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CANADIAN SPACE AGENCY

Departmental Performance Report
For the period ending
March 31, 2010

Analysis of Program Activities by Strategic Outcome

- Detailed Performance Information -

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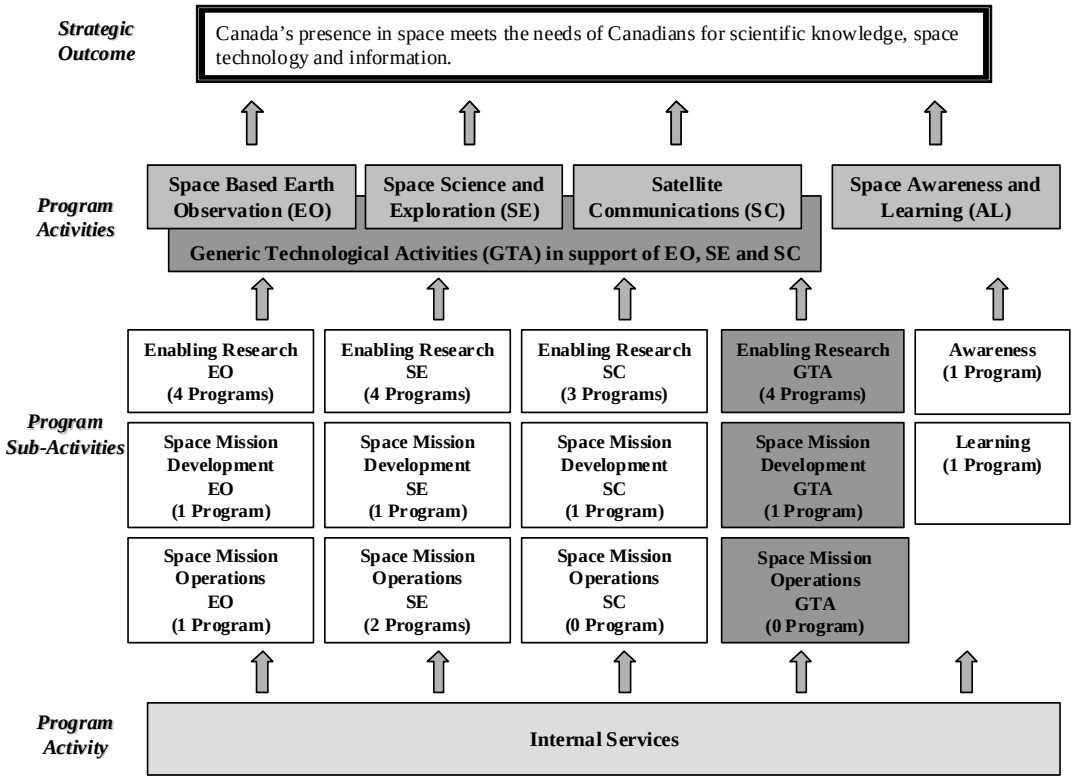
INTRODUCTION

Since 2005-2006, the Canadian Space Agency's (CSA) achievements are reported according to the Program Activity Architecture (PAA) framework. The information is presented by Program Activities, Program Sub-Activities and then by Program Sub-Sub-Activities.



SECTION 2: ANALYSIS OF PROGRAM ACTIVITIES BY STRATEGIC OUTCOME

2.1 HOW TO READ THE DETAILED ANALYSIS

Program Activity: For this level, the information is reported against final results and performance indicators. During the Performance Measurement Framework (PMF) exercise, the results and indicators were reviewed thoroughly and were presented for the first time in the 2008-2009 Report on Plans and Priorities (RPP). The first final results full analysis will take place in 2010 at the end of the five-year cycle that started with the approval of the Canadian Space Strategy in February 2005 and the implementation of the Program Activity Architecture (PAA) in 2005-2006. It is the second time that a progress report from the year 2005-2006 is provided.

Program Sub-Activity: For this level, intermediate results and performance indicators were only developed in 2007-2008 and were listed for the first time in the 2008-2009 RPP. For each Program Sub-Activity, the section *Highlights of Main Accomplishments* shows example of achievements selected from the array of projects and activities carried out by the CSA and its industry, academic and government partners, in response to what was forecasted in the corresponding RPP.

Program Sub-Sub-Activity: For this level, the information is reported yearly against immediate results and performance indicators. In this year's report, a 3-year trend performance analysis is provided for each sub-sub-activity.

Performance Analysis: Every year, a performance analysis is completed for each level of the PAA. This analysis provides contextual, complementary or methodological, as well as financial and human resources information. A 3-Year Trend Analysis at the sub-sub-activity level is provided as illustrated by the following star system. In addition, trend analysis is annually performed by slipping one year – adding the new-year value and knocking the fourth year value. This allows displaying the trend stability.

★★	**SUPERIOR ACHIEVEMENT:** Uncommon achievement over targeted superior limit.
★	**SATISFACTORY ACHIEVEMENT:** Expected or maintained achievement within lower and superior targeted limits.
⚑	**OPPORTUNITY FOR IMPROVEMENT:** Achievement below targeted lower limit.
⇧ ⇔ ⇩	**COMPARISION TO PREVIOUS YEAR:** The current trend is compared to the one recorded the previous year. Icons can show an improving, stable or declining trend.

2.2 SPACE BASED EARTH OBSERVATION

SPACE BASED EARTH OBSERVATION
2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT

BENEFITS FOR CANADIANS

Earth Observation (EO) enables monitoring of the environment with unparalleled coverage and scope, enhancing our forecasting capabilities and our understanding of environmental systems.

EO data are used for sustainable management and development of natural resources, land use, fisheries and agriculture and providing support for disaster management.

EO missions are critical to security and sovereignty, offering cost-effective, wide-area surveillance of land and maritime environments that are difficult to access such as the Northwest Passage.

Among Canada's government users benefiting from EO data are Environment Canada, Fisheries and Oceans Canada, the Canadian Ice Service, Natural Resources Canada, the Department of National Defence, and the Provinces and Territories.

EXPECTED RESULT

The benefits of activities involved in Earth Observation from space serve Canadian users in the fields of environment, resource and land-use management, and security and sovereignty.

MAIN ACCOMPLISHMENTS IN 2009-2010

RADARSAT-2 is fully operational since April 2008. The Canadian Government has a $445 million credit over the life of the satellite. There is a substantial increase in the use of data by a number Canadian government departments which used data valued at over $34 million in 2009-2010 compared to $13.8 million in 2008-2009.

The CSA continued the planning and development of the first of three satellites for the RADARSAT Constellation, the follow-on mission to RADARSAT-2, to be launched in 2014 and 2015. A Preliminary Design, initiated in November 2008, was completed in March 2010 and the detailed design phase started in March 2010.

The CSA ensured Canada's commitment, as an official member of the International Charter *Space and Major Disasters.* CSA continued to contribute critical EO images in support of relief, aid and humanitarian efforts undertaken in response to disasters in countries around the world. This year alone CSA has supported 30 Charter activations providing data world-wide for covering different disaster types such as floods, earthquakes, volcanos, oil spills, land slides, and hurricanes.

Indicators	Performance Summary
1. Proportion of active missions relative to the total number of missions supported by Canada in the EO priority areas.	25%; 9 active missions out of 36 supported missions.
2. Number of applications developed as a result of CSA's participation in space missions and/or support to projects/activities in EO considered "operational" from program standards.	A total of 15 applications became operational in 2009-2010.

3. Number of uses of EO data as a result of CSA's participation in space missions and/or support to projects/activities in EO.	A total of 74 uses were reported.

Indicator 1 – Performance Analysis

At the time of the Departmental Performance Reporting, the Canadian Space Agency presents a list of space missions to which it actually contributes or plans to contribute. The fact that a mission appears on the list does not mean that it will be completed. Any mission must necessarily follow many critical steps depicted in a simple manner as such:

- Mission under review: A mission that is subject to concept of feasibility studies. At the end of this step, a decision is made whether to continue, to cancel or to postpone the participation to the mission.
- Mission in development: The participation implies that activities produce assets which are not yet operational. The final milestones prior to operation are the launch and the full commissioning of the mission.
- Mission in operation: The mission is operational, delivering results until being fully completed. By virtue of being in operation, a mission will spark scientific, technological and operational activities in order to reach its objectives.

EO missions at the operation stage (9): * = 0
EO missions at the development stage (13): * = 0
EO missions under review (14): * = 1

(Year) = Actual or projected launch date or date of completion when known.
***** = New missions in 2009-20010: 3% (1/36)

Descriptions of missions can be found in Section 2.8 – List of Space Missions.

Earth Observation (EO) missions at the operation stage:

Mission	Status	Field
CloudSat (2006)	In operation, objectives met	Environment
ESA-ENVISAT (2002)	In operation	Environment, Resource and Land Management
ESA-ERS-2 (2005)	In operation	Environment, Resource and Land Management
ESA-GOCE (2009)	In operation	Environment
MOPITT (1999)	In operation, objectives met	Environment
OSIRIS (2001)	In operation, objectives met	Environment
RADARSAT-1 (1995)	In operation	Environment, Resource and Land Management, Security and Foreign Policy

RADARSAT-2 (2008)	In operation	Environment, Resource and Land Management
SCISAT (2003)	In operation, objectives met	Environment

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Earth Observation (EO) missions at the development stage:

Mission	Status	Field
Constellation RADARSAT (2014)	In development	Environment, Resource and Land Management, Security and Foreign Policy
ESA/JAXA-EarthCARE (2013)	In development	Environment
ESA-ADM/Aeolus (2009)	In development	Environment
ESA-Cryosat (2009)	In development	Environment
ESA-Sentinel-1 (2011)	In development	Environment, Resource and Land Management, Security and Foreign Policy
ESA-Sentinel-2 (2012, 2016)	In development	Environment, Resource and Land Management, Security and Foreign Policy
ESA-Sentinel-3	In development	Environment, Resource and Land Management, Security and Foreign Policy
ESA-Sentinel-5 Precursor	In development	Environment
ESA-SMOS (2009)	In development	Environment
ESA-Swarm (2011)	In development	Environment
JC2Sat	In development	Technology demonstration
NIRST (AQUARIUS / SAC-D) (2010)	In development	Environment
PROBA-2 (2009)	In development	Environment, Technology demonstration

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Earth Observation (EO) missions under review:

Mission	Status	Field
CANSOC	Under review	Infrastructure, Data reception
CASS	Under review	Environment
MCAP	Under review	Environment
MEOS	Under review	Environment

MOPITT 2	Under review	Environment
PCW/PolarSat (weather component) (2016)	Under review	Meteorology, Climatic Change, Environment, Resource and Land Management, Security and Foreign Policy
* PHEMOS (atmospheric component)	Under review	Environment
SMAP	Under review	Environment
Snowsat	Under review	Environment
SOAR	Under review	Environment
STEP	Under review	Environment
SWIFT (Chinook) (2014)	Under review	Environment
TICFIRE	Under review	Environment
WaMI	Under review	Environment

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Indicator 2 – Performance Analysis

A total of 15 applications became operational in 2009-2010 compared to 23 last year; 5 from the EOADP and 10 from GRIP divided as such: 8 monitoring applications (*e.g. Environmental Monitoring, Ecological Integrity, Ice Movement Mapping; Water Quality Monitoring*), 4 detecting applications (*e.g. Oil Slick and Ship Detection; Forest Monitoring; Energy and Biomass Monitoring*), and 3 measuring applications (*e.g. Soil Moisture and Geological and Water Monitoring, Winds and Waves Extraction*).

Source: Internal documents.

Indicator 3 – Performance Analysis

Thirty-five of the 74 uses (47%) reported had national purposes. The uses could be grouped under four main themes: Natural disaster, the Great North/Arctic, Water/Fisheries, Forest/Mining/Agriculture. Here are a few examples taken from CSA's EO Express publication:

Natural catastrophes: Studying satellite radar data from the ENVISAT Earth observation satellite, scientists have begun analyzing the movement of Earth during and after the 6.3 earthquake that shook the medieval town of L'Aquila in central Italy on 6 April. (Edition 34 – topic 11)

In July 2009, heavy rains have caused floods and landslides in mountainous northern regions of Vietnam. According to officials, at least 15 deaths were reported and houses and roads have been destroyed by floods. The Canadian RADARSAT-2 Earth observation satellite is a key resource in a variety of disaster management scenarios. The ability to deliver data to regional authorities is essential for relief operations to map and monitor damage and for assessing the impact. The UNDP Vietnam has used RADARSAT-1 and RADARSAT-2 flashed-flood products to better manage the event in Nguyen Phuc, Bach Thong, and Bac Kan Provinces. (Edition 37 – topic 8)

The Great North/Arctic: The RADARSAT-1 and RADARSAT-2 mosaic of the Foxe Basin region captures the contrast of the icy shallower waters of Foxe Basin with the warmer deeper waters of the Foxe Channel. It ensures the safety of Canadians, their property and their environment by warning them of hazardous ice conditions in Canadian territorial waters; and provides present and future generations of Canadians with sufficient knowledge about their ice environment to support sound environmental policies. (Edition 41 – Topic 4)

Water/Fisheries: Ocean waves are a very important marine physical factor for coastal protection, offshore oil and gas development, transportation, people involved in fisheries, and marine recreation, wind and wave energy farms. Spaceborne synthetic aperture radar (SAR), such as RADARSAT-2, can provide large area high spatial resolution observations of ocean waves under all-weather conditions. Development of new improved retrievals of wave and wind information by means of polarimetric RADARSAT-2 data in open-sea and coastal regions can contribute to improved marine forecasts in these areas. Improved wave and wind information is directly relevant to the Department of Fisheries and Oceans (DFO) priorities. (Edition 35 – Topic 2)

Forest/Mining/Agriculture: Extreme weather along with climate change induced natural disasters is a major concern to all of Canada, particularly to the Canadian Prairies, and each year at least some part of the country is impacted. To monitor drought, crop condition and soil moisture provides crucial information for adaptation and mitigation programs. At regional and national scale, high and medium resolution microwave and optical satellites EO information offers the unique opportunity to derive many surface parameters over a range of temporal and spatial scales. The value added EO data from sensors like ENVISAT/MERIS and RADARSAT-2 are integrated in agriculture related models such as Productivity Efficiency Model (PEM) and Ecological Assimilation of Land and Climate Observations (EALCO). This will further improve agricultural decision making, increase the ability to manage extreme events (e.g. drought, flood), and strengthen the Earth observation capabilities. (Edition 42 – Topic 1)

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
85.8	87.3	75.5
2009-2010 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
78.0	58.1	19.9

The programs under this Program Activity are divided into three Sub-Activities: Enabling Research, Space Mission Development and Space Mission Operations.

Program Sub-Activity: Enabling Research – Earth Observation

Objective: Provide leadership, coordination or support to Earth Observation (EO) applied research and experimental development in line with the CSA priorities and stakeholders expectations in order to increase the knowledge base and devise new applications through space missions, and to allow the transfer of intellectual property and proven technologies to Canadian industry, academia, and government organizations.

Expected Result #1	
New project/mission concepts that progress to subsequent development phases related to Agency's priorities.	
Indicators	**Performance**
1. Ratio of the number of new concepts presented to the number of new concepts retained for subsequent phase.	There was no new concept presented nor retained in 2009-2010.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	Unavailable this year.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Enabling Research projects/missions.	
Indicator	**Performance**
1. Number of consulting requests received by CSA personnel from external sources such as the private sector, academia and other space agencies.	For all program activities combined, the CSA personnel responded to an estimated 92 consulting requests from external sources in 2009-2010.

Performance Analysis
Expected Result #1 Indicators 1-2 Analysis not applicable. **Expected Result #2** Indicator 1 The number "92 requests", 16 more than last year, represents an estimation based on an average number of days allocated per request from OGD, universities and industry for rare expertise held by CSA personnel. Examples of such requests are participation in research grant submissions or academic case studies, provision of technical advice to industry and academia on space related projects, and technical evaluation of proposals or documents received by OGDs. Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
23.3	22.8
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
14.6	14.4

ENABLING RESEARCH – EARTH OBSERVATION

Four Earth Observation Enabling Research Programs with a combination of accomplishments demonstrate how the following expected results were measured and attained at the program sub-sub-activity level.

1- EO Mission Concepts – Objective: Assume the leadership and support in the enabling research and development of new mission concepts leading to the realization of CSA or international EO space missions.

EXPECTED RESULT #1

Industry, government and/or academia conduct mission and payload concept and feasibility studies to establish the technical and/or scientific feasibility and relevance of missions or payloads in order to enable CSA decisions on future EO space missions.

Indicator	Performance
1. Number of concept/feasibility (mission and payload) and phase 0/A studies initiated, pursued or completed. (Target: 12)	**Target met:** 12 concepts.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on four consecutive data although this year two sectors contributed to the indicator. Trend analysis maintains the satisfactory rating for targeted achievements were slightly exceeded on the three occurrences evaluated. Benchmark cannot be extrapolated at this time since available values did not reach appropriate stability.

★ ⇧

Satisfactory

Indicator 1

Space Science: 8 contracts completed: WaMI, MOPITT-2, and 6 APOCC concepts.
2 contracts initiated: SWIFT-DASH and CASS.
Space Technologies: Completion of the phase 0 study for the EO payload on PCW and starting of a new study for the phase of that payload.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
0.4	2.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.9	3.8

2- European Space Agency (ESA) Programs in EO – Objective: Through key international partnerships, enhance the Canadian industry's technological base and provide access to European market for value-added products and services in the field of EO.

EXPECTED RESULT #1

Successful development and demonstration of advanced technologies, systems, components, or studies provided for in the contracts awarded by ESA to Canadian firms under EO optional programs. (ENVISAT, EOEP, EarthWatch GMES Service Element, GMES Space Component)

Indicator	Performance
1. Canadian industrial return in ESA optional programs in EO. (Target: 84% or higher)	**Target exceeded:** 118%

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis maintains the superior rating for targeted achievements were consistently exceeded. Benchmark is well established among ESA community.

Superior

Indicator 1

The return coefficient corresponds to the ratio between the actual number of weighted contracts given to a country and the ideal number of contracts to be given to that country according to existing rules. Canadian industrial return coefficients are by Program Activity. The EO optional programs are: ENVISAT the largest ever Earth observation satellite built by ESA, EOEP (Earth Observation Envelope Program), Earth Watch GMES (Global Monitoring for Environment and Security) Service Element and GMES Space Component.

Source: Geographical distribution of contracts ESA/IPC(2009)13, rev.3, published on March 2, 2010, and covering the period between Jan 1, 2000 to December 31, 2009.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
9.2	6.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	0.0

3- Science Programs in EO – Objective: Coordinate the Canadian Earth Observation (EO) scientific community in order to pursue world-class research space missions to advance our knowledge in the fields of atmospheric environment and climate change phenomena studies.

EXPECTED RESULT #1

Identified opportunities for Canadian scientists to advance understanding and scientific knowledge of atmospheric environment through the use of space-based observations.

Indicators	Performance
1. Number of scientific publications, reports and conference proceedings acknowledging CSA funding. (Target: 80)	**Target exceeded:** 105 as of April 30, 2010.
2. Number of Highly Qualified Personnel (HQP) involved in the program. (Target: 70)	**Target exceeded:** 145 as of April 30, 2010.

3. Number of research partnerships (nationally and internationally). (Target: 15)	**Target exceeded:** 38
4. Number of awards granted yearly under the CSA Grants and Contributions Program. (Target: 4)	**Target exceeded:** 13

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis upgrades the satisfactory rating to superior because all targeted achievements were exceeded. Benchmark values could only be confirmed for two indicators, the others have yet to reach an appropriate stability.

Superior

Indicator 1

52 No. of Peer Reviewed Publications acknowledging CSA Funding

1 No. of Non-Peer Reviewed Publications acknowledging CSA Funding

1 No. of Books acknowledging CSA Funding

38 No. of Peer Reviewed Publications acknowledging CSA Funding

13 No. of Non-Peer Reviewed Publications enabled by CSA Funding

0 No. of Books enabled by CSA Funding

Target exceeded due to better management of survey; facilitated principal investigator (PI) responses with a user friendly survey and an easier data management/reporting procedure using ORIS (Organized Research Information System).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 2

6 Canada Research Chair
29 Tenured Faculty
4 Non-Tenured Faculty
5 Research Associates
17 Post-Doctoral Fellows
16 Research Assistants
17 Graduate Students
5 Undergraduate Students
21 Engineers/Technicians
25 Other personnel

Target exceeded due to better management of survey; facilitated principal investigator (PI) responses with a user friendly survey and an easier data management/reporting procedure using ORIS (Organized Research Information System).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 3

21 partnerships for Grants and contracts
17 additional partnerships for Internal Collaborative Arrangements partnerships (MOU, MOA, etc.).

Target exceeded due to better management of survey; facilitated principal investigator (PI) responses with a user friendly survey and an easier data management/reporting procedure using ORIS (Organized Research Information System).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 4

3 on-going grants + 10 new grants awarded.
Exceeded due to good proposals received from SSEP 2008 AO and availability of G&C funds.

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
1.1	1.2
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
1.9	1.9

4- EO Application Development Programs – Objective: Enhance Canada's ground receiving and data processing systems, develop and demonstrate EO data value-added applications for commercial use and for Canadian government operations.

EXPECTED RESULT #1

Development of EO applications responding to user needs in government, industry, academia and not-for-profit organizations in the fields of environment, resource and land use management, and, security and foreign policy.

Indicators	Performance
1 Number of new applications using EO data. (Targets: 22 that is 4 for EOADP and 18 for GRIP)	**Target exceeded:** 29 (5 applications for EOADP and 24 for GRIP)
2. Number of new users of EO applications. (Targets: 52 that is 8 for EOADP and 44 for GRIP)	**Target exceeded:** 67 (9 for PDAOT and 58 for GRIP)

PERFORMANCE ANALYSIS:	
3-Year Trend Indicator #2 was introduced in 2008-2009 RPP and is measured for the second time. Trend analysis is based on two measurements for one indicator and five for the second one and since both achievements exceeded increased targets, the rating was upgraded from satisfactory to superior. Benchmark values could only be confirmed for indicator #2 even though it was slightly increased, the other indicator has yet to reach an appropriate stability. Indicators 1 and 2 No comment. Source: Internal documents.	★★⇧ Superior

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
12.7	13.5
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
11.8	8.6

Highlights of Main Accomplishments – Enabling Research (EO)

- Following the successful launch of RADARSAT-2 in December 2007, the Canadian government data allocation management plan is successfully being implemented to manage the $445 million worth of prepaid data from the satellite. The objective of the program is to ensure that the allocation is effectively used by the Canadian Government. CSA negotiates agreements with government departments to develop their data acquisition plans and utilisation, and monitor its implementation. During the first full year of operations, the CSA has met its forecasts established at the beginning of the year and even saw a substantial increase in the use of RADARSAT-2 data by some Canadian government departments. At the same time, the CSA has monitored the cost of services associated with the data ordering closely with the user government departments in order to reduce unnecessary expenses.

- The Canadian Space Agency, in cooperation with the Center for South-eastern Tropical Advanced Remote Sensing (CSTARS), the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA), has launched in 2008 an International Announcement of Opportunity (AO) for researching new developments in applications of RADARSAT data and innovative research and mapping applications related to ocean surface space borne SAR imagery of hurricanes. The Announcement of Opportunity circulated among the global research community and generated 14 proposals from Canada and other countries. The results from the research groups are now complete.

- The Earth Observation Application Development (EOADP) and the Government Related Initiatives (GRIP) Programs are CSA's main vehicles to support satellite data application development and utilization to enhance Earth Observation capabilities within the Canadian government departments and agencies and the service industry. This Canadian EO community continues to show a growing interest in these programs and, following a Call for Interest issued in late fall 2009, the GRIP program received an unexpectedly high number of proposals (48) for EO applications with a value equivalent to twice the funds available for the program.

- Given the development of the Long Term Space Plan and the CSA reorganization, the initiation of concept studies to evaluate how Canadian and international user needs can be met using space based EO has been postponed to 2010-2011.

- The CSA actively supported Canadian government scientists through its GRIP to exploit European Space Agency (ESA) Earth Explorer mission data. ESA launched three Earth Explorer missions during the year: Global Ocean Circulation Experiment (GOCE), Soil Moisture and Ocean Salinity (SMOS), and CryoSAT-2. Canadian scientists are actively involved in the commissioning activities for all three missions as well as the on-going calibration and validation activities.

- A Canadian company, in collaboration with University of Calgary, is developing advanced space-borne instruments for ESA's SWARM mission, which are designed to monitor the ionosphere. SWARM is in the final stage of development: the flight model is ready to be delivered. The Polar View project under ESA's GMES Service Element was successfully completed under the leadership of C-CORE (Newfoundland) and has been extended in view of its success.

- The MORSE initiative aims at developing and demonstrating the usefulness of EO data for monitoring coastlines and coastal processes in the Arctic focusing on the information needs of Arctic coastal users in government, industry and in scientific organizations. It supports, enhances and stimulates coordination among Arctic coastal communities having common Earth observation-related information needs and activities across sectors and across disciplines. Four proposals have been identified; the first one to be implemented is called eSPACE, a multi-agency project to develop and demonstrate the use of EO data for emergency preparedness and response and habitat conservation, which already began in late 2009-2010.

- The CSA initiated a study contract to complete the assessment of the requirements of the Canadian government users for a polar satellite system as part of a joint study with Department of National Defence (DND) and Environment Canada. The concept of the Polar Communications and Weather Mission is to put a constellation of satellites in highly elliptical orbit over the North Pole to provide continuous communication and monitoring weather services in the Arctic.

Program Sub-Activity: Space Mission Development – Earth Observation

Objective: Provide coordination or support to the development of Earth Observation space missions in line with CSA priorities and stakeholders' expectations through the definition, critical design, manufacturing, integration, testing and delivery phases leading to launch and early operations of space systems.

Expected Result #1	
Space mission proposals that efficiently, effectively and economically progress to subsequent operations phases in accordance with objectives, requirements, initial or revised specifications.	
Indicator	**Performance**
1. Number of projects requiring more than one EPA (Effective Project Approval) or an amendment to initial EPA over the total number of projects.	There were no new EPA submitted to TB in 2009-2010 nor were there any amendments made to previous EPAs for the Earth Observation Program Activity.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Development projects.	
Indicator	**Performance**
1. Rate of expertise matrix support to all of CSA's program activities.	A 51% rate of planned expertise matrix – all program activities combined.

Performance Analysis

Expected Result #1

Indicator 1

Analysis not applicable.

Expected Result #2

Indicator 1

This 51% rate of planned expertise matrix support, a planning 13% higher than last year, is based on the average support of 83 specialized personnel to 10 missions at the development stage. A 50% rate of planned matrix support by specialized personnel is considered adequate from a management perspective.

Source: Internal reporting documents (E-Ram).

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
48.2	40.7
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
36.9	25.0

SPACE MISSION DEVELOPMENT – EARTH OBSERVATION

One EO Space Mission Development Program, with a combination of accomplishments, demonstrates how the expected result outlined below was measured and attained at the program sub-sub-activity level.

1- EO Projects – Objective: Ensure the development, delivery and commission of space-qualified systems for EO missions in the fields of advanced imaging technologies, atmospheric environment and climate change phenomena studies through effective project, quality and engineering management.

EXPECTED RESULT #1	
EO projects' deliverables meet mission objectives at critical steps.	
Indicator	**Performance**
1. Number of missions/projects associated with science support. (Target: 3)	**Target met:** 1

EXPECTED RESULT #2	
EO projects' deliverables are met.	
Indicators	**Performance**
1. Project milestones are met as defined in the detailed work plan. (Target: 75% of milestones achieved versus planned)	**Target exceeded:** 83%
2. Project cost is maintained within authorized levels. (Target: 100%)	**Target met:** 100% was maintained within authorized levels for RCM and JC2Sat.
3. Risks are identified and mitigation plans prepared for each project. (Target: 100%)	**Target met:** 100 % Risks are identified and mitigation plans prepared for RCM and JC2Sat.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the first time for all indicators. Trend analysis maintains the satisfactory rating for targeted achievements have almost all been met. Benchmark values could only be confirmed for two indicators, the others have yet to reach an appropriate stability.

★ ⇔

Satisfactory

Expected Result #1

Indicator 1

Ongoing mission: SMAP.
SMAP is the only EO project in phases B-C-D.
Note: The target appears to have been over-optimistic.

Source: Internal documents.

Expected Result #2

Indicator 1

12 activities (RCM, R2 and JC2Sat).
RCM EPA was postponed & Agreement with JAXA on JC2Sat was also postponed.

Source: Internal documents.

Indicator 2

No comment.

Source: Internal documents.

Indicator 3

RCM completed Phase B with $1.3 million of risk funds returned to the risk reserve.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
48.2	40.7
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
36.9	25.0

Highlights of Main Accomplishments – Space Mission Development (EO)

- A Preliminary Design for RADARSAT Constellation, initiated in November 2008, was completed in March 2010. The detailed design phase started in March 2010. This program will enhance the Canada's ability to use radar imagery for operational maritime surveillance, disaster management and environment and resources monitoring and will support the strategic objectives of Canada on security and sovereignty, particularly in the Arctic. The launch of the first satellite is planned for 2014 followed by the other two satellites in 2015.

- Many Canadian companies are supplying Space and Ground Segment subsystems for the missions Sentinel-1, 2 and 3 of ESA Global Monitoring for Environment and Security (GMES) space component program. For Sentinel-1, Canada is providing a SAR processor and an active calibration transponder. For Sentinel-3, Canadian companies were successful in receiving contracts to provide the SAR antenna and support for the Attitude Orbit Control Subsystem (AOCS). Sentinel missions are designed to provide information on the environment for government users including Canada. Several cooperation meetings were held to discuss interoperability between RADARSAT Constellation and Sentinel-1 C-band SAR missions, which would facilitate the sharing of data from both missions.

- Many Canadian companies are participating in EarthCARE mission through ESA and JAXA (Japanese Space Agency). Canadian companies successfully won the bids to supply RF-Front-End for Cloud Profiling Radar and a detector for Broad-Band Radiometer.

- The CSA continued development of a tandem Nanosat mission JC2Sat with JAXA. Both satellites will carry an infrared sensor but in two different frequency bands. These sensors will use innovative bolometer technology developed in Canada. The project is being re-formulated as a result of uncertainties regarding the availability of a Japanese launcher.

- The CSA is also exploring partnership with NASA on JPL's (Jet Propulsion Laboratory) Earth observation missions which are complementary to the CSA program, in order to provide data to Canadian government users on soil moisture. In 2009, the CSA held discussions with JPL on possible contributions to the Soil Moisture Active Passive (SMAP) mission in order to provide direct access to Environment Canada, of soil moisture information for the land mass of Canada over the next decade. Soil moisture information is important for weather prediction on precipitation and to predict flash floods by giving the level of soil humidity saturation. Options for hardware contributions and science validation activities were discussed. Contribution to science activities is now being pursued as the Canadian contribution to the Program. CSA began supporting development of the Canadian SMAP Science Plan in 2009-2010 through an MOU with Environment Canada. An Implementing Arrangement between NASA and CSA for Cooperation on the SMAP mission has been initiated.

Program Sub-Activity: Space Mission Operations – Earth Observation

Objective: Provide coordination or support to the operations of Earth Observation space missions in line with the CSA priorities and stakeholders' expectations through the development and conduct of on-orbit operations, system maintenance and logistic support, as well as data handling and delivery.

Expected Result #1	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Operations activities.	
Indicators	**Performance**
1. Annual rate of investment in maintenance and improvement of the infrastructure required for missions in operation phases.	After a second attempt, the data collection for this indicator revealed to be too strenuous; therefore, it will no longer be measured.
2. Quality of the internal expertise specializing in advice and technology-watch to ensure the successful flow of missions reaching operation phases.	After a second attempt, the data collection for this indicator revealed to be too strenuous; therefore, it will no longer be measured.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
14.2	12.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
26.5	18.8

Note: Planned Spending exclude reinvestment of royalties from sale of RADARSAT-1 data estimated at $4.1 million.

SPACE MISSION OPERATIONS – EARTH OBSERVATION

One EO Space Mission Operations Program, with a combination of accomplishments, demonstrates how the expected result outlined below was measured and attained at the program sub-sub-activity level.

1- EO Mission Operations – Objective: Operate the space and ground segments for EO mission operations.

EXPECTED RESULT #1

CSA operational satellite missions are supported in accordance with mission requirements.	
Indicator	**Performance**
1. Provision of services and infrastructures for operational EO satellite missions as per requirements. (Target: services for RADARSAT-1, RADARSAT-2 and SCISAT-1)	**Target met:** Services and infrastructure provided as per requirements for RADARSAT-1, RADARSAT-2 and SCISAT-1.

EXPECTED RESULT #2

Data and images received from EO satellites are delivered in accordance with client requests.	
Indicator	**Performance**
1. Volume of data acquired or delivered as per mission requirements and resources. (Targets: 300 Gbytes from SCISAT-1; 5 000 SAR minutes from RADARSAT-1; 5 000 images from RADARSAT-2)	**Target exceeded:** 900 Gbytes from SCISAT-1, 9,000 SAR minutes from RADARSAT-1, 21,060 images from RADARSAT-2.

EXPECTED RESULT #3

EO Space Mission Operations meet user/client needs as per mission requirements.	
Indicator	**Performance**
1. Number of missions in operational phase associated with science support. (Target: 4)	**Target met:** 4 ongoing missions.

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is measured for the third time for one of the three indicators based on five consecutive data, one trend was completed for one indicator and a new indicator was measured following its introduction in the RPP 2009-2010. Trend analysis maintains the rating to superior for targeted achievements were all met or consistently exceeded. Benchmark values were confirmed for two indicators.	★★⇔ Superior

Expected Result #1

Indicator 1

No comment.

Source: Internal documents.

Expected Result #2

Indicator 1

21,060 images includes background mission.

Source: CSA's Mission Operations Center System; CSA's Mission Management Office/Database Management, Internal documents.

Expected Result #3

Indicator 1

MOPITT, OSIRIS, SCISAT and CloudSat.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
14.2	12.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
26.5	18.8

Note: Planned Spending exclude reinvestment of royalties from sale of RADARSAT-1 data estimated at $ 4.1 million.

Highlights of Main Accomplishments – Space Mission Operations (EO)

- RADARSAT-1 operation was fully maintained with the usual level of high performance for satellite reliability and image production. An increased volume of data was provided to Canadian government clients from RADARSAT-2 as per client needs. The two satellites together in operations has helped tremendously in reducing the imaging conflicts and meeting the data needs of the Canadian government departments, as well as data continuity to users was more assured. Moreover, a contingency plan is in place to secure the use of ENVISAT from ESA as backup in order to continue to meet the needs of operational users if Canadian satellites were unable to meet this requirement. This contingency plan provides an equivalent back-up capability to ESA using RADARSAT-1 and RADARSAT-2.

- The CSA has continued to ensure Canada's commitment, as an official member of the International Charter *Space and Major Disasters*, to use EO satellites in response to disasters. The CSA regularly contributes RADARSAT's data and strategic EO-derived information products upon charter activation. This year alone CSA has supported 30 Charter activations providing RADARSAT-1 and RADARSAT-2 data world-wide for covering different disaster types such as flood, earthquake, volcano, oil spill, land slide, hurricane, etc.

- The CSA has continued to support and operate SCISAT, a Canadian mission launched in August 2003. The mission continues to be nominal and is providing a large amount of very high quality data on more than 30 chemical species and related parameters (temperature, pressure, winds, and aerosols) in the Earth's middle and lower atmosphere for climate, weather and pollution studies. Through an agreement with ESA and NASA, the data that are not accessible from Canada are received by one European and one American station therefore greatly expanding the range of coverage.

- The CSA continued to support the validation of CloudSat data. CloudSat is a NASA satellite launched in 2006 to which Canada contributed essential radar components. It is designed to study the water, snow and ice content of clouds, providing data to improve climate models and weather forecasting. As part of an agreement with NASA, the CSA will continue collaborating with the Meteorological Service of Canada (MSC), Environment Canada to run comprehensive validation campaigns.

- Canada continues to support data retrieval and analysis from the Canadian OSIRIS instrument on the Swedish-Canadian-French-Finnish satellite Odin, launched in February 2001. This is a third-party mission of ESA. The retrieval of information on ozone and related species over this extended period is providing crucial data in relation to the recovery of ozone in the Earth's atmosphere through the Montreal Protocol. The retrieval of aerosol data from the instrument is particularly important since it is one of the few sources of global data on this Essential Climate Variable.

2.3 SPACE SCIENCE AND EXPLORATION

SPACE SCIENCE AND EXPLORATION 2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS The CSA sustains and increases Canada's contribution to humankind's scientific knowledge and to the development of space related technologies. Research in physical and life sciences and in space exploration has great potential to bring about socio-economic benefits. Space Science and Exploration (SE) endeavours, which invariably involve international partners, position Canada to play an influential role in building strong and mutually beneficial partnerships with an increasing number of space faring countries. In striving to become one of the most advanced, connected and innovative nation in the world, space science and exploration stimulates some of the brightest minds to contribute to the Canadian economy in an increasingly competitive international environment.	
EXPECTED RESULT Participation in Canadian and international missions expands the scientific knowledge base made available to Canadian academia and research and development communities in the areas of astronomy, space exploration and solar-terrestrial relation, as well as in the physical and life sciences.	
MAIN ACCOMPLISHMENTS IN 2009-2010 As a member of the first permanent six-person crew of the International Space Station (ISS), Dr. Robert Thirsk became the first Canadian Astronaut to live and work on the ISS for a six-month period where he assumed responsibilities for the maintenance and repair of the ISS and conducted experiments on behalf of Canadian and international researchers. Astronaut Julie Payette flew on a 15-day mission to the ISS where she used two Canadian and one Japanese robotic arms to install the Kibo Japanese Experiment facilities. These facilities provide an external platform for scientific experiments in the exposed environment of space. The Canadian TriDAR vision system was used on two flights for the docking of the Space Shuttle to the ISS. This advanced technology could be considered for future space exploration missions. CSA completed the testing of critical elements of the James Webb and Indian Space Agency space telescopes. This participation has garnered 5% of observing time for Canadian scientists on the telescopes when launched in 2014.	
Indicators	**Performance**
1. Proportion of active missions relative to the total number of missions supported by Canada in the SE priority areas.	40%; 43 active missions out of 107 missions supported.
2. Number of scientific instruments and technological applications developed as a result of CSA's participation in space missions and/or support to projects/activities in SE.	A combined total of 68 scientific instruments and technological applications.

3. Number of peer-reviewed papers produced in academia and the R&D community in Canada recognizing CSA's support through its participation in space missions and/or support to projects/activities in SE.	A total of 197 peer-reviewed papers, reports and conference proceedings acknowledging CSA funding were published in 2009-2010.

Indicator 1 – Performance Analysis

At the time of the Departmental Performance Reporting, the Canadian Space Agency presents a list of space missions to which it actually contributes or plans to contribute. The fact that a mission appears on the list does not mean that it will be completed. Any mission must necessarily follow many critical steps depicted in a simple manner as such:

- Mission under review: A mission that is subject to concept of feasibility studies. At the end of this step, a decision is made whether to continue, to cancel or to postpone the participation to the mission.
- Mission in development: The participation implies that activities produce assets which are not yet operational. The final milestones prior to operation are the launch and the full commissioning of the mission.
- Mission in operation: The mission is operational, delivering results until being fully completed. By virtue of being in operation, a mission will spark scientific, technological and operational activities in order to reach its objectives.

SE missions completed (25): * = 2
SE missions at the operation stage (18): * = 3
SE missions at the development stage (21): * = 7
SE missions under review (43): * = 8

(Year) = Actual or projected launch date or date of completion when known.
***** = New missions in 2009-2010: 19% (20/107)

Descriptions of missions can be found in Section 2.8 – List of Space Missions.

Space Science and Exploration (SE) missions completed:

Mission	Status	Field
Astronauts: EXPEDITION 20/21 (C1) (2009)	Completed (2006), objectives met	Bob Thirsk, ISS
Astronauts: STS-115 (2006)	Completed (2006), objectives met	Steve MacLean, ISS
Astronauts: STS-118 (2007)	Completed (2007), objectives met	Dave Williams, ISS
Astronauts: STS-121 (2006)	Completed (2006), objectives met	Julie Payette (Capcom), ISS

	Astronauts: STS-127 (2009)	Completed (2009), objectives met	Julie Payette, ISS
	Astronauts: TMA-6/10S (2005)	Completed (2005), objectives met	Robert Thirsk (Capcom and back-up), ISS
	BLAST (2007)	Completed	Astronomy
	eOSTEO (2007)	Completed (2008), objectives met	Life Sciences
	EVARM	Completed, objectives met	Life Sciences
	FUSE (1999)	Completed (2008)	Astronomy
*	HAWAII	Completed (2010)	Planetary Exploration
	H-Reflex	Completed, objectives met	Life Sciences
	ICE-First (2004)	Completed, objectives met	Life Sciences
	Matroshka-R (2006)	Completed (2008), objectives met	Space Medicine
	MSS: STS-114 (2005)	Completed (2005), objectives met	ISS, Technology demonstration
	MSS: STS-119 (2009)	Completed (2009), objectives met	ISS
	MSS: STS-123 1J/A (DEXTRE) (2008)	Completed (2008), objectives met	ISS
	MSS: STS-124 (2008)	Completed (2008), objectives met	ISS
	MSS: STS-126 (2008)	Completed (2008), objectives met	ISS
	Phoenix (2007)	Completed (2008), objectives met	Planetary Exploration
	PMDIS (2007)	Completed (2008), objectives met	Life Sciences
	SCCO (2007)	Completed (2009), objectives met	Physical Sciences
	TRAC (2007)	Completed (2008), objectives met	Life Sciences
*	TriDAR DTO STS-128 (08-2009)	Completed (2009), objectives met	Planetary Exploration
	WISE (2005)	Completed, objectives met	Life Sciences

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Space Science and Exploration (SE) missions at the operation stage:

	Mission	Status	Field
	ADAMS (Advanced Astronaut Medical Support)	In operation	Space Medicine
	APEX-Cambium (2009)	In operation	Life Sciences
*	APEX-CSA 2 (2010)	In operation	Life Sciences
	BISE (2009)	In operation	Life Sciences
	CADC/Hubble (2008)	In operation	Astronomy
	CCISS (2007)	In operation	Life Sciences
	CGSM (2007)	In operation	Solar-Terrestrial Relation
	ELERAD (2006)	In operation, objectives met	Life Sciences
	ESA-Hershel-HIFI/Spire (2009)	In operation	Astronomy
	ESA-MICAST (2009)	In operation	Life Sciences
	ESA-Planck (2009)	In operation	Astronomy
*	ESA-SODI DSC	In operation	Physical Sciences
*	ESA-SODI IVIDIL	In operation	Physical Sciences
	FPEF-JAXA Mangaroni (2008)	In operation	Physical Sciences
	MOST (2003)	In operation, objectives met	Astronomy
	MVIS (2008)	Launched, soon to be in operation	Physical Sciences
	THEMIS (2007)	In operation	Solar-Terrestrial Relation
	Vascular (2009)	In operation	Solar-Terrestrial Relation

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Space Science and Exploration (SE) missions at the development stage:

	Mission	Status	Field
*	BCAT-C1 (2011, 12)	In development	Physical Sciences
	BCAT-5 (2009)	In development	Physical Sciences
*	BRITE-Constellation (2011)	In development	Astronomy
	CASSIOPE-ePOP (2011)	In development	Solar-Terrestrial Relation
*	CCAP (2014)	In development	Life Sciences

	CHENNS (2014)	In development	Life Sciences
	CIMEX (2011)	In development	Physical Sciences
	EBEX	In development	Astronomy
*	ESA-Exomars	In development	Planetary Exploration
	ESA-NEQUISOL (2010)	In development	Physical Sciences
	ESA-Swarm (2011) (Canadian instruments to measure ions)	In development	Solar-Terrestrial Relation
	Hypersole (2010)	In development	Life Sciences
	ICAPS (2010)	In development	Physical Sciences
	JWST-FGS (2014)	In development	Astronomy
	MSL-APXS (2011)	In development	Planetary Exploration
	NEOSSat (2011)	In development	Planetary Exploration
*	PRET	In development	Space Medicine
*	Radi-N	In development	Space Medicine
	SPIDER	In development	Astronomy
*	TriDAR DTO STS-131 (04-2010)	In development	Planetary Exploration
	UVIT-ASTROSAT (2010)	In development	Astronomy

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Space Science and Exploration (SE) missions under review:

	Mission	**Status**	**Field**
*	Aquatic Orgs in µg	Under review	Life Sciences
*	ASTRO-H	Under review	Astronomy
	CanALSS	Under review	Planetary Exploration
*	Dark Energy Mission	Under review	Astronomy
	DynAMO	Under review	Planetary Exploration
	ESA-CrossScale	Under review	Solar-Terrestrial Relation
	EVIS	Under review	Planetary Exploration
	FPNS	Under review	Planetary Exploration
	GPR	Under review	Planetary Exploration
	HALO	Under review	Planetary Exploration
	ILN	Under review	Planetary Exploration
	Insect Habitat	Under review	Life Sciences
	ISRU	Under review	Planetary Exploration
	LEMUR	Under review	Planetary Exploration
	LiteArm	Under review	Planetary Exploration
	LORE	Under review	Planetary Exploration

	LSC	Under review	Planetary Exploration
	Lunar Rover	Under review	Planetary Exploration
*	Luna-Resource-Concept 1	Under review	Planetary Exploration
*	Luna-Resource Concept 2	Under review	Planetary Exploration
	MEMS LIDAR	Under review	Planetary Exploration
	M-FTSIS	Under review	Planetary Exploration
	MIM/ATEN	Under review	Physical Sciences
	MLM	Under review	Planetary Exploration
	MSO-FTIR	Under review	Planetary Exploration
	MSO-SAR	Under review	Planetary Exploration
	MSR NET	Under review	Planetary Exploration
	MWD	Under review	Planetary Exploration
*	NEW FRONTIERS	Under review	Planetary Exploration
	OCLE-DOCLE	Under review	Astronomy
	ORBITALS (2014)	Under review	Solar-Terrestrial Relation
*	PHEMOS	Under review	Solar-Terrestrial Relation
	RAO	Under review	Planetary Exploration
	RAPIER	Under review	Planetary Exploration
	RAVENS	Under review	Solar-Terrestrial Relation
	Remote Care Health	Under review	Planetary Exploration
	ROSM	Under review	Planetary Exploration
	SBIS	Under review	Planetary Exploration
	SCOPE	Under review	Solar-Terrestrial Relation
*	Si Si-Ge alloys	Under review	Physical Sciences
	SPICA	Under review	Astronomy
	TRACTEUR	Under review	Planetary Exploration
	VSE	Under review	Planetary Exploration

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Indicator 2 – Performance Analysis

The total of 68 scientific instruments and technological applications is associated with 35 missions. This number represents an additional 10 instruments/applications compared to last year. When divided by the number of missions, the number of instruments shows a ratio of 1.9 instrument/application per mission; some having a least one related instrument/application up to a maximum of 10 per mission. These 68 instruments/applications can be divided among 4 different fields: 33 instruments/applications were developed for Astronomy/Planetary Exploration missions (49%); 21 instruments/applications for Solar-Terrestrial Relation missions (31%); 11 instruments/applications were developed for Life/Physical Sciences missions (16%), and, 3 instruments/applications were developed for Space Operational Medicine (4%).

Source: Internal documents.

Indicator 3 – Performance Analysis

A total of 197 peer-reviewed papers, reports and conference proceedings acknowledging CSA's funding were published in 2009-2010 in Space Astronomy and Exploration, Solar-Terrestrial Relation, and Physical and Life Sciences. This number represents a 50% decrease from the 397 reported in 2008-2009.

Source: Internal reporting documents.

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
143.3	168.7	153.6
2009-2010 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
191.9	205.7	(13.8)

The programs under this Program Activity are divided into three Sub-Activities: Enabling Research, Space Mission Development and Space Mission Operations.

Program Sub-Activity: Enabling Research – Space Science and Exploration

Objective: Provide leadership, coordination or support to Space Science and Exploration (SE) applied research and experimental development in line with the CSA priorities and stakeholders expectations in order to increase the knowledge base and devise new applications through space missions, and to allow the transfer of intellectual property and proven technologies to Canadian industry, academia, and government organizations.

Expected Result #1	
New project/mission concepts that progress to subsequent development phases related to Agency's priorities.	
Indicators	**Performance**
1. Ratio of the number of new concepts presented to the number of new concepts retained for subsequent phase.	There was one new concept qualifying for investment in Space Science and Exploration this year.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	Unavailable this year.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Enabling Research projects/missions.	
Indicator	**Performance**
1. Number of consulting requests received by CSA personnel from external sources such as the private sector, academia and other space agencies.	For all program activities combined, the CSA personnel responded to an estimated 92 consulting requests from external sources in 2009-2010.

Performance Analysis

Expected Result #1

Indicator 1-2

The Space Science and Exploration was the only Program activities with new activity investment this year, a project called New Frontiers. This small number can be attributed to the restructuring of the organization and the transition toward the next strategic plan. The ranking of the new concept remains unavailable this year.

Source: Internal documents.

Expected Result #2

Indicator 1

The number “92 requests”, 16 more than last year, represents an estimation based on an average number of days allocated per request from OGD, universities and industry for rare expertise held by CSA personnel. Examples of such requests are participation in research grant submissions or academic case studies, provision of technical advice to industry and academia on space related projects, technical evaluation of proposals or documents received by OGDs.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
44.5	58.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
47.6	75.7

ENABLING RESEARCH – SPACE SCIENCE AND EXPLORATION

Four Science and Exploration Enabling Research Programs with a combination of accomplishments demonstrate how the following expected results were measured and attained at the program sub-sub-activity level.

1- SE Mission Concepts – Objective: Assume leadership and provide support in enabling research and development of new space mission concepts leading to the realization of CSA or international SE missions.

EXPECTED RESULT #1

Industry, government and/or academia conduct mission and payload concept and feasibility studies to establish the technical and/or scientific feasibility and relevance of missions or payloads in order to enable CSA decisions on future SE space missions.	
Indicators	**Performance**
1. Number of concept/feasibility (mission and payload) and phase 0/A studies initiated, pursued or completed. (Target: 24)	**Target exceeded:** 29
2. Number of analogue mission deployments realized. (Target: 2)	**Target exceeded:** 3

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is based for the second time on three consecutive data for indicator #1. This year two sectors contributed to this indicator. Trend analysis maintains the satisfactory rating because of the introduction of a new indicator in the 2009-2010 RPP that was measured for the first time. Benchmark value cannot be established at this time.

★ ⇧

Satisfactory

Indicator 1

Solar Terrestrial (4): Orbitals, UVAMC (Ultra Violet Aurora Monitoring Camera), Scope and Cross Scale
Life and Physical Science (3): ATEN, Hypersole, CCAP
Planetary Exploration and Space Astronomy (11): 3 Astro-H, Dark Energy, 3 New Frontiers approval initiated, SPICA, 3 phase 0 (HALO, LORE, MSO)

Source: Internal documents.

Indicator 2

One deployment through participation to a large NASA program in Flagstaff. The second was a dedicated Canadian test of technology developed by a Canadian company. The third on was a large deployment on a Hawaiian volcano lead by the CSA with NASA as a partner.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
21.4	36.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
13.6	41.5

2- ESA Programs in SE – Objective: Through key international partnerships, foster the participation of Canadian academia and the demonstration of Canadian space technologies in European SE missions.

EXPECTED RESULT #1

Successful development and demonstration of advanced technologies, systems, components, or studies provided for in the contracts awarded by ESA to Canadian firms under Human and robotics exploration programs, including ISS sciences. (Space Exploration, ELIPS program).

Indicators	Performance
1. Canadian industrial return in ESA optional programs in SE. (Target: 84% or higher)	**Target exceeded:** 90%

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis maintains the rating to satisfactory for targeted achievement was slightly exceeded for the first time. Benchmark is well established among ESA community.

Indicator 1

The return coefficient corresponds to the ratio between the actual number of weighted contracts given to a country and the ideal number of contracts to be given to that country according to existing rules. Canadian industrial return coefficients are by Program Activity. The SE optional programs are: Aurora and ELIPS.

Source: Geographical distribution of contracts ESA/IPC(2009)13, rev.3, published on March 2, 2010, and covering the period between Jan 1, 2000 to December 31, 2009.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
10.1	8.8
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	0.0

3- SE Programs – Objective: Coordinate the Canadian SE community in order to pursue world-class research space missions to advance our knowledge of basic physical and chemical processes, the near-Earth space environment and Earth's electromagnetic field, our solar system, the universe and its evolution, as well as the adaptation of humans and other life forms in the weightless environment.

EXPECTED RESULT #1

Identified opportunities for Canadian scientists to advance exploration readiness and scientific knowledge through CSA, national and international research missions.

Indicators	Performance
1. Number of scientific publications, reports and conference proceedings acknowledging CSA funding. (Target: 350)	**Target partially met:** 197 as of April 30, 2010.
2. Number of Highly Qualified Personnel (HQP) involved in the program. (Target: 400)	**Target exceeded:** 431 as of April 30, 2010.
3. Number of research partnerships (nationally and internationally). (Target: 80)	**Target exceeded:** 124
4. Number of awards granted yearly under the CSA Grants and Contributions Program. (Target: 25)	**Target exceeded:** 52

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on four consecutive data for all indicators. Trend analysis maintains the rating to satisfactory because one targeted achievement remained at partially met as well as dropped value from previous years. Benchmark values have yet to reach an appropriate stability.

Satisfactory

Indicator 1

105 No. of Peer Reviewed Publications acknowledging CSA Funding
26 No. of Non-Peer Reviewed Publications acknowledging CSA Funding
2 No. of Books acknowledging CSA Funding
47 No. of Peer Reviewed Publications acknowledging CSA Funding
17 No. of Non-Peer Reviewed Publications enabled by CSA Funding
0 No. of Books enabled by CSA Funding

Target partially met due to a lower level of response from principal investigators (PIs) (67%).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 2

14 Canada Research Chair
72 Tenured Faculty
15 Non-Tenured Faculty
47 Research Associates
35 Post-Doctoral Fellows
21 Research Assistants
96 Graduate Students
50 Undergraduate Students
55 Engineers/Technicians
26 Other personnel

Target exceeded due to better management of survey; facilitated principal investigator (PI) responses with a user friendly survey and an easier data management/reporting procedure using ORIS (Organized Research Information System).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 3

103 partnerships for Grants and contracts
21 additional partnerships for Internal Collaborative Arrangements partnerships (MOU, MOA, etc.)

Target exceeded due to better management of survey; facilitated principal investigator (PI) responses with a user friendly survey and an easier data management/reporting procedure using ORIS (Organized Research Information System).

Source: CSA annual survey of external principal investigators/scientists funded by Space Science Branch.

Indicator 4 5 on-going grants + 47 new grants awarded (SSEP: 33 and CARN: 14). Exceeded due to good proposals received from SSEP 2008 AO and CARN and due to availability of G&C funds. Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
8.0	8.9
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
21.5	21.8

4- Human Space Flight Expertise – Objective: Maintain a trained, experienced and versatile Astronaut Corps to meet the needs of the Canadian space science and human exploration community and while doing so increase access to space opportunities for Canadian scientists.

EXPECTED RESULT #1

Maintain a healthy, trained, and versatile Astronaut Corps and professional support team to meet the needs of the Canadian space science and human exploration programs.	
Indicators	**Performance**
1. Delivery of ongoing training plan for the Astronaut Corps and its professional support team as per international agreements. (Target: new astronauts started basic training; training requirements met for astronauts and professional support teams)	**Target met:** The 2 Canadian Astronaut candidates have relocated to Johnson Space Center.
2. Provision of expertise to CSA operational projects and external agencies initiatives. (Targets: 3 projects supported to meet medical needs; 2 external initiatives supported by astronauts)	**Target met:** 4 projects were supported to meet medical needs and 2 external initiatives were supported by astronauts.
3. Provision of operational support to missions. (Target: 2 missions supported by CSA professional support teams)	**Target met:** 2 missions were supported.

PERFORMANCE ANALYSIS:	
3-Year Trend Three new indicators were introduced in 2009-2010 RPP and measured for the first time therefore no trend could be established.	N/A
Indicator 1 Basic astronaut training (ASCAN training) along with American and Japanese Astronauts. CSA has initiated a project looking at training requirements for future astronaut candidates to be performed at CSA in preparation to the ASCAN training. Source: Internal documents.	
Indicator 2 The 4 projects supported to meet medical needs were: - Advanced Astronaut Medical Support project: Medical autonomy and delivery of health care. - Performance Readiness Evaluation Tool: Develop and validate an improved neurocognitive assessment tool for long-duration space missions. - Radi-N project: Radiation project performed on ISS looking at the neutron radiation environment from inside the ISS. - Biodosimetry: Pre-flight and post-flight samples collected on our long duration astronaut and data analyzed to look at radiation impact at the cellular level. The 2 external initiatives supported by Canadian Astronauts took place at Pavilion Lake and at Mauna Kea analogue sites. Source: Internal documents.	
Indicator 3 The first mission (C1) supported was the 6-month Canadian long duration mission on board the ISS completed by Canadian Astronaut Robert Thirsk. Support was provided in the following areas: clinical/medical, nutrition, exercise countermeasures, radiation, human behaviour and performance, logistics. The Medical Team received the Canadian Air & Space Pioneer award for their work in support of the C1 Mission. They also supported all ISS medical boards, working groups and the International Training Implementation Working Group. The second mission supported was Space Shuttle STS-127 with Canadian Astronaut Julie Payette. Source: Internal documents.	

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
4.9	4.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
12.5	12.3

Highlights of Main Accomplishments – Enabling Research (SE)

- The CSA continued to maintain its human space flight expertise to meet the requirements of the CSA's space sciences and human exploration programs. Two Canadian Astronauts flew in space in fiscal year 2009-2010. In July 2009, Julie Payette flew as a crewmember on STS-127 on a 15-day mission to the ISS for the delivery of the Kibo Japanese Experiment Module Exposed Facility and Experiment Logistics Module Exposed Section. These facilities provide an external platform for experiments in the exposed environment of space as well as a robotic arm that is attached to the Kibo Pressurized Module that will be used to position experiments outside the station. STS-127 represented the last Shuttle flight with a Canadian Astronaut as a crewmember. Canadian Astronaut Bob Thirsk flew on the ISS as a crew member on Expedition 20/21. This Expedition represented a milestone for the Canadian Space Program since it was the first time a Canadian took part in a long duration mission. Furthermore, this expedition saw the implementation of a crew of six onboard the ISS. Dr. Thirsk's first time launch took place on May 27, 2009 aboard a Soyuz rocket from the Cosmodrome in Baikonur, Kazakhstan and the landing occurred on Dec 1st, 2009 in the plains of Kazakhstan near the town of Arkalyk. This was the first time a Canadian Astronaut was travelling to space on a vehicle other than the U.S space shuttle. During this 6-month mission, Dr. Thirsk assumed responsibilities for the maintenance and repair of the ISS and conducted experiments on behalf of Canadian and international researchers. Astronaut Chris Hadfield was fully trained as a back-up crew member for Bob Thirsk. Mission support was provided in an integrated manner by CSA and NASA in coordination with the partners of the International Space Station.

- The CSA continued to explore how the Advanced Astronaut Medical Support (ADAMS) project can contribute to human exploration. It continued to explore solutions to the delivery of health care on future long duration exploration-class missions and how these solutions can help improve health care delivery on Earth through the transfer of space technology. Specifically, CSA is developing telemedicine and medical autonomy concepts of operation, technology and user requirements for medical infrastructure, exploring the role, efficacy and limitations of medical patient simulators in acquisition and maintenance of medical skills and establishing requirements of a core medical training curriculum for Crew Medical Officers. Ultimately, CSA will be prototyping a self-contained medical suite and capabilities to allow optimal interaction between a patient, a Crew Medical Officer, a medical Mission Control and telemedicine consultants. To this end, CSA participated to the Mauna Kea analogue deployment in February 2010.

- The CSA has developed a prototype of a Performance Readiness Evaluation Tool (PRET) to provide neurocognitive assessment capability using a 3D virtual reality simulator with embedded neurocognitive tests. This activity is the result of the medical evaluation requirement for long-duration missions to the International Space Station which stipulates that astronauts must undergo neurocognitive assessment before, during and after the flight to detect any indications of a reduced performance state. The prototype is planned to be tested in the Russian Isolation Study, Mars-500.

- The CSA continued to collect radiation exposure data through a collaborative project with International Partners on ISS using Canadian made radiation dosimeters. Specifically, CSA implemented project RADI-N during ISS Expedition 20/21. During this Expedition, Astronaut Bob Thirsk conducted 4 sessions during which he collected neutron radiation data on the ISS using Canadian made Bubble Detectors. This data is currently being analyzed.

- To ensure that Canada has enough astronauts to fully take advantage of the flight opportunities available through its investment in the International Space Station Program, the CSA selected two new Canadian Astronaut Candidates among 5351 applicants. Through the year-long recruitment process, candidates underwent evaluations ranging from robotics to physical fitness testing. In August 2009, David Saint-Jacques and Jeremy Hansen reported to NASA's Johnson Space Center in Houston, Texas, to begin a two-year astronaut training program with astronaut candidates from the United States and Japan.

- The CSA participated actively to the International Space Exploration Coordination Group (ISEGC) that was created in 2007 to promote coordination for Moon and Mars exploration between various space agencies around the world. In addition, as part of the International Architecture Working Group (IAWG), CSA was involved in five function teams and in the Campaign Integration Team and contributed to the creation on the first International Lunar Campaign.

- Within the Mission Concepts Program, the CSA established exploration core activities supporting the development of ground prototypes of systems that could become potential contributions to future Moon or Mars missions. The exploration core is being implemented in partnership with industry, university, research institutions and other government departments. In February 2010, an international analogue mission involving NASA, CSA, DRL and contractors was performed in Hawaii and was a success. As part of the Canada's Economic Action Plan, ten existing contracts under the CSA current exploration core program were extended to perform prototyping and twelve new contracts were awarded. Seven out of the nine advanced concept studies initiated in 2008-2009 were completed and two contracts for advanced concept studies for a vision system for a Russian lunar rover were put in place. The prototyping option in the nine advance concept studies were exercised for prototype development. The work resulting from the extension of prototyping contracts and one of the new contracts awarded in 2009-2010 enabled CSA to participate in the analogue mission deployment in February. The remaining contracts (eight of them) were awarded as part of the Exploration Surface mobility (ESM) stimulus project for the delivery of a number of payloads: small manipulator, mini-corer, microscope, micro-rovers, generic payload interface, next generation power system, next generation communication system and an ExoMars breadboard analogue deployment scheduled to take place in June 2010.

- Through partnership with the European Space Agency (ESA), the CSA continued to position the Canadian industry and scientists in future scientific and technological developments relating to the European planetary exploration program called Aurora and the physical and life sciences programs called ELIPS-2 and ELIPS-3.

Program Sub-Activity: Space Mission Development - Space Science and Exploration

Objective: Provide coordination or support to the development of Space Science and Exploration (SE) space missions in line with CSA priorities and stakeholders' expectations through the definition, critical design, manufacturing, integration, testing and delivery phases leading to launch and early operations of space systems.

Expected Result #1	
Space mission proposals that efficiently, effectively and economically progress to subsequent operations phases in accordance with objectives, requirements, initial or revised specifications.	
Indicator	**Performance**
1. Percentage of projects requiring more than one EPA (Effective Project Approval) or an amendment to initial EPA over the total number of projects.	There were amendments made to one EPA for the Space Science and Exploration Program Activity in 2009-2010.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Development projects.	
Indicator	**Performance**
1. Rate of expertise matrix support to all CSA's program activities.	A 51% rate of planned expertise matrix – all program activities combined.

Performance Analysis

Expected Result #1

Indicator 1

The NEOSSat mission obtained its first EPA in October 2005. Since then, additional costs due to delay in the schedule and the increase in the internal market prices for launchers have caused the need for a revised EPA in November 2009.

Source: Internal documents.

Expected Result #2

Indicator 1

This 51% rate of planned expertise matrix support, a planning 13% higher than last year, is based on the average support of 83 specialized personnel to 10 missions at the development stage. A 50% rate of planned matrix support by specialized personnel is considered adequate from a management perspective.

Source: Internal reporting documents (E-Ram).

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
43.4	36.6
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
16.9	23.2

SPACE MISSION DEVELOPMENT – SPACE SCIENCE AND EXPLORATION

One Science and Exploration Space Mission Development Program, with a combination of accomplishments, demonstrates how the expected result outlined below was measured and attained at the program sub-sub-activity level.

1- SE Projects – Objective: Ensure the development, delivery and commissioning of space-qualified systems for SE missions through effective project, quality and engineering management.

EXPECTED RESULT #1	
SE projects' deliverables meet mission objectives at critical steps.	
Indicator	**Performance**
1. Number of missions/projects associated with science support. (Target: 17)	**Target exceeded:** 18

EXPECTED RESULT #2	
SE projects' deliverables are met.	
Indicators	**Performance**
1. Project milestones are met as defined in the detailed work plan. (Target: 75% of milestones achieved versus planned)	**Target exceeded:** 9 Project milestones are met or exceeded out of 10 planned (90%).
2. Project cost is maintained within authorized levels. (Target: 100%)	**Target met:** 100%
3. Risks are identified and mitigation plans prepared for each project. (Target: 100%)	**Target met:** 100%

PERFORMANCE ANALYSIS:

3-Year Trend

For the first time, the 3-year trend is measured for all indicators based on three to five consecutive data. Trend analysis maintains the satisfactory rating although all targeted achievements have been met or exceeded. Benchmark values could only be confirmed for three indicators, the other have yet to reach an appropriate stability.

★ ⇧

Satisfactory

Expected Result #1

Indicator 1

Solar-Terrestrial (2): ePOP and Swarm/CEFI are both ongoing missions.

Life and Physical Science (11): SCCO, E-OSTEO, BISE, CCISS, Vascular, Hypersole, APEX-CAMBIUM, MVIS, ESA-SODI-IVIDIL, ESA-Nequisol, BCAT-5

Planetary Exploration and Space Astronomy (4): JWST, UVIT, NEOSSat, APXS

Source: Internal documents.

Expected Result #2

Indicator 1

With the remaining milestone partially achieved, 1 milestone partially achieved because final release of the report cannot occur before end of project (APXS).

Source: Internal documents.

Indicator 2

JWST, UVIT and APXS costs are within authorized levels. UVIT Phase D has been completed under budget.

Source: Internal documents.

Indicator 3

JWST, UVIT and APXS have documented risks matrix and mitigation plans. UVIT Phase D completed with risk funds being returned to President's reserve.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
43.4	36.6
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
16.9	23.2

Highlights of Main Accomplishments – Space Mission Development (SE)

- Canada is participating in the James Webb Space Telescope (JWST), a major facility-class space observatory that will be launched in 2014. The JWST is a successor to the highly successful Hubble Space Telescope (HST). Canada is responsible for the design and construction of the Fine Guidance Sensor (FGS), a critical element of the mission, which ensures the very precise pointing of the telescope and the provision to the international astronomical community of simultaneous images through the development of a cryogenic scientific instrument. CSA completed manufacturing and testing of the Engineering Test Unit (ETU) of the FGS. The manufacturing of the Flight Model (FM) FGS will continue in 2010 in order to be delivered to NASA in 2011. By virtue of the CSA's contribution, Canadian astronomers will have guaranteed access to 5% of the observing time of the James Webb Space telescope.

- The Enhanced Polar Outflow Probe (ePOP) mission, integrated with the CASSIOPE Mission, is scheduled for launch in 2011. It will probe the upper atmosphere and ionosphere region where solar variability exerts influence on global change in various time scales. The scientific data collected by ePOP will help scientists understand particle exchange and energy coupling processes between the Earth’s atmosphere and space environment. The suite of eight ePOP instruments integrated in the CASSIOPE satellite underwent full environmental testing at the David Florida Laboratory.

- The CSA completed the manufacturing and testing of the Flight Detector Subsystem for the UltraViolet Imaging Telescope (UVIT) onboard the ASTROSAT satellite of the Indian Space Research Organization (ISRO). The subsystem was delivered to ISRO at the beginning of 2010. It is now scheduled for launch by 2011. The CSA's participation will guarantee 5% of the observing time for Canadian scientists and obtain ASTROSAT's astronomic data

- The NEOSSat mission, a joint Canadian Space Agency and Department of National Defence mission, is a combination of the Near Earth Space Surveillance (NESS) and the High Earth Orbit Surveillance (HEOS) projects. It is expected that 50% of NEOSSat time will be used to observe the inner portion of the solar system to discover, track and study asteroids and comets. The other 50% of the operating time will be used to track satellites in high-Earth orbit to update the orbit parameters of known satellites flying over the Canadian territory. Detailed design was completed in 2009. The NEOSSat spacecraft manufacture, assembly integration and testing activities began in 2010 in order to be ready for launch in 2011.

- The CSA continued to support the Assembly and Test Launch Operations (ATLO) of the Alpha Particle X-ray Spectrometer (APXS) for the NASA Mars Science Laboratory. The Canadian contribution will help scientists to determine the chemical composition of various soil, dust and rock samples on the planet. The launch by NASA is scheduled for 2011.

- The TriDAR vision system flew in August 2009 as part of the STS-128 mission and generated data during docking of the space shuttle to the International Space Station. Due to the success of this mission, NASA offered another flight opportunity for the TriDAR on the STS-131 shuttle flight that was launched in April 2010. Again, all mission objectives were attained. This project is a joint venture with NASA. The technology is relevant to applications that could include rendezvous and docking, rover navigation and terrain mapping.

- The CSA continued to work with the European Space Agency (ESA) to support the activities of Canadian scientists in science teams that have as objective to utilize the CSA-developed Microgravity Vibration Isolation System (MVIS), which is part of the European Space Agency's Fluid Science Laboratory on the International Space Station.

Program Sub-Activity: Space Mission Operations – Space Science and Exploration

Objective: Provide coordination or support to the operations of Space Science and Exploration (SE) space missions in line with the CSA priorities and stakeholders' expectations through the development and conduct of on-orbit operations, system maintenance and logistic support, as well as data handling and delivery.

Expected Result #1	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Operations activities.	
Indicators	**Performance**
1. Annual rate of investment in maintenance and improvement of the infrastructure required for missions in operation phases.	After a second attempt, the data collection for this indicator revealed to be too strenuous; therefore, it will no longer be measured.
2. Quality of the internal expertise specializing in advice and technology-watch to ensure the successful flow of missions reaching operation phases.	After a second attempt, the data collection for this indicator revealed to be too strenuous; therefore, it will no longer be measured.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
55.4	59.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
127.5	106.8

SPACE MISSION OPERATIONS – SPACE SCIENCE AND EXPLORATION

Three Science and Exploration Space Mission Operations Programs with a combination of accomplishments demonstrate how the following expected results were measured and attained.

1- International Space Station (ISS) – Objective: Provide required CSA operations, training and engineering services to the ISS Program.

EXPECTED RESULT #1

The Canadian Space Station Program (CSSP) meets the requirements of the International Space Station Program (ISSP) in accordance with the Intergovernmental Agreement (IGA) and the NASA/CSA Memorandum of Understanding (MOU).

Indicators	Performance
1. Continuity of on-orbit operations of MSS to meet the ISSP requirements and to fulfil the CSSP mandate. (Target: scheduled MSS operations conducted in accordance with ISSP requirements)	**Target met:** Supported 2J/A, 17A, ULF3, 20A, HTV1, Soyuz, Progress and stage activities supported.
2. Delivery of MSS generic training to international astronauts and ground personnel. (Target: ISSP training requirements met)	**Target met:** All scheduled training was provided as agreed by the ITCB (ISS Training Control Board) schedule.
3. Delivery of MSS engineering and technical support (personnel and facilities) for the MSS. (Target: scheduled MSS operations supported in accordance with ISSP requirements)	**Target met:** Supported 2J/A, 17A, ULF3, 20A, HTV1, Soyuz, Progress and stage activities supported.

PERFORMANCE ANALYSIS:

3-Year Trend

All indicators were newly introduced in the 2009-2010 RPP. Only indicator #2 could be inferred to previous indicators reported. Therefore the trend analysis drops the rating from superior to satisfactory since it could only be done for indicator #2. Benchmarks are well established as targets are set at the International Space station Program level.

★ ⇩

Satisfactory

Indicator 1

No comment.

Source: Internal documents.

Indicator 2

No comment.

Source: Internal documents.

Indicator 3

No comment.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
47.7	50.9
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
111.9	93.4

2- SE and Human Space Flight Mission Operations – Objective: Operate the space and ground segment for SE missions and human space flight missions.

EXPECTED RESULT #1	
SE Space Mission Operations meet mission objectives and user/client expectations.	
Indicator	**Performance**
1. Number of missions in operational phase associated with science support. (Target: 12)	**Target exceeded:** 15

EXPECTED RESULT #2	
SE Space Mission Operations meet mission requirements and client needs.	
Indicators	**Performance**
1. Provision of expertise to support the needs of internal sponsoring organizations for payload projects throughout their development and operation. (Targets: 1 new ISS payload project supported; 1 ongoing ISS payload project supported; 1 ongoing non-ISS payload project supported)	**Target met:** Objective was fully satisfied for all three items.
2. Provision of Operations Engineering expertise to the development of new CSA missions and external agencies initiatives. (Targets: 2 initiatives supported)	**Target partially met:** 1 initiative.

PERFORMANCE ANALYSIS:

3-Year Trend

Two indicators were newly introduced in the 2009-2010 RPP. Only the first indicator was kept. Therefore the trend analysis maintains the rating to satisfactory since it could only be done for one indicator showing three consecutive data. Benchmark cannot be established at this time since available values did not reach appropriate stability.

Satisfactory

Expected Result #1

Indicator 1

Solar Terrestrial (2): Themis and CGSM are both ongoing missions.
Life and Physical Science (7): CCISS, APEX-Cambium, BISE, Vascular, BCAT-5, ESA-SODI-IVIDIL, MVIS.
Planetary Exploration and Space Astronomy (6): MOST, Phoenix, HIFI, SPIRE, ESA-Planck - LFI, ESA-Planck – HFI.

Source: Internal documents.

Expected Result #2

Indicator 1

For the ISS, the ongoing BISE payload was supported fully in 2009. A new payload, APEX-Cambium, was supported during all final integration activities leading to a successful launch in November. On-orbit operations were supported in December.
For non-ISS, a full time support was provided to the Exploration Surface Mobility Project during the planning for and execution of the analog site deployment in Hawaii.

Source: Internal documents.

Indicator 2

The only supported initiative was the lunar exploration mobile system. There was no other support expertise requested.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
7.7	8.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
15.5	13.3

Highlights of Main Accomplishments – Space Mission Operations (SE)

- The CSA continued to support the Canadian GeoSpace Monitoring (CGSM) Program, a network of ground facilities instruments across Northern Canada. It supports national and international scientific activities related to understanding near-Earth environment, namely, space weather. The CGSM serves also to collect and distribute high quality science data used by other government departments and in support of current and future planned Canadian satellite missions including ePOP, PCW, and ORBITALS.

- The Local Oscillator Source Unit (LSU) that was successfully integrated in the Heterodyne Instrument for the Far Infrared (HIFI) on ESA's Herschel satellite was launched in 2009. It carries an infrared telescope and three scientific instruments that will allow scientists to address key science questions such as how galaxies were formed in the early universe and how stars have been forming throughout the history of the universe. The science operations will continue in 2010.

- The CSA has upgraded its ground control operations for Canadarm2 to enable the handling of heavy payloads as scheduled. The development of expanded ground control capabilities for future Dextre operations will enable a more efficient on-orbit commissioning of this new element significantly reducing astronaut time requirements. The CSA will also develop concept studies for Dextre compatible tools to broaden Dextre's use on-orbit.

- The CSA has maintained operational preparedness for the MSS and supported 4 ISS assembly flights, one HTV-1 capture and more than 60 days of stage operations. This entails the preparation and certification of flight products and procedures to support these missions. Due to ISS operational constraints, the commissioning of DEXTRE has been postponed to fiscal year 2010-2011.

- The CSA released the MSS-6.1 software, which provides major enhancements to the Canadarm2's capability and enables it to capture free flying vehicles and enhance the Ground Control capabilities of Dextre. On September 17, 2009, Canadarm2 will be required to capture the first vehicle, the Japanese free flying H-II Transfer Vehicle (HTV).

- CSA built and pre-positioned on-orbit the camera lens covers that will be required to protect MSS cameras from contamination resulting from H-II Transfer Vehicle (HTV) free flier proximity operations. The CSA also built and delivered software to support the capture of commercial vehicles (Dragon) to the ISS in 2009 as well as the supporting software for follow-on HTV missions.

- The CSA has continued to fulfill its obligations for MSS operations. This involves maintaining and providing technical support for hardware and software; performing repair and overhaul work on hardware; providing MSS related training and qualification for all astronauts, cosmonauts and ground support personnel; planning and supporting MSS operations; and conducting operations in conjunction with the NASA Houston flight control room from the Remote Multi-Purpose Support Room in St-Hubert, Quebec. The CSA also prepared one spare Canadarm2 Latching End Effector (LEE) which was delivered and pre-positioned on-orbit in late 2009 in case of on orbit failure of Canadarm2 during its life.

- The CSA supported ESA for the on-orbit commissioning of the Microgravity Vibration Isolation System (MVIS) launched in early 2008. The CSA supported two commissioning test campaigns from the ESA support center located in Naples Italy. The CSA will provide operational and technical support to the MVIS throughout the life of the MVIS. By providing this important component to ESA, Canadian scientists gained access to this unique European ISS laboratory in space.

- The CSA supported the launch and operational activities related to the Advanced Plant Experiments (APEX). This experiment seeks evidence that gravity has a direct effect on the cells that contribute to the formation of reaction wood in willow (Cambium wood experiment). Two different investigations using different tree varieties, one with Willow the other with White Spruce, were successfully prepared, flown and grown on orbit during the year.

- The CSA successfully supported two physiological experiments, BISE and VASCULAR. A total of 7 crew members of the ISS participated in BISE and one so far for VASCULAR. These studies will attempt to better understand the effects of long-duration microgravity on human adaptability and health.

- The CSA supported operations of experiments and educational activities on the ISS. These experiments include the return of Cerebral control (CCISS) in 2008, Cambium wood experiment, Bodies in the Space Environment (BISE), IRIS, Tomatosphere III, and Binary Colloid Alloy Test-5 (BCAT-5) in 2009.

2.4 SATELLITE COMMUNICATIONS

SATELLITE COMMUNICATIONS 2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS Satellite Communications facilitates the linking of all Canadians by increasing the delivery of non-commercial services to Canadian remote communities, and support federal government department's program delivery. Space infrastructure allows access and dissemination of timely health, cultural, security and safety related information to all Canadians wherever they live in Canada. Satellite communication is essential to provide Canadians living in remote areas with timely access to expert knowledge and expertise related to health and education through a range of non-commercial services including: e-government, e-learning, tele-justice, tele-education, as well as tele-medicine.	
EXPECTED RESULT State-of-the-art systems and applications are developed to satisfy the needs of the Canadian Government and population in order to ensure that Canada remains a world leader in satellite communications.	
MAIN ACCOMPLISHMENTS IN 2009-2010 The CSA completed the environmental testing of the Cascade telecommunications payload as part of the CASSIOPE Mission which is ready for launch in 2011. The CSA completed the ground segment infrastructure upgrade needed for the utilization of the Government of Canada capacity credit of the Anik F2 satellite by northern communities. The mission and preliminary system requirements for the Polar Communications and Weather mission have started in order to meet the needs for a full-time communications coverage over Canada up to the North Pole.	
Indicators	**Performance**
1. Proportion of active missions relative to the total number of missions supported by Canada in the SC priority areas.	None of the 8 missions were active in 2009-2010.
2. Number of technological applications developed as a result of CSA's participation in space missions and/or support to projects/activities in SC.	8 applications.

Indicator 1 – Performance Analysis

At the time of the Departmental Performance Reporting, the Canadian Space Agency presents a list of space missions to which it actually contributes or plans to contribute. The fact that a mission appears on the list does not mean that it will be completed. Any mission must necessarily follow many critical steps depicted in a simple manner as such:

- Mission under review: A mission that is subject to concept of feasibility studies. At the end of this step, a decision is made whether to continue, to cancel or to postpone the participation to the mission.

- Mission in development: The participation implies that activities produce assets which are not yet operational. The final milestones prior to operation are the launch and the full commissioning of the mission.

- Mission in operation: The mission is operational, delivering results until being fully completed. By virtue of being in operation, a mission will spark scientific, technological and operational activities in order to reach its objectives.

SC missions at the development stage (4) = *
SC missions under review (4) = *

(Year) = Actual or projected launch date or date of completion when known.
* = No New Missions in 2009-2010.

Descriptions of missions can be found in Section 2.8 – List of Space Missions.

Satellite Communications (SC) missions at the operation stage:
NIL

Satellite Communications (SC) missions at the development stage:

Mission	Status	Field
Anik F2 (ground reception component)	In development	Satellite Communications
CASSIOPE/Cascade (2010)	In development	Satellite Communications
ESA – Alphasat	In development	Satellite Communications
ESA - Galileo SAT (2010)	In development	Search and Rescue
M3MSat (2011)	In development	Security, Satellite Communications

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010.

Satellite Communications (SC) missions under review:

Mission	Status	Field
Next Gen – Advanced Broadband payload #1 (2014)	Under review	Satellite Communications
PCW (telecommunications' aspect) (2016)	Under review	Security and Foreign Policy, Economic Development
QuickSat	Under review	Satellite Communications

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2009-2010

Indicator 2 – Performance Analysis

A total of 8 applications, compared to 5 in 2008-2009, were identified for the 5 missions listed above: Anik F2 ruggedized ground infrastructure and terminal servicing, Cascade (data storage unit) on board CASSIOPE, Antennas and filters for ESA-Alphasat, the MEOSAR instrument on board Galileo satellite and the RSS-GEMS for traffic identification, and 2 Automatic Identification System related applications for M3MSat; 63% of those applications (5/8) were related to Communications whereas the other 37% supported were related to Security/Search and Rescue. All applications, except one, served national objectives; MEOSAR which is developed in collaboration with ESA will serve the international community.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
20.3	20.6	19.7
2009-2010 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
14.2	15.2	(1.0)

The programs under this Program Activity are divided into three Sub-Activities: Enabling Research, Space Mission Development and Space Mission Operations. However, no Space Mission Operations are mentioned in this report since CSA is not operating communications satellite.

Program Sub-Activity: Enabling Research – Satellite Communications

Objective: Provide leadership, coordination or support to Satellite Communications (SC) applied research and experimental development in line with the CSA priorities and stakeholders expectations in order to increase the knowledge base and devise new applications through space missions, and to allow the transfer of intellectual property and proven technologies to Canadian industry, academia, and government organizations.

Expected Result #1	
New project/mission concepts that progress to subsequent development phases related to Agency's priorities.	
Indicators	**Performance**
1. Ratio of the number of new concepts presented to the number of new concepts retained for subsequent phase.	There was no new concept presented nor retained in 2009-2010.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	Unavailable this year.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Enabling Research projects/missions.	
Indicator	**Performance**
1. Number of consulting requests received by CSA personnel from external sources such as the private sector, academia and other space agencies.	For all program activities combined, the CSA personnel responded to an estimated 92 consulting requests from external sources in 2009-2010.

Performance Analysis
Expected Result #1 Indicators 1-2 Analysis not applicable. **Expected Result #2** Indicator 1 The number "92 requests", 16 more than last year, represents an estimation based on an average number of days allocated per request from OGD, universities and industry for rare expertise held by CSA personnel. Examples of such requests are participation in research grant submissions or academic case studies, provision of technical advice to industry and academia on space related projects, technical evaluation of proposals or documents received by OGDs. Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
14.7	15.6
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	7.1

ENABLING RESEARCH – SATELLITE COMMUNICATIONS

Three Satellite Communications Enabling Research Programs with a combination of accomplishments demonstrate how the following expected results were measured and attained at the program sub-sub-activity level.

1- SC Mission Concepts: Assume the leadership and support in the enabling research and development of new mission concepts.

EXPECTED RESULT #1

Industry, government and/or academia conduct mission and payload concept and feasibility studies to establish the user requirements for new missions and to evaluate the technical and scientific feasibility and the relevance of these proposed missions to the government priorities in order to enable a decision on future SC space missions.

Indicator	Performance
1. Number of concept/phase 0 and phase A studies completed. (Target: 2)	**Postponed (to another fiscal year).**

PERFORMANCE ANALYSIS:	
3-Year Trend No trend could be established since data available for three out of five periods without required consecutiveness.	N/A
Indicator 1 The work undertaken in the preparation of request for proposals was interrupted due to security issues and alignment with the new priorities of a long term space plan. Source: Internal documents.	

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
4.1	4.9
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	5.6

2- ESA Programs in SC – Objective: Through key international partnerships, enhance the Canadian industry's technological base and provide access to European market for value added products and services in the field of SC.

EXPECTED RESULT #1	
Successful development and demonstration of advanced technologies, systems, components, or studies provided for in the contracts awarded by ESA to Canadian firms under the SC programs. (ARTES, Galileosat and GNSS (Global Navigation Satellite System) Evolution programs)	
Indicator	**Performance**
1. Canadian industrial return in ESA optional programs in SC. (Target: 84% or higher)	**Target exceeded:** 105%

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis maintains the superior rating for targeted achievements were consistently exceeded. Benchmark is well established among ESA community.

Superior

Indicator 1

The return coefficient corresponds to the ratio between the actual number of weighted contracts given to a country and the ideal number of contracts to be given to that country according to existing rules. Canadian industrial return coefficients are by Program Activity. The SC optional programs are: Navigation and Telecommunications. This total includes the statistics from the navigation and telecommunications groupings.

Source: Geographical distribution of contracts ESA/IPC(2009)13, rev.3, published on March 2, 2010, and covering the period between Jan 1, 2000 to December 31, 2009.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
9.6	7.6
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	0.0

3- SC Application Development Programs – Objective: Enhance Canada's ground segment telecommunications technologies, develop and demonstrate Satellite Communications (SC) applications for commercial use and Canadian government operations.

EXPECTED RESULT #1

Northern Communities access and utilize the Anik F2 Government of Canada Capacity Credit.

Indicator	Performance
1. Number of communities using the Government of Canada Capacity Credit for government applications and services. (Target: between 1 and 3 users)	**Target partially met:** 8-10 pre-operational users.

PERFORMANCE ANALYSIS:	
3-Year Trend New indicator introduced in 2009-2010 RPP and measured for the first time therefore no trend analysis available.	NA
Indicator 1 Between 8 and 10 pre-operational users during the year for tests, trials and demos. No operational users as of yet because of manufacturing problems at Advantech; delivery of operational terminals expected for June 2010. First community expected to be the Nunavut Arctic College. Source: Internal documents.	

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
1.0	3.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
0.0	1.5

Highlights of Main Accomplishments – Enabling Research (SC)

- The CSA continued to work towards the utilization of the Government of Canada capacity credit (GoC CC) for broadband telecommunications services in the North. The contract for Ground Segment Upgrades and the procurement for the terminals are expected to be completed by June 2010. The Planning for the years 7 and 8 for the Utilization Phase is ongoing. A Call for Interest to potential end-users in the northern communities will be issued in summer 2010, with full deployment and use of the GoC CC by 2011.

- The contract for Phase A for the Polar Communications and Weather mission has started in July 2009 for the development of the Mission Requirements and the preliminary system requirements in 2009-2010. The Mission Requirements review was successfully held on Feb 24-25 2010 confirming the user requirements for the PCW mission. The Concept of the Polar Communications and Weather Mission is to put a constellation of satellites in highly elliptical orbit over the North Pole to provide communication and monitoring weather services in the Arctic. The weather component of the mission falls within the Earth Observation Program Activity, while the polar communication falls within the Satellite Communication Program Activity.

- The CSA has initiated the development of an enhanced Satellite Communications Applications Program aimed at developing applications and space based services in close relationship with the user communities. The program will be finalized in 2010-2011 taking into account the new strategic direction of the CSA and will produce innovative research in the area of propagation, flexible payload technologies and signal processing.

- The CSA has engaged with other government departments including the National Resources Canada (NRCan), the Department of Foreign Affairs and International Trade (DFAIT) and the Department of National Defence (DND) to improve the governance structure of global navigation satellite system (GNSS) with the view of creating a formal GNSS governance structure within the federal government.

- The CSA has started to assess the telecommunications requirements of federal government users and evaluate how future telecommunication satellite systems can respond to identified requirements. Efforts will continue in 2010-2011 in alignment with the new strategic direction of the CSA.

- The CSA has prepared the documentation required to initiate a preliminary study for a constellation of micro-satellites to provide an automatic identification system for ships with the objective of improving maritime monitoring on Canada's maritime approaches. The study will be conducted in 2010-2011.

- As a follow up to the successful completion of an initial concept study for a V-Band Next Generation Satellite Communications Payload, the CSA has initiated risk mitigation activities under two contracts. The aim of these contracts is to retire the risks on key technologies related to the integrated onboard communications system, the satellite antennas, and the ground systems. So far, the contracted work has successfully reached the scheduled mid-point and the go-ahead has been given to complete the remaining work packages.

- Canada's participation in the European Space Agency (ESA) programs has allowed our industry to access forward-looking studies on new telecommunications services; to develop new technologies, equipment and applications in multi-media, inter-satellite and mobile communications; and to demonstrate satellite-based communications services such as interactive communications services for remote communities and for disaster management. For example, in satellite navigation, CSA continued its collaboration with ESA to support the monitoring of the quality of the localization signal generated by the experimental satellites currently in orbit.

Program Sub-Activity: Space Mission Development – Satellite Communications

Objective: Provide coordination or support to the development of Satellite Communications (SC) space missions in line with CSA priorities and stakeholders' expectations through the definition, critical design, manufacturing, integration, testing and delivery phases leading to launch and early operations of space systems.

Expected Result #1	
Space mission proposals that efficiently, effectively and economically progress to subsequent operations phases in accordance with objectives, requirements, initial or revised specifications.	
Indicator	**Performance**
1. Percentage of projects requiring more than one EPA (Effective Project Approval) or an amendment to initial EPA over the total number of projects.	There was one new EPA submitted to TB for the Satellite Communications Program Activity in 2009-2010.
Expected Result #2	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Development projects.	
Indicator	**Performance**
1. Rate of expertise matrix support to all CSA's program activities.	A 51% rate of planned expertise matrix – all program activities combined.

Performance Analysis

Expected Result #1

Indicator 1

The M3MSAT mission obtained its first EPA in July 2009. Previous to this EPA, the mission had obtained from the TB its preliminary project approval (PPA) in July 2007. Since then, additional costs due to the increase in the internal market prices for launchers had to be taken into consideration.

Source: Internal documents.

Expected Result #2

Indicator 1

This 51% rate of planned expertise matrix support, a planning 13% higher than last year, is based on the average support of 83 specialized personnel to 10 missions at the development stage. A 50% rate of planned matrix support by specialized personnel is considered adequate from a management perspective.

Source: Internal reporting documents (E-Ram).

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.6	4.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
14.2	8.1

SPACE MISSION DEVELOPMENT – SATELLITE COMMUNICATIONS

One Satellite Communications Space Mission Development Program, with a combination of accomplishments, demonstrates how the expected result outlined below was measured and attained at the program sub-sub-activity level.

1- SC Projects – Objective: Ensure the development, delivery and commissioning of space-qualified systems for SC missions including search and rescue, and satellite navigation through effective project, quality and engineering management.

EXPECTED RESULT #1

SC projects' deliverables are met.

Indicators	Performance
1. Project milestones are met as defined in the detailed work plan. (Target: 75% of milestones achieved versus planned)	**Target partially met:** 67%
2. Project cost is maintained within authorized levels. (Target: 100%)	**Target met:** 100%
3. Risks are identified and mitigation plans prepared for each project. (Target: 100%)	**Target met:** 100%

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is measured for the first time based on three consecutive data for each indicator. Trend analysis maintains the satisfactory rating for targeted achievements have almost all been met. Benchmark values could only be confirmed for two indicators, the others have yet to reach an appropriate stability.	★ ⇧ Satisfactory

Indicator 1

Overall: 8 / 12 = 67%
CASSIOPE: testing completed; launch postponed, program reviews completed => 2 / 3
ePOP: instruments environmental testing completed => 1 / 1
M3MSAT: EPA submission completed; CDR postponed; phase D decision postponed => 1 / 3
NEOSSat: start phase D completed; AI&T test readiness review postponed => 1 / 2
RSS-GeMS: phase BCD contract awarded; PDR completed; CDR completed => 3 / 3

Source: Internal documents.

Indicator 2

Overall: 100% of projects had their cost below authority.
CASSIOPE: below authority
ePOP: below authority
M3MSAT: below authority
NEOSSat: all costs were maintained per EPA amendment (approved October 2009)
RSS-GeMS: below authority

Source: Internal documents.

Indicator 3

Overall: 100% of projects have risks identified and have contingency plans.
(CASSIOPE, e-POP, M3MSAT, NEOSSat, RSS-GeMS)

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.6	4.1
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
14.2	8.1

Highlights of Main Accomplishments – Space Mission Development (SC)

- In 2004-2005, as part of the CASSIOPE Mission Contribution Program, the CSA initiated the development and demonstration of the Cascade telecommunications payload on a small satellite bus. This small satellite spacecraft is fully designed and constructed by Canadian companies. Environmental testing of the spacecraft was completed in 2009, spacecraft is in storage and the launch is scheduled for the mid of 2011. Cascade is the precursor of a communication satellite constellation that will help position Canadian industry on the international market, both as a supplier of advanced components and as a service provider of high-volume, high-data-rate telecommunications anywhere in the world.

- CSA and the Department of National Defence are partnering to manage M3MSat, a second micro-satellite project (the first one being NEOSSat) which payload will be an Automatic Identification System (AIS). The objectives of this project are to demonstrate a multi-mission micro-satellite bus capability; to establish micro-satellites as operationally cost effective; to allow optimization of the AIS payload in maritime traffic identification; to significantly support Canadian industry business development strategies in a global market context; and to be a complement with CSA's RADARSAT-Constellation program and with DND's Polar Epsilon program. Detailed design is partially completed and will be finalized by mid 2010. The launch is planned for mid 2011 and the mission demonstration should end in 2013.

2.5 GENERIC TECHNOLOGICAL ACTIVITIES IN SUPPORT OF EO, SE AND SC

GENERIC TECHNOLOGICAL ACTIVITIES IN SUPPORT OF EO, SE AND SC 2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS Through its R&D investments and the resulting transfers of applications to the private and public sectors, the CSA's programs and activities attract highly educated and highly skilled labour that contributes to Canada's knowledge-based economy; helps enhance the Canadian space industry's competitiveness by encouraging dynamic trade relationships with other nations; and increases Canada's ability to compete in the global marketplace.	
EXPECTED RESULT Canada's industrial technological capabilities can meet the needs of future space missions and activities.	
MAIN ACCOMPLISHMENTS IN 2009-2010 The Generic Technological Activities (GTA) continued to bring industry and research organizations to propose innovative technologies, reduce risk on critical technologies required for future missions of Canadian interest, and contributed to the enhancement of Canadian capabilities. CSA's patent portfolio was entirely reviewed. Only patents with the highest potential of being licensed were maintained. Three new licenses were negotiated and five commercial studies were conducted on the potential transfer of emerging technologies to the private sector.	
Indicators	**Performance**
1. Ratio of the number of priority technologies identified for future EO, SE and SC missions to the number of priority technologies developed in GTA.	The number of priority technologies identified was 31. The number of priorities having been financially supported was 15, a ratio of 2.1.
2. Number of priority technologies supported that are ready to be used.	None of the 31 prioritized technologies supported are ready to be used.

Indicator 1 – Performance Analysis

Measured for the second time, the ratio equal to 2.1 remained the same as last year's. Over the years, the ratio should get closer to 1, meaning that almost all technological priorities will have been selected and developed.

Source: Internal reporting documents.

Indicator 2 – Performance Analysis

In order to be considered "ready to be use", a technology must reach a level of readiness (TRL) of "6" or higher on the scale developed by NASA. As a new technology proceeds to a higher level of maturity, the risk associated with its implementation in a space mission lessens substantially. Each level represents a development milestones, such as:

TRL 6: System model or prototype demonstration in a relevant environment;
TRL 7: System prototype demonstration in a space environment;
TRL 8: Actual system completed and "flight qualified" through test and demonstration; and,
TRL 9: Actual system "flight proven" through successful mission operations.

It takes time and investment for a new technology to reach these levels of readiness and therefore the priority selection often precedes the actual need and eventual use by several years. None of the newly prioritized technologies reached the "readiness" stage in 2009-2010.

Source: Internal reporting documents.

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
53.8	55.0	43.0
2009-2010 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
137.7	110.3	27.4

The programs under this Program Activity are divided into three Sub-Activities: Enabling Research, Space Mission Development and Space Mission Operations. However, no Space Mission Operations are mentioned in this report, since CSA is not carrying out generic space mission operation activities.

Program Sub-Activity: Enabling Research – Generic Technological Activities in support of EO, SE and SC

Objective: Provide leadership, coordination or support to Earth Observation (EO), Space Science and Exploration (SE) and Satellite Communications (SC) applied research and experimental development in line with the CSA's priorities and stakeholders' expectations in order to increase the knowledge base and devise new applications through space missions, and to allow the transfer of intellectual property and proven technologies to Canadian industry, academia, and government organizations.

Expected Result #1	
Space technology concepts that support projects/missions related to Agency's priorities.	
Indicator	**Performance**
1. Ratio of adherence to the technology development plan/track records.	The track record is not available yet.
Expected Result #2	
Canadian industries and research organizations that are actively involved in space R&D.	
Indicators	**Performance**
1. Number of requests received vs. the number of requests accepted.	66 received vs. 38 accepted – 58%
2. Number of requests received vs. the number of requests funded.	66 received vs. 26 funded – 39%

Performance Analysis

Expected Result #1

Indicator 1

A technology development plan was finalized this year and therefore, the reporting of its tracking will begin next year.

Source: Internal reporting documents.

Expected Result #2

Indicators 1-2

More than 55% of the requests received were considered acceptable from a series of strict criteria and rigorous selection process; and more than one out of every three ideas were actually funded; compared to last year, a 2% declined in the number of accepted but identical percentage of funded requests.

Source: Internal reporting documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
46.2	37.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
94.7	70.9

ENABLING RESEARCH – GENERIC TECHNOLOGICAL ACTIVITIES IN SUPPORT OF EO, SE AND SC

One Generic Enabling Research Program, with a combination of accomplishments, demonstrates how the expected results outlined below were measured and attained at the program sub-sub-activity level.

1- Space Technology Development Program: Support the development and transfer of advanced space technologies by industry, government, and academia in support of EO, SE and SC activities.

EXPECTED RESULT #1

Development of advanced space technologies by industry, government, academia, and not-for-profit organizations in support of EO, SE and SC activities.

Indicators	Performance
1. Number of technologies brought to higher readiness levels. (Target: 40)	**Target met:** 40
2. Number of technologies chosen to enable future space missions of interest to Canada. (Target: between 1 and 3)	**Target met:** 1

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on four consecutive data for all indicators. Trend analysis upgrades the satisfactory rating to superior for targeted achievements were all met. Benchmark values could only be confirmed for one indicator, the other has yet to reach an appropriate stability.

Superior

Indicator 1

No comment.

Source: Internal documents.

Indicator 2

Ongoing development of Deep Charge Monitor which was selected for a technical demonstration.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
19.9	19.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
16.0	22.0

2- ESA Programs in Generic Space Technologies: Through key international partnerships, enhance the Canadian industry's technological base and provide access to European market for value added products and services in the field of generic space technologies. This is achieved through a financial contribution by the Agency to optional ESA programs in the field of generic space technologies.

EXPECTED RESULT #1

Successful development and demonstration of advanced technologies, systems, components or studies provided for in the contracts awarded to Canadian firms under mainly two ESA Programs.

Indicator	Performance
1. Canadian industrial return in ESA optional programs, and at the overall level. (Target: overall Canadian industrial return in ESA optional program (GSTP) and mandatory programs of 94% or higher)	**Target exceeded:** 110% = Technology Programs groupings including GSTP – global return coefficient.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis maintains the superior rating for targeted achievements were consistently exceeded. Benchmark is well established among ESA community.

Superior

Indicator 1

The global return coefficient is calculated on all the mandatory activities and the optional programs, to take into account the program refills in which Canada does not participate.

Source: Geographical distribution of contracts ESA/IPC(2009)13, rev.3, published on March 2, 2010, and covering the period between Jan 1, 2000 to December 31, 2009.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
11.5	8.9
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
2.7	4.0

3- Commercialization and Transfer of Technologies: Promote the commercial potential and support the transfer of space technologies to maximise the social and economic benefits for Canadians.

EXPECTED RESULT #1

Transfer of space technologies generated by the CSA in support of EO, SE and SC activities to industry, government, academia and not-for-profit organizations.

Indicator	Performance
1. Number of licenses granted for space technologies owned by the CSA. (Target: 5)	**Target partially met:** 3

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on four consecutive data. Trend analysis maintains the satisfactory rating for targeted achievement was almost met. Benchmark value could not be confirmed, it has yet to reach an appropriate stability.

Satisfactory

Indicator 1

No comment.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
1.5	0.9
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
7.0	4.7

4- Mission Related Expertise and Technology Development: Ensure the development and maintenance of scientific and technical expertise in the CSA, the government, industry and universities to initiate projects and provide support to EO, SE and SC missions.

EXPECTED RESULT #1

Maintenance of in-house scientific and technical expertise, within the CSA and for the benefit of government, industry and universities, in support of EO, SE and SC activities.

Indicator	Performance
1. Number of specialized personnel across the Agency supporting CSA projects and/or programs. (Target: 80)	**Target met:** 80

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the first time based on three consecutive data. Trend analysis maintains the satisfactory rating for targeted achievement was met. Benchmark value could not be confirmed, it has yet to reach an appropriate stability.

Satisfactory

Indicator 1

No comment.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
13.3	8.2
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
69.0	40.2

Highlights of Main Accomplishments – Enabling Research - Generic Technological Activities in support of EO, SE and SC

- The CSA has developed a coherent Technology Plan, which includes a framework and selection criteria for the establishment of long-term technology roadmaps and niche technologies, also called Signature Technologies, based on the needs of future missions. A preliminary list of Signature Technologies for Earth Observation, Satellite Communication and Space Exploration has been established following CSA internal consultations. Niche areas will be finalized after consultation with other government departments, industry and academia. This process fosters partnership in the Canadian space community and also enhances the coordination of technology development activities throughout government departments.
- Through different procurement mechanisms, the Space Technology Development Program (STDP) continued to bring industry and research organizations to propose innovative technologies, reduce risk on critical technologies required for future missions of Canadian interest, and contributed to the enhancement of Canadian capabilities. Examples of STDP activities in 2009-2010 include:
    - Development of an engineering qualifying model of a Middle Earth Orbit Search-and-Rescue (MEOSAR) transponder was continued in 2009-2010 up to the sub-system level. The unit final integration and testing will be conducted in 2010-2011;
    - Development of technologies to demonstrate the concept feasibility of lunar vehicles, Mars' Rovers, and rendezvous technology;
    - Development of an ultra miniature electronic module to eliminate the need for a bulky centralized power converter for spacecraft energy management;
    - R&D on Self Healing Carbon Fiber Structures to address the challenge facing space missions once a material is damaged it is hardly repairable in space;
    - Development of a satellite Spot Beam Forming Network that will allow satellites to communicate with mobile users via energy beams that can dynamically adapt the available satellite energy to best cater to traffic demands; and,
    - Development of a compact fiber optic based cytometer allowing for advanced biology experimentation on the International Space Station. This novel work has the potential of radically changing how public health is performed by introducing high performance laboratory test equipment in the field. An example of the application for this technology is AIDS testing in remote or difficult settings.

- By using the Partnership Support Program and Natural Sciences and Engineering Research Council of Canada's (NSERC) Collaboration R&D Program, the CSA and NSERC have continued to foster closer collaboration between industry, universities and government in space research and technology development. In particular, CSA has within this framework supported 16 collaborative research projects through grants and in most cases also through in-kind contributions as well in a wide variety of areas, ranging from the development of a soy-based functional food for space-faring astronauts, over the design of fault tolerant and intelligent attitude control subsystem for micro and nano satellites, to the development of power system management and optimization tools for robotic exploration missions.

- CSA's portfolio of patents was entirely reviewed. Only patents with highest chances of finding a Licensee were maintained. Three new licenses were negotiated and five commercial studies were conducted on the potential transfer of emerging technologies to the private sector.

Program Sub-Activity: Space Mission Development Generic Technological Activities in support of EO, SE and SC

Objective: Provide coordination or support to the development of Earth Observation (EO), Space Science and Exploration (SE) and Satellite Communications (SC) space missions in line with CSA's priorities and stakeholders' expectations through the definition, critical design, manufacturing, integration, testing and delivery phases leading to launch and early operations of space systems.

Expected Result #1	
The CSA's in-house personnel are highly qualified, with recognized expertise, and are supported by a high-technology infrastructure that is suited to all Space Mission Development projects.	
Indicator	**Performance**
1. Number of aerospace related missions, projects/activities supported by David Florida Laboratory (DFL) facilities.	A total of 13 missions/projects/activities for the CSA, other governmental departments and the private companies were supported.

Performance Analysis

Expected Result #1

Indicator 1

From those 13 missions, 7 were government related (the CSA and DND) and 6 were privately sponsored by 24 external organizations; the number of missions and external organizations supported this year are slightly lower than those of last year where 18 missions and 31 external organizations benefited from DFL's services.

Source: Internal reporting documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
7.6	6.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
43.0	39.5

SPACE MISSION DEVELOPMENT – GENERIC TECHNOLOGICAL ACTIVITIES IN SUPPORT OF EO, SE AND SC

One Generic Space Mission Development Program, with a combination of accomplishments, demonstrates how the expected result outlined below was measured and attained.

1- David Florida Laboratory (DFL) supporting the Canadian Space Plan – Objective: Provide world-class space qualification services on a national scale, including facilities and expertise in support of the Canadian Space Program and international EO, SE and SC missions.

EXPECTED RESULT #1

Development, provision of expertise and supply of space qualification services, functional, and environmental testing of space hardware primarily for CSA sponsored programs and projects, and subsequently to the Canadian space industry and other private and public sector clients.

Indicator	Performance
1. Percentage of satisfied clients. (Target: based on client feedback and customer satisfaction surveys, achieve a client satisfaction rating of 95% or more)	**Target exceeded:** 99.5%

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the third time based on five consecutive data. Trend analysis maintains for the third time the superior rating for targeted achievements were consistently exceeded. Benchmark is well established and supported through the ISO9001:2000 processes.

Superior

Indicator 1

23 of the 64 Client Satisfaction Surveys sent out were returned = 36% return rate. Returned surveys revealed that customer responses meet or exceed expectations.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
6.3	6.0
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
43.0	39.5

Highlights of Main Accomplishments – Space Mission Development – Generic Technological Activities in support of EO, SE and SC

- David Florida Laboratory continued to provide world-class and cost-effective environmental space qualification services for the assembly, integration and testing of spacecraft systems and sub-systems to all of CSA's programs. The hardware for many priority projects were assembled and tested at DFL – such as:

  Science and Exploration:

  - CASSIOPE ePOP mission: A series of tests were performed including simulation on-orbit testing and magnetic field testing.

  - James Webb Space Telescope Space Telescope (JWST): The mission dominated DFL activities for much of the fiscal year. Thermal vacuum testing was completed on the FGS cryodetector unit, as were a series of vibration and mass properties measurements on the FGS ETU. A series of EMC tests were also performed on the ETU.

  - UltraViolet Imaging Telescope (UVIT): A series of vibration, thermal vacuum and EMC tests were performed on component boards, and the flight sub-system.

  Satellite Communications:

  - CASSIOPE Cascade mission: The full environmental test campaign was completed (thermal vacuum, vibration and EMC/RF testing) on the CASSIOPE spacecraft.

  Earth Observation:

  - JC2Sat: The RF testing was completed on UHF antennas.

  Commercial Programs:

  Provided test support to a number of space and non-space programs and projects including:

  - Space Systems Loral and, Nimiq 5
  - Nanosat AISSAT-1
  - Various units of Space Station Remote Manipulator System (SSRMS) and SRMS
  - Galileo flight model search and rescue antenna
  - Space Station Japanese Experimental module
  - Inmarsat Aeronautical Antennas

Department of National Defence:

- Near-field RF measurements were performed on a series of nose cone radome antennas for the, CF-18 Program.
- Canadian Space Agency: RF testings were performed on UHF antennas for QUICKSAT project.

2.6 SPACE AWARENESS AND LEARNING

SPACE AWARENESS AND LEARNING 2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS The CSA fosters science and technology literacy as a mean to influence the career choices of young Canadians towards science and technology.	
EXPECTED RESULT Targeted level of awareness of space among Canadians is reached.	
MAIN ACCOMPLISHMENTS IN 2009-2010 The number of visitors to the CSA's interactive website decreased by 35% from 1,616 million in 2008-2009 to 1,050 million in 2009-2010. A total of 102 public events were conducted in communities throughout Canada, including 15 specifically involving Canadian Astronauts, and 4 traveling exhibits were loaned for display with science center partners to raise awareness of space science and technology. A total of 1,221 educators received professional development in workshops conducted in provinces across the country and at annual conferences of teachers in four provinces: British Columbia, Alberta, Ontario and Prince Edward Island. Students from across the country were reached through an estimated 6,9 million occasions ranging from workshops and learning materials developed by the CSA to activities and events supported by the Space Learning Grants and Contributions Program.	
Indicator	**Performance**
1. Survey results obtained every 3 years.	No National Public Opinion survey was conducted.

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
8.9	8.9	5.9
2009-2010 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
26.0	24.0	2.0

The programs under this Program Activity are divided into two Sub-Activities: Awareness and Learning.

Program Sub-Activity: Awareness

Objective: To increase public awareness and understanding of how space programs affect and improve the quality of life.

Expected Result #1	
Target audiences are reached through outreach activities.	
Indicator	**Performance**
1. Number of initiatives according to targeted audiences.	**Target exceeded:** 87 events.

Performance Analysis
Expected Result #1 <u>Indicator 1</u> Last year, 81 events (media and public) took place. This explains why the target was exceeded this year. Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.9	4.3
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
21.0	19.0

Highlights of Main Accomplishments – Awareness

The major communications activities focused on the following:

- The conclusion of the Agency's third National Astronaut Recruitment Campaign which drew national attention to the quality of more than 5,300 highly educated and talented Canadians vying from all parts of the nation and abroad.

- The space flight of Dr. Robert Thirsk, the first Canadian Astronaut to live and work on the International Space Station for a six-month period. Related to this mission, the Agency encouraged the public to "Get Fit for Space". 37,183 people met the challenge and the campaign was awarded a gold medal by the International Council on Active aging for encouraging physical activities for an aging population.

- The space flight of Canadian Astronaut Julie Payette to the ISS. A robotic intensive construction mission during which the astronaut used Canadian robotics, Canadarm and Canadarm2, and the Japanese robotic arm to complete ISS assembly tasks, including fitting the external scientific platform and experiments to the Japanese KIBO module.

- Over 85 public events took place with astronauts and Agency speakers and four traveling exhibits on space were loaned for display with science center partners in communities across the nation.

- Canada's first space adventurer, Guy Laliberté's spaceflight generated public interest in Canada and around the world. The CSA collaborated with the One Drop Foundation to raise awareness of how observing the Earth from space can help to better understand our planet especially water resources.

- A range of awareness activities surrounding the International Year of Astronomy took place including public speaking events and video messages. Both Dr. Robert Thirsk and Julie Payette flew items to space in order to commemorate this event, and a partnership with the Legendary Sky project was undertaken to raise awareness of space and inspire youth in the Northern regions of Canada.

Program Sub-Activity: Learning

Objective: To direct a sustained, multi-dimensional, interactive learning program to build knowledge and enhance interest in space science and technology.

Expected Result #1	
Canadian educators and students further their learning related to science and technology through space theme.	
Indicators	**Performance**
1. Number of educators reached through professional development initiatives.	**Target exceeded:** 1,221 educators reached.
2. Number of students reached through learning activities.	**Target exceeded:** 6,873,623 students reached.

Performance Analysis

Expected Result #1

Indicator 1

Increase of 348 educators from the previous year.

Source: Internal documents.

Indicator 2

3,050,000 students reached through Bob Thirsk's C1 and Julie Payette 's STS-127 mission learning campaigns; 16,000 through Get Fit for Space; 647 through Astromenu; 12,000 through the Workshop program; 360,600 through Tomatosphere; 9,950 through downlinks; 3,424,426 students reached through organizations supported by the Space Learning grants and contributions. This is the first year that we have captured the impact of the Space Learning grants and contributions. This explains the important increase in the reach of the Learning Program over the previous year, where in 2008-2009, 1,720,340 students were reported to have been reached.

Source: Internal documents.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
3.0	1.7
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
5.0	5.0

Highlights of Main Accomplishments – Learning

The major learning activities focused on the following:

- Professional development workshops and teaching initiatives using tele-learning opportunities for educators. A total of 121 educators attended the Agency's 3-day professional development workshop, while another 3,321 educators received professional development in workshops across the country and at annual conferences of teachers in four provinces: British Columbia, Alberta, Ontario and Prince Edward Island.

- Partnered initiatives with schools, youth organizations and other institutions to expand student and educator access to space science and technology-focused educational resources.

- Targeted space-focused learning materials and teaching modules for educators at the primary and secondary level. Twenty nine new space science and technology-resources were created to support educators.

- Targeted grants, contribution and sponsorship programs in partnership with other government departments and agencies to support research, development and training in space science and technology. This included supporting Canadian medical students and residents to participate in aerospace medicine training offered by NASA.

- CSA pedagogical materials and participation in satellite downlinks, video and internet classrooms have markedly increased, as has the participation of educators seeking CSA space science and technology training. For example:

    - An estimated 3,400,000 students were reached across the country through a range of workshops and learning materials including products developed specifically for Canada's first long-duration mission aboard the International Space Station with Dr. Robert Thirsk and Julie Payette's second space mission.

    - Another 3,424,426 students were reached through activities and events supported by the Space Learning grants and contributions.

2.7 INTERNAL SERVICES

INTERNAL SERVICES 2009-2010 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS The CSA strengthen accountability for results by implementing the Government's commitment to modern public service management. Improvement of internal services at all levels of management raises the overall level of organizational performance by providing an added value to CSA managers in the performance of their duties.	
EXPECTED RESULT #1 Internal Services provide an added value to CSA managers in the performance of their duties.	
Indicator	**Performance**
1. Services provided meet standards set under Government-wide and CSA policies as well as Management Accountability Framework (MAF) expectations.	MAF rating from the 2009-2010 Round VII assessments against the 19 area of management indicators were: Strong = 0 Acceptable = 15 Opportunity for improvement = 4 Attention required = 0
Indicator 1 – Performance Analysis The Treasury Board's assessment addresses only indicators related to management quality. Overall, the results are slightly better than the assessment in 2008-2009. Compared to 2008-2009, 4 areas of management have improved, 14 have remained the same, 1 has declined. The number of areas of management at the acceptable level increased from 13 to 15 and the number of areas showing an opportunity for improvement declined from 5 to 4. Since the Round VI assessment, the CSA has assigned an officer of primary interest for each area of management and a compliance report is used to monitor progress being made to achieve targeted ratings. Source: Round VII 2009-2010 Management Accountability Framework Assessment (May 2010).	
EXPECTED RESULT #2 The four highest priority risks identified in the CSA Corporate Risk Profile are addressed and mitigated.	
Indicator	**Performance**
1. Mitigation action plans are implemented against the three corporate risks identified as highest priority. (Target: 80%)	Overall, 14 out of 23 (61%) risk mitigation actions were completed in 2009-2010.

Indicator 1 – Performance Analysis

Six out of 12 actions (50%) were completed for the corporate risk *Integration and implementation* defined as "The capacity of CSA to align its strategies, planning, priorities, funding levels, operations and capacity to deliver, and to obtain clear understanding and buy-in from managers and staff at all levels". The corporate risk assessment concluded that this risk remains a high priority and a mitigation action plan was developed.

Five out of the 7 (71%) actions were completed for the corporate risk *Workforce* defined as "The capacity of CSA to hire and maintain a qualified workforce of public servants to deliver its mandate." The corporate risk assessment concluded that this risk remains a high priority and a mitigation action plan was developed.

Three out of 4 actions (75%) were completed for the corporate risk *Trust in CSA Governance* defined as "The capacity of CSA in gaining and maintaining the confidence of the Minister, Central Agencies and stakeholders in the governance and effective management of its affairs in accordance with the Public Service Values and Ethics". The corporate risk assessment concluded that this risk is no longer a high priority.

Source: CSA Corporate Risk Profile (Internal document).

2009-2010 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
43.0	45.9	46.9
2009-2010 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
263.4	249.7	13.7

Program Sub-Activity: Internal Services

This Program Activity has three program sub-activity levels: Governance and Management Support, Resources Management Services and Asset Management Services. However, the sub-activity Asset Management Services is not presented in this report.

Program Sub-Activity: Governance and Management Support

Objective: Implement the Government's commitment to modern public service management in the area of governance and management support in accordance with the Management Accountability Framework's expectations.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
10.3	10.5
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
60.0	59.4

Main Expected Accomplishments – Governance and Management Support

- In order to align strategies, planning priorities, funding levels, and operations with the upcoming Long Term Space Plan, the CSA:
    - has reviewed the organizational structure which became effective on April 1, 2010;
    - has submitted to TBS a reviewed Program Activity Architecture (PAA); and,
    - has integrated the reviewed PAA in the corporate work planning, financial planning, and control systems in time for the 2011-2012 Annual Reference Level Update.

- In order that project and program management meets standards set by the new Government wide Investment Planning – Assets and Acquired Services and Management of projects Policies, the CSA has submitted a Draft Investment Plan which includes an Organizational Project Management Capacity Assessment and Project Complexity and Risk Assessment.

Program Sub-Activity: Resources Management Services

Objective: Implement the Government's commitment to modern public service management in the area of resource management support in accordance with the Management Accountability Framework's expectations.

2009-2010 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
18.8	21.6
2009-2010 – Human Resources (FTEs)	
Planned	**Actual**
169.0	161.5

Main Expected Accomplishments – Resources Management Services

- In order to ensure that the President and the Executive Committee receives the information needed to manage risk, improve performance and demonstrate accountability, the CSA, in collaboration with TBS, has put in place a Departmental Audit Committee. The fundamental role of this audit committee is to ensure that the deputy head has independent, objective advice, guidance and assurance on the adequacy of the department's control and accountability processes.

- In order to fine tune its internal control procedures to assure its managers that all payments are compliant with current financial policies, the CSA has streamlined payment verification and has implemented quality control procedures.

- In order to attract and retain a qualified workforce to deliver its mandate, the CSA continued the implementation of its 2007-2010 Integrated Corporate Human Resources Plan (ICHRP). A staffing blitz was completed with qualified candidates identified for 80% of the targeted positions and the pool of engineer candidates has progressed as planned. These actions contributed to reduce the difference between planned and actual FTEs from 103.5 in 2008-2009 to 49 in 2009-2010. Key leadership competency profiles were integrated in staffing and performance evaluation activities for all executive positions. Phase III of CSA Continuous Learning Program for managers was implemented and a learning plan was integrated in performance evaluation of all CSA employees.

2.8 LIST OF SPACE MISSIONS

ADAMS

Advanced Astronaut Medical Support (ADAMS) project can contribute to human exploration. Specifically, CSA has continued to explore solutions to the delivery of health care on future long duration exploration-class missions and how these solutions can help improve health care delivery on Earth through the transfer of space technology.

Anik F2

The Anik F2, Telesat Canada's innovative, high-speed Ka-Band, multimedia telecommunications satellite is one of the largest, most powerful communications satellites ever built. It is designed to support and enhance North American voice, data, and broadcast services. Through its support of Anik F2, the Government of Canada has secured a Government Capacity Credit access worth $50 million over 11 years to support the connectivity for remote and underserved northern rural communities.

APEX- CAMBIUM

CAMBIUM is part of the Advanced Plant Experiments (APEX) on orbit. The objective of the CAMBIUM experiment is to determine the role of gravity in the formation of "tension wood" forming after tilting or looping of the stem. The experiment has implications for fundamental plant responses to gravity and to the understanding and potential control of tension wood formation, which is important to the forestry industry.

APEX-CSA 2

APEX-CSA2 follows APEX-Cambium, a University of New Brunswick study led by Professor Rod Savidge that sent willows to the Space Station in November 2009. Canadian white spruce seedlings will be sent to the International Space Station (ISS) to help researchers understand how trees make wood. Known as APEX-CSA2 (short for Advanced Plant Experiments on Orbit), the experiment is led by Dr. Jean Beaulieu of Natural Resources Canada's Canadian Wood Fibre Centre in Quebec City, with the close collaboration of the Canadian Space Agency (CSA) and NASA. 24 white spruce (Picea glauca) seedlings will be launched to the ISS aboard the Space Shuttle Discovery on April 5, 2010. After 30 days of growing in space, the tips of the seedlings' and their roots will be clipped and placed in cold storage. They will return to Earth on Space Shuttle mission STS-132 in May 2010.

AQUATIC ORGS in µG

The objective of this multi-institutional, team-based and multidisciplinary project is to establish the first permanent facility in Canada for studies of the effects of altered gravity on fish. This will be realized through the construction of aquaria and 2- and 3-dimensional clinostats (equipment that will move the aquaria in such a way as to constantly change the direction of gravity as experienced by the fish) to simulate reduced-gravity conditions, and the 3-dimensional clinostat will be adapted to allow study of increased gravitational forces. This equipment will then be used to study the effects of gravity on fish embryonic development, and the effects of gravity on the function of adult fish, as a general model of development for aquatic animals with backbones.

ASTRO-H

Scheduled for launch in 2014, Astro-H is a Japanese Aerospace Exploration Agency (JAXA) X-ray Space Observatory spacecraft. The satellite will be equipped with hard X-ray imager, soft X-ray imager, a spectrometer and a gamma-ray detector, to explore structure and evolution of the Universe. With a total length of 14 m, the spacecraft will deploy an extensible boom holding the hard X-ray imager. Canada is considering providing a metrology system that will measure precisely the vibration of the boom in order to improve the performance of the imager.

Astronauts: Expedition 20/21

In 2008, Dr. Thirsk was assigned to the crew of Expedition 20/21 21 also known as C1 Mission the first Canadian mission onboard Soyuz for ISS. This Expedition represents a milestone for the Canadian Space Program since it will be the first time a Canadian takes part in a long duration mission. Robert Thirsk will have the privilege to expand the boundaries of space exploration by living and working onboard the International Space Station for six months. The launch took place on May 27, 2009 aboard a Soyuz rocket from the Cosmodrome in Baikonur, Kazakhstan. During this long duration mission Dr. Thirsk will assume responsibilities for the maintenance and repair of the ISS, while conducting experiments on behalf of Canadian and international researchers.

Astronauts: STS-115

Mission STS-115 took place from September 9 to 21, 2006. During these 12 days in space, Canadian Astronaut Steve MacLean and his crewmates successfully resumed the assembly of the International Space Station. They delivered and installed on the Station new truss segments and solar arrays, doubling the power capacity of the orbiting laboratory. During this mission, Steve MacLean became the first Canadian to operate Canadarm2 in space and the second Canadian to perform a spacewalk.

Astronauts: STS-118

Launched on August 8, 2007, the top priority of mission STS-118 is to deliver and assemble the S5 truss segment to the ISS. The 11 + 3 day mission marks the 22nd shuttle trip to the ISS, and the 20th flight of space shuttle Endeavour. Canada's contribution is once again crucial. During the mission, Astronaut Dave Williams, a veteran of shuttle mission STS-90, will set a Canadian record by spending over 19 hours outside the space station during three scheduled spacewalks. In addition, Canadian-made robotics and sensor technologies will help ensure the success of the mission and the safety of the shuttle and crew.

Astronauts: STS-121

Mission STS-121 took place from July 4 to 17, 2006. During these 13 days in space, the crew of Space Shuttle Discovery continued to test new equipment and procedures that increase the safety of space shuttles. Canada played a critical role in this mission by providing an extension to the Canadarm tipped with a Laser Camera System that allows the inspection of every inch of the spacecraft for possible signs of damage. This flight to the International Space Station also delivered critical supplies and cargo to the complex for repair and future expansion of the outpost. Canadian Space Agency Chief Astronaut Julie Payette was the lead Station Capsule Communicator acting as the orbiting astronauts' sole voicelink with Mission Control.

Astronauts: STS-127

The main goal of this ambitious mission is to deliver the final permanent components of the Japan Aerospace Exploration Agency's (JAXA) contribution to the station program. Astronauts will complete assembly of Kibo - the multi-part Japanese Experiment Module (JEM) by attaching an outdoor terrace or porch filled with Japanese experiment packages designed to be exposed to the vacuum of space. Also on the docket for the Shuttle crew is a tricky replacement of six batteries at one of the farthest ends of the station's truss.

Astronauts: TMA-6/10S

The Italian Mission took place from April 15 to 25 onboard Soyuz. During the mission the Canadian Astronaut Robert Thirsk was a communications coordinator with the European control centre. The European Space Agency (ESA) invited him to train as a backup astronaut to Roberto Vittori for the upcoming Italian Soyuz Mission, also known as Eneide - Italian for The Aeneid, the epic poem by Virgil about the voyages of Aeneas and the founding of Rome. So, for example, if Roberto Vittori encountered a problem with an experiment in orbit, he contacted Robert Thirsk who worked with the ground crews to solve the problem and fulfill the mission objectives.

BCAT-5 / BCAT-C1

The Binary Colloid Alloy Test 5 (BCAT C-5) is a Canadian experiment concept that will study the effect of phase separation on crystal growth in the ISS microgravity environment using samples consisting of colloidal suspensions with added polymer. On Earth, gravity causes the colloids to settle making such a study particularly difficult. Improved understanding of crystal growth will lead to more refined manufacturing processes and commercial products. During the Expedition 20/21 (mission C1), Canadian Astronaut Dr. Robert (Bob) Thirsk has performed colloid experiments aboard the ISS where visual information will be transmitted to scientists on the ground for data analysis.

BISE

The Bodies in Space Environment (BISE) experiment measures the relative contributions of internal and external cues to self-orientation before, during and after microgravity exposure. The project aims to better understand the importance of different types of cues in the neurological process that tell astronauts which way is "up" in a microgravity environment. Illusions and other phenomena could interfere with routine operational processes as well as emergency procedures on platforms such as the International Space Station (ISS).

BLAST

In June 2005, a team of researchers from Canada, the U.S., the U.K. and Mexico has launched the Balloon-borne Large Aperture Sub-millimetre Telescope (BLAST) to probe the heavens to identify starburst galaxies and enabling researchers to study the formation and evolution of stars, galaxies and star clusters.

BRITE

BRight Target Explorer (BRITE) is a nano-satellite developed by Space Flight Lab of University of Toronto's Institute for Aerospace Studies. The nano-satellite will carry a small telescope to observe very precisely the brightness variation of many bright stars from space. The uninterrupted observations over a long duration, with similar science objectives as MOST, will help to understand the structure and evolution of massive stars that create the heavy elements in our galaxy. The mission includes a constellation of 6 nano-satellites, 2 provided by Canada, 2 by Austria and 2 by Poland. CSA plans to fund this project through a contribution agreement in 2010. Launch is planned for 2012.

CADC/HUBBLE

The Canadian Astronomy Data Center (CADC) is a data archiving and access facility to support science done by Canadian astronomers and to contribute to international astronomy research. CADC archives astronomical images and data from major ground based observatories, from CSA missions as well as from the Hubble Space Telescope.

CanALSS

The Canadian Advanced Life Support System (CanALSS) is a CSA mission concept to supply the Higher Plant Chamber as one component of an international bioregenerative life support system by the year 2050. CanALSS is based on Canadian technologies currently being developed and will allow Canada to expand on this capability where it is recognized as a world leader.

CANSOC

CANSOC (Canadian Satellite Operation Centre) is a multi-mission control centre with ground stations for telemetry, tracking and commanding and data reception, and it is composed of data ordering and planning, flight control, data archiving and cataloguing, data processing and quality control, and communications networks systems, and it is responsible for end-to-end operations and management of satellite missions.

CASS

The Chemical and Aerosol Sounding Satellite (CASS) mission is a partnership concept study composed of a NASA instrument and a CSA instrument on a small satellite that will provide solar occultation measurements that address issues of stratospheric ozone recovery and impacts of climate change.

CASSIOPE

The **Cascade** Demonstrator, Smallsat Bus and Ionospheric Polar Explorer (CASSIOPE) is a small hybrid satellite that includes the telecommunication instrument Cascade, which will provide the very first digital broadband courier service for commercial use, and the scientific payload **enhanced Polar Outflow Probe** (ePOP), which will be used to study the ionosphere.

CCAP

The Cell Culture and Analysis Payload (CCAP) is to be a wide-use automated cell and tissue culture facility that will be capable of obtaining sufficient science data such that it will not be necessary to return the biological specimens to ground for post-processing. CCAP is intended for installation and application on the International Space Station.

CCISS

The experiment Cardiovascular and Cerebrovascular Control on return from ISS (CCISS) will study cardiovascular and cerebrovascular adaptations to microgravity to improve astronaut function and capacities upon return into planetary gravity.

CGSM

The Canadian GeoSpace Monitoring (CGSM) system is a Canadian network of ground-based instruments to monitor and study geomagnetic activity near Earth, as well as space weather. It includes high-frequency radars, sky imagers, computer models and data portals located across the country. Canada is especially vulnerable to the effects of space weather and solar storms and CGSM provides data, knowledge and information to protect critical and expensive space and ground communication and navigation assets from space weather.

CHENSS

The Canadian High Energy Neutron Spectrometry System (CHENSS) will increase scientific understanding of the high-energy neutron spectrum in space. This will help understand and plan mitigations for radiation risk to astronauts during long term space missions.

CIMEX

The Convection and Interfacial Mass Exchange (CIMEX) experiment will investigate fundamental and applied aspects of mass transfer through fluid interfaces (mainly evaporating liquids). Improved understanding of this process can be achieved through microgravity experiments because of the lack of convection. The results can be applied to heat-exchange pipe design and design of evaporators.

CloudSat

CloudSat is making the first comprehensive three-dimensional study of clouds. It gathers data on their structure, frequency and volume, and helps improve our understanding of how they influence the weather and climate. It uses a radar hyperfrequency device to probe the cloud cover.

DynAMO

The Dynamic Atmosphere Mars Observer (DynAMO) is CSA concept of an instrument proposed as a key element in the 2016 Mars Science Orbiter program for characterization of the Martian Atmosphere. DynAMO would be capable of measuring winds globally on Mars.

EBEX

NASA's E and B EXperiment (EBEX) is a mission using a high-altitude balloon-borne instrument to study the sky in the far infra-red (FIR) and measure the polarization of the cosmic microwave background which is the signature of the Big Bang. Canada will provide a state-of-the-art digital electronic readout system for use with large arrays of FIR bolometers.

ELERAD

The ELERAD study will assess radiation damage on long duration flights. A genetically engineered strain of C. elegans worms is currently on board the ISS to test if it can be used as a biological dosimeter. Upon return, the worms will be analyzed to assess the genetic alterations caused by radiation in Low Earth Orbit. The experiment will be carried out in a scientific/educational mission sponsored by NASA and the Malaysian Space Agency.

eOSTEO

The goal of the eOSTEO mission is to better understand the fundamental causes of bone loss in microgravity using an automated cell culture system. The eOSTEO is made of three Canadian experiments to study how bone cells in microgravity react to signals that increase and decrease bone formation; whether microgravity compromises bone cell architecture; and whether a hormone that promotes bone creation can, in weightless conditions, prevent the death of cells that build bone. Applications of the research are expected for development of better treatments for osteoporosis on Earth and during long duration space missions.

ESA - ADM/Aeolus

The Atmospheric Dynamics Mission (ADM) is an European Space Agency (ESA) Explorer Core mission, which will probe the lowermost 30 km of the atmosphere from 400 km above the Earth's surface using a high power Doppler wind lidar. The measured data will improve the accuracy of numerical weather forecasting and advance our understanding of atmospheric dynamics and processes relevant to climate variability and modeling.

ESA – Alphasat

The primary objective of ESA under the Alphasat Program is to facilitate an early first flight, and in-orbit validation of the Alphabus platform, currently under development with European industry. The Alphasat mission will extend the capabilities of geomobile satellite infrastructure, both in terms of performances and capacity, resulting in an enhancement in the current services and additional capacity for new services.

ESA - Cross Scale

Cross-Scale is an ESA mission concept to study multi-scale coupling in space plasmas. Its objectives are the quantification of fundamental plasma processes (shocks, reconnection, and turbulence) that operate universally in astrophysical and laboratory plasmas but are only accessible to direct sampling of particles and fields in near-Earth space. Possible Canadian participation would be through instrument contribution.

ESA - Cryosat

Cryosat will measure changes in the sea-ice thickness and variations in snow depth to better understand the influence that climate change is having on the Earth's polar ice masses. It is one of six missions being developed under ESA Earth Explorer Opportunity mission.

ESA/JAXA - EarthCARE

The ESA Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) mission is being implemented in cooperation with JAXA (Japanese Space Agency). The payload consists of instruments for measuring clouds (Cloud Profiling Radar and multispectral imager) and aerosol properties (atmospheric lidar), and a broadband radiometer to measure top-of-the atmosphere radiances and fluxes.

ESA- ENVISAT

ENVISAT, is the European Space Agency's (ESA) most ambitious Earth Observation (EO) satellite, which was launched successfully in 2002. It carries a suite of 10 instruments including an Advanced Synthetic Aperture Radar (SAR), scatterometer, altimeter, and passive optical instruments for atmospheric chemistry, ocean and sea surface temperature observations. There are 28 Canadian scientific teams currently participating in exploiting the data, and its mission duration has been extended to 2013.

ESA - ERS-2

ESA Earth Observation satellite was launched in 1995 and is carrying similar set of instruments as the ENVISAT satellite. It is still operating and providing useful data to many scientific teams. Canada participated in development of the satellite for ERS-1 and ERS–2. This participation also played an important role in the building of Canadian RADARSAT-1.

ESA - EXOMARS

ExoMars is a European-led space exploration mission, currently under development by the European Space Agency (ESA) that will send a robotic rover to the surface of Mars. The mission began as part of ESA's Aurora program. ExoMars will combine technology development with investigations of major scientific interest. It is a robotic mission which will provide Europe with new technologies for the exploration of Mars, specifically the Entry, Descent and Landing System (EDLS), the surface Rover and its Drill and Sample Preparation and Distribution System (SPDS).

ESA - Galileo

Galileo is a joint program of the European Space Agency and the European Union that will create a system of 32 satellites to improve and complement satellite navigation and positioning systems such as the US-led GPS and Russia's Glonass. Canada was the first non-European country to join the program in 1999. Specifically, Galileo targets the design and development of four satellites to prove the In-Orbit Validation (IOV) concept of the Galileo GNSS Constellation.

ESA - GOCE

The ESA Gravity field and steady-state Ocean Circulation Explorer (GOCE) mission is dedicated to measuring the Earth's gravity field and modeling the geoid with unprecedented accuracy and spatial resolution. This mission will advance our knowledge of ocean circulation, which plays critical role in energy exchanges, sea level change and Earth interior processes. GOCE will also make significant advances in the field of geodesy and surveying.

ESA - Herschel-HIFI/Spire

The Herschel Space Observatory will help scientists determine how early galaxies formed and evolved. The observatory has three instruments and Canada is contributing to two of them: the Heterodyne Instrument for the Far Infrared (HIFI) and the Spectral and Photometric Imaging Receiver (SPIRE).

ESA - MICAST

The MICAST (MIcrostructure in CASTings) European Space Agency project is a ground-based and microgravity experiments. Canadian members of the MICAST team will be carrying out specific ground-based solidification of aluminum experiments under combined magnetic fields (with strong static and weak rotating magnetic fields) using the existing state-of-the-art experimental facility at the University of Victoria Crystal Growth Laboratory.

ESA - NEQUISOL

The Non-equilibrium Solidification, Modeling for Microstructure Engineering of Industrial Alloys (NEQUISOL) study aims to use microgravity experiments to improve models of solidification of "under cooled" alloys, in order to better predict conditions required for the production of superior materials.

ESA - Planck

Planck is a European Space Agency medium-sized mission that will be launched with the Herschel Space Observatory. It is a survey instrument that will map the entire sky. Canada is involved mainly in the development of Quick Look Analysis software and Real Time Analysis software for scientific checkout of the data at early stages.

ESA - Sentinel-1

The Sentinel-1 mission is being built under ESA Global Monitoring for Environment and Security (GMES) program. Its payload consists of a C-band Synthetic Aperture Radar (SAR) (Similar to RADARSAT-2) to provide operational data continuity beyond existing C-band SAR.

ESA - Sentinel-2

The Sentinel-2 mission is developed within ESA Global Monitoring for Environment and Security (GMES) space component program. Its payload consists of a multispectral optical imaging mission as follow-on to LandSat and SPOT missions for monitoring of land cover application. The mission consists of two satellite constellation.

ESA - Sentinel-3

The Sentinel-3 mission is developed within ESA Global Monitoring for Environment and Security (GMES) space component program. Its payload consists of an instrument suite providing data from visible to thermal at medium (200 m) to modest spatial resolution (1 km) for ocean color, sea surface temperature and global land mapping (data continuation of MODIS and MERIS), an interferometric SAR altimeter for ocean observation. The mission consists of two satellite constellation.

ESA - Sentinel-5 Precursor

The Sentinel-5 Precursor mission is developed within ESA Global Monitoring for Environment and Security (GMES) space component program. It is designed as a gap filler mission to ensure the continuity of data of Sentinel-5 which will be launched in 2019 as part of Post-EPS mission of EUMETSAT. The mission is to monitor atmospheric composition covering spectral range from UV, VIS NIR and SWIR. The UN-VIS-NIR spectrometer is based on the TROPOMI developed by the Netherland.

ESA - SMOS

The ESA Soil Moisture and Ocean Salinity (SMOS) mission objective is to measure soil moisture and ocean salinity using a novel technique of aperture synthesized radiometry in L-band. The measures will be used for weather/climate prediction.

ESA – SODI DSC

This mission is dedicated to the study of the movement of molecules in liquids due to temperature gradients (thermodiffusion). Thermodiffusion is a process common to various industrial processes including petroleum extraction from deep reservoirs such as Hyberia off the East coast of Canada. This European-led long-duration mission onboard the International Space Station will allow Canadian and international scientists to further understand the role of gravity in molecular movement important for Canadian industry. The predecessor of the DSC experiment, known as IVIDIL, was assembled and commissioned by CSA Astronaut Bob Thirsk in 2009. Both missions involve Canadian co-investigator Professor Ziad Saghir from Ryerson University in Toronto, Canada.

ESA – SODI IVIDIL

The Influence of Vibration on Diffusion in Liquids (IVIDIL) experiment will help understand and acknowledge the effects of vehicle vibration on microgravity experiments on double diffusion. Double molecular and thermal diffusion often occurs in hydrocarbon reservoirs, making assessment of reservoir composition difficult. Microgravity experiments can improve such assessments.

ESA - SWARM

The ESA Swarm mission is a constellation of three satellites that will provide high-precision and high-resolution measurements of the strength and direction of the Earth magnetic field. Canada is providing an Electric Field Instrument (EFI).

EVARM

EVARM, Extra Vehicular Activity Radiation Monitor, measures the radiation exposure astronauts receive while working outside the Space Station or Shuttle. Astronauts on a spacewalk, or EVA, will wear small electronic badges in their space suits to record the amount of radiation they are exposed to on their spacewalk.

EVIS
The Extraction Vehicle for In Situ Resource Utilization (EVIS) is a CSA concept study to create a concept definition and high level requirements for the systems, technologies and materials required for an extraction vehicle. In particular, this concept study will address the operating and design concepts for a mobility platform focused on In Situ Resource Utilization and associated accessories and instrumentation.

FIRI
FIRI is a Far Infra-Red Interferometer capable of achieving high resolution imaging and spectroscopy dedicated to the study of the early stages of the galaxies, stars and planets formation. It was proposed as part of the ESA Cosmic Vision program but was not retained in the down-selection. However groups of international researchers are continuing to develop mission concepts.

FPEF
The Fluid Physics Experiment Facility (FPEF) is installed on the ISS. Its objective is to collect important experimental data on the role of a liquid bridge in material solidification, an important system used in semiconductor manufacturing. The role of gravity complicates industry's understanding of this system on Earth, and different inserts will allow researchers to study various liquids and liquid bridge dimensions.

FPNS
The Feature-based Planetary Navigation System (FPNS) is a CSA concept study of a camera and Lidar-based navigation system that uses surface features to provide absolute navigation capability to planetary orbiters and landers. These are functionally similar to GPS and GNSS on Earth but without the cost and complexity of a GPS constellation. The FPNS aims to integrate Canadian Lidar Technology, space-qualified cameras and advanced algorithms into a self-contained navigation subsystem that will meet the requirements of a large number of future planetary missions.

FUSE
NASA's Far Ultraviolet Spectroscopic Explorer (FUSE) mission was terminated in October 2007 after nine successful years of operations. Canadian scientists have obtained the data in exchange of the CSA contributing the Fine Error Sensors to the telescope.

GPR
The Ground Penetrating Radar (GPR) is a CSA concept study to examine the scientific, technical and programmatic aspects of using radar to explore the lunar subsurface. While current lunar missions are focusing on global-scale mapping and understanding of geological processes, future efforts will require detailed site-scale characterization of local geology and resource potential. The GPR would yield a greater understanding of the structure and composition of the shallow subsurface at targeted sites of interest.

Halo
The CSA Hyperspectral And Luminescence Observer concept study will examine the combination of an orbital hyperspectral imager and rover-borne luminescence instrument for Mars in the context of the Mars Sample Return mission. Data analysis techniques will be developed to solve the data volume problem associated with this type of instrumentation for the particular case of the robust identification and mapping of predefined, targeted, water-related mineral deposits on the surface of Mars, supported directly by ground/rock truth data from in-situ luminescence measurements.

HAWAII
As part of the Hawaii 2010 analog deployment on Mauna Kea, Astronaut Chris Hadfield took part in ARTSE (Augmented Reality Tools for Space Exploration). The goal of this mission was to understand how a science backroom can help an astronaut accomplish geological tasks over a series of lunar surface traverses, and to explore the potential of an augmented shared reality (ASR) system to enable this activity. This was accomplished by tracking communications between a group of geologists 'on Earth' at the ExDOC mission control facility at CSA, and Hadfield on site carrying out geological tasks relevant to in-situ resource utilization. Hadfield had some geological training, but also needed the expertise of the remote team to complete his tasks successfully.

H-Reflex
It is Canada's first International Space Station (ISS) science experiment. It studies the effect of space travel on our nervous system.

Hypersole
The proposed study aims to use monofilament (vonFrey Hairs) and vibration testing to determine changes in skin sensitivity post space flight. The results will formally document changes in skin sensitivity post-space flight and will contribute to our knowledge of current theories on skin contribution to postural control on Earth which could have an impact on crew safety upon return to gravity and/or public health.

ICAPS
The Interactions of Cosmic and Atmospheric Particles (ICAPS) experiment will study, the interactions of cosmic and atmospheric particle systems under microgravity conditions. ICAPS has applications to particle physics, atmospheric science, and planetary science

ICE-First
The project ICE-First focuses on genetic repair mechanisms using C. elegans, a small worm widely used for genetics research. Half of C. elegans' genes have human counterparts. This worm can also mate, reproduce and develop normally during space flight, making it an ideal subject to study the effects of space travel on living organisms. The project will measure the amount of radiation, its effects on genes, and to eventually develop a biological radiation dosimeter for measuring how much damage radiation causes to living cells on long flights.

ILN

The CSA Canadian International Lunar Network (ILN) mission concept study is to examine the scientific and technical feasibility of creating a stand-alone Canadian ILN node. Along with the base ILN science objectives, the project will identify the scientific questions that Canadian scientists will explore on the mission. The project will then define a conceptual mission capable of delivering the international and Canadian scientific payloads to the lunar surface and show how the resultant technologies are re-usable for future space missions and for terrestrial applications.

Insect Habitat

The CSA Insect Habitat (IH) instrument provides the systems required to support a wide range of fundamental gravitational biology research on the ISS. It is a facility intended to house insect specimens for long duration exposure to a microgravity environment.

ISRU

The Drilling Systems in Support of In-Situ Resource Utilization (ISRU) is a CSA concept study of a sample acquisition system based upon drilling and coring technology. ISRU would characterize the form and concentration of the resources available, understand the environment the resource is found in, and adequately validate that the processes required for extracting and processing the resource will operate in the environment for the desired mission duration.

ISS

The International Space Station (ISS) is the most ambitious engineering project ever undertaken by humanity. Canada is contributing the Mobile Servicing System (MSS), a space robotics system astronauts use to assemble and maintain the ISS. The MSS consists of three main elements: the Space Station Remote Manipulator System (SSRMS), known as Canadarm2, the Mobile Base System (MBS), and the Special Purpose Dexterous Manipulator (SPDM), known as Dextre.

IXO

The International X-ray Observatory (IXO) is aimed as the next generation large X-ray observatory. It is a concept proposed by ESA, JAXA and NASA and recently mentioned in the US Decadal survey as one of the top mission priority. Launch is planned in the 2020's.

JC2Sat

JC2Sat is a Canada-Japan collaborative research and engineering project to develop a pair of nano-satellites. The objective of the mission is to demonstrate innovative technologies as well as formation flying techniques using very small spacecraft.

JDEM

The Joint Dark Energy Mission (JDEM) is a joint mission between NASA and the U.S. Department of Energy (DOE) proposes to investigate the Dark Energy. The recently released US Decadal survey of Astronomy and Astrophysics recommends that a dark energy mission be the top priority in space astronomy over the next decade. The report refers to a mission named WFIRST (Wide Field Infrared Survey Telescope) which is based on one of the designs proposed for JDEM. It is a similar concept of the ESA Euclid mission, retained in the Cosmic Vision program. Neither missions are officially approved, but concept development continues and may result in further collaboration mission. CSA has supported a mission concept study (2010) to identify potential contribution to such a mission. Launch would be in the late 2010's.

JWST

The James Webb Space Telescope (JWST) is a joint mission involving NASA, ESA, and the CSA. This major facility-class space observatory will be a successor to the Hubble Space Telescope. The JWST will be used to observe targets that range from objects within our Solar System to the most remote galaxies, which are seen during their formation in the early universe. The CSA is contributing with the development of two instruments; a Tunable Filter Imager (TFI) and a Fine Guidance Sensor (FGS).

LEMUR

The Lunar Exploration Manned Utility Rover (LEMUR) is a CSA exploration concept that could lead to a critical and central Canadian contribution to the lunar surface mobility architecture. LEMUR is a small, agile, unpressurized surface mobility system. When driven manually, it accommodates two suited astronauts. In addition, LEMUR accommodates small payloads (such as luggage and small scientific instruments) with expansion capabilities for larger payloads (such as cargo and full suites of scientific instruments).

LiteArm

The Lightweight, Scalable Manipulator Family for Exploration (LiteArm) is a CSA concept study focused on potential Canadian manipulator participation in future surface exploration missions. This study would provide an overview of present and planned surface exploration missions which could require manipulator systems, and Canada's potential role in them. Additionally, this study would provide architectures for an optimal number of manipulator classes that satisfy the range of capabilities required to meet the objectives of these surface missions and their associated costs and development schedules.

LORE
The CSA Lunar Origins and Resource Explorer concept study will examine the scientific and technical feasibility of investigating the lunar polar environment, determining surface and near-surface solar wind-implanted ions, ilmenite abundances, surface and subsurface ice distribution, dust physical and compositional properties, mineralogy, and dust levitation using Ultra-violet (UV), Visible (VIS) and Mid-InfraRed (MIR) reflectance spectroscopy and a Complementary Metal-Oxide Semiconductor (CMOS) micro-imager for target morphology and grain size.

LSC
The Lunar Surface Communications (LSC) is a CSA study of requirements, architecture and a design concept for a Moon surface communication system that enables wireless surface operational support. The proposed lunar network comprises a combination of orbiter relay, direct to Earth links and surface radio communications. This study would focus on defining a Moon surface communication architecture and design concepts that would enable future surface communication.

Luna – Resource
Two concepts are being developed for further consideration in future mission to the moon.

Lunar Rover
The CSA Lunar Rover Concept Study is an operational concept for a rover and associated subsystems that would fit into the published NASA Lunar Exploration Architecture. The proposed concept is a general-purpose, configurable rover that satisfies mission requirements ranging from short one and two-day sortie missions to longer multi-day outpost missions.

M3MSat
CSA and the Department of National Defence are partnering to manage the Maritime Monitoring and Messaging Microsatellite (M3MSat) which payload will be an Automatic Identification System (AIS) supported on a micro-satellite bus. This project will demonstrate a multi-mission micro-satellite bus capability and will allow optimization of the AIS payload in maritime traffic identification.

Marangoni
The JAXA's Marangoni experiment will be carried out on the ISS. The Canadian scientific contribution is an advanced three-dimensional numerical model that will be developed and used with the g-jitter data from the ISS to predict vibration-induced surface oscillations of a liquid bridge undergoing oscillatory Marangoni convection that can affect adversely the synthesis of new materials such as semi-conductor crystals.

Matroshka-R
The Matroshka-R experiment investigates how much radiation different organs in the human body receive in space over prolonged periods of time. The data gained from Matroshka-R will be vital to estimate health risks to astronauts aboard the ISS and on longer space missions since the total radiation risk depends largely on the dose received by the internal organs. It will also increase understanding of the distribution of different types of radiation within the ISS and within the human body. This experiment is followed by the RaDI-N experiment.

MCAP
The Mission for Climate and Atmospheric Pollution (MCAP) is a CSA concept study composed of four nadir-viewing instruments on a small satellite for the acquisition of a global precise dataset of atmospheric composition measurements (trace gases and aerosols) that are important for climate process and air quality studies.

MEMS LIDAR
The CSA Micro-Electro-Mechanical Systems and Light Detection And Ranging (MEMS LIDAR) concept study will focus on the Canadian contribution of a 3D active vision sensing capability based on the needs for rover operations on the JAXA SELENE-2 Lunar mission.

MEOS
The Miniature Earth Observing Satellite (MEOS) mission is a CSA concept study composed of several miniaturized limb and nadir-viewing instruments on a micro satellite focusing on the measurement of greenhouse gases, aerosols and clouds. It will permit the study of terrestrial vegetation absorption and emission of tropospheric gases.

MEOSAR
Middle Earth Orbit Search-and-Rescue (MEOSAR) will use navigation satellites such as GPS and Galileo to relay in near real-time signals from activated distress beacons located in ships, plane or on a single individual needing help for search and rescue missions. Its payload will support the COSPAS-SarSat Search-and-Rescue satellite system.

M-FTSIS
The Mars Fourier Transform Spectrometer Interferometer Subsystem (M-FTSIS) is a CSA concept of an occultation Fourier Transform Spectrometer for measuring the atmosphere of Mars based on Canada's experience with the Atmospheric Chemistry Experiment Fourier Transform Spectrometer on Canada's SCISAT satellite. A solar occultation spectrometer has the potential to significantly increase knowledge of the atmosphere of Mars and provides a unique Canadian opportunity to perform international cutting-edge research in space exploration.

MIM/ATEN
The Microgravity Vibration Isolation Mount (MIM) is an ISS hardware that isolates experiments from on board vibrations, providing a more "pure" microgravity. ATEN is used with the MIM Base Unit. It is a furnace designed to meet a wide range of scientific requirements on the ISS.

MLM
The Manned Lunar Mission (MLM) is a CSA concept study that will provide a budgetary Rough Order of Magnitude (ROM) cost for a core mobility system concept as the foundation of Canada's contribution to the international exploration architecture. It will establish a Canadian Lunar Mobility Architecture to aid definition of architectures by international partners and provide CSA with the prerequisites to kick-start rover technology developments.

MOPITT
One of five instruments on NASA's Terra satellite, MOPITT (Measurements of Pollution in the Troposphere) contributes to our understanding of the sources and pathways of atmospheric pollutants.

MOPITT-2
Concept studies to develop the next generation of instruments for the measurements of pollution in the troposphere. This is one of the instruments being proposed as part of the Mission for Climate and Air Pollution (MCAP), one of the CSA mission concepts being completed in 2009.

MORSE
This initiative aims at developing and demonstrating the usefulness of EO data for monitoring coastlines and coastal processes in the Arctic focusing on the information needs of Arctic coastal users in government, industry and in scientific organizations. It supports, enhances and stimulates coordination among Arctic coastal communities having common Earth observation-related information needs and activities across sectors and across disciplines.

MOST
The Microvariability and Oscillations of Stars (MOST) microsatellite is Canada's first space telescope launched in 2003. It measures tiny fluctuations in light intensity from stars, enabling scientists to probe star interiors seismically and to set a lower limit on the age of the universe. MOST is also sensitive to the light variations caused by planets around other stars, giving us unique information about these distant worlds.

MSL - APXS
The Alpha-Particle-X-Ray-Spectrometer (APXS) is an instrument for the Mars Science Laboratory. The Canadian contribution will help scientists to determine the chemical composition of various soil, dust and rock samples on the planet.

MSO - FTIR

The CSA study will focus on increasing the level of readiness of the science ant the technology associated with the solar occultation Fourier Transform InfraRed (FTIR) spectrometer of the Mars Science Orbiter (MSO). The long-term goal is to propose the successful Canadian technology to that NASA mission.

MSO - SAR

The Synthetic Aperture Radar (SAR) Payload for Mars Science Orbiter is a CSA study to advance the payload concept of a dual-band SAR instrument and radiometer for the exploration of Mars. This study targets the MSO opportunity in 2013 as a possible Canadian-built SAR instrument mission.

MSR - NET

The CSA concept study Vision system for Mars Sample Return (MSR) will focus on vision system technology needs for the automated rendezvous and capture operations of the MSR mission while simultaneously introducing key technology components for next generation 3D vision sensors.

MSS – STS-114

The Return to Flight Space Shuttle mission took the American flagship spacecraft back into orbit; it's been over two years since the Columbia accident. A mission like no other, STS-114 is a unique test flight that serves as a foundation for every Shuttle mission to follow. The mission tested new designs incorporated into the Shuttle's external fuel tank and processes that eliminate the likelihood that future Space Shuttle flights could suffer damage similar to Columbia. New cameras and techniques photographed the tank during launch and after it is jettisoned from the Shuttle to allow engineers to evaluate the performance of those new designs. The mission also tested a variety of new techniques to ensure that the health of the heat shield can be confirmed in space. New ground and flight camera and sensor systems observe the Shuttle environment during launch and in orbit. New techniques will be used for in-flight inspection. New methods under development for repair of the Shuttle's heat-shielding Thermal Protection System were tested. Also, Discovery delivered a pressurized cargo container full of supplies to the Space Station and a key spare part that was installed during one of the mission's three spacewalks.

MSS – STS-119

Move over, Morning Star. Once Canadarm2 installs the fourth and final set of solar array wings to the International Space Station, the Station will surpass Venus as the brightest object in the night sky, second only to the Moon. The Space Shuttle Discovery is set to deliver the power-generating solar panels and Starboard 6 (S6) truss segment to the ISS on the 125th mission in the Shuttle program, known as STS-119/15A (which launched on March 15, 2009). This final piece of the Station's backbone brings the ISS to its full length of 102 metres (roughly the size of a Canadian football field), and increases the quantity of electricity available for science experiments by 50%. This additional power also means that the Station is ready to house a crew of 6 astronauts instead of the current 3. Canadian Space Agency Astronaut Dr. Robert Thirsk will be a member of Expedition 20/21-the first 6-person Station crew set to launch in late May 2009.

MSS – STS-123 1J/A (DEXTRE)

In mid-March 2008, Space Shuttle Endeavour flew its 25th assembly mission to the International Space Station to deliver the Canadian-designed two-armed robot called "Dextre" the Special Purpose Dexterous Manipulator (SPDM), supply the first component of the Japan Aerospace Exploration Agency (JAXA) Japanese Experiment Module (JEM), and make an astronaut rotation. An essential, versatile tool for servicing the Station, Dextre can remove and replace small components on the Station's exterior that require precise handling. It is equipped with specialized grippers, built-in socket wrenches, four robotic tools, video equipment, lights, and umbilical connectors to provide power and data connectivity, and a stowage platform. Dextre is a sophisticated two-armed robot, part of Canada's contribution to the International Space Station. Canadarm2, a moveable work platform called the mobile base, and Dextre form the Mobile Servicing System. These three robotic elements can work together or independently.

MSS – STS-124

CSA supported the STS-124 mission whose main objective was to install the Japanese Experimental Module (Kibo) to the ISS. The STS-124 mission was the second of three flights where Canadarm2 was used to assemble an element of the final Kibo laboratory. Afterwards, Kibo's logistics module, which had been installed in a temporary location during STS-123, was relocated by Candarm2 and attached to the Japanese Experiment Module (JEM). STS-124 was the 26th shuttle mission to the International Space Station.

MSS – STS-126

On November 10, 2008, Canadarm2 extracted the Multi-Purpose Logistics Module (MPLM) from the Space Shuttle Discovery and berthed it to the ISS to support the transfer of supplies and other logistics payloads to the ISS. Canadarm2 then reinstalled the MPLM into Discovery's payload bay prior to its return to earth.

MSS – STS-128

On August 31, 2009, Canadarm2 extracted the Multi-Purpose Logistics Module (MPLM) from the Space Shuttle Discovery and berthed it to the ISS to support the transfer of supplies and other logistics payloads to the ISS. Canadarm2 then reinstalled the MPLM into Discovery's payload bay prior to its return to Earth.

MSS – STS-129

CSA supported the STS-129 mission whose main objective was to install Express Logistics Carriers ELC 1 and ELC 2: moved from payload bay to respective locations on P3 and S3 truss segments, Transfer S-Band Antenna and Support Assembly (SASA) to Z1 location, Transfer and install spare High Pressure Gas Tank (HPGT) (O2) from ELC2 to ISS Airlock using the Space Station Remote Manipulator System (SSRMS) and Relocate Pressurized Mating Adapter (PMA) 3 to Node 1 Nadir using SSRMS.

MSS – STS-131

On April 08, 2010, Canadarm2 extracted the Multi-Purpose Logistics Module (MPLM) from the Space Shuttle Discovery and berthed it to the ISS to support the transfer of supplies and other logistics payloads to the ISS. The Space Station Remote Manipulator System (SSRMS) was also used to transfer an Ammonia Tank Assembly (ATA) to the ISS. Canadarm2 then reinstalled the MPLM into Discovery's payload bay prior to its return to Earth.

MVIS

Canada has developed key technology that will help isolate experiments from the harmful effects of these vibrations. The compact Canadian-built Microgravity Vibration Isolation Subsystem (MVIS) is a control system that is integrated into the European Space Agency's Fluid Science Lab protecting it from the daily shakes and trembles on board the ISS. It uses a magnetic field to suspend a container for experiments.

MWD

The Measure While Drilling (MWD) is a CSA concept study that would examine the potential for combining information from sensors attached to the drill with intelligent algorithms as a tool for identifying prospective lunar resources. This technology would involve monitoring specific characteristics of the drilling process, analyzing and interpreting this data and implementing algorithms to efficiently extract knowledge from these large data sets. The sensors would monitor drilling parameters such as drill rotational speed, dynamic thrust forces, rate of penetration and real-time power consumption of the drill.

NEOSSat

The Near Earth Orbit/Object Surveillance Satellite (NEOSSat) is a joint CSA-DND mission. It is a combination of the Near Earth Space Surveillance (NESS) and the High Earth Orbit Surveillance (HEOS) projects. It will be used to observe the inner portion of the solar system to discover, track and study asteroids and comets, and will also be used to track satellites in high-Earth orbit to update the orbit parameters of known satellites flying over the Canadian territory.

NEW FRONTIERS

New Frontiers is a NASA program to explore the solar system with frequent, medium class spacecraft missions that will conduct high-quality, focused scientific investigations designed to enhance our understanding of the solar system. The program objective is to launch high-science-return planetary science investigations on an average of once every 36 months. Added to the NASA budget for the first time in 2003, New Frontiers will build on the innovative approaches used in NASA’s Discovery and Explorer Programs, but will provide a mechanism for identifying and selecting missions that cannot be accomplished within the cost and time constraints of Discovery.

NEXT GEN

Advanced Broadband: First experimental payload on board a commercial satellite in GEO to provide ultra-high speed connectivity.

NIRST (Aquarius/SAC-D)

The New Infra Red Sensor Technology (NIRST) is a CONAE (Comision Nacional de Actividades Espaciales) instrument to which CSA contributed detectors that use advanced Canadian microbolometer technology. NIRST is carried on the Aquarius/SAC-D satellite, a partnership mission being developed by NASA and CONAE. The NIRST instrument will acquire thermal imagery that will be especially useful for measuring the radiative power of biomass fires, an indication of emission type and quantity. NASA's Aquarius instrument will measure global sea surface salinity (SSS). The observations it makes will fill the gaps between conventional in situ sampling to give a global view of salinity variability. Aquarius will help us understand the physical processes that link the water cycle, the climate, and the ocean.

OCLE-DOCLE

Oort Cloud Dynamic Occultation Experiment (OCLE-DOCLE) is a payload concept study done for CSA in 2009. The study considered a micro-satellite platform for 30 cm telescope to observe transient events – occultation of Oort cloud and Kuiper belt objects (small bodies at edge of the solar system), in order measure their distribution and better understand the model of our solar system.

ORBITALS

The Outer Radiation Belt Injection, Transport, Acceleration, and Loss Satellite (ORBITALS) is a Canadian space physics mission that aims at studying the harsh space weather phenomena in the outer radiation belts. That part of space is intensely radioactive and experiences occasional severe storms that can damage expensive and critical space assets. Understanding and predicting the radiation phenomena in this part of near-earth space is also essential to support long-duration human space flights and robotic missions.

OSIRIS

ODIN Swedish satellite carries the Optical Spectrograph and Infra-Red Imaging System (OSIRIS). It measures the concentration of various gases in the stratosphere, thereby allowing our scientists to make a significant contribution to the global understanding of stratospheric ozone depletion processes.

PCW

The Polar Communications and Weather (PCW) mission is to position a constellation of satellites in highly elliptical orbit over the North Pole to provide robust 24/7 two-way communications capability to all of the Canadian North for high data rate (HDR) data and information products, potentially also low-data rate (LDR) communications capability, and also near-real time (NRT) meteorological information products in the Arctic region. The CSA will complete the assessment of the requirements of the Canadian government users for a polar satellite system as part of a joint study with DND and Environment Canada.

PHEMOS

Polar Highly Elliptical / Molniya Orbit Science (PHEMOS) aims at developing a secondary Science payload that could potentially be accommodated on the «Polar Communication and Weather» (PCW) Mission. The PCW platform and its highly elliptical orbit provide significant potential to advance science payload concepts that address certain topics in Atmospheric Remote Sensing, Geospace Imaging and In-situ Space Environment Science. The PHEMOS Atmospheric Remote Sensing concept studies will assess the feasibility of measuring gases and aerosols that are important for climate warming and for air quality.

PHOENIX

The Phoenix Mars Lander is the first mission to explore a polar region of Mars at ground level. Phoenix landed near Mars's northern polar cap on May 25, 2008, and then spent 90 days probing Mars's soil and atmosphere to determine if the environment could be hospitable to life. Canada's contribution to Phoenix is a meteorological station that recorded daily weather using temperature, wind and pressure sensors, as well as a light detection and ranging instrument.

PMDIS

The Perceptual Motor Deficit in Space (PMDIS) experiment will demonstrate the cause of the hand-eye coordination dysfunction seen early in space missions and indicate countermeasures to reduce or eliminate the problem. PMDIS is the first experiment to use the ISS allocation rights.

PRET

This exploration mission is planned to take place from September 2010 to November 2011. CSA has developed a prototype of a Performance Readiness Evaluation Tool (PRET) to provide neurocognitive assessment capability using a 3D virtual reality simulator with embedded neurocognitive tests. This activity is the result of the medical evaluation requirement for long-duration missions to the International Space Station which stipulates that astronauts must undergo neurocognitive assessment before, during and after the flight to detect any indications of a reduced performance state. The prototype is planned to be tested in the Russian Isolation Study, Mars-500.

PROBA

The PRoject OnBoard Autonomy (PROBA) was launched in 2001, as a technology demonstration mission and it is now operating as an Earth Observation mission. PROBA performs autonomous guidance, navigation, control, on board scheduling and payload resources management. Its payload includes a compact multi-spectral imager and high-resolution camera. PROBA also aims to use and demonstrate automatic functions, both on board and in the mission ground segment.

QUICKSAT

QuickSat is a microsatellite platform that was designed and built by CSA engineers and by students, in collaboration with industry. The platform has reached the stage where it is available to accommodate a payload and to transit into a CSA mission.

RADARSAT-1

RADARSAT-1, Canada's first Earth Observation satellite is the only fully operational civilian remote sensing satellite that carries Synthetic Aperture Radar (SAR). This technology, contrary to optical sensor satellites, has the capacity to image day and night, in all weather conditions, regardless of cloud cover, smoke, haze and darkness. Launched in November 1995, RADARSAT-1 was meant to operate for five years. RADARSAT-1 has continued to supply SAR data to clients in its extended mission.

RADARSAT-2

RADARSAT-2 was launched on December 14, 2007. RADASART-2 is a Canadian satellite from the next generation with its Synthetic Aperture Radar (SAR) technology and the most advanced satellite of its kind in the world. It incorporates new capabilities that ensure Canada's continued leadership in the global marketplace for radar image data by leveraging the knowledge and experience gained through the RADARSAT-1 mission.

RADARSAT Constellation (RCM)

The RADARASAT Constellation also known as RCM is the evolution of the RADARSAT missions with the objective of ensuring data continuity, improved operational use and improved system reliability over the next decade. The three-satellite configuration will provide complete coverage of Canada's land and oceans offering an average daily revisit at 50m resolution, as well as a significant coverage of international areas for Canadian and international users. It will also offer average daily access to 95% of the world.

RADI-N

Radi-N is the next generation bilateral Russia-CSA radiation study, based on and following Matroshka-R project. The CSA continued to collect radiation exposure data through a collaborative project with International Partners on ISS using Canadian made radiation dosimeters. Specifically, CSA implemented project RADI-N during ISS Expedition 20/21 (Mission C1). During this expedition, Astronaut Robert Thirsk conducted 4 sessions during which he collected neutron radiation data on the ISS using Canadian made Bubble Detectors. This data is currently being analyzed and will continue until May 2011. Another set of sessions is planned for C2 Mission in 2012-2013.

RAO

The Robotics and Automation for Orion (RAO) is a CSA concept study of Canadian participation in future NASA Constellation Program missions centered on the Orion Crew Exploration Vehicle (CEV). The study would include a comprehensive overview of planned exploration missions which require in-space automation and robotics. This study would propose a highly configurable robotic system concept that can be tailored to suit the launch constraints imposed by the various missions.

RAPIER

The Robotic Assistant & Precursor Investigation and Exploration Rover (RAPIER) is a CSA concept of a small rover with a “plug-and-play” reconfigurable chassis and built-in provisions for communication, power and variable autonomy tele-operation guidance and navigation. It is capable of operating as an investigative scout, astronaut assistant and mobile infrastructure platform in support of returning astronauts to the Moon. This concept could lead to a critical and central Canadian contribution to the lunar surface mobility architecture. “

RAVENS

Recurrent Auroral Visualization of Extended Northern Storms (RAVENS) is a concept study submitted to the CSA from a proposed Canadian-led space science mission which would use UV cameras on two polar-orbiting satellites to study space weather over Canada.

REMOTE CARE HEALTH

The CSA concept study entitled "Training Development and Maintenance of a Competence Program for Remote Care Health Providers" focuses on optimal ways of providing autonomous medical support for exploration space missions. Some of the top medical challenges for Moon exploration space missions and beyond that have been identified include clinical training and maintenance of skills for crew medical providers. The study explores the concept of Medical Autonomy as part of a possible infrastructure contribution that could be made by Canada to a global partnership for exploration missions.

ROSM

The CSA Robotic Orion/Orbital Service Module (ROSM) study will perform an evaluation of concepts for a robotic service module for NASA-Orion and ESA Exploration Missions and other commercial missions. It will define fielding concepts for manned and unmanned missions, interface definition and resource requirements, technology development requirements, roadmap for the development and fielding, and development of preliminary system design requirements.

SBIS

The Surface-Base Infrared Sensor (SBIS) is a CSA concept of an optical payload based on a Fourier Transform spectrometer operating in the infrared that will be used to map and classify minerals on the surface of the Moon. The payload will operate on the surface from a rover or other platform, and will measure spectra of the radiance reflected and emitted by the surface.

SCCO

The Soret Coefficient in Crude Oil (SCCO) experiment will determine the diffusion coefficient of crude oil under microgravity conditions in order to improve extraction processes.

SCISAT

The Space Science Satellite (SCISAT) is Canada's first scientific satellite in 30 years. SCISAT focuses on polar ozone budget and dynamics but also contributes to measurements and modeling of mid latitude ozone and upper troposphere chemistry as well as Chlorinated Fluorocarbons' (CFC) greenhouse gases. SCISAT has continued to produce large volumes of very-high quality space data for climate, weather and pollution studies.

SCOPE

SCOPE is a JAXA mission concept involving five spacecraft flying in a tetrahedral formation with an apogee of 30 earth radii in the magnetosphere. The mission proposes to untangle the fundamental physics underlining energy storage and release processes behind space weather. Possible Canadian participation would be contribution of instrumented spacecraft.

Si Si-Ge Alloys

The Silicon in Silicon-Germanium Alloys (Si Si-Ge Alloys) study is dedicated to understanding the role of gravity in the solidification of semiconductor materials. Understanding the gravitationally-induced microscopic movements of liquid molecules in the semiconductor fabrication process is important for both scientific and industrial communities, as well as for the Canadian economy. This Canadian study prepares the Canadian scientific community for mission opportunities onboard the International Space Station. The Principal Investigator of the study is Prof. Daniel Labrie from Dalhousie University in Halifax, NS.

SMAP

The NASA's Soil Moisture Active and Passive (SMAP) mission will measure soil moisture and surface freeze/thaw with the accuracy, resolution, and coverage that are required to further our understanding of the Earth's water, energy, and carbon cycles.

SNOWSAT

SnowSat is a CSA mission concept study composed of a cloud/precipitation radar instrument on a small satellite (or as a contribution to a partner platform) to measure clouds, snowfall and light precipitation. The advanced instrument concept builds on the experience of CloudSat and EarthCARE.

SOAR

The Solar Occultation for Atmospheric Research (SOAR) mission is a CSA concept study composed of two instruments on a small satellite that will study the changes occurring in our atmosphere, specifically those related to climate change and air quality. The satellite will use an advanced Fourier Transform Spectrometer in solar occultation to provide vertical profiles of atmospheric composition, both trace gases and aerosols.

SPICA
SPICA is a JAXA & ESA lead mission to discover the origins of galaxies, stars and planets. SPICA offers an improvement in sensitivity over Herschel Space Observatory by two orders of magnitude and observations over the full MIR/FIR range with sophisticated imaging, spectroscopic and coronagraphic instruments. Canada contributes a concept study for instrument design of the different detector technologies.

SPIDER
Spider is a mission concept using high-altitude balloon-borne instrument to study the sky in the far infra-red and measure the polarization of the cosmic microwave background which is the signature of the Big Bang.

STEP
The Stratosphere-Troposphere Exchange Processes (STEP) mission is a CSA concept study composed of three limb-viewing instruments on a small satellite focusing on the retrieval of relevant information about the photochemistry, dynamics and radiative properties associated with the upper troposphere and lower stratosphere.

SWIFT (Chinook)
SWIFT, Stratosphere Wind Interferometer For Transport studies, is a Canadian instrument that will increase our understanding of our atmosphere and will lead to advances in weather and climate prediction models that are key tools to provide answers on the health of the ozone layer and climate change.

THEMIS
The THEMIS mission stands for "Time History of Events and Macroscale Interactions during Substorms". The CSA is funding the participation of Canadian scientists in the NASA THEMIS mission comprised of a system of 5 satellites for the study of northern lights phenomena. THEMIS will help to pinpoint where in the magnetosphere the energy of the solar wind transforms explosively into auroras.

TICFIRE
The Thin Ice Clouds in Far IR Experiment (TICFIRE) mission is a CSA concept study composed of one nadir-viewing instrument on a micro satellite that aims to fill a global observational gap in the far IR for the detection and the measurements of radiation anomalies induced by thin ice clouds and light precipitation from cold regimes in polar regions and in the upper troposphere.

TRAC
The Test of Reaction and Adaptation Capability (TRAC) is to determine if the degradation of human manual skills during spaceflight occurs because the process of adaptation to spaceflight consumes a substantial portion of available computational resources in the brain, leaving fewer resources to carry out skilled manual actions. TRAC is carried out on the International Space Station (ISS).

TRACTEUR

The Terrainable Reconfigurable Autonomy-Capable Tool-using Exploration and Utility Rover (TRACTEUR) is a CSA concept of a large, modular "work-horse" rover that could lead to a critical and central Canadian contribution to the Global Exploration Strategy (GES). The concept is primarily targeted at manned exploration of the Moon but has a technology development path that could lead through a robotic precursor mission.

TriDAR DTO

The TriDAR is a vision system built to support rendezvous and docking operations. It permits to track spacecraft from a distance of 1 km down to 0 meter. The TriDAR flew on the STS-128 and STS-131 flights as a Detailed Test Objective (DTO) under a collaboration between NASA and CSA. The TriDAR was used to provide images of the International Space Station (ISS) and to track it while the Space Shuttle was approaching the ISS. Similar operations were performed during undocking.

UVAMC

UVAMC means Ultra Violet Auroral Monitoring Camera. It is a technology in phase 0 that the University of Calgary is developing to photograph the aurora borealis from space. Some candidate missions are KuaFu (China) and PCW. Current studies aim to determine the sensitivity required to obtain scientific validated images.

UVIT-ASTROSAT

The ASTROSAT satellite is a Multi-wavelength Space Borne Observatory for carrying out astronomical research. The Ultra-Violet Imaging Telescope (UVIT) aims to image selected parts of the sky in three distinct spectral regions (Far UV, Near UV and Visible) using two nearly identical telescopes. The CSA has agreed to provide to the Indian Space Research Organization (ISRO) the Flight Detector Subsystem. Our participation in the mission ensures that Canadian astronomers have observation time on ASTROSAT, providing new opportunities for astronomical research and discoveries.

Vascular

The Cardiovascular health consequences of long-duration space flight (Vascular) project will investigate vascular inflammation occurring during space flight and support the development of countermeasures to improve astronaut health upon return to gravity.

V-Band Experimental Payload

Following the successful deployment of broadband, multimedia services using Ka- Band technology on the Canadian Anik F2 satellite operated by Telesat, the objective of this mission will be to demonstrate new telecommunications services using extremely high frequencies, thereby allowing new niche expertise for Canadian industry and improved, faster two-way internet service in all regions of Canada.

VSE

The Vision Systems for Exploration (VSE) is a CSA concept study to examine the potential technology to fulfill requirements for autonomous rendezvous and docking mission, and for planetary surface operations such as inspection and navigation. The study would identify technology roadmaps for both near-term and long-term applications as early as 2 years, and as far as 12 years from now.

WaMI

Advanced study for an instrument to observe upper atmosphere dynamics through waves Michelson interferometer (WaMI).

WISE

The Women International Space Simulation for Exploration (WISE) study is to assess the roles of nutrition and combined physical exercise in countering the adverse effects of extended gravitational unloading through bed rest. Bed rest studies have been used for decades to reproduce on Earth the impact of weightlessness or weight unloading that is experienced by astronauts in orbit or during space flight. Results will prove valuable in planning long-duration human missions in space. This research will also have clinical significance on Earth, advancing knowledge and pointing to improved methods of assisting recovery by bedridden patients.

Nom du document : Final DRAFT DETAILED Performance Information DPR 09-10 (ENG) (2010-10-12).doc
Répertoire : C:\Users\NVezina\AppData\Local\Microsoft\Windows\Temporary Internet Files
Modèle : C:\Users\NVezina\AppData\Roaming\Microsoft\Templates\Normal.dotm
Titre : DRAFT #0 (June 12, 2006)
Sujet :
Auteur : Administrator
Mots clés :
Commentaires :
Date de création : 07/10/2010 3:59:00 PM
N° de révision : 21
Dernier enregistr. le : 12/10/2010 5:01:00 PM
Dernier enregistrement par : lcouturier
Temps total d'édition :74 Minutes
Dernière impression sur : 04/11/2010 1:13:00 PM
Tel qu'à la dernière impression
Nombre de pages : 116
Nombre de mots : 33 485 (approx.)
Nombre de caractères : 190 866 (approx.)