Evaluation of the Observation Systems, Planning and Preparatory Activities of the Space Utilization Program

For the period from April 2017 to March 2022

Audit and Evaluation Directorate

December 2023

Agence spatiale canadienne | Canadian Space Agency

Canada

Evaluation of the Space Utilization Program's Observation Systems, Planning and Preparatory Activities of the Canadian Space Agency

Project #21/22 02-01

December 2023

Canadian Space Agency's Audit and Evaluation Directorate

Cat. # : ST99-86/2024F-PDF (PDF file, French)
ISBN: 978-0-660-69471-9

Cat. # : ST99-86/2024E-PDF (PDF file, English)
ISBN: 978-0-660-69470-2

Ce document est aussi disponible en français sous le titre *Évaluation des Systèmes d'observation, planification et activités préparatoires du programme de l'Utilisation de l'espace*.

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Acknowledgments

This evaluation was made possible through the contribution and collaboration of many people. We wish to thank everyone who participated in interviews and data collection, responded to inquiries, and provided information and feedback.

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Abbreviations and Acronyms

AO	Announcement of Opportunity
AOM	Arctic Observing Mission
CAF	Canadian Armed Forces
CHM	Canadian Hyperspectral Mission
CSA	Canadian Space Agency
DND	Department of National Defence
DRF	Departmental Results Framework
ECCC	Environment and Climate Change Canada
EO	Earth Observation
EPMO	Enterprise Project Management Office
ESA	European Space Agency
FTE	Full-Time Equivalent
G2	Gate #2
G&Cs	Grants and Contributions
G&P	Governance and Performance
GBA Plus	Gender-Based Analysis Plus
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRIP	Government Related Initiatives Program
HAWC	High-altitude Aerosols, Water vapour and Clouds Mission
IGMF	Investment Governance and Monitoring Framework
IIRB	Integrated Investment Review Board
MDA	MacDonald, Dettwiler and Associates
NASA	National Aeronautics and Space Administration (United States)
O&M	Operations and Maintenance
OSPPA	Observations Systems, Planning and Preparatory Activities
PEA	Planning, Engagement and Applications
PIP	Performance Information Profile
PIPD	Programs and Integrated Planning Directorate
PMS	Performance Measurement Strategy
R2	Review point #2
R&D	Research and Development
RCM	RADARSAT Constellation Mission
SAR	Synthetic Aperture Radar
SatCom	Satellite Communications
SatNav	Satellite Navigation
SESS	Sun-Earth System Science
SMILE	Solar wind Magnetosphere Ionosphere Link Explorer Mission
SSA	Space Situational Awareness
STDP	Space Technology Development Program
SUMC	Space Utilization Management Committee
SUP	Space Utilization Program
SUSC	Space Utilization Steering Committee
SWOT	Surface Water and Ocean Topography Mission
TBS	Treasury Board Secretariat

Executive Summary

This report presents the findings of the evaluation of the Observations Systems, Planning and Preparatory Activities (OSPPA) of the Canadian Space Agency's (CSA) Space Utilization Program (SUP), for the period from April 2017 to March 2022. The evaluation covers the planning, preparatory activities and development of the satellite missions during the aforementioned time frame for which the SUP is responsible. This is the first evaluation covering all Program business lines. The evaluation was carried out by the CSA's Audit and Evaluation Directorate between January 2022 and September 2023, with the support of the firm PRA Inc. It was conducted in accordance with the CSA's *Departmental Evaluation Plan* and the Treasury Board of Canada's *Policy on Results* (2016). It addresses the main evaluation issues set out in the *Directive on Results* (2016), namely relevance, effectiveness and efficiency. In response to requests from the Program, the evaluation also paid particular attention to decision making, priority setting, governance and values and ethics.

Relevance

Satellites play an essential role in the lives of Canadians, and the SUP ensures that Canada takes full advantage of the potential offered by space for the benefit of its citizens. It supports the mandates of other entities that may have a positive impact on Canadians, for instance with respect to the environment, national security, and disaster management. Indeed, the SUP makes it possible for public, industrial and academic organizations within Canada to access space data, information and services in order to better understand the Earth, inform policy and decision making, and connect Canada and Canadians. The SUP's objectives and activities are aligned with the federal government's priorities and core responsibilities. The SUP is a pillar of the CSA, enabling it to support Canada's space ambitions. Furthermore, it is of strategic importance to many other federal departments in achieving their respective mandates. Canadian satellites, such as the RADARSAT Constellation Mission (RCM), provide considerable benefits for Canada, which justify the significant resources allocated to their design, development, and operation. Over the years, the SUP has accurately identified the needs of its target groups and it has designed and supported missions that meet the majority of the needs identified. However, the federal government's Earth observation data needs are increasingly numerous, and the SUP meets these needs within the limits of its human and financial capacities.

Effectiveness

Most of the data on the SUP's performance were available, reliable and useful for the purposes of the evaluation. In terms of effectiveness, the output and outcome targets were generally achieved or even surpassed. The number of agreements signed by the SUP has fluctuated over the years, but the number of images[1] obtained from synthetic aperture radar (SAR) satellites significantly increased between 2019 and 2022 due to the launch and commissioning of RCM in 2019 and the efforts undertaken by the SUP to maximize the availability of the data collected. The results of the last few years demonstrate the unparalleled effectiveness and capacity of RCM compared to its predecessor. As early as fiscal year 2019-20, the 53,648 images obtained through the CSA's SAR satellites included 32,062 images from RADARSAT-2, and

[1] For the purposes of this evaluation, "images" and "scenes" are used interchangeably, despite there being a technical engineering distinction between the two.

21,586 images that were already captured by RCM after only a few months of operation (not to mention its enhanced engineering capabilities). Nonetheless, RCM data accessibility proved to be more complicated than expected due to the high volume of acquisition requests, the sensitivity of some images captured, and important needs related to national defence.

Efficiency

The data collected indicate that OSPPA-related spending is appropriately managed and that actual expenditures are lower than anticipated in the financial forecasts, which include allocated funds for risk management. Over the years, the SUP has demonstrated its ability to work effectively with various internal and external stakeholders as part of an interdepartmental and international approach. The activities related to planning and developing satellite missions are harmonized both within the Program and the CSA, as well as across the Canadian space ecosystem and with international partners. However, unlike the CSA's other programs, the SUP operated with two Performance Information Profiles (PIP) from 2019 to 2022, i.e. until the second edition of CSA's PIPs in March 2022. The SUP strategic planning team has made significant efforts to improve performance measurement and create efficiencies, in collaboration with the team responsible for coordinating the Programs' performance measurement at the CSA. These efforts resulted in improvements, the most noteworthy being the consolidation of methodologies and indicators into a single PIP. In addition, international collaboration enables the Program and the CSA to engage in more opportunities and reduce costs, among other benefits.

The evaluation has brought to light challenges related to the planning and development of observation systems between 2017 and 2022. Overall, the prioritization of SUP's missions and activities was a challenge during the period covered by the evaluation, and the data collected show that this challenge results from various interrelated factors. Among other things, the Program branch responsible for strategic planning and stakeholder engagement is relatively new. In addition, the SUP's business model has evolved over the past few years, shifting from a model where almost all human and financial resources were geared towards a shared objective (RCM) to a model where several missions are progressing in parallel. This model has its advantages, but it also has an impact on efficiency because employees are working on developing various missions in a context where the number of employees is limited. Lastly, the CSA does not have a budget envelope to fund the development of specific initiatives from their inception, considering that satellite missions are mainly selected based on federal priorities, departmental objectives, the needs of target groups (e.g. federal departments), collaboration opportunities, as well as the risks and functional requirements of these initiatives; which require prior efforts and the right timing. However, it is important to mention that the efforts made between 2017 and 2022 made it possible to confirm future investments in observation systems. As such, the Program is now increasing its focus on developing the missions it has committed to delivering.

Furthermore, the design and development of observation systems are aligned with the CSA's governance structures and processes. However, the requirements related to the financial approval and detailed cost estimates required to pass Gate #2 of the CSA's *Investment Governance and Monitoring Framework* (IGMF) are considered challenging by many employees, who say it is difficult to estimate detailed costs for an observation system before even establishing the project needs and technical requirements. While this does not prevent the Program from successfully carrying out various missions, the lack of clarity on this element has caused a loss of efficiency, created tensions and complicated daily work. That said, the Treasury Board Secretariat replaced the *Guide to Cost Estimating* with the *Guide to Costing* in May 2023. It is therefore still

too early to assess the repercussions of this new guide on the SUP activities. Moreover, the CSA's corporate teams are currently working to establish a standardized method and tools to streamline the costing process at the CSA.

Within the Program itself, the evaluation findings indicate that some elements could be clarified, documented, and centralized in order to optimize the decision-making process and to reduce staff workload in the short-term. First, there is currently no centralized management tool or process within the SUP to provide an overall portrait of the human resources assigned to each phase for all ongoing missions. This is particularly challenging at the outset of initiatives since the planning function is divided among the Program branches. Second, there is no centralized database within the Program to compile and organize all the needs identified over the years by employees of the different branches, which increases the number of consultations held by the Program and complicates the establishment of prioritization criteria related to the needs of the target groups. Finally, the evaluation found that roles and responsibilities should be clarified across three levels, i.e. within the Program (e.g. between branches participating in project teams), between the Program and the CSA's other directorates, and with other federal departments. The data collected also indicate that the work to develop a vision undertaken by the SUP over the last several years will only truly succeed as part of a concerted effort both within the CSA as a whole and among the wider federal government. On this last point, the onus is on stakeholders to determine the desired level of CSA involvement in the SUP areas of responsibility, and to identify the actions to be taken to achieve it.

Recommendations

In light of the key evaluation findings described above, the evaluation recommends the following actions to support the Space Utilization Program's decision making and efficiency:

1. Clarify the operational vision, roles and responsibilities, and develop a management framework that reflects the Program's direction.
2. Centralize, compile and organize information related to the needs of target groups.
3. Ensure centralized and holistic planning, management and monitoring of the Program's human resources related to observation systems, for each phase of all satellite missions undertaken by the Program.

About the Evaluation

Purpose and Scope

This report presents the findings of the evaluation of the Observations Systems, planning and preparatory Activities (OSPPA) of the Canadian Space Agency's (CSA) Space Utilization Program (SUP), in accordance with the commitment set out in the CSA's *Departmental Evaluation Plan* and the Treasury Board of Canada's *Policy on Results* (2016). The evaluation covers the main evaluation issues set out in the *Directive on Results* (2016), namely relevance, effectiveness and efficiency, and Gender-Based Analysis Plus (GBA Plus). It is part of a constructive approach and aims to provide a neutral assessment supported by evidence.

The evaluation was conducted by the CSA's Audit and Evaluation Directorate between January 2022 and September 2023, with the support of PRA Inc. It is the first evaluation to cover all SUP business lines. It covers planning, preparatory activities and the development of observation systems for which the SUP is responsible, for the period from April 1, 2017, to March 31, 2022. In response to specific information needs from SUP representatives, the evaluation also paid particular attention to decision making, priority setting, governance, and values and ethics considerations. While data collection was carried out in 2022, the evaluation considered all subsequent changes while drafting and publishing this report in order to ensure recommendations are relevant, and to present information in accordance with the most up to date information.

This evaluation is the first in a series of two separate but complementary evaluations of the CSA's SUP. It includes the "*Planning and Preparatory Activities*" and "*Observation Systems*" sub-programs, to which almost all SUP activities and resources are assigned. Data utilization and application development are excluded from the evaluation scope because they will be subject to a forthcoming evaluation.

Methodology

Case studies. Nine case studies were conducted as a part of this evaluation. They covered satellite missions of various types, scales and stages of development, namely the RADARSAT Constellation Mission (RCM), the Surface Water and Ocean Topography mission (SWOT), the WildFireSat mission, the High-altitude Aerosols, Water vapour and Clouds Mission (HAWC), the SCISAT mission, the Solar wind Magnetosphere Ionosphere Link Explorer mission (SMILE), the WaterSat mission, the Arctic Observing Mission (AOM), and the Canadian Hyperspectral Mission (CHM). The case studies are based on the analysis of data collected from the document review and interviews. Their purpose was to highlight practices related to the SUP's implementation, comparing various features of the satellite missions.

Document review. The evaluation is based, among other things, on the careful analysis of public and internal documents related to the SUP, and specialized books on project management. The objective of this method was to gain familiarization with the Program environment, identify best practices, and evaluate the Program's relevance, effectiveness and efficiency.

Internal data. Internal CSA data were used to evaluate the Program's effectiveness and efficiency, as well as to triangulate information and deepen the analysis. These data include financial data, human resources data and performance data, among others.

Literature review. A review of previous SUP evaluation reports, which comprised a wide breadth of SUP's activities, aided the evaluation team in their understanding of the Program.

Interviews with key informants. Semi-structured interviews were conducted to collect information on SUP's implementation and to expand on, corroborate and clarify the information obtained through other data sources. They contributed to documenting the planning process, facilitating factors, challenges encountered by stakeholders and efficiency considerations. A total of 76 individuals from different stakeholder groups were consulted through 55 individual and group interviews. More specifically, 33 interviews were conducted within the CSA among SUP teams[2], CSA senior management and representatives from other CSA directorates[3], and 22 interviews were conducted with external stakeholders from other federal departments[4] and universities[5].

Table 1. Number of interviews and respondents by category

Respondent categories		Respondents	Interviews
Internal	CSA senior management (including the Program)	10	10
	SUP and other CSA directorates employees	41	23
External	Other Government of Canada departments	19	16
	Academia	6	6
TOTAL		**76**	**55**

Observation. The evaluation team attended the 2nd edition of the National Forum on Earth Observation hosted by the CSA from October 4 to 6, 2022. They also attended a few meetings of the Space Utilization Steering Committee (SUSC) and the Space Utilization Management Committee (SUMC). The observation sessions helped provide an understanding of SUP's operations and corroborated the information collected through other data sources.

Consultations. An advisory group comprised of employees from both the Program and from across the CSA with a direct link to the Program was formed to give advice, feedback and guidance during the evaluation.

Comparative analysis. The evaluation considered how other organizations in charge of large-scale projects (including those outside of the space sector) carry out their strategic planning, in order to identify best practices and lessons learned. This analysis focused on two of CSA's partner space agencies (ESA and NASA) and on three large-scale Canadian projects, namely the National Shipbuilding Strategy, the construction of Canadian Forces Base Petawawa, and the construction of the Samuel-De-Champlain Bridge.

[2] 26 SUP employees were interviewed.

[3] 15 employees from the following directorates were interviewed: Space Exploration; Space Science and Technology; Programs and Integrated Planning; Policy; Finance; and Human Resources.

[4] Department of National Defence; Natural Resources Canada; Environment and Climate Change Canada; Fisheries and Oceans Canada; and Agriculture and Agri-Food Canada.

[5] University of Sherbrooke; University of Toronto; University of Waterloo; University of Saskatchewan; University of Calgary; and University of Alberta.

Limitations

Evaluation scope. The decision to evaluate the entire SUP in two separate but complementary evaluations was made with the intention of distributing efforts and more quickly responding to decision makers' information needs. It is prudent however to mention that not addressing the topic of data utilization as part of this evaluation does result in some limitations, since data utilization is the primary justification for the design and development of satellite missions, and because it is also an essential component of the SUP's expected outcomes.

Likewise, it is difficult to evaluate the planning, preparation and development of observation systems from April 2017 to March 2022 only, considering that the life cycle of satellite missions spans multiple years, if not decades. Indeed, some missions under review were planned and prepared well before the period covered by the evaluation (e.g. RCM) or will continue after this period (e.g. WildFireSat). It is therefore too early to evaluate the outcomes of certain practices and decisions.

To mitigate these limitations, the evaluation triangulated information using documents developed both before and after the evaluation period. Furthermore, it considered certain aspects of data utilization when directly relevant to the evaluation.

Financial data for fiscal year 2017-18. The financial data for fiscal year 2017-18 are difficult to compare with data from following years because of the different financial structure used by the CSA until April 1st, 2018. To mitigate this limitation and provide an indication of expenses and FTEs related to OSPPA in 2017-18, the evaluation and the Finance directorate attempted to align the amounts coded under the CSA's former Program Architecture with the CSA's current structure. It is important to note that there remains a potential margin of error.

Performance data for fiscal year 2017-18. The methodology employed to measure the performance of CSA programs for fiscal year 2017-18 is different from the methodology used to measure results from subsequent years. The CSA transitioned from Performance Measurement Strategies (PMS) to Performance Information Profiles (PIP) in 2019 in light of the Treasury Board's *Policy on Results* (2016). In 2017-18, the results of the SUP were essentially calculated in terms of areas of activity and subprograms under the CSA's former Program Architecture, whereas today's results are calculated per department and per service, making it nearly impossible to compare fiscal years, or the elements included and excluded from the evaluation.

Program Description

The Canadian Space Agency (CSA) includes three main programs defined in the Program Inventory: the Space Capacity Development Program, the Space Exploration Program, and the Space Utilization Program (SUP).

General Overview

Mandate and Objectives

Satellites play an essential role in the lives of Canadians, and the SUP ensures that Canada takes full advantage of the potential offered by space for the benefit of its citizens. It makes it possible for public, industrial and academic organizations within Canada to access space data, information and services in order to better understand Earth, inform policy and decision making, and connect Canada and Canadians.

The SUP supports organizations that have the potential to positively impact the lives of Canadians. Indeed, space-based solutions help the Government of Canada and the broader public sector in their service delivery to further key national priorities, such as national security and disaster management, to name a few. These solutions, provided in the areas of Satellite Communications, Satellite Navigation and Earth Observation, also enable the growth and competitiveness of the Canadian industry while producing jobs for highly qualified personnel and providing the scientific community with the necessary inputs required to perform research in areas related to the Sun-Earth System. While carrying out these activities, the SUP is also seeking to enhance Canada's international impact by improving coordination between federal departments in support of international forums (CSA, 2017a).

Implementation Approach

The SUP fulfills its mandate using two implementation approaches, i.e. transfer payments and programs/services for Canadians. The types of transfer payments used by the SUP are grants and contributions offered through the CSA's Class Grant and Contribution (G&C) Program[6], which supports the CSA's three main programs and was recently subject to its own evaluation, in March 2022. Programs/services for Canadians are defined by the Treasury Board of Canada Secretariat (TBS) as "The provision of public servant (i.e. non-military) and/or contracted (i.e. non-public servant) delivered programs or services directly to Canadians or organizations designed to influence behaviour or provide a statutory benefit." (TBS, 2016)

Business Lines and Domains of Activity

The CSA uses the concept of "business lines" to structure the various activities related to the space missions it carries out or takes part in. The SUP's business lines are Earth Observation (EO), Sun-Earth System Science

[6] The CSA's Class G&C Program aims to support knowledge development and innovation in the CSA's priority areas while increasing the awareness and participation of Canadians in space-related disciplines and activities (CSA, 2023a). Its funds are allocated through announcements of opportunity (AO) that may be related to more than one program and branch, and through unsolicited proposals. There is no lead authority for the Program, although the CSA's G&C Centre of Expertise falls under the responsibility of the Chief Financial Officer (CSA, 2022a). The CSA's branches are responsible for planning, developing, and evaluating AOs for their respective programs, and for issuing and managing agreements under the Class G&C Program (CSA, 2020a).

(SESS), and Satellite Communications (SatCom). They include different domains of activity supported by the SUP, such as EO, Space Situational Awareness (SSA)[7], Satellite Navigation (SatNav)[8], and SatCom.

Target Groups

The SUP's Performance Information Profile (PIP) establishes three main categories of target populations for the SUP: the public sector, the downstream industry, and the scientific community (CSA, 2017a).

Another internal document on the SUP's organizational structure since 2020 reveals more about the program's background, outlining three main stakeholder categories (CSA, 2020):

- Clients: Government of Canada user departments, Provinces and Territories, and Municipalities.
- Enablers: International partners, Government of Canada provider departments, CSA directorates, academia, and industry.
- Other stakeholders: International organizations and Government of Canada central agencies.

It must be noted that the term "client" here refers to the primary beneficiary of the information generated by the satellite systems, but it does not necessarily mean that the client is paying for the development of these systems. Furthermore, the SUP has geared almost all of its activities towards federal departments over the past few years, but some interview respondents indicated that there was also a willingness to align with other levels of government in the future, though there has yet to be any specific plans enacted to this effect. Lastly, the data collected demonstrate that there is currently no consensus within the program regarding which stakeholders currently are, or should be, referred to as target groups and beneficiaries, apart from federal departments (see "*Relevance*" and "*Efficiency*" sections).

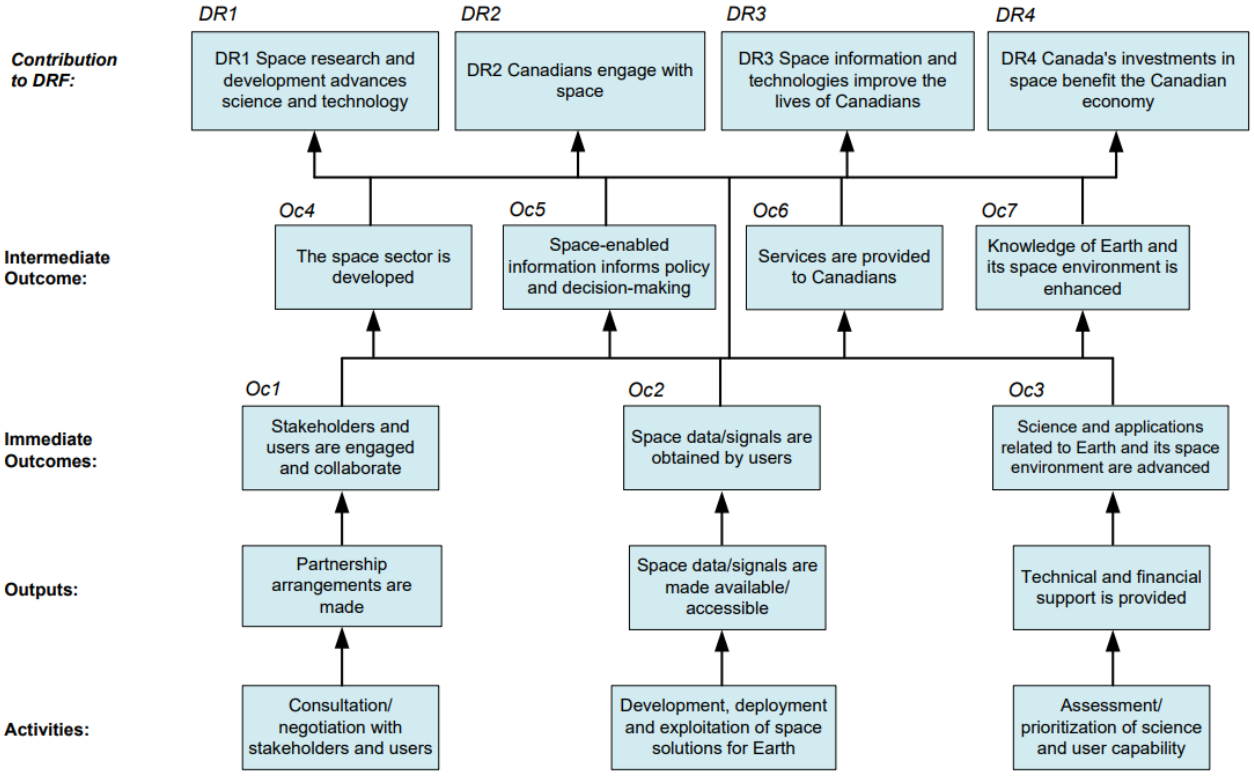
Program Logic

As set out in the PIP, the SUP's design is based on the assumption that the program's activities, i.e. partnerships, space missions, and support to users, will enable the program's target groups to use the space services and information provided (CSA, 2017a). Through the activities carried out and the outputs produced, the SUP expects to achieve a series of three immediate outcomes and four intermediate outcomes, which should ultimately allow the SUP to contribute to the CSA's final objectives, i.e. the *Departmental Results Framework* (DRF). The following figure presents the SUP's logic model that was in effect from December 2017 to March 2022, that is to say for almost the entire period covered by the evaluation. The logic model shows the causal links between the SUP activities, outputs and expected outcomes.

[7] SSA consists of three sub-domains: Space debris, Space weather, and Near-Earth objects.

[8] SatNav includes Global Navigation Satellite Systems (GNSS), of which the best known to Canadians is the Global Positioning System (GPS).

Figure 1. The SUP's Logic Model (2017-2022)



Source: SUP (CSA 2017a)

Activity #1 – Partnering (*consultation/negotiation with stakeholders and users*): This activity involves the engagement and collaboration with Canadian and international Program and stakeholders in order to:

1. Identify space solutions to meet needs on Earth;
2. Define, design and develop space missions;
3. Take part in missions led by other entities (e.g. NASA and ESA);
4. Access data (e.g. satellite scenes) and signals from missions that CSA is not involved in, but that benefit Canada;
5. Engage resources, including infrastructure to generate intermediate outcomes with these data and signals.

Activity #2 – Space missions (*development, deployment and exploitation of space solutions for Earth*): This activity includes the planning and implementation of satellite missions (or organized access to missions), in order to give users reliable access to space data and signals.

Activity #3 – Support to users (*assessment/prioritization of science and user capability*): This activity includes the support provided by the Program to users of space data and signals, to advance their capabilities to transform Earth observation data and space signals into final products. It is directly related to data utilization and application development.

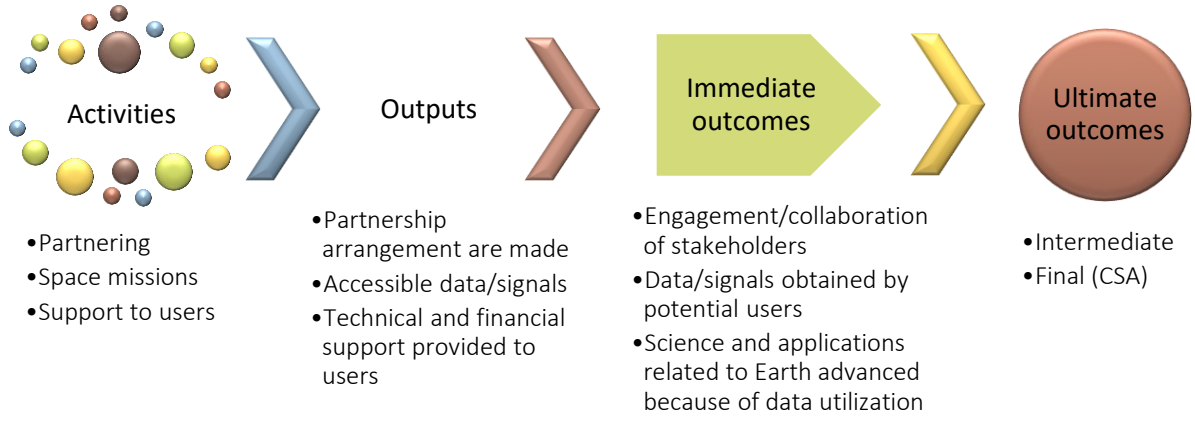
Theory of Change

The partnerships and collaborations with stakeholders created at different levels enable the development, deployment and operation of space-based solutions for Earth, both as a part of CSA space missions and through missions led by other entities to which the CSA contributes. As a result, operational space missions make it possible for data/signals to be accessible to potential users. Clients may then request access to the data/signals they need in furtherance of their mandates. The technical and financial support provided to users increases the amount of available data/signals for use in applications on Earth or to improve Earth and environmental sciences.

Through the activities achieved and outputs produced by the SUP, the users of data and signals can now further science and applications with respect to the Earth and its environment, which then allows the SUP to produce a series of intermediate outcomes that contribute to the CSA's ultimate objectives. It is important to note that the SUP does not use the data/signals it contributes to producing, making accessible and supplying because these data/signals are intended for use by other organizations that provide services and programs to Canadians. In summary, the SUP supports the mandates of other entities that have the potential to positively impact the lives of Canadians.

Therefore, the use of data by external stakeholders is the cornerstone of the SUP's expected outcomes, and it explains why the SUP's mandate is intimately tied to the mandates of other organizations, especially those of other federal departments.

Figure 2. SUP Theory of Change (2017-2022)



Governance, Roles and Responsibilities

Several stakeholders and committees are responsible for the governance of activities related to OSPPA.

Program senior management: The Director General of the program assumes overall responsibility for activities carried out under the SUP. The Director General's duties are carried out in accordance with the applicable Treasury Board of Canada policies and the CSA's *Investment Governance and Monitoring Framework* (IGMF). Internal committees on space utilization (SUSC and SUMC) are both chaired by the

Director General. The latter is supported by three directors who are responsible for the activities carried out within their respective branches.

- *Space Exploitation*: Responsible for satellite operations and operational missions, such as the RADARSAT Constellation Mission (RCM) and the mission that will follow it. Also typically responsible for mission management starting from IGMF Gate #2.
- *Sun-Earth System Science*: Responsible for scientific missions, designing and directing the development of new scientific missions, and co-funding (which is also discussed in the two other branches).
- *Planning, Engagement and Applications*: Relatively new branch that underwent a few changes over the evaluation period. Responsible for the SUP development, including strategic planning, performance measurement and partnership engagement.

Space Utilization Management Committee (SUMC): Responsible for the day-to-day management of the SUP, including human and financial resources for the SUP activities. Directors are responsible for applying measures resulting from decisions made by the SUMC chair in relation to their respective branches, and managers are responsible for directing their employees in the execution of those activities.

Space Utilization Steering Committee (SUSC): Establishes strategic direction and formulates directives regarding the SUP investments. The SUSC chair makes decisions related to investments after consideration of member recommendations (CSA, 2019a), for instance relating to the IGMF and comments from external partners (e.g. federal departments and scientific advisory committees), following consultations on needs for space data/signals.

Integrated Investment Review Board (IIRB): Central decision-making body of the CSA responsible for the proper management of investments, including the SUP's investments, to ensure their financial viability and that they produce the expected outcomes. It also works to coordinate and optimize CSA resources. It has decision-making authority regarding the approval and advancement of most SUP missions.

Interdepartmental governance committees: The CSA space missions carried out under its financial and project authorities are usually only subject to internal governance bodies (CSA, 2020b). However, depending on the type of investment, the complexity and the project risk, external governance committees may be solicited, such as the Deputy Minister Governance Committee for Space and the Director General Space Committee. RCM is an example of a Major Crown Project that required the decision making and oversight of interdepartmental governance committees (CSA, 2020b).

Federal and international stakeholders: Certain federal departments involved in space missions may have decisional authority on the furthering or discontinuing of space missions. Furthermore, when Canada takes part in satellite missions designed and developed by foreign agencies, they are the main authorities for those missions. As such, they decide the conditions and requirements to the missions (e.g. schedule, project continuity or stoppage).

Program Resources

Financial Resources

The funding attributed to OSPPA* amount to approximately $308M for the evaluation period (2017-22). From 2018 to 2022, CSA funding allocated to the SUP amount to approximately $218.7M. These include amounts spent on management, operations and maintenance (O&M), salaries, contracts, and contributions.

Table 2. Summary of Financial Expenditures by Type and Fiscal Year, 2018 to 2022

Activities	Type of expenditure	2018-19	2019-20	2020-21	2021-22	$ TOTAL
SUP management (BLM02.1)	Salaries	$2,153,162	$2,553,244	$2,401,163	$3,677,122	$13,065,522*
	O&M	$662,344	$642,020	$364,008	$534,281	
	Capital	$0	$0	$78,178	$0	
	Grants	$0	$0	$0	$0	
	Contributions	$0	$0	$0	$0	
Planning and preparatory activities (BLM02.2)	Salaries	$1,487,095	$1,354,675	$1,950,723	$2,556,220	$19,474,899
	O&M	$1,161,406	$1,361,993	$4,487,031	$4,615,757	
	Capital	$499,999	$0	$0	$0	
	Grants	$0	$0	$0	$0	
	Contributions	$0	$0	$0	$0	
Observation systems (BLM02.3)	Salaries	$6,098,575	$5,675,912	$5,179,950	$4,898,349	$186,233,246
	O&M	$11,641,991	$10,337,622	$10,489,198	$22,311,242	
	Capital	$33,377,815	$47,079,653	$18,844,260	$5,730,295	
	Grants	$0	$0	$0	$0	
	Contributions	$1,103,864	$1,223,773	$1,016,913	$1,223,834	
TOTAL $		$58,186,251	$70,228,892	$44,811,424	$45,547,100	**$218,773,667**

Data source: CSA Finance Directorate.

**The data available for program management represent all of the coded data under BLM02.1.*

The funding for 2017-18 are difficult to compare to the rest of the financial data because of the different financial structure that was used by the CSA until April 1st, 2018. The evaluation and the Finance Directorate aligned, to the extent possible, the amounts coded under the former Program Architecture with the current structure, in order to provide an indication of the funding related to OSPPA activities prior to April 1, 2018. These data indicate that the sums allocated amount to $89.1M. However, it must be noted that a slight margin of error remains possible.

Table 3. Financial Expenses Related to OSPPA for Fiscal Year 2017-18

Activities	Type of expenditure	2017-18	$ TOTAL
SUP activities related to OSPPA under the CSA's former Program Architecture (≈BLM02.1, BLM02.2 and BLM02.3)	Salaries	$9,964,390	**$89,098,960**
	O&M	$12,001,870	
	Capital	$65,588,626	
	Grants	$300,160	
	Contributions	$1,243,914	

Data source: CSA Finance Directorate.

Over the course of the evaluation period, almost all of the SUP's funding was allocated to Earth observation (EO) activities, followed by space situational awareness (SSA) and satellite communications (SatCom) activities as a distant second and third. The SUP expenses between 2017 and 2020 were mostly dedicated to preparing for the launch of RCM in June 2019 and its commissioning in the months that followed. An increase in EO funding is expected over the coming years because of the government's increased need for satellite EO, and specifically expenses related to the mission to extend RCM's lifespan and ultimately replace it.

Human Resources

The SUP staff includes mission managers, project managers, engineers, analysts, and administrative support officers. On average, 86 full-time equivalents (FTE) were assigned to OSPPA each year between 2017 and 2022. Furthermore, the FTEs assigned to OSPPA represent nearly all of the SUP's FTEs for the evaluation period, i.e. 91.3%. In 2017-2018, in anticipation of the launch of RCM, the SUP assigned 99.4% of its human resources to OSPPA.

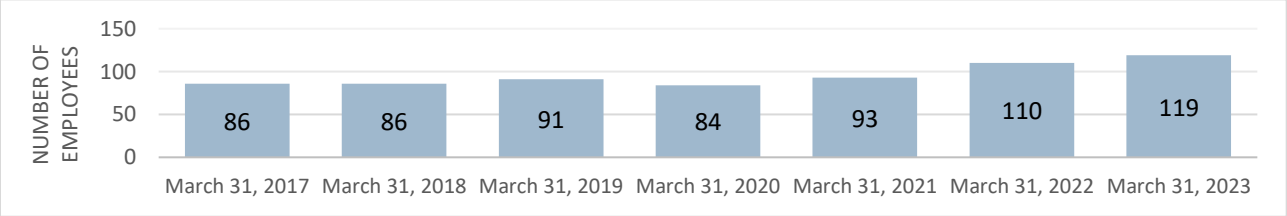
Table 4. Number of Actual Full-Time Equivalents (FTE) per Fiscal Year (2017-2022)

Activities	2017-18	2018-19	2019-20	2020-21	2021-22	TOTAL	
SUP management	90.86	19.27	23.99	20.77	35.94	≥ *99.97*	
Planning and preparatory activities		13.06	12.21	17.82	21.7	≥ *64.79*	
Observation systems		46.81	44.09	43.17	41.2	≥ *175.27*	
OSPPA TOTAL	90.86	79.14	80.29	81.76	98.84	**430.93**	**91.26%**
SUP TOTAL	91.42	90.34	89.59	91.52	109.28	**472.15**	

Data source: CSA Finance Directorate.

The data provided by CSA's human resources directorate indicate that an annual average of 92 employees worked within the SUP between April 2017 and March 2022. The number of employees remained relatively stable between 2017 and 2020, with a marked increase in 2021.

Figure 3. Evolution of the Total Number of SUP Employees by Fiscal Year (2017-2023)



Data source: CSA Human Resources Directorate.

The majority of the SUP's employees are concentrated within the Space Exploitation branch, closely followed by the Sun-Earth System Science branch. The number of personnel dedicated to the "new" Planning, Engagement and Applications branch has fluctuated over the years, but has remained considerably lower than those of the other SUP branches.

Relevance

Overall finding. The objectives and activities of the SUP are aligned with the federal government's priorities and core responsibilities. The SUP is a pillar of the CSA, and enables it to support Canada's space aspirations, inter alia by making it possible to provide services to Canadians by contributing to economic growth, facilitating scientific research and strengthening national and international partnerships. It is also of strategic importance to many other federal departments in achieving their respective mandates. The SUP effectively identified the needs of its target groups, and the missions it supported or designed met most of the needs identified. The federal government's EO needs are numerous and increasing, in particular for synthetic aperture radar (SAR) data, and the SUP meets these needs within the limits of its human and financial resource capacity. Canadian satellites provide considerable benefits to Canada, which justify the significant resources allocated to their design, development, and operation.

Alignment between Program Objectives and Government Priorities

The Program aims to make sure that Canada takes full advantage of the potential offered by space for the benefit of its citizens, by ensuring that the Canadian public sector, private sector and academia have access to space data, as well as space-enabled information and services, to inform policy and decision making, connect Canada and Canadians, and understand Earth (CSA, 2017a). More specifically, the SUP aims to provide space-based solutions in order to:

- Assist the Government of Canada and broader public sector to provide services under their respective mandates with respect to national priorities;
- Enable the growth and competitiveness of Canadian industry (e.g. highly skilled jobs);
- Provide the scientific community with the necessary input required to perform research in areas related to the Sun-Earth System;
- Increase Canada's international influence (CSA, 2017a).

Alignment with Federal Priorities

The SUP's objectives are aligned with federal government's priorities. First, the SUP's objectives are aligned with *Canada's Space Policy Framework* (2014), in which the government set out the five following priorities: 1) ensure Canada's national sovereignty, security and prosperity through the effective utilization of space (e.g. satellite surveillance); 2) support the Canadian space industry; 3) maintain and strengthen partnerships; 4) support and advance Canadian expertise in selected technology niches (e.g. telecommunications); and 5) inspire youth (GC, 2014).

In 2019, the government introduced the *Space Strategy for Canada*, in which it reiterated its desire to maintain Canada's status as a spacefaring nation, by employing space utilization to provide space-based solutions to Canadians' problems, the creation of a dynamic and sustainable space sector and the strengthening of industry partnerships (CSA, 2019b). The program objectives are therefore aligned with certain key priorities set out in the Strategy, such as harnessing space to solve everyday challenges for Canadians; positioning Canada's commercial space sector to help grow the economy and create the jobs of the future; and ensuring

Canada's leadership in acquiring and using space-based data to support science excellence, innovation and economic growth (CSA, 2019b). Furthermore, in Budget 2021, the government stated that it wanted to continue supporting Canadian capabilities, innovation and jobs in the EO satellite domain, since they provide critical services that Canadians rely on and create high-quality jobs in Canada (GC, 2021).

The SUP is also aligned with other federal innovation and development priorities, such as the *Innovation and Skills Plan* and the United Nations' sustainable development objectives, which Canada reiterated its commitment to in 2021. Finally, Gender-Based Analysis Plus (GBA Plus)[9] is integrated into the Program's decision-making process, in accordance with federal priorities regarding equity, diversity and inclusion. For instance, the WildFireSat mission, which is currently in development, is intended to monitor wildfires in Canada, and will benefit all Canadians, but will yield specific benefits to Canadians living in remote wooded areas and Canadians facing health issues such a respiratory illness. Furthermore, in terms of values and ethics, a "trust room" which was accessible both in-person and remotely was created as part of the WildFireSat mission, in order to integrate all stakeholders and create a solutions-focused climate of respect and openness. This practice has been positively noted by a number of partners, including internationally, thereby contributing to strengthening partnerships and increasing Canada's influence on the international scene.

Alignment with CSA Strategic Objectives

The SUP's objectives are directly aligned with both overall federal government priorities and CSA priorities, the latter being outlined in the departmental plans and the *Departmental Results Framework* (DRF). The DRF in effect at the time of the evaluation comprised the following tenets: Space research and development (R&D) activities in the space sector advances science and technology; Canadians engage with space; space information and technologies improve the lives of Canadians; and Canada's investments in space benefit the Canadian economy. The SUP orients its activities to respond to the CSA's departmental objectives, developing the Canadian space sector, providing space-based information to facilitate decision making, providing services to Canadians, and increasing scientific knowledge about the Earth and its environment. Canadian satellites are also an important means for the CSA to deliver on its commitments, such as ensuring Canada's continued significant involvement in *The International Charter "Space and Major Disasters"*, signed by the CSA in 2000, which provides rescue teams with satellite images of disaster areas. A concrete example of this was when RCM contributed to the efforts related to the flooding in Nepal in July 2020.

In accordance with federal priorities, the CSA also attaches great importance to the principles of equity, diversity and inclusion. In 2020, it committed to furthering those principles by signing the *Dimensions Charter*, and it developed a *Policy on GBA Plus* in 2017 to ensure that "Canadian values and government commitments on progress toward gender equality be reflected in the development and implementation of policies and programs at the CSA" (CSA, 2017b). Therefore, the CSA committed to integrating GBA Plus into its decision-making processes and requires that any initiatives, both new and requiring renewed approval, are subject to

[9] GBA Plus is an intersectional analytical process that consists of identifying the potential impacts (positive and negative) of government activities on various groups of men, women and non-binary people who make up the Canadian population, and then taking appropriate corrective or mitigation measures, where necessary. The "Plus" signifies that the analysis is not limited to sex and gender, but also considers other identity factors (e.g. age, language, place of residence). Despite some similarities between GBA Plus and employment equity, they must not be confused (CSA, 2021).

GBA Plus. The analysis can be conducted at any point in the life cycle of initiatives, but it is especially useful during the design phase because it helps guide the scope of the initiative, its objectives, implementation, target groups and stakeholders. The IGMF requires that a GBA Plus be conducted during the planning and preparation phase of each mission, before Gate #2 when the CSA decides to officially engage in a mission. In other words, GBA Plus is one of the deliverables required to pass Gate #2, regardless of the level of investment.

However, it remains difficult to determine whether GBA Plus was systematically carried out for each mission that reached IGMF Gate #2. The evaluation was able to find a GBA Plus for most missions under evaluation after having reached a sufficiently advanced stage of development, i.e. RADARSAT-2, RCM, SWOT and WildFireSat. That said, it must be pointed out that some missions under evaluation were planned before the CSA's adoption of its policy on GBA Plus in 2017. Regarding future needs, the evaluation noted that a GBA Plus had already been completed for the mission to succeed the RCM, and the SUP reiterated its commitment to this policy in the second edition of its PIP (March 2022). The evaluation has not found any negative repercussions caused by the SUP's proposals. On the contrary, they have the potential to result in positive outcomes for various groups, as previously shown by the WildFireSat mission. The evaluation also found that the considerations related to GBA Plus were integrated into other SUP activities, such as the second EO forum in 2022[10], which was attended by more than 100 people in person and by another 200 remote attendees from across Canada. The team responsible for stakeholder relations reached a historic CSA milestone during this event, inviting the Mohawk Chief of Kahnawake to open the Forum and participate in discussions.

Alignment with Core Federal Responsibilities

The SUP's objectives are aligned with the federal government and the CSA's essential responsibilities as set out in the *Canadian Space Agency Act*. The act establishing the CSA states that its mission is "to promote the peaceful use and development of space, to advance the knowledge of space through science, and to ensure that space science and technology provide social and economic benefits for Canadians" (s. 4). The SUP's objectives and activities are directly aligned with the CSA's mandate and the core functions related to it. The SUP is a pillar of the CSA, without which the CSA would not be able to fulfill its mandate. Furthermore, it is of strategic importance to many other federal departments in achieving their respective mandates.

Needs of Target Groups

Identifying User Needs

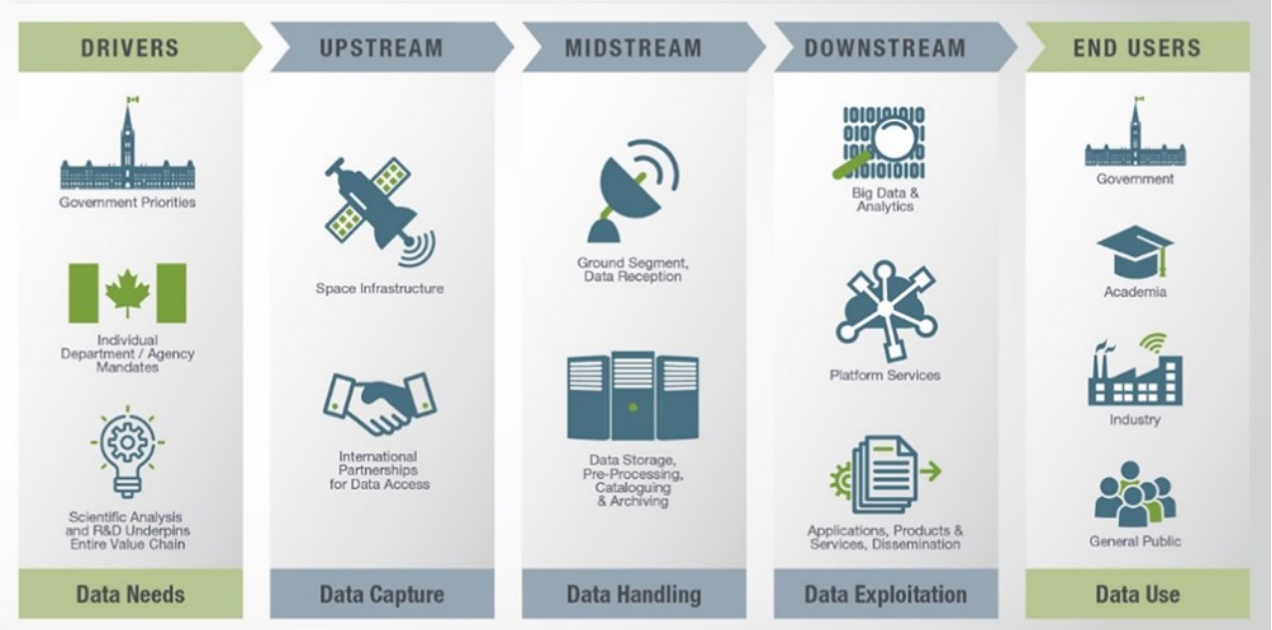
Needs identification is mainly carried out through consultations with target groups, i.e. the public sector (especially federal departments), academia and industry. The consultations are intended to meet differing needs and they take various forms: ad-hoc consultations for the needs of a specific mission, working groups, interdepartmental and international committees, specific discussions during national forums, or even for the

[10] The second forum on EO (2022) gathered stakeholders from government, industry, academia and Indigenous communities. It aimed to inform stakeholders of what had been accomplished since the first forum in 2018; solicit opinions and obtain guidance from the community on the proposed consultation mechanisms; provide an update on current initiatives and accomplishments by those in the EO field in order to include that information in the next planning phases; and relaunched networking between various EO communities in Canada.

implementation of strategic documents. Thanks to these consultation mechanisms, the SUP was able to successfully identify target populations needs and have these needs reflected in its activities.

With respect to strategic planning, the program engaged in several efforts to identify the needs of target groups either to plan for future missions or to ensure the continued relevance of the systems currently in orbit. Of particular note, it organized the first National Forum on EO in November 2018 and led a series of consultations with various stakeholders from the public sector, industry and academia, which led to the development of the *Engagement paper: Space-Based EO* in June 2020, and the *Canada's Strategy for Satellite EO* in March 2022. The internal and external stakeholders interviewed on the subject stated that the Strategy was a significant step forward in identifying future EO needs in Canada, especially given that it provides the basis for a pan-governmental approach to using satellite EO data. Some external key informants pointed out the critical role that the SUP plays in this process, as well as noting the efforts it makes to successfully carry out this major consultation and coordination exercise.

Figure 4. Satellite Earth Observation (EO) Value Chain in Canada (CSA, 2020c)



> "It's during Phase 0 or pre-Phase 0 that we identify needs, define the needs of users and missions. There may be changes to the needs or technical requirements later on in the process, but usually the concept studies are carried out with partners."
>
> - Internal key informant (interview)

In the specific context of missions, needs are mainly identified during the planning and preparation phase of satellite missions, in accordance with the CSA's governance process under the IGMF. Among other things, mission managers must develop a business case and a GBA Plus for every mission in which the SUP is considering investing. Collaboration with stakeholders takes place at different stages of the value chain to identify needs and adapt missions as needed.

Meeting User Needs

The evaluation found that the missions designed or supported by the SUP in the last five years meet demonstrable needs in Canada's economic, scientific and social spheres. The program dedicated almost all of its efforts and resources to meet the EO needs of federal departments, since they are the biggest EO data users, and because EO was the most important domain with regards to the SUP's mandate. That said, the SUP's domains of activity aim to meet the needs identified across all relevant stakeholder categories. These three aforementioned categories of stakeholders (public sector, private sector and academia) create a mutually reinforcing ecosystem in which each contributes to providing for, and supporting, the other two.

EO has asserted its place as one of CSA's most important spheres of activity since the launch of the RADARSAT-1 mission in 1995, and this importance continued with RADARSAT-2, which was launched in 2007 and remains operational, exceeding its initial operational end date of 2015. In June 2019, the SUP enabled the CSA and Canada to make history by launching Canada's first satellite constellation mission, and the first mission owned and operated exclusively by Canada: the RADARSAT Constellation Mission (RCM). In 2017, the evaluation of the CSA's EO business line stated that the change from a privately owned satellite (RADARSAT-2) to a government-owned satellite (RCM) would help the CSA to more effectively meet the needs of government departments and organizations (CSA, 2017c). EO satellites make it possible to obtain data on oceans, ice, land masses and the atmosphere, and they are useful for monitoring, protecting and understanding the Earth, while helping in the management of resources and ensuring the safety of Canadians (CSA, 2023b). The currently active Canadian EO satellites are RCM, RADARSAT-2 and SCISAT, and Canada is contributing to international satellite missions such as SWOT. Furthermore, Canada's WildFireSat and HAWC missions (13 universities are involved) are currently being developed. Lastly, the Arctic Observing Mission (AOM) and the mission that is going to replace RCM are currently being prepared.

At the height of the **RADARSAT Constellation Mission (RCM)** project's development, almost all of the SUP's resources were assigned to the mission, and approximately 300 people were working on its construction in more than 50 Canadian companies. 125 suppliers in 7 provinces played a role in the project (CSA, 2019c). The main purpose of RCM's data is to support the services and needs of the federal government, but external stakeholders can also access most of the data, subject to certain national security restrictions.

Third RCM satellite about to be placed in a thermal vacuum chamber at the CSA's David Florida Laboratory on September 17, 2017. Source: CSA, John A. Brebner (CSA 2023c).

The RCM is the SUP's biggest investment to date and one of the CSA's most significant investments ever made. It was designed and launched first and foremost for Government of Canada users, even though it also helps meet the needs of the scientific community for space-based information and contributes to the prosperity of the space sector. RCM was designed to ensure the continuity, growth and improvement of the capacity to use synthetic aperture radar (SAR) technology of the RADARSAT© missions, as well as to strengthen national sovereignty, ensure safety, protection and essential services to Canadians, and support the Canadian space sector. In order to meet these needs, RCM consists of three satellites which ensures better surveillance of Canada and the Arctic, and it is equipped with two payloads, a powerful SAR and an automatic

identification system that is used for ship detection. The mission that is going to replace RCM is being prepared with an eye to the current and future user needs.

In 2022, a report by the Office of the Auditor General of Canada titled *Arctic Waters Surveillance*, covering the period from April 1, 2021, to March 31, 2022, highlighted the importance of SAR satellites for Canada, along with their current limitations and related risks:

> "I am preoccupied by the replacement of RCM and its lifespan."
>
> - Internal key informant (consultation)

> "*Maritime surveillance in the Canadian Arctic relies largely on satellites that provide radar imagery and relay Automatic Identification System signals. […] For maritime surveillance, the federal government relies primarily on the Canadian RADARSAT-2 and RADARSAT Constellation Mission satellites. […] The RADARSAT Constellation Mission satellites, already used at full capacity, cannot accommodate all the demands of federal organizations for radar imagery of Canada's territory. Every time a priority request is made, the imagery acquisition plan must be reviewed to determine which other needs will be delayed or not met. We also found that these radar imagery satellites are at or will reach the end of their expected service lives long before the planned launch dates of the replacement satellites. […] The government acknowledges that it will take another decade for the Canadian Space Agency to launch a successor to the RADARSAT Constellation Mission and that an interruption of satellite earth-observation services past 2026 is therefore a significant risk. Budget 2021 allocated $9.9 million over 2 years to the agency to plan the next generation of earth-observation satellites. At the time of our audit, the agency was developing options to replace the constellation's capabilities and to fill gaps in earth-observation services that could emerge after 2026. […] Should the RADARSAT-2 or the RADARSAT Constellation Mission cease functioning or suffer performance limitations before new satellites become operational or other sources of satellite data are secured, National Defence and other federal organizations could be left with limited Canadian surveillance capabilities in the Arctic for years. This could significantly degrade Canada's ability to detect and track vessels in its Arctic waters and would likely increase Canada's reliance on its allies for surveillance information."* (OAG, 2022)

The evaluation found that the federal government's EO data needs are numerous and constantly growing, and that the SUP is attempting to meet these needs, to the extent possible, within its human and financial capacity limitations. Target populations needs are well identified, documented and have been developed to the extent possible. That said, some non-CSA federal government representatives questioned the SUP's role and objectives, particularly because RCM plays such an essential role in national defence and its use is therefore not solely civilian in nature (see "*Effectiveness*" and "*Efficiency*" *sections*).

> "We know the needs. The departments are clear. Regarding the chain, users do not pay for data. They want the data, they need it, they are dependent on it, but they are not the ones who pay for it."
>
> - Internal key informant (interview)

> "It takes time from the moment when a decision is made to when it can be implemented. Four months for approvals. And the time needed to coordinate with other government departments creates an additional challenge."
>
> - Internal key informant (consultation)

In addition to EO, the SUP's activities cover scientific satellite missions that are used in physics studies as well as in studying the effects of various phenomena, such as the impact of solar flares on the Earth's magnetic field (CSA 2023d). In the last few years, for example, the SUP has allocated resources to the operation of Canada's NEOSSAT satellite.

Finally, the SUP's activities also encompass satellite communications (SatCom), which enables the development of applications such as internet, television and telephone services. This field has become almost

entirely commercialized, and CSA funding allocated to SatCom activities has significantly reduced over the past few years, now representing only a marginal portion of OSPPA activities. During the period covered by the evaluation, the SUP has nevertheless continued to oversee certain SatCom missions based on meeting the data requirements of user organizations, such as the Department of National Defence's data requirements.

Future Needs

The federal government respondents who were interviewed for the evaluation regard the CSA and the SUP as the foundation of Canada's space-based satellite data projects. The respondents from academia also regard the CSA as an essential player which provides both direct research and development (R&D) opportunities and coordinates observation system R&D projects by bringing together stakeholders from government, academia, and industry. The academic stakeholders who were interviewed stated that they hoped the CSA would provide more funding opportunities to increase involvement in future scientific missions. The evaluation also found a somewhat unexpected success story, that of the SCISAT mission, in operation since 2003, it is a surprise not only because of its unexpectedly long lifespan, but also because of the fact that it made it possible to maintain atmospheric science capacity in certain Canadian universities. In the coming years, most of the other government departments interviewed planned to place a great deal of emphasis on EO missions, including on AOM and the successor mission to RCM, as well as an increased need for SAR data. Lastly, other government departments expressed the desire for the CSA to become more involved following the launch of satellites, since the CSA is considered Canada's centre of expertise in space and observation systems by the respondents. These other federal government departments appreciate the CSA's expertise in space-based systems engineering and its leadership in coordinating interdepartmental efforts and would like its involvement to continue or even grow as needs arise.

Effectiveness

Overall finding. Most of the data on the SUP's performance was available, reliable and useful for the purposes of the evaluation. Over the last five years, the program has produced the expected outputs for OSPPA, which means it established partnership agreements and made the space data and signals available. Furthermore, it generally achieved the expected outcomes since stakeholders and users effectively collaborated, and most clients obtained the space data and signals they required. The output and outcome targets under evaluation were generally achieved and exceeded. The number of agreements signed by the SUP has fluctuated over the years, but the number of images obtained from the SAR satellites has significantly increased from 2019 to 2022 thanks to the launch and commissioning of RCM, as well as the efforts made to maximize the availability of the scenes collected. However, RCM data accessibility has proven to be more complicated than expected, due to the high volume of acquisition requests and the sensitivity of certain images captured.

Performance Information

In accordance with the requirements of the *Directive on Results* (2016), the evaluation found that the majority of SUP performance data was available, reliable and useful for evaluation purposes. A transition was made from the Performance Measurement Strategies (PMS) to the Performance Information Profile (PIP) in 2019, making it nearly impossible to compare performance data from 2017-18 with data from subsequent years, both between fiscal years and among elements included and excluded from the evaluation. The SUP results for fiscal year 2017-18 were calculated in terms of business lines and subprograms under the CSA's former Program Architecture, whereas results are now calculated by department and by service. Moreover, data on outputs are easily accessible, but incomplete, since there is no comparable for fiscal year 2017-18, and because reporting to central agencies regarding outputs was not a part of the CSA's PIP requirements for the 2017-2022 period. During this period, the SUP nevertheless undertook internal reporting on its outputs for its long PIP, in order to better report on its activities and results. However, considering that this data was collected on a voluntary basis, not all results were measured each year.

Moreover, the accuracy of the performance information for immediate outcome #2 (*Space data/signals are obtained by users*) is only partially validated because two different methods are used by the SUP to report on the official indicator (*Number of scenes*[11]*acquired from the CSA SAR satellites*). The CSA had two operational SAR satellite missions at the time of the evaluation, i.e. RADARSAT-2 and RCM. These satellites were the result of a collaboration between the federal government and industry, particularly prime contractor MacDonald, Dettwiler and Associates Ltd. (MDA). These systems have different characteristics in terms of both their engineering and property right specifications, which has a slight impact on the indicator's definition and on how the SUP can report on the indicator, which was originally created for RADARSAT-2. MDA operates and holds ownership of RADARSAT-2. The SUP's immediate outcome #2 is therefore measured based on the SAR

[11] For the purposes of this evaluation, "images" and "scenes" are used interchangeably, despite there being a technical engineering distinction between the two.

scenes obtained from MDA, which is also made possible by the fact that RADARSAT-2 always has the same imaging parameters.

RCM, on the other hand, is owned by the federal government and is operated by the CSA. Furthermore, RCM's imaging parameters change according to the client's acquisition requests (height, definition, etc.), making it difficult to perform calculations based on the number of scenes obtained. For RCM, the SUP therefore measures this indicator based on acquisition requests and not on scenes obtained. This methodology did not restrict the SUP's ability to report on the indicator and outcome #2 for RCM, but it is worth noting that TBS had already stated that in order to effectively monitor the progress of a program, indicators should be valid, i.e. measure what they intend to measure (TBS 2010). As a result of several factors, including the fact that this indicator is linked to the SUP's DRF contribution, which will be subject to an upcoming review, the fact that the indicator is verging on data utilization and thus outside the scope of the evaluation, and that the OSPPA evaluation period happens to end just as SUP's new PIP and logic model come into force (March 31, 2022), it was deemed more appropriate to examine any potential changes to said indicator within the upcoming evaluation on data utilization and applications development. A key SUP informant also said that this methodology would be the subject of a forthcoming review in 2024, in collaboration with the CSA Governance and Performance (G&P) team, which is responsible for ensuring performance measurement coordination across CSA programs.

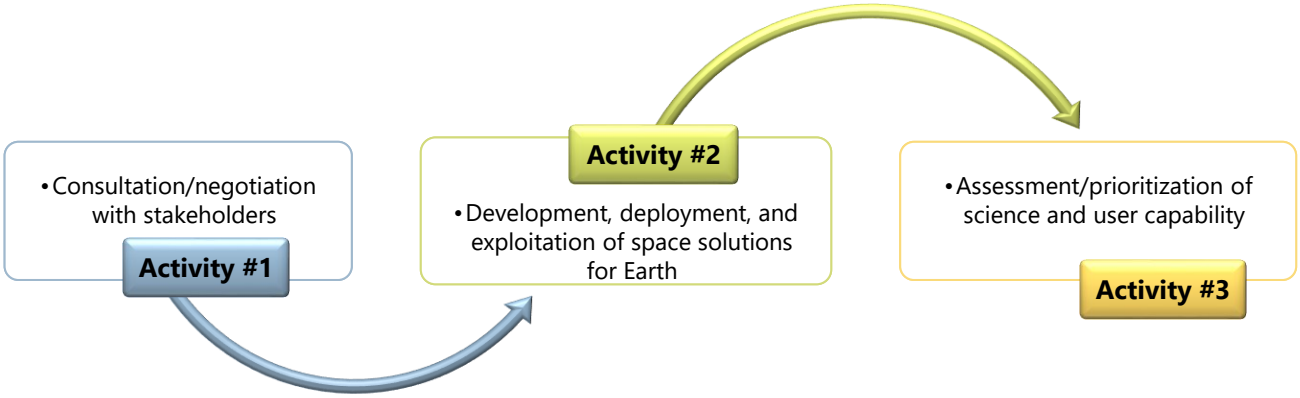
Similarly, the evaluation found that intermediate outcome #5 of the logic model (*Space-enabled information informs policy and decision-making*) was not officially measured from 2017 to 2022, because this outcome was not linked to any indicators and targets in the SUP's short PIP. Performance information for this outcome is available because the SUP measured it as part of its long PIP. However, a key informant indicated that the situation had been corrected in the second edition of the PIP.

Ultimately, the evaluation found that performance information was sufficiently available, reliable and useful to assess the SUP's effectiveness in achieving the OSPPA's intended outcomes. The evaluation also makes note of efforts made by the SUP and the CSA G&P team to ensure that the program's performance measurement is being continuously improved, which has resulted in significant accomplishments in the second edition of the PIP.

Program Activities

During the period covered by the evaluation, the Program carried out its activities in accordance with its PIP and logic model. Throughout the entire observation systems value chain, the SUP conducted a series of consultations with stakeholders and clients in order to identify their needs. It ensured partner engagement in order to define, design and develop satellite missions; that the resources needed to carry out these missions were allocated; and ensured that stakeholders had access to the satellite data and signals that they needed, through Canadian or foreign partner missions (Activity #1). By doing so, the SUP has also developed, deployed and exploited space solutions for Earth by planning and executing satellite missions (or organizing access to the missions) in order to provide clients with reliable space data and signals access (Activity #2). The SUP assessed and prioritized science and user capacity (Activity #3) in order to improve their ability to transform data and signals into products/applications. The figure below illustrates the logical connection between the three program activities identified in its PIP and its logic model (2017-2022).

Figure 5. Value Chain for Observation Systems based on Program Activities



Outputs and Outcomes Achieved

The SUP's mandate involves providing space data and signals to potential users. To fulfill this mandate, they must be involved in the SUP's various activities, such as needs definition. Indeed, developing and maintaining partnerships with the public, academic and private sectors is an essential part of the SUP's activities, whose role is to make sure that Canada takes full advantage of the potential offered by space for the benefit of its citizens. As previously mentioned, the SUP carried out a series of consultation and coordination activities with various stakeholders and users from the public, academic and private sectors over the past five years. These activities have led to a series of space mission partnership agreements that have been developed or supported. The SUP's leadership in coordinating efforts between national and international players was highlighted by nearly all internal and external respondents interviewed for the evaluation.

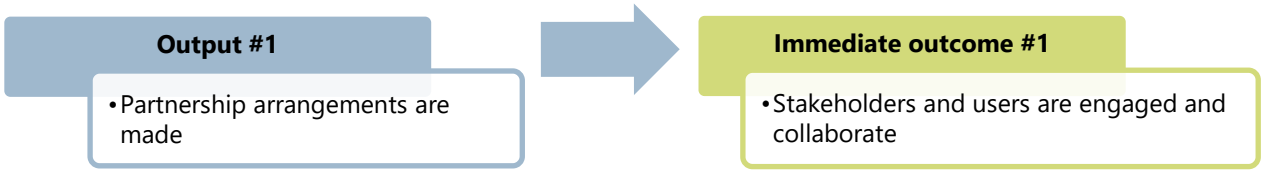
According to the SUP's internal data, it established **1,247 partnership arrangements[12] with stakeholders** between 2018 and 2022 for all of its activities, i.e. 438 partnerships in 2018-19, 436 partnerships in 2019-20, and 203 partnerships in 2020-21. The results stem from grant and contribution partnerships made by the SUP, as well as contracts established starting in 2019. It should be noted that several partnerships can be established with the same partner. The number of agreements established is based on the number of partnerships listed in the CSA's UNITAS system, whose data are collected annually through the Performance Indicators Survey for all CSA programs. As expanded upon in the section on SUP resources, no funds were disbursed in the form of grants between April 2018 and March 2022, but $4,568,384 million in contributions were allocated for "Observation Systems" during that same timeframe. $300,160 in grants and $1,243,914 in contributions were also allocated in 2017-18.

For contracts specifically, the SUP established 11 partnerships with 12 different unique companies or universities in 2019-20, 27 partnerships with 30 different unique companies or universities in 2020-21, and 34 partnerships with 38 different unique companies or universities in 2021-22. It should be noted that the increase over the years is due to the inclusion of more types of contracts in the Performance Indicator Survey

[12] It should be noted that "partnerships" is the word used by the SUP to report on its results, in accordance with its official PIP, but is not intended to be interpreted in the legal sense of the term.

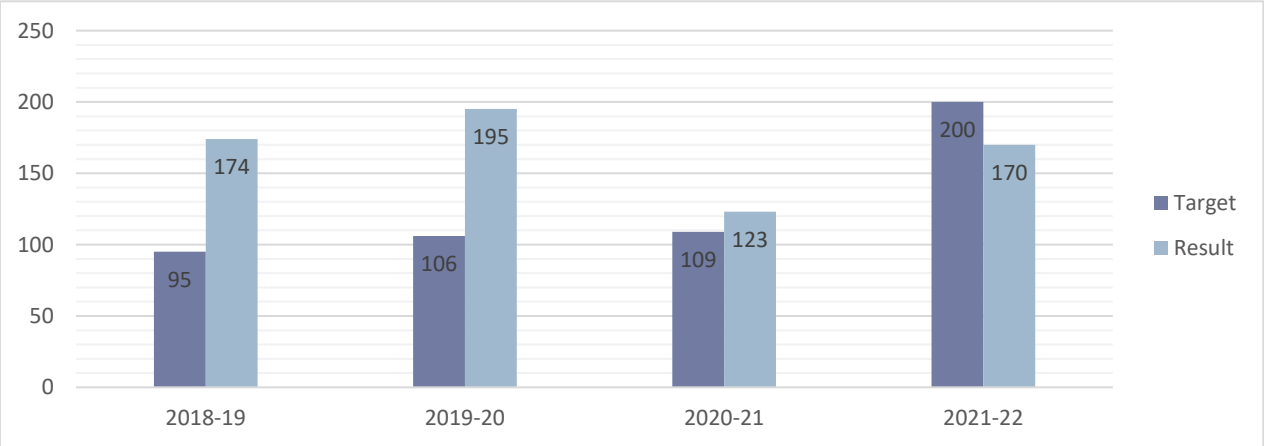
(R&D contracts) and not due to a real increase in the number of contracts. The results are related to development contracts (including subcontractors and international companies) between Gate #2 and Gate #4 of the IGMF, because pre-project contracts have not been processed uniformly in recent years. Furthermore, the results do not include contracts dedicated to RCM operations. However, it is important to mention that this situation goes beyond SUP's control, and that efforts are currently being made across the CSA to address these issues.

Figure 6. Partnerships and Stakeholder Engagement Theory of Change



Through the partnership arrangements established, the SUP achieved its immediate outcome #1, as defined in its logic model 2017-2022, i.e. stakeholders and users collaborated and were engaged. The SUP created or sustained partnership arrangements with an **annual average of 166 organizations** between 2018 and 2022 across all SUP activities. The number of organizations with which partnerships were established and maintained by the SUP fluctuated during the evaluation period, but targets were met and surpassed for all fiscal years except 2021-22. According to a key program informant, the gap was mainly caused by the Government Related Initiative Program (GRIP) coming to an end in 2020-21, which reduced the number of partnerships made with the public sector captured through the Performance Indicator Survey, and also because of delays caused by procurement-related issues that prevented the implementation of SmartEarth initiative projects, which had the potential to generate many partnerships. The upcoming evaluation on data utilization and application development may further explore this fluctuation. While these two elements had a downward impact on the outcome, the number of partnerships has nevertheless been relatively consistent over the past four years.

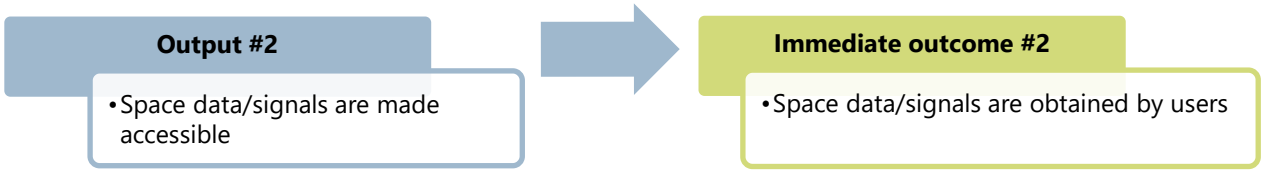
Figure 7. Number of Organizations with whom Partnerships were Created and Sustained per year



Moreover, considering that the SUP's mandate is to provide space data and signals to users, it must also ensure that these data/signals are accessible to those who wants to use them. Space data and signals made available through SUP's support are obtained either from the development of a Canadian mission or by the

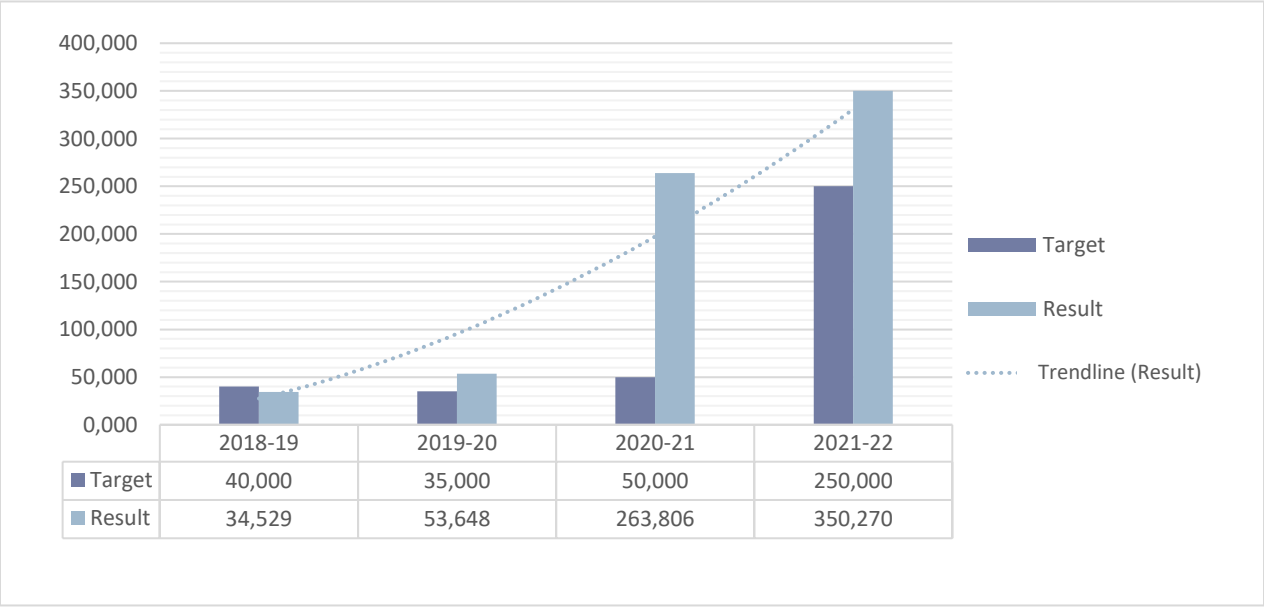
SUP's participation in a foreign mission, and the output is calculated by the Program with each initiative counting as one dataset. According to internal SUP data, the latter made **20 datasets available per year between 2018 and 2020**. Data and signals from many missions supported by the CSA are available to users, but the fact that the CSA makes data available does not necessarily mean that the target audience is using them. Therefore, the SUP measures the amount of data downloaded by users.

Figure 8. Theory of Change for Space Data/Signals Accessibility and Availability



The CSA does not have access to user information or statistics for every CSA supported mission (e.g. ESA missions). Only CSA SAR satellites are used to measure immediate outcome #2 (RADARSAT-2 and RCM) considering that the CSA has access to information and statistics on users for these satellites. Once data have been made available and collected, they can then be used by external stakeholders to produce intermediate and ultimate outcomes. These results are going to be evaluated soon in the data utilization and application development evaluation, because the OSPPA evaluation is not intended to assess how users are using these data and signals.

Figure 9. Number of Images Downloaded from CSA SAR Satellites per Year



	2018-19	2019-20	2020-21	2021-22
Target	40,000	35,000	50,000	250,000
Result	34,529	53,648	263,806	350,270

702,253 images[13] were obtained from SAR satellites between 2018 and 2022. More specifically, 34,529 images were obtained from the RADARSAT-2 satellite for fiscal year 2018-19, and the significant increase

[13] For the purposes of this evaluation, "images" and "scenes" are used interchangeably, despite there being a technical engineering distinction between the two.

observed from 2018 to 2022 can be explained by RCM's launch (in June 2019) and commissioning (in November 2019). The results of the last few years, particularly fiscal year 2021-22, highlight the unparalleled effectiveness and capacity of RCM when compared with its predecessor. As early as fiscal year 2019-20, the 53,648 images obtained through the CSA's SAR satellites included 32,062 images from RADARSAT-2, and 21,586 images from RCM after only four months of operation. In addition, RCM has enhanced engineering capabilities (e.g. improved quality of images captured).

The marked growth in data obtained for 2020-21 and the deviation from the target can be explained by the fact that RCM was already operating at full capacity (250,000 images) in its first full year of operation. Meanwhile, the increase in images captured in 2021-22 all of the way up to 350,270 images is attributed to Program efficiencies in improving request coordination thereby maximizing the availability of the data collected and more effectively responding to user needs.

> "We went from 5,000 images per year with RADARSAT-2 in 1995 for other federal departments, to 250,000 images used per year now. It means that we have 50x more images, more hardware, more storage, more automation. Every time we build a new satellite, there are new features, it is way more performing. The key word here is 'transition.' When we left RADARSAT-2 utilization to integrate RCM, departments were ready. Without CSA support, departments would have had more difficulty preparing to absorb this amount of data. From the very first year, we saw that the utilization growth was optimized. Usually, when you start using a new system, you start by slowly using it to do tests. However, in this case, departments were prepared, so we were already almost at full capacity when RCM became operational. I think RCM is a huge success, because the investment has been used at 110%. Nevertheless, we placed considerable emphasis on other government departments, while we let industry and academia fall by the wayside a bit when it came to access or reuse of the data. We have been somewhat limited by the data distribution policy."
>
> - Internal key informant (interview)

Unexpected Outcomes

Information gathered from internal and external key informants indicates that RCM data accessibility has proven to be more complicated than expected, because of a large number of acquisition requests and the sensitivity of some images captured. In December 2019, the Department of National Defence (DND) noticed that RCM was taking photos of sensitive areas. Although federal departments quickly gained access to RCM data, external users, such as academia and Canada's partner space agencies, gained access more slowly due to DND and Global Affairs Canada requirements to develop an RCM data access policy, for national security purposes.

Similarly, some external respondents also noted that DND and the Canadian Armed Forces' (CAF) significant need for RCM data, in order to ensure the safety and protection of Canada and Canadians, had the unexpected outcome of creating an imbalance and limited RCM's capacity to meet all user needs, including users within the federal government. This concern is heightened by the fact that the CSA's mandate is first and foremost linked to the civilian use of space (see "*efficiency*" section).

Finally, internal interviews also indicate that RCM has strengthened Canada's global reputation in the field of SAR data, which had the effect of maintaining and nurturing important international collaborations to increase the SUP opportunities of collaboration in the context of future satellite missions, but also to have a strong presence of Canada on the international stage.

"RCM is almost a victim of its own success. It operates at full capacity. It is useful, which led users to want more. So we adapted, we reassessed our operations, and we managed to extend its actual capacity to provide more data and meet more needs."

- Internal key informant (consultation)

"You need to be an authorized user in order to have access to RCM data. It's not optimal, but it works. Accessibility is an issue for all RCM users. There are too many high-priority users. It's almost impossible for academia to submit a request. We are working with departments like Environment and Climate Change Canada (ECCC), who are making requests for projects that we are involved in."

- External key informant, university (interview)

"DND and CAF are probably the biggest beneficiaries and users of RCM, with others such as ECCC and Natural Resources Canada also benefiting. Other government departments such as Fisheries and Oceans Canada also get benefits from RCM. All of these users obtain EO data from RCM to support their departmental agendas. DND and CAF have their own set of objectives that do not necessarily align with the CSA and the other user groups."

- External key informant, federal department (interview)

"As soon as you pick up the phone to prepare post-RCM, countries say "yes" right away. It opens the door to great opportunities for collaboration. For our industry, I think it also sends the message that Canada is still a key player."

- Internal key informant (interview)

Efficiency

Overall finding. Over the years, the SUP has demonstrated its ability to work effectively and in tandem with various stakeholders, both internal and external, employing an effective interdepartmental and international approach. Activities related to the planning and development of observation systems are harmonized within the SUP, the CSA, the Canadian space ecosystem, as well as with international partners. However, some elements should be clarified, documented, and centralized to optimize decision making and reduce workloads. The Program's efficiency could be improved by clarifying the operational vision, roles and responsibilities; by compiling and organizing information related to the needs of target groups in a shared Program repository; and ensuring that personnel for each satellite mission under the Program are centrally allocated and monitored for all mission phases.

Alignment of Activities, Roles and Responsibilities

Within the Canadian Space Ecosystem

The SUP's activities during the evaluation period have largely been focused on EO, including on missions that are primarily aimed at supporting other federal departments. The development of the RCM Major Crown Project, a significant public investment and property of the federal government, required the collaboration of numerous stakeholders (i.e. at least ten federal government partners) and significant nationwide coordination from the SUP. Throughout the process, the SUP staff ensured effective collaboration with other federal departments to prevent requests and feature development from being siloed.

At the strategic planning level, the 2016 evaluation of the EO business line found that Canada had a lack of strategic direction in EO. Over the past five years, the SUP has worked to clarify its role in the Canadian ecosystem and to define a common vision for future investments by working with various CSA directorates and consulting federal departments, the industry and academia. Work performed by the SUP throughout the evaluation period was instrumental in the drafting of the *Engagement Paper: Space-Based Earth Observation* (June 2020). In this paper, the SUP establishes its commitment to a series of best practices that are needed for future EO success in Canada. The paper covers, but is not limited to, the long-term planning of EO investments for operational and scientific needs; a whole-of-government approach to planning and operating EO observation systems; a partnership approach with other major stakeholders (universities, private companies and provincial/ territorial/Indigenous governments); and an international approach.

In addition, the SUP's efforts led to *Canada's Strategy for Satellite Earth Observation* (March 2022). This strategy is the result of a government-wide consultation with the private sector and academia. Most employees surveyed in the course of this evaluation thought it was an excellent step in the right direction, in particular because it establishes a vision statement on the use of satellite EO data in Canada. The second National Forum on Earth Observation (2022) highlighted the CSA's convening role in the Canadian EO ecosystem and the CSA's leadership in consulting and engaging partners.

Nevertheless, the SUP's work currently underway to clarify its vision remains relevant and necessary. In fact, the evaluation found that despite the significant advances noted, several internal and external stakeholders are still unsure of the SUP's specific role in the Canadian ecosystem. Federal departments recognize the key role of the SUP and the CSA as experts and coordinators of satellite EO efforts in Canada. Internal and external respondents however still raised questions about the program's overall role and objectives. In addition, the SUP's operational vision remains unclear for many SUP employees, who expressed their difficulty in understanding how the current vision applies to their day-to-day work. For example, who is responsible for developing the funding strategy and taking the significant risks inherent to each of Canada's satellite missions? Also, who is responsible for prioritizing the needs of different federal departments, and by extension, the missions developed to meet those needs?

> "Does Canada have the capacity to support both civilian and military interests through one single mission?"
>
> - External key informant, federal department (interview)

> "I don't think the CSA has clearly defined its role in EO. We have not been able to develop a vision for EO as a whole yet. It requires deep reflection. We do define a specific vision for each project, but by definition, a project has a finite lifespan."
>
> - Internal key informant (interview)

The division of roles and responsibilities between the CSA and other federal departments would benefit from clarification in the near future, especially since departments surveyed in this evaluation expect to increase their use of EO data over the next ten years. The EO field is directly linked to service delivery and the core mandates of several departments, which creates an interdependence between those departments and the SUP. This justifies, among other things, the need to adopt a departmental and whole-of-government approach to the creation of an operational vision that can clarify the role of the CSA and the SUP in Canada.

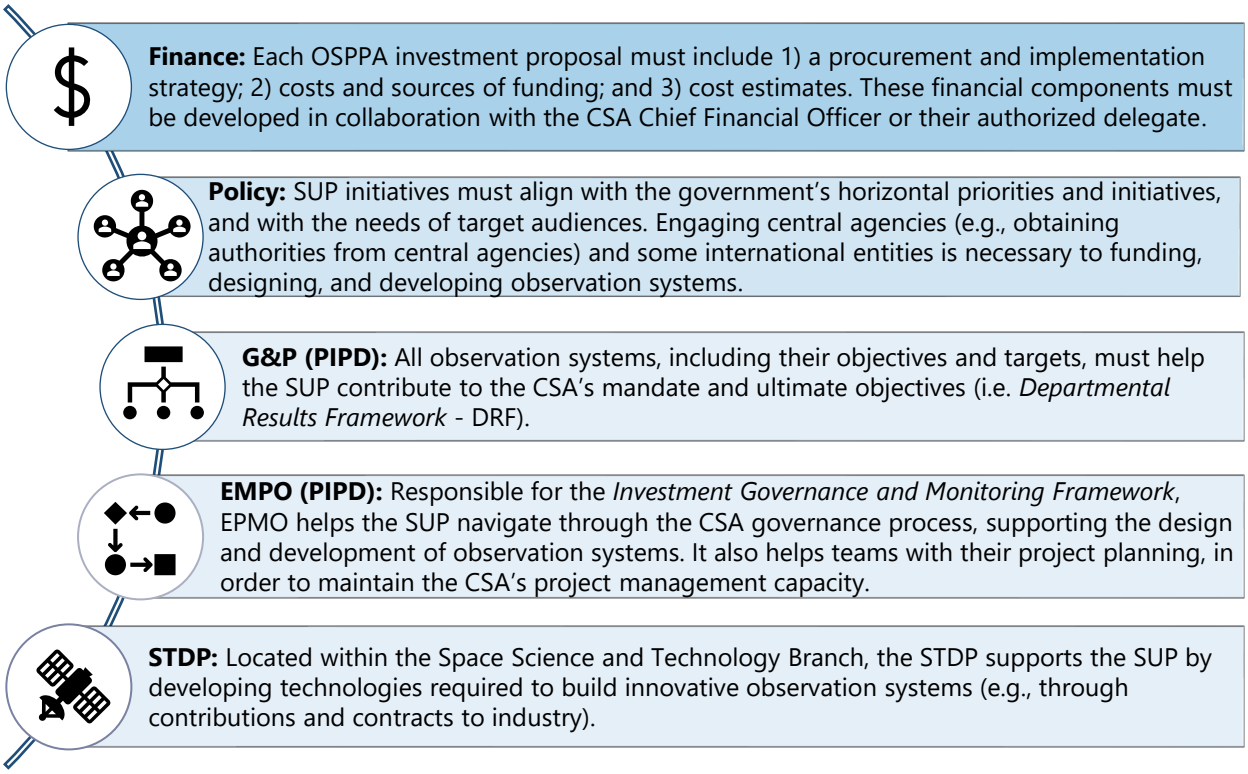
Some respondents questioned the role the CSA intends to play in the future regarding provinces and municipalities, as well as in areas other than EO, such as SSA and SatCom. Although some work has been undertaken in these areas, the CSA's vision and objectives remain vague. The data collected demonstrate that there is currently no consensus within the SUP regarding which stakeholders listed in the 2022 strategy either currently are, or should be, identified as its target groups and beneficiaries (outside of other federal government departments). Similarly, some respondents from academia brought to light the need for an elucidated SUP science vision. This echoes the concerns of a program manager when he indicated that he was not sure who the SUP's target groups were in the scientific field. The strategic planning team is continuing its work to clarify the program's role and vision, but the high workload and the precariousness of resources allocated to the team complicate the process.

Within the CSA

Synergies and Collaboration

The SUP collaborates effectively and closely with other CSA directorates to plan, prepare and develop the observation systems. These sectors represent key players in fulfilling the SUP's mandate and achieving its objectives, through a harmonized approach of roles and responsibilities. These sectors include the Finance Directorate, the Policy directorate, the Space Technology Development Program (STDP), and the Programs and Integrated Planning Directorate (PIPD), which includes the Governance and Performance (G&P) team and the Enterprise Project Management Office (EPMO).

Figure 10. Overview of Key OSPPA Stakeholders Roles and Responsibilities at the CSA



There is a strong complementarity at the CSA regarding activities and functions related to planning and preparation of observation system, especially because of the *CSA Investment Governance and Monitoring Framework* (IGMF), which is a CSA-wide investment management and oversight directive. The IGMF's purpose is to ensure that the CSA closely manages and monitors investments by defining general governance requirements and processes, and by establishing the roles and responsibilities associated with them. More specifically, the IGMF objectives are to: 1) maximize return on investment and benefit realization; 2) align investments with Canadian government priorities; 3) enable transparent decision making and accountability at all levels; 4) maintain robust and exemplary project management that meet the CSA's needs of. It supports various Treasury Board directives and policies (CSA 2022b). Similarly, PIPD also ensures that all CSA investment programs are subjected to a standardized performance measurement process and that all projects which are managed under the IGMF produce the expected benefits. In addition to the work done within the IIRB, regular coordination meetings have been established between the vice-presidents and the three programming directorates, which further increases the synergy of observation system-related roles and functions within the CSA. Furthermore, some internal respondents also highlighted the good relations between the SUP staff and the CSA's other two programming branches, noting that regular meetings were organized between them.

Although internal respondents perceived all of these coordination activities in a positive light, some key informants noted that the roles and responsibilities of SUP staff and Policy directorate should be clarified or further communicated, considering that their respective functions remain confusing for some employees,

which could also put an additional pressure on both teams. A key informant also made similar comments with respect to the dynamic of roles and responsibilities between the SUP and the STDP.

Governance and Investment Life Cycle

The design and development of observation systems aligns with the CSA's governance structures and processes. For governance structures, the program mainly uses the CSA IIRB and two internal committees, the Space Utilization Management Committee (SUMC) and the Space Utilization Steering Committee (SUSC). The SUSC is the SUP's directorate-specific steering committees on investment programs, as required by the IGMF. The evaluation found that meeting minutes are produced for the SUSC and that the Program increased efficiencies when it changed its documentation and storage method in May 2020[14]. Indeed, the change of platform offers several management advantages, including automatically numbering meeting minutes and the ability to link minutes directly to relevant employees for ensuring their follow-up and action. SUMC meeting minutes stopped being produced in order to reduce employees' workload and administrative tasks, since this committee was making a relatively small number of decisions (see "*Program description*" section). Key informants, however, indicated that SUMC meeting minutes were a valuable communication tool for disseminating information on how current SUP affairs were managed to all levels of staff. As such, the discontinuation of these minutes slightly reduced communication channels within the Program.

In terms of governance processes, Investments related to the design and development of observation systems generally comprise the type of CSA investments that are governed by decision points, and they follow the IGMF investment life cycle. Over the past five years, the SUP has successfully designed, developed and launched observation systems through the IGMF investment life cycle. Internal respondents identified the requirements for passing Gate #2 (G2) relating to cost estimates as the main challenge when it comes to the development of observation systems. Although the IGMF specifies that alignment between the CSA's governance and systems engineering phases is not required, many employees stressed that in practice alignment is in fact required considering that G2, where the CSA decides to formally become involved in a mission, is located at the border of engineering phases 0 (project planning) and A (detailed project requirements). Therefore, many employees expressed difficulties with cost estimate requirements, and said that producing a detailed cost estimate for an observation system is very challenging when the project's needs and requirements in Phase A (which includes technical requirements) have yet to be established. In that respect, some stakeholders indicated that it would be a significant improvement if Phase A was not considered to be part of the project at all, but rather was integrated into the options analysis and planning phase, in anticipation of G2.

This situation does not prevent the Program from successfully conducting missions. Nevertheless, data collected in interviews and observation sessions indicate that the lack of clarity on this aspect hinders the SUP's efficiency, complicates the work for the staff assigned to missions, increases staff workload and stress, builds tension between the SUP and CSA teams responsible for applying TBS financial governance requirements, and presents a risk to the SUP's ability to deliver on international projects, whose schedules are outside the SUP's direct control. In May 2023, following the collection and analysis of evaluation data, TBS replaced the *Guide to Cost Estimating* with the *Guide to Costing*. The aim of the new guide is to better

[14]The SUP used an Excel file from 2017 to May 2020.

align with Treasury Board policies and provide additional resources for costing processes, from cost accounting to cost estimating. It is therefore still too early to assess the impacts of the new guide on the SUP activities. Moreover, CSA's corporate teams are currently working to establish a standardized methodology and tools in order to facilitate the costing process at the CSA.

Table 5. Gated Investment Life Cycle at the CSA

Pre-project				Project				Post-project
Ideation phase	Option analysis and planning phase			Definition phase			Implementation phase	Post-implementation
	Identification of options	Option selection	Project planning	Detailed requirements	Preliminary definition	Detailed definition		Operation & disposal
Identify business needs (or opportunity), strategic alignment, and plan the next phase	Identify options to fulfill needs, stakeholders, and initiate the business case	Finalize the business case and select an option	Project planning and preliminary functional requirements	Finalize functional requirements, and initiate development of project requirements	Refine project requirements and initiate planning of project implementation phase	Finalize project requirements and planning of implementation phase	Create products or solutions, and verify requirements	Use products or solution and realize outcomes. Dispose of products or solution, and close the investment
		R2	G2					
Engineering➔ phases*	Pre-phase 0	Phase 0		Phase A	Phase B	Phase C	Phase D	Phase E/F

*The IGMF indicates that systems engineering phases are given for reference only and do not need to be exactly aligned with investment life cycle phases.

Among RCM success factors identified by internal respondents, the evaluation notes that specific governance and steering committees were established[15] within the CSA to successfully carry out this major Crown project. It is also notable that establishing project-specific steering committees is identified as a project management best practice.

Performance Measurement

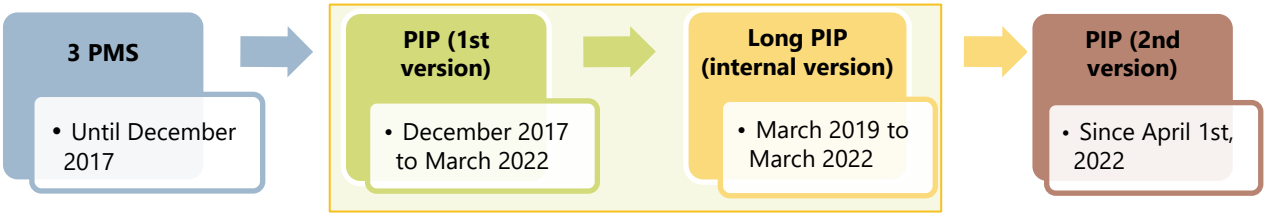
CSA programs restructured their performance measurement tools after the *Policy on Results* (2016) came into force. In doing so, the programs three performance measurement strategies (PMS) were replaced by performance information profiles (PIP) in December 2017. According to an internal key informant, the process that led to the SUP's PIP creation proved to be complicated. The final version of the 2017 PIP, aligned with other CSA program PIPs, was regarded as insufficient by the SUP to fully capture all its results, so it developed an unofficial internal version (referred to as the long PIP) of its original PIP (then referred to as the short PIP). Unlike its CSA counterparts, the SUP therefore operated with two PIPs from 2019 to 2022, i.e. until the second edition of the CSA's PIPs were released in March 2022. The decision to develop a long PIP was taken in order to better support SUP management and to better measure expected outputs and outcomes. However, this resulted in an increased workload and efficiency loss within the SUP, considering that it had to report on two PIPs which used different methodologies until 2022 (since some indicators and targets were not included in the official PIP). Although the 2019 long PIP did not align with other CSA PIPs, it remained aligned with the *CSA's Departmental Results Framework* (DRF).

[15]These are federal government central agency requirements. The CSA's IGMF also specifies that a specialized project management office can be established for a project, typically for Tier 3 projects or projects with a high degree of risk or complexity (CSA, 2022b).

The SUP strategic planning team has made significant efforts to improve Program performance, in collaboration with the G&P team to improve the Program's performance measurement and increase efficiency. These efforts resulted in enhancements that can be seen in the second edition of the PIP (completed in March 2022), such as the grouping of short and long PIP indicators, targets and methodology into a new single PIP; the integration of indicators that used to be monitored informally; the standardization of similar indicator methodologies with other CSA programs; the integration of official output-related indicators; better description of the breadth of SUP activities; as well as better alignment with federal priorities (e.g. GBA Plus) and the CSA's strategic objectives (e.g. CSA's logic model).

Nevertheless, concerns were raised within the SUP regarding whether the CSA's new logic model would be able to build an SUP-specific results story, particularly with the long PIP no longer being in effect. That being said, performance measurement continues to be rethought within the SUP and across the CSA, through ongoing collaboration with the various internal stakeholders responsible for results data at the CSA.

Figure 11. Evolution of SUP's Performance Measurement Tools (2017-2022)



The evaluation found that the SUP's long PIP contained a large amount of strategic information that was crucial to fully understanding the Program and facilitating its implementation, such as an overview of governance structures (e.g. SUSC), information on relevant stakeholders, and additional miscellaneous information on its overall activities and sub-activities. This information was not included in the second edition of the PIP, and the SUP would benefit from incorporating it into another central management document, which could also include other strategic information on governance, operational vision, roles and responsibilities, as is the case with the CSA Space Capacity Development Program's management framework.

Within the SUP

The planning function is fragmented within the Program. However, the SUP's processes generally permit activities undertaken to be well harmonized. The SUP strategic planning is now under the responsibility of the *Planning, Engagement and Applications* (PEA) directorate, while the planning function for observation systems is shared between *Sun-Earth System Science* and *Space Exploitation* directorates, which are staffed by mission managers and project managers, and have the systems engineering and project management expertise required to design and develop satellites. In this context, the PEA directorate provides support to other directorates, particularly through the involvement of a team that helps mission and project managers navigate the CSA governance process. Each directorate therefore plays a key role in mission design and development. During the period covered by the evaluation, the three SUP directors worked closely to strengthen the planning and management of their activities, for example by meeting once a month to address emerging issues. The SUSC also monitors all activities undertaken by the three directorates to better prepare IIRB approval requests. In the same vein, a dashboard is created for each SUP mission to make it easier to

manage activities. These dashboards are shared monthly with the mission director, and then with the SUP Director General as well as with the Vice-president, Science and Technology.

> "What matters is the mission. We adapt to fit the mission."
>
> - Internal key informant (consultation)

However, the data collected from both the interviews and the documents reviewed indicate that external engagement activities could be better aligned across SUP directorates to reduce the consultation fatigue experienced by some federal partners. In addition, roles and responsibilities could be clarified between the SUP directorates as well as between project teams during the pre-project phase. Indeed, clarification should be made regarding the division and transition of responsibilities between the mission manager and the project manager in the TBS "option analysis and planning" phase. In most cases, a leadership transition occurs at revision point #2 (R2) of the IGMF, but some employees think the transition occurs at G2. It should also be noted that the role of mission manager and the tasks associated with it are not established in the IGMF or the *IGMF Interpretation Guide*, unlike those of the project manager[16]. Also, while *Sun-Earth System Science* directorate is generally responsible for planning and preparing missions up to R2, *Space Exploitation* directorate is sometimes responsible for these steps as well. Some key informants noted that it was difficult to manage a team or work in a team where members' roles and responsibilities were not always clear. In recent years, the SUP has initiated discussions and efforts to clarify the division of roles and responsibilities within the Program and within project teams. Nevertheless, additional efforts are required to ensure a common understanding as well as to increase the efficiency of the process.

With International Partners

International collaboration has been part of the Canadian space program since its inception, with the launch of the science satellite Alouette 1 in September 1962, when the United States invited Canada to participate in an international collaboration project as part of its satellite construction program. Canada then became the third nation to design and build its own artificial satellite (CSA, 2018). Today, international collaboration remains an important implementation tool for the SUP to leverage in the design and development of observation systems. Among other things, collaboration, and alignment of functions between Canada and its international partners increase project opportunities, reduces construction costs, and reinforces Canada's position on the international stage. However, international collaboration can also bring additional challenges, when international partners are responsible for missions in which Canada is participating, for example regarding schedule and stakeholders on which the SUP and the CSA have less decision-making power.

Resource Utilization

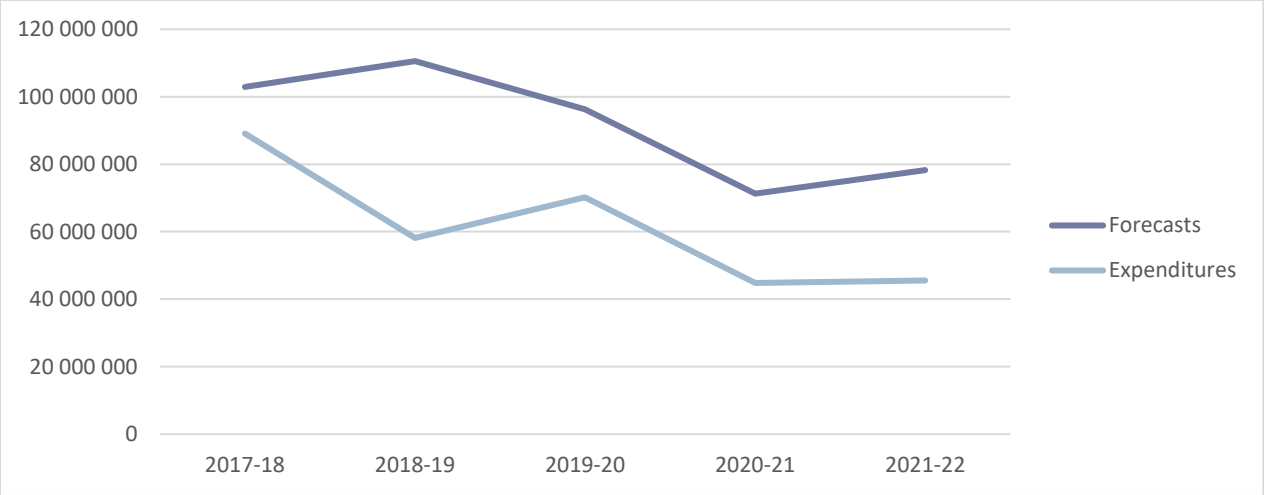
Program Overhead

Program spending on OSPPA is well managed and actual spending has consistently been lower than the financial forecast during the years under evaluation, as shown in the figure below. SUP expenditures from 2017 to 2020 were largely allocated to RCM launch preparation, which happened in June 2019 with its

[16] Among other things, the IGMF indicates that project manager is responsible for all aspects of project planning (starting at R2) and project management (until project closure at G4) (CSA, 2022b).

commissioning occurring in the following months. Budget forecasts include funds reserved to manage project risk. The important discrepancy between planned funding and actual spending in 2018-19 is therefore mainly attributed to the fact that the SUP used very little of the risk management funding envelope that had been allocated to RCM. In general, spending is expected to increase in the coming years due to the growing needs of the government for satellite EO, particularly the expenditures associated with the mission to extend RCM's operational lifespan and its eventual replacement mission.

Figure 12. SUP Planned and Actual OSPPA-Related Funding ($)



Source of data: CSA Finance Directorate.

Table 6. Discrepancy Between SUP's Financial Forecasts and Actual Expenditures

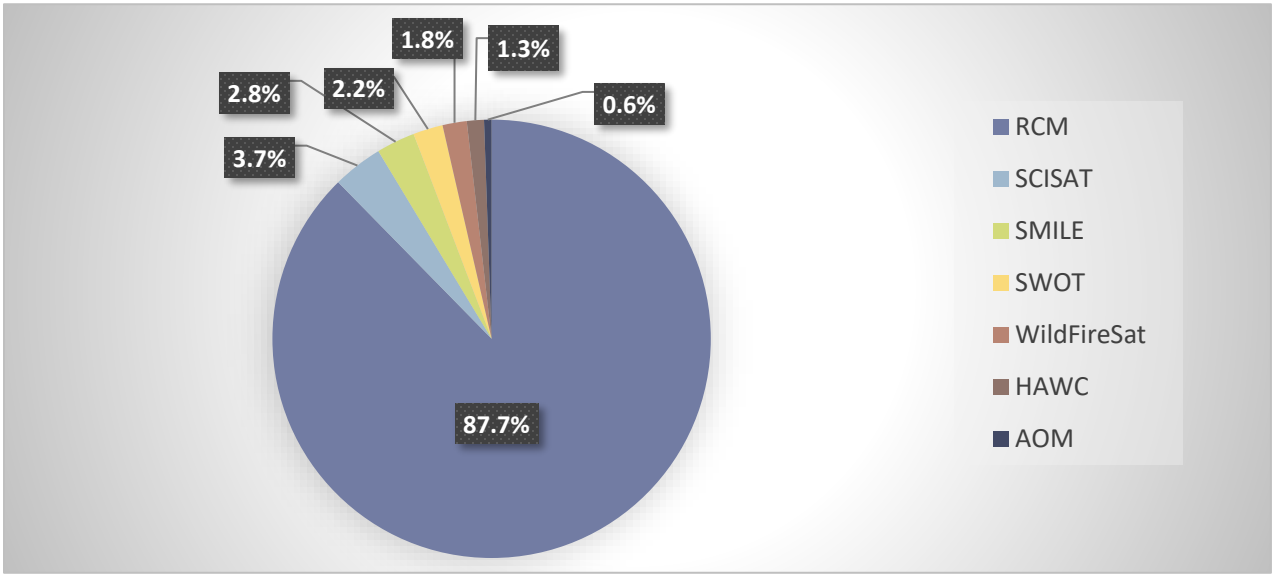
Fiscal year	2017-18	2018-19	2019-20	2020-21	2021-22
Deviation ($)	$13,835,717	$52,385,624	$26,092,925	$26,461,736	$32,711,456
Deviation (%)	13.4%	47.4%	27%	37%	41.8%

Source of data: CSA Finance Directorate.

The administrative data collected as part of the evaluation indicate that budgetary allocations for staff salaries remained relatively stable during the first four years of the evaluation, and then saw a marked increase in fiscal year 2021-22. In addition, every internal stakeholder that was interviewed noted that all investment decisions related to observation system design and development between 2017 and 2022 were made with rigour and diligence, specifying the importance of using public funds carefully and respectfully. Furthermore, two facilitating factors of the SWOT mission, whose implementation has been identified by some respondents as a model, were the proper planning of its budget and the fact that SWOT was smaller than other SUP missions. A key informant also mentioned that the project team benefited from having experience in the development of the required SWOT mission instrument technology, which made it possible to produce a realistic cost estimate early in the process.

The figure 13 establishes how program funds were allocated for missions under evaluation, from 2018 to 2022. As mentioned earlier, RCM is the SUP's largest investment to date. However, it is important to note while considering this data that not all missions were at the same stage of development during the evaluation period; some were more advanced than others.

Figure 13. SUP Funding Allocation by Project Evaluated (2018-2022)



Source of data: CSA Finance Directorate.

Workload and Prioritization of Activities

The SUP business model changed between 2017 and 2022, from a model in which almost all human and financial resources were directed towards a common objective (i.e. RCM) to a model in which the Program manages a portfolio of several concurrently evolving missions. The portfolio approach presents clear benefits for the SUP, which is then able to seize opportunities with different partners and respond to the needs and priorities of the government within a reasonable timeframe, when the budget allows it. However, although several employees indicated that they understand the relevance of such an approach, the evaluation found that the mission portfolio model also had an impact on employee motivation, on team spirit, and on the SUP's efficiency by dividing the efforts on different missions in a context where human resources are limited. According to several internal respondents, the SUP staff's workload leaves little room for innovation and training, and concerns were raised by some key informants regarding the Program's capacity to complete certain planned missions, due to limited human resources and the unpredictability of financial resources.

Except for RCM and its successor mission, which were considered priorities, program activity prioritization was a challenge between 2017 and 2022. Many stakeholders consider the fact that the CSA does not have a budget envelope to fund the development of specific initiatives from the outset to be one of the biggest challenges faced in the strategic planning of observation systems. This complicates mission prioritization and the SUP's long-term planning with international partners. That being said, no baseline funding envelope is provided because the decision to engage in a satellite mission can vary based on federal priorities, departmental objectives, the needs of the target groups (e.g. federal departments), collaboration opportunities, and the risks and functional requirements of the initiatives (e.g., required technologies), all of which requires prior work and the right timing.

The data collected indicate that prioritization challenges within the SUP contribute to the creation of an environment where there are often last-minute emergencies both within the program and the other CSA

directorates with which the program collaborates. Key informants also noted that unexpected priorities can suddenly arise, further complicating daily work and increasing staff workload. However, it is important to mention that work performed during the period covered by the evaluation has made it possible to cement future investments in observation systems. Therefore, the SUP is now increasing its focus on developing the missions it has committed to delivering.

Table 7. Budget Allocations for Staff Salaries and Overtime

Fiscal year	Salary expenditures	Overtime expenditures ($ and %)	
2017-18	$9,964,390	$313,960	3.2%
2018-19	$9,738,832	$202,889	2.1%
2019-20	$9,583,832	$265,122	2.8%
2020-21	$9,531,836	$385,846	4.1%
2021-22	$11,131,692	$334,552	3%

Source of data: CSA Finance Directorate.

"Prioritization is a challenge, especially in an environment where there are so many stakeholders. Prioritization is very difficult, and despite many attempts to establish some kind of objective or mathematical prioritization system, we have not succeeded. We have functional governance on all the levels up to deputy ministers, but I'm not sure that we have all the necessary tools for full consensus seeking or consensus building around priorities. I would prefer to see a more systematic process for prioritizing our investments."

- Internal key informant (interview)

"I'm putting in a lot of work for an initiative, but we don't know if it will lead anywhere or will be funded. I have a colleague who is doing the same for another initiative. The government will then decide which initiative it will fund, according to its priorities of the moment… but the work we're doing in the meantime may be unnecessary and we are competing against each other, in a way. Maybe no initiatives will be funded, or maybe just one, or maybe there will be funding for all initiatives? We don't know yet. Giving my 100% for an initiative without knowing if it will go anywhere in the medium or long term, that is troubling me very much. It really stresses me out. It's something that bothers me. If people need me, I will be there to help, but I would like to know that my efforts are going to pay off."

- Internal key informant (interview)

The human resources assigned to missions in the ideation phase and Phase 0 are not formally documented in the planning process and are not included in the CSA's resource allocation matrix[17] since the future is unclear for missions that are still in the pre-project phase, considering that the CSA's official involvement in a mission is confirmed only after G2 of the IGMF. Therefore, concerns were raised by many employees regarding how this framework limits the effective planning and allocation of human resources. A key informant also emphasized that no process had been established for planning the staff assigned to a mission and said that each project has to create its own process.

Managers have worked to implement a timesheet system to track the time that staff on their team spends on each activity or project. However, there is currently no centralized management process within the SUP that makes it possible to have a global picture of the personnel that have been allocated to each phase of an ongoing mission. The evaluation found that this situation increases the staff workload, because some of the

[17]The current system is mainly used to plan FTEs, starting at point G2. In addition, managers are not required to log the project resource allocation during the post-project phase, although it is recommended.

work performed at the start and end of a mission is not always accounted for and therefore noticeable to decision makers. This also complicates the decision-making process, because information on the allocation and availability of human resources is not easily available. Indeed, several respondents in management positions indicated that it was difficult to manage a team whose number of FTEs is not clear.

> "I don't have all the information I need. How many FTEs are there? What percentage of time can they allocate to the project? What are their roles, responsibilities, and deliverables? I don't have that information. It prevents me from doing my job. I don't have a clear picture of the people assigned to my project."
>
> - Internal key informant (interview)

Similarly, the evaluation found that there is no centralized tool or database within the SUP to compile and organize all of the needs identified by different employees during the many consultations over the years, which affects the number of consultations conducted, as previously mentioned, and also makes it harder to establish clear and precise selection criteria to prioritize the advancement of certain missions. In recent years, the Program has started to develop a database to identify the needs expressed by target groups, but the high workload and limited resources have limited its development. However, in a multi-stakeholder environment, where there is also an interdependence with federal departments, it is crucial for the SUP to identify the needs of its target audiences (which it does successfully), as well as to compile, organize, and centralize that information to better guide efforts and resources. Key informants also indicated that such a tool should support decision making and not simply become yet another repository for storing information.

Conclusion and Recommendations

The evaluation highlighted the relevance of the Canadian Space Agency's (CSA) Space Utilization Program (SUP) and found that the needs that gave rise to the SUP are still present and relevant. The SUP is of strategic importance to the CSA and several federal departments in terms of fulfilling their respective mandates. In terms of effectiveness, the output and outcome targets under evaluation were generally met or surpassed by the Program. The launch and commissioning of the RADARSAT Constellation Mission (RCM) in 2019 has allowed the CSA and the SUP to significantly increase Canada's synthetic aperture radar imaging capacity, to increase the production of Earth observation satellite data, to increase the service offering to Canadians and partners, and to strengthen Canada's place on the international stage. Nevertheless, the most important SUP project is somewhat a victim of its own success. The accessibility of RCM data remains more complicated than expected due to the high volume of acquisition requests, the sensitivity of some captured images, and important national defence needs.

In recent years, the SUP has successfully designed and developed various satellite missions, using an interdepartmental and international approach. However, the evaluation finds, based on the data collected, that certain elements should be clarified, documented, and centralized to improve program efficiency, and more specifically to optimize decision-making process and reduce employee workload. The Program is composed of passionate and talented employees, who are nonetheless overloaded with work because of several interconnected factors. These being the absence of a broad view of time allocation to each phase for all ongoing missions and the lack of a centralized compilation of needs identified, as well as unclear roles and responsibilities.

The evaluation also found that the vision development work undertaken by the SUP over the last several years will only truly succeed as part of a concerted effort across the CSA and the larger federal government. Roles and responsibilities should therefore be clarified across three levels, i.e. within the Program, between the Program and other CSA directorates, and with other federal government departments. On this last point, the onus is on stakeholders to determine the desired level of CSA involvement in SUP's areas of responsibility and the actions to be taken to achieve it.

In light of the key evaluation findings described above, the evaluation recommends the following actions to support the Space Utilization Program's decision making and efficiency:

1. Clarify the operational vision, roles and responsibilities, and develop a management framework that reflects the Program's direction.
2. Centralize, compile and organize information related to the needs of target groups.
3. Ensure centralized and holistic planning, management and monitoring of the Program's human resources related to observation systems, for each phase of all satellite missions undertaken by the Program.

Management Response and Action Plan

RECOMMENDATIONS	MANAGEMENT RESPONSE	ACTION PLAN DETAILS	RESPONSIBLE PERSONS	TIMELINE
Recommendation #1 Clarify operational vision, roles and responsibilities, and develop a management framework that reflects the Program's direction.	CSA and SUP senior management concurs with this recommendation.	We will develop a management framework for the Space Utilization Program, in which we will clarify (but not limited to): • The Program's strategic vision, including its mandate and role in Canada. • The Program's operational vision, including its structure, the governance process for observation systems, roles and responsibilities within the Program, and roles and responsibilities between the Program and other CSA's directorates.	Director General of Space Utilization With the support of the CSA Executive Committee	March 25 (Fiscal year 2024-25)
Recommendation #2 Centralize, compile and organize information related to the needs of target groups.	CSA and SUP senior management concurs with this recommendation.	We will finalize the development of a centralized tool for collecting, organizing, and prioritizing longer-term user needs.	Director General of Space Utilization With the support of the Chief, Information Technology; and the Director General, Policy	March 2026 (Fiscal year 2025-26)
Recommendation #3 Ensure centralized and holistic planning, management and monitoring of the Program's human resources related to observation systems, for each phase of all satellite missions undertaken by the Program.	CSA and SUP senior management concurs with this recommendation.	1) We will conduct an analysis of existing tools and evaluate options with stakeholders across the CSA. 2) We will implement a centralized and standardized approach for optimizing the planning and management of the Program's human resources for each phase of satellite missions.	Director General of Space Utilization With the support of the Chief Information Technology Officer, the Executive Director, Programs and Integrated Planning; the Executive Director, Human Resources; and the Chief Financial Officer.	September 2025 (Fiscal year 2025-26)

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