



STATE ^{OF} THE CANADIAN SPACE 2021 SECTOR 2022

Facts and Figures 2020 & 2021

2021 & 2022 State of the Canadian Space Sector Report FACTS AND FIGURES 2020 & 2021

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The Tarantula Nebula – NIRCam

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About this Report

OBJECTIVE

The *State of the Canadian Space Sector Report* provides factual information about the Canadian space sector. The report, which is now in its 24th/25th edition, is based on a questionnaire sent to companies, not-for-profit organizations, research centres and universities with space-related activities in Canada.

To align with international practices, the publication is identified by the year in which the survey took place (2021 & 2022), but reports on data covering the year 2020 and 2021. All of the information in the report represents data from 2020 and 2021, with the exception of the work done in collaboration with Statistics Canada on the Linkable File Environment (LFE) sections of this report, where data covers up to 2019. Further information on the LFE is available in Annex B.

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. In this edition, data on economic trends are reported for the 2017–2021 period. Readers should consult previous editions (available on the Canadian Space Agency website or the Government of Canada Open Government portal) for information regarding results prior to 2017.

The organization-specific information used to compile this report remains strictly confidential and will not be released in any manner other than aggregate form. Consequently, in certain circumstances, a detailed explanation or in-depth reporting of the results cannot be provided in order to protect the confidentiality of the respondents.

Of note, the numbers presented throughout the report may not add up precisely to the totals provided due to rounding. Additionally, the findings presented throughout this report are provided at current prices (i.e. unadjusted for inflation).

ABOUT THE AUTHORS

Policy Branch

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FOR MORE INFORMATION

For more information about the Canadian space sector, or for an electronic copy of this report, please go to www.asc-csa.gc.ca/eng/publications.

ACKNOWLEDGMENTS

The CSA wishes to acknowledge all those who responded to the questionnaire. Without them, this report would not have been possible.

President's Message

As the President of the Canadian Space Agency (CSA), I am pleased to present the *2021 & 2022 State of the Canadian Space Sector Report: Facts and Figures 2020 & 2021*. The report, which has been published since 1996, contributes to our understanding of the sector by providing comprehensive data, as well as long-term trend analysis on the economic activity generated by the Canadian space sector. In order to better understand the impacts of recent global events, the CSA has combined the results from the 2021 and 2022 surveys into a single report.

The report is based on information gathered from almost 200 organizations involved in space activities from across Canada, including small businesses, multinational space companies, not-for-profit organizations, research centres and universities.

In 2020, the global economy experienced an unprecedented challenge related to COVID-19, which rippled into wider economic issues across the world. The impact on the Canadian space sector varied – some areas experienced declines while other areas fared much better and even saw growth.

Revenues have declined. The most pronounced impact is on revenues, which dropped to \$4.9B (-11%) in 2020, and remained at that level in 2021. The largest segment responsible for this decline was export activity, which fell to just \$1.9B in 2020 and \$1.8B in 2021. The opportunity for recovery is present in 2022 as challenges from the pandemic and issues in the supply chain begin to recede.

Research and Development (R&D) activity reached peak levels. R&D expenditures reached new highs in both 2020 and 2021, totalling \$479M in 2020, and \$547M in 2021. The increased R&D activity is primarily led by the private sector, supporting a growing downstream market in Canada and aligning with the rapid growth of the global space sector. In addition, an analysis of return on investment (ROI) for CSA space development programs shows that for every dollar invested, 2.2 dollars are returned through follow-on revenues.

The workforce has been resilient, but is experiencing increased competition for workers. The Canadian space workforce has been resilient over the past two years, declining slightly to 10,900 (-3%) in 2020, but recovering rapidly and showing growth in 2021, reaching over 11,600 (+7%). Workforce multiplier impacts indicate that activities in the space sector supported more than 12,000 additional



Lisa Campbell,
President of the Canadian Space Agency (CSA)

jobs in the wider Canadian economy in both 2020 and 2021. Organizations have increasingly highlighted that competition for experts in the sector is high, leading to labour shortages.

Government funding continues to be an anchor for the sector. Government funding still plays a significant role in supporting the space sector, but this is primarily in the upstream segment where ~40% of revenues derived from government. In the downstream segment, government funding does not offset recent declines given the large percentage of revenues derived from non-government clients (~95%). That said, some survey respondents noted that government COVID-19 relief during the pandemic was essential in maintaining workforce and operations.

It is evident that the space sector continues to be an important part of the Canadian economy. Investing in space does more than just support activities in space: it has a direct impact on the socio-economic benefits for Canadians back on Earth. We have seen first-hand how Canadian space activities drive innovation, push technological and scientific boundaries, and build the workforce of tomorrow. As we look forward to exciting missions to observe our Earth and explore our solar system, I am certain that the space sector will continue to play a key role in improving the daily lives of Canadians.

I would like to convey my gratitude to all those who contributed to both the 2021 and 2022 surveys. This publication would not be possible without the generous collaboration of members of the Canadian space industry and academia.

1 Executive Summary

While overall showing resilience, in 2020, the Canadian space sector faced challenges as COVID-19 negatively influenced the normal functions of organizations. The challenges continued in 2021, and were exacerbated by supply chain issues in the global economy. The overall impacts on the Canadian space sector varied, including declines in some areas, and growth in others.

In 2020, total revenues in the Canadian space sector declined to \$4.9B (down 11%), and remained at this level in 2021. Domestic revenues decreased by 6% in 2020, and then rebounded by 4% in 2021 to a total of \$3.1B. Export revenues were severely impacted in 2020, decreasing by 18%, and continued to decline in 2021, decreasing by another 3%, to a total of \$1.8B.

The average annual growth rate of the space sector between 2017 and 2021 was negative 3.29%. The space sector is estimated to have contributed \$2.7B to Canada's GDP in 2020, increasing to \$2.8B in 2021, and supported a total of 22,846 (2020) and 24,190 (2021) full-time equivalent (FTE) jobs in the greater Canadian economy (including space sector jobs, supply industry jobs and jobs created as a result of consumer spending).

In the sectors of activity, Satellite Communication has been impacted most significantly over the past two years, with revenues declining by 12% in 2020, and a subsequent 3% decline in 2021, settling at just \$3.9B (from \$4.6B in 2019). Space Exploration has seen robust growth, accelerating by 11% in 2020, and an additional 24% in 2021. The remaining sectors of activity saw slight increases from 2019 to 2021, but Space Science saw slight declines.

The space sector workforce added government employees at the CSA for this edition, and data have been backdated to accurately reflect sector trends. The space sector workforce declined by 3% in 2020 to total 10,868 space-related FTEs. Subsequently, in 2021, the total number of space related FTEs grew by 7% to reach a new high of 11,629. Information relating to gender has been relatively constant, with 29% of people in the Canadian space sector identifying as female, and 71% identifying as male. The percentage of the total space workforce representing

STEM and HQP has not shifted significantly over the past two years. In 2021, 62% of the total workforce were STEM (science, technology, engineering and mathematics) related employees, and 67% were highly qualified personnel (HQP).¹ Similarly, academic organizations have not seen a large shift in workforce, contributing 19% of the total space sector workforce in 2021 with 2,240 FTEs, of whom 87% were HQP and 96% were STEM (similar to 2019).

Business expenditures on R&D (BERD) saw significant growth over the past two years, increasing to \$479M in 2020, and \$547M in 2021, an increase of 46%. The return on investment (ROI) revealed that for CSA space development programs, for every dollar invested, 2.21 dollars are returned through follow-on revenues – a multiplier of 2.21 times. Space sector organizations reported a total of 226 new inventions and 76 new patents registered in 2021, similar to previous years.

In 2021, the top 30 Canadian space organizations (including four universities) generated 95% of total space revenues and represented 69% of space employment. They also accounted for 81% of BERD, 31% of registered patents, and 41% of inventions.

SMEs accounted for 93% of all Canadian space companies in 2021. Together, SMEs accounted for 42% of Canadian space sector revenues and 30% of all employees.

¹ Employees in possession of at least a bachelor's degree.

2 Economic Impact Analysis

KEY RESULTS

- In 2020, the space sector contributed \$2.7B to Canada's GDP and supported a total of 22,846 jobs.
- In 2021, slight growth in GDP from 2020 resulted in the space sector contributing \$2.8B to Canada's GDP and supporting a total of 24,190 jobs.

The methodology used for the following economic impact analysis is detailed in Annex B.

ECONOMIC IMPACT – GROSS DOMESTIC PRODUCT

The space sector contributed \$2.7B to Canada's GDP in 2020, and \$2.8B in 2021. This represents the value of all final goods and services produced by the space sector within Canada. Total GDP contribution was broken down into the following:

2020

- \$1.34B in space sector impacts;
- \$0.60B in supply industry impacts; and
- \$0.72B in impacts related to consumer spending by associated employees.

2021

- \$1.41B in space sector impacts;
- \$0.62B in supply industry impacts; and
- \$0.78B in impacts related to consumer spending by associated employees.

The space sector creates benefits in the larger economy with a GDP multiplier of 1.98 (2020), and 1.99 (2021). In other words, every dollar that the space sector contributed to GDP resulted in an additional \$0.98 (2020) and \$0.99 (2021) in GDP contributions for the broader economy.

ECONOMIC IMPACT – JOBS SUPPORTED

The space sector supported a total of 22,846 jobs (2020) and 24,190 jobs (2021) in Canada. The total workforce contribution was broken down into the following:

2020

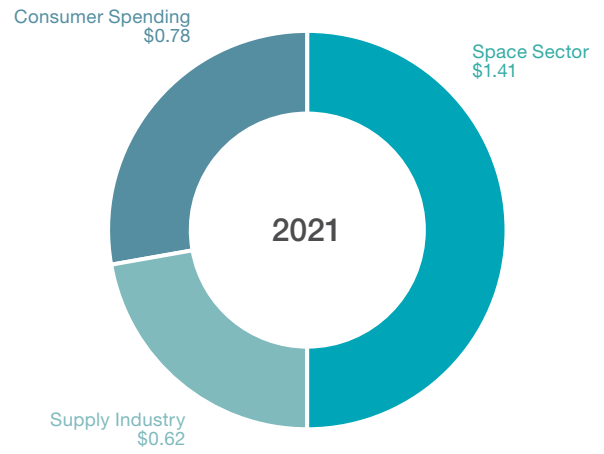
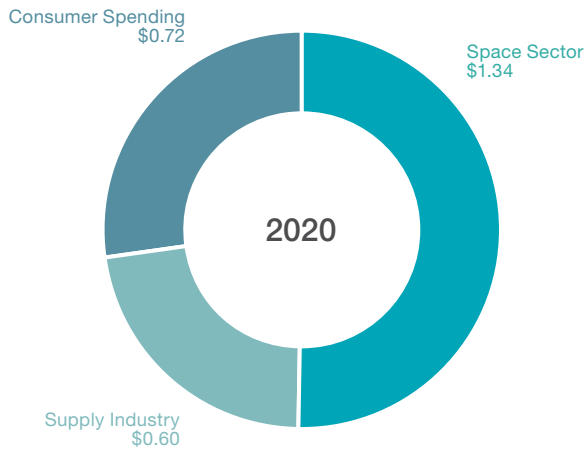
- 10,868 space sector jobs;
- 6,170 supply industry jobs; and
- 5,808 jobs created and supported as a result of consumer spending by associated employees.

2021

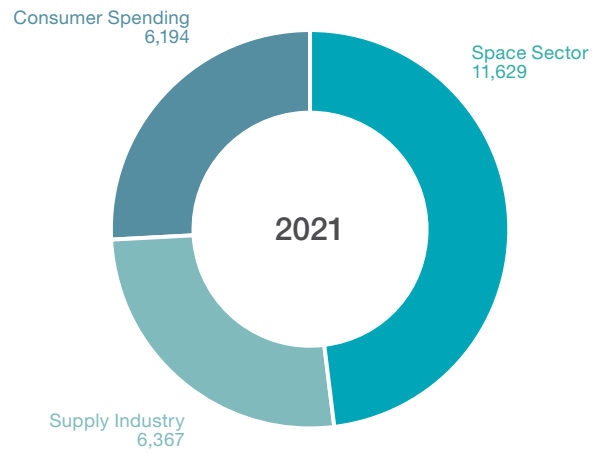
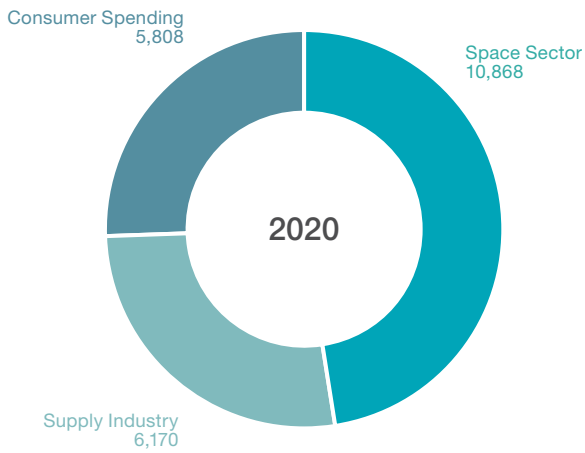
- 11,629 space sector jobs;
- 6,367 supply industry jobs; and
- 6,194 jobs created and supported as a result of consumer spending by associated employees.

The space sector creates jobs in the broader economy with a workforce multiplier of 2.10 (2020) and 2.08 (2021). In other words, every job in the space sector supports an additional 1.10 jobs (2020), or 1.08 jobs (2021) in the broader economy.

Total GDP Impact: 2020 & 2021 (in \$B)



Total Workforce Impact: 2020 & 2021 (number of jobs)



3 Overall Results

KEY RESULTS

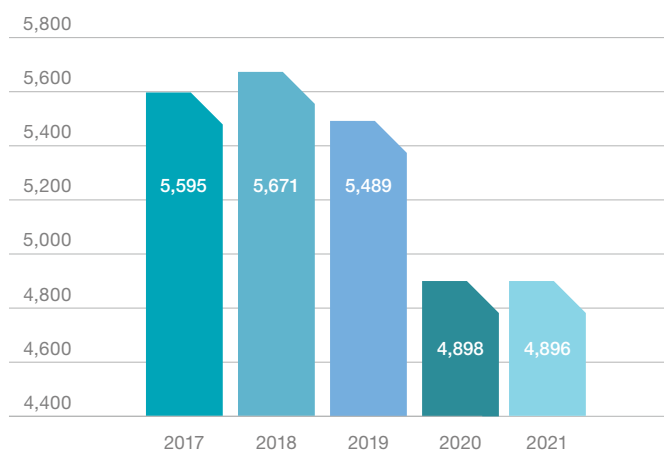
- Total revenues in the Canadian space sector declined from 2019 figures to \$4.9B for both 2020 and 2021.
- In Ontario, Quebec, and the Atlantic provinces, space revenues have declined over the past two years, but the Prairies and B.C. have both shown revenue growth since 2019.
- The Canadian space workforce increased by 7% in 2021 to 11,629 space-related FTEs. The increase more than compensated for the declines from 2020, showing growth in the total workforce.
- The Canadian space sector workforce is predominantly made up of people who identify as male (71%), with those identifying as female representing the remaining 29% of the workforce.
- The STEM workforce experienced significant growth in 2021, rising by 11% to 7,238 FTEs, which is higher than 2019, and accounted for 62% of the total Canadian space workforce.
- HQP (employees with at least a bachelor's degree) accounted for 67% of the workforce and totalled 7,784 FTEs, which is higher than in 2019.

TOTAL REVENUES

In 2020, total revenues in the Canadian space sector significantly declined, totalling \$4.9B, a -11% (-\$592M) decline year-over-year. Revenues for the space sector were virtually unchanged in 2021, remaining at \$4.9B. The compound annual growth rate (CAGR) of the space sector between 2017 and 2021 declined 3.3%.²

COVID-19 and global supply chain issues continue to impact the global economy and contributed to the decline and stagnation of Canadian space sector revenues. A detailed analysis of the source of this decline in growth can be found in the section of this report on Revenues by Markets and Customers.

Total Space Sector Revenues: 2017–2021 (in \$M)



² Calculated using Compound Annual Growth Rate (CAGR).

TOTAL WORKFORCE

In 2020, the space sector workforce totalled 10,868 FTEs, a 3.3% decrease, or -368 FTEs. The space sector workforce rebounded in 2021, totalling 11,629 FTEs, a 7% increase, or +761 FTEs.

The space sector workforce breakdown remained the same in 2020 and 2021, consisting of 47% of FTEs in the upstream segment, 46% of FTEs in the downstream segment, and the remaining 7% of FTEs at the CSA. Definitions of what classifies as upstream and downstream activities are available in Annex C.

Note that workforce data now include CSA employees.

Gender Distribution of Employees

In total, 121 (2020) and 130 (2021) organizations responded to the workforce section on gender, representing 63% and 68% of organizations surveyed, respectively.

Results indicated that the Canadian space sector workforce is primarily made up of people who identify as male, with 72% in 2020 and 71% in 2021. Those who identify as female represented the remaining 28% and 29% of the workforce, respectively. The Other category accounted for 0.3% (2020) and 0.1% (2021) of employees in the Canadian space sector.



Gender Question

- Respondents were asked to identify the gender breakdown of their space-related employees by percentage, under the headings Male, Female, and Other.

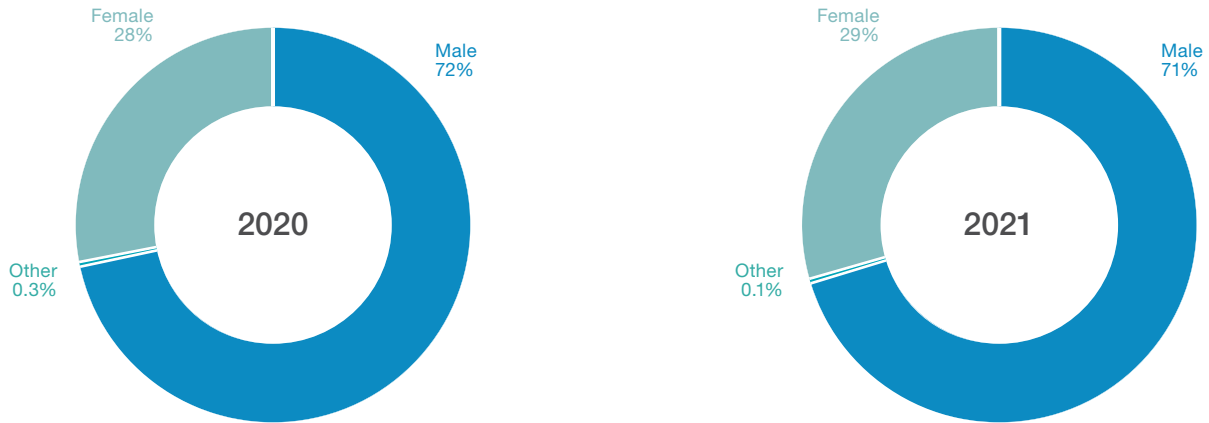


2022-12-15. The Canadian CubeSat Project

Team members from McMaster University in a clean room at the Canadian Space Agency. The Canadian CubeSat Project provides teams of students in post-secondary institutions with the unique opportunity to design and build their own nanosatellite called a CubeSat.

Credit: CSA

Space Sector Workforce Gender Distribution



Gender composition in the provinces is as follows:

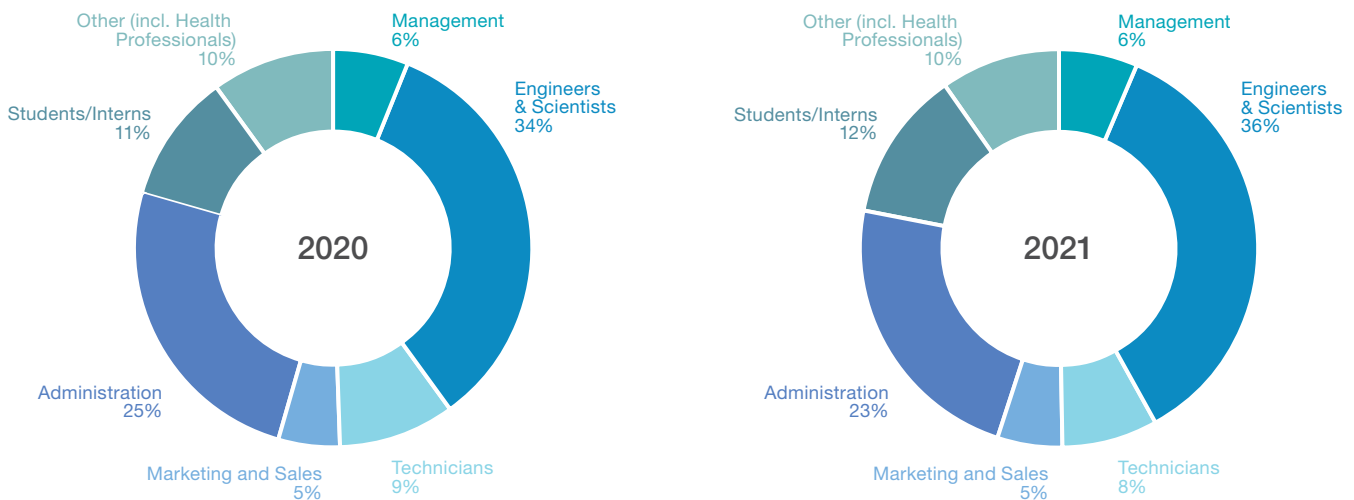
	2020			2021		
	Male	Female	Other	Male	Female	Other
B.C.	72.2%	27.6%	0.3%	70.2%	29.7%	0.1%
Prairies	77.2%	22.8%	-	75.8%	24.1%	0.1%
Ontario	70.6%	28.7%	0.7%	70.4%	29.5%	0.1%
Quebec	73.7%	26.3%	-	69.9%	30.1%	-
Atlantic	60.5%	39.5%	-	64.3%	35.3%	0.4%

Occupations

The CSA divides the space workforce into eight main occupation categories: Engineers and Scientists, Technicians, Management, Administration, Marketing and Sales, Students, Health Professionals, and Other Employees.

As is evident in the charts below, there were minimal shifts in the composition of the workforce in both 2020 and 2021. The breakdown is also similar to occupational composition data from 2019.

Canadian Space Sector Occupations: 2020 & 2021



STEM Employees

The STEM indicator tracks the number of engineers, scientists, technicians, management, health professionals and students working in the space sector. STEM employees totalled 6,532 FTEs in 2020 and 7,238 FTEs in 2021, which represented 60% and 62% of the total Canadian space workforce, respectively.

Definition of STEM Employees

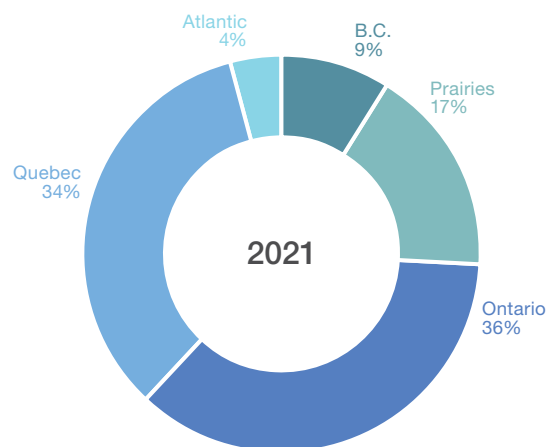
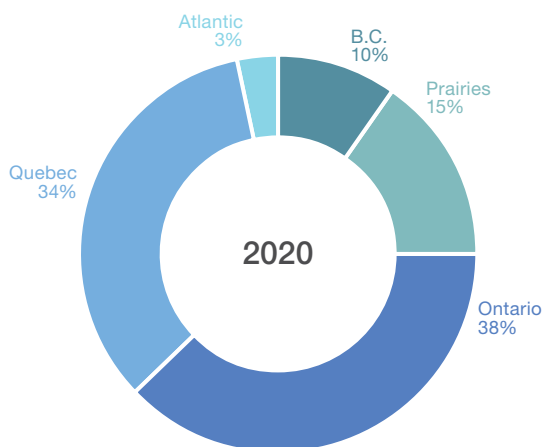
- STEM = Engineers, scientists, technicians, management, health professionals, and students

There are significant differences between the upstream and the downstream segments. In 2020, 81% of the workforce in the upstream segment were STEM,

while only 36% of the workforce in the downstream segment were STEM. Results for 2021 were similar, with 86% of the workforce in the upstream segment and 40% in the downstream segment identified as STEM.

Of particular note is the proportion of STEM employees as a percentage of the total workforce, examined at the regional level. In the Prairies (Alberta, Saskatchewan and Manitoba) and B.C., STEM employees accounted for more than 80% of the provincial space workforce. STEM employees accounted for less than 65% of the space workforce in Ontario, Quebec and Atlantic Canada (New Brunswick, Prince Edward Island, Newfoundland and Nova Scotia). A lower share of STEM employees often reflects an industry that includes more downstream companies (especially broadcasting companies), which tend to employ a higher number of administrative employees.

Distribution of STEM Employees by Region: 2020 & 2021



2022-10-20. Space Brain Hack session

Canadian Space Agency astronaut Joshua Kutryk facilitated a Space Brain Hack session with a group of grade 7/8. Together, they explored solutions for astronauts to stay mentally healthy in space.

Credit: CSA

STEM Workforce: 2020 & 2021

2020	Total Workforce	Total STEM	% of STEM Relative to Total Regional Workforce	% of STEM Relative to Total Number of STEM in Canada's Space Workforce
B.C.	746	638	86%	10%
Prairies	1,109	999	90%	15%
Ontario	3,984	2,469	62%	38%
Quebec	4,287	2,221	52%	34%
Atlantic	742	205	28%	3%
Total	10,868	6,532	-	100%

2021	Total Workforce	Total STEM	% of STEM Relative to Total Regional Workforce	% of STEM Relative to Total Number of STEM in Canada's Space Workforce
B.C.	808	679	84%	9%
Prairies	1,324	1,246	94%	17%
Ontario	4,215	2,628	62%	36%
Quebec	4,514	2,423	54%	34%
Atlantic	768	262	34%	4%
North	1	1	-	-
Total	11,629	7,238	-	100%

Highly Qualified Personnel (HQP)

The HQP indicator identifies the number of space sector employees with at minimum a bachelor's degree. HQP employees accounted for 6,902 FTEs in 2020, and 7,784 FTEs in 2021, which represented 64% and 67% of Canada's space workforce, respectively.

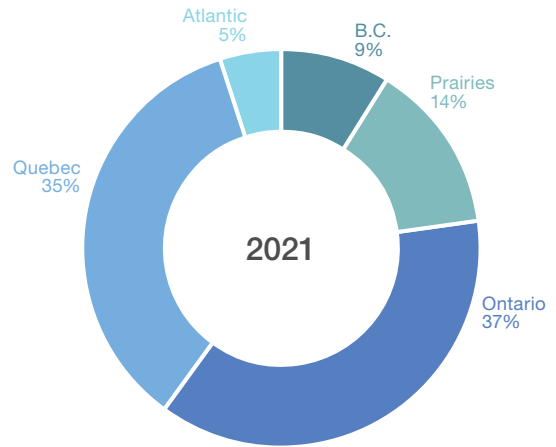
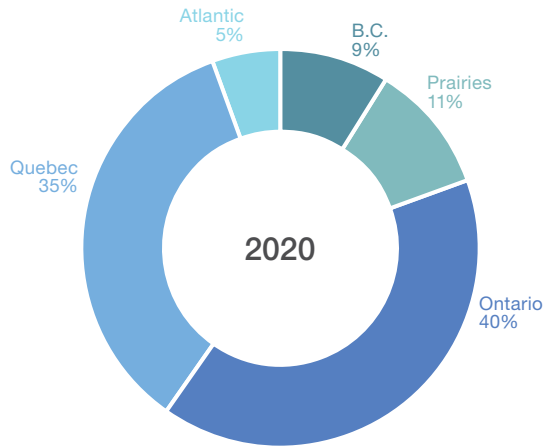
Definition of HQP Employees

- HQP = Employees having completed at least a bachelor's degree

The differences between HQP FTEs in the upstream and the downstream segments are less pronounced than for STEM employees, but are still significant. While 73% of the upstream workforce were HQP in 2020, only 52% of the downstream workforce were HQP. In 2021, representation of HQP grew in the upstream to 79%, and also increased to 56% in the downstream.

In B.C., HQP accounted for 83% of the workforce in 2020 and 2021, the highest proportion in Canada. The second highest HQP segment was in the Prairies, followed by Ontario, Quebec, and Atlantic Canada. Similarly to STEM employees, the share of HQP staff often reflects an industry that includes more downstream companies (especially broadcasting companies), which tend to employ a higher number of administrative employees.

Regional Distribution of Highly Qualified Personnel in the Canadian Space Sector: 2020, 2021



Distribution of Highly Qualified Personnel in the Canadian Space Sector: 2020, 2021

2020	Total Workforce	Total HQP	% of HQP Relative to Total Regional Workforce	% of HQP Relative to Total Number of HQP in Canada's Space Workforce
B.C.	746	622	83%	9%
Prairies	1,109	739	67%	11%
Ontario	3,984	2,762	69%	40%
Quebec	4,287	2,406	56%	35%
Atlantic	742	373	50%	5%
Total	10,868	6,902	-	100%

2021	Total Workforce	Total HQP	% of HQP Relative to Total Regional Workforce	% of HQP Relative to Total Number of HQP in Canada's Space Workforce
B.C.	808	670	83%	9%
Prairies	1,324	1,056	80%	14%
Ontario	4,215	2,904	69%	37%
Quebec	4,514	2,756	61%	35%
Atlantic	768	398	52%	5%
North	1	1	100%	-
Total	11,629	7,784	-	100%

Statistics Canada Linkable File Environment: The Impact of Business Innovation and Growth Support on Canadian Space Enterprises

The CSA has continued collaborating with Statistics Canada through the Linkable File Environment (LFE) to produce statistics relevant to the Canadian space sector.

Additional information on the LFE is available in Annex B.

The collaboration this year included an analysis and report of the Business Innovation and Growth Support (BIGS) of Canadian space development programs. The objective of the study was to measure the impact of CSA space development programs on employment and revenue of companies within the Canadian space sector from 2007 to 2019.

An analysis of CAGR showed that after one year, companies that received funding from CSA space development programs experienced a growth in the number of their employees (by 8%, which was 27% higher than a control group that did not receive funding), and in their revenues (by 22%, which was 17% higher than the control group). After three years, results showed that the CAGR continued

to grow by 18% (which was 27% higher than the control group) for the number of employees, but saw no change in revenues.

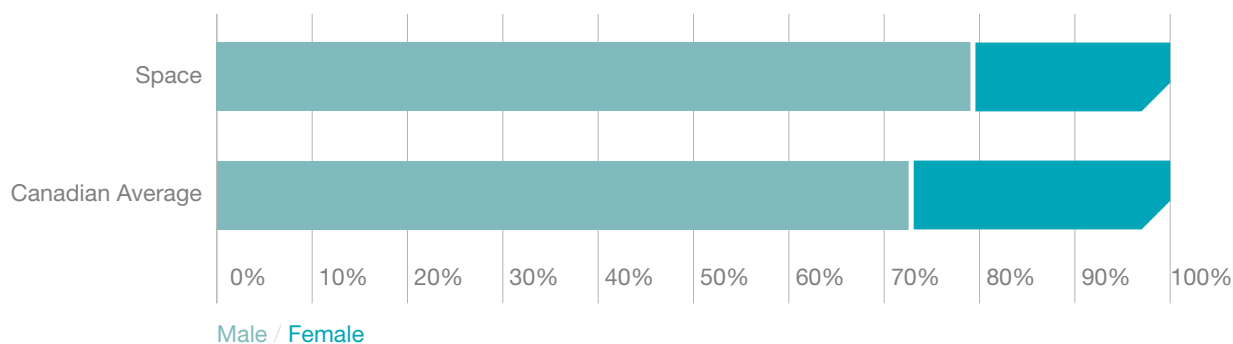
These results suggest that CSA space development programs have a positive impact on employment in the short and medium term (1 and 3 years), and to lesser extent on revenue for recipients in the short term (after 1 year).

Statistics Canada Linkable File Environment: Gender

In 2019, Canadian space sector companies with primary owners identifying as male represented 79%, and those who identified as female represented the remaining 21%. This is a 4% increase from 2018 in the representation of female primary owners.

It is important to note that there are limitations in the dataset for 2019, as a portion of the data is characterized as unknown and/or not available. As a result, the comparison above does not include the unknown/not available data for both 2019 and 2018 data.

Space Enterprises by Sex of Primary Owner (2019 Data)



Space Labour Force Challenges and Needs

In 2020, 55% of Canadian space companies faced difficulties hiring personnel to the extent that positions went unfilled. Hiring difficulties continued in 2021, where 61% of Canadian space companies were unable to fill vacant positions.

The professions for which companies had the most difficulty finding employees were unchanged across 2020 and 2021, and included engineers, scientists, technicians, and management, which is similar to the types of jobs that have been difficult to hire for since 2017.

The two main reasons highlighted for hiring difficulties were competition from other industrial sectors for the same talent,

followed by applicants lacking the skills required for the position.

In 2020, companies dealing with employee shortages used three main strategies to deal with the problem: they provided internal training to their employees, they shared the workload amongst existing employees, and they outsourced some of the work. In 2021, there was a shift in the third ranked strategy from outsourcing to hiring foreign workers.

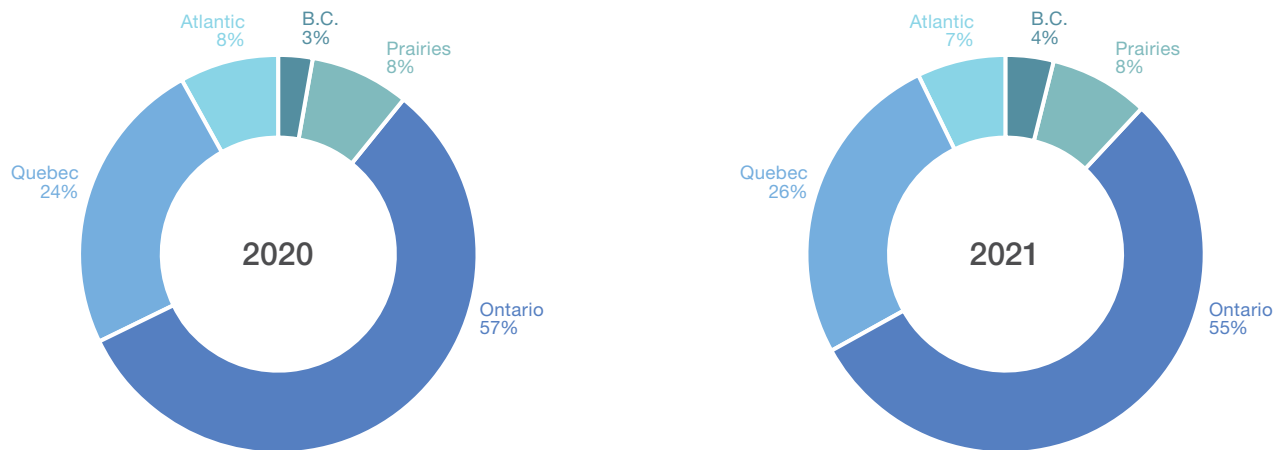
Over the next five years, Canadian space companies will be looking for employees with sought-after skills related to software development, electrical engineering systems, mechanical engineering systems, as well as business development and commercialization.

REGIONAL DISTRIBUTION AND TRENDS

In 2020, despite the challenges surrounding COVID-19, the proportional share of total revenues and employment by province remained relatively stable compared to 2019. Similarly, 2021 showed only small variations in the regional distribution from 2020.

*Note: The North (Yukon, Northwest Territories, and Nunavut) reported revenues for the first time. They are minimal and therefore not included in the graphs, but may appear in tables discussing total revenues.

Regional Distribution of Total Revenues: 2020, 2021



Revenues by Region, Domestic vs. Export (in \$M): 2019–2020–2021

	2019		2020		2021	
	Domestic	Exports	Domestic	Exports	Domestic	Exports
B.C.	\$61	\$102	\$74	\$92	\$97	\$87
Prairies	\$51	\$317	\$53	\$333	\$58	\$339
Ontario	\$1,832	\$1,393	\$1,635	\$1,150	\$1,682	\$1,021
Quebec	\$1,015	\$287	\$997	\$191	\$1,027	\$224
Atlantic	\$222	\$209	\$237	\$136	\$253	\$108
North	N/A	N/A	N/A	N/A	\$0.02	\$0

Revenues by Region

British Columbia

In 2020 and 2021, British Columbia had revenues of \$165M and \$184M, respectively. Revenues increased in total by 13% (\$22M) when comparing revenues in 2021 to 2019. Domestic revenues increased by 60%, or \$36M, from \$61M in 2019 to \$97M in 2021. Export revenues declined by 15%, or \$15M, from \$102M to \$87M between 2019 and 2021.

Between 2017 and 2021, B.C.'s total revenues decreased by 37% from \$290M to \$184M. This decline was driven by a 39% decline in domestic revenues, from \$158M to \$97M. Over the same period, export revenues contracted by 34%, from \$132M to \$87M.

B.C. accounted for 3% of Canadian space sector revenues in 2020, and 4% in 2021. Upstream segment organizations generated 40% (2020) and 31% (2021) of the province's space revenues, and downstream segment organizations generated 60% (2020) and 69% (2021) of the province's space revenues. Notably, the proportion of revenues between the upstream and downstream segments of the value chain reversed in 2020 in B.C., where previously the upstream segment generated more revenues than the downstream segment (2019). This is more in line with the space sector composition in the rest of Canada.

Prairies (Alberta, Saskatchewan and Manitoba)

Revenues in the Prairies reached \$386M in 2020 and \$396M in 2021, an increase of 8% (\$28M) from 2019 to 2021. Domestic revenues grew by 14%, or \$7M, from \$51M in 2019 to \$58M in 2021; export revenues increased by 7%, or \$21M, from \$317M in 2019 to \$338M in 2021. From 2019 to 2021, the following provincial changes occurred:

- Alberta's revenues increased by 12%, or \$31M, from \$253M to \$285M.
- Saskatchewan's revenues decreased by 13%, or \$13M, from \$100M to \$87M.
- Manitoba's revenues increased by 65%, or \$10M, from \$15M to \$25M.

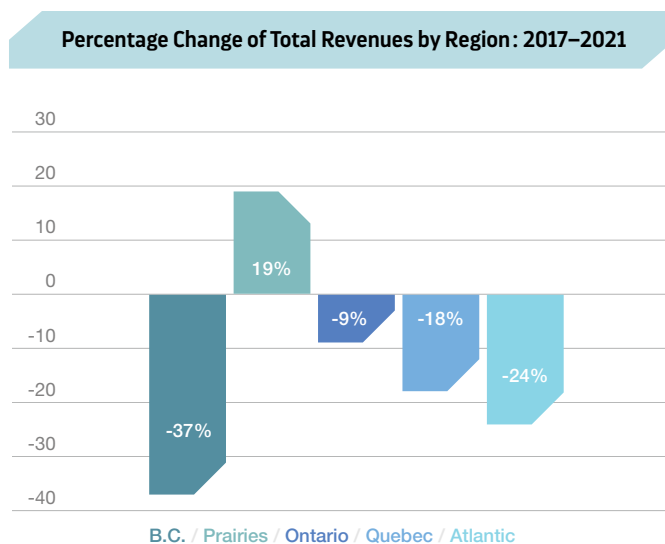
Between 2017 and 2021, total revenues grew by 19%, from \$332M in 2017 to \$396M in 2021. Domestic revenues decreased by 22%, from \$74M in 2017 to \$58M in 2021; exports grew by 31%, from \$258M to \$339M, in the same period.

The Prairies accounted for 8% of Canadian space sector revenues in both 2020 and 2021. Revenues in the upstream segment accounted for 30% (2020) and 25% (2021), while 70% (2020) and 75% (2021) came from the downstream segment.

Ontario

Revenues in Ontario fell to \$2.79B in 2020, and further decreased to \$2.70B in 2021, declining by 16% overall, or \$521M from 2019. Domestic revenues decreased from 2019 to 2021 by 8%, or \$150M, totalling \$1.83B, while exports declined 27%, or \$372M, totalling \$1.02B in 2021. The significant declines in Ontario were anticipated due to the impacts of COVID-19.

Total revenues in Ontario decreased by 9% between 2017 and 2021. The decline may not represent a trend, as the impacts of COVID-19 and supply chain issues in the global economy in 2021 impacted revenues. Domestic revenues



declined 6%, from \$1.78B in 2017 to \$1.68B in 2021. Export revenues declined by 14% over the same period, from \$1.19B to \$1.02B, highlighting the significant impacts of COVID-19 and global supply chain issues.

Ontario accounted for 57% and 55% of Canadian space sector revenues in 2020 and 2021. Two-thirds of Ontario space organizations worked in the upstream segment, but they accounted for just 12% and 14% of revenues in 2020 and 2021. Downstream segment organizations accounted for 88% (2020) and 86% (2021) of revenues in the province due to significant revenue in satellite operations, manufacturing of satellite communication hardware (such as satellite terminals), and broadcasting services.

Quebec

Revenues in Quebec declined to \$1.19B in 2020, and rebounded to \$1.25B in 2021. Overall, between 2019 and 2021 revenues declined by 4%, or \$51M. Domestic revenues increased by 1%, or \$18M, from \$1.02B in 2019 to \$1.03B in 2021; exports declined 22%, or \$63M, from \$287M in 2019 to \$224M in 2021. The significant declines in Quebec were anticipated due to the impacts of COVID-19.

Between 2017 and 2021, Quebec's total revenues decreased by 18%, from \$1.53B to \$1.25B. This has largely been driven by a 19% decline in domestic revenues, which went from \$1.26B in 2017 to \$1.03B in 2021. Export revenues declined by 16%, from \$266M to \$224M over the same period. Exports had previously been on an upward trajectory, and may return to growth after the shock of COVID-19 and global supply chain issues end.

Quebec accounted for 24% of Canadian space sector revenues in 2020, and 26% in 2021. Approximately two-thirds of Quebec organizations are in the upstream segment, while

revenues were heavily concentrated in the downstream segment at 83% (2020) and 77% (2021), compared to the upstream at 17% (2020) and 23% (2021).

Atlantic Canada (New Brunswick, Prince Edward Island, Newfoundland & Labrador and Nova Scotia)

Revenues in the Atlantic region decreased from \$431M in 2019 to \$373M in 2020, and further decreased to \$361M in 2021, which represented a decline of 16%, or \$71M, from 2019 to 2021. Domestic revenues grew by 14%, or \$31M, from \$222M in 2019 to \$253M in 2021. Export revenues declined by 48%, or \$101M, from \$209M in 2019 to \$108M in 2021. The significant declines in Atlantic Canada were anticipated due to the impacts of COVID-19 in 2020. From 2019 to 2021, the following provincial changes occurred:

- Revenues in Newfoundland and Labrador declined by 41% and totalled \$134M.
- Revenues in New Brunswick increased by 10% and totalled \$221M.
- Revenues in Nova Scotia increased by 13% and totalled \$5.2M.

Between 2017 and 2021, total revenues in the Atlantic region declined by 24%, from \$472M in 2017 to \$361M in 2021. Domestic revenues grew by 28%, from \$197M in 2017 to \$253M in 2021, while export revenues declined by 61%, from \$275M in 2017 to \$108M in 2021.

The Atlantic region accounted for 8% (2020) and 7% (2021) of Canadian space sector revenues. In Atlantic Canada, there are a few small to medium-sized upstream segment players, which are mainly in academia, and a handful of downstream segment organizations. Downstream segment organizations accounted for 98% (2020) and 97% (2021) of revenues, and upstream segment organizations accounted for the remaining 2% (2020) and 3% (2021).

North (Yukon, Northwest Territories and Nunavut)

In 2021, revenues were reported for the first time in the North, with \$20,000 reported in the region. The revenues account for only 0.0004% of the space sector and therefore their inclusion in other sections of the report is limited. As this is the first time revenues have been reported in this region, analysis is limited and trend data are not available.

Workforce Group by Region: 2020, 2021										
2020	Engineers & Scientists	Technicians	Management	Administration	Marketing and Sales	Students/Interns	Health Professionals	Other	Total	% of Total Workforce
B.C.	393.0	89.0	60.0	43.0	37.0	95.0	1.0	28.0	746	7%
Prairies	393.0	99.0	69.0	58.0	18.0	429.0	9.0	34.0	1,109	10%
Ontario	1,470.0	303.5	335.0	809.6	233.3	360.5	0.0	472.0	3,984	37%
Quebec	1,310.0	490.0	188.0	1,646.0	153.0	231.0	2.0	267.0	4,287	39%
Atlantic	103.0	40.0	22.0	162.0	119.0	30.0	10.0	256.0	742	7%
Total	3,669.0	1,021.5	674.0	2,718.6	560.3	1,145.5	22.0	1,057.0	10,868	100%
2021										
B.C.	391.8	95.3	67.2	51.0	49.0	124.0	1.0	29.0	808.3	7.0%
Prairies	571.0	74.0	91.0	28.0	13.0	500.5	9.0	37.0	1,323.5	11.4%
Ontario	1,581.9	271.0	339.6	731.0	296.0	425.0	10.0	560.0	4,214.5	36.2%
Quebec	1,451.0	438.0	221.0	1,691.5	153.0	311.3	2.0	246.0	4,513.8	38.8%
Atlantic	135.0	36.5	28.0	151.5	123.0	62.0	0.0	232.0	768.0	6.6%
North	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0%
Total	4,131.7	914.8	746.8	2,653.0	634.0	1,422.8	22.0	1,104.0	11,629.1	100.0%

The 2020 regional workforce is broken down into the following:

- **British Columbia:** 7% (746 FTEs) of Canada's space workforce, an increase of 1% (8 employees) over last year.
- **Prairies:** 10% (1,109 FTEs), a decrease of 1% (7 employees).
- **Ontario:** 37% (3,984 FTEs), a decrease of 11% (513 employees).
- **Quebec:** 39% (4,287 FTEs), an increase of 5% (198 employees).
- **Atlantic Canada:** 7% (742 FTEs), a decrease of 7% (53 employees).

The 2021 regional workforce is broken down into the following:

- **British Columbia:** 7% (808 FTEs) of Canada's space workforce, an increase of 8% (62 employees) over last year.
- **Prairies:** 11% (1,324 FTEs), an increase of 19% (215 employees).
- **Ontario:** 36% (4,215 FTEs), an increase of 6% (231 employees).
- **Quebec:** 39% (4,514 FTEs), an increase of 5% (227 employees).
- **Atlantic Canada:** 7% (768 FTEs), an increase of 4% (26 employees).
- **North:** (1 FTE), first time reporting workforce.



2022-01-20. Canada announces strategy for satellite Earth Observation

Twenty-one Canadian organizations receive funding to make innovative use of Earth observation data. Satellites provide a unique perspective of our planet, support cutting-edge science, and enable applications and services in many areas critical to the health and well-being of Canadians.

Credit: CSA/NASA

4 Revenues by Markets and Customers

KEY RESULTS

- In 2021, the upstream segment generated roughly \$0.8B in revenues, while the downstream segment generated \$4.1B in revenues.
- The Services sub-segment and the Research, Engineering and Consulting sub-segment have grown slightly since 2019. All other sub-segments declined, with Ground Segment Manufacturing and Products and Applications declining the most.
- In the sectors of activities, Satellite Communication represents 79% of all revenues and has declined significantly over the past five years. Over the past five years, Earth Observation has also continued to decline, but all other categories (except these two) have increased.
- Growth in the Canadian space sector was previously driven by exports, and this is the component that has been impacted most severely since 2019, declining from \$2.3B to just \$1.8B in 2021. Conversely, domestic revenues have almost recovered to 2019 levels.
- Export revenues declined to every region of the world. The U.S. remained the main export destination, accounting for 57% of space export revenues.
- Overall, 12% of space revenues were derived from government sources and 88% from non-government sources, similar to 2019 levels.

MARKET SHARE BY VALUE-CHAIN SEGMENTS

Space sector revenues can be broken down into value-chain segments and sub-segments based on the type of work that the organization is carrying out. The two main segments this analysis has been split into are upstream and downstream activities. The upstream segment – comprised of the research, engineering and consulting as well as the space segment manufacturing and ground segment manufacturing sub-segments – generated \$0.73B in revenues in 2020, and \$0.83B in 2021. The downstream segment – comprised of the satellite operations, manufacturing of products (e.g. terminals), development of software applications, and the provision of services (e.g. broadcasting) sub-segments – generated \$4.17B in revenues in 2020, and \$4.07B in 2021.

In 2020 and 2021, significant declines in revenues were noted across the value chain, due in large part to impacts from COVID-19 and global supply chain issues. Impacts differed year-over-year.

In 2020, the Services sub-segment of the value chain was the only area to see positive growth (5%), with all other areas of the value chain declining. The decrease in Products and Applications (42%) was the most significant within the value chain. Ground Segment Manufacturing was similarly impacted, declining 31%, followed by declines in Space Segment Manufacturing (-23%). The remaining areas of the value chain declined at a more modest pace.

In 2021, a partial recovery in revenues from the previous year was visible in the upstream segment of the value chain, with Research, Engineering and Consulting growing 23%, followed by growth in Space Segment Manufacturing at 23%, but a decline in Ground Segment Manufacturing by 10%. The downstream segment was less volatile, with declines in Satellite Operations of 8%, as well as declines in Services, Products and Applications by less than 2% each.

A detailed description of the value-chain categorization is provided in Annex C. Revenues in each sub-segment can be broken down as follows:

- Research, Engineering and Consulting amounted to \$265M in 2020 and \$326M in 2021, which represented an 11% increase (\$33M) from 2019. This sub-segment accounted for 5% of total revenues in 2020, and 7% in 2021.
- Space Segment Manufacturing amounted to \$255M in 2020 and \$314M in 2021, a decline of 5% (\$17M) from 2019. It accounted for 5% of total revenues in 2020, and 6% in 2021.
- Ground Segment Manufacturing amounted to \$210M in 2020 and \$188M in 2021, a 38% decline (\$118M) from 2019. It accounted for 4% of total revenues in 2020 and 2021.
- Satellite Operations amounted to \$879M in 2020 and \$813M in 2021, a 15% decline (\$145M) from 2019. It accounted for 18% of total revenues in 2020, and 17% in 2021.

- Products and Applications contracted to \$616M in 2020 and \$615M in 2021, a 42% decline (\$447M) from 2019. It accounted for 13% of total revenues in 2020 and 2021.
- Services amounted to \$2.67B in 2020 and \$2.64B in 2021, a 4% increase (\$100M) from 2019. It accounted for 55% of total revenues in 2020, and 53% in 2021.

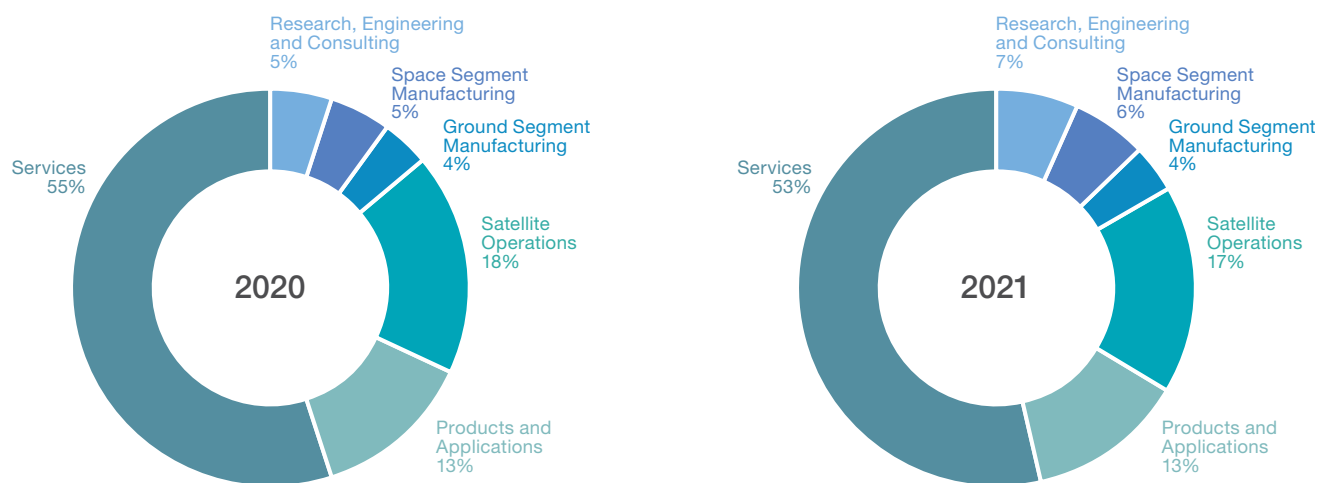


2022-09-30.
50th anniversary of the David Florida Laboratory (DFL)

Canada's world-class spacecraft assembly, integration and testing centre. Since 1972, the DFL has played a key role in some of the most significant Canadian space projects.

Credit: Communications Research Center Canada (CRC)

Proportion of Revenues by Space Value-Chain Segments : 2020, 2021



MARKET SHARE BY SECTOR OF ACTIVITY

In 2020, COVID-19 significantly impacted revenues across all Canadian space sectors of activity, with the exception of revenue growth in Space Exploration, and flat revenues in the Navigation sector. In 2021, revenues recovered in all Canadian space sectors of activity from declines in 2020, with the exception of an additional decline in revenue for the Satellite Communication sector. Trends for the 2017–2021 period are detailed below.

Satellite Communication

Satellite Communication generated \$4.0B (2020) and \$3.9B (2021) in revenues, accounting for 82% and 79% of total space revenues, respectively. The vast majority (90% in 2020, 89% in 2021) of Satellite Communication revenues was derived from activities in the downstream segment, broken down as follows:

	2020	2021
▪ Satellite Operations	\$840M	\$746M
▪ Products and Applications (e.g. antennas)	\$316M	\$303M
▪ Broadcasting Services	\$2.0B	\$2.0B
▪ All other telecommunication services	\$450M	\$456M

The remainder of Satellite Communication revenues (10%) was related to upstream segment activities:

	2020	2021
▪ Research, Engineering and Consulting	\$57M	\$67M
▪ Space Segment Manufacturing	\$169M	\$210M
▪ Ground Segment Manufacturing	\$163M	\$154M

Satellite Communication revenues declined by 12%, or \$565M, in 2020. Satellite Communication revenues declined by an additional 3%, or \$107M, in 2021. Between 2017 and 2021, Satellite Communication revenues experienced an 18% decline, or \$844M, from \$4.7B to \$3.9B.

Earth Observation (EO)

Earth Observation revenues totalled \$226M in 2020 and \$270M in 2021, accounting for 5% and 6% of total space revenues, respectively. The majority of EO revenues (55% in 2020, and 57% in 2021) was in the downstream segment:

	2020	2021
▪ Satellite Operations	\$33M	\$65M
▪ Products and Applications	\$38M	\$34M
▪ Services	\$55M	\$56M

The remainder of revenues (45% in 2020, and 43% in 2021) was related to activities in the upstream segment:

	2020	2021
▪ Research, Engineering and Consulting	\$34M	\$49M
▪ Space Segment Manufacturing	\$26M	\$35M
▪ Ground Segment Manufacturing	\$40M	\$31M

EO revenues declined by 9%, or \$21M, in 2020. EO revenues increased by 19%, or \$44M, to recover somewhat in 2021. Between 2017 and 2021, EO revenues experienced a decline of 31%, or \$121M, from \$390M to \$270M.

Space Exploration

Space Exploration revenues totalled \$132M in 2020 and \$164M in 2021, accounting for 3% of total space revenues in both years. The upstream segment accounted for 98% (2020) and 96% (2021) of Space Exploration revenues, distributed as follows:

	2020	2021
▪ Research, Engineering and Consulting	\$98M	\$120M
▪ Space Segment Manufacturing	\$29M	\$36M
▪ Ground Segment Manufacturing	\$2.5M	\$1.4M

The remainder of revenues was related to activities in the downstream segment:

	2020	2021
▪ Satellite Operations	\$0.05M	\$0.7M
▪ Products and Applications	\$1.4M	\$4.8M
▪ Services	\$1.8M	\$1.7M

Space Exploration revenues experienced growth of 11%, or \$14M, in 2020, and 24%, or \$32M in 2021. Between 2017 and 2021, revenues from Space Exploration grew by 43%, or \$50M, from \$115M to \$164M.

Navigation

Navigation revenues were relatively flat at \$421M in 2020, but grew to \$440M in 2021, which represented 9% of total space revenues in both years. In Canada, 99.7% (2020) and 99% (2021) of space activities related to Navigation are in the downstream segment.

Navigation revenues are broken down as follows:

	2020	2021
▪ Satellite Operations	\$0.0M	\$0.3M
▪ Products and Applications	\$259M	\$265M
▪ Services	\$161M	\$170M

The remainder of activities, which relate to the upstream segment, amounts to roughly \$1.3M (2020) and \$4.1M (2021), divided as follows:

	2020	2021
▪ Research, Engineering and Consulting	\$1.2M	\$3.4M
▪ Space Segment Manufacturing	\$0.1M	\$0.3M
▪ Ground Segment Manufacturing	\$0.1M	\$0.4M

Navigation revenues increased by 1%, or \$2.8M in 2020, and by 4%, or \$19M in 2021. Between 2017 and 2021, revenues from Navigation increased by 64%, or \$171M, from \$269M to \$440M.

Space Science

In 2020, Space Science revenues totalled \$90M and grew to \$94M in 2021, representing 2% of total space revenues in both years. The majority of space science revenues was in the upstream segment:

	2020	2021
▪ Research, Engineering and Consulting	\$66M	\$75M
▪ Space Segment Manufacturing	\$14M	\$10M
▪ Ground Segment Manufacturing	\$1.0M	\$0.5M

With the remainder in the downstream segment:

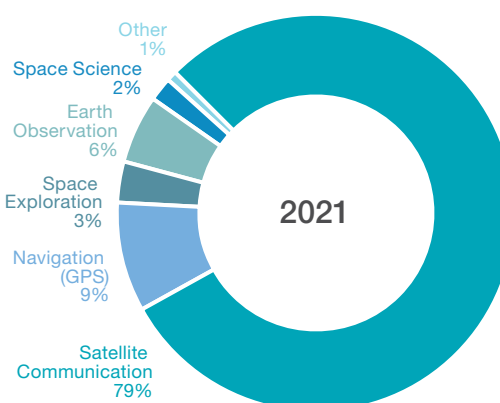
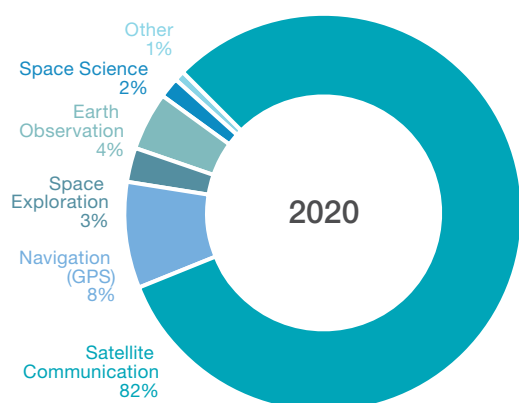
	2020	2021
▪ Satellite Operations	\$5.6M	\$1.1M
▪ Products and Applications	\$2.2M	\$6.8M
▪ Services	\$0.1M	\$0.4M

Space Science declined by 19%, or \$21M in 2020, and increased by 5%, or \$5M in 2021. Between 2017 and 2021, revenues from Space Science increased by 42%, or \$28M, from \$66M to \$94M.

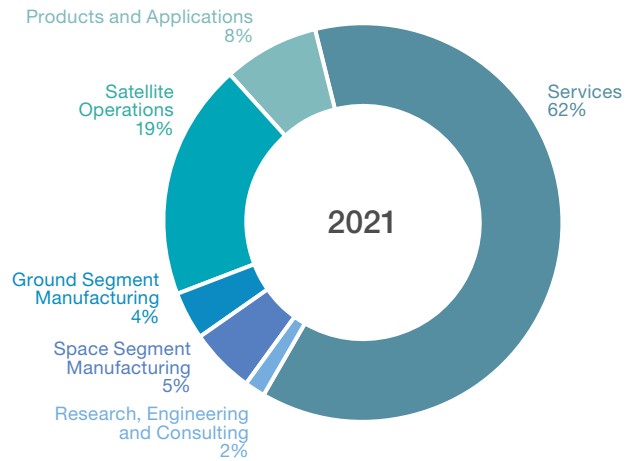
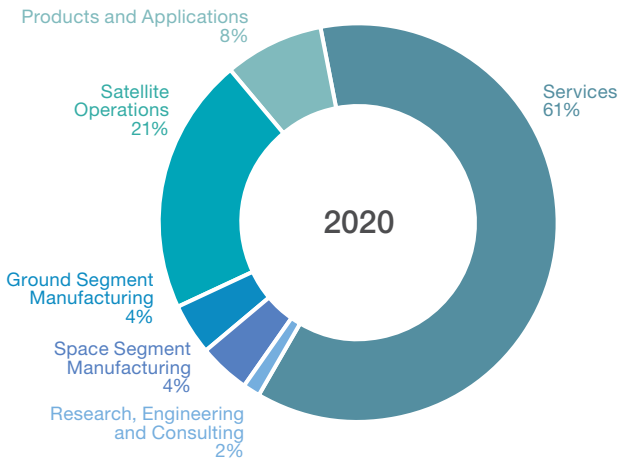
Other Revenues

In 2020, other revenues declined by 2%, remaining at \$31M, and in 2021 other revenues rebounded by 21%, rising to \$37M, and accounting for 1% of total space revenues (in both years). Activities that fall into the “Other” sector are by nature variable and subject to re-categorization; therefore, changes in this sector are less statistically relevant than for the previously noted sectors.

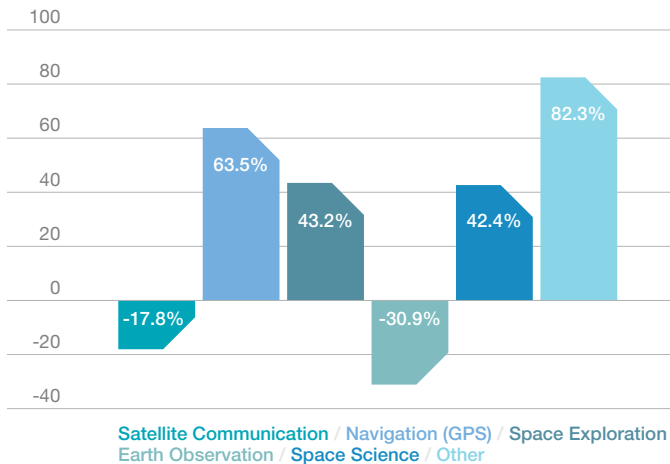
Proportion of Revenues by Sector of Activity: 2020, 2021



Breakdown of Satellite Communication Revenues: 2020, 2021



Percentage Change of Revenues by Sector of Activity: 2017–2021



MARKET SHARE BY CUSTOMER LOCATION

Domestic vs. Export Revenues

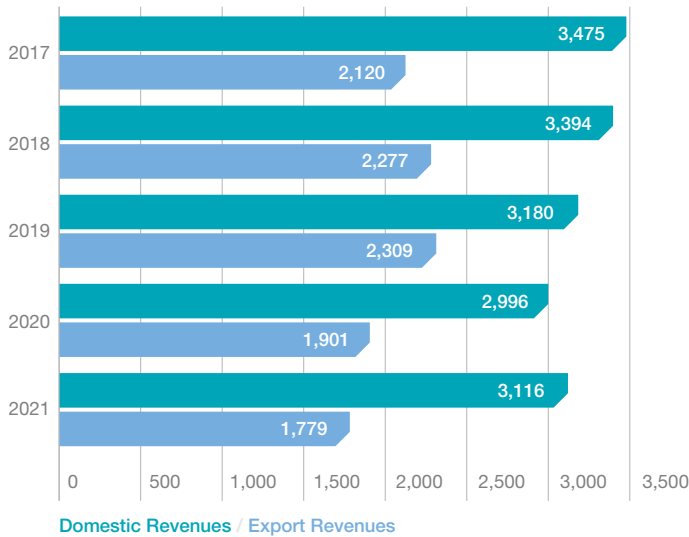
For both 2020 and 2021, Canadian space revenues totalled \$4.9B, of which 61% (\$3.0B in 2020) and 64% (\$3.1B in 2021) were from domestic sources, while the remaining 39% (\$1.9B in 2020) and 36% (\$1.8B in 2021) were from exports. Domestic revenues declined by 5.8%, or \$184M, in 2020, and increased by 4%, or \$120M, in 2021; exports declined by a significant 18%, or \$407M in 2020, and declined an additional 6%, or \$122M in 2021.

The compound annual growth rate (CAGR) between 2017 and 2021 was -3.29% for the entire space sector, -2.69% for domestic revenues, and -4.29% for exports.

Broadcasting is a large contributor to the space economy but is in continued decline as reflected in the divergence in numbers when broadcasting is excluded vs. included in the analysis. When excluding broadcasting, total revenues generated by the Canadian space sector declined from \$3.3B in 2017 to \$2.9B in 2021.

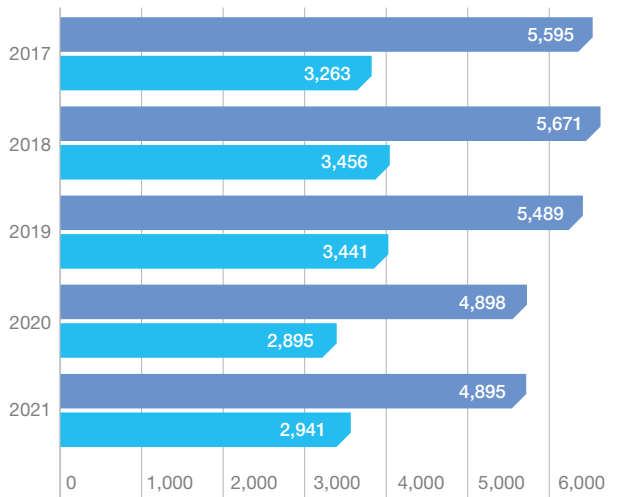
When excluding broadcasting, the CAGR between 2017 and 2021 was -2.6% for the entire space sector, +0.4% for domestic revenues and -4.29% for exports.

Domestic vs. Export Revenues: 2017–2021 (in \$M)



Domestic Revenues / Export Revenues

Total Revenues vs. Total Revenues (excluding broadcasting): 2017–2021 (in \$M)



Total Revenues / Total Revenues (excluding broadcasting)

Export Regions

Export revenues dramatically declined because of COVID-19 in 2020, dropping 18% and generating just \$1.9B in revenues. Declines in export revenues continued into 2021, dropping an additional 6% and generating just \$1.8B in revenues. The declines occurred to exports in almost every major trade region.

Domestic vs. Export Revenues: 2017–2021

	Domestic Revenues	Export Revenues
2017	\$3,475,200,911	\$2,120,153,923
2018	\$3,393,663,363	\$2,276,926,547
2019	\$3,180,456,444	\$2,308,782,280
2020	\$2,996,238,114	\$1,901,345,715
2021	\$3,116,136,976	\$1,778,880,183

The **U.S.** remained the main destination for Canadian space exports, totalling 60% (2020) and 57% (2021) of total exports. Revenues derived from exports to the U.S. contracted by 22%, or \$283M, from \$1.29B in 2019 to \$1.01B in 2021.

Europe remained Canada's second largest market for space exports. Canadian exports to **Europe** declined by 9%, or ~\$41M, from \$437M in 2019 to \$397M in 2021. Europe accounted for 21% (2020) and 22% (2021) of total exports.

Exports to **Asia** decreased by a significant 46%, or \$168M, from \$363M in 2019 to \$195M in 2021. Asia accounted for 10% (2020) and 11% (2021) of total exports.

Exports to **South America** decreased by 17%, or \$20M, from \$117M in 2019 to \$97M in 2021. The region accounted for 5% of total exports in both 2020 and 2021.

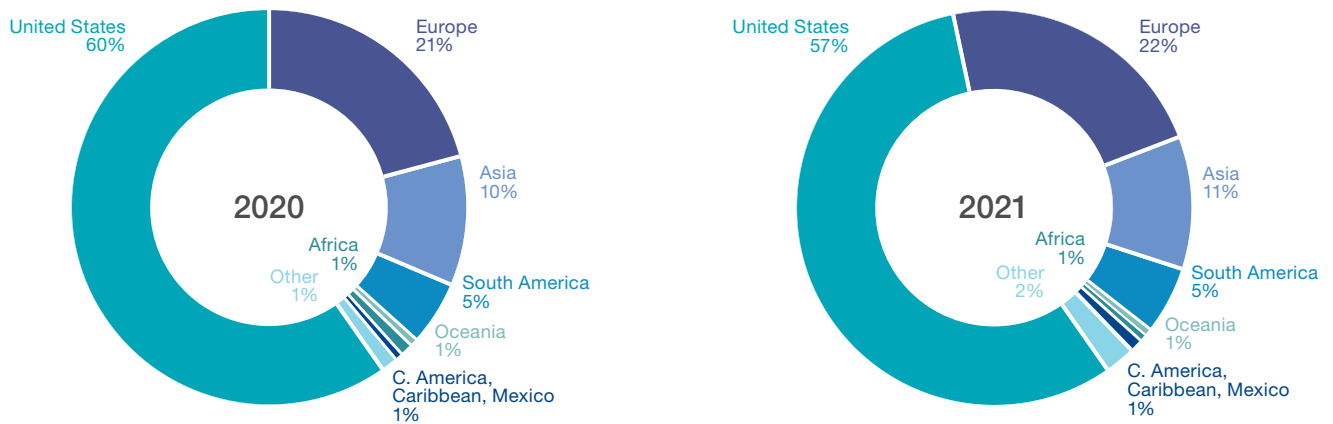
Exports to **Central America, the Caribbean and Mexico** declined by 40%, or \$12M, from \$30M in 2019 to \$18M in 2021. This region accounted for 1% of total export revenues in both 2020 and 2021.

Exports to **Oceania** decreased by 30%, or \$4.7M, from \$16M in 2019 to \$11M in 2021. Oceania accounted for 1% of total export revenues in both 2020 and 2021.

Export revenues from **Africa** decreased by 44%, or \$9.3M, from \$21M in 2019 to \$12M in 2021. Africa accounted for 1% of total Canadian space export revenues in both 2020 and 2021.

Finally, 1% (\$24M in 2020) and 2% (\$53M in 2021) of total exports were allocated to "other" region of the world.

Proportion of Export Revenues: 2020, 2021



MARKET SHARE BY CUSTOMER TYPE

Customers are categorized as either government or non-government. Government customers include domestic governments (municipal, provincial, federal) and foreign governments. Non-government customers include businesses, individual consumers and non-profit organizations or foundations (both domestic and foreign).

Overall, 11% of the space revenues in 2020 derived from government customers and 89% from non-government customers. Changes in 2021 were minimal, with 12% of the space revenues derived from government customers and 88% from non-government customers. It is important to note that government customers make up the majority of market share in some sectors, such as Space Exploration and Space Science, whereas Satellite Communication customers are primarily non-government.

Both upstream and downstream focused organizations derived revenues from non-government clients in 2020 and 2021. The upstream segment derived 58% (2020) and 60% (2021) of revenues from non-government clients, whereas the downstream segment derived 95% (2020) and 94% (2021) of revenues from non-government clients.

Domestic Customer Breakdown by Type

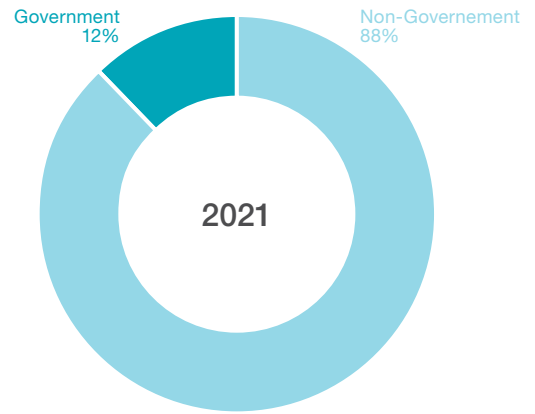
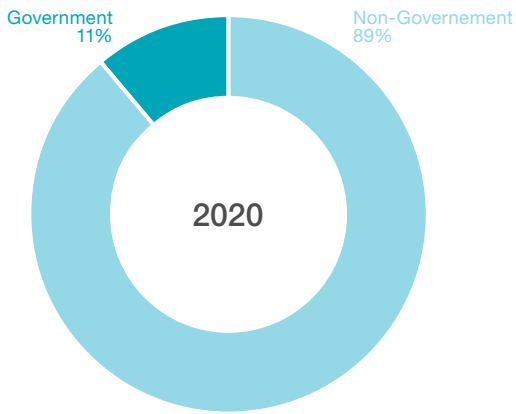
Non-government customers can be individuals, such as subscribers to television and radio broadcasting services. Other non-government customers include businesses, where space-derived information products are integrated into business operations (e.g. Navigation and EO data).

Non-government clients represented 89% of domestic revenues in 2020 and 87% of domestic revenues in 2021. A small proportion of non-government revenues are tied to financing or sales to non-profit organizations and foundations.

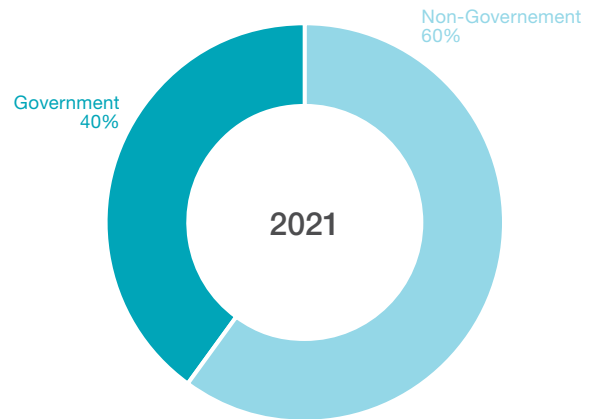
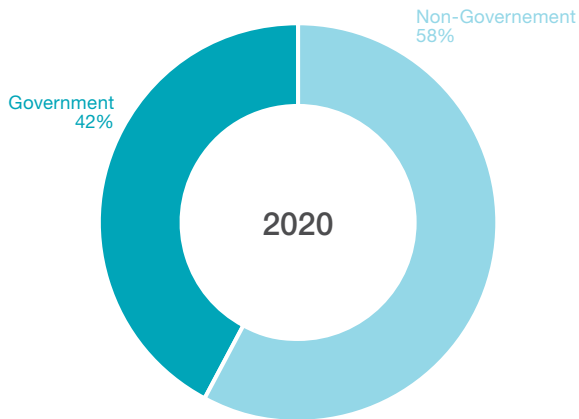
Government customers make up the remaining 11% (2020) and 13% (2021) of the overall domestic market. They represent the majority of domestic upstream revenue, where they constitute 87% (2020) and 77% (2021) of revenues. Government customers are mainly purchasing from the Research, Engineering and Consulting sub-segment. Non-government revenues constitute the remaining 13% (2020) and 23% (2021). In the domestic downstream segment, the situation is reversed, as government customers account for only 3% (2020) and 5% (2021) of revenues.

The majority of government funding comes from federal sources. The top three sources of federal government revenue reported by space organizations in 2020 and 2021 in order of funding size were the Canadian Space Agency (CSA), Public Services and Procurement Canada (PSPC), and the Natural Sciences and Engineering Research Council (NSERC).

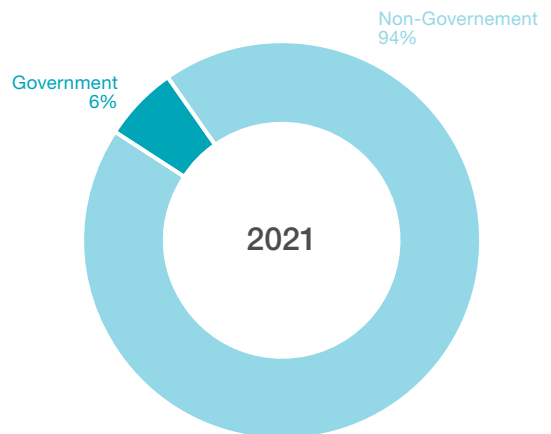
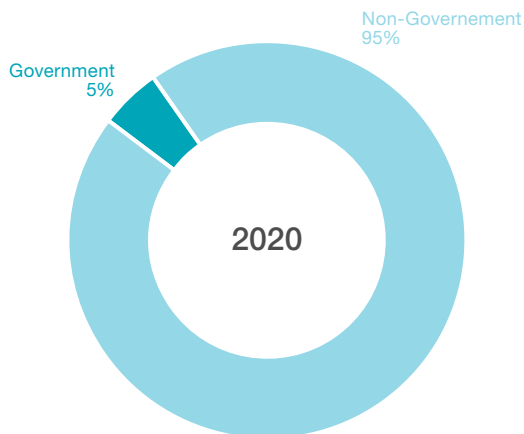
Market Share by Customer Type in the Canadian Space Sector: 2020, 2021



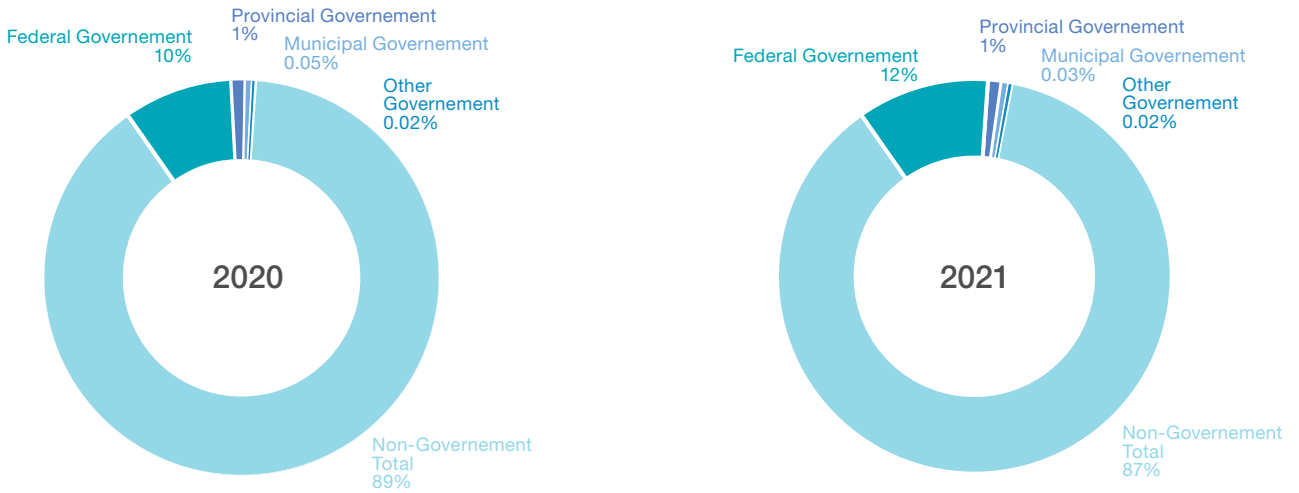
Market Share by Customer Type in the Upstream Segment: 2020, 2021



Market Share by Customer Type in the Downstream Segment: 2020, 2021



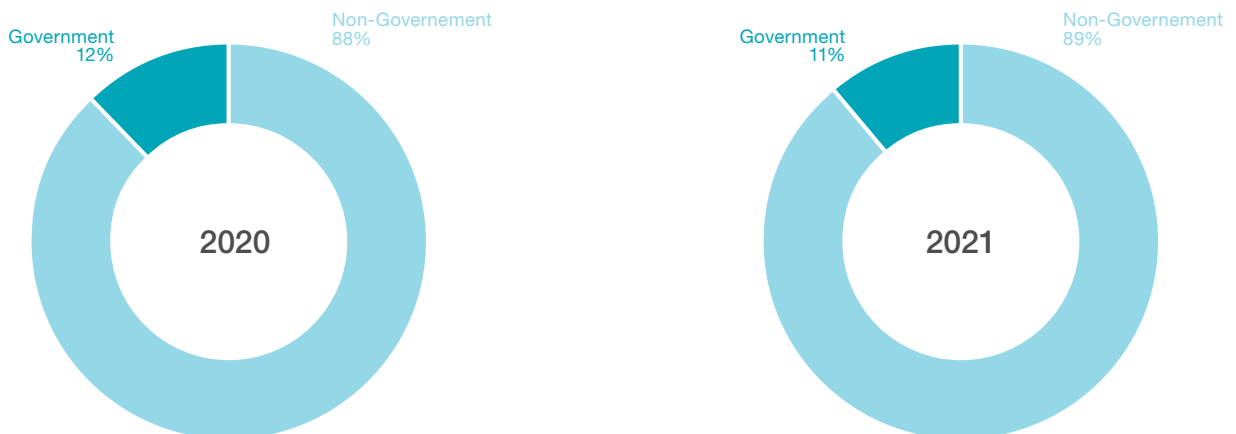
Proportion of Revenues by Domestic Customer: 2020, 2021



Foreign Customer Breakdown by Type

Non-government customers are the largest market segment abroad, accounting for 88% (\$1.7B in 2020) and 89% (\$1.6B in 2021) of export revenues. Foreign government clients make up the remaining 12% (\$223M in 2020) and 11% (\$187M in 2021) of exports. This is equally true for both the upstream and downstream segments, where non-government customers accounted for 83% and 90% of revenues, respectively in 2020, and 85% and 91% respectively in 2021.

Proportion of Revenues by Foreign Customer: 2020, 2021



5 Innovation

KEY RESULTS

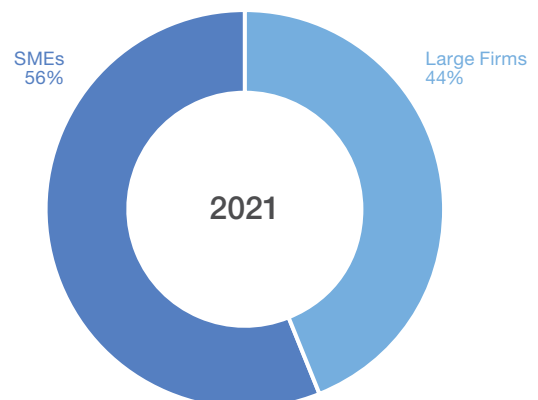
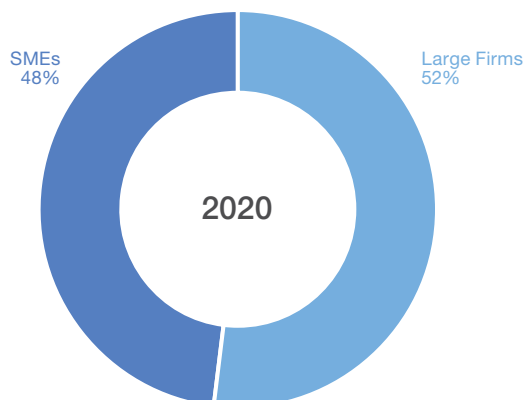
- Business Expenditures on R&D (BERD) has increased dramatically over the past two years, rising from \$376M in 2019 to \$547M in 2021, a 46% increase.
- R&D intensity for space manufacturing was **18 times** higher than the average for manufacturing in Canada.
- Commercialization revenues from externally funded R&D has continued to decline, reaching just \$136M in 2021, a 46% decline from 2019.
- Return on Investment (ROI) for CSA space development programs is 2.21 (for every \$1.00 invested, companies generated \$2.21 in additional follow-on revenues – a multiplier of 2.21 times).
- Space sector organizations reported a total of 226 inventions and 76 registered patents, similar to results in previous years.

BUSINESS EXPENDITURES ON R&D (BERD) (COMPANIES ONLY)

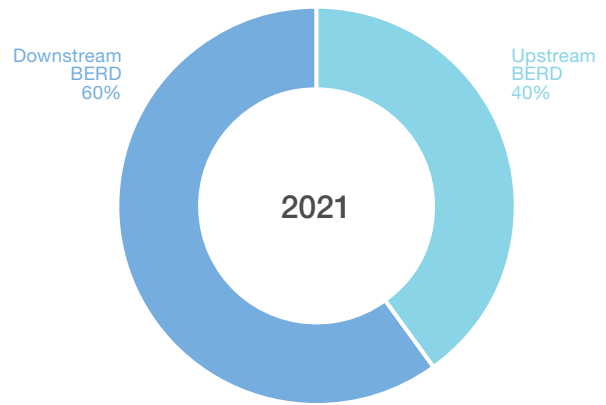
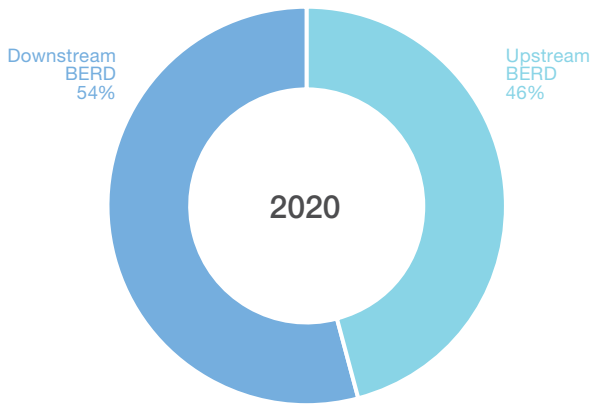
Canada has seen unprecedented growth in BERD expenditures over the past few years, reaching \$479M (from 77 companies) in 2020, and \$547M (from 78 companies) in 2021. This represents a 46% increase from the \$376M spent on BERD in 2019. Upstream organizations were responsible for 46% of total space sector BERD in 2020, and 40% of total space BERD in 2021.

R&D spending was financed through internal sources (e.g. company profits reinvested in R&D) at 64% (2020) and 76% (2021), while the remaining 36% (2020) and 24% (2021) was financed through external funding sources (e.g. government grants and contributions). Internally (i.e. company) funded R&D reached \$306M (2020) and \$414M (2021), and externally (i.e. government) funded R&D reached \$174M (2020) and \$133M (2021).

Proportion of Business Expenditures on R&D by Firm Size: 2020, 2021



Proportion of Business Expenditures on R&D by Market Segment: 2020, 2021



R&D INTENSITY LEVEL (COMPANIES ONLY)

The R&D intensity indicator reflects the ratio of BERD spending relative to the GDP contribution of the space sector. It serves as an indicator of the level of effort and investment by a company (or by an industry as a whole) in innovative activities such as the creation of new products, services and technologies, or the improvement of business functions such as production techniques. Overall, space sector R&D intensity was 46% in 2020, and 53% in 2021. The upstream segment is more R&D intensive than the downstream: upstream R&D intensity was 55% (2020) and 56% (2021), while downstream R&D intensity was 41% (2020) and 50% (2021).

- **In 2020, the R&D intensity for the manufacturing sub-segment (in the upstream) is 56%, which is 16 times higher than the average for manufacturing in Canada.**
- **In 2021, the R&D intensity for the manufacturing sub-segment (in the upstream) is 59%, which is 18 times higher than the average for manufacturing in Canada.**

COMMERCIALIZATION OF EXTERNALLY FUNDED R&D PROJECTS (ALL ORGANIZATIONS)

Organizations report on the level of commercialization of projects that were initially funded by government (externally funded R&D). Organizations derived \$198M (from 27 organizations in 2020) and \$136M (from 33 organizations

in 2021) in revenues through the commercialization of externally funded R&D projects. This represents a 46% decline from 2019 commercialization revenues, which is not unexpected given the large drop in demand associated with COVID-19 and supply chain related issues. The upstream segment accounted for 73% (2020) and 67% (2021) of commercialization revenues, while the downstream segment accounted for the remaining 27% (2020) and 33% (2021). Almost all commercialization takes place through companies.

RETURN ON INVESTMENT

For the past five years, the CSA has been surveying companies to determine the return on investment (ROI) from CSA space development programs.

Overall, 73% of respondent companies indicated that CSA-financed projects generated positive reputation benefits, 77% have attempted to generate follow-on revenues, and 76% intend to generate follow-on revenues.

Definition of Return on Investment

- The ratio rate of return between net income and investment

The total ROI figure encompasses data collected from the 2017–2021 period for projects that concluded in 2016–2020. It is expected that for each year beyond



2022-11-16. Launch of ARTEMIS I

At 1:47 a.m. on November 16, 2022, the Space Launch System (SLS) rocket and the Orion spacecraft lifted off from NASA's Kennedy Space Center as part of the Artemis I mission. The historic flight began a new chapter of human space exploration.

Credit: NASA/Bill Ingalls

the completion of a project, opportunities for further follow-on revenues are generated, and therefore the ROI has the potential to continue growing over time.

The analysis is conservative in nature, as the projects for which companies did not provide responses are counted as generating an ROI of zero. In addition, a lower return on investment for space development programs was expected in recent years due to the decline in demand for the space sector associated with COVID-19 and global supply chain issues.

CSA space development programs have demonstrated success in generating follow-on revenues for companies. The intent is to continue to follow CSA-funded projects that have ended, in order to determine the cumulative total ROI for each space development project.

The total ROI to date for projects that finished in 2016–2020 is 2.21 : 1 (for every \$1.00 invested, companies generated \$2.21 in additional follow-on revenues – a multiplier of 2.21 times)

A total of 42% of projects that finished in 2016–2020 generated an ROI.

Of the projects that generated an ROI:

- 37 had an ROI >1
- 19 had an ROI >5
- 11 had an ROI >10



2021-12-02. Health Beyond initiative

The Canadian Space Agency created the Health Beyond initiative to leverage our country's expertise in healthcare, medical research and emerging technologies such as artificial intelligence. The initiative is designed to identify and develop innovative, relevant, and sustainable solutions to healthcare challenges experienced by astronauts on deep-space missions. The information gathered as part of this initiative will also help Canadians living in remote or isolated locations.

Credit: CSA

INVENTIONS AND PATENTS (ALL ORGANIZATIONS)

In 2020, 55 organizations reported having made an invention and 25 registered a patent. Subsequently, in 2021, 48 organizations reported having made an invention and 23 registered a patent. Between 2019 and 2021, the number of organizations with inventions and registered patents decreased by 16% (from 57 organizations in 2019) and 8% (from 25 organizations in 2019), respectively.

Between 2017 and 2021, the number of organizations with inventions decreased by 13% (from 55 to 48), while the number of organizations registering patents decreased by 34% (from 35 to 23).

A total of 215 (2020) and 226 (2021) inventions, and 64 (2020) and 76 (2021) registered patents were reported.

The number of inventions decreased by 7%, from 243 (2019), to 215 (2020), to 226 (2021).

The number of registered patents increased by 15%, from 66 (2019), to 64 (2020), to 76 (2021).

6 Results by Types of Organizations

KEY RESULTS

- Canada's top 30 space organizations (by revenues) accounted for 95% of total revenues and 69% of the total workforce in 2021, similar to previous years.
- Ninety-three percent of Canadian space companies were SMEs in 2021; they accounted for 42% of Canadian space sector revenues and 30% of all employees.
- University and research centre revenues amounted to \$135M, representing 2.8% of total revenue. They contributed 19% of the total space sector workforce with 2,240 full-time equivalents.

CANADA'S LEADING SPACE ORGANIZATIONS

Canada's top 30 space organizations (i.e. based on their revenues) generated 97% (2020) and 95% (2021) of space revenues and accounted for 72% (2020) and 69% (2021) of space employment, which is consistent with results from previous years despite impacts from COVID-19 and changes in the composition and rank of the top 30 space organizations. Canada's top 30 organizations are comprised of 26 companies and 4 universities (2020 & 2021). In 2020, the top 30 organizations account for 89% of BERD (companies only), 48% of inventions, and 63% of registered patents. And, in 2021, the top 30 organizations account for 81% of BERD (companies only), 31% of inventions, and 41% of registered patents. In both years, 60% of the top 30 organizations were downstream companies, with the remaining 40% including upstream segment companies and universities.

Large companies, classified as having 500 employees or more, are rare in the space sector. Only 6% of the companies surveyed were classified as large enterprises in 2020, and 7% in 2021.

A total of 67 (2020) and 78 (2021) organizations reported space revenues in excess of \$1M.

SMALL AND MEDIUM-SIZED ENTERPRISES (SMES)

Ninety-three percent of Canadian space companies were SMEs in 2021 (94% in 2020), and many of Canada's top space companies were SMEs (defined as employing 1 to 499 workers). SMEs were concentrated most heavily in research, engineering and consulting activities in the upstream segment and in services in the downstream segment.

Of the SME respondents, 65% (2020) and 57% (2021) were upstream segment companies, while 35% (2020) and 43% (2021) were downstream segment companies. Together SMEs accounted for 42% (2020 & 2021) of Canadian space sector revenues and 28% (2020) and 30% (2021) of all employees.

Innovation is essential for space SMEs, and in the past few years they have overtaken large companies to represent the majority of BERD spending. In 2020, SMEs accounted for 48% of all space BERD and in 2021, they accounted for 56% of all space BERD. Upstream segment space SMEs accounted for 10% (2020) and 15% (2021) of total BERD, while downstream segment SMEs accounted for 38% (2020) and 41% (2021) of total BERD in the space sector. SMEs were also responsible for 67% (2020) and 74% (2021) of inventions, and 52% (2020) and 61% (2021) of registered patents.

Space SMEs are also export-driven. In 2020 and 2021, 60% and 58% of their sales reached customers abroad, respectively. The downstream segment accounted for 83% (2020) and 81% (2021) of SMEs' export revenues, while the upstream segment accounted for 17% (2020) and 19% (2021) of SMEs' export revenues.

The SME workforce is highly skilled and specialized, with 64% (2020) and 67% (2021) of SMEs' workforce classified as HQP (i.e. employees with at least a bachelor's degree), compared to 55% (2020) and 59% (2021) of the workforce in large firms. Similarly, 70% (2020) and 69% (2021) of SMEs' workforce were STEM employees, compared to 42% (2020) and 44% (2021) in large firms.

UNIVERSITIES AND RESEARCH CENTRES

University and research centre revenues amounted to \$123M in 2020, and \$135M in 2021, representing 2.5% and 2.8% of total revenues, respectively. Universities and research centres received \$111M (2020) and \$121M (2021) in domestic funds, with the majority from government sources:

	2020	2021
▪ Federal	\$87M	\$93M
▪ Provincial	\$14M	\$14M
▪ Municipal	\$108K	\$12K

The remainder came from private foundations or companies.

In addition, universities and research centres accessed \$12M (2020) and \$14M (2021) in funding from foreign sources. American organizations remain an important source of support for space-related activities in Canadian universities and research centres, with funds totalling \$7.7M (2020), and \$10.5M (2021). European organizations were the second largest contributor, with funds totalling \$2.7M (2020) and \$1.8M (2021). The remaining funding came from other regions.

Academic organizations contributed 17% of the total space sector workforce in 2020 with 1,885 FTEs, of whom 86% are HQP and 96% are STEM employees. In 2021, academic organizations represented 19% (2,240 FTEs) of the total space sector workforce, including 87% who are HQP, and 96% who are STEM. In addition, 40% (2020) and 54% (2021) of the university and research centre workforce was comprised of students, mostly at the graduate level, who were in receipt of wages or a stipend from their university for work as research assistants, as teaching assistants, or in other employee-type arrangements.

The North reported revenues and FTEs for the first time in 2021. However, given that revenues and workforce were very low relative to the rest of the country (<0.5% of revenues and workforce), they are not included in the chart or subsequent graphs.

Of the 41 university and research centre respondents, eight reported coming up with inventions in 2020 and five filed for patents. In total, Canadian universities and research centres generated 19 inventions and filed 16 patents in 2020, accounting for 9% of space inventions and 25% of registered patents.

In 2021, 42 university and research centres responded to the survey, with seven reporting inventions and three filing for patents. In total, Canadian universities and research centres generated 25 inventions and filed 14 patents in 2021, accounting for 11% of space inventions and 19% of registered patents.

Universities and research centres are categorized as part of the upstream segment of the value chain, as they are mostly engaged in research and engineering. However, it is important to note that some universities and research centres also participate in downstream segment activities, such as satellite operations and the development of software and algorithms to transform space data into space-enabled solutions.



2022-10-18. Atmosphere Observing System (AOS) mission

The Honourable François-Philippe Champagne, Minister of Innovation, Science and Industry, announced that Canada is contributing to the Atmosphere Observing System (AOS) mission led by NASA.

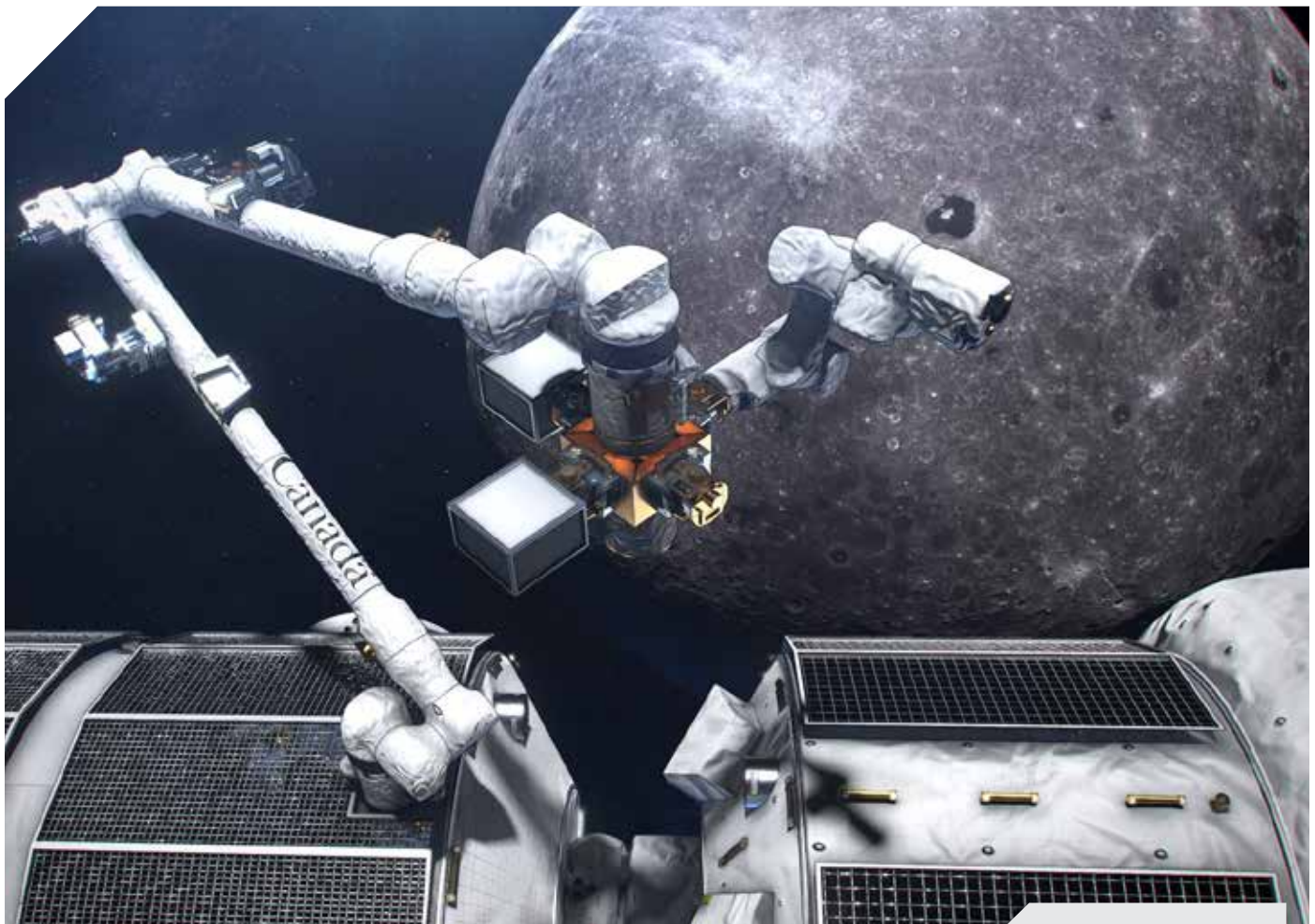
Credit: CSA

7 Conclusion

The economic effects of COVID-19 affected the Canadian space sector in 2020 and 2021. Revenues declined by 11% to \$4.9B in 2020, and remained at that level in 2021. Declines in the space sector workforce by 3% in 2020 were temporary, with the workforce increasing by 7% in 2021, reaching a new peak. Export revenues suffered the most, declining by 18% in 2020 and an additional 3% in 2021 to total just \$1.8B in revenues. Domestic revenues have recovered from declines in 2020, and are now approaching previous levels.

BERD increased significantly over the past two years, reaching \$547M in 2021, a new high for the space sector. The R&D intensity for space manufacturing was 18 times higher than the average for manufacturing in Canada. The return on investment (ROI) for CSA space development programs revealed that for every \$1.00 invested, companies generate \$2.21 in additional follow-on revenues – a multiplier of 2.21 times.

The most significant impacts on employment appear to have been mediated throughout the challenges of the past two years, but the sector still faces challenges in recovering from significant declines in revenues. The CSA will continue to monitor the health and dynamics of the Canadian space economy.



2022-03-10. Canadarm3

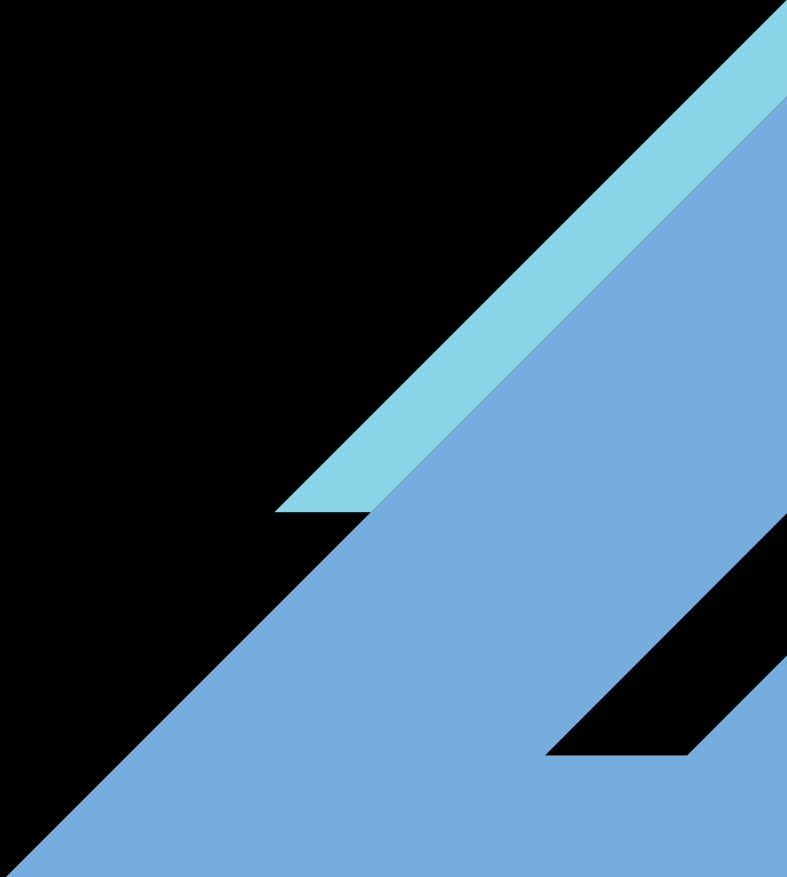
The Honourable François-Philippe Champagne, Minister of Innovation, Science and Industry, announced that Brampton-based company MacDonald, Dettwiler and Associates Ltd. (MDA) will execute the second phase of Canadarm3. Through this design work, Canadian industry will push its capabilities and know-how in space robotics further than ever before.

Credit: CSA, NASA



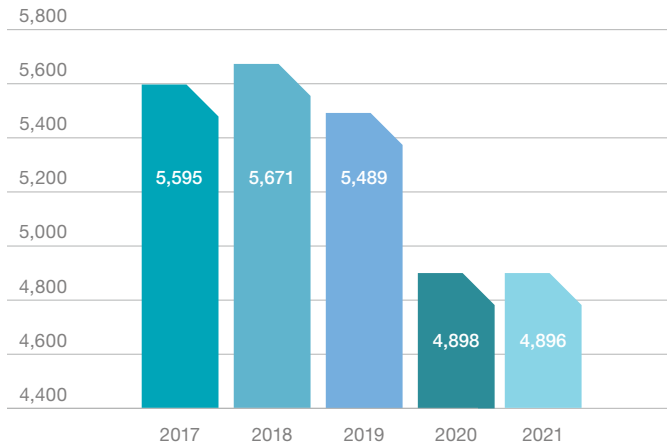


Annexes

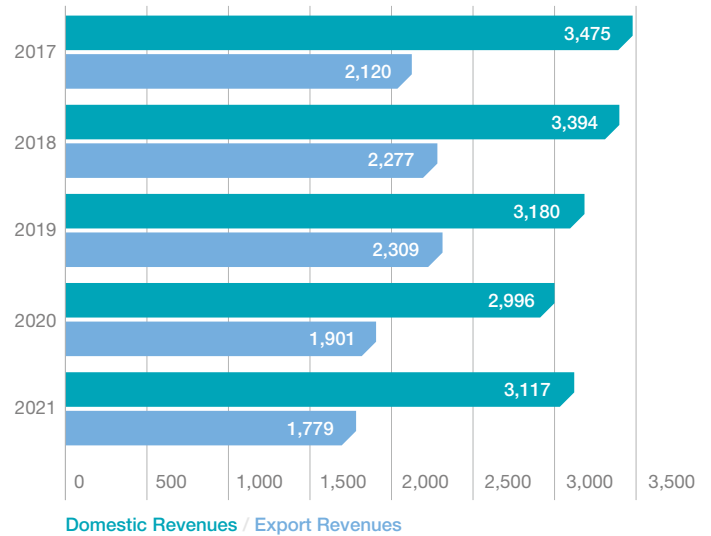


A Annex A Economic Trends: 2017–2021

Total Space Revenues (in \$M)



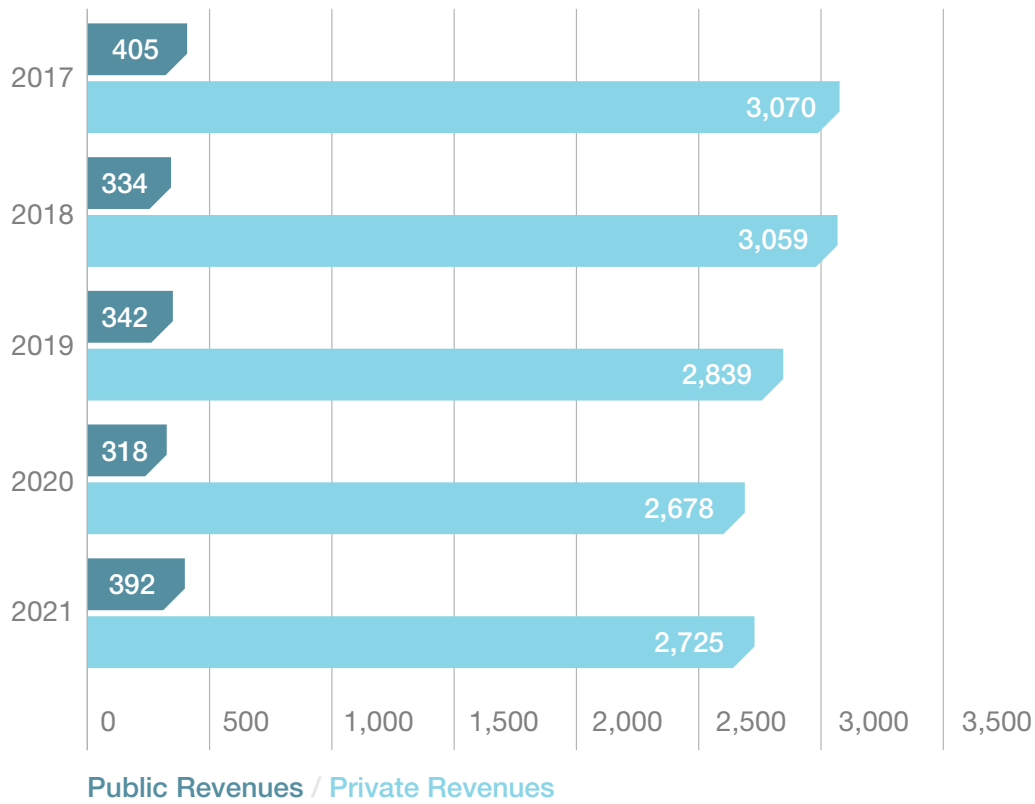
Domestic vs. Export Revenues (in \$M)



Domestic vs. Export Revenues Overall

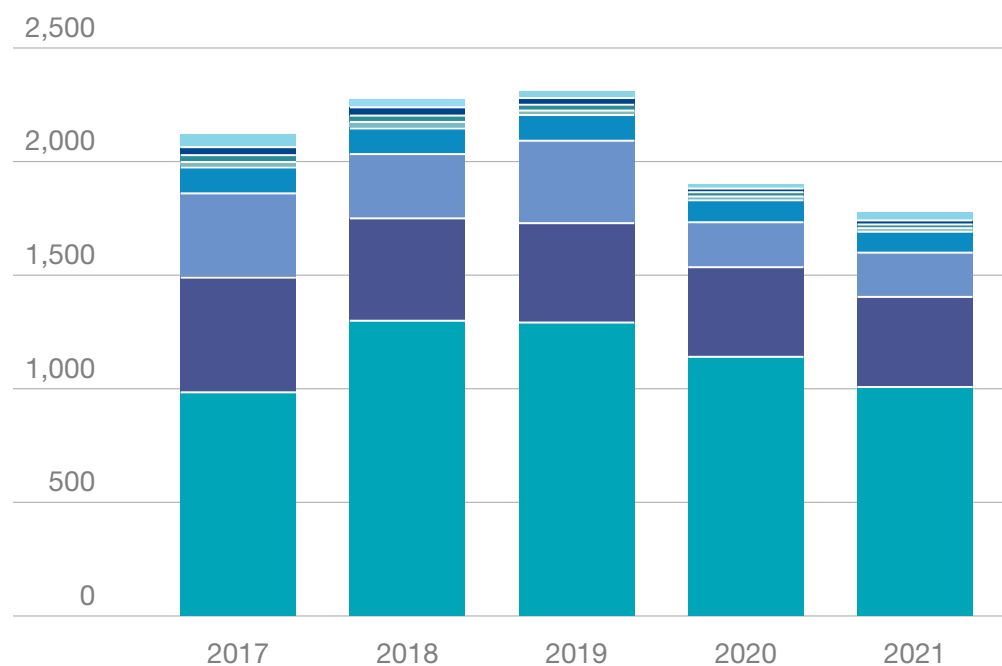
	Total	Domestic	%	Exports	%
2017	\$5,595,354,834	\$3,475,200,911	62%	\$2,120,153,923	38%
2018	\$5,670,589,911	\$3,393,663,363	60%	\$2,276,926,547	40%
2019	\$5,489,238,724	\$3,180,456,444	58%	\$2,308,782,280	42%
2020	\$4,897,583,829	\$2,996,238,114	61%	\$1,901,345,715	39%
2021	\$4,895,816,981	\$3,116,936,798	64%	\$1,778,880,183	36%

Sources of Domestic Revenues Public vs. Private (in \$M)



Sources of Domestic Revenues Public vs. Private		
	Public Revenues	Private Revenues
2017	\$405,481,021	\$3,069,719,890
2018	\$334,463,454	\$3,059,199,909
2019	\$341,561,639	\$2,838,894,905
2020	\$317,946,253	\$2,678,291,861
2021	\$391,644,769	\$2,725,292,029

Sources of Export Revenues (in \$M)

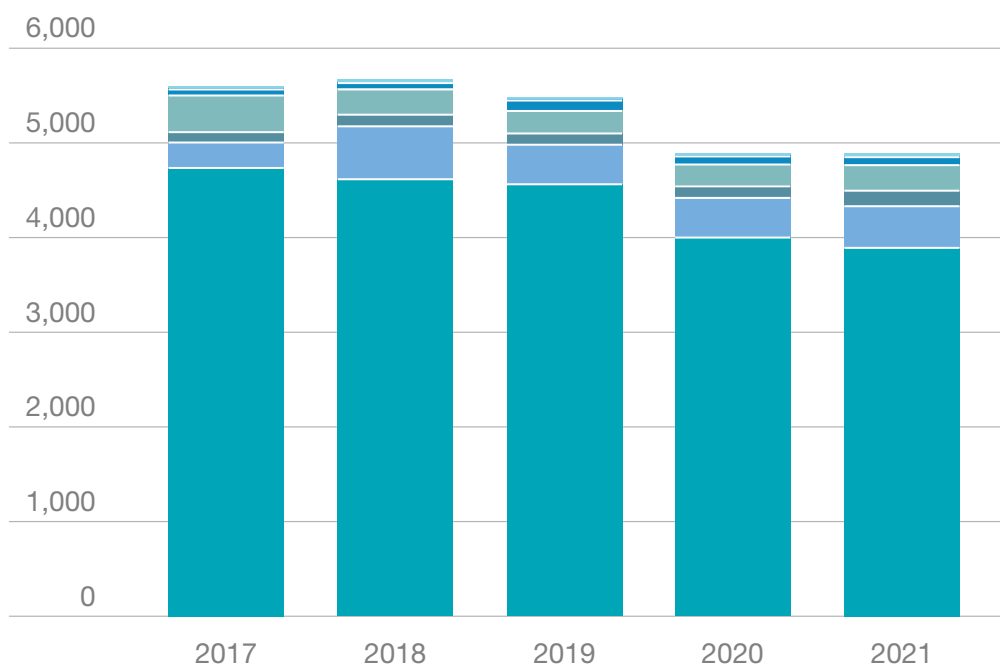


United States / Europe / Asia / South America / Oceania
Africa / C. America, Caribbean, Mexico / Other

Sources of Export Revenues

	2017	2018	2019	2020	2021
United States	\$984,377,868	\$1,299,441,910	\$1,289,465,682	\$1,140,660,531	\$1,007,647,615
Europe	\$511,604,753	\$450,898,448	\$437,331,709	\$394,361,393	\$396,668,524
Asia	\$363,963,814	\$282,266,077	\$362,963,708	\$197,876,444	\$194,814,435
South America	\$118,768,200	\$117,568,822	\$117,005,504	\$101,220,609	\$96,698,504
Oceania	\$19,427,205	\$24,221,719	\$15,666,472	\$14,230,483	\$10,950,191
Africa	\$26,756,979	\$25,378,752	\$21,278,947	\$16,730,868	\$11,983,525
C. America, Caribbean, Mexico	\$34,064,675	\$38,795,654	\$30,029,638	\$12,390,313	\$17,936,913
Other	\$61,190,428	\$38,355,166	\$35,040,622	\$23,875,072	\$42,180,476

Revenues by Sectors of Activity (in \$M)

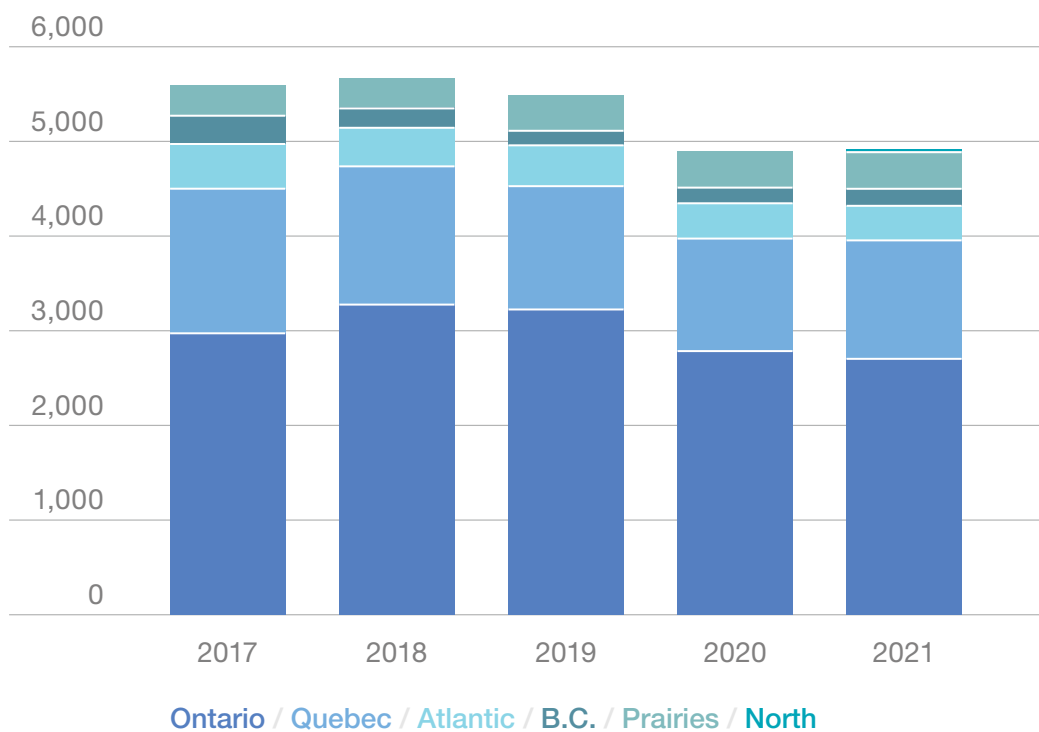


Satellite Communication / Navigation (GPS) / Space Exploration
 Earth Observation / Space Science / Other

Revenues by Sectors of Activity

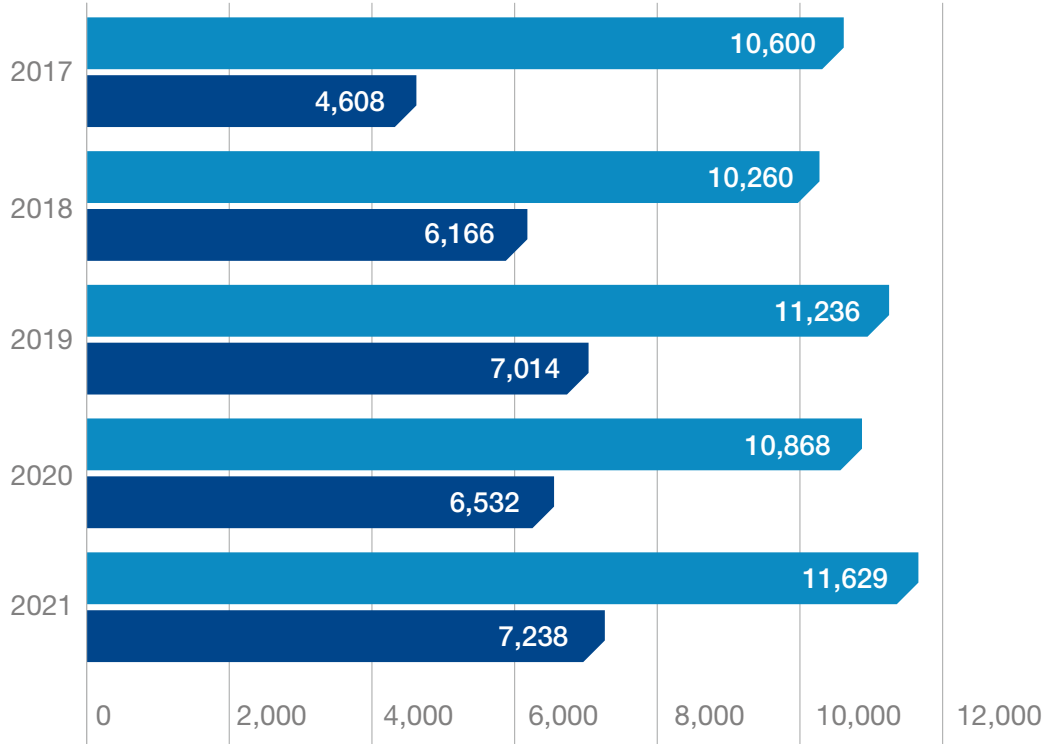
	2017	2018	2019	2020	2021
Satellite Communication	\$4,735,120,617	\$4,615,929,082	\$4,562,739,085	\$3,998,194,805	\$3,891,182,123
Navigation (GPS)	\$268,991,704	\$559,109,223	\$418,054,090	\$420,879,915	\$439,781,649
Space Exploration	\$114,615,832	\$122,957,630	\$118,684,514	\$132,214,066	\$164,153,878
Earth Observation	\$390,365,118	\$277,547,875	\$247,689,131	\$226,193,564	\$269,778,700
Space Science	\$66,065,425	\$66,058,595	\$111,020,253	\$89,558,926	\$94,097,657
Other	\$20,196,138	\$28,987,504	\$31,051,651	\$30,542,552	\$36,822,973

Revenues by Canadian Region (in \$M)



Revenues by Canadian Region					
	2017	2018	2019	2020	2021
B.C.	\$290,382,929	\$214,914,678	\$162,646,505	\$165,436,391	\$184,293,574
Prairies	\$332,403,251	\$310,883,213	\$368,163,142	\$385,869,507	\$396,398,755
Ontario	\$2,972,817,122	\$3,276,098,193	\$3,224,599,935	\$2,784,964,016	\$2,703,135,966
Quebec	\$1,527,544,588	\$1,453,241,361	\$1,302,444,860	\$1,188,485,809	\$1,251,287,427
Atlantic	\$472,206,944	\$415,452,464	\$431,384,383	\$372,828,105	\$360,681,259
North	-	-	-	-	\$20,000

Total Workforce vs. STEM Employees

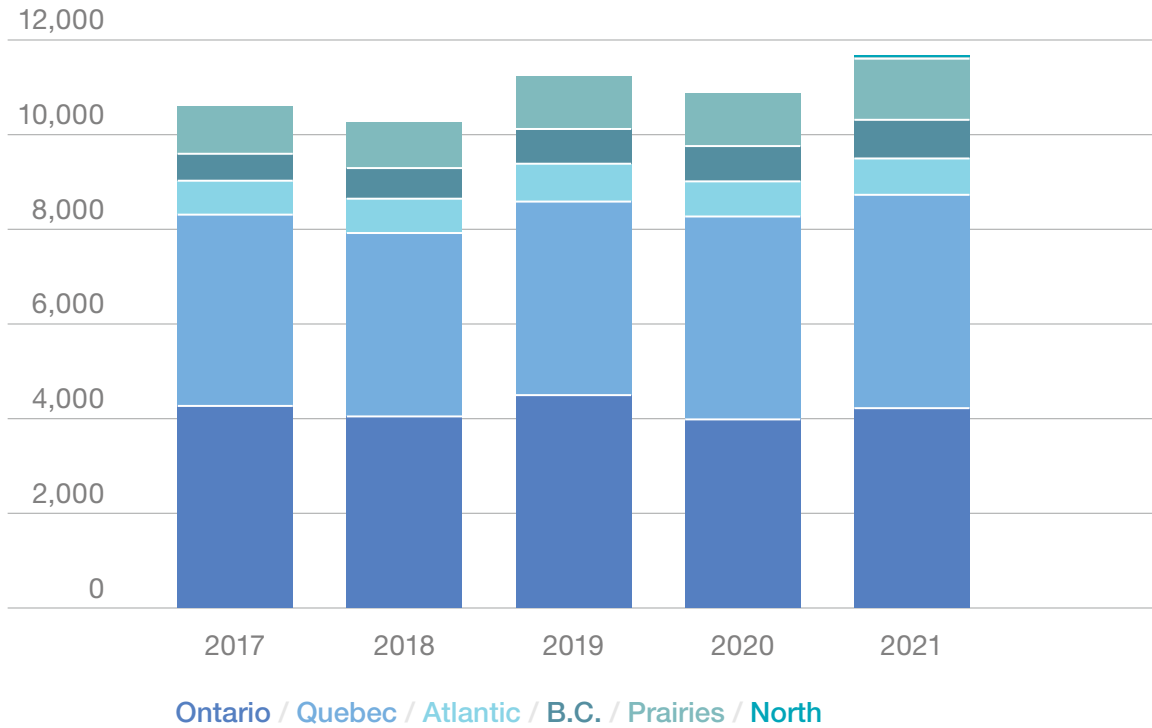


Total Workforce / STEM

Total Workforce vs. STEM Employees

	Total Workforce	STEM
2017	10,600	4,608
2018	10,260	6,166
2019	11,236	7,014
2020	10,868	6,532
2021	11,629	7,238

Workforce by Canadian Region (FTEs)



Workforce by Canadian Region (FTEs)					
	2017	2018	2019	2020	2021
Ontario	4,269	4,047	4,497	3,984	4,215
Quebec	4,041	3,875	4,089	4,287	4,514
Atlantic	717	734	795	742	768
B.C.	569	638	739	746	808
Prairies	1,005	966	1,116	1,109	1,324
North	-	-	-	-	1

B Annex B Methodology

QUESTIONNAIRE

In order to measure the changes taking place in Canada's space sector each year, the CSA uses a questionnaire to collect baseline data. Questionnaires are sent to private sector enterprises, not-for-profit organizations, research organizations and universities in Canada that engage in space activities. The questionnaire follows a census model and therefore aims to be as inclusive and exhaustive as possible.

Most organizations that responded to the 2020 and 2021 questionnaires reported on a fiscal year (generally ending March 31), with the remainder reporting on a calendar year, from January 1 to December 31, 2020 and 2021. As in previous years, the questionnaire had a high response rate, covering a total of 191 (2020) and 190 (2021) organizations over the past two years.

Additionally, the CSA performs quality control measures on the survey data to ensure the accuracy of the findings.

ATTRIBUTION

Data are also supplemented based on CSA transfer payments (Contracts, Grants, and Contributions) in cases where this information has not been included as part of the survey responses to more fully capture revenues.

In addition, there is a limited number of cases where data are compiled from publicly disclosed reports (e.g. for publically traded companies) and verified through consultation with company officials.

ECONOMIC TRENDS

Prior to 2017, the CSA made changes to the methodology, whereby significant adjustments impacted indicators for domestic revenues, Satellite Communication revenues, government vs. non-government funding, and workforce. For that reason, the economic trend analysis for this report assesses the past five years (2017–2021). For information on the economic trends prior to 2017, readers are invited to consult previous editions of this report.

STATISTICS CANADA LINKABLE FILE ENVIRONMENT

Through a linkage process, the Linkable File Environment (LFE) leverages the single-subject ability of existing surveys and administrative data to inform on business and economic issues. It positions these surveys and administrative data to support longitudinal and cross-sectional analysis and offers opportunities to use additional variables to assess entrepreneurship, employment, productivity and competitiveness.³

Additional information on the LFE is available at: <https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=6000>

ECONOMIC IMPACT ANALYSIS

As described in the OECD's 2012 Handbook on Measuring the Space Economy, and further elucidated in the updated OECD Handbook on Measuring the Space Economy, 2nd Edition (2022), measuring economic impacts in the space sector is a challenging task, as there is no single industrial classification for space activities. In order to overcome this difficulty, a model was developed jointly by the CSA and Innovation, Science and Economic Development Canada (ISED) to calculate the space sector's contribution to GDP (gross domestic product or value added). This process involved taking into account the various industrial classifications, weighing them and categorizing them using a value-chain approach, in order to develop a set of multipliers based on Statistics Canada's Input-Output tables. These multipliers are used to determine the impacts on GDP and employment of the space sector, the suppliers to the space sector, and the consumer spending by employees associated with both the space sector and its supply industry.

³ Excerpt from the Statistics Canada website

A detailed explanation of the Economic Impact Model follows:

1. North American Industry Classification System (NAICS) codes were retrieved for each space company through Statistics Canada's Business Register. This exercise generated a list of 11 separate industrial classifications that covered all active Canadian space sector companies.
2. Canadian space companies were categorized into a value-chain model based on the goods and services they provide: Research, Engineering and Consulting; Manufacturing; Satellite Operations; Service Providers; and Broadcasting Services.
3. Universities, research centres and associations were grouped together under Research, Engineering and Consulting, as in most cases their space sector activities are related to R&D.
4. The grouping of NAICS codes in each of the value-chain categories were then weighted for their relative importance within that particular category. Weighting was established on the basis of workforce tied to each NAICS code. The more workforce associated with organizations in a particular NAICS code, the heavier that NAICS code was weighted relative to the grouping of NAICS codes in that value-chain category.
5. Customized economic multipliers were then built for each value-chain category based on Statistics Canada's input-output accounts for existing NAICS codes. These multipliers are at three levels: space sector, supply industry and consumer spending by associated employees.
6. Employment levels for each value-chain segment of the space sector (collected directly from companies through the questionnaire) are entered in the Economic Impact Model. The customized economic multipliers are then applied to generate the space sector's total GDP and workforce impact numbers.

The "multiplier effect" refers to the total impacts (space sector, supply industry and consumer spending by associated employees) divided by the initial space sector impact. This gives the reader an idea of the impact that one job or one dollar in the space sector has on the wider economy.

Note: Two types of primary inputs can be used in an input-output model: revenues or employment. Employment has been chosen here, as it provides a more accurate portrait of the true level of economic activity being performed within Canada's borders. The results of this analysis can be considered a conservative estimate of Canada's space sector impact, particularly when compared to third-party studies or comparative international reports, which may use different methodologies.

C Annex C Definitions

CANADA'S SPACE SECTOR

The Canadian space sector is defined as organizations (private, public and academic) whose activities include the development and use of space assets and/or space data.

SPACE VALUE-CHAIN CATEGORIES

This report uses a methodology developed by the Organisation for Economic Co-operation and Development's Space Forum, of which the CSA is a Steering Committee member, to characterize Canadian space activities on the basis of a value-chain approach. The definitions of space sector categories were updated in the 2014 edition of this report as per the value-chain approach, with findings presented on the basis of upstream and downstream segment activities. This re-categorization is intended to improve the measurement of the space sector and enable international comparisons.

Under this value-chain approach, data have been organized into categories that align with the stages of producing space goods and services: Research, Engineering and Consulting; Space Segment Manufacturing; Ground Segment Manufacturing; Satellite Operations; Products and Applications; and Services. This approach replaces the space categories used in the annual State of the Canadian Space Sector Reports from 1996 to 2013.

Upstream Segment

The upstream segment refers to the effort required to design, test, build, integrate, and launch⁴ assets into space.

- **Research, Engineering and Consulting:** Research and development (R&D) related to non-commercial or pre-commercial activities; applied science; design and testing of spacecraft, satellites and payloads or components thereof; support services directed at enabling other space sector actors throughout the value chain, including outreach activities, legal services, insurance provision, market research, policy and management services.

- **Space Segment Manufacturing:** Building and integration of spacecraft, satellites, payloads or any component thereof.
- **Ground Segment Manufacturing:** Building and integration of facilities and equipment on Earth for satellite operations, often known as "ground stations."

Downstream Segment

The downstream segment refers to the effort required for the day-to-day operation of space assets, manufacturing of products and software applications that transform space data and signals into useful end products, and services provided to end-users.

- **Satellite Operations:** Day-to-day management of satellites and spacecraft once they are in space, e.g. telemetry, tracking and command; monitoring, recovery operations and collision avoidance; mission planning for satellite passes; uplinks and downlinks for signal processing to reception facility; lease or sale of satellite capacity.
- **Products and Applications:** Manufacturing/development of software or hardware that enable the transformation of space-derived resources into a usable/useful format, e.g. computer software applications, chipsets, Very Small Aperture Terminals and other terminals, antennas, satellite phones, video and audio receivers-decoders, and GPS devices. This category also includes publishing digital or print books, atlases and maps using space-based data.
- **Services:** Provision of services which are dependent on space-based signals or data to various end-users (individual consumers, government departments, or businesses), e.g. subscriptions to satellite radio, phone, television or Internet services; engineering, architectural and environmental consulting based on the processing and analysis of Positioning, Navigation and Timing (PNT) or Earth Observation (EO) data; support services provided to users of space-based products and applications, such as provision of computer consulting and facilities management, data processing, Web hosting and portals, and streaming services.

⁴ Note that launch-related activities do not represent a significant area of activity in the Canadian space sector, hence why it is not included as a separate value-chain category in this report. Launch-related activities include the building and integration of space transportation vehicles (rockets), launch pads, spaceports and related technologies, as well as launch service provision.

SECTORS OF ACTIVITY

The activities of space organizations can also be broken down, as has been done in previous reports, according to the ultimate use or purpose of the research carried out or the goods and services produced. Space sector activities can serve commercial, civil or military purposes, and refer to activities across the value chain:

- **Navigation:** The development and use of satellites for localization, positioning and timing services. Navigation is used for air, maritime and land transport, or the localization of individuals and vehicles. It also provides a universal referential time and location standard for a number of systems.
- **Satellite Communication:** The development and use of satellites to send signals to Earth for the purpose of fixed or mobile telecommunications services (voice, data, Internet, and multimedia) and broadcasting (TV and radio services, video services, Internet content).
- **Earth Observation (EO):** The development and use of satellites to measure and monitor Earth (including its climate, environment and people) for a number of purposes such as resource management, mineral exploration, disaster assessment, security and defence.
- **Space Exploration:** The development and use of crewed and uncrewed spacecraft (space stations, rovers and probes) to investigate the reaches of the universe beyond Earth's atmosphere (e.g. the Moon, other planets, asteroids). The International Space Station and astronaut-related activities are considered in this sector.
- **Space Science:** The various science fields that relate to space flight or any phenomena occurring in space or on other planets (e.g. astrophysics, planetary science, space-related life science).
- **Other:** Generic technologies or components that are not destined for use on a specific space system or for a specific space application. This could be the case for early-phase research, small off-the-shelf components used in various systems, or services based on integrated applications.

RETURN ON INVESTMENT (ROI)

is defined as the ratio rate of return between net income and investment.

For the past five years the CSA has been surveying companies to determine the return on investment (ROI) from CSA space development programs. The process involved asking a series of questions related to reputation effects, intent to generate revenues, and revenues generated for each project supported by space development programs.

HIGHLY QUALIFIED PERSONNEL (HQP)

is defined as space-related employees who have at least a bachelor's degree. This definition aligns with Statistics Canada's definition of HQP, enabling comparisons with other sectors of the economy.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EMPLOYEES

are space-related employees involved in science, technology, engineering or mathematics activities. For the purpose of this survey, STEM employees include engineers, scientists, technicians, management, health professionals and students working in the space sector. Management employees are included in the STEM indicator because the vast majority of employees in this category are managing STEM-related activities. Similarly, students were included in this indicator, because the vast majority of students employed by space companies are directly involved in STEM activities. This approach aligns more closely with Statistics Canada's and the OECD's definitions of STEM employees.

CANADIAN SPACE AGENCY (CSA) EMPLOYEES

The report now includes data on CSA employees as members of the space sector, and will look to incorporate other government departments in the future. Data related to CSA employees have also been backdated in order to be consistent with trend analyses throughout the report.

BUSINESS EXPENDITURES ON RESEARCH AND DEVELOPMENT (BERD)

BERD measures the spending towards R&D activities in a company. The source of funds could include their own internal private investment (cash on hand; debt; private injection) or external funding sources (government funding, other).



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