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The Case for Enhanced India-Canada Space Cooperation

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Executive Summary

This paper assesses the national policies and space programs of India and Canada in an effort to suggest the basis for enhanced bilateral cooperation in space activities between the two countries. Based on the premise that both India and Canada are space-faring nations actively involved in the exploration and use of outer space toward scientific and commercial ends, the paper seeks to show the way for each country to derive optimum scientific and economic benefits from their space activities through bilateral cooperation. Although each country's space program has a different focus, the paper demonstrates that they could be complementary and beneficial to each other. For instance, whereas Canada has developed very highly advanced technology in the field of earth observation (remote sensing), and also has access to the International Space Station (ISS) for microgravity and other research purposes, it is lacking in the area of indigenous launch services. India, on the other hand, has been able to develop and continually advance an array of indigenous launch vehicles and is currently able to offer world-class reliable and cost effective launch services. India has also developed a very high level of expertise in the processing and distribution of remote sensing data. However, India lacks access to the ISS for microgravity research and human activities in space. Notwithstanding the presently conducive political environment for bilateral cooperation as shown by the recent high-level political exchanges between the two countries, a major finding of this paper is that there are several regulatory and policy obstacles that will hinder any efforts toward bilateral space cooperation. Although most of these regulatory and policy barriers are on the Canadian side, and may even involve international obligations assumed by Canada toward third party states, the paper concludes that they are not insurmountable if Canada takes the initiative to resolve them. The paper offers some viable options for overcoming the challenges identified or envisaged.

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Introduction:

Over the past few years, India and Canada have entered into dialogue and embarked on initiatives for economic cooperation. The official visits of high-level delegations from both countries have resulted in a review of their bilateral economic relations and a discussion of important international and regional issues, including initiatives that would strengthen their partnership. One element of such a partnership envisages cooperation in the field of science and technology in general, and space technology in particular.

With the rapid development and equally fast rate of commercialization of space science and technology, space-related products and services are becoming elements of significant commercial value. India has become a new member of the elite club of space-faring nations. Canada's space capabilities are undoubtedly world-class. In order to explore the possibilities for bilateral cooperation between India and Canada (specifically their respective space agencies) and the opportunities for their respective space industries in three key areas of space activities -- satellite remote sensing data collection, processing, and distribution; microgravity research on board the ISS; and launch services). This paper provides brief descriptions of the national policies and space programs of both countries, their strengths and needs for cooperation, and the challenges to such cooperation. Due to their specific national needs, both have developed advanced satellite capabilities for communications. Though there is good potential for bilateral cooperation, the area of satellite communications is not addressed here. A separate and focussed study should be undertaken due to the complexity and extensive breadth of the communications industries in both the countries. This study analyzes existing regulatory barriers and suggests some viable policy and regulatory options. It is undertaken in the general context of broader India-Canada political and economic relations.

I. General Context:

A. Policy Agenda and Space Activities of India

India has a population of over one billion people, spread out over its extensive landmass. Although the agricultural sector employs a large majority of the Indian labour force, India's industrial sector has been developing rather rapidly. More importantly, the services sector in India has been expanding quickly to the point that it currently accounts for more than half the country's gross national product. For its balanced development in the agricultural, industrial and services sectors, the importance of India's advanced and extensive communications system, remote sensing capability, and meteorological data must not be underestimated. In order to provide these vital necessities for the achievement of the overall objective of socio-economic development of the country, India has established a vigorous national space program.

The Indian program has been implemented by the Central (Federal) Government's Department of Space (DOS), which currently spends approximately US$900 million on space activities annually. Due to the very high priority accorded to the space sector, the DOS has been put directly under the office of the Indian Prime Minister. The DOS implements the policies put forward by the Space Commission and carries out space research and other related activities through the Indian Space Research Organisation (ISRO), India's space agency.

India's vision has always been to possess autonomous space capability. At present, the country designs, develops, builds, launches and operates its indigenous launch vehicles and all classes of satellites for applications in the communication, remote sensing and scientific fields. India has two major operational satellite systems. They are (a) the Indian National Satellite system (INSAT), used for telecommunications, television broadcasting and meteorological services, and (b) the Indian Remote Sensing Satellite system (IRS), used to monitor and manage natural resources, as well as other earth observation applications.

It is acknowledged that at present, India "has the world's largest constellation of civilian remote sensing satellites."[1] This constellation includes IRS-1B, IRS-P2, IRS-1C, IRS-P3, IRS-1D, Oceansat-1, Resourcesat-1, Cartosat-1, Cartosat-2 and Technology Experiment Satellite (TES) remote sensing satellites that "provide data in a variety of spatial, spectral and temporal resolutions," meeting India's needs for many applications.[2] India is constructing its first radar remote sensing satellite, the Radar Imaging Satellite (RISAT), which is expected to be launched in 2009. The global remote sensing data and products market is estimated to be worth US$30-40 million annually and India captures about 15% of that market in its addressable product rage. India has entered this market through Antrix Corporation, ISRO's marketing arm. It has developed an efficient marketing strategy and usually supplies data products in about three days, with rush requests being met within 24 hours.

There are two series of operational launch vehicles: the Polar Satellite Launch Vehicle (PSLV), used primarily for launching remote sensing/scientific experimental satellites and payloads of up to 1,600 kilograms into polar or low Earth orbits. Secondly, India has developed a Geosynchronous Satellite Launch Vehicle (GSLV) capable of putting 2,200-kilogramme satellites into space. For GSLV, ISRO is developing indigenous cryogenic engines to be used in the upper stages, replacing the current Russian-supplied stages. This is the most powerful operational launch vehicle in India. However, because of a need to increase the payload capability of the vehicle, ISRO started developing a new launch vehicle, known as the GSLV Mark III (GSLVM3). The GSLV Mark III, which is similar to the European Ariane-5 launch vehicle, will have the launch capability of placing up to 4,000-kilogram satellites into the geostationary transfer orbit for these payloads to be placed at an altitude of 36,000 kilometres about the Earth's equator. Its first flight is scheduled to take place in 2009. Additionally, in order to expand its launch facilities, India commissioned a second satellite preparation and launch pad facility in 2006 at Satish Dhawan Space Centre. These space systems have continued to provide valuable services to the

country in a self-reliant manner. The capabilities that India has built in the process have been gainfully used to market Indian space hardware and services in the international market.

India has already opened its launch services to foreign clients. It conducted its first foreign launch of German and South Korean satellites to low Earth orbit in May 1999. Since its first successful launch in 1994, India's PSLV has proved its high reliability, payload capability and competitive pricing for international customers as it is credited with 11 consecutive successful launches and for placing in orbit in January 2007 four satellites (India's CARTOSAT-2, Space Capsule Recovery Experiment-1, Indonesia's LAPAN-TUBSAT and Argentina's PEHUENSAT-1) in a single launch. On January 21, 2008, PSLV was used for a successful commercial launch of a foreign satellite, the Israeli TECSAR satellite. The latest commercial launch by India has set the world record when on April 28, 2008 a single PSLV-C9 mission successfully launched ten satellites, including eight nano satellites of customers from Canada, Denmark, Germany, Japan and the Netherlands. One of the nano satellites launched was NLS-5 that has been built by the Spaceflight Laboratory of the University of Toronto. To meet the increasing demand for its space products and services, ISRO's Antrix Corporation is presently able "to meet the increasing challenge of advanced technology and [handle] complex manufacturing jobs."[3] ISRO has adopted policies that have continually played a major role in the commercialization of space for national development. It is expected that this growing space market will open up opportunities for ISRO to take part in the global market for spacecraft and the related launch services and technology. It has correctly been reported that "successful launches in recent years added to the space agency's confidence and technological prowess to venture into the fast-growing satellite-launching business."[4]

Despite possessing substantial space capability and enormous potential, India does not have readily available and proven facilities for microgravity research in outer space. The 1979 Workshop at ISRO had recommended the possibility of the "(i) Utilization of any opportunities on International Space Station (ISS) which would provide long duration microgravity experiment facility, and (ii) Utilization of data available from foreign missions through international collaboration."[5] However, no major or serious microgravity facility was developed. Neither were any experiments conducted. Recently, under its National Microgravity Research Program, ISRO took an important step by developing and successfully testing the Space Capsule Recovery Experiment (SRE-I) with microgravity experiments in space. This success has been heralded as "a new research platform for microgravity research and has opened up opportunities for microgravity research."[6] An announcement of Opportunities for Research on Microgravity was issued in October 2007.

With regard to the exploration of deep space (i.e. beyond Earth orbit), India's near-term attention has been focused on the Moon. ISRO is currently developing a lunar orbiter mission, Chandrayaan-1, for launch during second half of 2008 by using a modified version of the PSLV (PSLV-C11). Although India presently has no specific

projects involving human space flight, ISRO has declared the possibility of establishing and implementing such a program by 2014.

International cooperation has been the hallmark of the Indian space program. ISRO has signed over 25 agreements dealing with various areas of space technologies and services.[7]

Ready availability of specialized and highly skilled human resources is crucial for any space program. Last year, ISRO created the Indian Institute of Space Science and Technology (IIST). This residential institute of excellence with the first year enrolment of 140 students is offering under-graduate specialized education in space science and technology. In addition to the highly qualified graduates from India's world-class centrally funded Indian Institute of Science and the Indian Institutes of Technology, the space specialists from the IIST will meet the growing human resources needs of the Indian space program.

India is creating a broad-based space industrial infrastructure consisting of both the public and private sectors. ISRO has also focused on extending space-based technologies to the private industry, and good progress has been made in this endeavour. In this regard, there are several technologies presently at various stages of certification for transfer to the Indian space industry. On the other hand, ISRO has a policy of utilizing existing industrial capability for its own programs. Private industry is also becoming involved in the construction of some crucial spacecraft hardware, such as optical solar reflectors, spacecraft mechanism elements, precision components for array deployment, bonded film lubrication for spacecraft mechanism, optical coatings on large panels, the polishing of sun shields for the INSAT-3D coolers, and two-stage cryo-refrigerators to cool the detectors of the Thermal Infrared Radiometer payload.

In essence, India's space policy and activities have been and are guided by its efforts to use space to extend socio-economic benefits to society, to attain and maintain independent access to space and self-sufficiency in space capabilities, to rely on international cooperation and to promote international business in the space sector. India can offer launch services at competitive rates, supply satellites, and provide satellite assembly and integration services as well as proven technologies. However, India still remains dependent on international partners for various requirements, including space-qualified electronic parts and components for its advanced satellite systems and launch vehicles, radar remote-sensing data and advanced processing of such data, and long-duration microgravity research in space. Could Canada could be India's such international space partner?

B. Policy Agenda and Space Activities of Canada

Canada is the second-largest country in the world in geographical terms and has a population of only about 33 million, mostly inhabiting a horizontal corridor with a width

of 200 kilometres along the US border. To serve the specific domestic needs of a country with such a vast territory, abundant natural resources, and a thin population, the Government of Canada began using space technology almost from the beginning of the space age, and thus devised a unique space program and policy. Canada became the third country in the world to design and build its own satellites when it launched the Alouette I research satellite in 1962.

In 1990, Canada decided to establish a single governmental entity, known as the Canadian Space Agency (CSA), to carry out space research and development within a coherent Canadian space program. The main objectives of the CSA, as specified in the 1990 Canadian Space Agency Act, are "to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians." The Agency reports to the Canadian Parliament through the Minister of Industry.

In 1994, the Government of Canada adopted the Space Policy Framework in order to guide the implementation of the Canadian space program. This Framework considers space as an area of strategic importance to Canada, particularly for its transition to a knowledge-based economy, and to the social, scientific, security and foreign policy objectives.

Canada's niche world-class expertise in the space sector lies in two fields: Earth Observation (EO or remote sensing) and space robotics. With its synthetic aperture radar (SAR) sensors, Canada's highly advanced and unique remote sensing satellite system, called RADARSAT, is capable of capturing data through clouds, darkness, fog and smoke. It has been aptly observed that at "the forefront of EO data development, management and exploitation since the early 1970s, Canada has become a world leader in Synthetic Aperture Radar (SAR) data collection, operations and services with the launch of RADARSAT-1 in 1995".[8] The second generation satellite, RADARSAT-2, launched on December 13, 2007, is a collaborative project to which the Canadian government has contributed about $430 million, and a private Canadian company -- MacDonald, Dettwiler and Associates Ltd. (MDA) of Richmond, B.C. -- has invested about $92 million. MDA owns the satellite and the related ground segment, and will operate it. MDA also olds exclusive rights to distribute the data from RADARSAT-1 and RADARSAT-2 outside Canada.[9] In return for its financial contribution, the Government of Canada is entitled to procure RADARSAT data worth an equal amount. RADARSAT is being used not only for commercial purposes, but also for national security.

Canada has also been a world leader in the field of space robotics since the development of Canadarm-1, the tremendously successful and efficient robotics arm installed on NASA's space shuttles. Owing to this unique expertise, the US invited Canada to join a multinational program in 1984 in order to develop, build, and operate an international space station. For several years, the CSA, in collaboration with the National Research Council, has been conducting microgravity research using several

parabolic flights. For long-duration microgravity experiments, the CSA, under its space science program, has been supporting Canadian scientists to participate in international microgravity projects. Canada's membership in the International Space Station (ISS) partnership provides excellent opportunities and facilities. Whenever there is a need, the CSA makes Announcements of Opportunities or Requests for Proposals inviting interested Canadian, and possibly foreign, scientists to participate in proposed/planned microgravity research projects. Since 1991, the CSA's two goals for its Space Station Office have been: (a) to enhance Canada's ability to operate in space and to exploit space by facilitating participation in the ISS by Canadian industries, governments, and universities, and developing user-demonstration experiments stressing technologies with commercial possibilities, and (b) to maximize social and economic advantages to Canadians by promoting the commercialization of ISS technologies.

To effectively carry out all space activities, access to and use of space transportation and launch capabilities is of paramount importance. However, from the beginning of Canadian space activities, Canada had decided not to develop its own launch vehicle and has opted to rely mostly on the launch services of its close allies.

International space cooperation and partnership has been the cornerstone of Canadian space activities and space policy. It has been particularly important in view of Canada's constantly limited space budget allocations to expand the commercial opportunities for Canadian industry and create synergies between Canadian and international industrial partners. Canada's historical space partners have been the US – for launch services and participation in the ISS – and Europe. Canada has a treaty of cooperation with the European Space Agency (ESA) and, through the CSA, has participated in various ESA projects. These include the ENVISAT satellite, launched in February of 2002, to whose design and construction various Canadian space companies contributed key components. This traditional partnership seems to be changing, as Canada is looking for cooperation beyond these two political allies. Russia's launch of the Canadian (a) 3,670-kilogram Nimiq-2 telecommunications satellite in 2002, (b) Microvariability and Oscillation of Stars (MOST) satellite in 2003, and (c) RADARSAT-2 in 2007, are significant indicators of this change.

Irrespective of Canada's impressive, though limited, achievements in the space sector, the reality is that this sector never enjoyed political priority in Canada. There appears to be little possibility of any significant change in this policy, at least in the near future. With an annual budget of only $368.2 million for 2007-2008 and a workforce of about 708 employees,[10] the CSA is considered a medium-sized space power. In order to achieve its space objectives and enhance its activities, CSA must continue to seek partners, particularly in the fields of launch services, human space activities, and microgravity research and development. Therefore, the Canadian government should consider space cooperation with India as a means not only to supplement its space activities but also to expand general economic ties between the two countries.

C. India-Canada Political and Business Relations: Policies and Facts

Irrespective of their strong historical ties and political similarities, bilateral relations between India and Canada have seen several ups and downs since India's independence from Britain in 1947. The primary reason for their low level of economic contacts has been the underdevelopment of the Indian economy, India's nuclear tests in 1974 and 1998, as well as India's longstanding and close relationship with the former communist Soviet Union. Recently, these factors have started changing, as have the political and economic relationship between these two members of the Commonwealth of Nations.

The new era of the India-Canada relationship began in 2002 with the visit of the Indian External Affairs Minister to Canada and the return visit of the Canadian Foreign Minister to India in 2003.[11] Since 2002, there have been various governmental and industry missions at several levels from Canada to India and vice versa, which tend to enhance bilateral political, economic, strategic and scientific cooperation, as well as business relations. The major factors for a push toward enhanced relations are the dramatic expansion of the Indian economy to the present level of nearly US$1 trillion[12] (and growing at an average rate of 8-9% annually), rapidly expanding middle class of about 300 millions, the indication of significant further economic growth since more than half the Indian population is below 20 years of age, and the availability of fully trained manpower in science and technology, particularly in information technologies.

In 2006, the Prime Ministers of India and Canada expressed their determination to widen and deepen relations between the two countries, encouraging greater commercial and economic exchanges and closer links between their civil societies. Annual bilateral trade has gradually increased from a small base in the last 14 years, from $788.49 million in 1992 to approximately $3.6 billion in 2006.[13] In June 2007, Canada and India concluded the Foreign Investment Protection and Promotion Agreement, which is "a bilateral, reciprocal agreement designed to protect and promote foreign investment through the establishment of legally binding rights and obligations." Canadian investments in the fields of Indian banking, insurance, financial services, energy, mining, engineering, and consultancy services has grown, though much more still needs to be done. Prime Minister Stephen Harper envisions strong possibilities for significant trade growth in the future since at present "India ranks as only the 14th largest export market for Canada, while Canada is India's 24th largest export market."[14]

On the investment side, the Indian Government has changed its regulations in order to allow foreign investment in special areas. A previous restriction limiting such investment to 50% of the net worth of the Indian company, as well as a foreign investment ceiling of US$100 million, have been eased. On the other hand, Canadian companies have seen rapid growth in foreign direct investment (FDI) by Indian firms. Many flagship Indian IT companies have enlarged their operations in Canada by setting up software development centres. Some major Indian business enterprises

have embarked on huge acquisitions in Canada, for example, VSNL of the Tata Group bought Teleglobe for $285 million and has invested $30 million to modernize it. Other Canadian fields seeing increased Indian investment are pharmaceuticals, metals, petrochemicals and auto-ancillaries.

The policy agendas of both India and Canada rest on the premise of seeking strategic partners that can appropriately help build and further their economic future through the development of the skills of their people and corporations. The environment created by India's persisting market liberalization and prioritized infrastructure development initiatives have provided an improved setting for the Canadian private sector to compete in an increasingly dynamic market. Thus, against the backdrop of the commonality of their commitment to democracy, rule of law, and similarities in legal, financial and political systems, the presence of a vibrant Indo-Canadian community in Canada providing entrepreneurial skills and scientific and educational links would help both countries enhance their efforts to cultivate meaningful linkages in all sectors, including science and technology.

D. India-Canada Science and Technology Cooperation: Policies and Facts

Translating their intention into action, India and Canada agreed, in 2003, to accord "priority to an enhanced policy dialogue and strengthened bilateral cooperation in science and technology, research and development, and the environment."[15] Following this commitment, the Canadian government has taken steps in supporting science and technology partnerships between Canadian firms and research institutes and their counterparts in other countries, including India. The official visits of the Canadian Prime Minister to India in January 2005, followed by that of the Minister of International Trade in April 2005 (focusing on science and technology), were significant official efforts toward encouraging and sustaining such a partnership. The Canadian government's promise "to develop a program to increase international science and technology collaboration by Canadian organizations, to promote Canadian R&D capacity abroad and to accelerate the commercialization of R&D"[16] can be seen as laying the broad foundation of the bilateral policy agenda between Canada and India. A joint communiqué issued by the Prime Ministers of both countries clearly expressed their determined stand to enhance the architecture of the Canada-India partnership by concluding an intergovernmental Science and Technology (S&T) arrangement and encouraging strategic collaborations in selected areas of science and industrial technologies under what is known as the Science and Technology Initiative.[17] Canada provided funding not only "to expand science and technology links and international R&D teamwork, but [also] bridging the gap between domestic innovation and international commercialization [through] effort and collaboration across the government."[18]

An important step in facilitating science and technology-related linkages was the completion of the Science and Technology Agreement signed in 2005.[19] This Agreement hopes to assist the development of science and technology partnerships and collaborative research among business, academic, and government researchers

and innovators in the different fields, including biotechnology and nanotechnology, renewable energy and Earth sciences and information communications technology. It intends to encourage joint research and development activities that will assist Canadian companies in commercializing their innovations by providing access to international technologies. This Agreement, according to Canada's then International Trade Minister, is expected to "boost Canada's competitiveness through knowledge and technology transfer to address the challenges and opportunities created by the rise of emerging markets such as India."[20]

In the space sector, India (ISRO) and Canada (CSA) signed an interagency Memorandum of Understanding (MOU) in 2003, which provides for space cooperation. The parties recognized the similarities in the objectives and vision of their space programs and reflected the determination of their space agencies to continue working closely in order to generate concrete economic, technological, and scientific benefits for their citizens. The MOU is meant to "foster the study of cooperative programs in satellite communications and satellite remote sensing as well as [encourage] cooperation in the field of exploration and use of space by the private sector and academia in both countries." [21] While a detailed blueprint of the modus to achieve the specific projects had never been finalized, both parties exchanged letters referring to several projects and activities in which ISRO and the CSA had a joint interest. ISRO and CSA began cooperating, but remained confined to one project related to the development of the Ultraviolet Imaging Telescope (UVIT), which is planned to be placed on ASTROSAT, ISRO's multi-wavelength astronomy satellite. In essence, though this bilateral cooperation policy document has been in place for the space sector, the implementation mechanisms have been lacking, and consequently, no significant cooperation has been achieved.

On the other hand, India has strong and active bilateral space cooperation with several other countries, the most important of which are the Russia Federation, the US, and a number of European countries. Historic space ties with Russia have remained steady, but the relationship with the US has seen several ups and downs. India-US ties have primarily paralleled the nature and scope of their general political and strategic relations. India's strategic proximity to the Soviet Union, tactical policy of non-alignment, and independence in nuclear capability determined the nature of India-US space relations. With the demise of the Soviet Union and the possible emergence of China as a rival to US global dominance, both India and the US are establishing never-before-seen close relations in all areas of significant importance, i.e. trade, military cooperation, nuclear technology and space technology. On January 12, 2004, President George W. Bush and Indian Prime Minister Atal Bihari Vajpayee announced the Next Steps in Strategic Partnership, which proposed expanded bilateral space cooperation in several strategic areas, including civilian space programs.[22] Subsequently, the July 2005 India-US Joint Statement, which emphasized closer ties in space exploration, satellite navigation and launch, and commercial space area, set in motion a strong commercial bond between India and the US. During the US President's visit to India in 2006, the two countries, committed themselves to moving forward with agreements that would allow the launch of US

satellites and satellites containing US components and technology by Indian space launch vehicles. Two memoranda of understanding for space cooperation were signed between ISRO and the American National Aeronautics and Space Administration (NASA), under which NASA's Miniature Synthetic Aperture Radar Instrument and Moon Mineralogy Mapper (M3) Instrument would be carried aboard ISRO's Chandrayaan-1 lunar mission. On February 1, 2008, both NASA and ISRO signed a framework agreement that will replace their soon-to-expire 1997 agreement in order to continue and expand their space related cooperation.[23] This renewed cooperation between India and the US may be expected to have positive implications for India-Canada space cooperation, particularly if the US allows India to launch American satellites and Canadian satellites carrying American technology.

ISRO is actively expanding its international cooperation and business activities both with public sector enterprises and private corporations in Europe. For example, ISRO entered into (a) an agreement with EADS-Astrium of Paris to jointly build communication satellites; (b) a commercial contract for the launch of the 360 kg Italian satellite AGILE as the primary payload with India's PSLV-C8 launch vehicle; (c) an agreement with EUMETSAT for using meteorological data from its METEOSAT-5 in exchange for weather pictures collected by INSAT; (d) an MOU with the French National Space Centre (CNES) for the purpose of developing and implementing the Megha-Tropiques project (relating to understanding the life cycle of convective systems and to understand their role in the associated energy and moisture budget of the atmosphere in tropical regions); and (e) an agreement in June 2005 with ESA for including in Chandrayaan-1 mission three European instruments [Imaging X-Ray Spectrometer (CIXS), Near Infra-Red Spectrometer (SIR-2), and Sub keV Atom Reflecting Analyser (SARA)].

These examples of India's recent and active space cooperation with the US and Europe leave Canada far behind. Thus, it is in Canada's interest to look at India's space capabilities more seriously and to devise policies, regulatory mechanisms, and programs that would benefit the Canadian space program and industry.

Turning now to specific areas to determine if and how India and Canada could explore the possibilities of cooperation for their respective space programs:

IV. Specific Areas:

A. Remote sensing (Earth observation)

According to an expert study entitled *Risk management using Remote Sensing data: moving from scientific to operational application,*[24] complementary different systems, e.g. radar systems such as RADARSAT and optical systems such as the Indian remote-sensing satellites and the French SPOT satellite, can maximize the potential of optimal resource utilization and hazard management.[25] Accordingly, Canada, with its highly developed radar sensor systems, and India, with high-performance optical

systems, can be considered complementary technologies and resources. Moreover, (a) forthcoming Indian satellites with more advanced optical systems, (b) Canada's newly developed technology for Optical Spectrograph and Infrared Imager System, and (c) India's initiative in radar systems may create a platform for mutual Indo-Canadian collaboration in the field of earth observation.

Collaborative ventures would be complementary to the needs of each country and would accordingly bring about meaningful economic development. This would consequently encourage business opportunities and enhance closer political relations. In order to achieve this, it will be important that both the governments conclude an intergovernmental framework agreement incorporating their respective obligations and specifying precisely the role to be played (i.e. the activities to by undertaken) by their respective public and private entities. There are certain regulatory barriers that might hinder growth and cooperation. These barriers include, but are not limited to, respective licensing, data distribution policies and export control regimes. Their policies for the dissemination and trading of such data are also different, although both countries present significant markets for their respective remote sensing data and services.

Indian Remote Sensing Data Policy regulates the distribution of data only higher than five-metre resolution over Indian territory. Thus, in general, India follows an open remote sensing data policy as there is no law to control remote sensing data. As per this policy, the National Remote Sensing Agency acts as the national acquisition/distribution agency for all satellite data within India, and distributes data for civilian purposes with no licensing requirements, treating data as a public good.

However, under the Remote Sensing Space Systems Act of 2005, the Canadian remote sensing regulatory control is much stricter and resembles the US approach on the subject in certain ways. MDA and RADARSAT's general operations are required to comply with Canadian law and policy, which comprise rigid data access and regulatory controls for commercial operations. The Minister of Foreign Affairs is vested with the discretionary power to approve, issue, amend, renew or suspend a licence, or even restrict or interrupt any operation pursuant to concerns of national security, defence, international relations, Canada's international obligations and any prescribed factors. The Minister has the discretion and authority, through licensing conditions, to control the distribution of the raw data and remote sensing products. The Act gives blanket authority and power to several Ministers (the Ministers of Foreign Affairs and National Defence, and the Solicitor General of Canada) or their delegates to have immediate priority access to all services of the licensee. Therefore, while the Act permits Canadian corporations to own and operate remote sensing satellite systems, including the reception, storage and processing of data collected by Canadian satellites and the distribution of this information to potential clients, it also gives the Government of Canada the authority to order priority access or to interrupt normal service under the pretext of protecting national security and defence or international relations and foreign policy interests, and to observe international obligations. This pervasive control of the government at every level of operation might

create unease or pose a threat to potential bilateral data acquisition and transfer initiatives with potential foreign collaborating entities, including those from India. In view of the Canadian Remote Sensing Act and an interest on the part of the Indian government to come up with appropriate legislation,[26] there seems to be a need to devise regulatory and policy options in order to strike the right chord for commercially viable business solutions within the parameters of state control (or other adequate, mutually acceptable economic regulations).

One may note that there already exists some form of a bilateral relationship between India and Canada, both at the governmental and private sector levels, at least for the purpose of the processing and distribution of RADARSAT data. Through MDA's agent, SATCOM Technologies Private Limited of Bangalore, which is India's leading private firm concentrating on applications based on satellite technologies, India is already processing Canada's RADARSAT data. Moreover, the National Remote Sensing Agency, an autonomous organization under the Indian Department of Space, is also engaged in the distribution of RADARSAT data in India, Nepal, Bhutan, Sri Lanka and the Maldives.

The 2003 interagency MOU between the CSA and ISRO contains a commitment on the part of both space agencies to foster cooperation in the satellite remote sensing field.[27] Working out a common ground through synchronized policies (including regulations) and cooperative ventures in the field of satellite imagery collection, processing and distribution could enable both countries to optimally utilize their resources, expand market shares and generate increased revenues. The recent establishment of the Antrix-US remote sensing data transactions could be an encouraging example for a more viable Indo-Canadian cooperation and commercial partnership.

B. Microgravity research

Through its membership in the ISS and its contribution of resources and infrastructure to operate and use the ISS modules (e.g. the Canadian robotic arm), Canada is entitled to receive a fixed share of the use of certain elements in exchange. Canada enjoys utilization rights for microgravity research equivalent to one internal rack (eight lockers) per year, and one external pallet adapted per year on board the ISS. The CSA has made 50% of Canada's ISS utilization rights available for commercialization while keeping the remaining 50% for its own purposes. On the other hand, it can be expected that the success of India's SRE-1 as a low cost platform for microgravity experiments might be opened up to foreign participants, including those from public and private Canadian entities. The strength of both countries in the availability of microgravity research facilities, though different but complementary, can act as a mutual incentive to foster cooperation.

However, Canada's participation in, and utilization (or limitation thereof) of, the ISS are tightly regulated by an international legal framework, comprised of the Intergovernmental Agreement on International Space Station of 1998 (IGA98), the

MOUs between NASA and each Cooperating Space Agency (MOU83), and bilateral implementing arrangements between national space agencies. Canada's utilization rights are defined and governed by Article 9 of IGA98, the MOU between NASA and the CSA, and the implementing arrangement. Though under Article 9(2), Canada has the right to barter or sell any portion of its respective allocations to any 'non-partner or private entity under the jurisdiction of a non-partner,' such a right is subject to restrictions; i.e. any such proposed use of an ISS module shall require prior notification to, and timely consensus of, all partner states through their Cooperating Agencies. Thus, the procedural hurdles and complexities (in IGA98 and the MOU between NASA and the CSA) of inbuilt restrictive mechanisms to transfer Canada's utilization rights in ISS to any non-partner or private entity is a deterrent and/or impediment to a meaningful cooperation with a foreign non-partner like India.

If the CSA were to make its utilization rights for microgravity research on board the ISS available to India (ISRO or Indian private companies), it would have to carefully examine the required conditions and follow the procedures established. This could prove a challenging task. On the other hand, India may offer trouble-free usage of SRE-1 for microgravity experiments from Canada (CSA and Canadian private companies) if the Canadian laws and regulations relating to intellectual property rights are complied with by both parties.

C. Space launch (transportation) services

There could be a possible cooperation between India and Canada in the field of robotics through complementary exchanges of the advanced robotics transportation equipments (including advanced *nano* satellite technology), which is developed by the CSA. This is especially important and timely when India is in the process of launching its first unmanned mission to the Moon. Since ISRO has declared its interests in a manned space mission in the near future, the CSA's expertise in robotics and robotic arms with proven technology could prove a good collaboration platform as well as a cooperative commercial venture.

With its proven space transportation capability, India could serve Canadian launch requirements on a very competitive basis. According to the Chairman of ISRO, a "launch on [India's] GSLV–Mark 3 should cost about half the rate charged by France, the US and Russia."[28] With the launch of Israel's satellite (TECSAR) in January 2008 under a commercial contract worth a generally reported price of only US$11 million, India has indicated that it could offer launch services not only at competitive prices to international customers but also it can be a trustworthy partner in sensitive security matters. It should also be noted that the cost of transportation of Canadian satellites to India will not be higher than that for carrying them to Baikonur, Kazakhstan, for launch by Russian rockets. Thus, by using Indian launch services, the Canadian space program and industry could benefit from significant cost savings. The launch by India of a nano satellite built by the University of Toronto is a significant, though

small, beginning of a possible important relationship between India and Canada in the field of launch services.

However, Canada's export control regime poses regulatory challenges in transferring Canadian robotics equipment, technology and satellites to India. Canadian laws pertaining to export controls are a complex collection of domestic and international rules, regulations and policies. The Export and Import Permits Act (EIPA) is the key legislation that controls exports and the transfer of certain goods and technologies contained in the Export Control List (ECL) and those designated for certain countries [as specified on the Area Control List (ACL) of such exports]. In this regard, there are three important and relevant regulatory issues:

Firstly, the export or transfer of goods and technologies specified in the ECL and ACL requires export permits by a Canadian resident. Groups 1 and 2 of the ECL, namely the dual-control list and the munitions list, control satellites , space qualified items, technical data, technical assistance and information necessary for the development, production, or use of an item included in the ECL.

Secondly, Canada is a member of the Wassenaar Arrangement by virtue of which it exercises its "national discretion" in implementing the rights of transfer or denying a transfer of items (like satellites and launch vehicles) in the Arrangement's Group-1 (dual-use) list or Group-2 (munitions) list through the EIPA. Under the Wassenaar Arrangement, Canada is obliged to disclose information related to transfers or denials of transfers of certain controlled, dual-use items, especially for the items on the Sensitive or Very Sensitive List of the Wassenaar Arrangement. It should be noted that under the 2003 Statement of Understanding On Control of Non-Listed Dual-Use Items, Canada has an added responsibility of ensuring that its regulations require authorization for the transfer of non-listed, dual-use items to destinations subject to a binding UN Security Council arms embargo or regional arms embargo that Canada is bound to or has agreed to adhere to.[29]

Thirdly, besides space launch vehicles and certain components, the export or transfer of a spacecraft or space technology in any manner from Canada to a place outside Canada attracts the application of US export control regulations. Canada's list of Controlled Goods is essentially the same as the Munitions List of the US[30] The US export controls could interfere with India's launch of Canadian satellites requiring licences or export authorizations[31] from the US where: (a) US-origin items (especially if they are subject to International Traffic in Arms Regulations) are re-exported to third countries from Canada' (b) the Canadian unfinished product has incorporated certain US goods and technology and (c) US-origin technical data is re-exported to anyone except the export licence authorized end user.

As noted earlier, the 2004 Next Steps in Strategic Partnership between India and the US in the field of civilian space programs has created a positive environment for India-Canada space cooperation, including launch services. The United States is interested in enhancing cooperation regarding Indian commercial satellite

operations,[32] and has shown flexibility by adopting a liberal approach in granting India more access to 'dual-use' technology from the US.[33] However, one must keep in mind that impediments based on political implications could possibly be triggered by the US in view of a potential loss of market share or access if Canada establishes a bilateral arrangement for launch services by India. The American export control regulations that are in place add a wrinkle, or even a layer, of legal inconveniences for Canada.

However, under appropriate framework bilateral agreement(s) with India on economic, nuclear and space technologies, Canada should allow Canadian satellites (even those with American technology) to be transferred to and launched by India. The precedent for such agreement(s) can be seen in the earlier noted cases of transfer to and launch of Canadian satellites by Russia.

Final Remarks and Recommendations:

India aspires to be a 'developed nation' in the sense that the country must not only be strong economically but also technologically and militarily and must be a major global political player. The development of all-round independent space capabilities is very much part of that ambition. Spending about three times more than the annual Canadian space budget, India is determined to be a major global space power. It has in place unambiguous long-term vision, a clear commitment of multi-year and sufficient funds supported by all political parties and the general public, and a specialized institution of higher education for training space scientists and engineers.

In general, the Western countries including Canada do not seem to fully understand India's realities and aspirations. Though some Indian sources deny the exclusive reliance on India's nuclear weapon program on the Canadian reactor in the early 1970's, Canada continues to cling to its version of betrayal by the Indians more than three decades later. On the other hand, the US has moved quickly in recognising the fact that India matters not only at international strategic level (though primarily to counterbalance China's rising power in Asia), but also as a major partner in economic and space matters. India and the US have started developing closer economic and political ties, irrespective of the fact that India maintains its nuclear weapon capability and has no intention of becoming a party to the Nuclear Non-Proliferation Treaty. The US has already become India's most active space partner. In fact, all other major powers of the world have established closer cooperative economic and space-related arrangements with India. However, Canada is lagging behind other nations, though has recently and slowly started realising the importance of closer relationships with India.

While during the last couple of years India and Canada have started moving toward more cooperative economic relations, no significant activity has been undertaken pursuant to their 2003 interagency MOU related to space cooperation. There are several reasons for a lack of space collaboration. In Canada, the space sector does

not enjoy a high political priority and visibility compared to other science and technology fields. Secondly, not much awareness exists of each nation's space capabilities. Thirdly, the Canadian space sector has been in somewhat disarray for the last few years. Irrespective of a highly skilled workforce, Canada started lagging behind in space capabilities primarily because the CSA's budget has become one of the lowest in the G8 countries and the Agency is lacking clear leadership and direction as it has been headed by three presidents during the past three years.[34] It is interesting to note that recognising the current dismal situation of the Canadian space programs, the Government of Canada created in March 2008 an Advisory Committee on the Canadian Space Agency to suggest "the direction of Canada's space program and foster a better alignment of its programs with the evolving priorities of Canada and Canadians." This indeed is an important step in the right direction but its real benefit, if any, will only be realized in the future and will depend upon the appropriateness of the Committee's recommendations and their effective and prompt implementation by the government and the CSA.

On the other hand, the US and Europe, with their well focussed, carefully planned and sufficiently financed programs, have been pursuing much more active and significant space collaboration with India in order to supplement their own space activities by reducing their costs and taking advantage of the Indian expertise and facilities. Therefore, Canada needs a country-specific (i.e. India) and sector-specific (i.e. Space) public policy regarding Canada's engagement in the Asia Pacific region. In this regard, it will be prudent for Canada to initiate the negotiation of an intergovernmental framework agreement with India replacing the 2003 interagency space-related MOU. The agreement should contain (a) general principles and modalities of space cooperation, (b) a list of specific projects to be jointly undertaken by both the countries, (c) the mechanisms for implementation of these projects by identified public and private entities and academic institutions, (d) a provision for speedy compliance with, or exemption from, regulatory controls under the Canadian Export and Import Permits Act and the Remote Sensing Space Systems Act as well as similar regulatory constraints in India, (e) a provision for easy exchange of space scientists and technical personnel, and (f) a procedure for monitoring progress and further consultation.

Both the US and Europe work with India through the US-India Joint Working Group on Civil Space Cooperation and the EC-India Joint Commission respectively. Pursuant to the proposed framework agreement, an India-Canada Joint Working Group should be established for regular discussions regarding collaboration in the public and private space sectors. In addition, joint seminars and workshops for the exploration of possible targeted collaborations might also prove useful in making the respective parties aware of each other's technological strengths and opportunities.

Private enterprises play an important role in the space sector. However, the nature and scope of their activities are essentially determined by political and regulatory decisions of the government in power because space business is not like any other business. Therefore, the Government of Canada must first show leadership in the

form of appropriate policies and regulatory procedures that are conducive to the interests of the private sector. In this regard, the Canadian private enterprises should be allowed to participate in the suggested India-Canada Joint Working Group. They should be encouraged and supported to act as the implementers of some projects pre-determined under the proposed framework agreement.

Though, there are great possibilities for space cooperation between India and Canada, several Canadian regulatory procedures (particularly those that are related to both remote sensing and export controls) pose significant challenges to collaborations. Therefore, it is necessary for Canada to overcome its regulatory hurdles, not only under Canadian law, but also those related to the American export control legal regime. The proposed India-Canada Joint Working Group should have the task of examining all barriers and suggesting means to resolve them for enhanced India-Canada space cooperation.

India possesses excellent expertise in the design and building of small inexpensive remote sensing satellites. Due to high cost for procuring RADARSAT-3, there seems to be no specific plan for a follow-up mission of RADARSAT-2. Therefore, Canada should seek cooperation with India in the design, construction, and launch of next generation of RADARSAT. This sort of collaborative project will not only be beneficiary to the space programs but could also serve as a showcase for Indo-Canadian friendship for boarder cooperation between the two nations.

India's public sector entities are already using RADARSAT data. It is proposed that India should seek collaboration with Canada in the development of remote sensing applications through joint projects for which Canada provides free of charge RADARSAT data and India contributes its expertise and facilities. It should be kept in mind that the Government of Canada is entitled to procure RADARSAT data worth $430 million from MDA and might not be able to use all of that data for its own needs. This project should be a part of the suggested list of projects and may be negotiated with close consultation and involvement of ISRO (and the National Remote Sensing Agency of India) and CSA and Canada Centre for Remote Sensing). It may be noted that recently the Government of Canada decided not to allow that sale of MDA to ATK of the United States. If the proposed sale was allowed, there would have been concurrent application of American law to ATK and also to MDA, although MDA would continue to be a Canadian company (though a subsidiary of an American corporation) and, as such, would have remained subject to the applicable Canadian law, including the 2005 Act Governing the Operation of Remote Sensing Space Systems. Under such dual application of American law and Canadian law, it is foreseeable that conflict of policies and interests, both economic and strategic, of the US and Canada could have risen and made the operations of MDA very difficult and Canada's freedom and ability to use RADARSAT data could have possibly been compromised.

India's recent launch of an Israeli satellite for strategic purposes and with sensitive technology indicates that India can be trusted for storing and mating such critical

payloads with Indian rockets and serves as a precedent for fostering space cooperation between India and Canada. Canada's use of comparatively cheaper Indian launch services is a viable economic and technological strategy in order to increase the competitiveness of the private Canadian companies in space products and services. This will also be a boost to the scientific research conducted by the CSA, academic institutions and other private sector researchers for which space transportation cost has always been a major factor.

Both India and Canada have excellent universities and innovative industries as well as English as a common working language in the scientific and commercial sectors. There is a global trend to produce small satellites and microwave remote sensing satellites. India and Canada with their respective strengths should seriously consider owning a joint commercial remote sensing satellite system for global service. Canadian companies are planning innovative small satellite constellations with high potential for global applications. Thus there is a potential for cooperation between India and Canada in launching such constellations in a reliable and affordable manner and also developing cooperation in applications of such satellites. The recent launch of a Canadian nano satellite by India is an excellent example for future cooperation between a Canadian academic institution (and possibly a private company) and ISRO. The suggested cooperative framework covering such projects engaging both sides will be quite fruitful.

Indo-Canadian space partnership could promote their presence in the commercial space field by fostering competitiveness among their respective private companies in the global space market, which has already become a US$250 billion industry. Moreover, space being a highly visible sector would help build closer strategic relations between these two nations, and consequently, bring broader business cooperation and economic benefits to their respective peoples.

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