, to encourage youth to undertake careers in science and technology, and to promote the diffusion of space knowledge to enhance the general public's the interest and awareness in science and technology. To this end, the Agency has established a network of five Space Resource Centres that provide students, teachers, and the general public with ready access to a wide range of information about space.

The Agency's Space Awareness Program taps into a Canada-wide network of learning establishments, from resource centres to museums, to provide information on the many aspects of working and studying in the field of space. The Program's grants and contributions assist groups organizing space-related activities and support students pursuing advanced studies in space science and engineering at educational institutions, including the International Space University. The Program also serves those with hearing and visual impairments by involving them in our national space program.

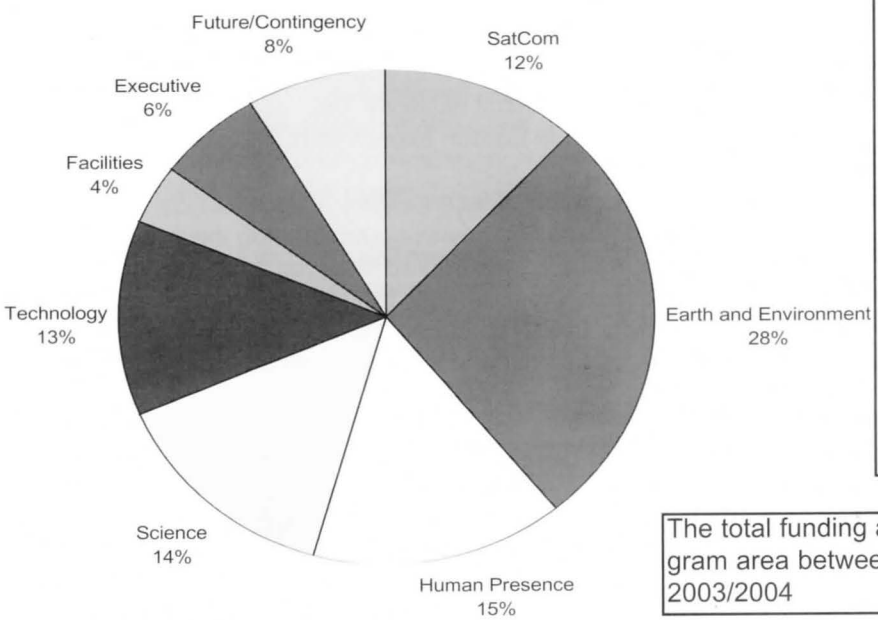
THE NEW CANADIAN SPACE PROGRAM

Canada's new space program was approved in 1999. The new budget provided the Canadian Space Agency with C$430 million of new funds over next three years, stabilized the Agency's budget at $300 million per year, starting in 2002/2003, and provided the Agency with the ability to adjust its programs to the rapidly evolving environment.

Based on a recognition of the need to address the Agency's future funding problems now, the 1999 budget establishes a solid financial base to plan, implement and adapt Canada's space activities. Up until this year the Canadian Space Program was funded on a multi-year basis; the new budgetary framework will allocate the CSA programmatic funding on an annual basis, giving the Agency much greater programmatic flexibility and funding stability.



In addition to receiving new program funding, the Canadian Space Program has been re-structured around five priority areas:



Areas of Strategic Importance to Canada:

- ***Earth & Environment***
- ***Space Sciences***
- ***Human Presence in Space***
- ***Satellite Communications (SatCom)***
- ***Generic/Enabling Space Technologies***

The total funding allocation by program area between 1999/2000 and 2003/2004

Based on extensive and open consultations with Canadian stakeholders and a comprehensive process of identifying opportunities for potential cooperation with international partners, consensus emerged on the following program elements:

Earth Observation

The two major factors influencing the Earth observation business are: (i) a world-wide emphasis on global environmental monitoring and natural resource protection; and (ii) a trend towards the separation of Earth observation satellites into low cost or free low resolution satellites for global environmental monitoring and commercial high resolution satellites for mapping, surveillance and local applications. In addition to participating in the global effort to understand climate change processes and effects, Canada is a recognized leader in the acquisition and commercialization of space-based remote sensing data. By modernizing the country's data reception infrastructure and encouraging industry to develop the products and services demanded by world markets, Canada's Earth Observation (EO) Support Programs are playing an essential role in ensuring Canadian leadership in international markets. Moreover, the development of a high performance RADARSAT-2 will further enhance Canada's competitive position in EO.

The objective of Canada's new Earth and Environment programs is to enhance Canada's ability to understand, monitor, predict and protect the Earth and its environment and to ensure that Canadian industry maintains leadership in the emerging global Earth observation market. The program elements include the following:

· The Space Environment Program includes the development of technologies for *in-situ* studies of space plasma and the Earth's electromagnetic field, contributing to the understanding and development of advanced modelling for space weather phenomena. Activities to be supported include participation in international missions; CANOPUS (ground-base network); and a data assimilation facility.

· The Atmospheric Environment Program includes the development of space-borne payloads to study the dynamic of the atmosphere, the ozone layer, green house gases and other climate change phenomena. Activities to be supported include participation in international missions; data assimilation and integration studies; and Canadian micro-satellite and high altitude balloon experiments.

· The Surface Environment Program includes the development of technologies aimed at studying the cryosphere; monitoring the sustainable development of Canadian forest; understanding the interaction between land-based ecosystems and climate change; mapping near-shore changes and studying the evolution of coastal zones and their ecosystems; and monitoring offshore marine environment and its interaction with global climate at northern latitudes. Activities to be supported include participation in international missions; development of value-added applications; and a Canada-led international project (through CEOS) for global observation of forestland.

· The Advanced Imager Component Program includes the development of next generation space-based technologies for natural resources management and environmental monitoring. Activities to be supported include the development of advanced Synthetic Aperture Radar (SAR) payload technology for RADARSAT missions and participation in international electro-optical and hyperspectral missions.

· The Ground Infrastructure and Resources Monitoring Applications Program includes the development of technologies and applications aimed at enhancing ground based systems to receive, process, distribute and use satellite remote sensing data. Activities to be supported, most of which are related to the RADARSAT system, include: research, development and industrial demonstration of land, coastal and aquatic applications using SAR, hyperspectral, *in-situ* and other data; and on-line access and long-term data archiving systems.

· The Disaster Management and Surveillance Program includes the development and demonstration of technologies and applications to plan, predict, mitigate and assess disasters, as well as technologies for near real-time surveillance. Activities to be supported include interactive processing for ice mapping, ocean monitoring and vessel traffic management; integration of Earth observation, communications and navigation technologies; development of disaster information services, focussing primarily on hydrological related disasters; and the use ofinternational mission data such as the ESA ENVISAT.

Space Science

The human quest for knowledge about space, the growing interest in planetary exploration and the new era soon to be opened by the International Space Station will provide new opportunities to the Canadian scientific community in the years to come. Canada's Space Science Program ensures that Canada maintains a position of excellence in the world-wide exploration and utilization of space. Based on cooperation with both Canadian and international scientific communities, the Program allows our universities to contribute to the global knowledge base and, in particular, to federal objectives related to global climate change and health through the life sciences activities.

Space sciences are key to keeping Canada moving forward in the knowledge-based economy. In addition to participating in the global effort to understand the universe and our solar system, the objective of Space Science programs is to enable the Canadian science community to use the unique environment of space to advance knowledge in material as well as life sciences. It will also maintain the Canadian industry's expertise in the development of leading-edge space science instruments. The program elements include the following:

· The Space Astronomy program will enable our scientific community and industry to participate and contribute to international efforts aimed at understanding the past and present state of the universe and predicting its evolution. Activities to be supported include participation in international missions and the development of small payload instruments.

· The Space Exploration program will enable our scientific community and industry to participate in and contribute to the international effort aimed at understanding our solar system in relation to the origin of life and evolution of our environment. Activities to be supported include Canada's participation in international missions to other planets.

· The Life Science program will enable our scientific community and industry to use the International Space Station to generate advanced knowledge related to the cardiovascular system, bone research, neurology, early development and radiation effects on living organisms. Activities to be supported include gravitational biology projects and osteoporosis research.

· The Microgravity Science program will enable our scientific community and industry to use the International Space Station to generate advanced knowledge related to proteins and biotechnologies, fluid and combustion sciences, advanced material sciences as well as fundamental physics and chemistry. Activities to be supported include the development and, in some cases, the commercialization of instruments and facilities to be used in space for carrying out microgravity experiments.

Human Presence in Space

The signing of the Intergovernmental Agreement to incorporate Russia as a partner in the International Space Station confirmed the commitment of the world's space faring nations to this program, providing more opportunities for Canada's astronauts to continue their important scientific work. Moreover, the increasing use space agencies are making of space robotic technologies augurs well for Canadian

expertise in the coming years. Besides which, space robotics and Canadian astronauts are among the most recognized symbols of Canada's excellence in science and technology.

The objective of Human Presence in Space programs is to maintain Canada's leadership in space robotics, its meaningful and visible role in the International Space Station, and the active involvement of Canadian astronauts in human space flight missions. These programs will ensure our visible presence in space and position Canada to participate in future, long term human space flights to other planets. Canadian astronauts will continue to inspire Canada's youth to reach for excellence and pursue careers in science and technology. The program elements include the following:

· The International Space Station Program includes the cost-effective development, maintenance and operation of the Mobile Servicing System (MSS), maintaining Canada as a full partner in the International Space Station. Activities to be supported include: MSS mission operations and astronaut training facilities in St-Hubert, Quebec; managing the Canadian share of Space Station utilization; and Canada's ISS commercialization program.

· The Canadian Astronaut Office includes maintaining a group of competent and well regarded astronauts who regularly participate in human space flight missions, and promote scientific literacy and careers in science and technology among our youth. Activities to be supported include astronaut training, their active participation in various space flight missions, an operational space medicine program, and astronauts' involvement in the Canadian Space Agency's activities aimed at fostering education and space awareness.

Satellite Communications

The space-based communications industry is growing at an unprecedented pace and shows no sign of abating. Communication systems are now global in nature and the competition between very large industry consortiums is fierce. Satellite communications are an essential tool for Canada in meeting its objective of becoming the most connected nation in the world and are expected to expand considerably to meet the growing demand for advanced multi-media and mobile personal services.

The objective of Satellite Communications programs is to maintain or increase Canadian industry's share of the rapidly growing world wide market for satellite communications and ensure that Canadians have access to the world's most advanced satellite communication technologies. The program elements include the following:

· The Flight Demonstration Program includes the development and demonstration of next generation multimedia payloads, satellite access technologies and networks. Activities to be supported include the flight demonstration on domestic or international satellite platforms of developed technologies such as analogue and digital on-board processing, multibeam antennas, and high data rate inter-satellite links. As well, technologies will be developed for advanced user terminals and networks which form part of next-generation multimedia satellite communications systems.

· The Applications Development Program includes the development and demonstration of advanced applications in which satellite networks have unique advantages. Applications to be demonstrated include multimedia tele-education, tele-medicine in remote communities and mobile satellite marine information networks. Also planned is the development of technologies designed to lower user access costs for satellite-based services.

Generic Space Technologies

The trend towards smaller, shorter and less expensive space missions among the world's space faring nations is based on rapid and far reaching development of new space technologies offering promising opportunities for industrial growth. Canada needs to develop new technologies that cut across many activities and investigate innovative technologies for potential use in future missions. Space Technology Programs help industry develop strategic technologies in specific niches, establish links with foreign firms and improve access to international markets, and facilitate the transfer of space technologies towards non-space applications.

The objective of Generic/Enabling Space Technologies programs is to develop, flight demonstrate and ensure the commercialization of next generation technologies of strategic importance for the Canadian Space Program. The program elements include the following:

· The Leapfrog Technology Program includes the development of technologies of next generation spacecraft sub-systems aimed at enhancing the international competitiveness of our industry and at preparing Canada for future space missions. Activities to be supported include projects in areas such as micro-miniaturization of instruments, high temperature superconductivity, space servicing systems, smart structures, and attitude control sensors and actuators.

· The Flight Demonstration program includes the development of international cooperation ventures to flight demonstrate the capability and reliability of new Canadian space technologies. Activities to be supported include the joint development of a small or micro-satellite platform with a foreign partner.

· The Technology Commercialization program includes activities aimed at the protection, diffusion and commercialization in Canada of intellectual property generated by government investments.

THE FUTURE OF SPACE

Canadian sociologist Marshall McLuhan's prediction of a global village has become a reality. We have entered a new era, an era in which accessing information has become nearly effortless, in which our lives are increasingly influenced by global ideas and values, and in which information and the services related to it will drive an economy many times more important than the industrial production of the world's nations.

But we have also entered an era in which we recognize that humankind is exhausting our planet's capacity to sustain our ever-growing population and may be spending the well-being of future generations for the sake of current consumption. We are waking to the environmental challenge, gaining a new appreciation of the fragility of life on Earth. Gradually, we are changing our behaviour. Out of a globally shared sense of responsibility is emerging a sustained effort to limit waste and pollution, protect our flora and fauna, and undo the harm done to our home.

It is space, and more precisely our strategic and effective use of space, which will allow us to bridge the information age with our newly-acquired appreciation of the fragility of the Earth.

Yet much remains to be done. Satellite communications systems, the catalysts of the new global society, have far to go before reaching their full potential, when instantaneous, practical and affordable communications will be possible from any point of the globe to any other point, anytime of day. Much also remains to be done in satellite remote sensing. The unique vantage point that space provides will enable instantaneous monitoring of changes on Earth and provide us with a much better understanding

of our planet's fragile environment and limited resources. Likewise, we have only just begun our journey of discovery in space science, a journey that promises enormous challenges and rewards. And in space exploration we are on the threshold of establishing permanent habitation in space, expanding profoundly the frontiers of human experience.

These endeavours are linked: we will only understand the viability of continued, sustainable life on Earth for all nations and peoples when we have learned more about our planet, our solar system, and our universe. This is humanity's collective challenge for space in the 21st Century.

WEB SITES

Government of Canada: http://www.canada.gc.ca/

Canadian Space Agency (CSA): http://www.space.gc.ca

Canada Centre for Remote Sensing (CCRS): http://www.ccrs.nrcan.gc.ca/

Communications Research Centre (CRC): http://www.crc.doc.ca/

For any additional information, please contact:
Canadian Space Agency
6767 route de l'Aeroport
Saint-Hubert, Quebec
J3Y 8Y9
Tel: (450) 926-4800
Fax: (450) 926-4352

This document is also available on the CSA Web Site at www.space.gc.ca

Aussi disponible en français