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Need for space governance for India and global space governance

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1 Why state policy

Global space economy consisting of activities of governments and private companies grew to $314 billion in 2013. Private-sector commercial space activity is now growing at a faster pace, while governmental activity is slowing down. Between 2012 and 2013, commercial space products and services revenue grew 7%; commercial infrastructure and support industries grew by nearly 5%; while government spending decreased by almost 2%. Space investment is a major part of the infrastructure of communications—both telecommunications and broadcast—of weather and geological monitoring, and defense. Thus, commercial development of outer space is outpacing governmental activities in space. As private firms launch commercial space activities, the legal obligations and liability of space-faring states proliferate as well

With the growth of number of states in space activities, many nations have enacted their owner space legislations. Many are enacting national space legislation, establishing governmental space regulatory institutions and giving them jurisdiction to license private sectors and ensure compliance with regulatory requirements. In order to fulfill their international obligations based on space treaties ratified by them and to protect the citizens from harm, to protect their treasuries from liability, and to encourage and foster the development of commercial space activities, many states have their own rules and regulations on space issues generally harmonious with international treaties. This can be interpreted as filing a void in absence of an international regulatory regime addressing safety and navigation of aerospace vehicles. Though a number of commentators (including the present one) have urged

the International Civil Aviation Organization [ICAO] [1] to regulate the safety and navigation of aerospace vehicles, to date, this has not been done. Moreover, the world community has failed to draft a single multilateral treaty addressing space issues since 1979. ICAO and UNOOSA held for the first time a joint meeting in 2015 at the ICAO headquarters in Montreal to consider the issues of management of aerospace. This was the first step toward getting ICAO involved in issues of aerospace travel. There is a need for framing of standard and recommended practices (SARPs) like ICAO is doing for aviation.

Five multilateral conventions, drafted in a dozen years, place numerous obligations upon states. Further, space law consists of a growing number of international multilateral and bilateral agreements and conventions, U.N. resolutions, decrees by international organizations, national legislation and regulations, and court decisions. These require states to adhere to principles of international law, assume responsibility and liability for activities in space (whether governmental or non-governmental), authorize and supervise the activities of their nationals in space, and notify and register their space objects. Among requirements imposed by the Outer Space Treaty of 1967 are the following:

- States must carry on space activities in accordance with principles of international law;
- States bear international responsibility for national activities in space and on the moon and celestial bodies, including activities of both governmental and non-governmental entities;
- States must authorize and supervise the activities of its nationals in space;
- States that (a) launch, (b) procure the launch, or (c) from whose territory or facility an object is launched, are internationally liable for damage to another or its national or juridical persons by such object in the air or in space;
- States on whose registry an object is launched must retain jurisdiction and control over the object and any personnel thereon;
- States must avoid harmful contamination and adverse environmental consequences from the introduction of extraterrestrial matter; if it believes an activity or experiment by it or its nationals in space would potentially harm or interfere with activities of other states in space, it must consult with such states before proceeding; and

- States must inform the UN Secretary General of the “nature, conduct, locations and results” of its activities in space.

Several of these provisions also are elaborated upon by the Liability Convention of 1972. Building on Article VII of the Outer Space Treaty, the Liability Convention imposes liability upon a launching state (i.e., the state that launches, procures the launch, or from whose territory or facility a space object is launched) to pay compensation for personal injury and property damage

caused by its space objects on the surface of the Earth, or to aircraft. The convention establishes a two-tier liability regime, providing that the “launching state” is absolutely liable for damage caused by its space objects on the surface of the Earth or to an aircraft in flight, and liable in negligence for damage caused to a space object of another state or to persons or property on board. Where there is more than one launching state, they shall be jointly and severally liable for the damage they cause. Hence, by ratifying or acceding to either the Outer Space Treaty of 1967, or the Liability Convention of 1972, the launching or launch-procuring state becomes potentially liable for damages caused by itself and its commercial launch sector. A ratifying state accepts absolute liability for damage on the ground or to aircraft in flight outside its territory when a launch takes place from its territory or facilities, or when it procures a launch from another state. A state incurs fault-based liability for damage caused in outer space. In addition to these multilateral conventions, additional legal obligations are imposed upon states through customary international law, an array of United Nations Security Council and General Assembly Resolutions, and a growing body of “soft law.”

Further, the role of ICAO is to harmonize state regulation of aircraft safety and navigation in—may apply to vehicles transporting space objects through air space. But to date, ICAO has promulgated no Standards and recommended practices governing aerospace vehicles or rockets, though in time, it may.

Considering the gap created by international treaties on space without proper international space legislation as done by ICAO for air, the international obligations and the liability exposure created thereby, as well as a desire to protect the health and safety of their citizens, their property and the environment, a growing number of states have promulgated national legislation to regulate commercial space activities. As one

source notes, “Since a government can only act on the basis of laws or respective regulations, the establishment of national space laws is the most effective way of providing the state with the means to authorize and supervise non-governmental space activities.” At least twenty-six states—about 14% of the members of the United Nations—regulate space activities. Among the states that have enacted national space legislation are Algeria, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, the People's Republic of China [PRC], Colombia, France, Germany, Italy, Japan, Kazakhstan, Netherlands, Nigeria, Norway, Russian Federation, South Africa, the Republic of Korea [South Korea], Spain, Sweden, Ukraine, United Kingdom, United States, and Venezuela. Hong Kong also regulates space activities.

The United Nations Committee on the Peaceful Use of Outer Space [COPUOS] recommends that, “Space activities should require authorization by a competent national authority; the authorities and procedures, as well as the conditions for granting, modifying, suspending and revoking the authorization should be set out clearly to establish a predictable and reliable regulatory framework.

The conditions for authorization should be consistent with the international obligations and commitments of States, in particular under the United Nations treaties on outer space” Governmental oversight of space activities is essential to protect public safety, property, and the environment, and to fulfill state obligations under international law. Licensing becomes the bedrock of governmental regulation of commercial space activities.

2 India: background to space activities

India established Indian Space Research Organization (ISRO) in 1969. With self-reliance as a goal, the space program was based on the premise of ‘end to end’ system concept. This premise enabled the Indian Space Program to overcome numerous hurdles and challenges in leaning and experimenting with new technologies [2].

The Indian Space Program was started not by addressing India's military requirement but rather developmental needs. Satellite based instructional television was the beginning. The first was the Satellite Instructional Television Experiment (SITE) with telecommunication satellites. By 1970 s, India had procured its own communication satellite ‘Aryabhata’, a 360 kg satellite named after an Indian astronomer. It was

launched by Russian launch vehicle. India by then decided to have its indigenously designed space worthy satellite, conduct a series of complex operations in space, set up ground based receiving, transmitting and tracking stations, and also establish an infrastructure for fabrication of spacecraft systems.

The second phase of grand plan for indigenous 'end to end' system for development and manufacture started with satellite Aryabhata, led to Bhaskara series—India's first experimental geo-stationary satellite. Thereafter came the development of Launch Vehicles such as SLV-3 and ASLV. By the late 1970s, India had already built a considerable infrastructure of laboratories and facilities and also initiated a 3-pronged program-INSAT (Indian National Satellite) program for communication satellites; IRS (Indian Remote Sensing Satellite) for remote sensing; and launch vehicle programs for launching of Polar and Geo-synchronous satellites.

In the third phase starting in the year 2000, India had achieved the basic technological maturity required for developing a space system. However, India also announced around this time its augmentation satellite to compliment GPS in GNSS and further announced seven satellite based Indian Regional Navigation System known as IRNSS. This mini-constellation would be operational by the end of April 2016. It also started planning for an unmanned mission to Moon with Chandrayaan I, which was successful in 2008–09. It is now planning to go in for reusable launch vehicle.

Later in 2011, ISRO took upon a new challenge of a foray to Mars in 2013. The Mars Orbiter Mission (MOM) was successfully launched in November 2013 and has already completed more than 90% of its traverse to Mars. MOM has entered mars orbit and has started its experiments of imaging and measurements. But more significantly, MOM would establish the fact that India can successfully undertake long-duration planetary missions and has gained tremendous experience in this regard.

So far, the achievements of Indian space policies have been mainly due to government funding with ISRO as its implementer. The achievements can be summed up as:

- A full space infrastructure has been built up over half a century.
- Approval for 200 missions has been accorded by Indian government but 125 missions have been accomplished—out of which 111 missions have been successful.

- Leading satellite capability that covers a wide variety of applications satellites. These can be grouped in five categories:

  i) Satellite communications,

  ii) Broadcasting satellites,

  iii) Remote sensing (Earth observation),

  iv) Location and timing satellites,

  v) Metrological satellites.

- Use of INSAT communications systems have resulted in the wide outreach of TV signals (from early 1980s onward) to almost whole of the country. In addition, growth of large-scale DTH and VSAT data communication business has been achieved.
- The availability of low-priced and easily available IRS images (from about 20 IRS missions) has given a great thrust to use of images and geographical information techniques into many governance and national building activities, including disaster management.
- Weather and ocean services modeling have derived a great boost from the availability of INSAT and Oceansat images/data on a variety of ocean and atmospheric data—thus consolidating the Scientific

  Services of Meteorological Department and Earth Sciences.
- Forays in planetary missions have been made through Chandrayaan-1 and MOM-1 to establish the technological capability of Indian space to undertake far-reaching planetary exploration and also undertaking advanced scientific studies.
- Unique missions for astronomical observations—Astrosat and operational positioning services—through Indian Regional Navigational Satellite System (IRNSS) constellation of seven satellites already in orbit. Astrosat has multiple imaging methods: ultraviolet, soft X-rays and hard X-rays. This will involve expansion of space applications for ISRO.
- The next lunar mission Chandrayaan II by ISRO is being planned for which ISRO is developing a Rover, a lander and orbiter.
- ISRO has another major mission in mind: Aditya I,

a satellite to look at the Sun.

- Global commercial operations of Indian space includes 43 commercial/foreign satellites launches; sale of IRS images and value-addition services and lastly more lucratively, transponder lease business in India. This has estimated to have resulted in revenue earnings of about INR 50 billion over the past 20+ years.

3 Commercialization of space apps in India: Antrix Corporation 1992

By 1992, the government had realized the potential of commercial space activities and set up a wholly owned company called Antrix Corporation in that year to market Indian space capabilities developed by ISRO globally. Thus Indian government entered the commercial space market in 1992 through a wholly owned company Antrix Corporation which is still attached to ISRO.

Antrix Corporation has access to specialized design, test and manufacturing facilities of ISRO and its staff of 16,000 experienced scientists and engineers with in depth knowledge of the crucial parameters of the space industry. Antrix Corporation has focused on enhancing functionality and value to the customer. Antrix offers satellite systems and sub-systems with proven performance in space and incorporating advanced features of power and reliability and long life. The earth observation data services powered by a state of the art constellation of Indian remote sensing satellites (IRS) and a network of ground stations provide a valuable and assured resource for business to customers worldwide. Antrix facilitates the utilization of Indian space assets in the field of telecommunications and broadcasting for a variety of services including TV feed,

DTH, VSAT, mobile communications and socially relevant services such as telemedicine and tele-education. A track record of successful space launches in a variety of earth orbits through India's PSLV and GSLV launch vehicles has made Antrix a choice for many customers.

Antrix Corporation has already achieved:

- Successful supply of reliable satellite systems and sub-systems. Some of Antrix's better known customers are Hughes, MatraMarconi, WorldSpace, etc.
- Successful commercial satellite.

- Execution of many support services to International space agencies. Some of the customers using Antrix services are World Space PANAMSAT, GE Americom, AFRISTAT.
- Successful launch of TecSar(Israel).
- Two satellites; one from France and another from Japan were launched in September 2012.
- Successful launchoffivesatellites, including French SPOT7 satellite on 30 June 2014.

3.1. Business agreements

On 29 January 2014, Antrix Corporation Limited (Antrix), signed Launch Services Agreement with DMC International Imaging, the wholly owned subsidiary of Surrey Satellite Technology Limited (SSTL), United Kingdom (UK), for launch of three DMC-3 Earth Observation Satellites being built by SSTL, on-board ISRO's Polar Satellite Launch Vehicle (PSLV). On 5 February 2014, Antrix signed another Launch Services Agreement with ST Electronics (Satcom and Sensor Systems) Pte Ltd, Singapore, for launch of TeLEOS-1 Earth Observation Satellite, on-board PSLV. On September 29, 2014, Canada announced award of contract for launch of M3M (Maritime Monitoring and Messaging MicroSatellite) communications satellite to Antrix at International Astronautical Congress at Toronto.

4 Size of Indian commercial space industry: need for private sector initiative

It is estimated that while the global space economy is worth $314.17 billion which includes $226 billion is commercial, the Indian space industry is, however, worth only $1.1 billion of which private commercial space economy consisting mainly of Space SME sector is only $48 million. It is felt that Antrix Corporation, as a commercial arm of ISRO, will not be flexible enough to compete in the world space market. The need for small, lean, young, flexible organization is felt.

Some of the growth areas of Space based activities in

India are disaster and flood management, tele-medicine,

tele-education, vehicle tracking, women safety, management of land issues, remote sensing for minerals, urban development and creation of smart cities.

India has issued two policy documents so far: Satcom policy in 1999 and remote sensing policy in 2001 and 2011.

5 Analysis of Satcom policy (1999) and remote sensing data policy (2001 and 2011)

(a) While stating the usual goals, the Satcom Policy of 1999 also mentioned that it would encourage and promote privatization of satellite communications in India by way of encouraging private sector investment in space industry and also attracting foreign investments. This proved to be true.

It also authorized leasing of capacity of Indian National satellites (INSAT) to nongovernment (Indian and foreign) parties on commercial terms. This was essential so that commercial services could ride on INSAT—envisaged to spur the DTH and VSAT market in India to a large extent. It also allowed Indian parties to provide services including TV uplinking through Indian satellites which helped opening up of a large variety of TV channels in India. It also opened up the operations from Indian soil using foreign satellites under certain conditions.

Further the Satcom Policy proved to be a great boost for DTH business, Vsat services, connectivity for education outreach across the country, reliable telemedicine connectivity, increased capacity leasing and a great growth in Indian ground equipment manufacturing. It was also envisaged that this policy should help position JVs for communication satellite ventures and also bring in a variety of new value-added services, especially for mobile phones.

The Satcom policy gave preference to Indian satellite systems (ISS) in giving service licenses—thereby ensuring “protective cover” for INSAT for Indian services against global commercial systems. However, the Satcom policy did not in any way prohibit the use of foreign satellite systems—which, after a due process, can be treated on par with ISS for service licensing in India. This has not happened mainly due to deficiencies of appropriate procedures in implementation. Further, it was decided to channelize all lead foreign satellites through ISRO/Antrix which brought in major bureaucratic hurdles for private persons.

The impact of SATCOM policy has been very positive. On top of this, announcement of "Digital India Policy" in 2014 has further added impetus. This has also led to ecommerce startups offering services of online shopping, to locating taxis, restaurants, etc. Use of SMS alerts by banks, airlines has become common. Use of SMS to inform value of shares and other financial services are gaining momentum. But more important is the use of GIS in integrating information relating to land ownership and physical features (water bodies, roads, forests, etc.). These can be super imposed on basic top sheets as has been done by the Government of Gujarat. The state government has also enacted a law for institutional framework for use of GIS. E-governance has now been made a policy by Government of India leading to growth of e-kiosks in small towns and villages. In the recent budget, funds have been allocated to lay out a national optical fiber network program of 75,000 km to connect 250–1000 villages. This is a part of the 'Digital India' strategy.

(b) The remote sensing data policy (RSDP) 2001 and 2011 lays down rules for regulations for acquisition, dissemination of satellite images in India—earlier, RSDP-2001 and now RSDP-2011 governs how satellite images are to be acquired and distributed—allowing up to 1 m images to be openly disseminated to users. The RSDP embeds the concept of “regulation” to address the dissemination for 1 m images [3].

The RSDP-2001 provided the basic “framework” for a comprehensive imaging policy. Remote sensing was identified as a “public good”. The RSDP introduced the concept of “one-window” access to any image (Indian or foreign satellite)—which today appears to be against “free market” concept. Concept that RSDP-2001 brought in was mainly to prevent access to 5.8 m images that could become a security concern. The RSDP also required foreign satellite images to be routed through the national agency—National Remote Sensing Centre (then Agency), NRSC. Thus, even though the RSDP, 2001 clearly emanated from the competitive challenge of US 1 m images against the Indian 5.8 m IRS system in the Indian market—it was certainly a protective regime for IRS till it could also match with commercial 1 m image availability from other sources.

By 2005–06, India also launched 2.5 m and 1 m images but by then the larger proliferation of 1 m images from US commercial satellites had also happened. Thus, the 5.8 m threshold of RSDP-2001 as “regime for non-discriminatory access” became irrelevant.

With NRSC the “sole agency” for distributing images, it had become further monopolistic as it adopts IRS-centricity and pushed 2.5 m and limited 1 m images—thereby denying Indian users 0.3 m level images for national development. At the same time, India was unable to match the resolution quality of US commercial systems (that have reached 0.3 m level in global market) and had planned for a 0.5 m imaging IRS in 2017 timeframe. Because US 1 m images became widely popular in India as against 5.8 m/2.5 m images and very limited 1 m images from IRS systems RSDP 2001 was a failure. Consequently, in RSDP-2011 the bar was lowered for "non-discriminatory access” to 1 m while fully retaining all other aspects of RSDP-2001.

6 Shortfall of Antrix Corporation

While ISRO together with Antrix has a monopoly for the trading of satellite bandwidth in India, less than 50% of commercial satellite demand in India is served today by Indian satellites, with the majority being provided by foreign satellite operators such as SES, Intelsat and AsiaSat through subleasing capacity to ISRO. ISRO in turn further leases it to Indian private companies while making for themselves undue profits. This situation is the result of a disparity between the lack of capacity available from ISRO and the strong growth in demand in recent years, driven by DTH TV broadcasting and monopoly rights with ISRO.

7 Upgrading satellite manufacturing and launching

The successful launch of GSLV-D05 using an indigenously developed in India a cryogenic engine in January 2015 was a critical milestone for ISRO's communication satellite program. Routine operation of GSLV Mark 2 will help ISRO in achieving self-reliance for launching satellites now in the pipeline for Direct to Home television (DTH TV) and broadband communications. The development of the GSLV Mark 3 with its capacity of 4000–5000 kg should accelerate in the coming years after success with the indigenous cryostage, which has been a bottleneck in ISRO's geostationary launcher development program over the past 20 years. In future, therefore, India should be able to launch heavier satellites [4].

8 Future of commercial space apps in India

Euroconsult has predicted in its recent study “India Satcom markets 2014,” an average growth of 8% per year in commercial bandwidth demand driven by DTH satellite pay-TV platforms, cable television, cellular backhaul and enterprise and government VSAT, or very small aperture terminal, communications networks has been predicted. To meet growing commercial demand, ISRO has not been able to provide enough satellites and instead has taken foreign satellites on lease for the past 10 years especially for Ku-band. Although it considers those leases as gap-fillers until sufficient domestic capacity becomes available, it is highly likely that ISRO's dependence on foreign operators will continue, as it has not been able to launch more than one communication satellite per year in the past. Also, ISRO, being a government body has to reserve capacity for government users such as the Department of Telecommunications, All India Radio, Prasar Bharti and the military that account for more than one-third of its current bandwidth supply, therefore limiting the capacity available for commercial users. There is, therefore, a definite need for government to open satellite development and launch to private industries which is so far an ISRO preserve and thereby give ISRO competition on equal footing. As of today, ISRO has vendor base in private sector only.

Regulation still limits market growth, as all Ku-band leases have to go through ISRO/Antrix in a process that is often lengthy and cumbersome for operators, including strict price regulations, royalty fees and service-level license regulations by the Department of Telecommunications and the Ministry of Information and Broadcasting. Some of these regulatory restrictions are likely to be revised in the country's new Satcom policy expected to be released shortly [5]. Expectations are high from satellite operators, equipment vendors and service providers alike.

9 ISRO to scale up outsourcing to private industries

In a recent statement, a former of Chairman of Indian Space Research Organization (ISRO) had stated that India would significantly scale up outsourcing to industries to meet the shortfall in demand and to fuel the quantum jump in the programs being undertaken by it. He had also proposed to have a risk-sharing model, as more than 500 industries (micro, small, medium and large) already account for 60% production of the Space Agency's Program and their share would further go up. ISRO is witnessing a quantum jump in the production of rockets (Polar satellite launch vehicle) and satellites, in the last 2–3 years.

At present, ISRO's suppliers are located in different parts of the country, and the idea now is to cut down the turnaround time and get the products on time. The ISRO has proposed to set up a specialized industrial park near the Sriharikota spaceport on the Andhra coast so that its industrial partners can set up their production there.

ISRO has also mooted an idea for industrial partners that they can work in consortium mode if they wish— like coming together of players in the field of electronics, production, metals and precision fabrication, among others. In spite of all said above, India still does not have a space policy or a space legislation.

10 Need for greater private initiative in space activities

10.1. Shortcomings in the Indian space ecosystem

The space ecosystem of India is driven by the Department of space with upstream, downstream and commercialization of space assets all done by the government institutions with limited support in supplies of products and service by the space industry. As Department of Space also acts as the regulator for all sectors of the industry, there exists a conflict of interest for it to promote private space industry. This, combined with industry entry barriers like high cost, high risk, lack of regulations, and sometimes long gestation periods, discourages the industries that supply to the space activities currently to be able to become the turnkey solution provider in space capabilities and launch systems. Indian space activities. This also limits Indian commercial space industry in their ability to cater to international requirements. Antrix Corporation has the mandate to commercialize products and services including remote sensing data, launch contracts for foreign satellites, development of turnkey spacecraft, and others. Yet, given that Antrix and ISRO overlap—the former tends to function more like a quasigovernment organization rather than a private one that competes effectively in the international market. As private sector space enterprises grow, Antrix Corporation's power becomes an issue to be studied for opening of the sector.

10.2. Capacity in capturing the international demand

With the extremely busy schedule of ISRO in the current five-year plan 12 with 58 missions, the ability of Antrix Corporation to leverage on the facilities and infrastructure developed in ISRO for AIT of satellites, manpower in consultancy will remain limited. The last of such (and the only instance of) satellite development taken up by ISRO via

its commercial wing Antrix has been the satellites manufactured and shipped for two major European companies, W2M for Paris-based Eutelsat Communications (subcontracted to India from European Aeronautic Defense and Space Company (EADS) subsidiary Astrium) and for the 13 14UK-based Avanti Screen Media. The failure of the W2M satellite had an effect on the international market sentiment for development of communication satellites by India.

However, it may be added as a background that ISRO has launched about 25 foreign satellites all with its workhorse rocket launcher PVSL without a single failure. It may be further added that PVSL has been continuously upgraded is now a very versatile vehicle which can do much more. GVSL, on the other hand, is using cryogenic engine and is using tested components of PVSL.

11 Boosting private sector in space industry: need for space policy and space law in India

As the geospatial market is growing and is around $315 billion, India has a lot of potential and capability to export is space products. Over 500 small scale industries provide a supplier base to ISRO which help make satellite components. As a result, ISRO, with its low development costs, can build a package which is nearly unbeatable in the market. ISRO's involvement of small and even big industries in India has already provided a solid technological foundation and ecoenvironment for private industry. However, the need now is to get beyond ISRO and Antrix corporation in India and let private sector get into commercial space activities on their own without the umbrella of Antrix Corporation.

11.1. Government investments and polices with reference to space

The maturity and size of the space industry is heavily dependent on government investment and policies. The largest share of the global commercial space industry belongs to the United States due to higher investments by government and a well-defined space policy that promotes industrial participation. Futron's Space Competitiveness Report (2014) found that not only has the US been successful in leading with globally reputed space companies like Boeing, Lockheed Martin and SpaceX, but it is also leading in creating human capital. Much of this success can be attributed to its large investments in defense space, providing these companies to scale up their operations without largely affecting the cash flow.

12 India's opportunity in space sector

India's space budget has increased in size and is now one of the largest in the world; however, the lack of an active space industry at turnkey level might have an immense opportunity cost for India in manufacturing satellites and launch vehicles to service the global market. Further, not a single Indian company among the top space companies in the world and this needs to be addressed urgently through a policy push under the several grand schemes announced by the current government, such as 'Make in India' and 'Digital India' by declaring a space policy followed by space legislation. As India ramps up its space defense capabilities, the lack of a mature space industrial base will potentially hurt its ambitions. India counts itself among the top nations in the world in terms of government space investment, but is far behind when it comes to creating successful private industry that is globally reputed.

India's private sector has already proved its metal in software, automobile sectors, etc. but has stayed away from space sector due to policy restrictions. The success of a privatized space industry will enhance capacities within the country and complement the government driven program, which has been historically proven in advanced spacefaring countries such as the US. Capacity building in the private industry at a turnkey level for both upstream and downstream shall assist the economic development of the country by keeping up to the pace of requirement of the marketplace (e.g. Direct-to-Home TV, Broadband Internet), while reducing the inherent dependence on foreign assets. Only one among the seven DTH providers is leasing transponder from the INSAT system from Indian Satellite System and the primary reason for this disparity is the slow pace at which ISRO has added satellite transponders to the commercial market. The net effect is that the DTH providers are incurring higher transponder costs on foreign satellites when INSAT could have been an equally reliable, and more cost efficient, alternative.

India's cost advantage is well established. India's Moon and Mars missions have shown how India can do it cheaply. India has already complete 1 year of Mars orbital mission known as Mangalyaan which arrived at the red planet on 23rd September 2014 and its cost was around $73 million. Earlier India's Moon mission called Chandrayaan also completed its objective successfully and a second Moon mission has been planned for 2018 again at a very low cost. This cost advantage that India has now needs to be leveraged to enter space industry.

References

[1] ICAO was creation of the Chicago Convention, 1944. This Convention gave full details and powers of ICAO.

[2] India's three leading Space Scientist Dr. Mukund Kaduswami Rao, Prof Sridhar Murthy and Dr. VS Ramamurthy have recently published a paper in which they have divided the Indian Space industry development in three phases: Future of Indian Space- Renewing Policy Dimensions, IAC14.E3.2.7 www.nias.res.in

[3] A detailed analysis can be found in a paper “Perspective for a national GI policy" by Mukund Rao, KR Sridhar Murthy, produced for National Institute of Advance Studies Bangalore, available at www.nias.res.in

[4] For full details of ISRO future activities, see “What Next for ISRO”: the Economic Times, 19th Feb. 2015.

[5] India is still working on The Indian Telegraph Act of 1885, The Indian Wireless Telegraphy Act, 1933 and the Cable Television Networks (Regulation) Act, 1995. There is a dire for a new legislation on the subject.

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