

Book 4 – CSA Partners

Table of Contents

- 1. International Relationships and Activities 2
 - 1.1. Key international partners 2
 - 1.1.1. National Aeronautics and Space Administration (NASA)..... 2
 - 1.1.2. European Space Agency (ESA) 2
 - 1.1.3. European Union Space Activities 3
 - 1.2. International Organizations 3
 - 1.2.1. UN COPUOS..... 3
 - 1.2.2. Committee on Earth Observation Satellites and Group on Earth Observation 3
 - 1.2.3. OECD Space Forum 4
 - 1.2.4. International Space Exploration Coordination Group (ISECG)..... 4
 - 1.3. FVEYs / Civil and Security Discussions..... 5
 - 1.4. International Engagement Directive 5
- 2. Domestic Partners..... 6
 - 2.1. Government of Canada..... 6
 - 2.1.1. Agriculture and Agri-Food Canada (AAFC) 6
 - 2.1.2. Department of Fisheries and Oceans (DFO) 6
 - 2.1.3. Department of National Defence (DND)..... 6
 - 2.1.4. Environment and Climate Change Canada (ECCC)..... 8
 - 2.1.5. Natural Resources Canada (NRCan)..... 8
 - 2.1.6. Global Affairs Canada (GAC) 9
 - 2.2. Government of Canada - up and coming space users 9
 - 2.3. Academia 10
 - 2.3.1. Advisory Committees 10
 - 2.3.2. U15..... 11
 - 2.4. Industry 11
 - 2.4.1. Space Sector Stats 11
 - 2.4.2. Major Industrial Partners Profiles..... 12
 - 2.4.2.1. MacDonald Detwiller and Associates (MDA) 12
 - 2.4.2.2. Honeywell 12

1. International Relationships and Activities

International partnerships are at the heart of Canada's space program and play a prominent role given the complexity, risks and costs associated with space missions. To date, the CSA has over 20 active Memoranda of Understanding (MOUs) and a number of implementing agreements with space agencies around the world. These partnerships allow Canada to contribute key technologies and expertise to large scale missions that Canada could not do alone. In return, Canada benefits from significant advancement in science for Canadian researchers as well as opportunities to test and prove Canadian technology in space. Canadian companies also get access to new contracts and markets, resulting in economic benefits for Canada. This section highlights Canada's two closest partners, the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA). Information on other space agencies that CSA has traditionally partnered with or is exploring a partnership will be presented at future opportunities.

1.1. Key international partners

1.1.1. National Aeronautics and Space Administration (NASA)

The U.S. has the largest and most comprehensive space program in the world, with a combined civil and defense budget of \$41B in 2018. The majority of their funding goes towards human space exploration and science. The U.S. space program includes a number of government departments but is also prominent at the political level through the establishment of a space council chaired by the Vice President.

The Canada-U.S. space collaboration began over 50 years ago when the US launched Canada's first satellite studying space weather and the ionosphere. The launch, in exchange for data, made Canada the third nation in space, marking the birth of Canada's space program. This partnership flourished into a series of science collaborations, followed by the Canadarm on the US space shuttle, and then participation through the International Space Station.

Today, collaboration with NASA spans space activities in all areas, ranging from space exploration, earth observation, science, technology, education, outreach as well as international policy development. Canadian astronauts train alongside NASA astronauts in Houston. The next major collaboration includes Canada's participation on the Lunar Gateway, a small outpost orbiting the Moon, where Canada will provide key robotic capability through Canadarm3.

1.1.2. European Space Agency (ESA)

ESA is an international organization and is Europe's primary access to space. With one of the largest space programs in the world, ESA is at the forefront of research and development and innovation for activities in outer space. ESA's 2019 budget was €5.84B, which was sourced from contributions from 22 Member States, 5 European Cooperating States, the European Union, other European entities, and Canada. Canada is privileged to remain the only non-European cooperating state member of ESA. For ESA's 2019 budget, Canadian contributions accounted for approximately 15M Euros (0.26% of the total).

Canada's participation in ESA programs is facilitated through a treaty-level cooperation agreement – the first one was signed in 1979 and the most recent in 2019, and is valid until 2030. Participation in ESA allows Canada to share the costs and risks of a variety of complex missions that Canada would not be able to do alone. It provides a number of other benefits, including R&D advancements for Canadian science and technology, spaceflight opportunities to test and prove Canadian technology in orbit, provide contracts to Canadian industry and to help enable access to the European market.

Canada currently participates in ESA programs related to Satellite Communication, Earth Observation, Navigation, Space Exploration and General Support Technology Development. A significant portion of Canada's investments in ESA optional programs return to Canada in the form of contracts for the Canadian space sector. Experience shows that follow-on opportunities for Canadian companies is valued at almost 3 times the initial investment contract awarded. Additionally, the ESA Education Office has a series of programs for students to gain valuable skills and experience in the space sector, which Canadian students are eligible to participate in.

1.1.3. European Union Space Activities

The European Union (EU) has its own space policy, programs and agency which focuses on helping Europeans carry out everyday activities on earth. Key aspects of the program include the Copernicus constellation (the most comprehensive earth observation system), Galileo constellation (a Global Navigation Satellite System system) and EGNOS (a safety navigation service). Although an independent entity with a different membership, the EU space programs are facilitated through the European Space Agency which has the technical expertise to enable the programs.

The CSA's engagement with the European Commission is largely through participation in ESA programs. Although direct collaboration outside of ESA has been minimal to date, there is an active effort to increase data sharing between CSA on the behalf of GC and the EU on earth observation related missions.

1.2. International Organizations

1.2.1. UN COPUOS

The United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) was established in 1959 to govern the peaceful exploration and use of space for the benefit of all humanity and was instrumental in the creation of the five treaties and five principles of outer space. The Committee, which now comprises 95 Member States, is responsible for reviewing international cooperation in peaceful uses of outer space, studying space-related activities that could be undertaken by the United Nations, encouraging space research programmes, and studying legal problems arising from the exploration of outer space. The technical work is divided among two subsidiary bodies: the Scientific and Technical Subcommittee (STSC), and the Legal Subcommittee (LSC) which report their findings to the Committee for consideration. The final Committee decisions are considered at the Fourth Committee of the United Nations General Assembly for adoption.

As one of the founding members of UN COPUOS, Canada has played a key role in the Committee over the last several decades, including a recent, and highly successful, Chairmanship of the Committee. More specifically, the CSA has and continues to actively participate in the work of the Committee and its subsidiary bodies annually by continuing to uphold and support the "...promotion of the peaceful use and development of space..." as outlined in the CSA Act. Over the last several years, the CSA has been instrumental in moving some significant files forward, including the adoption of the preamble and the 21 long-term sustainability guidelines for outer space activities in June 2019, which is considered by many to be the most significant body of work on the multilateral space policy front, to provide policy and regulatory guidance on the safety of space operations and sustainability of the outer space environment.

1.2.2. Committee on Earth Observation Satellites and Group on Earth Observation

The Committee on Earth Observation Satellites (CEOS) was established in September, 1984 in response to a recommendation from a panel of experts on remote sensing from Space. The original function of

CEOS was to coordinate and harmonize Earth observations to make it easier for the user community to access and use data and it initially focused on interoperability, common data formats, the inter-calibration of instruments, and common validation and inter-comparison of data products, but has since evolved and is the primary forum for international coordination of space-based Earth observations. [CEOS Agencies](#) communicate, collaborate, and exchange information on Earth observation activities and work together to launch multi-agency collaborative missions.

CEOS played an important role in the establishment of the [Group on Earth Observations](#) (GEO), created in 2003 as a network connecting government institutions, academic and research institutions, data providers, businesses, engineers, scientists and experts to create innovative solutions to global challenges, helping to identify gaps and reduce duplication in the areas of sustainable development and sound environmental management. The CSA and Environment and Climate Change Canada co-represent Canada at GEO.

1.2.3. OECD Space Forum

OECD (Organisation for Economic Co-operation and Development) is an intergovernmental organization comprised of 36 member countries and 300 expert committees/working groups addressing the economic, social and environmental challenges of interdependence and globalization. The Space Forum was established by the OECD to better identify the statistical aspects of the space sector, while investigating the space sector's economic significance, innovation role and potential impacts for the larger economy.

The OECD Space Forum activities include the development of research and publications, bilateral briefings with ministries and administrations on space issues, as well as two annual events. In collaboration with NASA, CSA hosted the first OECD Space Forum workshop to take place in Canada in June 2019; the theme was the economics of space debris.

The Space Forum's Steering Group includes eleven members in charge of space activities from OECD economies (Canada, USA, France, Germany, Italy, Korea, U.K., Norway, Switzerland, Netherlands) and the European Space Agency. It is supported by contributions from member countries.

1.2.4. International Space Exploration Coordination Group (ISECG)

In 2006, 14 space agencies, including the Canadian Space Agency, began a series of discussions on global interests in space exploration and elaborated a vision for peaceful robotic and human space exploration, focusing on destinations within the solar system where humans may one day live and work, and developed a common set of key space exploration themes. This vision was articulated in The Global Exploration Strategy: The Framework for Coordination, which was released in May 2007. A key finding of this framework document was the need to establish a voluntary, non-binding international coordination mechanism through which individual agencies may exchange information regarding interests, objectives, and plans in space exploration with the goal of strengthening both individual exploration programmes as well as the collective effort. This coordination mechanism is the International Space Exploration Coordination Group (ISECG).

ISECG develops products that enable participating agencies to take concrete steps towards partnerships for a globally coordinated exploration effort. The Global Exploration Roadmap (GER) is a non-binding product that captures a shared vision for human and robotic space exploration beginning with the International Space Station and extending to the Moon, asteroids, Mars and other destinations. The most recent addition was released in 2018 and was followed by a supplement released in August 2020 entitled "*Lunar Surface Exploration Scenario Update*".

ISECG membership has expanded and now includes 24 agencies. The most recent additions include: the Brazilian Space Agency (AEB), the Luxembourg Space Agency (LSA), the Norwegian Space Agency (NOSA) and the Vietnamese National Space Center (VNSC) as the latest ISECG members. They have joined the Group in recent months. Already in the course of 2019, the Australian Space Agency (ASA), the Romanian Space Agency (ROSA) and the Swiss Space Office (SSO). The CSA will take over chairmanship of the ISECG from JAXA, the Japanese space agency, in September. This will be the second time that CSA is the Chair.

1.3. FVEYs / Civil and Security Discussions

Description

Space security is an increasingly important topic given the growth in actors able to use and access outer space and the inherent dual-use nature of space assets. It is an issue that impacts civil, military and diplomacy aspects of the space file with the ultimate goal of ensuring outer space remains safe and sustainable. Likeminded partners coordinate on these matters to ensure a common understanding of responsible behavior. This group called the Five Eyes (FVEY), includes Australia, Canada, New Zealand, United Kingdom and the United States. In addition to coordinating on the establishment of acceptable norms and behaviors, the group also engages in UN related space security matters, sharing best practices for national legislation and regulation, and assessing scenarios through war games.

Considerations

Global Affairs Canada is the lead for space security issues in Canada. The Department of National Defense is also playing an increasingly important role with the establishment of the Space division in the Canadian Air Force. The CSA is heavily involved in providing support on a number of files to represent the interests of civil/commercial space in these security-focused discussions.

1.4. International Engagement Directive

In 2019, the CSA approved a directive on international engagement. This directive is applicable to all CSA employees or any other individuals who may engage with foreign states, entities, and individuals, in settings both domestically and abroad, as a representative of the Agency.

The objectives of this directive are to:

- Ensure all international engagement activities are in line with the CSA's objectives and functions;
- Ensure that all CSA staff are aware of and act in accordance with Canada's foreign policy interests;
- Ensure that all CSA staff have situational awareness of relevant geopolitical and security considerations.

Due to the current COVID-19 situation, and conflicting priorities, the implementation of the directive has been delayed.

2. Domestic Partners

2.1. Government of Canada (in alphabetical order)

2.1.1. Agriculture and Agri-Food Canada (AAFC)

AAFC's mandate is to support the Canadian agriculture and agri-food sector through initiatives that promote innovation and competitiveness. AAFC has a small but dedicated team that accesses data from the Radarsat Constellation Mission (RCM) and international satellites, and previously benefitted from the CSA's former funding program, the Government Related Initiatives Program (GRIP) to develop new methods in satellite remote sensing for agriculture. For AAFC, satellite data is often the most reliable method of obtaining cost-effective, timely, accurate and scalable information on the state of Canada's agricultural systems at a national scale. Operational applications of space-based Earth observation at AAFC currently include: (a) annual crop type and land cover mapping at the field-scale; (b) the Integrated Canadian Crop Yield Forecaster (ICCYF) that forecasts crop yields during the growing season (with Statistics Canada); (c) weekly surface soil moisture observations and anomalies applied to drought and climate risk monitoring (with ECCO); and (d) weekly near-real-time mapping of crop condition and its deviations from normal (with Statistics Canada). These activities use data acquired by various satellites (e.g., RCM, Landsat-8, Sentinel-1, Sentinel-2, RADARSAT-2, and MODIS).

2.1.2. Department of Fisheries and Oceans (DFO)

DFO is the federal lead for safeguarding Canada's waters and managing Canada's fisheries, oceans and freshwater resources. DFO supports economic sustainability in the marine and fisheries sectors, and innovation in areas such as aquaculture and biotechnology. DFO also helps ensure healthy and sustainable aquatic ecosystems through habitat protection and sound science. CSA along with DFO (and Transport Canada (TC)) is working in close collaboration on SmartWhales, an initiative under smartEarth. The CSA released an RFP on June 24, 2020, which aims to allocate \$5.4M over the next 4 years (\$4.2M from CSA and \$1.2M from DFO) to fund R&D using satellite data to help find a solution to the North Atlantic Right Whales (NARW) issue. The RFP calls for industry led consortia, with participation of the academic sectors, to explore and develop innovative solutions in which satellite data can be used in conjunction with other information sources to contribute to the protection and environmental management of NARW in Canadian waters. It is expected that a contract will be awarded in January 2021, at the latest.

DFO makes use of a wide variety of space-based Earth observation (SBEO) sources within the optical (e.g., WorldView, Pléiades, Sentinel-2, Landsat, PlanetScope, MODIS) and SAR (RADARSAT-2, Sentinel-1, TerraSAR-X) domains. It is expected that DFO's use of all forms of SBEO will increase in the future. In addition to its operational activities, DFO is actively supporting research to enhance the department's use of SBEO. Currently this is concentrated within hydrographic applications (e.g., fast navigational hazard identification, optical and SAR bathymetry), coastal hazard identification (e.g., effluent discharges, pollution events) and aquaculture/fisheries management support.

2.1.3. Department of National Defence (DND)

Space capabilities are critical to national security, sovereignty and defence. To deliver on these capabilities, responsibility for defence space activities rests with both the Department of National Defence (DND) and the Canadian Armed Forces (CAF) two distinct but complementary organizations.

The Royal Canadian Air Force (RCAF) now leads space operations for DND/CAF. A major reorganization of responsibilities for space operations, force development and plans within the RCAF is underway and is expected to continue for several years. Space operations are conducted using DND/CAF-owned, GC-shared, commercial and allied space systems. DND/CAF has built a CAF Joint space program that contributes to the success of a wide range of missions. Equally important, the DND/CAF operations are dependent on other government departments such as the CSA, and a growing list of industry partners. In recent years, the DND/CAF space paradigm has evolved from viewing space as providing uncontested enabling capabilities to a more complex view of space as a congested, contested, and competitive operational domain.

Satellites provide support across all levels of military operations – from humanitarian assistance and disaster response, to peace support, and even combat. Satellite communications (SATCOM) are essential on a global scale for secure, protected, and survivable communications links. Space-based search and rescue support capabilities contribute to force protection and national search and rescue mandates. Intelligence, Surveillance and Reconnaissance (ISR) satellites (including RCM) provide critical time-sensitive information and situational awareness, and global position, navigation and timing capabilities are critical to both domestic and global missions.

Currently, DND/CAF downloads a host of satellite data to its ground stations (referred to as Polar Epsilon by DND/CAF) to build a clear picture of Canadian and international waters. This information is shared with several other federal departments, such as Public Safety Canada, the Canadian Border Services Agency, Royal Canadian Mounted Police, Canadian Coast Guard, and Transport Canada in their roles within the marine security operations centres. The new RCM satellites, which are equipped with both Synthetic Aperture Radar (SAR) and Automatic Identification System (AIS) payloads, will downlink to the new Polar Epsilon 2 ground stations to provide enhanced global maritime surveillance.

The CSA and DND/CAF have a long history of formalized bi-lateral cooperation dating back to 1995. Founded on the acknowledgement that the Canadian Space Program, administered by the CSA, and Canada's Defence Space Program were distinct but often complementary in nature; this partnership has been instrumental in developing RCM, an internationally esteemed space-based maritime domain awareness capability, has helped advance Canada's capabilities in Space Situational Awareness (via NEOSAT and DND's Sapphire satellite), and validated potential space solutions to address Canada's Arctic communication requirements, to name a few. In addition to strong bi-lateral partnership, the CSA and DND/CAF also cooperates at the multilateral level as we are often members of the same multi-departmental committees.

DND/CAF's positions and views on space were publicized via the release of Canada's Defence Policy – Strong, Secure, Engaged (SSE) in 2017. The policy acknowledges that space capabilities are critical to national security, sovereignty, and defence. The policy also highlights that space capabilities have become an essential bulwark for CAF operations. In addition, SSE establishes the following space-related objectives for DND/CAF:

- In collaboration with allies, deter against threats to or attacks on Canadian interests, which is increasingly relevant to the space and cyber domains;
- Defend and protect military space capabilities, including by working closely with allies and partners to ensure a coordinated approach to assuring continuous access to the space domain and space assets;

- Work with partners to promote Canada’s national interests on space issues, promote the peaceful use of space and provide leadership in shaping international norms for responsible behaviour in space;
- Invest in and employ a range of space capabilities, including space situational awareness, space-based earth observation and maritime domain awareness, and satellite communications that achieve global coverage, including in the Arctic; and
- Conduct cutting-edge research and development on new space technologies in close collaboration with allies, industry, and academia to enhance the resilience of space capabilities and support the Canadian Armed Forces’ space capability requirements and missions.

2.1.4. Environment and Climate Change Canada (ECCC)

ECCC informs Canadians about protecting and conserving Canada’s natural heritage, and ensuring a clean, safe and sustainable environment for present and future generations. ECCC’s use of SBEO is vast and varied, with a role that spans the full life cycle of satellite data. ECCC is dependant on SBEO as mission-critical data to deliver on its mandate of ensuring a clean, safe and sustainable environment for Canadians through science-based services, regulation, and enforcement. The department is able to leverage this information to support activities from weather forecasts and warnings to understanding climate change, inland and coastal water quality monitoring, and ecosystem assessment and monitoring. The use of SBEO data supports ECCC with its enforcement of legislation and regulations concerning pollution and the protection of wildlife and habitats. Other ECCC applications like air quality, ozone and greenhouse gas monitoring are demonstrating considerable improvements to operational products with the addition of new and advanced satellite missions to data assimilation processes.

ECCC relies on many different types of SBEO data. For example, Canada’s RADARSAT program has been fully integrated into many of ECCC’s application areas (e.g., sea ice, pollution and ecosystem monitoring). To ensure real-time access to mission-critical satellite data for operational use in ECCC’s forecasting and environmental monitoring (e.g., weather, sea ice, volcanic ash, etc.) programs, ECCC operates two satellite reception networks; a geostationary network capable of receiving data from the GOES and next generation GOES-R series of satellites; and a polar-orbiting network receiving National Oceanic and Atmospheric Administration (NOAA) series, Aqua/Terra, Suomi-NPP and Metop-A. In addition, ECCC accesses the majority of SBEO data sets through global data exchanges, international agreements, and from global data archives.

2.1.5. Natural Resources Canada (NRCan)

NRCan’s mandate is to ensure that the country’s abundant natural resources are developed sustainably, competitively and inclusively. NRCan is also the Government of Canada’s lead geospatial agency. CSA and NRCan share a long-standing involvement in furthering space science, research, technology, services, applications, and governance. Areas of mutual interests include: Earth Observation and geospatial data; Position, Navigation and Timing and Global Navigation Satellite Systems; utilizing space resources; Space weather; Environmental monitoring and management, including in areas such as climate change, forests, and resource development projects; Arctic and Northern considerations; and, Emergency and disaster management.

An umbrella MOU to refresh the 2001 MOU is currently under preparation. This MOU will establish a framework for cooperation between the Parties relating to the space policies and programs of the GC. NRCan is also active across the entire SBEO value chain, as a major user and an important enabler of SBEO within the federal EO community. On behalf of the GC, NRCan operates a national ground station network that, along with tasking and controlling multiple satellites, is responsible for collecting and distributing RADARSAT data to civilian users in Canada. Operational users in ECCC, AAFC and DFO rely on

the timely acquisition and delivery of RADARSAT data through this NRCan network everyday. NRCan's Earth Observation Data Management System (EODMS) is the federal access point for a variety of historical archives of EO data. NRCan is also home to the Canada Centre for Remote Sensing, the federal centre of SBEO expertise whose foundational science advances current and future uses of SBEO in Canada. In addition to earth observation, the CSA is also working closely with NRCan on emerging space issues related to policy development for space resource utilization (SRU). NRCan has a strong interest in this given their responsibility for mining and the inclusion of space as a new frontier for mining in the Canadian Minerals and Metals Plan (CMMP).

2.1.6. Global Affairs Canada (GAC)

GAC plays a key role in the space file. In addition to providing guidance related to international affairs and trade engagement, GAC is a space regulator and plays a lead role on space security issues. One of GAC's main responsibilities includes the licencing of any remote sensing system operated from Canada or by Canadian entities abroad via the [Remote Sensing Space Systems Act \(RSSSA\)](#). The purpose of the RSSSA is to ensure that observations of earth, from space, are conducted in a peaceful manner, consistent with Canada's security interests and international treaty obligations. In addition, GAC is engaged in multilateral discussions at the United Nations, including the [Conference on Disarmament \(CD\)](#), and the [First Committee](#) of the United Nations General Assembly, which focus primarily on discussing and recommending solutions to security and disarmament issues in space, and further participates alongside the CSA at the [United Nations Committee on the Peaceful Uses of Outer Space \(UN COPUOS\)](#), its subcommittees, and the [Fourth Committee](#) of the United Nations General Assembly to advocate for sustainability, and international cooperation in the peaceful uses of outer space. The CSA also collaborates with GAC on issues related to diplomacy as it relates to engagement with other countries and their respective embassies. This is further leveraged through collaboration with the GAC trade commissioner service, which provides businesses development opportunities for Canadian companies in foreign markets.

2.2. Government of Canada - up and coming space users

As accessing and using satellite data becomes easier, more departments and government agencies are beginning to explore the value of SBEO for meeting their mandates and providing services to Canadians. A total of 12 departments use RADARSAT data, 5 of which are considered major user departments and an additional 7 that are developing their expertise and usage.

Before the COVID-19 pandemic, the Public Health Agency of Canada (PHAC) was engaged in exploring the role that satellite data might have in better understanding and forecasting air quality and heat events due to the links between these conditions, and others, on the health of Canadians. With the onset of the COVID-19 pandemic, in collaboration with the CSA, Statistics Canada, and other space-using departments, PHAC has begun convening a team of experts to explore the role satellite data may have in tracking the impacts of COVID-19. From changes in urban activity and air quality due to prevention measures, to the confluence of weather and climate factors with COVID-19 risks, SBEO has its own role to play in the wider response to COVID-19.

Another emerging player in space is Shared Services Canada (SSC), whose mandate to manage government data movement and access is vital in the development of smoother open satellite data databases.

On the other end of the supply chain, National Research Council (NRC) is working to develop new technologies of relevance for Earth observation, human spaceflight, and space exploration. Working in partnership with Canada's top academics and companies, the NRC is Canada's lead in experimentation

and development of new technologies ranging from robotics and materials, to computing and medical devices. In 2020, the CSA and NRC signed a new MOU for cooperation which acts as an umbrella to numerous other agreements on specific projects such as robotic arm technologies and food production in harsh environments.

2.3. Academia

Earlier in 2020, the CSA updated its inventory of space-related research capacity in Canada with a national Academic Study. It had two objectives: a) providing an update on the state of research, expertise, and knowledge mobilization activities related to space in Canadian postsecondary education institutions; and, b) identifying key challenges and trends in academic space science related disciplines in Canada, and their interface with the CSA. Fifty-two out of 54 universities participated (96% response), in addition to six out of 8 colleges (75% response).

The main findings were:

- Many researchers remain unaware of the Space Strategy or how their institutions' core capabilities are relevant to the CSA's priorities;
- There was significant growth in the diversity of space-related talent in Canadian universities and (to a much lesser extent) colleges (2x increase in the last five years);
- Renewed call for the CSA to support the development of space-related research talent;
- The diversity of Federal funding programs makes it challenging for researchers to effectively navigate funding opportunities; and,
- Capabilities in indirect fields of space studies are on the rise, such as: human behavior; space policies & law; artificial intelligence/ machine language (i.e., enabling technologies); and New Space

The full Academic Study is available in Book 5 – Additional Reading Material

2.3.1. Advisory Committees

Description

The CSA has six Science Advisory Committees. The mandate of the committees is to provide independent feedback to the CSA on its scientific disciplines and their associated programs. The disciplines are: astronomy, planetary exploration, space health and life sciences, solar-terrestrial science, atmospheric science, and Earth system science. The Science Advisory Committees' guiding principles, terms of references and recruitment strategies are being revised at the moment by the CSA's Science Advisor to the President in collaboration with CSA's science community and stakeholders within the government, private sector and academia. The intent is to diversify the membership, where necessary, with individuals from various social and geographical backgrounds (see "Membership"), improve the dialogue between the agency and the committees, and increase the information flow and engagement - especially from early career researchers - in order to add value to CSA decision-making processes.

Membership

Membership is composed mainly of academics, with additional scientists from the CSA, the federal government and the private sector in some cases. In addition to current efforts to diversify membership, representation within the disciplines is another issue being addressed. For instance, the astronomy and solar-terrestrial sciences are well defined communities with proportionally large engagement with CSA space sciences. Earth system sciences, planetary sciences, and space health and life sciences lie,

however, within large communities where space-related opportunities compete with cyclical (or regular), well-run, well-funded programs for terrestrial research.

2.3.2. U15

Established in the mid-1980s, the U15 is an association of the largest 15 Canadian public research universities. Headquartered in Ottawa, the U15 represents its members' interests on the research enterprise and government programs supporting research and development. The group's member institutions undertake 80 percent of all competitive university research in Canada, rank among the world's premier institutions and conduct about \$8.5 billion worth of research annually. Collectively, U15 member institutions produce more than 75 percent of all doctorates awarded in Canada and are home to 46 percent of all students in Canada. Gilles G. Patry is the current Executive Director, who last met with CSA (then) President Sylvain Laporte in November 2018.

2.4. Industry

2.4.1. Space Sector Stats

The [State of the Canadian Space Sector Report](#), which the CSA has been publishing since 1996, provides comprehensive and authoritative data, as well as long-term trend analysis on the economic activity generated in the Canadian space sector. The report includes data on the number of organizations active in the sector and their composition, the sectors of activity, the Canadian space workforce and its composition, research and development (R&D), and innovation.

The report is based on a questionnaire sent to companies, not-for-profit organizations, research centres and universities with space-related activities in Canada. The 2019 State of the Canadian Space Sector Report: Facts and Figures 2018, which was published in March 2020 is based on data from 174 organizations.

2019 State of the Canadian Space Sector (2018 data) – Executive Summary

In 2018, total revenues in the Canadian space sector remained stable at \$5.7B. The average annual growth rate of the space sector between 2014 and 2018 was 1.3%. The space sector was estimated to have contributed \$2.5B to Canada's GDP and supported a total of 20,891 jobs in the greater Canadian economy (including space sector jobs, supply industry jobs and jobs created as a result of consumer spending).

In 2018, the upstream segment (which includes Research, Engineering and Consulting as well as manufacturing) accounted for \$812M in revenues, while the downstream segment (which includes satellite operations, products and applications, and services) accounted for the majority of revenues, at \$4.9B. Of note, satellite broadcasting services revenues were \$2.2B in 2018, representing a 46% share of the downstream segment. While Satellite Communication remained the sector of activity that accounted for the majority of revenues (81%), Navigation was the sector that experienced the highest growth (108%) in 2018. Domestic revenues decreased by 2.4% year-over-year and totalled \$3.4B in 2018. Export revenues, on the other hand, increased by 7%, totalling \$2.3B.

The space sector workforce totalled 9,567 space-related full-time equivalents (FTEs) in 2018, of whom 61% were STEM (science, technology, engineering and mathematics) related employees and 64% were highly qualified personnel (HQP) (who are defined as employees in possession of at least a bachelor's degree). Space companies hired 741 employees, of whom 26% were women and 74% were men. Academic organizations contributed 20% of the total space sector workforce with 1,909 FTEs, of whom 92% were HQP.

Business expenditures on R&D (BERD) totalled \$356M in 2018, with 74 organizations undertaking space R&D projects. This represents a 2% decrease over 2017 results, with BERD down by \$7M. Space sector organizations reported a total of 170 new inventions and 53 new patents registered in 2018.

Canada's space ecosystem is dominated by a few large companies that account for the majority of the revenues and workforce. In 2018, Canada had 8 large space companies, which accounted for 57% of revenues and 69% of the workforce. SMEs, which made up 94% of all Canadian space companies in 2018, accounted for the remaining 43% of Canadian space sector revenues and 31% of all employees.

In 2018, the top 30 Canadian space organizations (based on revenues), which included 4 universities and 22 small and medium enterprises (SMEs), generated 96% of total space revenues and represented 78% of space employment. They also accounted for 89% of BERD and 68% of registered patents, but only 33% of inventions.

2.4.2. Major Industrial Partners Profiles

2.4.2.1. MacDonald Detwiler and Associates (MDA)

MacDonald Dettwiler and Associates (MDA) Ltd., is Canada's largest space company and is a global player in advanced space technology solutions for commercial and government markets including space robotics, satellites sub-systems, synthetic aperture radar imagery, geospatial data and analytics. It is an established leader in the development of technology for domestic and export use in both commercial and defence markets. On December 31, 2019 MDA was acquired by Northern Private Capital, a private Canadian investment firm, for \$1 Billion from US-based MAXAR, thus changing MDA's status from publicly traded to private company. On April 8, 2020, the acquisition closed and MDA sale to Northern Private Capital was completed.

MDA has a long-standing history of collaboration with the CSA on multiple high-profile projects, including the development and operations of robotic systems for NASA's Shuttle Program and the International Space Station as well as the proposed Canadarm3 for the Lunar Gateway. In addition, MDA led the design and construction of the RADARSAT series of satellites, the Mars Exploration Science Rover prototype and the design and construction of the laser altimeter instrument for OSIRIS-REx spacecraft currently at the asteroid Bennu. MDA is also a key contractor for ESA's ExoMars rover. In July 2020, CSA awarded pre-phase A contract for Canadarm3 integration support to MDA, who was selected as prime contractor for Canadarm3 project earlier this year. Since 2014, MDA has secured approximately \$890M in contracts and contributions from the CSA.

2.4.2.2. Honeywell

Honeywell Aerospace (HA) is the world's largest supplier of avionics and a leading supplier of aircraft engines, and related products and services for aircraft manufacturers, airlines, aircraft operators, military services, as well as for defence and space contractors. HA is Owned by Honeywell International and headquartered in Glendale, Arizona. In 2016, HA acquired Cambridge, Ontario based COM DEV International Ltd. (COM DEV).

Building on COM DEV's history of collaboration with the CSA, HA has continued to receive contracts and apply for funding under the Space Technology Development Program (STDP). HA's core Canadian activities include a number of COM DEV projects such as the Fine Guidance Sensor (FGS) and the Near-Infrared Imager and Slitless Spectrograph (NIRISS) for the James Web Space Telescope (JWST),

construction of M3MSat, a satellite that demonstrated the Automatic Identification System (AIS) for ship detection from space, and the Automatic Identification System receivers for the three Radarsat Constellation Mission spacecraft through Honeywell Aerospace's U.K. division (formerly COM DEV Europe). In 2019, HA was awarded two contracts totaling nearly \$36 million; \$34.5 million for the design, build and implementation of the Quantum Encryption and Science Satellite (QEYSsat) and related quantum ground station and, \$1.38 million Phase A contract for the WildFireSat mission. Since 2014, HA has secured approximately \$70M in contracts and contributions from the CSA.