Canada and ESA: 20 Years of Cooperation

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This year marks the 20th Anniversary of the signing of the first Cooperation Agreement between Canada and the European Space Agency (ESA), which has resulted in numerous benefits on both sides of the Atlantic. These include the development of strategic technologies for Canadian and European space programmes, the creation of alliances between Canadian and European space companies, and a 'rapprochement' between Canada and Europe in space science and technology. The future therefore looks bright for continued cooperation between Canada and ESA.

Canadian space achievements and capabilities

Canada's total surface area is three times that of all ESA Member States taken together, but the population of Member States is twelve times that of Canada. Canada's unique geography and demography has inspired the rapid development and adaptation of space technology to meet national needs, particularly in the areas of telecommunications and earth observation. Today, Canada is one of the largest users of space systems and services in the world for communications, search and rescue, navigation, resource management, surveillance and environmental monitoring.

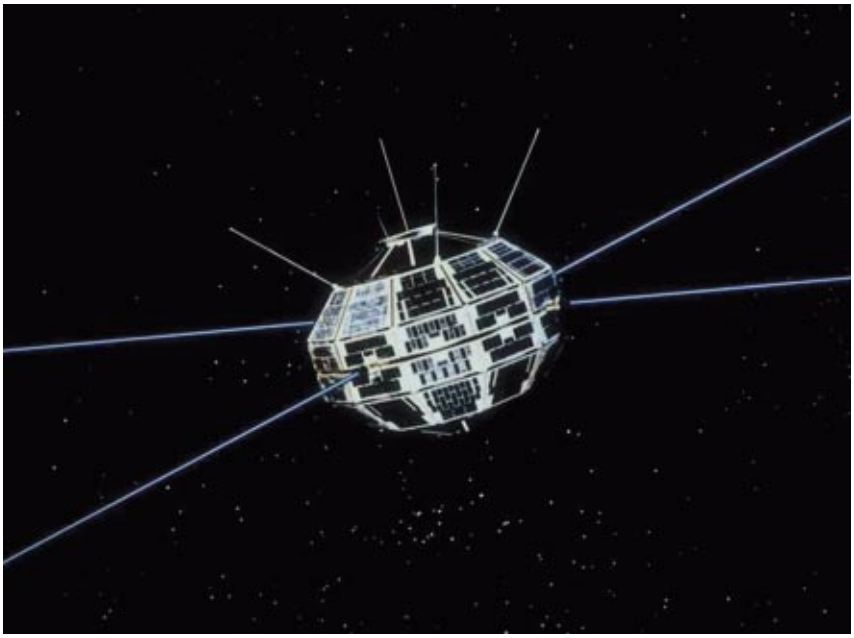

Figure 1. Alouette-1, Canada's first research satellite for the study of the ionosphere (photo courtesy of CSA)

On 29 September 1962, Canada became the third nation after the USSR and the USA to enter the space age with its own satellite Alouette-1, which measured the electron density distribution in the ionosphere, a problem for radio communications at northern latitudes. Designed for a one-year lifetime, the spacecraft exceeded all expectations and was decommissioned on its tenth anniversary.

In 1972, Canada became the first country with a domestic commercial satellite communication system (Anik-A) and, later, the first to use direct-broadcast TV. From the experimental CTS-Hermes satellite in 1976 and the subsequent developments of the Anik satellites until today, advances have continued in the development of critical technologies and applications for future satellite communications systems, in concert with the private sector.

Remote sensing has been the other focal point for the development of the Canadian space programme from the very beginning. In 1972, Landsat-1, the first environment-monitoring satellite, was launched and its first image was received at the ground station in Prince Albert, Saskatchewan. Developed and operated by the Canadian Space Agency (CSA), Radarsat-1 is Canada's first earth-observation satellite and the world's first operational commercial Synthetic Aperture Radar (SAR) system. Launched in November 1995, it provides all-climate, day-and-night imagery for very fast delivery to customers around the world. Key applications include the monitoring of the global environment in areas of ice navigation, cartography, geological exploration, maritime surveillance, disaster relief operations and agriculture and forestry monitoring.

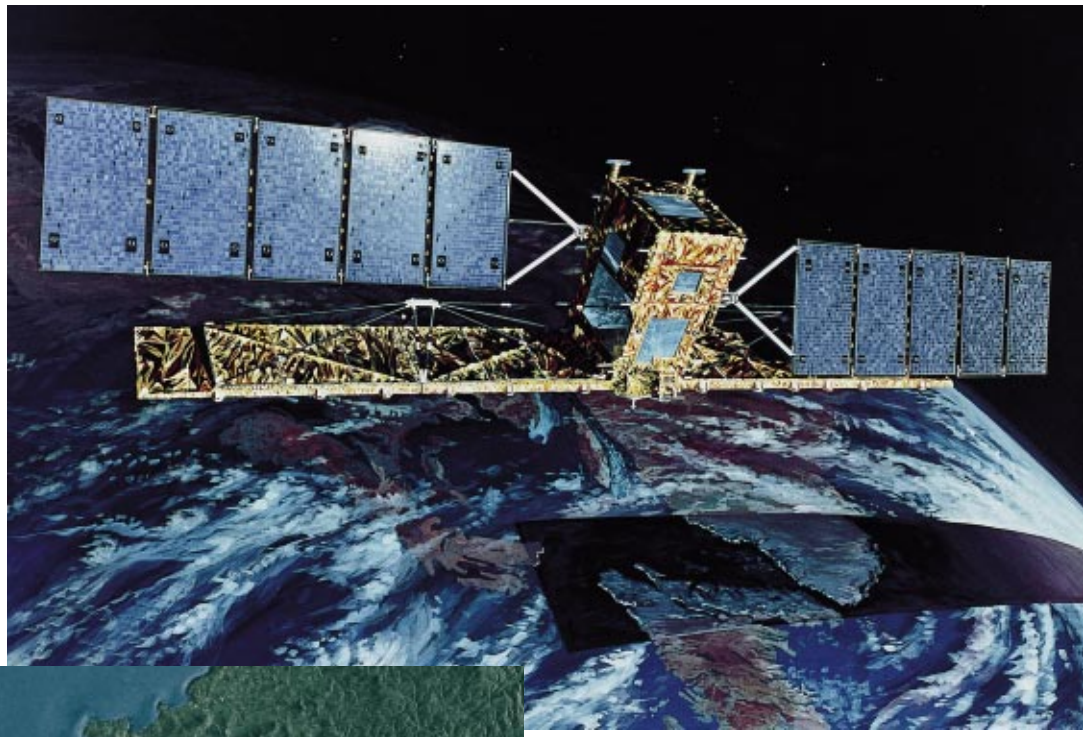

Figure 2. The Radarsat-1 spacecraft

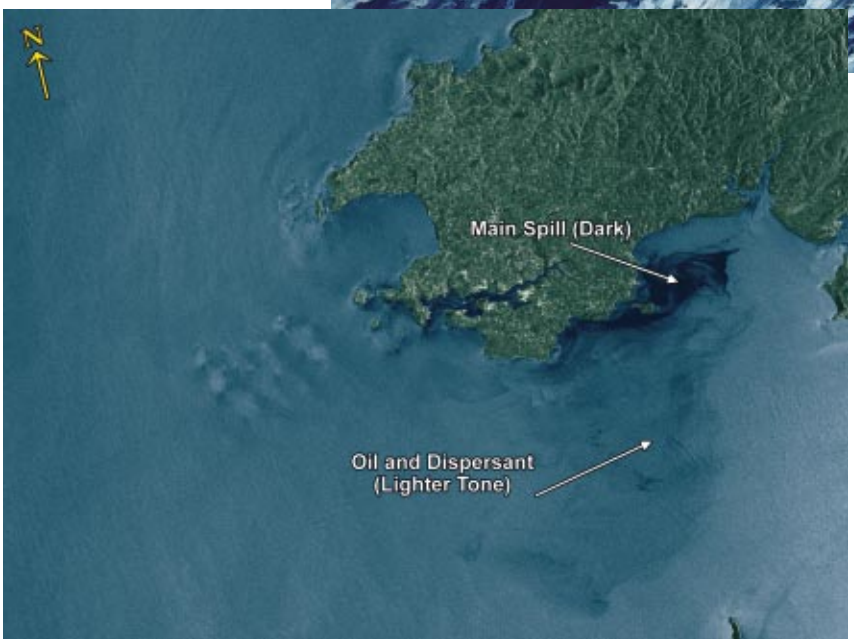

Figure 3. Image taken by Radarsat-1

Radarsat-1 is the first space-borne radar that provides the opportunity to acquire images in variable modes of ground resolution, coverage swaths, and incident radar beam angles. Users have access to a variety of beam selections that can image a swath from 35 to 500 km with resolutions from 10 to 100 m, respectively. Incidence angles range from less than 20 deg to more than 50 deg.

Canada is now planning the follow-on Radarsat-2. Under a policy of partnership with the private sector, CSA will contribute approximately $225 million towards the construction and launch of the new satellite, with the private sector assuming the rest of the financial obligations, as well as the ownership of the system and the lead role in its operation and the marketing of the images. Following an international competition conducted by CSA, the industrial team led by the Canadian firm MacDonald Dettwiler and Associates (MDA) won the contract for Radarsat-2. MDA will build a lighter, cheaper, and considerably more capable satellite, providing the same type of data as Radarsat-1 as well as new capabilities including new modes, higher resolution, multi-polarisation, more frequent revisits and increased downlink margin, allowing the reception of data from lower cost receiving antenna systems.

In 1982, the Remote Manipulator System had its maiden flight on the US Space Shuttle, opening a new era for Canada's space industry in the area of space robotics and giving the world a symbol of Canada's technological prowess. ESA and Canada are also partners with the USA, Japan and Russia in the International Space Station Programme. Canada's contribution is the Mobile Servicing System, which will be essential for the assembly, maintenance and operation of the Station. The first element, the Space Station Remote Manipulator System, will be launched at the end of 1999. Canada also has an active astronaut programme, as well as long-standing activities in space science (atmospheric research, astronomy, solar-terrestrial relations and microgravity) and space-technology development.

By virtue of its national investment in space, Canada is the world's seventh space nation. In 1996, Canadian space industry generated $970 million in revenues, 30% of which was in the form of exports, and employed approximately 5000 people.

Figure 4. Canada's contribution to the International Space Station, the Mobile Servicing System that will be essential in the assembly, maintenance and servicing of the ISS (photo courtesy of CSA)

Canada is also the only non-European nation to be so closely associated with ESA. This is an essential component of the Canadian Space Agency's efforts to build a strong national programme, to work with like-minded partners, and to enhance industry's competitiveness.

History of Canada's cooperation with ESA

Cooperation between Canada and ESA's forerunner the European Space Research Organisation (ESRO) started in the early 1970s*, when ESRO provided critical elements (solar-cell panels, low-noise receiver and the 20 W Ku-band travelling wave tubes) for the Canadian Communications Technology Satellite (CTS), later renamed Hermes. This satellite was launched on 17 January 1976, and became the first one to operate in the Ku-band. The David Florida Laboratory (now part of CSA), located west of Ottawa, was built to integrate and test

* Cooperation between Canada and Europe in space existed before ESA and the Canadian Space Agency (CSA) were created. The Convention establishing ESA was signed on 30 May 1975 and ratified on 30 October 1980. The law creating the CSA was adopted on 15 December 1989.

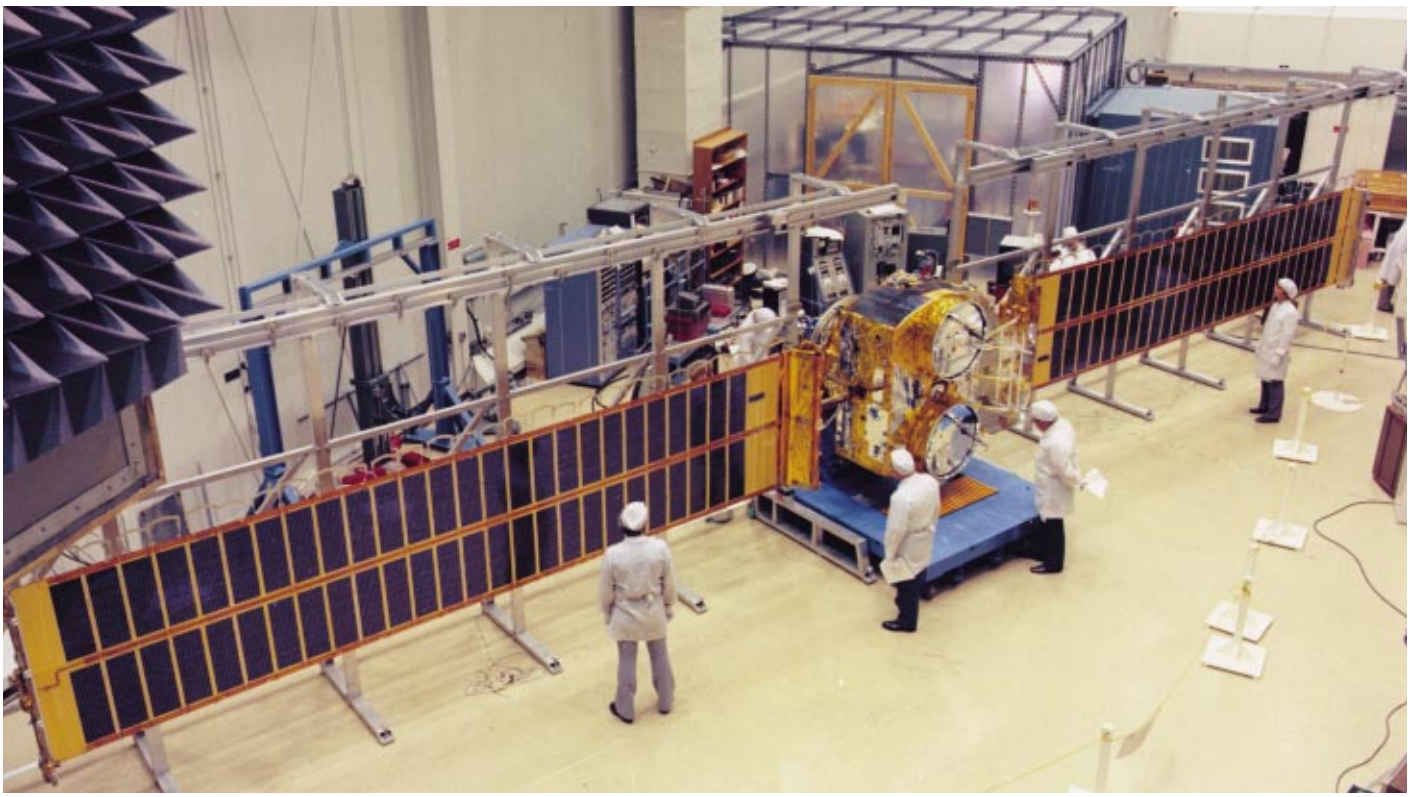

Figure 5. CTS-Hermes engineers monitoring solar-array deployment in the high bay of the David Florida Laboratory, near Ottawa (photo courtesy of Communications Research Centre)

the satellite. The CTS/Hermes satellite occupies an important place in the evolution towards high-power satellites because it permitted future communications systems to realise the small, low-cost ground stations and opened the way to a variety of direct-broadcasting applications. ESA's large solar panels provided 1200 W of power for CTS/ Hermes, making it the most powerful communications satellite of its time. During that period, Canada was also an observer at meetings of the European Space Conference.

Figure 6. Olympus under test at the David Florida Laboratory in Ottawa (photo courtesy of Communications Research Centre)

Pursuant to Article XIV.1 of the ESA Convention, the first Agreement between the Government of Canada and ESA was signed on 9 December 1978, and entered into force on 1 January 1979. It was renewed in 1984 and again in 1989, the second time for a period of ten years, expiring on 31 December 1998. These Agreements, which were part of a broader strategy of the Canadian Government to strengthen cooperation with Europe in critical areas of science and technology, made it possible for Canada to participate directly in ESA programmes, activities and deliberations. Canadian industry has the ability to bid for, and receive, contracts for work in programmes of interest. Canada also obtained the right to participate in ESA's deliberative bodies, and to take part in decision making.

Programmes

Canada and Canadian space industry have actively participated in several ESA programmes, mostly in the areas of satellite communications, remote sensing and generic technology development. These programmes include ERS, EOPP and Envisat in remote sensing, Olympus, PSDE, ASTP, Artemis and ARTES in satellite communications, MSTP/ Hermes in manned space flight, and GSTP.

Olympus

The Olympus programme was initiated by ESA in 1978. For the scientists and engineers involved in space-based telecommunications in Canada, Olympus was a natural follow-on to technology demonstration and the experimentation associated with high-power satellites that had begun with CTS/Hermes and continued with Anik-B. Canada, the third largest participant in the programme, was involved in the solar-array subsystem, assembly integration and test support, payload amplifiers and microwave components. The final assembly, integration and testing were performed at the David Florida Laboratory in Ottawa, because at that time Europe did not possess the infrastructure necessary to test a satellite the size of Olympus.

ERS

The concept of a Synthetic Aperture Radar (SAR) was developed in Canada in the early 1970s and the first digital SAR image from space was produced in Canada in 1978. This demonstration that the processing of SAR data was possible convinced Canada to take an active role in ESA's first European Remote Sensing Satellite (ERS-1). The focus of the ERS mission on providing essential data addressing a wide range of environmental concerns paralleled Canada's increasing interest in using remote-sensing activities to monitor and protect our global environment.

Canada has been involved in the ERS programme since the beginning of the preparatory phase in 1980, and Canadian industry made a major contribution to the development of the ground segment and the microwave hardware. Canadian ground stations in Gatineau and Prince Albert receive and process the data from the ERS-1 and ERS-2 satellites. The expertise acquired from SAR technology and the experience gained in the reception, processing and use of ERS-1 and ERS-2 data have facilitated the development and operation of Radarsat-1.

The information provided by ERS and Radarsat has had a profound impact on our understanding of oceans and polar ice caps and an

immediate benefit in many other areas such as ice-cover surveys, pollution and natural-disaster monitoring, ship-routing and offshore exploration, all of which are of prime importance for Canada.

Canada is now a participant in the Envisat-1 programme. The experience gained by Canadian industry on ERS was used on Radarsat-1, which in turn served the Envisat programme and so on with Radarsat-2 and future missions. The remarkable synergy that exists between the ESA and Canadian programmes is a prime example of the benefits of the cooperation.

Objectives of the cooperation with ESA

Canada's objectives fall into three categories: policy, programme and economic/industrial. From a policy point of view, the focus is on the diversification and reinforcement of Canada's posture as an international space partner and on fostering closer collaboration between Canada and Europe in science and technology research. Programmatically, Canada seeks to develop and demonstrate advanced systems and technologies by participating in large space projects on a cost-sharing basis, thereby supporting the implementation of the Canadian Space Programme. Canada also seeks to support the competitiveness of Canadian industry, through alliances with European firms, and to foster the two-way transfer of technologies between Europe and Canada.

Benefits of the cooperation

During 1996, CSA commissioned a complete external evaluation of Canada's cooperation with ESA since 1978. This study, completed in spring 1997, showed that Canada's overall objectives in its relationship with ESA have been achieved. Canadian investments in ESA have resulted in significant direct contracts to Canadian companies and follow-on spin-off sales, promoting the development of the industry as a whole. Several strategic alliances have been concluded, for the performance of ESA and other commercial programmes. Canadian space projects such as the Radarsat and Anik series of communications satellites have been facilitated by Canadian involvement in ESA activities. Moreover, Europe and Canada have developed a much closer working relationship in this critical area of international science and technology*. The evaluation also surveyed the views of Canada's European partners (at ESA, in Member States and their industries) and revealed their views that cooperation with Canada had also been very beneficial to Europe, for reasons similar to those above.

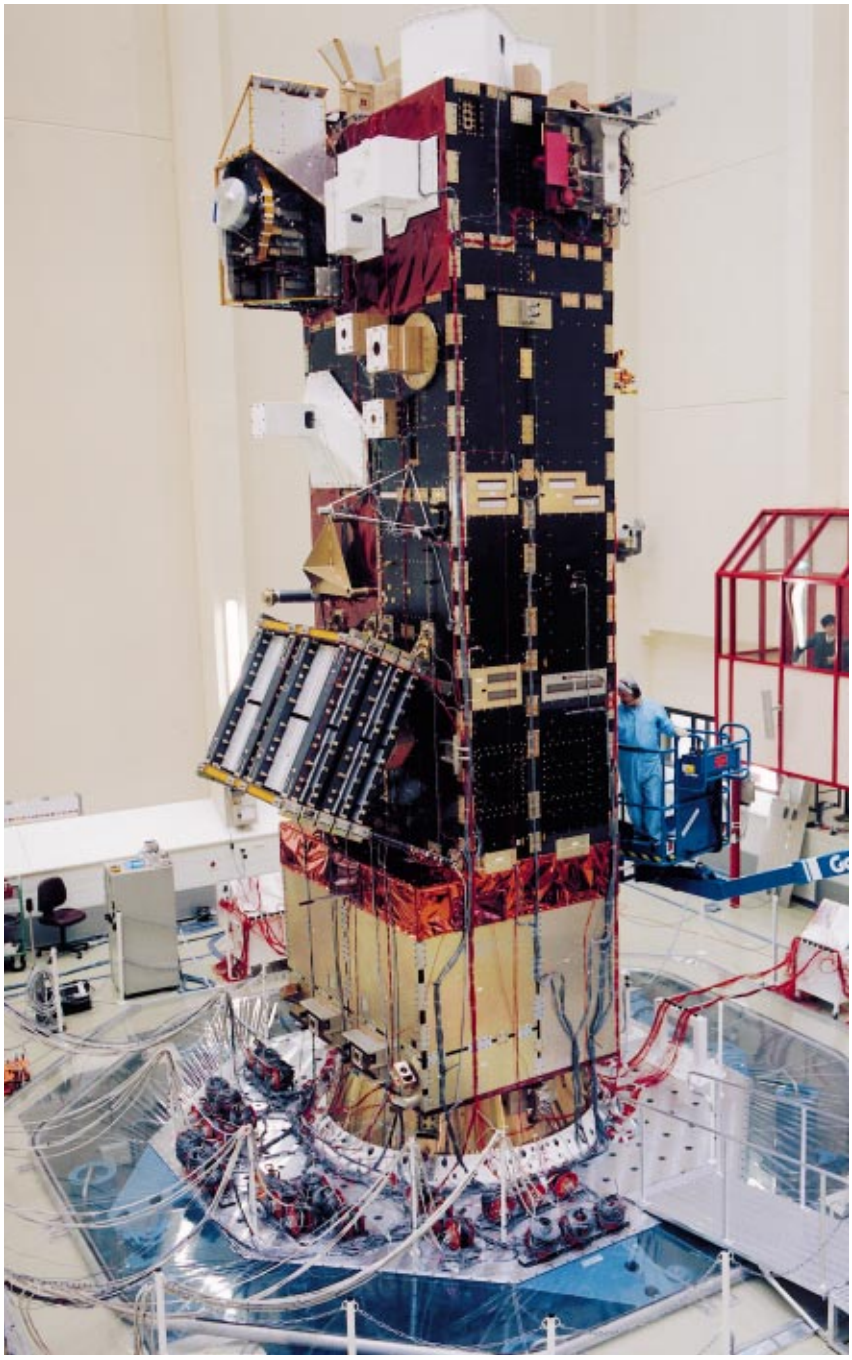

Figure 7. The Envisat spacecraft

In 1994, an economic study performed by the University Louis-Pasteur (Strasbourg) and the Ecole des Hautes Commerciales (Montreal) revealed that every ECU spent by ESA in Canada created 4.20 ECU of additional added value (indirect spin-offs) for the contracting firms and their Canadian suppliers. The ratio calculated in this study was significantly greater than that calculated in a similar study performed in 1989 (3.50).

There are a number of structural differences between Canada's relationship with ESA and that of its Member States: Canada's status as a Cooperating State; the geographical distance; and the specialisation of Canadian companies in technology niches. However, experience has

* Canada also has a science and technology cooperation agreement with the European Union (EU), which allows Canadian companies and organisations to partner with Europeans and participate in the EU's Research and Technology Development Framework Programme.

Figure 8. The Canadian flag, flying alongside those of some of its ESA Member State partners, at the European Space Research and Technology Centre (ESTEC), in the Netherlands

demonstrated that these differences can often be very constructive. Indeed, Canadian industry has developed a worldwide lead in some technologies, which can be of benefit to ESA. Also, since Canada's national space programme involves expenditures about ten times greater than its ESA contribution, the work performed by Canadian industry for ESA benefits from a strong technology base. In addition, Canadian and European companies, working side-by-side in ESA programmes, learn a lot about their respective management practices and business cultures.

Policy aspects

ESA and CSA objectives are almost identical. Both the Act that created the CSA and the ESA Convention refer to their mutual mission to promote the development of space science and technology for exclusively peaceful purposes. There is also a strong similarity between the visions of CSA and ESA. A primary focus of both agencies is to promote the competitiveness and success of their industries through technology development programmes and innovative and flexible funding mechanisms.

Conclusion

The space cooperation between Canada and ESA is unique. ESA is the only international space agency in the world and, to this day, Canada is the only non-European country to be so closely associated with ESA. In addition to ensuring substantial socio-economic benefits on both sides of the Atlantic, this collaboration has strengthened the bonds between Canada and Europe in critical areas of science and technology. Whereas twenty years ago the cooperation was primarily technology-driven, this is now complemented by a strong commercial element.

The next Canadian Long-Term Space Plan (LTSP-III), to be proposed to the Canadian Cabinet in early 1999, will include a recommendation for the continuation of Canada's cooperation with ESA. This recommendation will be based in part on consultations with all concerned stakeholders in Canada, and will set the stage for Canada-ESA relations to continue into the next millennium.

As we look to the future, we can be confident that space cooperation between Canada and ESA will be as mutually beneficial and fruitful as the past 20 years have been. esa