CANADIAN SPACE AGENCY

Departmental Performance Report
For the period ending
March 31, 2009

Analysis of Program Activities by Strategic Outcome

- Detailed Performance Information -

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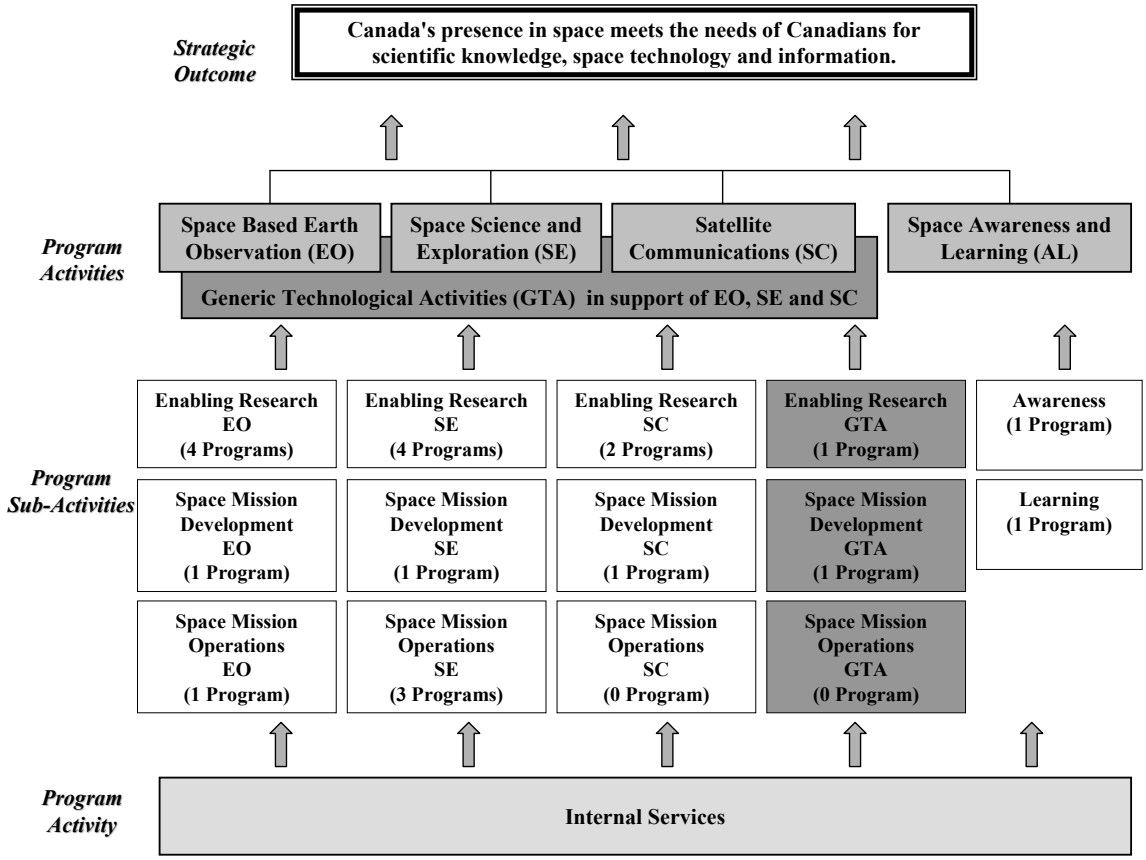
INTRODUCTION

Please note that this document is only available electronically.

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 Management 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 anually 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 2008-2009 PROGRAM ACTIVITY PERFORMANCE MEASUREMENT	
BENEFITS FOR CANADIANS Earth observation 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 2008-2009 RADARSAT-2 is fully operational since April 2008. A total of 264 projects were supported during the 2008-2009 period, focussing on applications development of the advanced mode of RADARSAT-2. From the Canadian government data allocation value at $445 million, $13.8 million were used this year. The CSA continued the planning of the first satellite for the RADARSAT Constellation, the follow-on mission to RADARSAT-2, to be launched in 2014. Canada's first scientific satellite in 30 years, SCISAT, entered its sixth year of successful operation with an expanding the range of coverage from international agreements. Canada's participation in ESA-EO programs opened the door to ten teams of Canadian scientist, and nine value-added companies were attributed contracts.	
Indicators	**Performance Summary**
1. Proportion of active missions relative to the total number of missions supported by Canada in the EO priority areas.	28 %; 9 active missions out of 35 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 23 applications became operational in 2008-2009.
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 44 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)
EO missions at the development stage(13): * = 3
EO missions under review (13): * = 8

* = New missions in 2008-2009 – 31% (11/35)
(Year) = Actual or projected launch date or date of completion when known.
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 2008-2009.

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 2008-2009.

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 (weather aspect) (2016)	Under review	Meteorology, Climatic Change, Environment, Resource and Land Management, Security and Foreign Policy
* 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 2008-2009.

Indicator 2 – Performance Analysis

A total of 23 applications became operational in 2008-2009; 17 from the EOADP and 6 from GRIP: 9 monitoring applications *(e.g. sea ice mapping, flood mapping, ice river jam)*, 2 detecting applications (*e.g. ship detection, iceberg identification and location)*, and 12 measuring applications (*e.g. soil subsidence map, geohazard mapping)*.

Source: Internal documents.

Indicator 3 – Performance Analysis

Twenty-six of the 44 uses (60%) reported had national purposes. The uses could be grouped under four main themes: Natural catastrophes, the Great North/Arctic, Water/Fisheries, Forest/Mining/Agriculture. Here are a few examples taken from CSA's EO Express publication:

Natural catastrophes: RADARSAT-1 data contributed to emergency response operations for the aftermath of the 7.8 Earthquake in eastern Sichuan, China (Edition 27 – topic 13).

The Great North/Arctic: Because the Arctic has seen the highest rate of climate warning and with their protected nature, national parks, are clearly the best laboratories for studying and reporting climate change in the Arctic ecosystems to Canadians (Edition 26 – topic 2).

Water/Fisheries: In partnership with the Department of Fisheries and Oceans, new tools and methodologies based on Earth observation data are being developed to better understand ocean ecosystems, climate changes and renew the economic viability of our fisheries as a result of detecting the first patch of Sargassum on the North Atlantic Ocean. Sargassum is a floating marine vegetation that absorbs carbon dioxide (CO2) a greenhouse gas that contributes to global warming (Edition 31 – topic 1).

Forest/Mining/Agriculture: The province of Alberta often has landslides, which have serious consequences for the economy, transport infrastructure and the health of Canadians. Information from Earth observation satellites enables the Alberta Geological Survey to monitor soil movements by radar interferometry techniques. Space-derived information is used to map geological hazards and produce land-use planning tools for decision-makers and the oil industry (Edition 26 – topic 7).

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
129.2	100.7	46.3
2008-2009 – Human Resources (FTEs)		
Planned	**Actual**	**Difference**
82.2	60.4	21.8

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 – 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.	Two out of ten (20%) concepts were retained for subsequent phase.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	The concepts retained were not formally rated against the Priority Ranking Framework. Therefore, no average evaluation rating can be reported 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, Space Technologies Branch responded to an estimated 76 consulting requests from external sources in 2008-2009.

Performance Analysis
Expected Result #1 Indicators 1-2 If we consider that a total of 26 new concepts were presented, all program activities combined, it can be said that Earth Observation contributed to 38% of the new concepts (10/26) and that 22% of the concepts retained (2/9) were Earth Observation related. The ranking of the chosen new concepts is unavailable this year. Source: EO Road Map. **Expected Result #2** Indicator 1 The number "76 requests" 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. In the future, this indicator will provide more specific examples of such requests. Source: Internal reporting documents. Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
26.8	22.9
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
16.6	0.5

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:

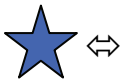
Industry, government and/or academia conduct mission and payload concept and feasibility studies to establish the technical and/or scientific feasibility and relevance of missions or payloads in order to enable CSA decisions on future EO space missions.

Indicator	Performance
1. Number of concept (mission and payload) studies initiated, pursued or completed. (Target: 5)	**Target Exceeded:** 7; 1 completed: WaMI and 6 pursued: MOPITT 2, STEP, SOAR, MCAP, MEOS, Ticfire.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is based on three consecutive data. Trend analysis maintains the satisfactory rating for targeted achievements were slightly exceeded on the three occurrences. Benchmark can not be extrapolated at this time since available values did not reach appropriate stability.



Satisfactory

Indicator 1

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
1.2	1.2
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
5.1	5.9

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:

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.

Indicator	Performance
1. Canadian industrial return in ESA optional programs in EO. (Target: 84% or higher)	**Target Exceeded:** 125%

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is measured for the second time based on four 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: Report issued on September 30, 2008: "Geographical distribution of contracts" ESA/IPC(2008)13, rev.2.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
9.9	7.4
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
0.0	0.0

3- Science Programs for EO – Objective: Coordinate the Canadian 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:

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 Highly Qualified Personnel (HQP) involved in the program. (Target: 150)	**Target Partially Met:** 105 HQP
2. Number of awards granted in the year under the CSA Grants and Contributions Program. (Target: 4)	**Target Exceeded:** 5; 4 ongoing and 1 new grant awarded.
3. Number of research partnerships (nationally and internationally). (Target: 20)	**Target Exceeded:** 21 research partnerships (nationally and internationally).

4. Number of scientific publications, reports and conference proceedings acknowledging CSA funding. (Target: 60)	**Target Exceeded:** 85
5. Number of scientific presentations. (Target: 100)	**Target Exceeded:** 188

PERFORMANCE ANALYSIS:

3-Year Trend

For the first time, the 3-year trend is based on three consecutive data for all indicators. Trend analysis maintains the satisfactory rating because one targeted achievement remained at partially met. We can expect enhancing the rating to superior should all achievements continue on their current trend. Benchmark values could only be confirmed for two indicators, the others have yet to reach an appropriate stability.

Satisfactory

Indicator 1

The term "Highly Qualified Personnel (HQP)" includes undergraduate, graduate and postdoctoral fellows, as well as research assistants, research associates, faculty and non-faculty staff.

Result is based on survey responses received until April 27, 2009.

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

Indicators 2 and 3

Source: Internal documents.

Indicator 4

Result is based on survey responses received until April 27, 2009.

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

Indicator 5

The 188 scientific presentations comprised of the following:

166 Conference/Seminar/Workshop;

19 Presentation to general public; and,

3 other presentations including media interviews.

Result is based on survey responses received until April 27, 2009.

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

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
1.2	0.7
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
2.5	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:

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. (Target: 20)	**Target Exceeded:** 26; 16 for EOADP and 10 for GRIP programs.
2. Number of new users of EO applications. (Target: 36)	**Target Exceeded:** 50; 35 for EOADP and 15 for GRIP programs.

PERFORMANCE ANALYSIS:

Satisfactory

3-Year Trend

Indicator #2 was introduced in 2008-2009 RPP and is measured for the first time. This caused the rating to be lowered from superior to satisfactory although both achievements exceeded targets. Benchmark values could only be confirmed for indicator #1, the other have yet to reach an appropriate stability.

Indicators 1 and 2

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
14.6	13.5
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
9.0	8.3

Highlights of Main Accomplishments – Enabling Research (EO)

- Following the successful launch of RADARSAT-2 in December 2007, the Canadian government data allocation plan manages the $445 million worth of prepaid data from the satellite of which 13.8 million were used this year. The objective of the program is to ensure that the allocation is effectively used by the Canadian Government. During the first year, CSA has negotiated agreements with eight Canadian Government departments to develop data acquisition plans.

- Building on the success of its first Announcement of Opportunities, the Science Operational Application Research Program (SOAR) supports the development of specific initiatives. The SOAR-International pre-launch initiatives are still in progress with 182 active projects. Several new initiatives, targeting specific remote sensing communities, have been initiated during the 2008-2009. The SOAR-Education, opened in December 2008, is targeting the Canadian educational organizations and research centers. CSA concluded a collaborative agreement with the European Space Agency to initiate a SOAR-Europe which will support research development using Canadian RADARSAT-2 and ESA EO satellite data. SOAR-Europe will be launch in April 2009. Other SOAR initiatives will be launched in the coming years.

- The Government-Related Initiatives Program (GRIP), the Earth Observation Applications Development Program (EOADP) and the Science Operational Application Research Program (SOAR) generated research projects and pilot and demonstration projects from industry, government, universities as well as international partners. More than 250 projects have been supported during the 2008-2009 period, focussing on applications development of the advanced mode of RADARSAT-2 to support the growth of Earth observation capabilities within Canadian Government Departments and Agencies and within value-added industry. A few of these projects contributed to the International Polar Year.

- The Coordinated Earth Observation Marine Surveillance initiative (CEOMS) delivered its final report and consulted with the Marine Community on the priorities and way forward for enhanced coordination providing an exhaustive understanding of EO needs and requirements for operational users among the Canadian Government Marine Surveillance and Security Community.

- The CSA, 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), launched in early 2008 an International Announcement of Opportunity for researching new developments in applications of RADARSAT-1 data. Innovative research and mapping applications related to ocean surface space borne SAR imagery of hurricanes will help to understand the dynamics of hurricane genesis, morphology, movement and the effect of wind on the sea surface. This new research will also prepare investigators for the use of more advanced data from missions like RADARSAT-2 and other future international missions.

- The CSA, in conjunction with the United States Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA), has initiated an international initiative to stimulate new research into the monitoring of subsidence processes in New Orleans using RADARSAT-1 SAR imagery as the primary data source. Final reports from the research groups have been presented at the Pecora Remote Sensing Symposium in Denver, Colorado in November 2008.

- CSA has completed the first phase of the TIGER initiative and has initiated the preparation for phase 2 in cooperation with the European Space Agency (ESA). TIGER aims to demonstrate the usefulness of Space Based Earth Observation for water management applications in Africa.

- The following activities have been carried out in the areas of advanced space-borne instrument development and user-oriented applications by Canadian organizations through participation in ESA Earth Observation programs:

    - In preparation for launches in September and December, 2009 for SMOS and CryoSAT-2 missions, a total of ten teams consisting of scientists from government (EC, DFO, NRCan) and universities (U. of Sherbrooke, U. of Calgary, U. of Manitoba) are involved in calibration, validation and algorithm development;

    - Canadian value-adding companies were awarded nine contracts for data exploitation in the areas of forestry monitoring, climate change, mining waste management, urban pollution, ice monitoring, and Arctic tourism;

- With regard to high resolution mapping of Canadian Arctic coastline, a user workshop was held in St-John's, NF between Canadian and European participants to define the requirements of the MORSE initiative which is in the process of being implemented; and,

- The Electric Field Instrument designed to make precise ionospheric measurements for ESA's Swarm magnetic mapping mission has successfully passed Critical Design Review and an Engineering Model has been built. Its development is on schedule for launch in June 2011.

- Many scientific teams are continuing to exploit the data generated from the ENVISAT satellite. In particular, an arrangement is in place to receive ENVISAT MERIS Full Resolution/Near Real Time data directly over Canada. For example, the data is used by other Government departments such as, Fisheries and Oceans Canada, Environment Canada and Natural Resources Canada for ocean colour and forestry applications land cover/change monitoring, snow mapping, and forestry applications.

- The CSA has completed 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. The concept of the Polar Communications and Weather Mission (PCW) is to put a constellation of satellites in highly elliptical orbit over the North Pole to provide communication services and to monitor weather in the Arctic region. A request for proposals for a preliminary study (Phase A) is under preparation with a view to start work in early 2009-2010.

- In collaboration with Environment Canada, the CSA is developing a plan to participate in the first of the NASA Earth Science Decadal missions. The mission SMAP (Soil Moisture Active/Passive) will measure soil moisture and freeze/thaw for weather and water cycle processes. The CSA plans to assist Environment Canada in establishing a validation program as well as help in developing data products from this mission specifically to quantify soil moisture and related information over Canada.

- As a consequence of a series of discussions with the Canadian atmospheric sciences community, based in academia, industry and federal government departments, the CSA has established a program to measure important parameters related to climate change. This program, entitled “Atmospheric Processes Of Climate and its Changes” (APOCC) is supporting six concept studies that will be further refined through subsequent phases.

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. 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 no new EPA submitted to TBS in 2008-2009 nor were any amendments made to previous EPAs – all program activities combined.
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 38% 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 38% rate of planned expertise matrix support is based on the average support of 68 specialized personnel to 10 missions at the development stage.

Source: Internal reporting documents (E-Ram).

Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
86.7	9.9
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
34.0	15.4

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 are met.	
Indicators	**Performance**
1. Project milestones are met as defined in the detailed work plan. (Target: 75%)	**Target Partially Met:** 5 project milestones achieved out of 7 planned (71%).
2. Project cost is maintained within authorized levels. (Target: 100%)	**Target Exceeded:** 100% project cost is maintained within authorized levels.
3. Risks are identified and mitigation plans prepared for each project. (Target: 100%)	**Target Met:** 100% risks are identified and mitigation plans prepared for each project.

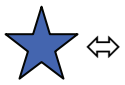
EXPECTED RESULT #2:

EO projects' deliverables meet mission objectives at critical steps.	
Indicators	**Performance**
1. Number of missions associated with science support. (Target: 2)	**Target Met:** 2 missions were supported.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on two to four consecutive data. 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

RADARSAT Constellation Mission (RCM) and RADARSAT-2 milestones were all met as well as JC2SAT (added at Mid-year). Chinook was returned in phase A and decision was delayed.

Source: Internal documents.

Indicator 2

RADARSAT-2 was completed within the increased authorities approved by Treasury Board. RADARSAT Constellation Mission (RCM) Phase B achieved milestones with a lower budget than planned.

Source: Internal documents.

Indicator 3

RADARSAT-2 has realised its risk funding. RADARSAT Constellation Mission (RCM) Phase B risks and mitigation plan have been documented.

Source: Internal documents.

Expected Result #2

Indicator 1

The missions NIRST and CHINOOK got science support. While the mission NIRST is still in development, the CHINOOK mission was returned to Phase A to further study risk mitigation on the SWIFT instrument, assess options to validate key technology components and options for international partnership.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
86.0	9.3
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
29.5	14.3

Highlights of Main Accomplishments – Space Mission Development (EO)

- With the successful launch of RADARSAT-2 on December 14, 2007, commissioning of the satellite was completed in April 2008. The transition to routine operation was completed in December 2008. The RADARSAT-2 Major Crown Project close-out activities and final report was completed in March 2009. The Evaluation activities will be completed at the end of June 2009. The Treasury Board approval for close-out is expected by the summer 2009.

- The CSA continued the planning of the first satellite for the RADARSAT-Constellation, the follow-on mission to RADARSAT-2. The Phase B Contract (Preliminary Design) was initiated in November 2008. The RADARSAT-Constellation will further improve Canada's ability to manage its resources and environment and improve cosystem-monitoring, maritime surveillance, disaster management and Arctic sovereignty. The launch of the first satellite is planned for late 2014 followed by the other two satellites in 2015 and 2016 respectively.

- Under the European Space Agency's GMES program, several Canadian companies were awarded contracts as part of the Sentinel 1, 2 and 3 missions. For the space segment, Canada is providing a Synthetic Aperture Radar antenna for Sentinel-3, and support to its Attitude and Orbit Control sub-system. For the ground segment, Canada was successful in wining a contract to provide SAR processor and the associated facility for Sentinel-1 mission. The Sentinel missions' procurement will continue into 2009-2010.

- Several Canadian companies participate in the EarthCARE mission developed by ESA in collaboration with the Japanese Space Agency (JAXA). They are supplying millimetre wave Radio Frequency Front-end to JAXA for a Cloud Profiling Radar, and an uncooled microbolometer detector for Broad-Band Radiometer. These contract awards were made possible by CSA's initial support for the development of mm-wavetechnologies developed for the CloudSAT mission and by early R&D investments in microbolometer technology as part of our national Space Technology Development Program (STDP). Canadian scientists are involved in algorithm development activities and participate in the Mission Advisory Group.

- The CSA is redefining the Chinook mission to further study risk mitigation on the SWIFT instrument, assess options to validate key technology components and options for international partnership. This mission is designed to study stratospheric winds and ozone flux so we can improve medium-range weather forecasts, better assess the ozone layer recovery and better predict climate change.

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.	Unavailable this year.
2. Quality of the internal expertise specializing in advice and technology-watch to ensure the successful flow of missions reaching operation phases.	Unavailable this year.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
15.6	13.5
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
31.6	5.8

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:

EO Space Mission Operations meet user/client needs as per mission requirements.

Indicators	Performance
1. System performance, as per mission requirements and resources. (Target: 80%)	**Target Exceeded:** Better than 93%
2. Volume of data acquired or delivered as per mission requirements and resources. (Targets: 8,000 SAR minutes of RADARSAT-1 data, 300 Gbytes of SCISAT-1 and establishment of data distribution service for RADARSAT-2)	**Target Exceeded:** 24,000 SAR minutes of RADARSAT-1; More than 950 Gbytes of SCISAT; Data service fully established.
3. Number of missions in operational phase associated with science support. (Target: 4)	**Target Met:** 4 completed; SCISAT, MOPITT, OSIRIS, CLOUDSAT.

PERFORMANCE ANALYSIS:

Superior

3-Year Trend

The 3-year trend is measured for the second time; it is mostly based on four consecutive data of indicators 1 and 2. Trend analysis has upgraded the rating from satisfactory to superior for targeted achievements were consistently exceeded. As well, benchmark values were confirmed for the first two indicators.

Indicator 1

RADARSAT-1 Mission was extended for three more years.

Source: CSA's Mission Management Office/Database Management (MMO/DBM), internal documents.

Indicator 2

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

Indicator 3

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
15.0	12.7
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
27.6	21.2

Highlights of Main Accomplishments – Space Mission Operations (EO)

- RADARSAT-1 operations were maintained with the same level of high performance for satellite reliability and image production. At the same time, RADARSAT-2 commissioning operations were successfully completed and the supply of data to Canadian Government departments from RADARSAT-2 was started in the spring of 2008 through a fully functional Order Desk as per client needs. With two satellites in operations data continuity to users is now more assured. Moreover, pursuant to a contingency plan in place, the necessary agreements and procedures were established to secure the use of foreign sensors as backup in order to continue to meet the needs of operational users if Canadian satellites were unable to meet the requirements. These arrangements reciprocally provide for the equivalent back-up capability using RADARSAT-1/-2 and the ESA satellite data in case of asset failure of one of them.

- CSA continued to deliver on 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 contributed newly acquired and archive data from the two RADARSAT satellites and strategic EO-derived information products upon Charter activations all over the world.

- The CSA continued to support and operate SCISAT, a Canadian mission launched in August 2003. The mission provides a large amount of very high quality data on more than 30 chemical species in the atmosphere for climate, weather and pollution studies. Data from the SCISAT orbits that are not accessible from Canadian receiving stations are down linked to ESA and NASA receiving stations. All SCISAT data are processed by Canadian science facilities and provided to the international science team for analysis.

- The CSA continued to support MOPITT and OSIRIS, two major Canadian science instruments that are currently orbiting Earth and collecting new environmental data. MOPITT on the NASA Terra satellite measures pollutants in the troposphere, providing a wealth of data on global pollutant monitoring and transport. OSIRIS on the Swedish Odin satellite measures ozone in the stratosphere and mesosphere, providing important data to assess and predict the health of the ozone layer.

- The CSA continued to support the validation and analysis of CloudSat data. CloudSat is a NASA satellite launched in 2006 to which Canada contributed important 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) for development and validation of data products derived from CloudSat measurements that are of importance to Canada, especially for cold season clouds with mixed ice-water composition.

2.3 SPACE SCIENCE AND EXPLORATION

SPACE SCIENCE AND EXPLORATION 2008-2009 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 In the context of environmental change and resource depletion, fundamental and applied research in physical and life sciences and in space exploration has great potential to bring about socio-economic benefits. For instance, the development of a surface mobility capability on the Moon will require the use of solar-powered electrical propulsion vehicles, which, in turn, could well lead the way toward spin-off commercialization of green technologies for the transport vehicles of the future. Space exploration, science and technology endeavours, which often 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 nations in the world, Canada offers and shares tremendous opportunities for the prosperity of global commerce and the safety of the global community through the peaceful use of space.	
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 physics and life sciences.	
MAIN ACCOMPLISHMENTS IN 2008-2009 The successful Phoenix Mars Lander mission ended in November 2008. Phoenix exceeded expectations by performing breakthrough science far beyond its planned 90-days in the hostile environment of the Red Planet, with discoveries like the presence of water ice in the Martian soil, and the Canadian discovery of snow falling from clouds in Mars' atmosphere. Two new astronauts were chosen among 5,351 applicants after a year-long recruitment process; Jeremy Hansen and David St-Jacques are the first Canadians to join the astronaut corps since 1992.	
Indicators	**Performance**
1. Proportion of active missions relative to the total number of missions supported by Canada in the SE priority areas.	37%; 33 active missions out of 89 supported missions.
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 total of 58 scientific instruments and technological applications combined.
3. Number of peer-reviewed papers produced in academia and the R&D community in	A total of 397 peer-reviewed papers, reports and conference proceedings acknowledging CSA

Canada recognizing CSA's support through its participation in space missions and/or support to projects/activities in SE.	funding were published in 2008-2009 in Space Astronomy and Exploration, Solar-Terrestrial Relation, and Physical and Life Sciences.

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 (20): * = 3
SE missions at the operation stage (13):
SE missions at the development stage (22): * = 6
SE missions under review (34): * = 31

* = New missions in 2008-2009 – 45% (40/89)
(Year) = Actual or projected launch date or date of completion when known.
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: STS-115 (2006)	Completed (2006), objectives met	Steve MacClean, 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: TMA-6/10S (2005)	Completed (2005), objectives met	Robert Thirsk (Capcom & 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
H-Reflex	Completed, objectives met	Life Sciences
ICE-First (2004)	Completed, objectives met	Life Sciences
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
WISE (2005)	Completed, objectives met	Life Sciences

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2008-2009.

Space science and exploration (SE) missions at the operation stage:

Mission	Status	Field
ADAMS	In operation	Life Sciences, Astronauts
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-Planck (2009)	Launched, soon to be in operation	Astronomy

Mangaroni (2008)	In operation	Physical Sciences
Matroshka-R (2006)	In operation, objectives met	Space Medicine
MOST (2003)	In operation, objectives met	Astronomy
MVIS (2008)	Launched, soon to be in operation	Physical Sciences
THEMIS (2007)	In operation	Solar-Terrestrial Relation

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2008-2009.

Space science and exploration (SE) missions at the development stage:

	Mission	Status	Field
	APEX-Cambium (2009)	In development	Life Sciences
*	Astronauts: Expedition 20/21 (2009)	In development	ISS
*	Astronauts: STS-127 (2009)	In development	ISS
*	BCAT-5 (2009)	In development	Physical Sciences
	CASSIOPE-ePOP (2010)	In development	Solar-Terrestrial Relation
	CHENNS (2014)	In development	Life Sciences
	CIMEX (2011)	In development	Physical Sciences
	EBEX	In development	Astronomy
*	ESA-Exomars	In development	Planetary Exploration
*	ESA-MICAST (2010)	In development	Physical Sciences
	ESA-Swarm (2011) (instruments canadiens pour mesurer les ions)	In development	Solar-Terrestrial Relation
	FPEF (2011)	In development	Physical Sciences
*	Hypersole (2010)	In development	Life Sciences
	ICAPS (2010)	In development	Physical Sciences
	IVIDIL (2009)	In development	Physical Sciences
	JWST-FGS (2014)	In development	Astronomy
	MSL-APXS (2011)	In development	Planetary Exploration
	NEOSSAT (2011)	In development	Planetary Exploration
	NEQUISOL (2010)	In development	Physical Sciences
	SPIDER	In development	Astronomy
	UVIT-ASTROSAT (2010)	In development	Astronomy
	Vascular (2009)	In development	Life Sciences

(Year) = Actual or projected launch date or date of completion when known.
* = New missions in 2008-2009.

Space science and exploration (SE) missions under review:

	Mission	Status	Field
*	CanALSS	Under review	Planetary Exploration
*	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
*	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
	ORBITALS (2014)	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
*	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 2008-2009.

Indicator 2 – Performance Analysis

The total of 58 scientific instruments and technological applications can be divided among 5 fields: 28 instruments/applications were identified for five Solar-Terrestrial Relation missions; 22 instruments/applications were identified for 14 Astronomy/Planetary Exploration missions; and eight instruments/applications were identified for 21 Life/Physical Sciences missions. A ratio of 1.5 instruments/applications per mission is observed with some missions having as many as ten instruments/applications per mission and some missions having none.

Source: Internal documents.

Indicator 3 – Performance Analysis

A total of 397 peer-reviewed papers, reports and conference proceedings acknowledging CSA funding were published in 2008-2009 in Space Astronomy and Exploration, Solar-Terrestrial Relation, and Physical and Life Sciences. This number represents a 4% increase from the 383 reported in 2007-2008.

Source: Internal reporting documents.

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
115.4	156.6	146.5
2008-2009 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
188.4	181.0	7.4

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.	Six out of ten (60%) concepts were retained for subsequent phase.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	The concepts retained were not formally rated against the Priority Ranking Framework. Therefore, no average evaluation rating can be reported 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, Space Technologies Branch responded to an estimated 76 consulting requests from external sources in 2008-2009.

Performance Analysis

Expected Result #1

Indicator 1-2

If we consider that a total of 26 new concepts were presented, all program activities combined, it can be said that Space Science and Exploration contributed to 38% of the new concepts (10/26) and that 67% of the concepts retained (6/9) were Space Science and Exploration related. The ranking of the chosen new concepts is unavailable this year.

Source: SE Road Map.

Expected Result #2

Indicator 1

The number "76 requests" 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. In the future, this indicator will provide more specific examples of such requests.

Source: Internal reporting documents.

Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
25.7	37.0
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
39.5	(7.0)

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:

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.

Indicator	Performance
1. Number of concept/feasibility (mission and payload) studies initiated, pursued or completed. (Target: 15)	**Target Exceeded:** 27

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is based for the first time on three consecutive data. Trend analysis maintains the satisfactory rating for achievements although exceeding targets are not showing a strong trend. Benchmark value can not be established at this time.	 Satisfactory
Indicator 1 The 27 concepts (mission and payload) or feasibility studies initiated, pursued or completed are divided as follows: Planetary exploration and Space astronomy: 1; SPICA; Exploration Core: 3; HALO, LORE, MSO; Solar-Terrestrial Relation: 4; Orbitals, Ravens, ESA-Cross Scale, Scope; and, Life and Physical Sciences: 19; MIM/ATEN(1 study), Past announcements of opportunities (4 studies), 2004 announcement of opportunities (11 studies), Atlantic Canada (2 studies), Low Mass/Volume Research announcement of opportunities (1 study). Source: Internal documents.	

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
2.3	18.2
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
5.0	18.2

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:

Successful development and demonstration of advanced technologies, systems, components, or studies provided for in the contracts awarded by ESA to Canadian firms under European Physical and Life programs.

Indicators	Performance
1. Canadian industrial return in ESA optional programs in SE. (Target: 84% or higher)	**Target Partially Met:** Microgravity 42%. Manned Space and Exploration: 192%.

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is measured for the second time based on four consecutive data. Trend analysis upgrades the rating from opportunity for improvement to satisfactory for achievements were improved for both programs CSA contributes to. Benchmark is well established among ESA community.	 Satisfactory

Indicator 1

It is important to note that Canadian participation to ELIPS program, the only program on micro-gravity Canada participates in, is fairly new. It is unrealistic to reach the set benchmark at this time for this program. However rate has increased by more than 13.5%.

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: Report issued on September 30, 2008: "Geographical distribution of contracts" ESA/IPC (2008)13, rev.2.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.8	8.2
2008-2009 – 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:

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

Indicators	Performance
1. Number of Highly Qualified Personnel (HQP) involved in the program. (Target: 450)	**Target Exceeded:** 542 HQP involved in the program.
2. Number of research partnerships (nationally and internationally). (Target: 90)	**Target Exceeded:** 134 research partnerships (nationally and internationally).

3. Number of scientific publications, reports and conference proceedings acknowledging CSA funding. (Target: 650)	**Target Partially Met:** 310
4. Number of scientific presentations. (Target: 450)	**Target Exceeded:** 598
5. Number of awards granted under the CSA Grants and Contributions Program. (Target: 25)	**Target Exceeded:** 26 ongoing: 10 new grants awarded; Nano Quebec(6), EBEX, SPIDER(2), COSPAR.

PERFORMANCE ANALYSIS:

Satisfactory

3-Year Trend

For the first time, the 3-year trend is based on three consecutive data for all indicators. Trend analysis drops the rating from superior to satisfactory because one targeted achievement remained at partially met as well as dropped its value from previous years. Benchmark values have yet to reach an appropriate stability.

Indicator 1

The term "Highly Qualified Personnel (HQP)" includes undergraduate, graduate and postdoctoral fellows, as well as research assistants, research associates, faculty and non-faculty staff.

The 542 HQP came from the following activity areas:

22 = Canada Research Chair
86 = Tenured Faculty
17 = Non-Tenured Faculty
63 = Research Associates
36 = Post-Doctoral Fellows
19 = Research Assistants
121 = Graduate Students
57 = Undergraduate Students
42 = Engineers/Technicians
79 = Other personnel

Result is based on survey responses received until April 27, 2009.

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

Indicator 2

Source: Internal documents.

Indicator 3

The 310 scientific publications were comprised of the following:

182 Peer Reviewed Publications;
48 Other Peer Reviewed Publications based on/or enabled by CSA funding;
30 Non-Peer Reviewed Publications (conference/seminar/workshop proceeding);
44 Other Non-Peer Reviewed Publications based on/or enabled by CSA funding;
3 Book/Book Chapter; and,
3 Other Book/Book chapter based on/or enabled by CSA funding.

Results are based on survey responses received until April 27, 2009.

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

Indicator 4

The 598 scientific presentations were comprised of the following:

523 Conference/Seminar/Workshop presentations;
41 Presentation to the general public; and,
34 Other Presentation (Media Interviews).
Result is based on survey responses received until April 27, 2009.

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

Indicator 5

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
9.2	6.3
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
20.4	15.9

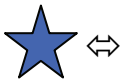
4- Human Space Flight Expertise – Objective: Maintain a trained, experienced and versatile Astronaut Corps to meet the needs of the Canadian space science and human exploration community and while doing so increase access to space opportunities for Canadian scientists.

EXPECTED RESULT:

Continue to develop and maintain human space flight expertise to meet the requirements of the CSA's space science and human exploration programs.

Indicators	Performance
1. Canadian Astronauts are recruited according to recruitment plan. (Target: Basic training plan under development)	**Target Met:** Recruitment campaign conducted exactly as per plans.
2. Canadian astronauts are qualified to be selected for missions on all flight vehicles such as Shuttle, Soyuz and ISS. (Targets: 4 on Shuttle, 2 on Soyuz and 3 for ISS)	**Target Met:** 3 Astronauts maintained qualification on Shuttle, 2 Astronauts qualified on Soyuz, and 2 qualified for ISS.
3. Number of space flights and missions to which Canadian Astronauts participate. (Target: Shuttle flights to be negotiated)	**Target Partially Met:** 3 Canadian Astronauts are participating in upcoming space mission.

PERFORMANCE ANALYSIS:



Satisfactory

3-Year Trend

For the first time, the 3-year trend is based on three consecutive data. Trend analysis maintains the satisfactory rating for one targeted achievement was partially met. Benchmark can not be extrapolated at this time since available values did not reach appropriate stability.

Indicator 1

As per plan. Basic training under development and the announcement of two new astronauts is scheduled for May 2009 at the end of the recruitment campaign.

Source: Internal documents.

Indicator 2

Targeted number of astronauts was estimated with the astronauts in place at the time of establishing the targets. Dave Williams has since retired from the Astronaut Corps which explains the reduced number of qualified astronauts.

Source: Internal documents.

Indicator 3

One on Shuttle (STS-127), one on Soyuz for a long-duration flight on the ISS, one as back-up crew on Soyuz (Expedition 20/21).

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
4.2	2.7
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
7.0	6.7

Highlights of Main Accomplishments – Enabling Research (SE)

- Through partnership with the European Space Agency (ESA), the CSA positions Canadian industry and scientists in future scientific and technological developments in planetary exploration as well as physical and life sciences. The CSA is participating in the ESA ExoMars program through both scientific and technology contributions that plans to land a highly versatile and capable rover on the surface of Mars in 2016. Canadian university scientists were highly successful in the last ELIPS bedrest announcement of opportunities. As a result, Canadian scientists are participating in five physical science experiments planned for the International Space Station. Physiological changes associated with bed rest simulate many of the changes see with humans in space. Canada does not have the facilities to conduct these studies so it is through participation in ELIPS that Canadians access these facilities.

- The CSA has established an Exploration Core initiative which supports the development of ground prototypes of systems that could become potential scientific and technological contributions to future Moon or Mars missions. This ensures the readiness of the space exploration community in Canada and also develops the user requirements for missions of potential interest for Canada. It is being implemented through contracts to industry, university and research institutions. Budget 2009 provided the CSA with an additional $110 million over three years for the Space Robotics Stimulus Initiative so that it can contribute to the development of terrestrial prototypes for space robotic vehicles such as Moon and Mars rovers, and for the further development of space robotics and other technologies. This will be implemented within the Exploration Core initiative.

- The CSA maintains a trained and versatile Astronaut Corps to develop and maintain human space flight expertise to meet the requirements of the CSA's space sciences and human exploration programs. Two Canadian astronauts have trained, one in preparation for Expedition 20/21, a 6-month assignment on the ISS, and another astronaut for a Shuttle flight, STS-127. Furthermore, a Canadian astronaut is expected to be assigned to a second long-duration expedition on ISS in the 2012-2014 timeframe. Canadian Astronauts perform additional duties for NASA and with the International Space Station Program.

- The CSA carried out a National Astronaut Recruitment Campaign to ensure that Canada takes full advantage of the flight opportunities available through its investment in the International Space Station Program and, possibly, to prepare for new missions with international partners. Two new astronauts, Jeremy Hansen and David St-Jacques joined officially the Canadian Astronaut Corps in May 2009.

- The CSA supports parabolic flight experiments in collaboration with the National Research Council. Scientific opportunities of up to 20 seconds of freefall are made available to Canadian researchers in preparation for longer duration missions on the International Space Station.

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 no new EPA submitted to TBS in 2008-2009 nor were any amendments made to previous EPAs – all program activities combined.
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 38% 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 38% rate of planned expertise matrix support is based on the average support of 68 specialized personnel to 10 missions at the development stage.

Source: Internal reporting documents (E-Ram).

Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
36.0	44.5
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
22.1	0.3

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 are met.

Indicators	Performance
1. Project milestones are met as defined in the detailed work plan. (Target: 75%)	**Target Met:** 9 project milestones achieved out of 12 planned (75%).
2. Project cost is maintained within authorized levels. (Target: 100%)	**Target Met:** 100% project cost is maintained within authorized levels.
3. Risks are identified and mitigation plans prepared for each project. (Target: 100%)	**Target Met:** 100% risks are identified and mitigation plans prepared for each project.

EXPECTED RESULT #2:

SE projects' deliverables meet mission objectives at critical steps.

Indicator	Performance
1. Number of missions associated with science support. (Target: 15)	**Target Exceeded:** 16 missions were supported.

PERFORMANCE ANALYSIS:

3-Year Trend The 3-year trend is measured for the second time based on two to four consecutive data. Trend analysis maintains the satisfactory rating although all targeted achievements have 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

Nine project milestones were achieved out of 12 planned. Out of the 3 remaining, 2 milestones were delayed due to technical issues on the project and 1 milestone recorded no activity.

Source: Internal documents.

Indicator 2

JWST, UVIT, MSL-APXS, NEOSSat and CASSIOPE-ePOP costs are within authorized levels.

Source: Internal documents.

Indicator 3

JWST, UVIT, MSL-APXS, NEOSSat and CASSIOPE-ePOP have documented risks matrix and mitigation plans.

Source: Internal documents.

Expected Result #2

Indicator 1

Solar-Terrestrial Relation: 2; CASSIOPE-ePOP, ESA-Swarm;
Planetary Exploration and Space Astronomy: 8; CADC/Hubble, ESA-HIFI, JWST, ESA-Planck, ESA-SPIRE, UVIT, NEOSSat, MSL-APXS;
Life and Physical Siences: 6; ELIPS (Nequisol), VASCULAR, BISE, APEX-Cambium, ESA bedrest study + 1 new ongoing under Bedrest study.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
36.0	44.5
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
22.1	21.9

Highlights of Main Accomplishments – Space Mission Development (SE)

- The Enhanced Polar Outflow Probe (ePOP) mission, integrated with the CASSIOPE Mission, is scheduled for launch in 2010 depending on the development of the Falcon 9 launch vehicle. It will probe the upper atmosphere and ionosphere region that is affected by solar activity 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 ePOP instruments has been integrated in the CASSIOPE satellite and it is undergoing environmental testing in CSA's David Florida Labs. Testing will be completed in August 2009.

- The CSA has completed the design of the detector subsystem and has delivered the engineering model for the near UV channel for the UltraViolet Imaging Telescope (UVIT) on board the ASTROSAT satellite of the Indian Space Research Organization (ISRO). It is now completing the manufacturing of the flight model for the UV invisible channel. The satellite is scheduled for launch no earlier than 2010. The CSA participation will guarantee 5% of the observing time for Canadian scientists and obtain ASTROSAT astronomic data.

- The CSA completed the manufacturing and delivered to NASA the Alpha Particle X-ray Spectrometer (APXS) for the Mars Science Laboratory to be launched by NASA in 2011. The Canadian contribution will help scientists to determine the chemical composition of various soil, dust and rock samples on the planet.

- Canada is participating in the James Webb Space Telescope (JWST), a major facility-class space observatory that will now 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 with the Tunable Filter Imager (TFI). The design of the FGS has been completed and the manufacturing is ongoing. 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 Local Oscillator Source Unit (LSU) that was successfully integrated in the Heterodyne Instrument for the Far Infrared (HIFI) of the European Space Agency's Herschel satellite was launched on May 14, 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 NEOSSat joint CSA-DND mission 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 also track satellites in high-Earth orbit to update the orbit parameters of known satellites flying over the Canadian territory. NEOSSat is scheduled to launch in 2011. A prime contractor has been selected and the Preliminary Design Review was completed in April 2008 and detailed design was 75% complete by end of March 2009.

- APEX-CAMBIUM is a NASA-CSA collaboration for the International Space Station. The experiment will look at plant growth in space and this information may be useful to better understand wood formation and be of value to the forestry industry.

    - The Body in Space Experiment (BISE) is being prepared for the International Space Station. The experiment looks at how astronauts perceive orientation on board ISS when their vestibular system is not functional.
    - Vascular, an experiment that looks at changes to the heart and circulatory system of astronauts who spend six months or more on ISS passed all the reviews and will be launched to the ISS in 2009-2010.

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 for subsequent phase.	Unavailable this year.
2. Quality of the internal expertise specializing in advice and technology-watch to ensure the successful flow of missions reaching operation phases.	Unavailable this year.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
53.8	65.0
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
126.8	14.2

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	
CSA robotics operations and engineering services meet ISS Program (ISSP) and Canadian Space Station Program (CSSP) stakeholders' expectations in accordance with the Intergovernmental Agreement (IGA) and the Memorandum of Understanding with NASA.	
Indicators	**Performance**
1. Availability of Operations Centre. (Target: at least 99%)	**Target Exceeded:** The RMPSR availability exceeded 99.87% for commanding, 99.83% for telemetry and 99.9% for voice.
2. Percentage of software and flight products delivered as required/scheduled. (Target: more than 95%)	**Target Exceeded:** 100%. CSA delivered all software builds on schedule and were able to provide additional deliveries.
3. Rate of training delivered vs. training requested. (Target: more than 95%)	**Target Exceeded:** CSA Training fully met (100%) of the planned training requirements and accommodated changes.
4. Rate of payload operational support availability for planned and unplanned events. (Target: 100%)	**Target Met:** 100% of the planned integration test and certification activities were supported.
5. Percentage of MSS system(s) and operational support availability for planned and unplanned events. (Target: more than 95%)	**Target Exceeded:** 100%. The MSS was available to support all planned and unplanned operational events.
6. Percentage of active participation of the CSSP team in the various ISS multi-lateral boards and panels managing the ISSP. (Target: more than 95%)	**Target Exceeded:** The CSSP Team exceeded the target of 95%.

PERFORMANCE ANALYSIS:

Superior

3-Year Trend

The 3-year trend is measured for the second time based on four consecutive data. Trend analysis maintains the superior rating for targeted achievements were consistently exceeded. Benchmarks are well established as targets are set at the International Space station Program level.

Indicator 1

Source: International Space Station Program Control Boards and Panels.

Indicator 2

All planned work was completed and additional deliveries were made to accommodate unplanned NASA requirements or technical issues.

Source: Remote commanding Monthly Availability Report (internal document).

Indicator 3

CSA Training actually accommodated 100% of the agreed requirements and also accommodated some schedule modifications.

Source: International Training Control Board and internal documents.

Indicator 4

For the payloads sponsored by the Space Science Branch, including BISE, VASCULAR, APEX-Cambium, all planned and unplanned activities related to payload development, integration, test or certification were successfully supported. In addition, several new and unplanned for payloads, including Iris and Tomatosphere, were added and these were also successfully supported during test and certification for flight.

Source: Internal documents.

Indicator 5

All ISS assembly, maintenance, check-out, survey or other related operation were supported by the MSS as required.

Source: Internal documents.

Indicator 6

All multilateral meetings where CSA participation was required were supported. This included unscheduled or ad-hoc meetings and short notice meetings.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
46.4	56.6
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
113.5	99.0

2- SE Mission Operations – Objective: Operate the space and ground segment for SE mission operations.

EXPECTED RESULT:

SE Space Mission Operations meet mission objectives and user/client expectations.

Indicators	Performance
1. Sponsoring organization's requirements for payload projects are met at critical steps of the operations. (Target: 95%)	**Target Met:** All planned activities for MVIS were successfully supported.
2. Number of missions in operational phase associated with science support. (Target: 3)	**Target Exceeded:** 10

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is based on two to four consecutive data. Trend analysis maintains the satisfactory rating for targeted achievements were met within planned limits. Benchmark can not be established at this time since available values did not reach appropriate stability.

Satisfactory

Indicator 1

The Microgravity Vibration Isolation System (MVIS) commissioning activities are still outstanding due to ongoing and persistent technical issues related to the ESA Fluid Science Lab, the system that MVIS is part of. These technical issues, coupled with severely limited crew time on the ISS have delayed the completion of the MVIS commissioning.

Source: Internal documents.

Indicator 2

Solar-Terrestrial Relation: 2; THEMIS, CGSM;
Planetary Exploration and Space Astronomy: 3; ESA-HIFI, MOST, Phoenix; and,
Life and Physical Sciences: 5; E-OESTEO (3), CCISS, ELERAD.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.1	6.3
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
2.1	4.8

3- Human Space Flight Missions Support – Objective: Manage human space flight missions assigned to the Canadian Astronaut Corps to optimize returns of scientific data and on-orbit operational knowledge.

EXPECTED RESULT:

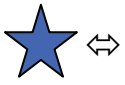
Ensure and maintain Canadian Astronauts' health and safety for space flight missions.

Indicators	Performance
1. Maintaining Astronauts' Health and Safety by satisfaction level from client (Chief Canadian Astronaut.) (Target: 100%)	**Target Met:** 100%. All assigned Canadian Astronauts certified for space flight.
2. Percentage of participation in ISS Medical Boards, Panels and Working Groups. (Target: 100%)	**Target Met:** 100%. A CSA representative was always present at medical related meetings.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is based on one to three consecutive data. Trend analysis maintains the satisfactory rating for targeted achievements were met within planned limits. Benchmark can not be established at this time since available values did not reach appropriate stability.



Satisfactory

Indicator 1

No safety issue rose during the training activities.

Source: Internal documents.

Indicator 2

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
2.3	2.1
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
11.2	8.9

Highlights of Main Accomplishments – Space Mission Operations (SE)

- The Phoenix mission, successfully launched on August 4, 2007, landed on the northern polar region of Mars on May 25, 2008. Canada contributed an on board Meteorological Station (MET) that recorded the daily weather of the Martian northern plains using temperature and pressure sensors, as well as a light detection and ranging (LIDAR) instrument. These instruments have exceeded expectations and positioned Canada as a respected and reliable provider of planetary science instrumentation. Moreover, they provided new scientific knowledge of the Martian atmosphere, and permitted Canadian scientists to have access to all data from the mission.

- The CSA continued the analysis of data from the eOSTEO space mission scientific experiment that was successfully completed in September 2007. Analysis will be completed by fall 2009. These experiments focus on bone loss in space that is one of the major obstacles to long duration space flight. The knowledge acquired will also enhance our understanding of bone loss in general and will have potential applications to osteoporosis.

- The Cardiovascular Control on the International Space Station (CCISS) a CSA-NASA collaboration continued to operate. This Canadian experiment operated by NASA looks at changes to blood pressure control in space and upon return to Earth.

- On the International Space Station, Dextre (Special Purpose Dexterous Manipulator) was launched to the ISS on March 13, 2008 and subsequently deployed and installed to the ISS during Shuttle mission STS-123/1J/A. The CSA also continued its activities to training and qualify all astronauts, cosmonauts and ground support personnel involved in the operations of the MSS including Dextre. CSA upgraded its ground control operational capability for the Mobile Servicing System. This new ground control capability enabled Canadarm2 to handle heavier payloads through ground controlled operations and initiated a limited range of ground controlled operations for Dextre. The development of these expanded ground control capabilities for Dextre operation enabled more efficient on-orbit

commissioning activities for this new element significantly reducing astronaut time requirement for this task. Canada was the first country to implement and use this type of technology in space operations.

- CSA continued to maintain operational preparedness for the MSS to support ISS maintenance operations. This entailed the preparation and certification of flight products and procedures to support operations that were not then fully defined. The operation of Dextre (the third element of the Mobile Servicing System) brings modification to MSS operations from highly planned and concisely tested assembly operations to more generic and holistic maintenance concepts. This will represent a major philosophical shift to Space Mission Design standards and better position Canada to support future exploration program endeavours.

- CSA completed development of the MSS-6 software, which will provide a major enhancement to the capability of the Canadarm2 to better facilitate the capture of free flying vehicles. Canadarm2 will be required to capture the first free-flying vehicle, the Japanese H-II Transfer Vehicle, in September 2009. The software was required earlier for astronaut training, simulation and mission development.

- CSA supported all planned MSS operations throughout the year. This involved the provision of technical support for MSS hardware and software and, launching one spare Canadarm2 joint to the ISS in early 2008 for pre-positioning in case of on orbit failure of the arm. In addition, CSA performed repair and overhaul work on the MSS hardware, operated MSS training facilities in Canada, planned and supported MSS mission operations, and conducted operations from the Remote Multi-Purpose Support Room in St-Hubert, Quebec in conjunction with the NASA Houston flight control room.

- The CSA continued to support preparations for the on-orbit commissioning of the Microgravity Vibration Isolation System (MVIS), launched in early 2008. The formal commissioning of the MVIS was delayed by ESA to mid-2009 for operational reasons. All activities in support of the MVIS sub-system will also be supported in 2009. By providing this important component to ESA, Canadian scientists will gain access to this unique European ISS laboratory in space.

- The CSA continued to explore how the Advanced Astronaut Medical Support (ADAMS) project could 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 healthcare delivery on Earth through the transfer of space technology. CSA participated to the Haughton-Mars field season on Devon Island working with industry, academia, OGD and international partners for requirements definition and proof of concept.

- The collaborative project with Agri-Food Canada to develop the one-day bonus menu for the ISS, was not completed due to delays in renewing the Memorandum of Understanding (MOU) between CSA and Agri-Food Canada and the inability to issue a contract in time to meet timeline requirements for Expedition 20/21. Off-the shelf items will supplement the menus for Expedition 20/21 and STS-127.

- The Matroshka-Radiation project (radiation exposure data collection and analysis), a collaborative project with Russia, was completed. The CSA has initiated project RADI-N, which will continue to collect radiation exposure data and which will be implemented during Expedition 20/21.

2.4 SATELLITE COMMUNICATIONS

SATELLITE COMMUNICATIONS 2008-2009 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 2008-2009 The Cascade telecommunications payload, part of the CASSIOPE Mission Contribution Program initiated in 2004-2005, became ready for environmental testing in 2009. The launch is planned for next year. The CSA awarded a contract to finalize 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 M3MSat mission, the second joint CSA - DND micro-satellite mission (the first one being NEOSSat), will optimize maritime traffic identification. The preliminary design was initiated in June 2008.	
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 2008-2009.
2. Number of technological applications developed as a result of CSA's participation in space missions and/or support to projects/activities in SC.	5 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)

* = New Missions In 2008-2009, however, note that this is the first time this list is compiled for a Departmental Performance Report. No new missions.
(Year) = Actual Or Projected Launch Date Or Date Of Completion When Known.
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
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 2008-2009.

Satellite Communications (SC) missions under review:

Mission	Status	Field
Anik F2 Utilization (2010)	Under review	Satellite Communications
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 2008-2009.

Indicator 2 – Performance Analysis

A total of five applications were identified for the eight missions listed above: Cascade on board of CASSIOPE (2010), Anik F2 ground infrastructure and terminal servicing, the MEOSAR instrument on board Galileo satellite and the RSS-GEMS for traffic identification. Sixty per cent of those applications (3/5) were related to Communications whereas the other forty per cent were related to Security/Search and Rescue. All applications, except one, had national aims; MEOSAR which is developed in collaboration with ESA will serve the international community.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
26.7	29.1	23.6
2008-2009 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
12.9	15.2	(2.3)

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.	One out of six (17%) concepts was retained for subsequent phase.
2. Quality of the concepts retained based on the average evaluation rating obtained according to the Priority Ranking Framework.	The concept retained was not formally rated against the Priority Ranking Framework. Therefore, no evaluation rating can be reported 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, Space Technologies Branch responded to an estimated 76 consulting requests from external sources in 2008-2009.

Performance Analysis

Expected Result #1

Indicators 1-2

If we consider that a total of 26 new concepts were presented, all program activities combined, it can be said that Satellite Communication contributed to 23% of the new concepts (6/26) and that 11% of the concepts retained (1/9) were Satellite Communications related. The ranking of the chosen new concept is unavailable this year.

Source: SC Road Map.

Expected Result #2

Indicator 1

The number "76 requests" 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. In the future, this indicator will provide more specific examples of such requests.

Source: Internal reporting documents.

Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
16.6	18.4
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
6.0	(0.5)

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

EXPECTED RESULT:

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

Indicator	Performance
1. Canadian industrial return coefficient in ESA optional programs in SC. (Target: 84% or higher)	**Target Exceeded:** 100%; Navigation: 100% and Telecommunications: 101%

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is measured for the second time based on four 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.

Source: Report issued on September 30, 2008: "Geographical distribution of contracts" ESA/IPC(2008)13, rev.2.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
12.5	10.9
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
0.0	0.0

2- 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:

Northern Communities access and utilize the Anik F2 Government of Canada Capacity Credit.	
Indicator	**Performance**
1. Use of the Government of Canada Capacity Credit for Government Applications and Services. (Target: to be determined)	**Target Partially Met:** There are currently 10 experimental terminals deployed in the North.

PERFORMANCE ANALYSIS:

3-Year Trend No trend available. Targeted achievement was measured for the first time this year.	N.A.

Indicator 1

Annual targets have been defined as follow:
FY 2009-2010: 1 to 3 communities;
FY 2010-2011: 5 to 10 communities; and,
FY 2011-2012: 10 to 15 communities.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
2.0	5.9
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
0.0	1.3

Highlights of Main Accomplishments – Enabling Research (SC)

- The CSA continues to work towards the utilization of the Government of Canada capacity credit for broadband telecommunications services in the North. Additional demonstration of Ka-band technology have continued to improve the use of the Anik F2 satellite by northern communities for trials of innovative government services and in specific areas of interest to other government departments such as tele-health and tele-learning. The CSA awarded a contract to finalize the ground segment infrastructure upgrade for the utilization of the capacity credit. The contract adds redundancy to the Vancouver and Winnipeg Hubs to meet required quality of service. It also produces a full complement of Satellite Interactive Terminals for end-users located in Northern Canada.

- Canada's participation in the European Space Agency (ESA) satellite communications and navigation programs 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, for security and safety and for disaster management. For example, in satellite navigation, Canada is contributing to the development of the Galileo ground infrastructure supporting the monitoring of the quality of the localisation signal generated by the four experimental satellites that will be put in orbit in 2010 as a precursor to the Galileo constellation.

- As part of the new Long Term Space Plan, CSA continued the assessment of an Advanced Satellite Communications Program aimed at developing and demonstrating innovative technologies to provide broadband connectivity and safety and security services to all Canadians and to maintain Canada's leadership in satellite based communications, navigation and search and rescue systems, in line with the priority given to information and communications technologies by the Government Science and Technology Strategy.

- The CSA has completed the assessment of the requirements of government users in the area of telecommunications in order to support the definition of the mission concept for the Polar Communications and Weather System (PCW). PCW would provide high data rate communications covering the Arctic. This project is moving into Phase A in 2009-2010.

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 were no new EPA submitted to TBS in 2008-2009 nor were any amendments made to previous EPAs – all program activities combined.
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 38% 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 38% rate of planned expertise matrix support is based on the average support of 68 specialized personnel to 10 missions at the development stage.

Source: Internal reporting documents (E-Ram).

Note: The Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
10.1	5.2
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
6.9	(1.7)

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:
SC projects' deliverables are met.

Indicators	Performance
1. Project milestones are met as defined in the detailed work plan. (Target: 75%)	**Target Partially Met:** 6 milestones achieved out of 12 (50%).
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 second time based on two to four consecutive data. 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

Three Milestones scheduled towards the end of fiscal year slipped to April 2009. Otherwise, they would have contributed to meet the 75% target. There was the M3MSat (GeMS) contract award and contract kick-off and two other milestones planned for FY 2008-2009 that were delayed to FY 2009-2010 due to contractor performance. They were the M3MSat preliminary design review and effective project approval.

Source: Internal documents.

Indicator 2

Project cost is maintained within authorized levels. M3MSat and CASSIOPE-Cascade costs are within authorized levels.

Source: Internal documents.

Indicator 3

Risks are identified and mitigation plans prepared for each project. M3MSat and CASSIOPE-Cascade have documented risks matrix and mitigation plans.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
10.1	5.2
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
6.9	8.6

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 being fully designed and constructed by Canadian companies. The integration of the payloads was completed in July 2008. Environmental testing of the spacecraft was initiated and will be completed in August 2009. The launch is planned for mid to end of 2010 depending on the development of the Falcon 9 launch vehicle. 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.

- The M3MSat mission is the second joint CSA - DND micro-satellite mission (the first one being NEOSSat). Payloads include an Automatic Identification System (AIS), a low data rate system (LDRS) ans a small technology demonstration payload supported on a micro-satellite bus. This project will demonstrate and further develop a multi-mission micro-satellite bus capability; will establish micro-satellites as operationally cost effective; will allow optimization of the AIS payload in maritime traffic identification; will significantly support Canadian industry business development strategies in a global market context; and will be a complement with CSA's RADARSAT-Constellation mission and with DND's Polar Epsilon program. Preliminary design was initiated in June 2008. The launch is planned for mid 2011 and end of mission demonstration in 2013.

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

GENERIC TECHNOLOGICAL ACTIVITIES IN SUPPORT OF EO, SE AND SC
2008-2009 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 2008-2009

The development of Technology Roadmaps to guide and prioritize technology R&D at CSA was a key priority in 2008-2009. The priority technologies were defined in consultation with the technology manufacturers, the users and the experts.

The Space Technology Development Program (STDP) had 4 priority reached an operational level (TRL 6).

Through the Intellectual Property and Technology Transfer group, the CSA managed 53 active patents for 27 different technologies and 32 licenses, including 22 commercialization licenses.

By using the Partnership Support Program and NSERC's 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. Eight projects are being supported in 2008-2009.

The David Florida Laboratory conducted 131 tests for the CSA's, another federal department and 31 private-sector clients.

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 43 and the number of priorities having been financially supported for the same period was 21 therefore a ration of 2.1.
2. Number of priority technologies supported that are ready to be used.	The number of priority technologies supported ready to be used is 4 out of the 43 identified (9%).

Indicator 1 – Performance Analysis

For a first year, it is too early to analyse this unique ratio of 2.1. Over the next three years, however, once the CSA's stabilizes its list of priorities, the ratio should be closer to 1.0 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 used, a technology must reach a Readiness Level of "6" or higher. As a new technology proceeds to a higher level of maturity, the risk associated with its implementation in a space mission lessens. It takes time and investments for a new technology to become ready to be used and therefore the priority selection must precede the actual need by a certain number of years. Like for the previous indicator, this one will, over the next three years, demonstrate how the CSA is making a steady progress towards meeting 100% of its identified priorities and therefore reducing its long-term risks.

Source: Internal reporting documents.

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
48.3	43.8	41.2
2007-2008 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
141.4	116.4	25.0

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 carrying out generic space mission operation activities.

Program Sub-Activity: Enabling Research – Generic Technological Activities in support of EO, SE, 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.	1. 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.	1. Number of requests received vs. the number of requests accepted. (66 received vs 40 accepted – 60%)
2. Number of requests received vs. the number of requests funded.	2. Number of requests received vs. the number of requests funded. (66 received vs 26 funded – 39%)

Performance Analysis
Expected Result #2 Indicators 1-2 More than 50% 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. Source: Internal reporting documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
40.5	35.3
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
96.9	19.2

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- Generic Technological Activities in support of Earth Observation, Science and Exploration, and Satellite Communications – Objective: Assume the leadership and support in the enabling research and development (R-D) of high-risk technologies leading to the realization of CSA or international EO, SE and SC missions.

EXPECTED RESULT 1:

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

Indicators	Performance
1. Number of technologies brought to higher readiness levels. (Target: 23)	**Target Exceeded:** 42; 6 technologies and 36 R&D projects to advance space technologies.
2. Number of technologies chosen to enable future space missions of interest to Canada. (Target: 6)	**Target Partially Met:** 3; 1 in autonomous robotics and 2 R&D projects.

EXPECTED RESULT 2:

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

Indicators	Performance
1. Number of Highly Qualified Personnel (HQP) supporting CSA projects and/or programs. (Target: 80)	**Target Met:** 80
2. Number of scientific and technical publications by CSA personnel and visiting researchers. (Target: 50)	**Target Partially Met:** 48

EXPECTED RESULT 3:

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: 94% or higher)	**Target Exceeded:** ESA mandatory programs: 108%. General Support Technology Programs: 100%

EXPECTED RESULT 4:

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

Indicators	Performance
1. Number of licences granted for space technologies generated by the CSA. (Target: 5)	**Target Partially Met:** 2 new licences were awarded in 2008-2009.

PERFORMANCE ANALYSIS:

3-Year Trend

The 3-year trend is based on three consecutive data for all but one indicator. Trend analysis maintains the satisfactory rating because one targeted achievement remained mostly at the met. Benchmark values could only be confirmed for one indicator, the others have yet to reach an appropriate stability.

Satisfactory

Expected Result #1

Indicator 1

The 6 technologies were: smart radiator, SMA actuator, autonomous navigation, MIRAD, OISL and LIBS.

Source: Internal documents.

Expected Result #1

Indicator 2

The same technology (Deep Charge Monitor by DPL Science Inc.) was selected twice for two different missions. This indicator should be reviewed over a period of at least 3 years and not annually. Furthermore it is very difficult to track the technologies between its STDP development and time it is actually selected for a mission. The STDP group is setting up an operating procedure to track the "usefulness" of its R&D by consulting with the "client" getting benefits from the technology.

Source: Internal documents.

Expected Result #2

Indicator 1

The term Highly Qualified Personnel (HQP) includes: graduate and postdoctoral fellows, as well as research assistants, research associates, faculty staff and industry R&D staff. The 80 HQP can be broken down into the following categories:

30 Space Technology Research Program
12 Payloads Engineering
30 Systems Engineering
8 Spacecraft Engineering

Source: Internal documents.

Expected Results #2

Indicator 2

Source: Internal documents.

Expected Result #3

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 GTA programs are: ESA mandatory programs and General Support Technology Programs.

Source: Report issued on September 30, 2008: "Geographical distribution of contracts" ESA/IPC(2008)13, rev.2.

Expected Result #4

Indicator 1

Other negotiations were still ongoing at year-end and will most probably be completed during 2009-2010.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
40.5	35.3
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
96.9	77.7

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

- The structure of CSA Technology Plan is being developed and dedicated resources have been allocated to the development of technology roadmaps to guide and prioritize technology R&D at CSA. Priority technologies are defined in consultation with the technology manufacturers, the users and the experts. A mission database was developed and is being populated with potential missions. The database will be a critical tool to identify technology requirements.

- The Space Technology Development Program (STDP) addresses priority technologies required for national and international space missions and activities of interest to the Canadian Space Program. Through periodic requests for proposals, STDP awards R&D contracts to industry for the development of innovative technologies and to retire risk on the critical technologies required for future missions. Examples activities under the STDP in 2008-2009 include:

    - Embedded distributed fiber optic sensor to determine temperature gradient as well as strain in composite structures;

- New Ka-Band antenna designs to improve performance, facilitate fabrication and lower the cost;
- Prototype of a novel tunable filter with integrated command and control functions to demonstrate the new technology in a simulated operating environment. This development is critical to the implementation of future space missions including reconfigurable communications satellites; and,
- Smart self healing materials that could sustain damage in orbit.

The CSA, in collaboration with industry continued to develop technologies, such as engineering qualification models to demonstrate the concept feasibility of Middle Earth Orbit Search-and-Rescue (MEOSAR) payload. The objective is to use navigation satellites such as GPS and Galileo to relay in near real-time signals from activated distress beacons located on ships, plane or on a single individual needing help. This development represents a significant leap forward in new satellite-aided Search-and-Rescue capabilities that will increase the number of lives saved around the world.

- The Space Technology Research Program contributed to the development of long-term high-risk space technologies and to maintaining CSA's technical capacity conducting applied R&D and prototyping activities that meet the criteria of excellence and relevance in support of future missions and programs of the CSA. The program included the development of:
  - Autonomous guidance of a space manipulator to smoothly capture a tumbling satellite;
  - New technologies for mitigating damage to spacecraft from space debris;
  - Collaboration with Canadian universities and industry for the demonstration of nano-satellite platforms;
  - Collaboration with Japan on laser communications; and,
  - Prototype of a reversible deployment mechanism using shape memory alloys.
- Through the Intellectual Property and Technology Transfer group, CSA manages its portfolio of patents (53 active patents for 27 different technologies) and intellectual property licenses (32 licenses, including 22 commercialization licenses). The group also conducts commercialization assessments in order to support the transfer of space technologies and their applications to other sectors of the economy and enhance Canada's industrial competitiveness.
- By using the Partnership Support Program and NSERC's 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. Eight projects were supported in 2008-2009.

Program Sub-Activity: Space Mission Development Generic Technological Activities in support of EO, SE, 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 18 missions/projects/activities for the CSA, other governmental departments and the private companies were supported.

Performance Analysis

Indicator 1

From those 18 missions, 6 were government related (the CSA and DND) and 12 were privately sponsored by 31 privates companies; those numbers are similar to those of last's year with 8 CSA's missions and 38 privates companies.

Source: SAP financial report and other internal reporting documents.

Note: the Expected Result #2 second indicator mentioned in the 2008-2009 RPP was not measured further to the corporate review of the PAA performance measurement framework.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
7.8	6.0
2008-2009 – Human Resources (FTEs)	
Planned	**Difference**
44.5	5.8

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 Program – 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.

Indicators	Performance
1. Percentage of satisfied clients. (Target: 95% or more)	**Target Met:** 98%

PERFORMANCE ANALYSIS:

Superior

3-Year Trend

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

Indicator 1

Year-end report indicates 98% of clients were either fully satisfied or better. Of the 2% that were less than satisfied, follow-up was initiated to identify specific performance deficiencies, and to implement specific corrective actions to increase client satisfaction.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
6.5	6.0
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
44.5	38.7

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

- David Florida Laboratory (DFL) provides world-class and cost-effective environmental space qualification services for the assembly, integration and testing of spacecraft systems and sub-systems to all of the CSA's programs. Many projects benefited from DFL support in 2008-2009.

The following Space Science and Exploration programs:

- CASSIOPE ePOP mission: series of Radio Frequency (RF) trials on the ePOP instrument;
- James Webb Space Telescope: completed thermal vacuum testing on the Fine Guidance Sensor (FGS) cryogenic unit; and,
- UltraViolet Imaging Telescope (UVIT): completed vibration tests on Engineering Models of the Engineering Unit (EU) and Central Processing Unit (CPU).

The following Satellite Communications programs:

- CASSIOPE: continued subsystem level testing on data storage units and on a series of antenna tests.

The following commercial programs:

- Test support for private sector space and non-space projects including:
  - Space Systems Loral (Asiasat, NIMIQ5 and Telestar 11N);
  - MDA (SSRMS, SRMS, Yamal Program, QZSS; JEM, Inmarsat);
  - SG Microwave (Intelsat);
  - CP1(Earthcare Program);
  - Comdev (spacecraft multiplexers);
  - Neptec Dsign group (TriDAR Laser Camera Assembly);
  - EADS CASA Espacio (Galileo);
  - Telecom (Inmarsat);
  - Ball Aerospace (Inmarsat);
  - EMS (Inmarsat);
  - NovAtel (GPS antennas); and,
  - Ultra Electronics (HCLOS radio set).

The following other Government departments projects:

- Department of National Defence(CF-18 Radome Characterization Project); and,
- Defence Research and Development Canada (IMOP).

2.6 SPACE AWARENESS AND LEARNING

SPACE AWARENESS AND LEARNING 2008-2009 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. It also offers opportunities to enhance the expertise of Canadian scientists, engineers and physicians in space science, space technology and space medicine.
EXPECTED RESULT Targeted level of awareness of space among Canadians is reached.
MAIN ACCOMPLISHMENTS IN 2008-2009 The number of visitors to the CSA's interactive Web site increased by 8% from 1.49 million in 2007-2008 to 1.62 million in 2008-2009. Over 81 public events were conducted in communities throughout Canada to raise awareness of Canadian space science and technology. Note that a video presentation was used in 2008-2009 reaching an audience estimated at 100 000 viewers. The Space Learning Program conducted 117 learning events, combining in-class experiences, presentations and tele-distance education with primary and secondary students throughout Canada. Over 1.7 million students participated in these learning events, a slight increase from previous year. A total of 873 educators participated in professional development workshops this year. It is a decrease from previous year for distance learning activities were postponed as program focused on learning resources development for Canadian astronaut missions STS-127 and Expedition 20/21.

Indicator	Performance
1. Survey results obtained every 3 years.	No National Public Opinion survey was conducted in 2008-2009 because of governmental guidelines.

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
7.9	6.6	6.1
2008-2009 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
29.0	22.1	6.9

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	
Target audiences are reached through outreach activities.	
Indicator	**Performance**
1. Number of initiatives according to targeted audiences. (Target: Confirm Benchmark)	**Target Met:** 61 media and public events; 20 astronaut tours.

Performance Analysis

Expected Result

Indicator 1

Fédération des astronomes; Alta & Ont Science Teachers; Astro Festival, Scientifete; Space Awareness; Winterlude; Tremblant, Astro2008; Arctic Polar Shelf; Eureka; 400e de Quebec; IGARRS; Cospar; Oceans; RADARSAT Workshop; IAC; Bar des sciences; Canadian Space Summit; Astronomy Year, Phoenix; Scientific Communications; UN COPUOUS; RASC; World Presidents; JAXA/Tsukuba; Agriculture Week; U. Ottawa GIS Day; CIG Symposium; Silverdart Centennial; Pavillon-Canada/Americana 2009; Collaboration: Museums/Science Centres (6).

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
5.1	3.8
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
24.0	17.2

Highlights of Main Accomplishments – Awareness

- Initiation of the creation of a series of short animations depicting scientific concepts and activities related to space to be used for communication and educational activities**.**

- An awareness campaign related to Mars landing of NASA's Phoenix Mars Rover with a Canadian science instrument and weather station aboard, garnered extensive media attention and attracted over 14,500 Canadians to public speaking events across the country.

- A public awareness media campaign focused on the launch of Dextre, the final component and contribution of Canada's advanced space robotics suite to the ISS, a two-armed dexterous manipulator that will enhance construction and maintenance of the International Space Station, garnered strong media attention across Canada.

- The CSA hosted the world's largest gathering of the space science community and the 50th anniversary of its most venerable and renowned institution, COSPAR, in July 2008 in Montreal. The conference attracted a record 3,500 scientists from around the world and public speaking events surrounding the James Webb Science Telescope model attracted close to 15,000 visitors.

- An awareness campaign related to the National Astronaut Recruitment Campaign, to encourage youth to pursue studies in science and technology began with media and Web outreach components.

- Promotion of the successful commissioning of Canada's most advanced Earth Observation imaging satellite, RADARSAT-2. The satellite was fully tested, declared operational, and began production of precise imaging for Government stakeholders in support of resource mapping and management, surveillance and Arctic sovereignty and commercial clients worldwide.

- Contributed to a global celebration of the 10th anniversary of the International Space Station; continuing promotion of Canada's key role as a member and contribution of critical scientific and technological expertise, and suite of space robotics that is building and maintaining the Space Station. Promotion of preparations by Canada and its international partners to send a full international crew to live and work on board the Station in the spring of 2009.

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	
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: Maintain or increase)	**Target Exceeded:** 837 educators attended space-centred professional development workshops.
2. Number of students reached through learning activities. (Target: Maintain or increase)	**Target Exceeded:** 1,720,340 primary and secondary students reached through space centered educational program.

Performance Analysis

Expected Result

Indicator 1

A total of 873 educators breakdown as such:
119 Educators attended space-centered professional development conference at CSA Headquarters;
615 Educators participated in professional development outside Montreal;
16 Educators-science and math consultants came to the CSA for specialized development; and
123 others.
Additionally, 332,310 educators visited CSA's Educational Web site to consult pedagogical and learning activity modules.

Source: Internal documents.

Indicator 2

1,720,340 (MS) students reached through 333 school boards and 40,254 classes using mission STS-127 learning modules. Here are some examples: 306,000 students participated in national space-education program: Tomatoesphere; 2,264 students participated through in-class workshops outside the Montreal area; 2,181students participated at CSA Headquarters educational classes; 1,026 students participated in tele-learning classes; 175,595 students visited CSA's educational Web site; 23,568 students reached by 7 organisations.

Source: Internal documents.

2008-2009 – Financial Resources ($ in millions)	
Planned Spending	**Actual Spending**
2.8	2.3
2008-2009 – Human Resources (FTEs)	
Planned	**Actual**
5.0	4.9

Highlights of Main Accomplishments – Learning

- Professional development workshops and teaching initiatives for educators and students using satellite enabled or web-based assisted tele-learning.

- Partnered initiatives with schools, youth organisations and other institutions to expand student and educator access to the space science and technology community and space-learning materials.

- Space-focused learning materials and teaching modules developed for educators and students at the primary and secondary level. In support of Mission STS-127, a 3-D curricular learning product was developed at the primary and secondary level. These targeted learning products were requested by 338 school boards in all provinces and territories reaching 40,475 classrooms, and 1,213,250 students in grades 5-6 and 9-10.

- Coordinated an integrated Grants, Contribution and Sponsorship Program in partnership with other federal departments and agencies to support awareness, research, development and training in space science and technology.

2.7 INTERNAL SERVICES

INTERNAL SERVICES
2008-2009 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 MAF expectations.	MAF rating from the 2000-2009 Round VI assessments against the 21 area of management indicators were: Strong = 1 Acceptable = 14 Opportunity for improvement = 5 Attention required = 1

Indicator 1 – Performance Analysis

The Treasury Board assesses management quality only through MAF indicators.

Overall, the results are slightly better than the assessment in 2007-2008. Compared to 2007-2008, 3 areas of management have improved, 14 have remained the same, 2 have declined, and 2 were unable to compare. The number of areas of management at the acceptable level went from 10 to 14 and the number of areas showing an opportunity for improvement declined from 7 to 5.

Compared to all the departments and agencies, the CSA rating was at the same level for 17 areas of management, at a lower level for 4 of them, and none was higher.

During 2008-2009, the CSA has undergone a transition at the presidency level, which has delayed the finalization of a number of MAF related initiatives. In response to round VI assessment, the CSA has assigned a officer of primary interest with an action plan for each areas of management.

Source: Round VI 2008-2009 Management Accountability Framework (MAF) Assessment.

EXPECTED RESULT #2

The three highest priority risks identified in the CSA corporate risk profile are addressed and mitigated. The are:

1. Values and Ethics: Increase the capacity of the CSA to instil public service values, to develop a working environment free of harassment, and promoting respect for individuals, integrity and honesty.

2. Workforce Competencies: Increase the capacity of CSA to maintain a qualified workforce of public servants to deliver CSA's mandate within the government legislative frameworks, policies and rules.

3. Function/Process Integration: Increase 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.

Indicators	Performance
Mitigation action plans are implemented against the three corporate risks identified as highest priorities.	Three out of the 6 risk mitigation action plans were implemented.
1. Phase 2 of the CSA Public Service Values and Ethics program is implemented.	1. **Target Not Met:** The implementation was postponed to the next fiscal year.
2.1. The key to leadership competency profile is integrated in human resources management strategies and activities. (Target: Competency profile is used for the hiring, evaluation and development of CSA managers)	2.1 **Target Partially Met:** The majority of managers have completed on time the key training programme leading to the delegation of financial and human resources management authorities (appointment authority excepted).
2.2. The majority of CSA managers are recognized as being qualified for increased delegation of authority. (Target: Full hiring delegated authority is granted by the Public Service Commission by September 2008)	2.2 **Target Met:** The CSA new Appointment Delegation and Accountability instrument was approved by the Public Service Commission.
3.1. The corporate Work Planning information system (eWP) is fully implemented and functional for all sectors for the planning of 2009-2010 and monitoring of 2008-2009.	3.1 **Target Exceeded:** All CSA sectors used the Work Planning information system and a new feature was added to monitor MAF and Corporate risk actions plans.
3.2. Completed development of a Long-term Investment Plan. (Target: The Plan is approved by CSA Executive Committee)	3.2 **Target Not Met:** The approval of a the plan was postponed to the next fiscal year in order to respond to Budget Strategic Review and integrate the requirements of the Long Term Space Plan in preparation.
3.3. Management actions plans are implemented further to audit findings and recommendations regarding CSA management frameworks.	3.3 **Target Met:** 89 % of the 227 actions in response to audit recommendations were fully implemented. Another 18% are in progress and only 4 % have not started yet.

Indicator 1 – Performance Analysis

Three out of the 6 risk mitigation actions were implemented. Out of the 3 remaining actions, one was partially met although it showed significant progress towards achieving the targets and two indicators were postponed giving priority to Strategic Review and Long Term Space Plan exercises. The CSA assessment concluded that the targeted risk tolerance levels were not reached and therefore remaining actions will be pursued in 2009-2010. The definitions of the priority corporate risks were reviewed in the RPP 2009-2010.

Source: CSA Corporate Risk Profile (internal document).

2008-2009 – Financial Resources ($ in millions)		
Planned Spending	**Total Authorities**	**Actual Spending**
40.6	45.3	42.2
2008-2009 – Human Resources (FTEs)		
Planned	**Annual**	**Difference**
270.1	225.4	44.7

Main Expected Accomplishments – Internal Services

As part of their current activities, Internal Services carried out key activities for constant service provision improvements:

The corporate strategy for the full deployment of the Performance Management Framework (PMF) at all levels of the Program Activity Architecture was initiated. As a result, a reviewed set of results and indicators was used in the preparation of the 2009-2010 Report on Plans and Priorities and for the performance measurement of 2008-2009.

The CSA has undergone successfully an internal priority review exercise as well as a Budget Strategic Review of its expenditures in order to align tits programs with the Government Science and Technology Strategy.

The CSA create an independent Departmental Audit Committee made of a majority of members from outside the federal public service and developed a risk-based multi-year internal audit plan.

CSA has reviewed its internal financial control procedures to be implemented starting in 2009-2010 in order to assure managers that all payments are compliant with current financial policies.

A financial forecast module was successfully implemented in the expenditure management system. It provides CSA with a better control of ongoing surplus and the reallocation of funds to priorities is optimized.

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 healthcare 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.

Astronauts: Expedition 20/21

In 2008, Dr. Thirsk was assigned to the crew of Expedition 20/21. 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 on board 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 onbord Soyouz. 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

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.

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.

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.

CAMBIUM
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.

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 recognised 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.

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 – Alphasat
The primary objective of ESA under the Alphasat Programme 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 - ADM/Aeolus
The Atmospheric Dynamics Mission (ADM) is a 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 - 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 programme. 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 - 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-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.

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 colour, 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 lauched 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 spectometer 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 - 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 Utilisation (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 Utilisation and associated accessories and instrumentation.

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.

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.

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.

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.

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.

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.

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.

Mangaroni
The JAXA's Mangaroni 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.

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
The CSA Micro-Electro-Mechanical Systems (MEMS) 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

focussing 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.

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 MSR will focus on vision system technology needs for the automated rendez-vous and capture operations of the Mars Sample Return (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.

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.

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.

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.

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 communication services and monitor weather 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.

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.

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

The RADARASAT Constellation 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.

RAO

The Robotics and Automation for Orion (RAO) is a CSA concept study of Canadian participation in future NASA Constellation Program missions centred 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: A concept study submitted to the CSA from a propsed 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 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.

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. 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.

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.