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### INDIA'S SPACE INDUSTRY ECOSYSTEM – CHALLENGES OF INNOVATIONS AND INCENTIVES

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#### Abstract

India's investments in space activities were mainly driven by the public policy and there had been steadily growing support for space technology developments and applications through investments by the government. Its space activities encompass diverse branches of space endeavours including space launches to applications to interplanetary scientific missions. As an integral strategy, the space industry development and promotion was pursued from the very early stages of development of India's space programme till now mainly to derive support for the public funded programme and also for creating necessary social and economic impacts. India's space industry role too had undergone an evolutionary process over the past three to four decades and certain epochs could be identified in tandem with the evolutionary phases in India's space activities and also changes in economic and social environment.

The entry of India's private sector into services which are based on space systems for over a decade was a major turning point that opened both growth and extension of value chain by industry. Although certain policy initiatives for industry roles including in the fields of satellite communications and remote sensing data distribution and applications were taken up more than a decade ago, the dynamic changes in market environment, specific nature as well as new advances in space technologies coupled with the issues regarding the harmony of public and private sector roles require policy responses to invigorate the role of space industry.

The opportunities and imperatives of domestic industries to relate to the global industry are also tempered by the policy environment, pointing to the need for periodically assessing gaps in policies and bridging these through a process involving all stake holders.

The paper analyses the state of space industry in India, the impacts created by it and their potentials for future, and, in that context identifies diverse policy innovation issues which need to be addressed. The analysis is structured to deal with different segments of value chain and also new areas of infrastructure and applications such as positioning which were hitherto not addressed. The paper also suggests possible improvements in policies and processes for further development and sustenance of India's space industry. A few cases of technology innovations by industry are indicated to highlight the environmental factors for innovation driven product/service development.

#### I. SIGNIFICANCE OF SPACE INDUSTRY

The history of Space activities across the world has shown a common trend – namely, such activities begin and grow through strong role and investments from the governments. As these activities evolve into many applications, the role of industry grows bigger and broader to a level that the annual revenues earned by industry through supply of products and services surpass the expenditures of the government. In other words, viable and sustainable industry begins to emerge. The industry then becomes an engine for accelerating economic impacts from the Space activities<sup>1</sup>. Rapid growth of Space industry in many countries was also a consequence of spurt in demand for military uses of

Space. In modern Space endeavours of humankind, the part being played by industry has been seminal.

Space industry also distinguishes itself from other traditional branches of industry by the multiplier effect which it can create. Space technology is essentially multi disciplinary. The technological and managerial demands of Space projects such as miniaturisation, fault tolerance; mass, volume and power optimisation; use of new materials; quality and reliability engineering practices provide a unique standard with associated spin offs to innumerable industries and markets. Space, through its wide outreach, reliability, global coverage as well as technological convergence capabilities can enable a large value chain to serve expansive markets with millions and millions of consumers – thus

multiplying the impact of investments made in Space system.

A mature Space industry with capability for system level developments in launch vehicles and Space craft is still a dream for India, even as the global Space industry has marched forward in a very strong way in the global markets already. Nevertheless, in India, the services industry which makes use of Space systems, like in Telecommunications and Television services and value adding business with Remote sensing data has been commanding a multibillion dollar market nationally and it comprises of some of enterprises from the most reputed and the largest industry groups of the country. Unlike even many advanced markets where we witness significant consolidation, the Indian market for Direct to Home Television service for instance presents large number of strong private actors such as Tata Sky, Airtel Digital TV, Dish TV, Reliance Digital TV, Sun Direct, Videocon d2h fiercely competing.

There is considerable potential still to be tapped as India's economy grows and societal needs continue to beckon innovative applications and solutions that only Space technology can provide. Many of ISRO's own products which were developed in alliance with Indian Industry had been accepted in the international market. Since Space industry, to be viable in the long run, has to consolidate and look beyond the domestic markets, the future shape of Space industry in India will have to be based on a unique model of creating effective public private partnerships on the one hand and developing industries' own outlook to be globally competitive and meeting global standards on the other.

## II. SPACE INDUSTRY POLICY DURING THE EARLY PHASE

Around mid seventies ISRO took major initiatives to define organisational mechanisms to promote technology transfer from its centres to industry with an aim to encourage industry to produce and deliver items needed for the Space projects as well as users outside. Drawing experts from different centres, the ISRO Technology Transfer Group was formed to help implementing the policy. The group facilitated a highly successful decentralised system for knowhow transfer that met diverse needs of ISRO from industry. Directly involving developmental teams to interface with industry was one of the success factors in the knowhow transfer and in overcoming the problems of absorption of technology. Multi pronged initiatives<sup>2</sup> resulted in terms of the group's work for awareness building, quality assurance, selection criteria for industries, know-how pricing principles, innovative contract systems and so on. ISRO provided buyback commitments, in cases

where such technologies mainly catered to the needs of ISRO's projects. One could witness very high level of motivation, dedication and orientation to success in the efforts of numerous personnel engaged in this activity across various ISRO centres.

The technology transfer items were numerous and covered a diverse range of technologies and uses such as rocket propellants, chemical powders that extinguished metal and oil fires, adhesives, precision optical coating processes, a variety of satellite communications equipments, weather radars and other user oriented terminals to mention a few. Synergy of existing capacity/ capability in industry with ISRO's needs was one of the major factors for choice of Industry.

Cooperative arrangements were evolved with prominent public enterprises such as Bharat Electronics and Hindustan Aeronautics Limited to set up dedicated divisions or production lines for space and ground systems that were hailed as a mile stone in ISRO industry collaboration. In time Indian Industry from both private and public sectors had become a partner for production of many complex subsystems such as satellite structures and other components, control systems of the rockets, the intricate fuel tanks and associated components, liquid rocket engines and stages, propellants and a host of special purpose equipment and test facilities.

ISRO also spearheaded numerous innovations in the field of materials and special chemicals and successfully productionising them in Industry. This involved collaborative efforts among ISRO, national research laboratories and industry. The development and use of Indian Maraging Steel, the Titanium alloys for tanks and gas bottles and a variety of other light alloys, high temperature resistant composites, special magnetic materials, insulators and materials compatible for cryogenic engine and stage are some examples of such indigenous developments. The collaborative environment brought about by ISRO in the development, scale up and ultimately realising the processes in industry for application in space systems is notable offshoot of a pragmatic self reliance policy that did not attempt to reinvent the wheel everywhere but provided the critical agility for sustaining the programme. .

Following the initial experimental space missions, ISRO's eyes were already fixed, by the beginning of nineteen eighties, on positioning operational services with satellites for telecommunications, television distribution, weather observations and generation of natural resource information through space based remote sensing. Development of a variety of ground equipment needed by users of space systems for these services and applications such as disaster

communications and educational broadcasts were spearheaded by ISRO. Extensive industrial interface was also developed for ground facilities such as tracking networks, satellite control facilities as well as data reception and processing facilities for remote sensing.

In the field of launch services ISRO received a high calibre industrial support in building facilities for assembly, fuelling, transportation, launch preparation and mission control activities integrating reliable safety systems. ISRO also entrusted responsibility on industry to operate a few facilities such as gas production plants.

A distinct characteristic of space industry policy nurtured by ISRO during initial decades of space programs in India had been strong public investments for developing total range of technologies for peaceful, national developmental applications of space and a strong recognition that harmony of government and industry endeavours are crucial for both<sup>3</sup>. It also emphasised the value of long term commitments that make Space and Industry partnership viable.

### III. FOUNDATIONS FOR GLOBAL OUTLOOK FOR INDUSTRY- FORMATION OF ANTRIX

With aforementioned multipronged initiatives for industry interface, a supportive industry comprising of a few hundreds of enterprises had emerged as sub contractors of the national space programme. Due to the strategy of user driven programme that was adopted by ISRO, demand for applications had steadily grown. However, wider economic impacts are possible only through the role of commercial industry<sup>4</sup>. In order to manage the expanding industry interface tasks of ISRO, and help evolve the fragmented Space industry in India to the next level of integration, as well as to position Indian Space capabilities on a global platform, Antrix Corporation was established in 1992 as a corporate commercial arm of ISRO. ISRO's anchor ship for such a commercial entity was initially necessary in order to meet the market's demands on heritage and also to mitigate high risks. Antrix relied maximally on the infrastructure, facilities and expertise created in ISRO as well as Indian industry. It made significant progress by forging collaborative relationships global industries and trying to create synergies<sup>5</sup> to serve both domestic and international markets.

Antrix made alliances with prominent global players to market space products. Collaboration in the field of remote sensing saw development of international ground stations for Indian Remote Sensing Satellites and an extensive reseller network. Another important area of business Antrix developed was the commercial lease of capacity from Indian communications satellites

to VSAT service providers, and DTH as well as Cable & Satellite TV service providers. Other areas where Antrix made good progress was alliance for joint manufacture and marketing of communications satellites (with Astrium) and offering launch services from PSLV for a large number of international customers for their small, micro and pico satellites in a cost effective and the most reliable manner.

### IV. EXPANDING NATIONAL MARKETS AND POLICY DEVELOPMENT FOR SPACE SERVICES

Advent of Antrix during the early nineties had also overlapped with the thrust from the Government of India on economic reforms, which liberalised the entry of private industry in the services related to telecommunications and television broadcasting. A policy framework for the satellite communications policy<sup>6</sup> was approved by the Union Cabinet in June 1997. Detailed procedures for implementation were also worked out and announced by the Government later. The Policy as well as norms, guidelines and procedures essentially enabled (i) provision of capacity from public funded INSAT satellites to non-governmental users by the Department of Space (DOS) on a commercial basis; (ii) provisions for establishment and operation of Indian satellites by private sector, wherein Indian registered companies with a foreign investment not exceeding 74% were allowed to establish and operate satellite systems.

On another front in 2001, the Government approved a comprehensive Remote Sensing Data Policy (RSDP) that dealt with acquisition and distribution of satellite remote sensing data – from Indian and foreign satellites for civilian users in India. The policy set the guidelines for data acquisition from satellite and distribution within India and also for licensing the IRS capacities to other countries. This policy has since been updated<sup>7</sup> in 2011, considering the tremendous changes in the environment brought about by web revolution and by easy access to high resolution data on a global scale.

#### II.I Ecosystem of Satellite Communications industry - Issues

Since the process of liberalisation began and above mentioned policies were developed continuous changes had been occurring in the national scene where market demands have been expanding and calling for supply side reforms with a dynamic outlook. Satellite Television and Satellite Communications Services are bound to expand further over the next decade given the growth in number of households and greater penetration, increase in the number of channels, expansion of HDTV and economic development outlook for India. Some studies had indicated more than doubling of needs of transponders<sup>8</sup> (from a level of 104

transponders in 2012 to 276 by 2017 in C and Ku bands for TV industry needs) and the inevitable gaps between demands and possible supply from public funded domestic satellites. This situation calls for serious reforms in policy implementation.

#### IV.I.i Urgent needs for Private sector investments in Indian Satellite Systems

From a long term national interest, it is essential to attract domestic private sector investments into space infrastructure and enable mutually beneficial collaboration between domestic and global industry players. It is also necessary to effectively enable the use of the public funded technologies in this field for accelerating economic engines of the nation. TV industry in India is about the size of INR 400 billion and satellite technology is critical growth driver for this. If domestic satellite technology capacities are relegated to a marginal role, it is undermining the public funded investments made over several decades. The effective direction for the mid term is public private partnership. Industry has to be a stakeholder in policy making

#### IV.I.ii Organisation of Regulations and Services

The second important aspect of reform needed for satellite communications is to ensure effective and independent regulatory mechanisms to facilitate public private partnerships and promoting competitive conditions satisfying the goals of meeting essential needs of the society.

#### IV.I.iii Incentives and enablers for industry

A third area of ecosystem revitalisation will be the Government's proactive role and policies for internationally coordinated resource needs (such as orbit and spectrum) and technology advancement support for enabling industry development in India.

#### IV.II Remote Sensing and GIS industry Ecosystem issues

Domestically, the national space agency ISRO is the sole agency having satellite capacities. India has made tremendous strides in the field of remote sensing technologies and applications and even catered satellite data to world markets. However, there are revolutionary developments in private sector capabilities in several parts of the globe led by policy changes in the United States. The world community has access to very high resolution data from privately owned satellites. While the role and need for public sector investments in some segments of remote sensing is inevitable, Indian market ecosystems in this field is badly in need of policy dynamism and satisfying potential demands in the market for high resolution data and enable a robust role

for industry. A vision for private sector investments into high quality remote sensing satellites should be enabled for a globally competitive service. The public sector could share the stakes with private sector. A vision for National GIS had been evolved in India<sup>9</sup> and its implementation can give fillip to imaging industry.

Several issues of policy had been studied by authors for an effective GIS policy<sup>10</sup> in India to provide a leading role for space business applications for better governance, commerce and citizen empowerment.

#### IV.III Space Launch Services Ecosystem

Antrix performed yeoman's service to international community in launching numerous small, micro, nano and pico satellites in a very cost effective manner using India's reliable workhorse launch vehicle PSLV. The GSLV and GSLV Mark III are yet become operational and these could potentially serve commercial markets. A predominant user of launch capacity in India is the government and a strong public sector/ government role in launch vehicle manufacture and services is likely to continue. Also, globally, the government markets are protected. The eco system today presents inadequate capacities in industry for increasing launch rates in India. The major role that one could foresee for Indian Industry in this field is their integration and moving up the value chain. ISRO needs to complete implementation of a suitable policy to enable further expansion of industrial capacity, to sustain Industries' interest and also to ensure their compliance to national security and export policy norms. The ecosystem revitalisation also requires legislative backups for dealing with liability issues, issues of state responsibility, national security, risk reduction, and safety in commercial launch operations. International Agreements on Technology Safeguards and Commercial Space Launch Agreements with major market players will also help to expand in overseas markets.

#### IV.IV Collaborative satellite manufacturing

A few private sector satellite industry start ups in India are relying on/ looking for overseas manufacture of satellites in view of capacity and policy constraints within the country. Also for India's domestic needs new and more efficient technologies need to be spun in. An effective way to enhance national capacity is to encourage collaborative manufacturing. Antrix – Astrium model showed the mutually beneficial aspect of such alliances. Necessary policy tools adopted in government procurements could be utilised to enhance technological level of Indian Industry as well as increasing their role in global markets. Further, there are nascent areas where India is developing space segment

capacity like in case of positioning services, where there is need for industrial contributions to ground segment, standards and services through collaborative efforts.

## V. GROWING AND SURVIVING IN A GLOBALISED WORLD

The Indian Space program has excelled in certain dimensions such as applications relevant to societal development. It has also contributed to international dimensions through its commercial and cooperative endeavours. As tremendous opportunities are opening up in Indian economy, which is growing as a major world economy, needs for speedy infrastructure growth had arisen in several areas. Role of Indian industry will be crucial not only to extend the value chain but also to ensure that space infrastructure segment does not remain only within the domain of public investments. Further the Indian Industry should also be enabled to compete and play a role in global markets. Expanding space markets in India provide unique opportunities and at the same time several big challenges. Hence there is need for synergetic efforts between the Government and Industry.

Without major policy initiatives at this time, ISRO will be facing constraints in meeting in diverse demands of the commercial sector and in taking full advantage of opportunities that are unfolding. A direction to address is the risk sharing partnerships with private sector and the empowerment of private sector addressing issues of the overall ecosystem. Ignoring such a possibility can diminish the value of investments made over decades in the national space programme. Need is to industries come together to produce state-of-the-art, cost competitive satellites on one side and manufacturing of launch vehicle and providing launch services on the side, so that the national space agency can find larger resources for future leadership in technologies and advanced missions. Policy issues which need to be resolved include but not limited to technology safeguards, IPR protection, government procurement policies, technical audit, risk management, international obligations and international collaboration, national security, permitting use of government owned specialized facilities like launch pads to provide launch services and financing options. Many initiatives are also needed from the private sector even as the government creates necessary enabling environment including its assuming an anchor tenant role as practiced in advanced economies to maximize value addition and job potentials within the country. In summary, (i) participation of private sector in owning and operating commercial space systems (ii) incentives to private sector for risk management and policy innovations to promote public private partnerships and (iii) development of an overarching and holistic space policy

allowing robust technology developments for national self reliance are central to the transformative vision for India's Space Industry

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<sup>2</sup> KR Sridhara Murthi and T S Shoba, (2010), Technology Transfer Trends in Indian space Programme, 67 Acta Astronautica 942

<sup>3</sup> Satish Dhawan, 1988, Prospects for a Space Industry in India, Fifth Lala Karam Chand Thapar Memorial Lecture, Patiala Technical Education Trust, New Delhi.

<sup>4</sup> U. R. Rao, 1995, 'Space and Industry Partnership', Lecture delivered at Association of Indian Engineering Industries, Indian Rocket Society and ISRO Seminar on "Opportunities in Space", Published by Indian Space Research Organisation, Bangalore.

<sup>5</sup> K Kasturirangan and KR Sridhara Murthi, "India's Future in Space Exploration" (2008) 9 Harvard Asia Pacific Review 19

<sup>6</sup> 'A policy framework for satellite communication in India', retrieved on 10<sup>th</sup>, September, 2014 at <http://www.isro.org/news/pdf/satcom-policy.pdf> and 'The norms, guidelines and procedures for implementation of the policy frame-work for satellite communications in India as approved by Government in 2000' retrieved on 10<sup>th</sup> September, 2014 at <http://www.isro.gov.in/news/pdf/SATCOM-norms.pdf>

<sup>7</sup> Remote Sensing Data Policy (RSDP- 2011) retrieved at <http://www.isro.gov.in/news/pdf/RSDP-2011.pdf> on 10<sup>th</sup> September, 2014.

<sup>8</sup> CASBAA, March 2013, Easing India's Capacity Crunch, An assessment of demand and supply for television satellite transponders, prepared by PricewaterhouseCoopers

<sup>9</sup> ICG (2011) - Implementation of a National GIS under INGO – Programme document. A National GIS Vision document prepared by Planning Commission's Interim Core Group and published by Ministry of Earth Sciences, Government of India in October, 2011

<sup>10</sup> Mukund Rao and KR Sridhara Murthi, Perspectives for a National GI Policy (Report R 11 - 2012) National Institute of Advanced Studies, Bangalore, India, September 2012.