ESTIMATES

Canadian Space Agency

Performance Report

For the period ending
March 31, 2002

Canada

The Estimates Documents

Each year, the government prepares Estimates in support of its request to Parliament for authority to spend public monies. This request is formalized through the tabling of appropriation bills in Parliament.

The Estimates of the Government of Canada are structured in several parts. Beginning with an overview of total government spending in Part I, the documents become increasingly more specific. Part II outlines spending according to departments, agencies and programs and contains the proposed wording of the conditions governing spending which Parliament will be asked to approve.

The *Report on Plans and Priorities* provides additional detail on each department and its programs primarily in terms of more strategically oriented planning and results information with a focus on outcomes.

The *Departmental Performance Report* provides a focus on results-based accountability by reporting on accomplishments achieved against the performance expectations and results commitments as set out in the spring *Report on Plans and Priorities*.

The Estimates, along with the Minister of Finance's Budget, reflect the government's annual budget planning and resource allocation priorities. In combination with the subsequent reporting of financial results in the Public Accounts and of accomplishments achieved in Departmental Performance Reports, this material helps Parliament hold the government to account for the allocation and management of funds.

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Foreword

In the spring of 2000, the President of the Treasury Board tabled in Parliament the document "Results for Canadians: A Management Framework for the Government of Canada". This document sets a clear agenda for improving and modernising management practices in federal departments and agencies.

Four key management commitments form the basis for this vision of how the Government will deliver their services and benefits to Canadians in the new millennium. In this vision, departments and agencies recognise that they exist to serve Canadians and that a "citizen focus" shapes all activities, programs and services. This vision commits the Government of Canada to manage its business by the highest public service values. Responsible spending means spending wisely on the things that matter to Canadians. And finally, this vision sets a clear focus on results – the impact and effects of programs.

Departmental performance reports play a key role in the cycle of planning, monitoring, evaluating, and reporting of results through ministers to Parliament and citizens. Departments and agencies are encouraged to prepare their reports following certain principles. Based on these principles, an effective report provides a coherent and balanced picture of performance that is brief and to the point. It focuses on outcomes - benefits to Canadians and Canadian society - and describes the contribution the organisation has made toward those outcomes. It sets the department's performance in context and discusses risks and challenges faced by the organisation in delivering its commitments. The report also associates performance with earlier commitments as well as achievements realised in partnership with other governmental and non-governmental organisations. Supporting the need for responsible spending, it links resources to results. Finally, the report is credible because it substantiates the performance information with appropriate methodologies and relevant data.

In performance reports, departments and agencies strive to respond to the ongoing and evolving information needs of parliamentarians and Canadians. The input of parliamentarians and other readers can do much to improve these reports over time. The reader is encouraged to assess the performance of the organisation according to the principles outlined above, and provide comments to the department or agency that will help it in the next cycle of planning and reporting.

This report is accessible electronically from the Treasury Board of Canada Secretariat Internet site:
http://www.tbs-sct.gc.ca/rma/dpr/dpre.asp

Comments or questions can be directed to:

Results-based Management Directorate
Treasury Board of Canada Secretariat
L'Esplanade Laurier
Ottawa, Ontario K1A OR5

OR to this Internet address: rma-mrr@tbs-sct.gc.ca

CANADIAN SPACE AGENCY

Performance Report
For the period ending
March 31, 2002

Allan Rock
Minister of Industry

Table of Contents

EXECUTIVE SUMMARY

The Canadian Space Agency (CSA) Performance Report presents the Agency's accomplishments in 2001-2002. In the spirit of the *Results for Canadians: A Management Framework for the Government of Canada*, the CSA is working to upgrade the way it collects and uses performance information for the purpose of improving programs and ensuring accountability to Canadians.

This year's report is divided into five sections: Minister's Portfolio Message, Overview of the CSA, Strategic Context, Performance and Annexes with financial tables. All sections provide useful contextual and complementary information, but this summary focuses on the CSA's contributions to the following seven Strategic Outcomes:

Economic Benefits
Economic benefits were achieved through the on-orbit commissioning of Canadarm2 (MSS), the continued operations of the RADARSAT-1 satellite, the development of an industry-run RADARSAT-2, the contributions of Canadian companies in developing key onboard instruments for the European Space Agency's (ESA) ENVISAT satellite, and the development of a Payload Flight Demonstration Program, which will help establish new satellite-based multi-media services. Canadian industry played an important role in the design and manufacturing of all elements for these initiatives.

Understanding the Environment and Contributions to Sustainable Development
The priority for this strategic outcome was to complete the development of SCISAT-1, the first Canadian industry-built satellite since Alouette in 1962. The instruments onboard the satellite will measure the chemical processes controlling the distribution of ozone in the upper atmosphere. RADARSAT-1 continued to be a unique data source for ice monitoring, marine oil surveillance, and natural disaster management, helping to manage eight major natural disasters around the World and supporting Hurricane Watch in 2001.

Technological Development and Diffusion
The priority of the Agency for this strategic outcome consisted of the development and demonstration of space technologies to enhance industry competitiveness and prepare for future space missions. Over the 2001-2002 period, industry contracts were awarded to develop new concepts and adapt emerging technologies for space. The resulting technological advances will reduce the cost of future missions and enable new missions in areas of interest to the CSA, as well as keep Canada's industry competitive.

Contributions to the Quality of Life
Space science and technologies contribute to a better quality of life by advancing knowledge on human adaptation to a weightless environment, which leads to improved medical procedures. The CSA's priority for this strategic outcome was to encourage the Canadian scientific community to utilize the International Space Station (ISS) research facilities for this purpose. The data from Canada's first experiments on the ISS (H-Reflex – study on muscles, EVARM – effects of radiation, and OSTEO-2 – study on

osteoporosis) has sparked interest among members of the research community and has lead to groundwork for future experiments.

World-Class Space Research
Canada has achieved an internationally recognized excellence in a number of areas, notably space robotics, solar-terrestrial relations sciences, space astronomy and space qualification services. International co-operation is a key element to maintain this level of research. This year, feasibility studies were conducted to determine possible major scientific instruments for Canada's participation in the Next Generation Space Telescope mission led by NASA, and in ESA's Herschel/Plank telescope mission. The integration and testing of MOST, a micro-satellite that could provide a better estimate for the age of the universe, is also well underway. The David Florida Laboratory has continued to provide world-class environmental space-qualification services for the assembly, integration and testing of spacecrafts.

Social and Educational Benefits
The CSA continues to take advantage of the unique appeal of space to encourage youth to undertake careers in Science and Technology with its Youth Awareness Program. The Agency is also committed to training qualified personnel for the high technology sectors by participating in different programs and initiatives with industry and universities.

Promotion of the Canadian Space Program (CSP)
Increasing the profile of Canadian space activities successfully accounted for a more effective promotion of the CSP. In April 2001, Chris Hadfield became the first Canadian Astronaut to perform a space walk during a mission and successfully installed Canadarm2. Ambitious communications strategies built around this mission helped the CSA to reach out to the Canadian public. During 2001-2002, the Web site visitor sessions increased significantly, and a National Public Opinion Poll indicated that Canadians felt proud about our achievements in space and believed it was important to have an active national space program.

Many Government departments are still learning about the potential advantages of adopting the use of satellite data in the delivery of essential public services, and others, which have fully integrated space-derived data into conventional operations, have limited funding to permit them to plan, develop, demonstrate and operate follow-on technologies. This is why the CSA initiated consultations in 2002 with some 25 Federal Government organizations to identify how space technologies could be used to enhance the delivery of their mandates and provide new or more efficient services to Canadians. Also, the first CSA Advisory Council meeting was held in Fall 2001. These consultations aim at ensuring that the Canadian Space Program is responsive to Government priorities and to the needs of Canadians.

SECTION: 1 Message

1.1 Minister's Portfolio Message

The dawn of the twenty-first century has seen the development of the global knowledge economy. The Government of Canada has been working for the past decade to create winning conditions for Canadians to ensure that we are ideally positioned - with both the tools and the skills necessary - to seize the opportunities offered in the new economy.

The Industry Portfolio is:

- Atlantic Canada Opportunities Agency
- Business Development Bank of Canada*
- Canada Economic Development for Quebec Regions
- Canadian Space Agency
- Canadian Tourism Commission*
- Competition Tribunal
- Copyright Board Canada
- Enterprise Cape Breton Corporation*
- Industry Canada
- National Research Council Canada
- Natural Sciences and Engineering Research Council of Canada
- Social Sciences and Humanities Research Council of Canada
- Standards Council of Canada*
- Statistics Canada
- Western Economic Diversification Canada

* *Not required to submit Departmental Performance Report*

It started with eliminating the deficit and with good fiscal management, followed closely by significant corporate and personal tax cuts and streamlining government. Over the last decade, we also built an impressive research and development (R&D) infrastructure and became one of the world=s most connected countries. We are now global leaders in per capita access to information technology and the Internet.

Today we are seeing the benefits of these investments. Our success can be measured in having the fastest rate of growth among the G7 countries in areas such as: private-sector R&D spending; external patent applications; R&D intensity; and the number of workers devoted to R&D.

But in this global race we cannot afford to rest on our laurels. That is why, in February of 2002, our government launched *Canada=s Innovation Strategy*. This strategy is designed to foster a culture of innovation in Canada, improve the quality of life for Canadians and to see the maple leaf become a hallmark of excellence for the world.

Canada=s Innovation Strategy identifies opportunities in four key areas: creating new knowledge and bringing those ideas to market quickly and effectively; ensuring that Canada has enough highly qualified people with the skills needed to compete globally; modernising our business and regulatory policies to foster entrepreneurship; and supporting innovation at the local level so that our communities continue to be magnets for investment and opportunity.

To develop this strategy, we are talking to Canadians from coast to coast to coast to create an action plan for the next decade. *Canada=s Innovation Strategy* is not a government program but a call for all sectors of the economy to work together to achieve ambitious targets for the future. The action plan will identify specific ways that government, business, academia and communities can achieve our national goals.

The Industry Portfolio, consisting of 15 departments and agencies, is an important instrument in fostering innovation in Canada. The Canadian Space Agency (CSA) plays a key role in the Industry Portfolio and I am pleased, therefore to present their Performance Report for 2001-2002.

The CSA can proudly state that all of the overriding priorities outlined in its 2001-2002 Report on Plans and Priorities progressed significantly and that the Agency continued to play a strategic role for the Canadian space sector. This report presents significant accomplishments such as the important milestone reached by the Canadian Space Station Program with the on-orbit commissioning of Canadarm2, the scientific experiments conducted onboard the International Space Station and the first Canadian space walk of Chris Hadfield. Other accomplishments worth mentioning are the continuation of RADARSAT-1 operations, the development of RADARSAT-2, as well as the development of scientific instruments placed onboard the European ENVISAT earth observation satellite. The report presents other innovative scientific and technological pursuits that have promising potential for the Canadian space industry.

These are only a few highlights. I invite you to explore the CSA's Departmental Performance Report to discover the many ways that the Agency contributes to Canada=s economic progress and growth.

Working together we are making our country a stronger and more prosperous place for all Canadians.

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Allan Rock
Minister of Industry

SECTION: 2 Overview of CSA

2.1 Mandate

The Canadian Space Agency (CSA), established in 1989, derives its authority from an Act of Parliament, the *Canadian Space Agency Act, S.C. 1990, c.13*. Its mandate is "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 Canadians."

In addition to delivering its own programs, the CSA is responsible for co-ordinating all federal civil space-related policies and programs pertaining to science and technology research, industrial development and international co-operation. This role was set by the Space Policy Framework, approved by the Government in 1994.

2.1.1 Canadian Space Program Objectives

Canada's unique geographic and demographic character has inspired Canadians to adapt space to meet national needs in the areas of communications, the environment, and natural resource management. Hence, the CSA's overriding objectives are to develop Space Science and technology so as to meet domestic needs and to support an internationally competitive space industry. The Agency is achieving these two objectives by implementing the Canadian Space Program (CSP) in accordance with the following principles:

- Development of technologies and applications in the fields of Earth and Environment, Satellite Communications and Space Robotics;
- Leverage of federal funding through partnerships with industry to ensure commercial success;
- Participation of a growing number of firms, particularly small- and medium-sized enterprises (SME), in space-related activities;
- Pursuit of sustainable industrial regional development through the use of regional distribution targets as guidelines;
- Promotion of greater synergies between civil and defence space activities to optimize federal space funding;
- Implementation of national communications programs to take advantage of the unique appeal of space, to improve scientific literacy among the general public, and to promote careers in science and technology among students.

By implementing the CSP, the CSA contributes to the following seven strategic outcomes:

- Economic Benefits
- Understanding the Environment and Contributions to Sustainable Development
- Technology Development and Diffusion
- Contributions to the Quality of life
- World-Class Space Research
- Social and Educational Benefits
- Promotion of the Canadian Space Program

The Strategic Outcomes are not mutually exclusive, and therefore, a single program may be contributing to more than one Strategic Outcome.

2.1.2 Domestic and International Partners

International cooperation is critical to the implementation of the CSP and the promotion of a competitive space industry. Canada's principal international partners are the United States (U.S.) National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA). Canada also maintains significant bilateral co-operation with several other national space agencies worldwide.

The CSA works closely with several government departments and agencies, notably with the Canada Centre for Remote Sensing (CCRS) of Natural Resources Canada, which operates satellite data ground receiving stations in Quebec and Saskatchewan, and the Communications Research Centre (CRC) of Industry Canada, which manages satellite communications programs on behalf of the Agency. The CSA also has close co-operation links with the Department of Foreign Affairs and International Trade, Industry Canada, Environment Canada, Fisheries and Oceans and others.

The CSA also works very closely with the Canadian Space Industry, the Canadian provinces, and the academic sector in the planning and implementation of the Canadian Space Program.

SECTION: 3 Strategic Context

3.1 External Environment

3.1.1 Government Priorities and the Canadian Space Program

The Speech from the Throne on January 30, 2001 outlining the government's priorities provided important guidance to the CSA in undertaking its strategic planning. First and foremost, in pursuit of the goal to be recognized as one of the most innovative countries in the world, the Canadian government expressed intentions to strengthen the research capacity of universities and government institutions and increase Canada's ability to commercialize research discoveries.

The CSA, along with other science-based departments and agencies, continuously looks to provide innovative solutions to Government objectives. Throughout its strategic planning process, the CSA works to ensure that links are made with key organizations in Government priority areas. For example, a dialogue with the Canadian International Development Agency was initiated in order to seek out ways Canadian space expertise could be brought to bear on the international development agenda. Though work was already underway to forge closer alliances with the Department of National Defence, the signing of a CSA-DND Memorandum Of Understanding in November 2001 responded to rising security and intelligence issues following the September 11th events.

The CSA initiated consultations with some 25 Federal Government organizations to identify where and how space technologies could be used to enhance the delivery of their mandates and provide new or more efficient services to Canadians. This consultation will form the basis of a new strategy, with key initiatives addressing cross-government priorities, as well as specific departmental needs. Keeping with its contracting model, the CSA will rely heavily on industry and research institutions to implement this strategy.

3.1.2 International Space Sector Perspectives

The Canadian space sector is highly influenced by trends and events occurring, in the international space industry and by decisions taken by major U.S., European and other space agencies.

More than ever, Canadian companies are seeking ventures outside the major U.S. and European markets. Some developing countries, such as Brazil, India and China, are continuing to invest in vigorous national space activities. Also, other countries, such as South Korea and Chile, are taking steps to create their respective national space agencies and space programs. Japan is reassessing its governmental and industrial approaches to international partnerships. All this could lead to new opportunities for the CSA and Canadian space companies.

Budget pressures remain significant in U.S. and European space agencies, as well as in the CSA, limiting the ability to participate in major new initiatives. For example, NASA's decision in 2001 to review the implementation of its commitments to the International Space Station (ISS) has caused uncertainty concerning the final configuration and science objectives of the ISS. This has led to a slow down in ISS assembly, with expected delays in the launch of Canada's remaining contribution, the Special Purpose Dextrous Manipulator (SPDM), and in the access to scientific and commercial utilization. Future flight opportunities for Canadian astronauts could also be affected.

The European Union (EU) and European Space Agency (ESA) have continued their rapprochement. This is evidenced by their co-leadership of two important programs: Galileo (satellite navigation) and GMES (Global Monitoring of Environment and Security). EU involvement adds an additional complex dimension to Canadian efforts to participate in these programs.

3.1.3 Canadian Space Sector Challenges

Canada's space sector is working in an increasingly competitive and consolidated industry, in which a handful of large, vertically integrated space companies now dominate the world space market for complete systems. The dramatic technology and telecommunications slowdown within the global space industry has further undermined the industry. Firms in Canada exist primarily on backlog, by cutting overhead, diversifying where possible, and/or reducing in-house R&D. Severely restricted budgets among both commercial and Canadian institutional customers have also meant a reduction of important opportunities to further the groundwork for future innovative developments.

The small size of Canada's indigenous space market, in comparison to the much more lucrative U.S. and European markets, has resulted in industry strong reliance on retaining and expanding access to these and other emerging export markets, such as Asia and South America. Faced with an increasingly controlled U.S. space market, significant benefits await those who obtain a right of entry into more generously financed space initiatives, often closely aligned to a restricted national defence program. To play you must pay, and industrial returns are intrinsically linked to the level of investments. Moreover, Canadian companies are seeking ventures outside of the U.S. market, including Europe and non-traditional markets within Asia.

Space sector market forces, the life cycle for space products, and the introduction of new services for consumers are accelerating, driven by greater competition and ever-improving and converging technologies. Clients are demanding faster turn-around cycles (from R&D through to flight-readiness), while industry is grappling with greater overhead, narrower profit margins, and restricted R&D funding.

The industry is faced with an inadequate level of funding for research, technology development and demonstration, as well as an inherently long cycle of bringing space

technologies to the market and keeping them there. After-market costs associated with commercialization and market retention can prove to be equal, if not greater, than those required in the early-stage R&D cycle, when public funding is more readily available.

Beyond the financial challenges, our industry is confronted with a domestic market that has yet to appreciate fully the benefits Space Science and technologies have to offer. Many Government departments are still learning about the potential advantages of adopting the use of satellite data in the delivery of essential public services, and others, which have fully integrated space-derived data into conventional operations, have limited funding to permit them to plan, develop, demonstrate and operate follow-on technologies.

3.2 CSA Business Management

The CSA continuously looks for ways to improve its decision-making and management practices in order to take better advantage of new opportunities in the international and Canadian space sectors as well as to ensure that the CSP is responsive to Government priorities and to the needs of Canadians.

Showing a clear commitment to an open and transparent decision-making process, the CSA Advisory Council held its first meeting in the Fall of 2001. The primary purpose of the Advisory Council is to advise the President of the CSA on the overall strategic direction to be given to the Canadian Space Program. It draws its membership from respected executive leaders of government departments and agencies, space industry, scientific research and academia. Similar sector-based advisory groups are being constituted and will hold their first meetings in 2002-03.

In 2001-2002, the CSA continued to implement a smooth transition from a project-funded agency to that of an organisation with stable, on-going funding. The Agency pursued major changes in its management practices, such as: the implementation of risk management to ensure program delivery within approved financial envelopes; the integration of project approval management into the work planning process; and the final implementation of the Financial Information Strategy (FIS).

The CSA's commitment to the government-wide Modernization of Comptrollership initiative reflects our leadership towards organisational excellence. Initiated in the last quarter of 2001-2002, the Project Office tabled the CSA's Capacity Assessment Final Report in April 2002 and will issue an action plan in early Fall 2002.

On May 2nd 2002, the CSA received the final audit report from the Canadian Human Rights Commission (CHRC). The CHRC's report found that the Agency was fully compliant with the *Employment Equity Act.*

SECTION: 4 Performance

4.1 Overview of Main Accomplishments by Strategic Outcomes

The government investment in space, provided Canadians with significant economic social and environmental benefits, through the following main accomplishments in 2001-2002:

Strategic Outcomes	Main Accomplishments
Economic Benefits	On-orbit commissioning of Canadarm2; Continued operation of RADARSAT-1; Development of RADARSAT-2; Participation in the development of ENVISAT.
Understanding the Environment and Contributions to Sustainable Development	Development of SCISAT-1, the first Canadian-built scientific satellite since *Alouette* in 1962.
Technological Development and Diffusion	Development and demonstration of space technologies to enhance industry competitiveness and prepare for future space missions.
Contributions to the Quality of Life	Preparation of the Canadian scientific community to utilize the International Space Station (ISS) research facilities; Initiation of experiments for the study of osteoporosis (OSTEO-2) onboard the ISS.
World-Class Space Research	Feasibility studies of scientific instruments for participation in the Next Generation Space Telescope (NGST) and the Herschel/Planck missions. Integration and testing of MOST.
Social and Educational Benefits	Development of youth oriented material. Training of qualified scientists, engineers and, technicians for the high technology industries.
Promotion of the Canadian Space Program	Increased profile of Canadian space activities.

Total actual CSA expenditures added up to $336.1 million compared to a budget of $371.1 million in 2001-2002. More information on the CSA's financial performance is presented in Section 5 of the Report. The following section presents the Agency's performance for each of the strategic outcomes.

4.2 Detailed Performance by Strategic Outcomes

4.2.1 Economic Benefits

In 2001-2002, expenditures of $201.7 million were incurred to contribute to the generation of Economic Benefits. This Strategic Outcome is supported by three main priorities: Satellite Communications, Earth Observation, and the Canadian Space Station Program.

Satellite Communications

Globalization of the economy has driven a restructuring of the world's space industry around a few giant firms capable of producing complete satellite systems with associated services to respond to worldwide communications needs. This situation has generated significant challenges for Canada's satellite communication industry, which used to build satellites to meet domestic market needs. This industry is by far the largest space-sector activity in Canada with $920 million in sales, representing 63% of the total space revenue in 2000. To learn more about the *State of the Canadian Space Sector* go to http://www.space.gc.ca/business/scss/default.asp.

The strategy of the Canadian industry is to re-deploy itself as a supplier of advanced sub-systems and components and to join international space-based multi-media and mobile communications consortia, while maintaining its competitiveness in traditional market niches. Important private and government R&D investments are a major condition for making this strategy a success.

The programs, *Payload Flight Demonstration*, *Ground Segment Technology and Applications Development* and *Canada/ESA Satellite Communications* support the implementation of the Canadian industry's strategy. In 2001-2002, expenditures of $34.4 million were incurred for these programs to achieve the following.

The **Payload Flight Demonstration Program** is a private/public sector partnership (Telesat from Ottawa, Ont., COM DEV from Cambridge, Ont., and EMS Technologies from Montreal, Qc.) to which the CSA contributes $80 million (with $60 million repayable in the form of services to the Government of Canada) to develop a Ka-Band payload for demonstrating a broadband multi-media service throughout North America on Anik-F2; this Telesat satellite is scheduled for launch in mid-2003.

The **Ground Segment Technology and Applications Development Program** co-funds with industry the development of satellite-based commercial applications, such as position determination and navigation for the marine sector, tele-education, and tele-medicine.

Planned Results: Positioning of the Canadian industry as a supplier of multi-media sub-systems (e.g., onboard processing, multi-beam antennas and high rate data transmission) and as a service provider for the next generation of satellite communications on international markets.

Main Accomplishments:

- The *Payload Flight Demonstration Program* has encountered some minor delays in the development of the Ka-Band payload: the 8 Flight Beam Link Payloads were delivered in March, April and May 2002, and all 8 were integrated on the satellite in June 2002. The two Space Mux units are scheduled for delivery in October 2002, for integration and testing in November/December 2002. The payload demonstration flight on Anik-F2 is planned for launch in mid-2003, with in-orbit testing in late 2003, and full operations starting in 2004. This program has already generated incremental sales and jobs in the industry through contracts, including: Norsat won a $5 million contract to develop Ka-band outdoor user terminals for Koreasat; and EMS Technologies won a $2.3 million contract to develop a multi-media satellite demultiplexer, in partnership with Italy's Alenia Aerospazio. In addition, Telesat procured a hub and 20 user terminals from EMS for use in Canada's SchoolNet Program.

- The contracts implemented under the *Ground Segment Technology and Applications Development Program* have generated further contracts with three companies for the development of satellite communications applications for the marine sector.

The **Canada/ESA Satellite Communications Program** enhances the industry's technological base and provides access to European markets in advanced telecommunication areas, such as interactive multi-media and Internet by satellite. The participation in ESA Advanced Research in Telecommunications Systems (ARTES 1,3,5,9) seeks to demonstrate new services and systems in optical communications, onboard processing, portable ground stations, and mobile communications. The participation in ARTEMIS demonstrates new inter-satellite optical communications. The GalileoSat Definition Program helps position Canadian companies as suppliers of sub-systems to global navigation satellite systems.

Planned Results: Enhancing technological capabilities of Canadian industry and access to international markets, in areas such as optical communications, onboard processing, portable ground stations, mobile communications and advanced communications applications, through participation in the most advanced ESA telecommunications programs.

Main Accomplishments:

- Participation in ESA's ARTEMIS Program enabled Canadian companies (e.g., COM DEV of Cambridge, Ont.; Perkin Elmer Optoelectronics of Vaudreuil, Qc.) to develop Ka-band multiplexers and Radio-Frequency modules, and to position

themselves as suppliers on the international market for optical inter-satellite links over the next years.

- As a result of the Definition Phase of Galileosat, study contracts were awarded to develop signal structure for satellite navigation receivers (NovaTel of Halifax, N.S.) and network integrity (Telesat of Ottawa, Ont.).

- Fourteen contracts valued at $2.7 million were awarded to Canadian companies under the ARTES 1,3,5,9 programs to carry out activities such as the demonstration of multi-media satellite services for the community and corporate environment, the demonstration of modulation and coding technique for satellite communications, and to study the use of navigation equipment in the railway sector.

To learn more about *Satellite Communications* go to http://www.space.gc.ca/csa_sectors/sat_com/default.asp.

Earth Observation

The Canadian Space Program responds to worldwide challenges to monitor global changes and protect Earth environment. Canada's principal niches in the vast international Earth Observation (EO) technologies are the use of Synthetic Aperture Radar (which allows for operating in total darkness and penetrating layers of clouds that obstruct the view of optical satellites), rather than optical cameras in remote sensing satellites, as well as data processing equipment and applications. The strategy has been to implement the Earth Observation programs as instruments for developing an internationally competitive, export-oriented, domestic equipment and service industry. For instance, the marketing of RADARSAT-1 data worldwide has been awarded to privately owned RADARSAT International Inc. (RSI) in return for royalties to facilitate their commercialization; the development and operation of the successor satellite (RADARSAT-2) has been privatized to MacDonald Dettwiler & Associates (MDA) to foster the growth of domestic industry. Today, EO makes up the second largest space sector activity with revenues of $254 million in 2000. To learn more about the *State of the Canadian Space Sector* go to http://www.space.gc.ca/business/scss/default.asp.

The main programs encompassing the Canadian strategy in Earth Observation are *RADARSAT-1 Operations*, *RADARSAT-2 Development, Earth Observation Support*, and *Canada/ESA Earth Observation.* In 2001-2002, expenditures of $97.7 million were incurred for these programs to achieve the following.

RADARSAT-1 is an advanced Earth Observation satellite system developed by Canada to monitor environmental change and to support resource sustainability. Operations are due to continue until the full commissioning of its successor.

Planned Results: Continue to operate RADARSAT-1 with the same high performance level until the full commissioning of RADARSAT-2 in 2004.

Main Accomplishments:

- In its seventh year of operation and two years beyond its design lifetime, RADARSAT-1 continues to perform with the same high performance level for satellite reliability, product quality, timely delivery, and responsive follow-up to customer requests. An average system performance of 96% was achieved (over the 95% specification), 99% data reception was reached by CCRS ground stations, and 22,215 user requests were processed. Royalties ($2.9 million) have been stable for the last two years.

RADARSAT-2 Development, which incorporates advanced technologies such as higher resolution and polari-metric modes to ensure continuity in radar data supply, maintains Canadian leadership in space-based radar technologies, opens up new international remote sensing markets, and develops a competitive worldwide value-added industry.

RADARSAT-1:
How CSA's R&D investments contribute to commercial shipping in Canadian waters.

The Canadian Earth Observation satellite RADARSAT-1, launched in November 1995, produces high-quality images of the Earth's surface to be used in many fields such as agriculture, forestry, geology, environmental monitoring, disaster response and mitigation, and coastal surveillance. As an example of the economic benefits being generated, the integration of RADARSAT-1 data to the Canadian Ice Services mapping of the Gulf of St-Lawrence and Artic waters provides 15 to 20 times more coverage, compared to the previous aircraft coverage system, with an annual operational cost savings estimated at $7.7 million. An efficient, reliable, and near-real-time coverage of ice-infested waters contributes to faster, cheaper and more secure commercial shipping in Canadian waters. (Source: Radarsat-1 – Extended Mission Review – 2002 -- http://www.space.gc.ca/csa_sectors/earth_environment/radarsat/radarsat_info/default.asp)

Planned Results: Maintaining Canada's position as the world leader in commercial space-borne radar technology and applications with RADARSAT-2.

Main Accomplishments:

- Some key milestones achieved in the development of the spacecraft are: the Bus, Extensible Support Structure (ESS) and Payload Critical Design Reviews. Additional challenges in the development of critical satellite components have resulted in a five-month delay in satellite integration and testing at the David Florida Laboratory (DFL). A more definitive timetable for the construction and launch of the spacecraft was established in May 2002 at the Mission Critical Design Review. The launch is now planned for March 2004. Modifications to accommodate a potential RADARSAT-2/3 tandem mission were incorporated into the spacecraft design in 2001.

- The institution of a regime to ensure secure access to RADARSAT-2 data is expected to be completed by the end of 2002.

- RADARSAT-2 applications to agriculture, oceans, geology and hydrology were simulated from airborne SAR data.

To learn more about *RADARSAT-2* go to
http://www.space.gc.ca/csa_sectors/earth_environment/radarsat2/default.asp.

Earth Observation Support programs aim to enhance Canada's ground receiving and data processing systems, to develop value-added commercial applications based on data from *RADARSAT* and other satellites through contracts to industry, and to develop advanced imager technologies for the next generation of EO missions.

Planned Results: Creating an enlarged competitive Canadian value-added industry capable of developing products and services based on current and future EO satellite data for the international market.

Main Accomplishments:

- The upgraded Canada Centre for Remote Sensing (CCRS) reception processing and transcription system capabilities located in Gatineau, Québec and Prince Albert, Saskatchewan are now receiving advanced SAR data from ENVISAT. The timetable for upgrades to the reception and archiving infrastructure for the RADARSAT-2 mission has been adjusted to coincide with the revised spacecraft launch date.

- The EO Application Development Program awarded 25 contracts (valued at $3.8 million) to industry for developing commercial value-added products and services and promoting their use in geology, forestry, and oceanography. Eight projects were supported under a new program launched in Summer 2001 to help industry seize immediate market opportunities. Examples of current projects utilising RADARSAT data include: assessment of environmental impact of oil and gas exploration in China, the extraction of snow-water equivalent over mountainous terrain, crop assessment reporting to help process crop loss insurance claims, pipeline integrity monitoring, and the evaluation of wind energy for electricity generation.

- The new Hyperspectral Development Program awarded 15 contracts (valued at $2 million) to industry. These contracts covered three main areas: an evaluation of stakeholder requirements; the evaluation of mission and instrument concepts to be flown onboard a small satellite or the ISS and, the development of critical hyperspectral technology, particularly in the area of data compression. A small satellite mission concept has been recommended by the industrial team. A more thorough evaluation of that concept will begin in the subsequent fiscal year.

Canada/ESA Earth Observation programs enhance the industry's technological base and provide access to European markets for value-added products and services derived from satellite-based EO data. Canada's participation in ENVISAT, a satellite complementary to RADARSAT, helped maintain Canadian leadership in space-based radar technologies and ensures the availability of C-Band SAR data. The EO Preparatory and EO Envelope Programs enhance Canadian industry's technology capabilities and develop international markets in areas such as hyper/superspectral application development, and sensor instrument calibration facility, and sensor data algorithm development (e.g., rice monitoring, measurement of land motion).

Planned Results: Enhancing the technological capabilities of Canadian industry and broadening access to international markets in areas such as space-borne radar instruments, ground segments and applications through participation in the most advanced ESA remote sensing programs.

Main Accomplishments:

- Canadian companies have been awarded $36.7 million in contracts and have contributed key components to the design and construction of ENVISAT satellite, launched in February 2002. In particular, ABB Bomem of Québec City, Québec, provided engineering support in instrument design and data analysis and developed optical test equipment for one of the ten special instruments placed onboard ENVISAT, namely, the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS). Furthermore, COM DEV of Cambridge, Ontario, supplied the MIPAS Signal Processing Sub-system Electronics and onboard flight software and delivered two leading-edge space qualified oscillator units for the microwave radiometer (MWR).

- Participation in the EO Envelope Program opens up strategic Canadian industrial and scientific participation in new research-targeted (Earth Explorer) and commercially oriented (Earth Watch) missions.

ESA-Canada Partnership:
How CSA promotes the expertise and services of Canadian companies.

The CSA, as a co-operating member with ESA, has been an active participant in the development of the ENVISAT satellite launched in February 2002. This key element of the ESA's plans for the next decade to monitor the Earth's environment provides an ideal platform for the promotion of Canadian expertise. Some of Canada's top space companies have contributed key components to the design and construction of ENVISAT, partnering with recognized international companies in the development of Earth Observation satellites. As an example of the various economic spin-offs stemming from this partnership, the company ABB Bomem of Québec City, Québec is now making components for U.S. polar-orbiting weather satellites, thanks to the expertise gained on the ENVISAT contract. (http://www.space.gc.ca/csa_sectors/earth_environment/envisat/about/default.asp)

This participation has resulted in the selection of the SWIFT instrument as an ESA Earth Explorer Opportunity Mission.

To learn more about the *CSA-ESA Earth Observation* go to http://www.space.gc.ca/csa_sectors/generic_space_tech/tech_manag/tech_esa_desc.asp.

Canadian Space Station Program (CSSP)

Canada has been a recognized world leader in space robotics since the development of Canadarm, the highly efficient robotic arm installed on NASA's space shuttles. Considering this unique expertise, Canada was invited by the U.S. to join a multilateral program in 1984 to develop and build a Space Station. International partners agreed that Canada's contribution would be the robotic equipment required to assemble, maintain and operate the International Space Station (ISS).

The Mobile Servicing System (MSS) includes the Space Station Remote Manipulator System (SSRMS, later renamed Canadarm2), mounted on a Mobile Base System (MBS) and designed to handle large loads onboard the ISS, and the Special Purpose Dextrous Manipulator (SPDM), a second robot designed to perform more delicate tasks. Following the development of the MSS, Canada will maintain operational capabilities, as well as provide MSS training facilities and real-time support to robotics operations for the flight and stage portion of every mission to the Space Station over the next 15 years.

The design and manufacture of all space and ground-based MSS elements have been contracted out to a Canadian Industrial Team, led by MDRobotics (previously SPAR Aerospace) as a prime contractor. Contracts have also been awarded to industry to provide Sustaining Engineering Support for the operations of the MSS. The total value of contracts to industry has exceeded $1.2 billion, since the beginning of the Program.

In 2001-2002, expenditures of $69.6 million were incurred for the **Canadian Space Station Program** to achieve the following.

Planned Results: Continuing with Canadian contributions to international efforts for establishing a human presence in space and maintaining Canada's position as a world leader in space robotics by completing the development and on-orbit commissioning of the MSS.

Main Accomplishments:

- The SSRMS was launched on April 19, 2001, and the first operational mission was successfully completed in July 2001.

- The MBS was launched on June 05, 2002, and on-orbit checkout was successfully completed in July 2002.

- The acceptance of the SPDM by the CSA has now been delayed to November 2002, due to joint friction and other problems discovered during testing. This delay will not cause a problem since the launch of the SDPM has been postponed by NASA to a probable date in early 2005.

Planned Results: Maintaining Canada's position as a world leader in space robotics by exercising full responsibilities for MSS Operations.

Main Accomplishments:

- An effective team of private contractors and necessary engineering facilities have been put in place to support on-orbit SSRMS and MBS operations and supply an adequate level of sustained engineering. This capability allows Canada to fulfill its increased responsibilities for MSS repairs and overhaul in exchange for offsets on the costs of CSA's astronaut training at NASA, payload launch, and communication services.

- Training was provided at CSA headquarters to 141 cosmonauts/astronauts, mission controllers and other ground support personnel from NASA and the CSA to enable them to meet all MSS operations mission requirements and simulations.

- Real time support was provided by the MSS Operations Complex, located at CSA headquarters, to four Space Station assembly missions with the full satisfaction of NASA (e.g., missions 6A for the installation of Canadarm2 on the ISS, 7A for installation of airlock and EVA support, 7A.1 and UF-1 for mission and EVA support).

Planned Results: Partial use by the private sector of Canada's share of ISS research facilities.

Main Accomplishments:

- The implementation of this policy aimed at encouraging the commercial utilisation of Canada's share of ISS facilities and resources has encountered some delays. Indeed, no firm was qualified to take charge of the commercialisation of ISS utilisation, following the Request for qualifications released by the CSA. Discussions with different companies interested in partnering with the Agency are ongoing.

To learn more about the *Canadian Space Station Program* go to http://www.space.gc.ca/about/sr_mcp/default.asp.

4.2.2 Understanding the Environment and Contributions to Sustainable Development

Protecting the Earth's environment and preserving natural resources have become increasingly important to Canadian agendas. These worldwide concerns have led to a rising demand for instruments enabling the monitoring of the Earth's environment from space. The unique scientific data provided by space-based instruments and EO satellites contributes to the understanding, monitoring and prediction of the Earth's environment

and climate change, the formulation of policies for emissions control of atmospheric pollutants with respect to Canada's international commitments, and the enhancement of natural resource and disaster management.

The Canadian strategy is to participate in international scientific missions, seek proposals for space instruments from the university community, and contract-out the design and construction of selected instruments to industry. The instruments are flown on the platforms of international partners, such as NASA and ESA. Also, *RADARSAT-1* contributes to this Strategic Outcome by supplying data for several environment-based applications, including the management of natural resources and the operational management of natural disasters around the world.

The main programs encompassing the Canadian strategy are *Atmospheric Environment, Space Environment,* and *Government Department-Related Initiatives.* In 2001-2002, expenditures of $32.1 million (excluding RADARSAT-1 operations costs shown in Section 4.2.1) were incurred to achieve the following contribution to the Strategic Outcome "*Understanding the Environment and Contributions to Sustainable Development"*.

The **Atmospheric Environment** programs study the dynamics of the atmosphere, the ozone layer, greenhouse gases, and other global climate change phenomena. Specific activities include: the development of SCISAT-1 instruments and satellite hardware and the development of the CLOUDSAT and SWIFT scientific instruments with international partners, the Meteorological Service of Canada and the Canada Centre of Remote Sensing (CCRS); the definition of a new micro-sat mission and instrument concepts for future international missions; and support to the operations of WINDII, MOPITT, and OSIRIS/ODIN in co-operation with the U.S. and Sweden.

Planned Results: Achieving a better understanding, monitoring and prediction of global climate and atmospheric pollution problems through space-based data gathered from Canadian instruments and improved modelling techniques. The advancement of scientific knowledge, resulting from data produced by space-based instruments, to help develop policies on emissions control of atmospheric pollutants to meet Canada's international commitments (e.g., Montreal Protocol and Kyoto Agreement).

Main Accomplishments:

- The development of SCISAT-1, the first Canadian scientific satellite built since Alouette in 1962, is being completed by the prime contractor (Bristol Aerospace from Winnipeg, Man.); its launch is scheduled for January 2003. The instruments onboard the satellite (a high resolution infrared Fourier Transform Spectrometer, developed by ABB Bomem from Québec City, and MAESTRO, for enhancing the aerosol measuring capabilities of the mission, developed by EMS from Montreal in close collaboration with Environment Canada) will measure the chemical and dynamic processes that control the distribution of ozone in the upper troposphere and stratosphere. The data will help understand the decline of stratospheric ozone at

northern mid-latitudes and in the Arctic, one of the most serious aspects of the atmospheric ozone problem.

- NASA's CLOUDSAT mission will provide the breakthrough information needed to improve climate and numerical weather prediction models. New information will be provided on the vertical distribution of cloud systems, including profiles of ice/water contents and cloud optical depth required for better understanding the radiactive heating of the atmosphere by clouds. The Canadian contribution to CLOUDSAT is the development of components for the Cloud Profiling Radar by COM DEV (Cambridge, Ontario), and CPI (Georgetown, Ontario) for which the designs were successfully reviewed in 2001-2002. The launch is scheduled for April 2004.

- The feasibility study on the SWIFT Mission was initiated in 2001. SWIFT will measure wind velocities and ozone concentrations in the stratosphere. The data will be used by weather prediction agencies, including the Meteorological Service of Canada, which will assimilate the data into atmospheric models, such as the Canadian Middle Atmosphere Model. The international team will be led by a Canadian scientist, and the satellite will be developed jointly by Japan. Canada's contribution, in partnership with ESA, will be the development of the instrument, Doppler Michelson interferometer, which is a concept closely modelled on Canada's WINDII. The launch is planned for 2007-08.

Measuring Air Quality:
How CSA contributes to the measuring of pollution from space.

Launched in December 1999, the Measurements of Pollution in The Troposphere instrument (MOPITT), funded by the CSA, is Canada's first major instrument to measure pollution of the Earth's atmosphere from space. It is also the Canadian Space Agency's biggest contribution to NASA's most ambitious study of the planet's environmental processes to date. During the five-year mission, MOPITT will continuously scan the atmosphere below to provide the world with the first long-term, global measurements of carbon monoxide and methane gas levels in the lower atmosphere.
Presently, Canadian scientists in the Meteorological Service of Canada in Montreal are using MOPITT data to develop and test data assimilation models, which will assist in predicting pollution events in Canada. Canadian scientists at the University of Toronto are using MOPITT data to look at the production and transport of carbon monoxide (and therefore other pollutants) from forest fires in North America.
(http://www.space.gc.ca/csa_sectors/space_science/atmospheric_env/mopitt.asp)

To learn more about the *Atmospheric Environment* go to http://www.space.gc.ca/csa_sectors/space_science/atmospheric_env/default.asp.

The **Space Environment** programs develop small payload missions for in-situ studies of space plasma and Earth's electromagnetic field. The principal activities include: the operations of a Canadian network of ground-based instruments for the study of upper atmosphere and ionosphere phenomena (CANOPUS); the development of a Canadian-led micro-satellite mission for the study of the near-Earth environment; collaborations with

Natural Resources Canada (NRCan) on a space weather forecasting facility; and operations support for existing instruments in co-operation with international partners (e.g., NASA, and Japan).

Planned Results: Using space-based scientific instruments and improved models to achieve an understanding of the near-Earth environment and the ability to forecast space weather.

Main Accomplishments:

- Instrument and mission feasibility studies for the Enhanced Polar Outflow Probe in preparation for a Canadian-led micro-satellite mission to study the near-Earth environment were carried out in 2001-2002. This small satellite will carry seven instruments (six Canadians and one Japanese) to study polar ion outflow and plasma instability over the Earth's polar cap. The launch is planned for 2006-07.

- The operation of a Canadian network of ground-based instruments for the study of upper atmosphere and ionosphere phenomena (CANOPUS) continued to provide a wealth of data in support of numerous space physics missions to domestic and international scientists.

- The development of the space weather forecast facility, in partnership with NRCan, is progressing as planned with the delivery of Phase I Modelling Software in 2001-2002. The Space Weather Capability, as part of the Canadian Geospace Monitoring Program, will serve to develop physics-based models that exploit data from ground and space instruments, and thus improve our understanding of auroral, magnetospheric, and particle processes driving space weather. This program is expected to be operational in October 2003.

To learn more about *Space Environment* go to
http://www.space.gc.ca/csa_sectors/space_science/spa_env/default.asp.

The **Government Department-Related Initiatives** aim to develop and demonstrate the application of space-borne technologies in activities related to natural resources, disaster management, and environmental protection.

Planned Results: Use of data and technologies derived from RADARSAT and other EO satellites by Canadian and international institutions, including federal departments and/or agencies mandated to promote environmental protection, natural resources and disaster management.

Main Accomplishments:

- The Government Department-Related Initiatives Program supported 13 initiatives (valued at $1.8 million) to demonstrate the application of space-borne data and technologies for managing disasters, studying the cryosphere, monitoring the

sustainable development of Canadian forests, understanding the interaction between land-based eco-systems and climate change, mapping near-shore changes, studying the evolution of coastal zones with their eco-systems, and monitoring northern offshore marine environment and its interaction with global climate.

- RADARSAT-1 stereo coverage of the Earth's land mass (Background Mission) was successfully completed in early 2002. The data acquired over the past six years has been primarily used for mapping applications, including 3D viewing, digital elevation models and image rectification. The high-resolution digital mosaics of Antarctica continue to be used by scientists in understanding the role of this continent in global climate change.

- The CSA, along with partners in the International Charter on "Space and Major Disasters," delivered RADARSAT data to help manage eight major natural disasters across the World in 2001, including the El Salvador seismic shocks. The CSA, Canada Centre of Remote Sensing (CCRS) and National Oceanic and Atmospheric Administration (NOAA) collaborated again to support "Hurricane Watch 2001" by acquiring images of the eyes and secondary atmospheric flow phenomena, which help understand hurricane dynamics and intensity changes.

To learn more about *Government Department-Related Initiatives* go to http://www.space.gc.ca/csa_sectors/earth_environment/default.asp.

4.2.3 Technology Development and Diffusion

Canada's continued success as a space-faring nation requires technological leadership in its areas of specialization: robotics and automation, communication, sensor payloads, and spacecraft technologies. The strategy adopted by the CSA to play its leadership role is to: support the development of the innovative advanced technologies, systems and components required to sustain the competitiveness of its industry, although faced with stiff competition on international space markets; generate proposals and identify technological requirements for future space missions; and build links with foreign partners so as to participate in international missions and ensure their access to the domestic industry. In order to carry out this strategy effectively, the CSA maintains an in-house core of expertise, R&D capabilities, and knowledge on worldwide technology advances. The Agency also seeks opportunities to demonstrate and prove Canadian technologies and products in space. The space-qualification of technologies is a vital requirement for acceptance in space hardware, and therefore, for exporting to world markets. Finally, the CSA seeks to achieve greater returns on the government's investments in space technologies by pursuing opportunities for applications in commercial markets.

The main programs encompassing the Canadian strategy are *Space Technology Development, Technology Demonstration, Commercialization Office* and *In-house Research and Development.* In 2001-2002, expenditures of $29.9 million (plus payments

to the ESA General Budget) were incurred to achieve the following contribution to the Strategic Outcome *"Technology Development and Diffusion"*.

The **Space Technology Development Program** co-funds with industry, through a competitive contracting-out process, the development of high-risk technologies, required for future space missions and offering a high potential for penetrating international markets.

The new **Technology Demonstration Program** announced in September 2001, is designed to provide flight opportunities to space qualify technologies developed by industry.

The **Commercialization Office** supports the diffusion of proven space technologies to the market place and their application to non-space products and services.

Planned Results: Enhancing the Canadian space industry's competitiveness and penetrating emerging international space markets through the development and space-qualification of innovative technologies and new products for future space missions.

Main Accomplishments:

- Industry contracts terminated in 2001-2002 were responsible for new concepts and emerging technologies being developed and made applicable to space, including prototypes, components, and sub-systems with high commercial potential (e.g., advanced robotics for future missions; high performance multimode horns for satellite antennas; an active laser camera system successfully tested on the Space Shuttle; object recognition and pose estimation system for space servicing operations; lidar-based automated planetary landing system; high-capacity Li-Ion batteries for large high-power geostationnary satellites; and, Micro Electromechanical Switches for communications satellites).

- Canadian industry, including SMEs from all regions, was awarded 21 new contracts valued at $4.3 million. The result is the development of components, sub-systems or processes with promising market potential, such as: advanced burst demodulator and modulation/coding techniques for broadband communication satellites, small Sat systems and equipment, a TITAN system on a chip ASIC processor, and integrated power and attitude control systems.

- A study confirmed that a Small/Micro-Sat is a low cost, reasonable option for demonstrating and space-qualifying technologies.

- The management of more than 100 active patents and licensing files, resulting from government R&D investments and several business opportunity/benefit studies, has supported space technology promotion and transfer.

In-house Research and Development programs maintained a base of expertise within the Agency through high risk and innovative technology development activities to support the implementation of the CSP, to acquire knowledge of worldwide technology trends and to explore, along with industry, the potential of emerging technologies.

Planned Results: Maintaining the CSA's expertise base to support the implementation of the CSP, to acquire knowledge on worldwide technology trends, and to explore, along with industry, the potential of emerging technologies.

Main Accomplishments:

- Scientific and engineering expertise was acquired in the fields of: advanced robotics and automation, space optics, ground systems and software development, radar and hyperspectral sensors, advanced materials, and thermal propagation.

- New processes and technologies were developed in the areas of: active stabilization of band-pass filter, space robot ground control, high speed databus, innovative space radiative thermal design concept and analysis tools, novel cryo-cooler technologies, smart and nano-materials for space systems, inflatable structures, data compression techniques and applications to remote sensing, optical inter-satellite link techniques and instrument, non-analytical control, laser ranging, infrared vision, nano-structured materials, batteries, Micro-Satellite sub-systems, radiation analysis and testing, Monolitic Microwave Integrated Circuits (MMIC) T/R module, high speed communication systems, radar, antennas, intelligent systems, and mission design and prototyping. These new technologies will reduce the cost of future missions, as well as enable new missions in areas of interest to the CSA, and will keep Canada's industry competitive.

- Over 70 papers and formal presentations were published at various conferences around the world, and one patent application was submitted. The International Symposium on Artificial Intelligence & Robotics and Automation in Space (ISAIRAS) was held at the CSA in June 2001 with close to 300 participants.

To learn more about *Technology Development and Diffusion* go to http://www.space.gc.ca/csa_sectors/generic_space_tech/default.asp.

4.2.4 Contributions to the Quality of Life

Space Science and technologies contribute to a better quality of life by advancing knowledge on human adaptation in a weightless environment, leading to improved medical procedures, and by making direct broadcasting television, and advanced multi-media and mobile communications services accessible to all Canadians, regardless of where they live in our vast country. Certain health problems, like disorientation, loss of bone mass, muscular atrophy, or high blood pressure are accelerated in space. Experiments in a microgravity environment improve our knowledge of how the human

body adapts to unusual conditions. The CSA maintains an A*stronaut Corps* to respond to the needs of manned space flights by conducting Canadian space material and life science experiments and supporting studies in health technologies. In addition, a space medicine program is being developed to prevent, diagnose and treat astronaut health problems. The results of these research studies and experiments have already contributed to improving treatments for the above-mentioned diseases and will help future astronauts spend more time in space aboard the ISS.

Long-term improvements in quality of life can be attributable to several space programs, but those, which contribute more directly, are the following: *Space Life Sciences* and *Microgravity Sciences.* In 2001-2002, expenditures of $18.6 million were incurred to achieve the following contribution to the Strategic Outcome *"Contributions to the Quality of Life"*.

The **Space Life Sciences Program** enables the Canadian scientific community and industry to advance our knowledge of changes to the cardiovascular, bone and nervous systems, as well as the adaptation of humans and other life forms in a weightless environment through Space Shuttle flights and the use of ISS facilities.

Planned Results: Improving the health of Canadians through the understanding of human adaptation to a weightless environment, and applications of this knowledge to improve medical treatments and drugs.

Main Accomplishments:

- The Insect Habitat, developed by the University of British Columbia and Routes Astro Engineering, will provide a unique environment for conducting life science experiments aboard NASA's Gravitational Biology Facility on the ISS. Critical Design Review of the Insect Habitat Facility was successfully conducted in 2001-2002; its launch is scheduled for 2005.

- Experiments for the study of osteoporosis (OSTEO-2), scheduled for the Space Shuttle Flight STS-107 in November 2002, were verified in final preparation for Flight. The Extra-Vehicular Activity Radiation Monitor experiment was launched on the ISS in November 2001, with experiments starting in January 2002. To date, 6 EVAs have been studied. Canada's first experiment on ISS (H-Reflex) continued to provide data to researchers, and even surpassed their expectations.

To learn more about *Space Life Sciences* go to
http://www.space.gc.ca/csa_sectors/space_science/space_life_sciences/default.asp.

The **Microgravity Sciences Program** enables the Canadian scientific community and industry to advance our knowledge of basic physical and chemical processes in the weightless environment by developing instruments and facilities for carrying out experiments on Space Shuttle flights and, eventually, the ISS.

Planned Results: Improving material processing techniques through greater understanding of fundamental physics and chemistry by conducting experiments using the effects of microgravity.

Main Accomplishments:

- The Critical Design Review for the Microgravity Vibration Isolation System (MVIS), a contribution to the ESA Fluid Science Laboratory on the ISS, was completed in 2001-2002. This is a major Canadian-made infrastructure to isolate the Fluid Science Laboratory (FSL) from the vibrations of the ISS. The ESA FSL is scheduled for launch as part of the ESA Columbus ISS module around 2006. EMS Technologies and Bristol Aerospace are two of the main contractors working on MVIS.

- Preliminary design of the Advanced Thermal Environment (ATEN) furnace was successfully reviewed in 2001. This fourth generation furnace, designed and built by Millenium Biologix in Kingston, Ont., is a high performance and reliable facility that will be used on the ISS, to support a variety of material science experiments. The facility is being developed in close collaboration with the scientific community to meet their needs.

To learn more about *Microgravity Sciences* go to
http://www.space.gc.ca/csa_sectors/space_science/microgravity_sci/default.asp.

4.2.5 World-Class Space Research

The strategy put forward to maintain Canada's tradition of excellence in the worldwide exploration of space is founded on seeking international co-operation in order to offer our scientific community opportunities to participate in world-class Space Science missions, notably the new era soon to be opened by the utilisation of the ISS. The industry has also benefited from this strategy by enhancing its technological base with the development of unique scientific instruments.

Canada has achieved internationally recognized excellence in a number of areas, notably space robotics, civilian space-borne radar technologies and applications, satellite communications sub-systems, certain Space Science disciplines (e.g., solar-terrestrial relations sciences, space astronomy), and space qualification services. As most of those areas have already been addressed in the previous sections, this section focuses on *Space Astronomy and Exploration Programs* and the *David Florida Laboratory* (DFL). In 2001-2002, expenditures of $21.1 million were incurred to achieve the following contribution to the Strategic Outcome *"World Class Space Research"*.

The **Space Astronomy and Exploration** programs enable our scientific community to contribute to international efforts aimed at understanding the universe and predicting its evolution.

Planned Results: Achieving a better understanding of space, the universe, and the basic physical and chemical make-up of our solar system.

Main Accomplishments:

- Integration and Testing of the Microvariability and Oscillations of Stars (MOST) micro-satellite got underway in 2001-2002. This micro-satellite, (developed by Dynacom from Toronto, Ont., and the Universities of Toronto and British Columbia) contains Canada's first space telescope used to examine the surface oscillations of stars, probe their internal structures and measure their age. The results of the MOST mission could provide a better estimate for the age of the universe. The launch is scheduled for early 2003.

- Feasibility studies of possible spacecraft and science instrument contributions continued with respect to Canada's participation in NGST (Next Generation Space Telescope mission led by NASA, as a follow-up to the Hubble Space Telescope), where Canada expects to provide major components such as the complete Fine Guidance Sensor (FGS), and additional science support. Flight hardware delivery to NASA is currently planned for 2008.

- Concept studies to propose instruments that Canada may provide to the Herschel/Planck mission (led by ESA) are underway. Herschel will be an orbiting facility class space telescope; in many ways, it will be the sub-millimetre/infrared counterpart to the Hubble Space Telescope. Its launch is planned for 2007.

- Canada is participating in its first interplanetary mission with Japan's satellite Nozomi. The Thermal Plasma Analyser instrument has been provided to measure the lowest energy particles and gases in the Martian atmosphere. Nozomi is expected to arrive to Mars in January 2004.

- Concept studies for determining the feasibility of Canadian participation in the scientific exploration of Mars, in particular, possible contributions in the area of subsurface sample acquisition and handling, and/or rendez-vous and docking LIDAR sensors to currently planned international missions, such as NASA's 2009 Mars Smart Lander Mission, were completed.

To learn more about *Space Astronomy* go to:
http://www.space.gc.ca/csa_sectors/space_science/space_astronomy/default.asp
and for *Space Exploration* go to:
http://www.space.gc.ca/csa_sectors/space_science/space_exploration/default.asp.

The **David Florida Laboratory** (DFL), a world-class facility providing environmental tests for the assembly of space hardware, has been contributing to the recognition of Canada's leadership in space research and the development of a competitive domestic space industry for over 25 years. The CSA's strategy is to market DFL facilities on a fee-for-service basis to domestic and foreign companies.

Planned Results: Continued provision of world-class environmental space-qualification services (certified ISO 9002) for the assembly, integration and testing of spacecraft systems and sub-systems.

Main Accomplishments:

- Only 55% of the DFL's potential utilisation time was used in 2001-2002. A total of 80 test reports were generated for 28 different clients and 43 separate programs. Total external revenues amounted to $940,000. Client satisfaction surveys indicated a 95% approval rating with DFL services.

- Space environmental/qualification testing of the SPDM and various Space Science experiments and instruments were successfully completed. Testing for Canadian and foreign industries was also conducted (e.g., multiplexers for COM DEV, antennas for EMS, reflectors for Telesat's Anik-F2, Space Vision System for Neptec, and other tests for INMARSAT and U.S. Orbital Sciences).

- The acquisition and development of new testing capabilities to meet emerging requirements were achieved (e.g., demonstration of the photogrammetry test capability on the SHAPE and Anik-F2 reflectors).

To learn more about the *David Florida Laboratory* go to
http://www.space.gc.ca/space_qualification/david_florida_lab/default.asp.

4.2.6 Social and Educational Benefits

The unique appeal of space serves to improve scientific literacy among students and educators, encourages youth to pursue careers in science and technology, and promotes awareness of the importance of science and technology to Canada's future. The nature of space hardware development, which involves meeting exceptional technical requirements, very stringent quality controls, and mastering advanced technologies, constitutes an excellent vehicle for training highly qualified scientists, engineers and technicians for Canada's high technology industries. Canadian astronauts significantly contribute to fostering education and space awareness. Their active participation in various public events instils a sense of pride among all Canadians and promotes scientific literacy, as well as careers in science and technology to the younger generations.

Educational benefits are attributable to several space programs, but those, which contribute more directly, are *"Youth Awareness"* and the *"Training of Qualified Canadian Scientist Engineers and Technicians"*. In 2001-2002, expenditures of $1.7 million were incurred to achieve the following contribution to the Strategic Outcome *"Social and Educational Benefits"*.

The **Youth Awareness** programs encourage youth to undertake careers in Science and Technology (S&T), through rewards and recognition activities, the distribution of space-related materials and public information campaigns across Canada.

The **Training of Qualified Canadian Scientists, Engineers and Technicians** for high technology and space-related industries was conducted through a series of programs jointly delivered with the Natural Sciences and Engineering Research Council of Canada (NSERC) and/or the Public Service Commission, as well as through new training initiatives (e.g., CSA Fellowship) with industry and universities.

Planned Results: Encouraging Canadian youth to pursue careers in S&T and increasing the availability of qualified Canadian scientists, engineers, and technicians for high technology and space-related industries.

Main Accomplishments:

- The development of youth oriented material, including three CSA-made products, three partner adaptations, and electronic classrooms. A high degree of satisfaction regarding availability and pertinence of CSA educator resources was achieved, as indicated by the results of a survey to educators having requested the kits: 94% of respondents indicated that they would request CSA materials in the near future, and more than 80% indicated that the material was of great value. The CSA Youth Web site (Kidspace) experienced 150 819 visitor sessions in 2001-2002.

- Five pro-active astronaut tours/visits were co-ordinated throughout the country, reaching stakeholders at the primary, secondary and university level.

- There has been growing awareness and use of the CSA/SchoolNet webcast presentations since April 2001, as indicated by a 47% increase in the number of participants.

To learn more about *Kids Space* go to http://www.space.gc.ca/kidspace/default.asp.

4.2.7 Promotion of the Canadian Space Program

The Agency places great emphasis on building national pride through public awareness of Canadian achievements in space, and on helping Canadians to better understand the importance of space programs in Canada's future. The promotion of partnership with international and domestic stakeholders is paramount to the successful delivery of the CSP. The activities dedicated to this Strategic Outcome are:

- Implementation of an ambitious communications strategy focusing on the promotion of key space events, such as Canadian astronauts' flights, the planned installation of Canadarm2 on the ISS, and the organisation of special activities.

- Performance of a wide range of activities to more effectively manage strategic aspects, as related to Canada's international co-operation agreements, and support to international marketing strategies pursued by our industries.

In 2001-2002, expenditures of $5.2 million were incurred to achieve the following contribution to the Strategic Outcome *"Promotion of the Canadian Space Program"*.

Planned Results: Initiating communications strategies and activities that satisfy the needs of the CSA, the government, the Minister and space stakeholders, and increasing the profile of the CSP and its achievements with the general public and Parliamentarians.

Main Accomplishments:

- ❖ Twenty-two media briefings and press conferences were organized to support CSA events; the Prime Minister participated in 2 events and the Minister of Industry in 4 others. More than 150 interviews were granted to journalists covering a wide variety of subjects (71 of these interviews were conducted with astronauts); 42 advisories, 51 press releases and 9 backgrounders were distributed.

- ❖ Media analysis following STS-100 indicated that 62% of the electronic coverage and 58% of print articles featured the mission objectives (in general) as their main subject, with 2% of electronic coverage and 5% of print coverage specifically centred on Canadarm2.

- ❖ The CSA Web site has registered an increase of 82% in visitor sessions, topping more than 1 million; the average time of a visit has increased to 14 minutes, up 32% over last year.

- ❖ A National Public Opinion Poll conducted in May 2001 indicated 85% support for Canada's participation on the ISS; 26% identified Canadarm2 as Canada's contribution to the ISS; and more than 80% felt proud about Canada's achievements in space and believed it important to have an active national space program.

To learn more about the *Canadian Space Program* go to
http://www.space.gc.ca/about/csagla/canspapro/default.asp.

Planned Results: Improvement of international co-operation with our traditional partners, notably the U.S., Europe, and Japan. Maintaining of effective and open relations between the CSA and its domestic stakeholders, notably industry, OGDs, the provinces and universities.

Main Accomplishments:

- ❖ Several agreements (Memorandum Of Understanding) are either in place or are being negotiated with NASA. Those in place include: RADARSAT-1 MOU extension (includes NOAA), SCISAT (to be launched in Januray 2003) MOU, and Letters of Agreement (LOA) for CLOUDSAT, and Mars Exploration. Those under negotiation

include: an up-date to the Mars LOA, CLOUDSAT MOU, and the Space Station multilateral Life Sciences Umbrella arrangement.

- Negotiations with the ESA on the implementation of RADARSAT-3 within the framework of Earth Watch culminated in the submission of a proposal to the ESA Council meeting at the Ministerial level, in Edinburgh, Scotland in November 2001. The ESA remains interested in identifying possibilities for participation in this program, while the CSA is presently considering alternative foreign partnerships.

To learn more about *International Business Development* go to http://www.space.gc.ca/business/ibd/default.asp.

SECTION: 5 Annexes

5.1 Financial Tables

5.1.1 Summary of Voted Appropriations

Financial Requirements by Authority ($ in millions)

Vote	Canadian Space Agency	2001-2002 Planned Spending	2001-2002 Total Authorities	2001-2002 Actual
30	Operating Expenditures	111.7	119.3	116.7
35	Capital Expenditures	194.1	195.7	166.0
40	Grants and Contributions	50.0	49.8	47.0
(S)	Contributions to Employee Benefit Plans	6.1	6.3	6.3
	TOTAL	**361.8**	**371.1**	**336.1**

Notes:

- Due to rounding, figures may not add up to totals shown.
- Planned Spending corresponds to Main Estimates Budget and to the Carry Forward of Capital Funds.
- Total Authorities are Main Estimates plus Supplementary Estimates and Other Authorities.
- Difference between Total Authorities and Actual Spending is mostly due to the re-profiling of funds in the Canadian Space Station Program from 2001-2002 to 2002-2003.

5.1.2 Comparison of Total Planned Spending to Actual Spending

Departmental Planned versus Actual Spending ($ in millions)			
	2001-2002		
Space Knowledge, Applications and Industrial Development	**Planned Spending**	**Total Authorities**	**Actual**
FTEs	429	429	461
Operating	117.0	125.0	122.4
Capital	194.9	196.3	166.7
Grants and Contributions	50.0	49.8	47.0
Total Gross Expenditures	**361.8**	**371.1**	**336.1**
Less:			
Respendable Revenues	0.0	0.0	0.0
Total Net Expenditures	**361.8**	**371.1**	**336.1**
Other Revenues and Expenditures			
Non-respendable Revenues	(4.6)	(3.9)	(3.9)
Cost of Services Provided by Other Departments	2.6	3.0	3.0
Net Cost of the Program	**359.8**	**370.1**	**335.2**

Notes:

- Due to rounding, figures may not add up to totals shown.
- Total Authorities are Main Estimates plus Supplementary Estimates and Other Authorities.
- Operating and Capital Expenditures include Employee Benefit Plans.
- Difference between Total Authorities and Actual Spending is mostly due to the re-profiling of funds in the Canadian Space Station Program from 2001-2002 to 2002-2003.

5.1.3 Historical Comparison of Total Planned Spending to Actual Spending

Historical Comparison of Departmental Planned versus Actual Spending ($ in millions)

Space Knowledge, Applications and Industrial Development	Actual 1999-2000	Actual 2000-2001	2001-2002 Planned Spending	2001-2002 Total Authorities	2001-2002 Actual
Canadian Space Agency	334.6	318.8	361.8	371.1	336.1
TOTAL	**334.6**	**318.8**	**361.8**	**371.1**	**336.1**

Notes:

- ✧ Planned Spending corresponds to Main Estimates Budget and to the Carry Forward of Capital Funds.
- ✧ Total Authorities are Main Estimates plus Supplementary Estimates and Other Authorities.
- ✧ Difference between Total Authorities and Actual Spending is mostly due to the re-profiling of funds in the Canadian Space Station Program from 2001-2002 to 2002-2003.

5.1.4 Crosswalk between Strategic Outcomes and Business Lines

Business Line: Space Knowledge, Applications and Industrial Development

Strategic Outcomes	2001-2002 Planned Spending	2001-2002 Actual Spending
Economic Benefits	227.1	201.7
Understanding the Environment and Contributions to Sustainable Development	25.5	32.1
Contributions to the Quality of Life	29.9	18.6
Technology Development and Diffusion	29.9	29.9
World-Class Space Research	20.4	21.1
Social and Educational Benefits	2.0	1.7
Promotion of the CSP	4.3	5.2
Strategic Outcomes – Sub total	**339.0**	**310.4**
Corporate and Executive functions	22.8	25.8
Total	**361.8**	**336.1**

Notes:

1) Due to rounding, figures may not add up to totals shown.

5.1.5 Revenues

Revenues ($ in millions)					
Respendable Revenues					
			2001-2002		
	Actual 1999-2000	Actual 2000-2001	Planned Revenues	Total Authorities	Actual
Canadian Space Agency	2.9	0.0	0.0	0.0	0.0
Unplanned	0.0	0.0	0.0	0.0	0.0
Total Respendable Revenues	**2.9**	**0.0**	**0.0**	**0.0**	**0.0**
Non-Respendable Revenues					
Canadian Space Agency	1.1	3.1	4.6	3.9	3.9
Unplanned	0.0	0.0	0.0	0.0	0.0
Total Non-Respendable Revenues	**1.1**	**3.1**	**4.6**	**3.9**	**3.9**
Total Revenues	**4.0**	**3.1**	**4.6**	**3.9**	**3.9**

Notes:

- ✧ Royalties are no longer listed under Respendable Revenues, but deposited in the Consolidated Revenue Fund as Non-Respendable Revenues.

5.1.6 Resource Requirements by Organisation and Business Line

Comparison of 2001-2002 (RPP) Planned Spending and Total Authorities to Actual Expenditures by Organisation and Business Line ($ in millions)			
Space Knowledge, Applications and Industrial Development			
Organisation	**2001-2002**		
	Planned Spending	**Total Authorities**	**Actual**
President's Office	2.7	2.7	1.2
Space Systems	165.6	162.4	138.4
Space Technologies	85.8	87.9	84.6
Space Sciences	59.4	53.5	53.4
Canadian Astronauts Office	8.5	8.2	5.4
Space Operations	14.4	23.2	23.1
Corporate Functions	13.3	16.4	16.3
Executive Functions	12.1	16.7	13.7
TOTAL	**361.8**	**371.1**	**336.1**
% of Total			**100%**

Notes:

- ✧ Due to rounding, figures may not add up to totals shown.
- ✧ Planned Spending corresponds to Main Estimates Budget and to the Carry Forward of Capital Funds.
- ✧ Total Authorities are Main estimates plus Supplementary Estimates and Other Authorities.
- ✧ Difference between Total Authorities and Actual Spending is mostly due to the re-profiling of funds in the Canadian Space Station Program from 2001-2002 to 2002-2003.

5.1.7 Capital Projects

Capital Projects ($ in millions)

Space Knowledge, Applications and Industrial Development	Current Estimated Total Cost	Actual 1999-2000	Actual 2000-2001	2001-2002 Planned Spending	2001-2002 Total Autho-rities	2001-2002 Actual
Canadian Space Agency						
Canadian Space Station Program (MCP)	1396.3	76.6	33.1	33.8	29.4	15.2
RADARSAT-1	662.2	10.8	12.0	8.4	12.5	12.4
RADARSAT-2	414.8	82.3	74.2	68.5	66.8	66.8
MOST	8.7	1.5	1.9	1.8	2.2	2.5
Insect Habitat	10.4	0.6	2.5	3.2	2.7	2.7
CLOUDSAT	13.9	0.6	1.9	7.9	5.8	6.0
SCISAT-1	50.3	7.1	15.4	10.0	16.9	19.4
MIM Base Unit (MIMBU)	6.3	0.0	0.2	0.0	1.0	0.7

Notes:

- ✧ The sums include contributions to Employee Benefit Plans.
- ✧ Due to rounding, figures may not add up to totals shown.
- ✧ Difference between Total Authorities and Actual Spending is mostly due to the re-profiling of funds in the Canadian Space Station Program from 2001-2002 to 2002-2003.

5.1.8 Contingent Liabilities

Contingent Liabilities ($ in millions)			
	Amount of Contingent Liability		
List of Contingent Liabilities	**March 31, 2000**	**March 31, 2001**	**Current as of March 31, 2002**
Claims, Pending and Threatened Litigation:			
Litigation:			
500-05-042325-98	6.0	14.4	14.4
Total			

Notes:

- Legal proceedings for damages in the amount of $6,000,000 were initiated in June 1998 for rights infringement on an invention. Following the defence produced by the Crown on February 26, 2001, the Plaintiff raised his claim to $14,375,000. File pending.

5.1.9 Transfer Payments

Transfer Payments ($ in millions)					
Space Knowledge, Applications and Industrial Development			**2001-2002**		
Canadian Space Agency	**Actual 1999-2000**	**Actual 2000-2001**	**Planned Spending**	**Total Authorities**	**Actual**
GRANTS					
Joint CSA / NSERC Programs	0.4	0.4	0.6	0.2	0.2
International Space University	0.2	0.2	0.2	0.3	0.3
Youth Awareness Program	0.0	0.0	0.1	0.0	0.0
CSA / Networks of Centers of Excellence Research Program	0.0	0.4	0.4	0.5	0.5
Total Grants	**0.6**	**1.0**	**1.2**	**1.0**	**1.0**
CONTRIBUTIONS					
Canada / ESA Programs					
General Budget	6.3	5.0	5.8	5.3	5.3
Satellite Communications Programs	8.1	6.2	7.3	8.2	8.1
Earth Observation Programs	8.6	7.6	9.0	8.8	6.1
Payload Flight Demonstration Program	0.0	12.0	26.0	26.0	26.0
Space Science Enhancement Program	0.8	0.4	0.5	0.3	0.3
Youth Awareness Program	0.5	0.5	0.1	0.2	0.2
Total Contributions	**24.3**	**31.6**	**48.8**	**48.8**	**46.1**
Total Transfer Payments	**25.0**	**32.6**	**50.0**	**49.8**	**47.0**

Notes:

✧ Due to rounding, figures may not add up to totals shown.

5.1.10 Status Summary of Major Crown Projects

Information on the Canadian Space Station Program, and, RADARSAT-1 and RADARSAT-2 Major Crown Projects is reported on the CSA Web site at the following address: http://www.space.gc.ca/about/default.asp.

5.2 Procurement and Contracting

Procurement and contracting is the core of the CSA program delivery. Most program objectives are achieved through the procurement of space hardware and services from Canadian industry, often implemented under international arrangements. In 2001, CSA awarded all of its contracts in accordance with the *Government Contracts Regulations.*

5.3 Abbreviations

ARTEMIS	Advanced Relay and Technology Mission Satellite
ARTES	Advanced Research on Telecommunications Systems
ATEN	Advanced Thermal Environment
CANOPUS	Canadian Auroral Network for the Observation of Plasmas in the Upper-atmosphere and Space
CCRS	Canada Centre for Remote Sensing
CHRC	Canadian Human Rights Commission
CRC	Communications Research Centre
CSA	Canadian Space Agency
CSP	Canadian Space Program
CSSP	Canadian Space Station Program
DFL	David Florida Laboratory
DND	Department of National Defence
ENVISAT	Environmental Satellite
EO	Earth observation
ESA	European Space Agency
ESS	Extensible Support Structure
EVA	Extravehicular Activity
EU	European Union
FGS	Fine Guidance Sensor
FIS	Financial Information Strategy
FSL	Fluid Sciences Laboratory
FTE	Full-Time Equivalent
GMES	Global Monitoring of Environment and Security
ISAIRAS	International Symposium on Artificial Intelligence, Robotics and Automation in Space
ISS	International Space Station
MBS	Mobile Remote Servicer [MRS] Base System
MCP	Major Crown Projects
MIMBU	Microgravity Isolation Mount Base Unit
MIPAS	Michelson Interferometer for Passive Atmospheric Sounding
MMIC	Monolitic Microwave Integrated Circuits
MOPITT	Measurement of Pollution in the Troposphere
MOST	Microvariability and Oscillations of Stars (MOST) micro-satellite
MOU	Memorandum of Understanding
MSS	Mobile Servicing System
MVIS	Microgravity Vibration Isolation System
MWR	Microwave Radiometer
NASA	National Aeronautics and Space Administration (United States)
NGST	Next Generation Space Telescope
NOAA	National Oceanic & Atmospheric Administration (United States)
NRCan	National Resources Canada

NSERC	Natural Sciences and Engineering Research Council
OGD	Other Government Departments
OSIRIS	Optical Spectrograph and Infrared Imaging
RADARSAT	Synthetic Aperture Radar Satellite
R&D	Research and Development
RPP	Report on Plans and Priorities
RSI	Radarsat International Inc.
SAR	Synthetic Aperture Radar
SL	Service Line
SME	Small and Medium Sized Enterprise
SPDM	Special Purpose Dextrous Manipulator
SSRMS	Space Station Remote Manipulator System
STS	Space Transportation System
S&T	Science and Technology
SWIFT	Stratospheric Wind Interferometer For Transport studies
U.S.	United States
WINDII	Wind Imaging Interferometer

5.4 List of Hyperlinks Cited

State of the Canadian Space Sector:
http://www.space.gc.ca/business/scss/default.asp

Satellite Communications:
http://www.space.gc.ca/csa_sectors/sat_com/default.asp

RADARSAT-1:
http://www.space.gc.ca/csa_sectors/earth_environment/radarsat/radarsat_info/default.asp

RADARSAT-2:
http://www.space.gc.ca/csa_sectors/earth_environment/radarsat2/default.asp

ENVISAT:
http://www.space.gc.ca/csa_sectors/earth_environment/envisat/about/default.asp

CSA-ESA Earth Observation:
http://www.space.gc.ca/csa_sectors/generic_space_tech/tech_manag/tech_esa_desc.asp

Canadian Space Station Program:
http://www.space.gc.ca/about/sr_mcp/default.asp

Atmospheric Environment:
http://www.space.gc.ca/csa_sectors/space_science/atmospheric_env/default.asp

MOPITT:
http://www.space.gc.ca/csa_sectors/space_science/atmospheric_env/mopitt.asp

Space Environment:
http://www.space.gc.ca/csa_sectors/space_science/spa_env/default.asp

Government Department-Related Initiatives:
http://www.space.gc.ca/csa_sectors/earth_environment/default.asp

Technology Development and Diffusion:
http://www.space.gc.ca/csa_sectors/generic_space_tech/default.asp

Space Life Sciences:
http://www.space.gc.ca/csa_sectors/space_science/space_life_sciences/default.asp

Microgravity Sciences:
http://www.space.gc.ca/csa_sectors/space_science/microgravity_sci/default.asp

Space Astronomy:
http://www.space.gc.ca/csa_sectors/space_science/space_astronomy/default.asp

Space Exploration:
http://www.space.gc.ca/csa_sectors/space_science/space_exploration/default.asp

David Florida Laboratory:
http://www.space.gc.ca/space_qualification/david_florida_lab/default.asp

Kids Space:
http://www.space.gc.ca/kidspace/default.asp

Canadian Space Program:
http://www.space.gc.ca/about/csagla/canspapro/default.asp

International Business Development:
http://www.space.gc.ca/business/ibd/default.asp