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CANADA'S FUTURE IN SPACE

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“The Government of Canada is committed to continue building on Canada’s strengths and accomplishments in space, promoting innovation and advancement, enhancing excellence in science and technology, and positioning Canada for continued economic growth.”

**THE HONOURABLE JAMES MOORE,
MINISTER OF INDUSTRY**

“The James Webb Space Telescope has been the single largest program in COM DEV’s history. We are proud to contribute to an observatory that will enable such important advances in our understanding of the universe.”

**MIKE PLEY, CEO OF COM DEV
INTERNATIONAL**

Canada has a proud history in space. We are the third country in the world to put our own research satellite in orbit and the first to have our own communications satellite. We are known for the Canadarms and for our leadership in robotics, optics, radar imagery and satellite communications. Our advances in space science and astronomy have helped us better understand ourselves, our planet and the universe. Our astronauts continue to inspire young Canadians to pursue studies and careers in science and engineering.

Today, space is a part of our everyday lives, thanks to the ingenuity of space firms and targeted investments by governments as both enablers and users of space-based systems and services. In recent years, the Government of Canada has taken steps to ensure that we remain at the forefront of space technology. In February 2014, the Honourable James Moore, Minister of Industry, unveiled *Canada’s Space Policy Framework*, a comprehensive guide for our future activities in space.

Canada has invested in future space exploration like the James Webb Space Telescope and OSIRIS-REx, and has advanced remote-sensing projects, such as the RADARSAT Constellation Mission. Canada is also supporting the development of innovative applications to better use data from RADARSAT-2. In addition, the Space Advisory Board is working to provide independent advice on Canada’s role and future in space.

Building on this foundation, Economic Action Plan 2015 provided measures to continue fostering the growth of Canada’s space sector, and to ensure that Canada remains a global leader in a fiercely competitive international market and a key partner for future space missions.

EXTENDING CANADA'S PARTICIPATION IN THE INTERNATIONAL SPACE STATION UNTIL 2024



The International Space Station (ISS) is a remarkable example of international collaboration, and its success paves the way for the next era in human space exploration. Canada has been a proud partner in the ISS since its inception, and is the third country in the world to confirm our participation in the ISS until 2024. We look forward to the many benefits this will bring for our citizens.

Inspiring the next generation of Canadian engineers and scientists

By renewing our commitment to the ISS, now **both Canadian astronauts will fly to the Station by 2024**. Astronauts play a critical role in onboard scientific experiments and in maintaining the ISS. Their exploits inspire young Canadians to follow their dreams and pursue careers in science, technology, engineering and mathematics.



Maintaining excellence in key capabilities

Extending Canada's participation in the ISS until 2024 will enable our world-leading space firms to continue to demonstrate space robotics and optics technologies. In addition to maintaining, updating and refurbishing Canada's robotics, leading-edge Canadian companies will use the ISS to continue pushing the boundaries of research and innovation in areas like biomedical technologies.

The knowledge and expertise acquired in the development of Canadarm2 and Dextre hold significant promise for a variety of applications in space and on earth. Canada is a world leader in optics and space vision technology. Canadian vision systems were used in more than 40 space shuttle missions and over a dozen ISS missions.



Credit: NASA

CANADARM2 AND DEXTRE

Canadarm2 and Dextre are globally recognized icons that continue to exceed expectations and demonstrate the potential uses for space robotics. Canadarm2 is essential to the ongoing operations of the ISS, including capturing and docking visiting commercial spacecraft. In addition to performing maintenance tasks on the ISS, Dextre has been used to test and prove that space robots are capable of refueling and servicing satellites in space. On-orbit robotic servicing technologies hold great potential for addressing the issue of space debris, a growing concern for the world's space agencies.

ISS TECHNOLOGIES COMING BACK TO EARTH

The knowledge and effort dedicated to building the world-famous Canadarm2 and Dextre have generated significant spin-offs, bringing these technologies back to earth for the benefit of all Canadians.

KidsArm, a spin-off of the Canadarm, is the first image-guided robotic surgical arm in the world specifically designed for surgery for children. KidsArm is a medical tool that will enable surgeons to safely and rapidly perform minimally invasive surgical procedures on children. It is capable of working in small and delicate spaces and will offer enhanced dexterity and precision.



Industry Minister James Moore at The Hospital for Sick Children (SickKids) in Toronto to witness firsthand how Canada's investment in space science research and development will be used to help improve surgical care for children.

Credit: Industry Canada



Credit: NASA/Neptec

TriDAR

Neptec's autonomous rendezvous and docking sensor, TriDAR, was developed with support from the Canadian Space Agency's Space Technology Development Program (STDP).

The Ottawa-based company was recently contracted by the US-based Orbital ATK to provide 13 of its TriDAR sensors for the Cygnus cargo spacecraft, which will use TriDAR as the main sensors when docking with the ISS.

TriDAR holds significant potential for future applications both in space and on earth. For example, it could play a role in the development of a solution for the growing problem of space debris or be used to refuel aircraft in-flight.

Remaining at the forefront of science

Canada's space firms and universities will benefit from continued access to the ISS. The unique environment of the ISS provides opportunities for cutting-edge research that will allow Canada's space sector to thrive and remain innovation leaders in their respective fields.

With the help of astronauts aboard the ISS, Canada's science community will continue investigating areas that affect Canadians in their daily lives and help prepare us to send humans further into space.



EVARM

With funding from the CSA, Best Medical Canada Ltd. (formerly Thomson Nielsen) supplied radiation detectors that were tested inside the space suits of astronauts during spacewalks. The radiation detection technology has been adapted for use in the measurement and targeting of radiation in cancer treatment and is now being implemented in over 1000 cancer clinics.

MICROFLOW

In 2012, the National Optics Institute (INO) in Québec City, Quebec, tested a mini medical lab on board the ISS. Known as Microflow, the space version of a biotechnology device called a flow cytometer (used to count cells) has generated a spin-off company called handyem that has commercialized a portable flow cytometer.

The instrument is currently being used by researchers in hospital research centres, universities and industrial companies for an array of applications. These include studies on Crohn's disease patients, identification of DNA damage for in vitro fertilization candidates and the measurement of contaminants in food and water for the agro-industry.

It could soon be used in hospitals and clinics across the country to perform highly sensitive tests for the diagnosis and evaluation of treatments for allergies, autoimmune disorders, cervical cancer, HIV and Lyme disease.





EFFECTS OF SPACEFLIGHT AND RESEARCH IN AGEING

Astronauts in space undergo a number of physiological changes that are an excellent parallel for studying problems that affect ageing and increasingly sedentary populations here on earth, who suffer from similar health issues.

Canadian research has shown that the effects of microgravity on astronauts share similar traits to the toll that time takes on our bodies, such as bone and muscle loss, stiffened arteries and cognitive changes. These studies provide researchers with a wealth of data that offers real potential for improving senior health.

FOUR NEW CANADIAN SCIENCE EXPERIMENTS TO BE CONDUCTED ABOARD THE ISS BEGINNING IN THE FALL 2015

Marrow: This study will investigate the effect of weightlessness on the bone marrow.

TBone: Using new 3D imaging technology that can distinguish changes in bone tissues and better assess bone strength, this study will measure the effect of weightlessness on bone quality and density.

Vascular-Echo: This research will examine changes in blood vessels and the heart, as stiffer arteries can cause increases in blood pressure (hypertension) and risk for cardiovascular disease.

At Home In Space: This study assesses culture, values and psychosocial adaptation of astronauts to a space environment shared by multinational crews on long-duration missions.

“I am delighted that Canada has committed to extending its participation in the International Space Station (ISS) through 2024 and its support for other exciting initiatives with NASA in space and Earth science, including the James Webb Space Telescope and the OSIRIS-REx asteroid sample return mission. The Canadian Space Agency’s Mobile Servicing System, robotics expertise and crew members continue to provide critical contributions to the ISS program. A commitment to continuing to utilize this tremendous resource will enable the international research community to accomplish important goals including cutting-edge research and technology development that will enable human and robotic exploration of destinations beyond low-Earth orbit, including asteroids and Mars. We look forward to our future cooperation.”

CHARLES BOLDEN, NASA ADMINISTRATOR

Positioning Canada as a valued partner

As nations work together to chart humanity’s next steps in space, Canada’s continued role in the ISS positions us as a key partner for future space missions.

Securing Canada’s place among the top space-faring nations requires long-term planning and vision. Extending Canada’s participation in the ISS and upholding our reputation as a valued partner is a key step in this regard.

“Canada has made a very important and strategic decision in extending its commitment to the International Space Station to 2024. Canadarm and Canadarm2 helped to build it, and Canadarm2 and Dextre play important roles in helping to maintain it. Renewing our commitment to this important international partnership helps to maintain Canada’s market position in space station robotics.”

DON OSBORNE,
PRESIDENT OF MDA’S INFORMATION SYSTEMS GROUP

INCREASING CANADA'S PARTICIPATION IN THE EUROPEAN SPACE AGENCY'S ADVANCED RESEARCH IN TELECOMMUNICATIONS SYSTEMS PROGRAM

Satellite communications have evolved rapidly and are now integral to everyday life, providing essential services to Canadians and people all over the world. Canada's global leadership in satellite communications began with the launch of Anik-A1 in 1972. Canada was also the first country to use satellites for domestic communications (1973) and to deploy a direct-to-home broadcasting service (1978).

Economic Action Plan 2015 proposes to add funding to the European Space Agency's (ESA) Advanced Research in Telecommunications Systems (ARTES) program. This will benefit Canada's space sector by maintaining leadership in satellite communications and stimulating the creation of highly skilled jobs through international partnerships.

Through a unique collaboration agreement, Canada is the only non-European member of ESA. This membership provides Canadian firms with the opportunity to bid on European projects, access the European space market and, through programs like ARTES, participate in projects where they can stimulate space-related technology development. These opportunities translate into jobs for Canadians, knowledge and expertise sharing, important commercial sales, partnerships with European firms and direct and indirect benefits for the Canadian economy.

CANADA'S CURRENT FUNDING FOR THE PROGRAM

Current funding

\$11.14M

over the next
5 years

+ \$30M
over four years,
starting in 2016-17



Maintaining leadership in satellite communications

With tremendous growth and innovation on the horizon, investing in ESA's ARTES program allows Canada to maintain a global leadership role in satellite communications through the development of leading-edge technologies.

ARTES will also allow Canadian firms to test their technologies in space. This is critical for strengthening our sector's competitiveness and supporting the commercialization of Canadian space technologies.

"This is a key milestone in the implementation of the Emerson Report and once again points to the tremendous support the government has offered to Canadian aerospace companies throughout the Aerospace Review and implementation process."

JIM QUICK,
PRESIDENT & CHIEF EXECUTIVE
OFFICER, AEROSPACE INDUSTRIES
ASSOCIATION OF CANADA

Over the past 20 years,
ESA has awarded

 **500**
contracts

worth in excess of

\$300M

to space companies across
Canada through the
Cooperation Agreement.



Stimulating the creation of highly skilled jobs through international partnerships

Through ARTES, Canadian firms will be able to partner with European firms at the early stages of research and development of this program. This will enhance competitiveness and open new markets for Canada's satellite communications sub-sector.

By boosting competitiveness and innovation in Canada's satellite communications sub-sector, this investment will provide highly skilled jobs and economic growth for Canadians.

Today, Canadian technology is used across the world for commercial communications satellites launched internationally, and Canada is home to the fourth largest fixed satellite service provider in the world.



CANADIAN SATELLITE COMMUNICATIONS SUB-SECTOR

40 FIRMS

\$2.655B
in revenue in 2012

=

80%
of the total revenue of the Canadian space sector

Leading firms include COM DEV INTERNATIONAL, MDA, SED Systems and Telesat

SUPPORTING CANADA'S PARTICIPATION IN THE WORLD-LEADING THIRTY METER TELESCOPE

Since the 1970s, Canada's leadership in astronomy and unique expertise in optics has facilitated the participation of Canadian researchers and companies in the construction of several international observatories, including the Canada-France-Hawaii Telescope and the Gemini Observatory.

In April 2015, the Government of Canada announced its intention to build on this scientific leadership by confirming Canada's participation in the Thirty Meter Telescope (TMT), which will be the world's most advanced ground-based observatory as well as one of the world's largest and most powerful telescopes. The TMT will allow astronomers to shed light on the mysteries of our universe. This investment will benefit Canada by:



Credit: TMT International Observatory

1. Upholding Canada's reputation on the international scene

Canada's leadership in astronomy and expertise in optics have given Canadian researchers and firms the chance to participate in the construction of several international observatories, including the Canada-France-Hawaii Telescope and the Gemini Observatory. Our role in the TMT will maintain our position as a world leader in this field and support our reputation as a valued and trusted international partner.

2. Maintaining Canadian scientific leadership in astronomy and fostering job creation

Canadian researchers will benefit from a 15 percent viewing share of the TMT once it is operational in 2021–22. This will promote our continued scientific leadership in astronomy, pave the way for important discoveries and provide unique opportunities for training highly qualified personnel.

Dozens of Canadian firms are expected to participate in the design, construction and assembly of key components for the TMT. This will develop advanced industrial capabilities and help create and maintain hundreds of high-quality jobs in communities across Canada.



CANADA
is providing
\$243.5M
over **10 years**

CANADA IN SPACE: A LOOK AT THE NEXT 5 YEARS

2016

ASTRO-H

Japan Aerospace Exploration Agency's next-generation space observatory.

CANADA'S CONTRIBUTION

The Canadian ASTRO-H Metrology System (CAMS) will help better calibrate the observatory's main telescope and significantly enhance its images.

Canada has secured three positions on the mission's Science Working Group to gain access to the data and allow Canadian astronomers to propose science investigations for the observatory to carry out.

2015-2017

MARS SCIENCE LABORATORY

Canada's continued participation in NASA's Mars Science Laboratory mission.

CANADA'S CONTRIBUTION

The Canadian-built Alpha Particle X-Ray Spectrometer (APXS) has been studying the rocks and soil of the Red Planet since 2012.

Canada has already contributed significantly to many of the mission's top science breakthroughs, including the discovery that ancient Mars could have had the right chemistry for microbial life.

2016

OSIRIS-REx

This NASA-led mission will study Bennu, an asteroid that has the potential to impact the earth in the late 2100s, and return samples of the asteroid to earth.

CANADA'S CONTRIBUTION

The OSIRIS-REx Laser Altimeter (OLA), a sophisticated laser-based mapping system, will create 3D maps of Bennu to help choose a site from which to collect a sample.

In exchange for OLA, the CSA will own 4% of the total returned sample, providing the Canadian scientific community with its first-ever direct access to a returned asteroid sample.

2016

MARITIME MONITORING AND MESSAGING MICRO-SATELLITE (M3MSAT)

Built by Canada's space sector, M3MSAT is a technology demonstration satellite that will help identify and track the direction and speed of vessels in Canadian waters.

2015

ASTROSAT

Canada is contributing two detectors to the UltraViolet Imaging Telescope (UVIT) for the Indian Space Research Organization's first astronomy satellite, which will allow Canadian astronomers observation time.

2018

THE JAMES WEBB SPACE TELESCOPE

This joint project between NASA, ESA and the CSA will be the most powerful space telescope ever built.

CANADA'S CONTRIBUTION

The Webb's Fine Guidance Sensor and the Near Infrared Imager and Slitless Spectrograph science instruments will help the telescope track moving targets and locate distant objects.

In exchange, Canadian astronomers will have a share of observing time on the telescope.

2018

RADARSAT CONSTELLATION MISSION (RCM)

Canada's next generation of earth observation radar satellites.

The RCM will monitor our ecosystem, assist in disaster management and improve maritime surveillance. It will map the Arctic and the data will help to manage its resources.



2018-2024

INTERNATIONAL SPACE STATION

Two Canadian astronauts will go to space.

2020

THE SURFACE WATER AND OCEAN TOPOGRAPHY (SWOT)

Mission developed by NASA and the French space agency (CNES), with solicited contributions from the CSA and the United Kingdom Space Agency.

SWOT will survey 90 percent of the globe, studying the earth's lakes, rivers, reservoirs and oceans.

CANADA'S CONTRIBUTION

A satellite radar component.

SWOT data could lead to improvements in many water-related services in Canada, including operations at sea and water management systems, and will provide measurements that do not currently exist for lakes and rivers in northern Canada.

CANADIAN SPACE AGENCY

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