Prasad, Narayan; Basu, Prateep

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Space 2.0 : shaping India's leap into the final frontier

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Narayan Prasad and Prateep Basu

OBSERVER RESEARCH FOUNDATION

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About the Authors

Narayan Prasad is the co-founder of Dhruva Space, a Bengaluru-based NewSpace company established in 2012 with a vision to lead the turnkey satellite development industry in India. He is an EGIDE scholar who holds an MSc in Space Technology, Sweden and MSc in Space Techniques and Instrumentation, France under the European Union's Erasmus Mundus Space Master programme.

Prateep Basu is a space industry analyst at Northern Sky Research (NSR), a global market research and consulting firm based in Massachusetts, USA. He covers markets on Unmanned Aircrafts, satellite manufacturing and launch services, and satellite-based Earth observation. He has worked as a propulsion engineer at the Indian Space Research Organisation (ISRO). He obtained his degrees from Indian Institute of Space Science and Technology, Trivandrum, and the International Space University, Strasbourg.

Space 2.0: Shaping India's Leap into the Final Frontier

Abstract

As a long-term investor in space technology and infrastructure, India aspires to be one among the top nations in the world in terms of government space investment. Though space investment has been growing over the past few decades, India's space competitiveness has suffered from the absence of a globally reputed, private space industry. The present work provides key insights into India's stance in the global market and its emergence as a space power, and puts in context the emergence of NewSpace globally.

The space sector of India is driven by the government with the Department of Space investing cross-sector in upstream, downstream and commercialisation of space assets. The private industry is currently limited to being vendors of products and services within this environment with all the turnkey aspects of deliverables performed by government institutions. The fundamental motivation to develop a strong private space industry ecosystem relates to the inherent advantages the country has over others in the availability of skilled workforce, a stable and business-friendly government, positive investor climate, and low cost of operations.

The key reasons for the Indian space industry's failure to take advantage of the global opportunities of market expansion are discussed in this paper. Various critical issues affecting the development of the space

sector—with special reference to the need for a support structure of ancillary small- and medium-scale industry—are examined. Aspects of planning of coordinated long-term road maps for national and global expansion are also put forth for consideration.

The need for a comprehensive regulatory and legal regime in support of private industry has previously been voiced, with possible establishment of a dedicated independent position and strategy analysis body for the assessments of policies in the space sector. Specific recommendations for kickstarting Space 2.0 in India are provided for the consideration of policy-makers to support development of public-private partnerships, enable a space cluster development and enhance support to the government's policy push for doing business in India ('Make in India') and for digitally connecting its citizens ('Digital India').

Introduction

India has been a long-term investor in the development of space, launch and ground systems infrastructure. The Indian Space Research Organisation (ISRO), a government institution under the Department of Space (DoS), has piloted all Indian activities in the space sector since its inception in 1969. The Indian space programme has had many successes in the five decades since it was envisioned, but no private turnkey solution provider has emerged out of the Indian space industry, both in the space and launch segments.

The current space value chain of India is predominantly driven by ISRO in both the upstream (satellite manufacturing, launch vehicles, Earth station setup) and downstream (data products, provision of SatCom capacity, ground operations, and others). The participation of the local space industry within the value chain is limited to provisioning products and services that are finally integrated by ISRO institutions in producing a turnkey solution. A variety of issues may have influenced such alignment within the space ecosystem, such as the following:

- Lack of volumes for dedicated investments by the private industry, hindering the maturity of the industry to provide turnkey solutions;
- Limitations via export control measures taken by advanced spacefaring nations such as the United States;
- Timelines for maturity of indigenous technology; and
- Marketability of Indian space upstream and downstream products in the international market.

However, the emergence of India as one of the leaders in the emerging market segment—and with a proven track record of a successful space

programme—has opened doors for the domestic space industry to break into the international market. With competitive products and services, quality infrastructure, and cost advantages utilising the manpower within the country, the Indian space industry offers a unique landscape for economic exploitation. It is therefore necessary for the Indian space ecosystem to renew its entrepreneurial spirit with encouragement from national policy-makers, as India cemented its position as a global leader in space technology with a successful Mars orbiter mission in 2014. There is a need for the local industry to move up the value chain within the country's space programme to essentially occupy the Assembly, Integration and Testing (AIT) role for space and launch systems to capture a larger chunk of the global market, built on the legacy of the Indian space activities.

The initiation of such vision shall involve transfer of roles for successful systems such as the Polar Satellite Launch Vehicle (PSLV), and for applications based on Indian Remote Sensing (IRS) and Indian National Satellite System (INSAT) to the local industry. A recent independent study by *Northern Sky Research (NSR)* projected that more than 1,800 satellites weighing more than 50 kgs will be ordered and launched over the next decade, generating $300 billion across global markets.[1] It is thus imperative for the policy-makers in government to chalk out plans quickly for capitalising on this opportunity that has the potential to bring in useful foreign exchange and investment into the Indian space sector.

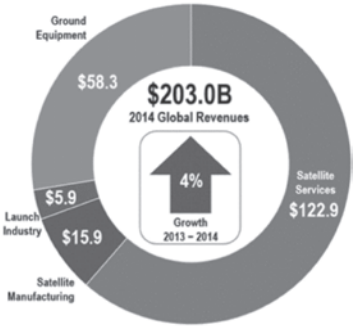
This paper addresses the motivations and gaps for doing business in the Indian space industry, and provides recommendations to streamline activities with the aim of commercial exploitation of the national space infrastructure. This can be explored through novel Public Private Partnership (PPP) models which will provide a foundation for a win-win situation for both the national space agency and the local industry. Such

options are already being mulled by ISRO.[2] It is expected that ISRO would transfer the responsibilities of routine development of space and launch systems to the competitive local industry, while taking up the challenging task of development of next-generation technologies, exploration of outer space, and development of a human spaceflight programme. While doing so, there are a number of hurdles that need to be addressed for smooth business operations in the space arena, some of which are summarised in the following sections.

India's Stance in the Global Market and Emergence of NewSpace

The key reasons for a nation to invest in space include: to utilise its strategic importance; enhance its scientific capability; create high-skilled jobs; and facilitate economic contribution to the nation's GDP. The continued investments in the space sector have seen the size of the global space industry almost treble in the last decade (See Figure 1).[3] As expected, downstream segments of satellite services and ground equipment generate ~90 percent of the total space industry revenues. By value, the size of these segments has however remained the same, as business in upstream services like satellite manufacturing and launch services— which has a higher government control due to the dual nature of the technology involved.

Figure 1: Global space industry size evolution between 2004 and 2014

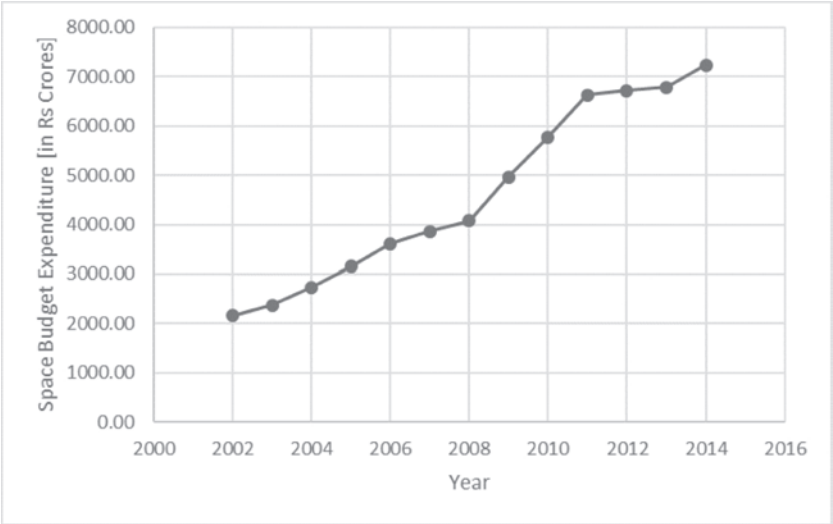


(Source: SIA)

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 defence space, providing these companies to scale up their operations without largely affecting the cash flow.

As India ramps up its space defence 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,[4] but is far behind when it comes to creating successful private industry that is globally reputed. India's space budget has increased in size (Figure 2) and is 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.[5] This in effect is also due to the absence of a single Indian company among the top space companies in the world (which in itself is an alarming statistic) that needs to be addressed urgently through policy push under the several grand schemes announced by the current government, such as 'Make in India' and 'Digital India'.

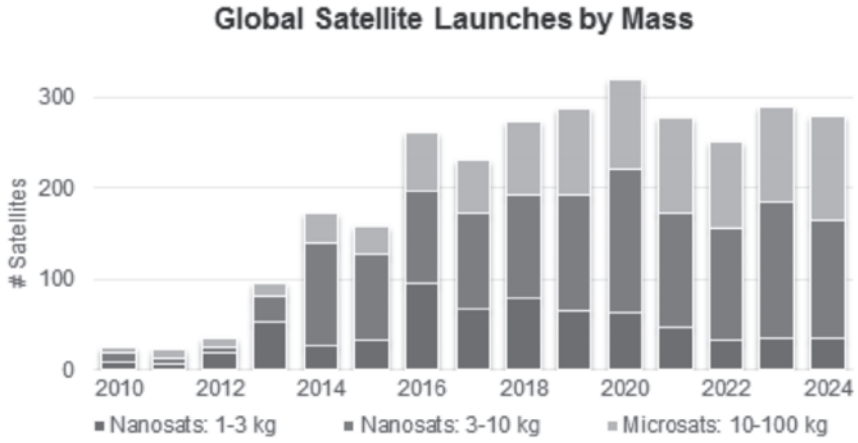
Figure 2: Evolution of India's Space Budget



(Source: Outcome of Budget ISRO)

Most of the apprehensions for private investment in space industry come from the requirements of high capital investment, and the long gestation periods of space projects to get substantial Return on Investment (RoI) for the investors. These trends have been put aside by a new breed of space companies calling themselves 'NewSpace', which thrive on new business models of low-cost access to space by capitalising on the advancements made in recent years in small satellite technology, consumer electronics, and computing power. Tiny modular satellites called 'CubeSats', weighing 1-4kgs and costing under $100,000 have revolutionised the way space products and services are delivered to end users. The movement began in Europe and US simultaneously as a by-product of university and space agency collaborated research, but it was the US which took the lead in successfully commercialising these technologies developed in laboratories. Figure 3 shows the forecast of nanosatellites weighing between 1-50 kg, which are scheduled to be launched globally between 2014 and 2024.[6]

Figure 3: Nanosatellites Forecast



(Source: NSR)

The high number arises from the fact that such nanosatellites have short development timelines, and provide the necessary agility for satellite operators to develop large constellations that can cater to a larger customer base with high service quality. These NewSpace companies have ushered in widespread changes in the traditional satellite manufacturing and launch services industry, with companies like Rocket Labs and Firefly Systems building new launchers at low cost using innovative techniques like additive manufacturing, to reduce the cost to orbit for these satellites. The impact of these companies has been felt within the space industry, as practices from these 'NewSpace' companies have been adopted to keep the costs low and have a factory-type approach in building systems in order to cater to the increasing demand. The NewSpace revolution has now led to companies such as Google, Virgin, and Qualcomm investing in small satellite-based communication technologies.

India, however, has remained shielded from the rapid changes that have happened in the global space industry over the past decade. ISRO, despite

its success in interplanetary scientific missions, has been slow to respond on both commercial and academic fronts, with only a handful of university-level, small satellite missions being launched during the same period, none of which could transform into a full-fledged commercial opportunity for the people involved. Partly to blame is the absence of clarity in India's space policy; there is also the lack of willingness of DoS to take up additional responsibility of creating an ecosystem that can potentially disrupt their own traditional one. In the following sections, the need for, and motivation to develop a strong private industry ecosystem is articulated.

Motivations to Develop a Private Industry Ecosystem in India

Presently, India has inherent advantages over other countries due to the availability of skilled workforce, a stable and business-friendly government, positive investor climate, and low cost of operations. Because India was an early mover in space technology, it is poised to become a major space power albeit with a slight policy push towards greater commercialisation of the industry. Table 1 shows the PESTLE analysis of India, in lieu of the motivation to develop a strong private space industry.

Table 1: PESTLE Analysis of India

Political	Economic	Social	Technological	Legal	Environmental
Stable government	Eased banking interest rates	Favorable demographics	High quality tech work	Restrictions on space tech exports	Proximity to Equator for launch service
Strong leadership	Investor friendly climate	Skewed income distribution	Good R&D	DOS is the regulatory body	Investors averse to financing non IT sector
Business friendly policies	Lower inflation	High social mobility	Moderately quick tech transfer	Lot of paperwork for licensing	Weak environmental laws
Open to FDI	Big market size for downstream applications	Availability of high-skilled workers	High level of expertise in ICT services	No laws for business protection	Competition low in market currently
Manufacturing thrust	Low cost of operations	High level of consumerism	Low rate of obsolesce		
Pro-growth via private industry	Low unemployment in organised sector				

The PESTLE analysis shows high suitability for services-based business models to operate out of India. The government's encouragement for private space industry within the country to develop capacity and capability in pursuing space activities should thereby be directed to both the spectrums across the industry value chain. A focused space policy mandate can have multiple direct and fringe benefits to the government, especially in the defence sector which has been the current government's area of interest through its 'Make in India' initiative. Some of the direct and indirect benefits of space technology include the following:

Civilian and Commercial

- Space industry has the potential to emerge as the third technological success front following the successes of the Information Technology (IT) and Biotechnology in the

country. Space has an important role in the overall economic development of the country and in the success of the government initiatives such as Digital India and Make in India. The development of the private space industry shall aid in rural connectivity, e-governance and setting up of manufacturing base for high-technology products in India, creating headway in the overall emergence of the country at the world stage.

- The success of the space industry will enhance capacities within the country and complement the government-driven programme, 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. For example, as per a recent Comptroller and Auditor General (CAG) report, only one among the seven DTH providers is leasing transponder from the INSAT system. 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.

- Space has its bearings over the imagination of youth and a strong emerging local industry can revolutionise the mindset of the national talent pool and can potentially aid

in reversal of brain drain from the country. Public outreach, awareness, and STEM education are some of the intangible impact that investment in space technology produces.

- The capacity built up within the industry shall foster Business-to-Business (B2B) collaborations within the country and with enterprises across the globe and create also a strong focus on Business-to-Customer (B2C) applications which moves from the traditional Government-to-Government (G2G) flow of development of capacity and application of technology. The B2B, B2C ecosystem in the space industry has immense potential of tapping the much successful IT infrastructure of the country and extending the IT knowledge base to core software-based applications of space-based information such as Geographical Information Systems (GIS).

- It shall create an environment of technological innovation which, when supported and encouraged, can sustain to create a secondary source of development of high-tech hardware, software and applications for the government. An ecosystem of technological innovation in space technology has the potential of creating the next-generation Small and Medium Scale Enterprises (SMEs) in India which shall leverage the frugal nature of engineering and can create products and services independently for local and global requirements.

Military

- In the development of space technology with several dual use capabilities, there exists a case for building up a sustained indigenous industry ecosystem that shall support the safety and security apparatus of the country. These range from development of capabilities in upstream such as satellite, launch vehicle development to creating specific downstream applications such as Automatic Identification of Ships (AIS), Electronic Intelligence (ELINIT), Communication Intelligence (COMMINT) and other Command, Control, Communications, Computers, Intelligence, Information, Surveillance, and Reconnaissance (C4I2SR) applications.

- Space Situational Awareness (SSA) is the ability to view, understand and predict the physical location of natural and man-made objects orbiting the Earth. SSA is a prominent concern for both military and commercial systems, mainly because of the increasing military reliance on space assets. The debris created by the anti-satellite testing by China in 2007 and the Kosmos-Iridium collision in 2009 has raised additional concerns about the safety of space assets. India primarily relies on NASA's data, and will operationalise its own system of Multi Object Tracking Radar (MOTR) by 2017.[7] But India has its own limited capacity in this regard too.[8] Meanwhile in the US, commercial operators have established the Space Data Association (SDA) for providing satellite operators reliable and efficient data for increased safety of satellite operations; this is in addition to

the Department of Defense's (DoD) own surveillance network.

- The changing space security environment and the rising international concerns over the rapid growth of military assets in space makes space security one of the most important issues to address. The need to have a space security policy is being increasingly debated in India and the IDSA Task force in 2009 produced a report which attempted to conceptualise such a policy.[9] However, there is reluctance to talk about the use of space for national-security needs, including its military applications. Though efforts are being made to synchronise the activities of ISRO which is responsible for India's civilian space programme and the Defence Research and Development Organisation (DRDO) which works on the use of space for national-security needs, the lack of a strong private industry that can meet heightened needs for such sophisticated missions hampers the progress in this direction, apart from the bureaucratic delay that is normally associated when two high security government agencies interact.

Capacity building within the space industry shall not only drive commercial applications, but also aid the government in situations of emergencies (e.g. natural disasters, intelligence gathering for fighting terrorism) and can eventually develop into a foundation that could potentially contribute as part of a strong foreign policy drive. Studying the impact of space technology on civilian life is a complicated task, especially when it comes to quantifying the tangible and intangible impact. The spillover of space technology is in sectors as varied as defence, agriculture

and education. There exist many ways to show the impact of investment in space technology; some of them are illustrated below.

Figure 4: Economic Impacts of Space *(Adopted based on OECD, 2012)*[10]

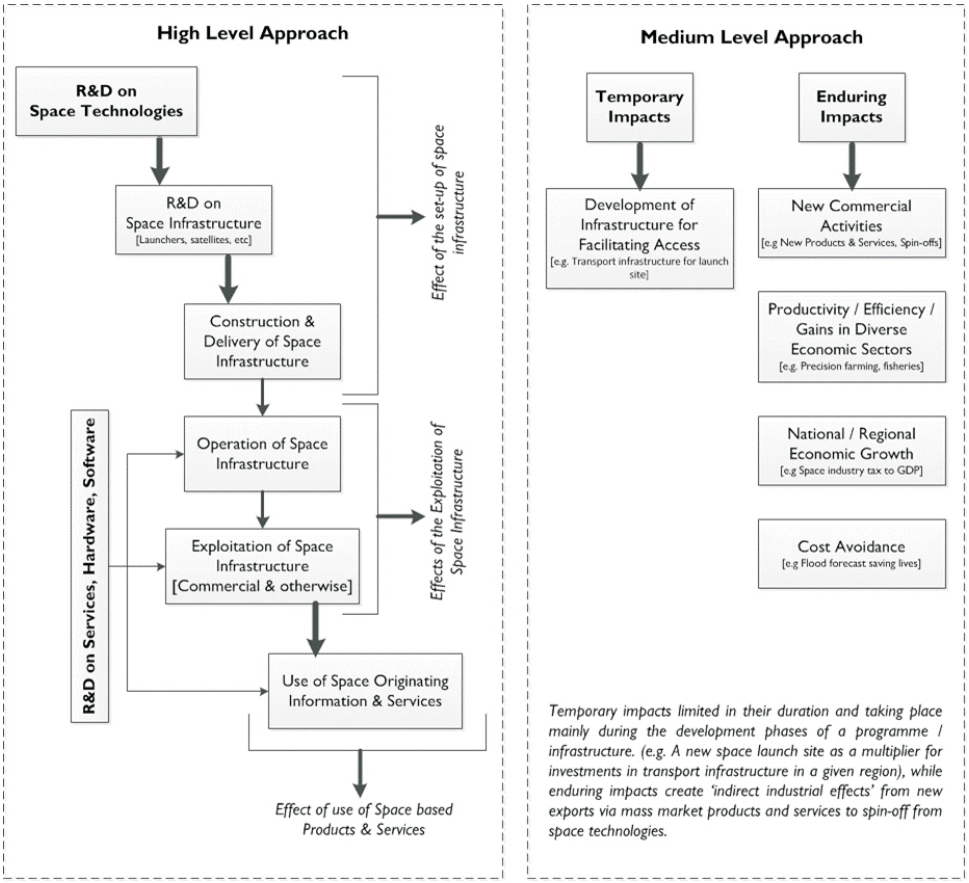
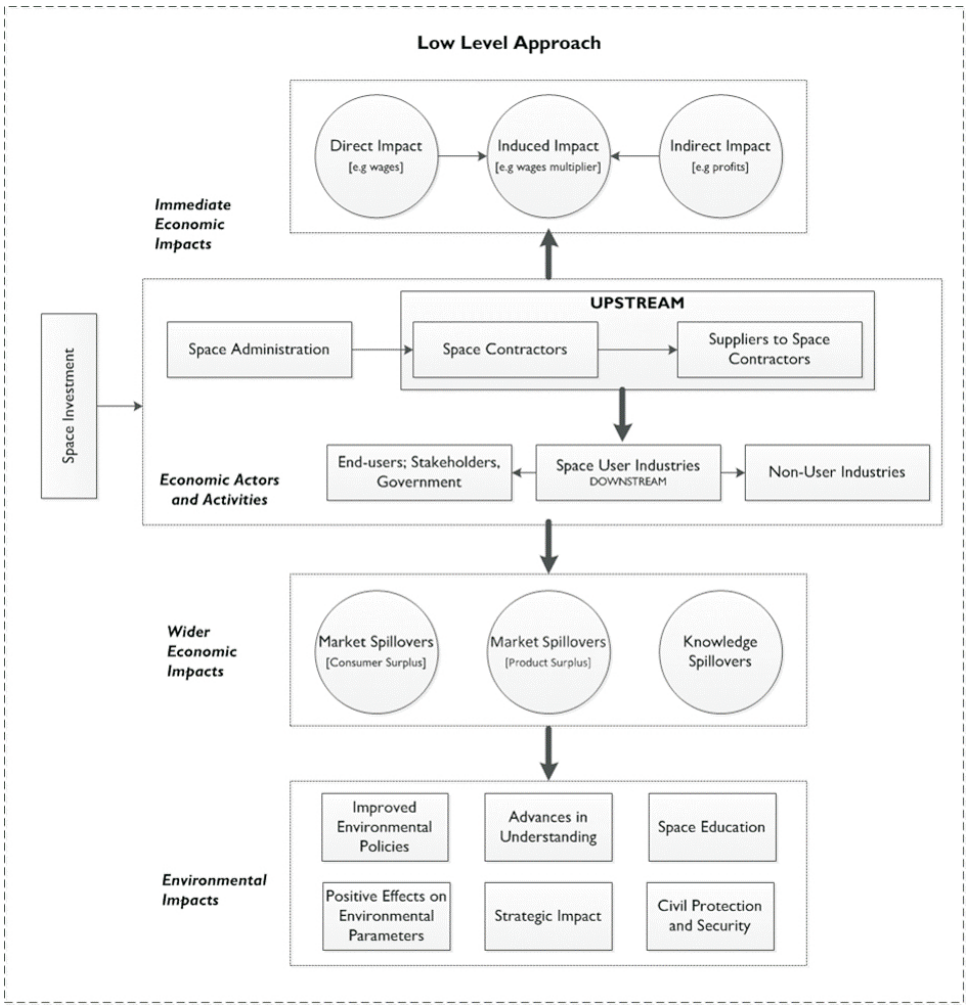


Figure 5: Impact of Space Technology: Low Level Approach[11]



Thus, the technological and knowledge backbone for space technology creates opportunities in the marketplace to create and explore commercial applications on a global scale, which traditionally might not be the fundamental focus of a government space agency. This will also create multiple intangible impacts across various sectors such as defence, education, agriculture, energy, transportation and environment. India has made substantial investment in its government space programme over the years, but it is a sustained policy push towards investments in the private

space industry ecosystem that will create commercial space applications, complementing the societal benefits motivation currently being pursued by the government.

Shortcomings in the Indian Space Ecosystem

The space ecosystem of India is driven by the DoS with upstream, downstream and commercialisation of space assets all done by the government institutions with limited support in supplies of products and service by the space industry. As DoS 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 reach the turnkey solution provider in space capabilities and launch systems, and their ability to cater to international requirements. Antrix Corporation, incorporated as a wholly government-owned company, attempts to commercialise the 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 quasi-government organisation rather than a private one that competes effectively in the international market.

Capacity in Capturing the International Demand

With the extremely busy schedule of ISRO in the current five-year plan with 58 missions,[12] 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 (sub-contracted to India from European Aeronautic Defense and Space Company (EADS) subsidiary Astrium) and for the UK-based Avanti Screen Media.[13] The failure of the W2M satellite[14] had an effect on the international market sentiment for development of communication satellites by India.

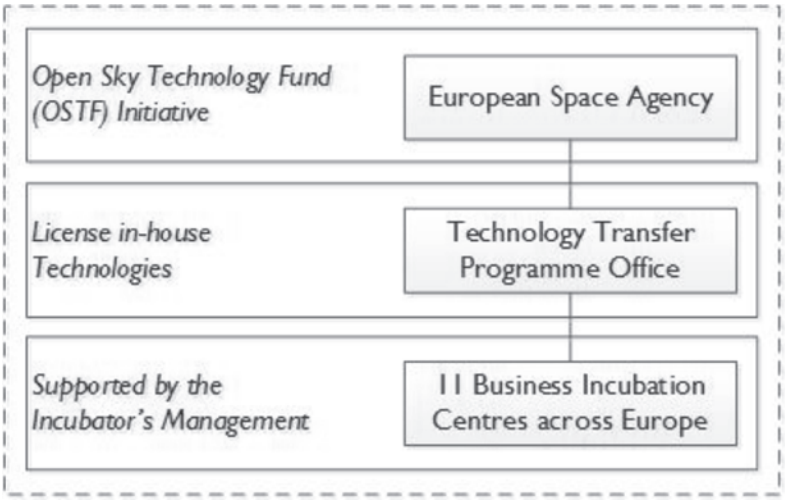
The increased number of missions of national importance alongside such possible market sentiment has resulted in Antrix Corporation focusing its commercial offering to signing of launch agreements for foreign satellites and in data sales from the Indian Remote Sensing (IRS) satellites. However, among the 40 foreign satellite launches that Antrix has done till date, only three satellites weighed 100kgs or more; the rest were all small satellites. Despite a strong demand for LEO launchers in the international market, and an excellent reliability record of the PSLV, Antrix has not been successful at marketing itself. A possible reason for such unaggressive approach is the schedule uncertainty associated with PSLV launches, as national missions are of higher priority and most foreign satellites are flying in rideshare mode. Delays in the national satellite or the primary payload in this case lead to delays for the other customers, and this does not go down well with commercial companies who stand to lose money in such cases.

Support Structure for SME Development and Promotion in the Space Sector

The current structure of the development of an SME base in India for space products and services is based on the industry development/ technology transfer policy of ISRO. Under the technology transfer policy, the space agency aims to transfer the know-how to the industry after

which the product/service is supplied back to the agency under buyback, while there is an opportunity for the SME partner to develop spin-off products/services based on the know-how.[15] However, there are no transparent national funds for products/services independently proposed by entrepreneurs in the space sector. Space business incubation funds as part of supporting independent ideas for space-based entrepreneurship such as the Small Business Innovation Research (SBIR) fund at NASA[16] have propelled independent ideas for development of applications/products/services based on space technology. There is also evidence of these supportive funds being managed professionally by a business concern (venture capital firm) as is in the case of the Open Sky Technology Fund (Figure 6) from the European Space Agency (ESA).[17] This can create a support system environment for start-up and early-stage companies that use space-related technologies or satellite applications.

Figure 6: Components of ESA's BIC Program



Some of the spacefaring nations such as UK and Germany have created special clusters for technology development which have fostered space entrepreneurs to utilise such platforms for the development of their

ideas, enabling a smoother transition to the global market place. Harwell space cluster[18] and the Berlin Adlershof[19] are typical examples of science and technology clusters that have enabled the global emergence of space companies such as Satellite Applications Catapult (UK), Oxford Space Systems (UK), Berlin Space Technologies (Germany), Astro-und Feinwerktechnik (Germany), among others. Harwell in itself has grown to house £1 billion worth of world-leading research infrastructure.[20] There is room to set up such science and technology enabling infrastructure with the encouragement of partial initial investment for independent ideas of merit by space entrepreneurs in the country.

Besides the government support system, there has also been the case of several space-dedicated incubators that have emerged in leading spacefaring nations such as USA (San Francisco, Colorado, Houston and Florida), UK (London), which are essentially a product of a strong entrepreneurial ecosystem in the respective countries, providing an opportunity for entrepreneurs developing space technology-based products and services to directly pitch to space-friendly angel investors and venture capitalist firms. This phenomenon is now spreading and Australia, for example, which is a new entrant to the space sector, has established Delta-V start-up accelerator, its first dedicated industry accelerator space-hub as a part of its efforts to capture the NewSpace market (Space 2.0).[21] Moreover, even traditionally State-driven space programmes and activities such as the Russian space programme have now seen the emergence of the New Space ecosystem with grants provided to entrepreneurs (e.g. $3.9M Skolkovo grant for Dauria Aerospace) in an effort to stimulate the creation of new products and new technologies in the space sector.[22] Even though India has mature space technology infrastructure and applications, the ecosystem has not evolved beyond the boundaries of the government to create such possibilities for Indian entrepreneurs to capture the resident market as

well as the global market, while building on top of the resources within the country. An example could be setting aside a designated section of the proposed Aerospace Technology Park in Bangalore exclusively for space ventures arising from India. This could be supported with a space business incubator that invites and funds new ventures using a combination of private equity and government funding depending on the nature of the enterprise.

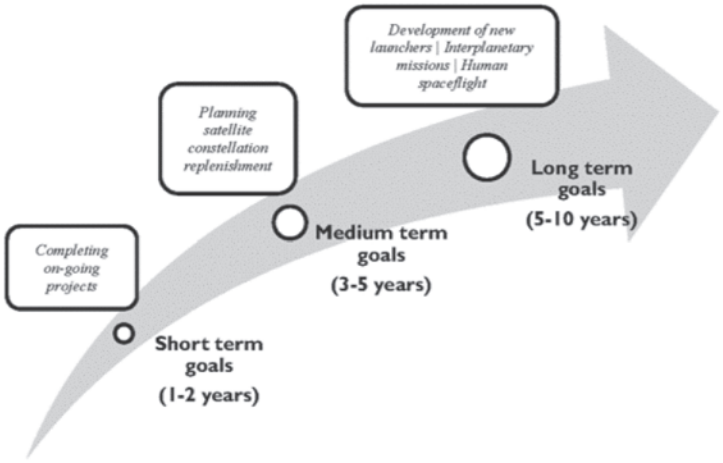
Development of Coordinated Long-term Roadmaps for National and Global Expansion

The development of an active and scalable private space industry in several spacefaring nations has been a result of coordinated long-term roadmap involving governmental efforts in the promotion of expansion of local industry to cater to the commercial local market while enabling industry to compete globally. Such coordination in India has been actively pursued by the influential apex business organisations such as the Confederation of Indian Industry (CII) and the Federation of Indian Chambers of Commerce and Industry (FICCI), but to limited effect. These organisations, which are to voice the sentiments of Indian businesses and industry in leading policy debates and act as catalysts in bringing about the growth and development of Indian Industry, have failed to provide traction in the space sector for the expansion of the private space industry of India. The last CII study—which provides comprehensive insights on Indian space activity, the state of Indian industry and the trends for future development and opportunities and business potential for the Indian industry—dates back to 2010.[23]

Development of an ecosystem to develop a space industry has a proven relationship to the ability of academia to realise independent research ideas alongside creation of an environment of sustained academia-

industry-agency interactions. In several cases the development of a private industry has resulted as a spin-off of a sustained academic effort within universities (e.g. Surrey Space Technology Limited, UK, a spin-off company of University of Surrey). While there are several premier Indian universities pursuing aerospace-related research and programmes, none of them have been able to generate such an outcome. Though there are some programmes within the country for sponsored space research such as the RESPOND from ISRO,[24] they limit the scope of academic research to derive outputs of such R&D to support ISRO programmes. This shall limit the execution of independent ideas from academia and the ability of spin-off companies that can build over such independent ideas.

Figure 7: Example of Long-term Roadmap for Space Programme



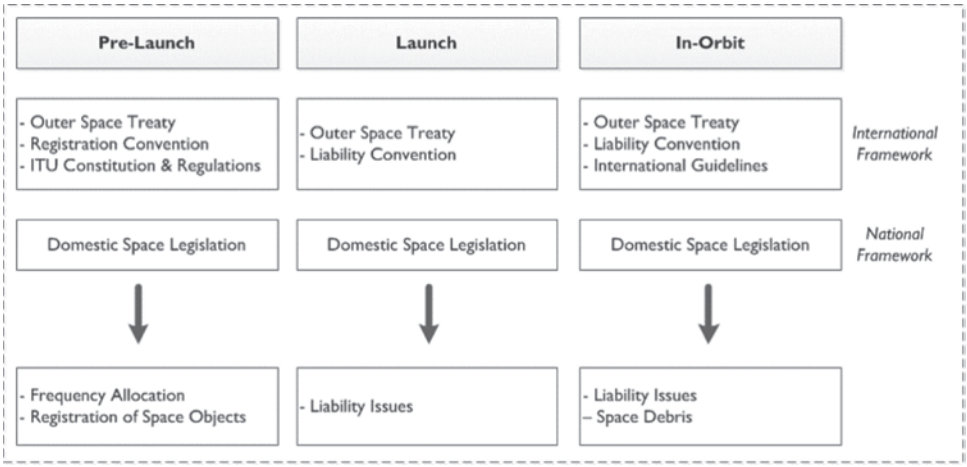
Lack of a Comprehensive Regulatory and Legal Regime

While India is a party to the space treaties under the United Nations (UN), the country has not enacted any national space law. The current regime of legal instruments for space activities are under the policies created by ISRO such as the SatCom policy, Remote Sensing Data Policy (RSDP), among others. These policies, as in the case of the SatCom policy, provide

a loosely written framework for entrepreneurs without transparency in decision timelines, licensing authorisation for commercial space launches, insurance, liabilities, dispute resolutions among others.[25] These have led to adverse business conditions in the Indian market with not a single Indian enterprise able to setup its own satellite system. Moreover, there is no clarity in regulatory and legal regimes for entrepreneurs who may want to setup non-telecommunications satellites such as the Low Earth Orbit (LEO) satellites for commercial remote sensing based applications. The Centre of Air and Space Law established at NALSAR University of Law has been focusing on promoting space policy within the country and is pursuing research in some of the legal issues in space; however, the pursuit in developing national space legislation which shall encourage entrepreneurs to develop independent turnkey products and services remains at infancy.

The current prevalent opportunities in the upstream of the space ecosystem in India which can help scale private enterprise-level and the country's competitiveness in the global space market include AIT of the launch vehicles to increase launch frequency, building up turnkey solution provider capability in development of satellites independently or based on Indian Mini Satellite (IMS)/ IRS/INSAT bus, and establishment and operation of Earth stations for NewSpace companies emerging in the global market within India. These listed opportunities have the potential for the private industry in India to gain a greater share of the international market as well as cater to the untapped local market such as military space. However, some of the key issues in regulatory and legal regimes must be sorted out to enable Indian entrepreneurs to take risks in engaging in such activities. These issues include licensing, technology certification, operational safety, financial investment, insurance, liability, protection of Intellectual Property (IP), dispute resolution, norms for environmental protection, and export control.

Figure 8: Legal Issues in Space Industry



(Source: EU-Brazil Sector Dialogues, 2014)[26]

Limited Independent Position and Strategy Analysis

There are presently no dedicated independent platforms for developing positions and strategies that can be provided to decision-makers with an independent view and analysis on mid-to-long term issues relevant to the use of space in the country. Some of the examples of such institutes of repute internationally include the European Space Policy Institute, Space Policy Institute of the Elliott School of International Affairs at George Washington University and Institute of Air and Space Law at the McGill University. The studies and research by these institutions have benefitted in not only shaping the space ecosystem of Europe, the United States and Canada over decades but also in providing an independent assessment of the performance of the national space programme, geo-political issues related to space, building a knowledge base on the international developments in the space sector (for both State and non-State actors), and others. Some of the research pursued by such think tanks on the commercial space industry have contributed in examining emerging

policy issues, providing a survey of the similar developments around the world, and offered case studies on national goal applications and international implications while pursuing such activities. While some of the Indian think tanks and institutes such as the Institute for Defence Studies and Analyses (IDSA), Observer Research Foundation[27] as well as the National Institute of Advanced Studies (NIAS) have periodically put out studies under the purview of their interests such as militarisation/ geo-political issues of space[28] and perspectives for a national policy,[29] the studies pursued by these think tanks are limited in size and scale when compared to those of their counterparts in the aforementioned institutes.

One of the only sources of an independent economic analysis of India's space programme dates back to 2007 when the Madras School of Economics pursued an exploratory analysis of the Indian Space Programme.[30] The premier management schools of the country—such as the Indian Institutes of Management (IIMs)—have not engaged in mapping the national space supply chain, relating India's space market to the global market, nor provided independent insights into the development of an active space industry ecosystem in their management reviews. The only other source of an independent assessment of the space programme in the purview of the national goals remains the independent reports produced by the Comptroller and Auditor General of India (CAG) office. However, these reports are limited to the performance of government departments, government owned corporations (in this case DoS and Antrix Corporation) and provide retrospective assessment of government investments in space.

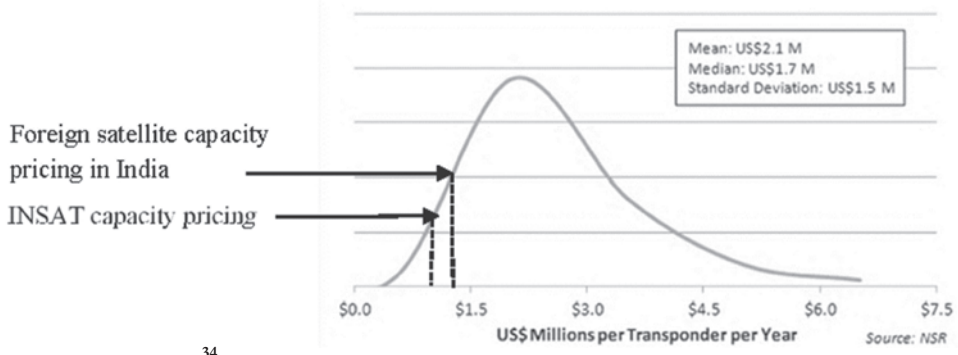
Inability to Leverage Space Assets to Maximum Effect

The CAG of India has published several reports on the shortcomings of DoS when it comes to managing its space assets. As per a recent CAG

report on the satellite capacity allocation, the INSAT Coordination Committee (ICC) which was entrusted with allocating satellite capacity over Indian satellites was not convened for seven years (2004-11). During the same period, three communication satellites were launched and theirs transponders leased to DTH operators by DoS directly, violating the mandate of the Sat Com Policy. There is still no documented directive of how satellite capacity will be allocated by DoS, despite this being an action item under its purview after the SatCom Policy was brought into effect in 1999. The first-come-first-service policy that DoS has maintained orally was lambasted by the CAG report, which found that Tata Sky was given a preferential slot over DD despite being lower in the waiting list for capacity allocation.[31]

Such irregularities apart, Antrix maintains strict control over transponder pricing in India, which is one of the lowest in the world. The prices are clearly undercut ($775,000/transponder/year according to a government press release) in comparison to global standards as can be seen in Figure 7.[32] Despite such low prices, only one DTH customer among the seven operating in India is presently using INSAT capacity, and rest are on foreign satellites, whose transponder pricing is again regulated by Antrix.[33] Far from being a free market, the business of leasing transponders in India is seen by the industry as 'deal-based' or specific opportunity based rather than a healthy marriage of demand and supply. A corollary of this market scenario is that private companies are not willing to invest in satellites to serve the Indian market exclusively given the policy risks of being able to sell in the Indian market. Furthermore, short-term contracts and price diktats by Antrix mean that it is residual or incidental capacity that gets allocated to India by the large global satellite operators.

Figure 9: Transponder Leasing Prices Globally



(Source: NSR, 2012)[34]

The CAG had also conducted a performance audit of the National Remote Sensing Centre (NRSC), the nodal agency for ISRO's remote-sensing activities that is involved in acquisition and archiving of satellite/aerial remote-sensing data and its dissemination. The CAG report found that there was a substantial gap between the number of images captured by the satellite and the data product generation capacity because of the limitations on the ground segment front, leading to less than 50 percent utilisation of the satellite's capacity. It also looked at the RoI for seven remote sensing satellites launched till 2010 and made pertinent observations that the revenue generated from the sale of data products from each satellite was far below the expenditure on them. The analysis of operational returns alone, where return against operational expenditure is compared instead of return on total investment, revealed that even the operational returns for the seven satellites were negative in all the years, implying that revenue from sale of data products was not sufficient even to meet the operational expenditure.[35]

Another setback of DoS was the implementation of the well-intended EDUSAT programme, which aimed to provide tele-education and tele-medicine facilities to rural India. It was observed in the CAG audit that

EDUSAT failed to achieve its objectives due to "deficiencies in planning for the network connectivity, content generation and failure to have a robust management structure".[36] The implementation of the programme had deficiencies, with the establishment of ground network being delayed, disparities in the allocation and idling of satellite bandwidth, inadequate content generation and shortcomings in monitoring and evaluation. Even the replacement strategy for the existing satellite was lacking, resulting in idling of operations after 2011. With an investment of INR 549 crores, EDUSAT remains an example of ISRO's good intentions but shortcoming in execution.[37] A public-private partnership model for such a novel programme could have lessened the burden on the government exchequer as well as brought about efficient project management practices to implement such a large-scale project.

Recommendations for Space 2.0 in India

- If Indian industry needs to claim a greater traction in the international space market there is a need to promote and develop a model for promotion of SMEs with independent technology ideas, which carry the potential of leapfrogging product/service offerings out of India and are scalable globally. If such an ecosystem needs to be established, the government must consider instituting a national fund for promotion of entrepreneurship in space industry on similar lines of the Small Business Innovation Research and the Open Sky Technology fund to replicate the success of promotion and development of SMEs by NASA and ESA.

- The emergence of Bangalore as an IT and Aerospace hub for the country should be leveraged for the space industry as well. Land should be allocated to space ventures emerging from India to

assist them in the startup stage. In addition, mentorship by senior ISRO and Antrix executives will ensure they operate within the Indian space policy framework but are still able to leverage technical expertise built by ISRO in an appropriate manner.

- Active engagement of clustered activities engaging academia-industry-agency is of significant importance for creating systemic changes in establishing a globally leading research output environment. One of the excellent methods of moving away from an 'Islands of Excellence' model to actively promoting inter-dependent engagement of academia-industry-agency is by creating flagship programmes (where each of these stakeholders have concrete involvement in deliverables and gain significant benefits having long term ecosystem prospects of spin-offs). Such templates are already available with programmes such as Hodoyoshi by the Japanese government.

- Enacting space legislations within the country to define regulatory, legal and procedural regimes with transparent timelines for pursuing space activities by the private space industry is currently at a nascent stage with no national legislations governing space activities, which however remains critically necessary. Enacting stand-alone policy packages for regulating a service/product as a retrospective measure on commercial interest can only be an initial step to the leap required in development of a holistic act for active promotion and encouragement of commercial space activities. The need of the hour is the development of time-bound, transparent procedural aspects of delivering authorisations, licenses, frequency allocations, and others.

- Issues around national security shall always be a concern when any actor chooses to pursue space activities. However, holding back possible commercial possibilities in utilising outer space hostage under the garb of national security will only hold back the country in expanding products/services globally. This may also lead to an ecosystem of Indian space entrepreneurs creating holding companies in space commerce friendly countries and operating their product/service, eventually creating loss of high-technology jobs and tax revenues for the country. Several scenarios of commercial space activities have played out in leading spacefaring nations and there already lies a template in steps taken by their respective governments in securing national security while actively promoting space commerce. These can provide significant lessons to the DoS in formulating an active commercial space strategy for promotion of Indian space industry.

- In order to be able to even debate and discuss commercial space in India and their viability within the government or to make specific recommendations to the government, there needs to be a foundation that facilitates such a topical discussion. It is more important that this foundation remain without any conflict of interest in order to make recommendations to the Government of India. With no particular, dedicated, independent think tank for space-related activities or a dedicated road map within ISRO for commercial space in India, there is a need to establish an 'Office of Space Commerce' that is independent of ISRO. The 'Office of Space Commerce' may be a principal unit under the Department of Industrial Policy and Promotion under the Ministry of Commerce and Industry, Government of India. The same department is in-charge of the much talked about 'Make in India' campaign, which also lists Space as a priority sector. Such a

template is already present in the US with the Department of Commerce creating 'Office of Space Commercialization', legislatively established under Section 8 of the Technology Administration Act of 1998 (Public Law 105-309, as amended) by the US Congress as a principal unit for its space commerce policy activities,[38] with a mission to foster the conditions for the economic growth and technological advancement of the US commercial space industry.

- The government has taken significant steps in the creation of an active investor mindset by rolling out programmes such as 'Make in India'. Space has been an identified sector in the Make in India campaign. However, there have been no significant proposals made under Make in India for manufacturing space-related systems in India. There is a need for a transparent strategy on how the potential of space sector can be leveraged under Make in India. There are significant opportunities in manufacturing (e.g. small satellites) and services (e.g. GIS) for which a framework for engagement needs to be developed.

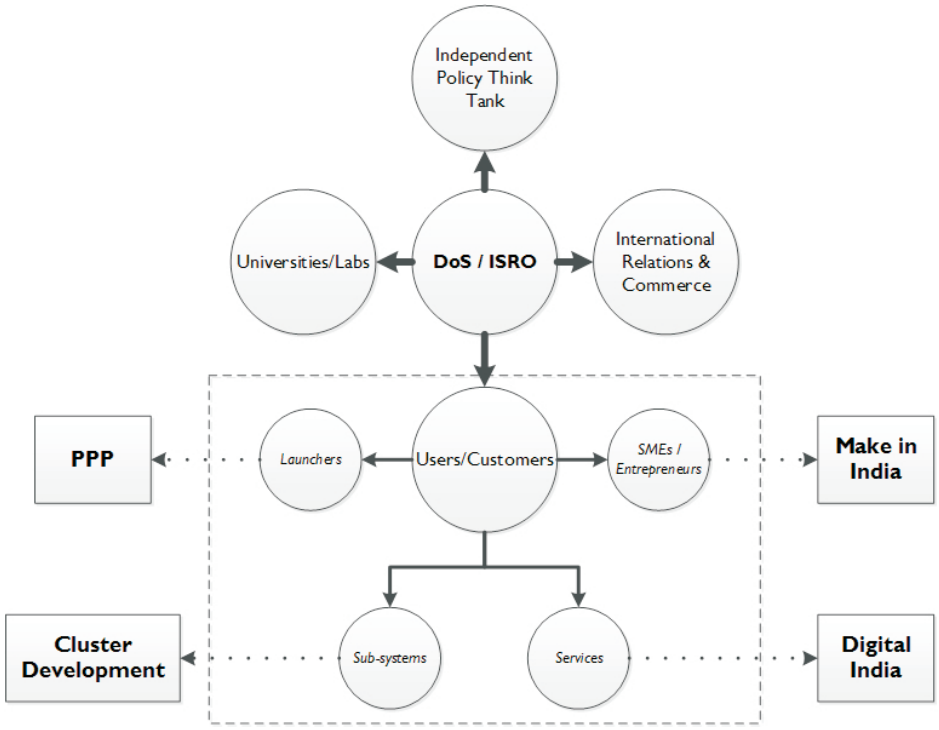
- There is scope to establish an independent, wholly space activities focused think tank within the country on the lines of the European Space Policy Institute constituting distinguished experts in the space field while preserving its independence in the preparation of its various research outputs, research materials and expert gatherings. Such a think tank will not only provide a fair assessment in purview of national goals; it can potentially provide key insights on space programme management, dual-use of technologies, economic impacts of space expenditures, space law, international cooperative space agreements, among other matters.

- FDI in defence has been opened up to 49 percent by the government. However, there is need for an active stand on leveraging outer space by defence forces. The first step in encouraging FDI in defence space shall be in rolling out a mandate in utilising outer space for defence operations and moving away from the present model of dual-use.

- For the small satellite industry to establish and flourish in India, the government can set up a dedicated fund vehicle which would disburse money based on a national prize event along the lines of Google's XPrize with ISRO being the primary promoter and bringing potential investors and stakeholders on the same table to promote innovation and entrepreneur ship in this sector.

These recommendations are provided to build a commercial ecosystem around the national space programme to reap the benefits of government investment in a more efficient manner. The ultimate objective is to utilise the downstream services that aid the economy and provide actionable intelligence for end users. Figure 10 shows the summary of how the DoS/ISRO can leverage the collaboration with public policy think tanks and universities, in addition to their national responsibilities and international commitments, creating a robust downstream space sector that supports the government's policy push for doing business in India (Make in India) and for connecting everyone with internet (Digital India).

Figure 10: Recommendations for Space Industry Ecosystem in India



Conclusion

The Indian Space Programme has taken giant strides in the area of space technology and its applications in the last two decades, ably supported by government funding and a vision to use space technology for societal benefits. Despite creating a strong knowledge base and taking steps to transfer this knowledge to other sectors, ISRO and DoS have been unable to exploit the commercial potential of space applications due to lack of policy guidelines and regulations. Trickle-down effect, which is one of the primary reasons for governments to invest in space technology has not been felt as widely as it could have due to several factors like a weak private industry base, lack of independent policy think tanks and poor

management of expensive projects. There is no doubt that ISRO has shaped the space industry ecosystem in the past 40 years, and has led capacity building in areas pertaining to space technology. Still, there exists a need for structural and policy reforms for the Indian private enterprises to play a bigger role, both in the local and international markets.

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Observer Research Foundation
20, Rouse Avenue, New Delhi-110 002
Email: orf@orfonline.org
Phone: +91-11-43520020 Fax: +91-11-43520003
www.orfonline.org