FUTURE INDIAN (new)SPACE – CONTOURS OF A NATIONAL SPACE POLICY THAT POSITIONS A NEW PUBLIC-PRIVATE REGIME

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ABSTRACT

Indian space activities have made tremendous progress in the past 50 years with successful programmes of Indian communication satellites in INSAT; Indian EO satellites in IRS and Indian launch vehicles in the PSLV and GSLV. India has also had a mission to Moon - Chandrayaan-1; a mission on-way to Mars and the IRNSS. Successful foray into global markets have also been achieved. In the 12th Five Year Plan (2012-2017), India is planning for 58 missions with an investment of almost 6 B USD (at 2013 rates).

Today, Indian Space Programme is at a cusp with the need for a LONG TERM STRATEGY FOR SPACE – basically creating a roadmap that will look 30-50 years ahead and address several key questions in the public domain. Indian space needs to orient for a quantum jump in technological growth, adopt organisational models and collaborative strategies that will ensure economic efficiency and position a vibrant private sector. Important questions are being raised on the public and national consequences for Indian human space-flight and planetary exploration programme; how India must quest for a larger share and role in global space market; strategies to deal with changing political and economic environments and focused imperatives of international cooperation.

Based on the in-depth analysis the evolving eco-system, unique performance dimensions, achievements and critical gaps of the past 40 years, along with a careful analysis of the existing policies – SATCOM-1999 policy and RSDP -2000/2011, the future contours of next 10-20 years of Indian Space activities have been studied. Looking ahead, a comprehensive "Indian Space Policy" which addresses the long-term strategy of Indian space – public goal of space as a national capability building; a national commitment to provide operational space service in the country; a good regulatory regime that promotes the Indian Space enterprise; enabling a vibrant and equitable eco-system of government-private sector partnership; systems to undertake advanced technology development; public and national commitment for human space-flight and planetary exploration mission investments; performance and social audits of space exploration activities etc.

The paper, resulting from 2 papers that NIAS prepared as part of its Policy Research studies and presented in International Astronautical Congress, discuses salient aspects of the newer policy regime (in a way – (new)Space for India) and outlines key highlights and strong arguments for a 2-pronged strategy for future – one, for growth of innovation and advanced space technologies through public investments that will spur risk-based future technologies and applications development AND second, carving a clearly larger role for Indian private sector that takes over operational space assets manufacturing/ownership/services and downstream application services – apart from becoming a "space-hub" for global space manufacturing.

1. INTRODUCTION

Outer Space has been a source of curiosity and inspiration for human kind since time immemorial. Since the launch of Sputnik, more than 50 years ago, the roles and meaning of space for humanity had been widely diversifying. What started as a competition for military superiority between the two super powers then is transformed today into multi-dimensional endeavours of large number of actors, both from the governments and private sector, impacting the social, economic, and scientific and security dimensions of global human society. Space has become a part of daily life for a majority of the citizens of the globe. These 50 years have mainly been mainly public space operations through government funding and development and coordination through international space policies.

Now, concept of NewSpace has emerged – mainly referring to private and entrepreneurial space activities - a concept affiliated with a rapidly emergent "privatisation of space activities" through a new role formation between public, private and academia – all of them addressing low-cost space technology, applications and policy.

National Institute of Advanced Studies (NIAS) had undertaken a "suo-moto" policy-analysis study for assessing Indian Space achievements and also for addressing future aspects of Indian Space Policy[1]. In fact, this study aligns to the concept and requirement of "NewSpace" in India – calling for a re-alignment of space activities under a re-structured public-private-academia frame.

2. INDIAN SPACE PROGRAMME – PAST 40 YEARS

Indian space activities originated from purely scientific interests of a large scientific community in 1960s with the sounding rocket launch experiments. The early space efforts owe much to the vision given by Dr. Vikram Sarabhai - "……to be second to none in the application of advanced technologies to the real problems of man and society". This extraordinary vision was based on realism and pragmatism and with deep insights into the then socio economic context of the country. Soon, by late 1960s, India had accreted a programmatic concept of basic experiments on the technology and user-development front to found an "end-to-end" systems concept that was very critical for space systems. The mantra of self-reliance that Dr Sarabhai gave became the life current that enabled space program to overcome numerous challenges in learning and experimenting with new technologies. The Indian space program evolution can be broadly categorized under three distinct phases:

- The proof of concept demonstrations of the use of the vantage point of Space for addressing the country's developmental needs and these were exemplified by the Satellite Instructional Television Experiment (SITE), the Satellite Telecommunications Experimental Project (STEP), and use of Landsat satellite data for natural resource management applications. The space segment was procured with international cooperation. By early 1970s, India was on its way to develop its first satellite – Aryabhata and started the "grand plan" of an indigenous end-to-end space technology development capability.
- The experimental phase saw the development of an end-to-end experience in the realization of space systems - experimental earth observation satellites like Bhaskara I and Bhaskara II; India's first experimental geostationary satellite APPLE and the initial space launch vehicles such as SLV-3 and ASLV characterise this phase. It facilitated competence building at the core level. Thus, by late 1970s and in 1980s, India invested considerably in building laboratories and facilities and also initiated a 3-pronged programme – Indian communication satellites in INSAT; Indian EO satellites in IRS and Indian launch vehicle programme through the Polar and Geo-synchronous launch vehicles.
- The operational phase was then taken up with an understanding of and analyzing the complex interplay of - evaluation of alternate approaches to arrive at the most optimal solutions; decide on exercising buy or build options parallel indigenous development plan to achieve self-reliance goals. This phase resulted in establishment of National Systems such as (i) Indian National Satellites (INSATs) / GSATs for communications, broadcasting and weather observations (ii) Indian Remote Sensing Satellite Series and (iii) Polar satellite Launch Vehicle, PSLV - all examples of operational space systems that have to meet stringent operational service performance criteria.

By early 2000, India had achieved a technological maturity of space systems and utilisation and this challenged it to envision missions to far-away Moon and thus came about Chandrayaan-1 – which originally started (in 2000) from a simple question "Can we go to the Moon?". Soon by 2002, India also started planning for its own Positioning Satellites systems in Indian Regional Navigational Satellite System (IRNSS).

Yet another aspect that emerged in mid 1990s and early 2000s was forays of Indian space products into the global market place – through Antrix Corporation which marketed Indian space capabilities globally and thereby capitalizing revenue models for Indian space. Most of the developments and manufacturing were organised into various units of about 16000 strong Indian Space Research Organisation (ISRO) with contract-mode industry-interfaces – which helped in the overall development process for ISRO.

Towards 2010s, India had challenges to comprehend because of failures of GSLV – even as PSLV emerged as a reliable launch vehicle of nearly 2t class spacecraft and the work-horse for ISRO. But the successive failures of GSLV have posed tremendous challenges which are being systematically overcome in recent times. Yet another challenge that faced India was the gap in satellite communication transponders that started stifling the service segment of DTH, social broadcasting, data communications – and more so in terms of slowing down technology development in newer areas (like Ka-band and large class satellites etc).

[1] **Future Indian Space – Renewing Policy dimensions** – Mukund Rao, KR Sridhara Murthi and VS Ramamurthy. Paper Presented at and published in Proceedings of 65th International Astronautical Congress, Toronto, October 2014.

In 2011, ISRO took upon a new challenge of a foray to Mars in the 2013 orbit-window for Mars. The Mars Orbiter Mission (MOM) was successfully launched in November, 2013 and on September 24, 2014, MOM was manoeuvred successfully to enter into Mars orbit and starts 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 the basic experience in this regard.

2.1. INDIAN SPACE ACHIEVEMENT METRICS

Thus, one can see that over the past 50 years, India has made significant progress in space technology – achieving projects, missions, programmes and developing new applications. India does not have a formal National Space Policy that has been legislated or formalised into a public-domain document. Indian space is still guided by Vikram Sarabhai vision of "……applications to the real problems of man and society" – which still serves as a national space policy tenet and has been guiding the developments over past 44 years. The programmatic definitions of Indian Space are made in the decadal space profiles and the Five Year Plans of the Indian Government.

As of 2014, here are some metrics of the past 40 years and over the past 8 Five Year Plans (1974-2017):

- A cumulative budget of about INR 804 billion has been actually allocated by Indian government but actual fund utilisation has been INR 490 billion.
- Approval for 200 missions has been accorded by Indian government but ~125 missions have been accomplished - out of which 111 missions have been successful.
- Independent access to space through a reliable and operational PSLV launch vehicle and a proven pre-operational Geostationary launch vehicle, GSLV incorporating an indigenously developed cryogenic upper stage
- World class satellite capability that cover a wide variety of applications satellites – INSAT, IRS and IRNSS for telecommunications, broadcasting, weather observations, remote sensing and navigation and scientific spacecraft including orbiters to the Moon and Mars.
- Wide use of INSAT communications systems have resulted in the wide outreach of TV signals (from early 1980s onwards) to almost whole of the country and growth of large-scale DTH and VSAT data communication business.
- The availability of low-priced and easily available IRS images (from about 20 IRS missions) and a great thrust to use of images and geographical information techniques proliferated IRS data into many governance and national building activities – by way of inventory and maps of natural resources, critical support to disaster management activities and environmental monitoring.
- Weather and ocean services modelling 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 IRNSS constellation have been planned but are yet to be launched or to be fully deployed.
- Global commercial operations of Indian space in 43 commercial/foreign satellites on its PSLV; sale of IRS images and value-addition services and, more lucratively, transponder lease business in India are estimated to have resulted in revenue earnings of about INR 50 billion over the past 20+ years. It must be noted that this estimated revenue earnings includes a after-tax profitability of anywhere between 10-12% - thereby, meaning that Indian government has net-earned about INR 5 billion in profits.
- Presently, in the 12th Five Year Plan (2012-2017), Indian Government has allocated INR 39 billion and has approved 58 missions over the 5 years period. The plan also makes forays into heavy

communications satellites, advanced EO and weather satellites, achieving operational status of geo-orbit launch systems and also advanced missions for exploration of Mars, lander on Moon and IRNSS constellation.

3. LOOKING AHEAD – *(new)*SPACE POLICY FOR INDIA

India's achievements in space technology and applications, viewed at an overall national level, have created a deep sense of "national pride" and a "public ownership" of the programme with consistent support from different political parties. National space activities are valued as a critical and most-coveted development/achievement. India is a nation of high ambitions of large hard-working and intelligent population – who struggle and aspire to be way ahead in life and "be second to none" - fortunately, achievements of Indian space has provided that outreach to society.

Looking ahead, what are the challenges that face Indian Space? This and the tenets of a public-private eco-system for space has been articulated in another paper that has been presented in 65th IAC[2]

- Building further focus and an **un-interrupted future national capability in space is quintessential** - the nation needs to be assured that space systems that best respond to national needs are made available all the time and that gaps in services do not get created as has been witnessed in satellite transponder capacities or high resolution imageries. A pragmatic long-term planning of Indian space is required with a visionary partitioning of roles for different segments in the national eco-system.
    - We visualise that in coming years there will be a burgeoning need for space based services and this will require more robust space infrastructure and timely and reliable access to such infrastructure for social and commercial service delivery systems. Revisit of current institutional arrangements or creation of new institutional measures will be necessary to meet the large scale demands of diverse sectors and removal of disconnects that afflicts efficiency of delivery system.
    - Space will also be developed as a vital tool for national security interests and safe-guarding Indian national interests.
- Building a **combinative ISRO and industry capacity is critical for future space success**. Especially in areas of operational satellites for communications, remote sensing, security, positioning, disaster management requirements – the concept of industry building, owning and operating space systems must be positioned. It will be advantageous to expand space capacity in the nation and enable a space eco-system into private sector space in India and enable a combinative national space capacity of ISRO and industries to emerge.
    - India will have to build and encourage Indian private sector in space business – not just to meet national needs but also to be globally competitive and efficient – so that Indian private sector will be able to build/develop national/global space business enterprises. Level playing fields for business and models of profitable revenue generation will have to be driven.
- **Advancement in state-of-art in space technology and adopting a leap-frogging approach are essential so that India can be on par with state-of-art systems**. This would require careful and judicious flexibility to "buy or build" approach for critical gap areas, assimilate and source/partner for newer technology systems, parallel approaches of source-and-develop for critical dependency systems etc. Such an approach is most critical if one has to maintain the excellence and also be equal and compete in global systems.
    - Indian space will have to go 2-pronged – on one side to meet its national needs, India will have to build and boost national capacity with Indian private sector and appropriate global commercial sector; and for larger science and planetary activities frontal international cooperation at bi- and multi-lateral level will have to be the medium of collaborative programmes/investments sharing.
    - India will have to renew and develop more robust and operational launch vehicles for the continued and un-hindered access to space and at same time strengthening national technological capability in the complex regimes of launch vehicle technology.

[2] **India's Space Industry eco-system – Challenges of innovations and incentives**. K R Sridhara Murthi and Mukund Rao. Paper Presented at and published in Proceedings of 65th International Astronautical Congress, Toronto, October 2014

- Space has triggered many new services and products/applications – which reach out all over the country and deep into society at multiple levels - administratively and jurisdictionally. **Newer institutional frameworks are called for down-stream national-level applications and delivery systems** – especially to address delivery systems for large demand for societal applications related to space. In an end-to-end concept, national space agencies must not "carry the burden" to undertake large national-level societal applications that emanate from administrative and governance demand. Space must be an instrument to spawn newer and larger structures/organisations for applications and usage.

    - Satellite services are critical for India's development and society/citizen services – thus a long-term and success-oriented commitment of government support and resources for pursuing satellite technology development is essential. Of course, this commitment must also be dove-tailed to key services/ministry sectors to utilise space inputs on a sustained operational basis.
    - Space science and planetary missions have a major role to play in catering to national scientific/education goals and aspirations – thus, a long-term continuity of planetary/science missions and programme is important – with well-defined science benefits.

- **Intensifying a two-way international cooperation is an essential step** – On one side, to embark on major exploratory programmes through synergy of partnership and assimilating technology and experiences from other nations and on the second side, for reaching/bringing Indian capability in the global markets of space. This combined approach must be intensified by active participation in multi-lateral space frameworks and selective bi-lateral space cooperation – especially in future human space flight and planetary exploration activities. Active cooperation also has to be pursued in further development of international policy and regulations in multi lateral forums for vital issues such as safe, secure and sustainable use of space, space debris mitigation and prevention of an arms race in outer space.

- **Build a comprehensive Space Governance System** – that brings into focus the governance of space activities within national systems and in agreed alignment with international space governance regimes.

    - Space activities will require high level of resource investment spread over years and decades – thus a long-term programmatic and investment road-map becomes critical as the high-level of investments for space activities must be well-justified with declared national benefits and transparency of progress in expenditures too.
    - In coming years, there are going to be a large number of Indian space assets (in-orbit) – their tracking, monitoring, de-activation schemes/protocols and national liability protection become important. At same time, protection of Indian space assets and usage and safe-guard from debris, attacks and stifling contingencies will require extreme level of technological and legal protection regimes.

We make an assessment that the need is for a (new)Space Policy – basically looking far ahead and creating a roadmap that will look 30-50 years ahead but also knit and integrate the various elements into efficiently-performing assets for Indian capability.

4. NATIONAL (new)SPACE POLICY …..POSSIBLE TENETS

India needs a National Space Policy that has agreed-upon road-map and vision of long-term (say, 20-30 years) and "compartments" of short-term missions and plans – but more importantly a holistic policy covering the gamut of space activities that will have to be pursued.

4.1. SPACE – IMPROVING GOVERNANCE, KNOWLEDGE & BUILDING NATIONAL TECHNOLOGICAL CAPABILITY

First and foremost will be the justification of space at national level and endorsement of "nation" – political, bureaucratic, industrial, scientific and citizens and this will go a long way in furthering long-term investments and commitments for space and building the resilience for ups-and-downs of space activities. The foremost justification for Space activities will have to be a part and parcel of NATIONAL GOVERNANCE NEEDS and to bring effective tools for governance and greater benefit to society. For example, satellite communications will need to be strongly justified as a vital element of national communications infrastructure for efficient and reliable communications of voice, data, image/video on various platforms and providing principal communication services for social sectors – large-scale education outreach in rural areas through a

tele-education network as a medium of next generation education services; boost quick and reliable first-level health-services using tele-medicine networks for contributing to securing health in society; DTH broadcasting for TV and mass media communication; dedicated high-speed network for government e-services - land, health, weather and many other social areas + dissemination of timely and critical public information to citizens; specialised private network capability for banks, railways, defence, aviation and other areas. At same time, space will also have to play a role as critical "redundant" secure communications infrastructure in times of national emergencies, disasters, special events; national security and defence etc. Similarly, satellite remote sensing and satellite positioning must provide on-demand imaging, observation and positioning services – thereby aiding to development of a National GIS, which holistically, in turn, will position GIS Decision Support Systems (DSS) that help identify and localise disparities in rural development and poverty; support food security – farmer information system and applications for high-productivity farming; infrastructure development planning – identifying at local levels what infrastructure is needed and its development; natural resources management – census and inventory of natural resources and conservation plans for forests/water/soils etc; environment sustainability – integrated pollution mapping and ES Indexing; operational national weather, ocean and climate services – providing near-real time weather and disaster alerts; support "operations" of city-management – traffic conditions, property taxation improvements, city growth plans etc; critical inputs to aviation, logistics, railways, defence and other services and a host of governance requirements. Space justification needs also to be in terms of helping build operational and sustaining national disaster and weather resilience; meet national security and defence needs – to secure the nation. **THUS, SPACE WILL HAVE TO MEET GOVERNANCE NEEDS** – calling for space missions to be planned and developed that meet these national needs effectively and with high-performance. A very effective strategy of combinative working and integrated alignment of space goals to governance goals (in fact, with governance goals of different ministries, states, citizens) will be most essential – rather than an isolated path of space for technology purposes. This, and only this achievement, will and can mark the FOREMOST MARK OF SUCCESS for future Indian space.

Space will have to be justified for its **scientific knowledge impetus** to Indian society and pushing the frontiers of Indian science – especially through widely assimilated space science missions, planetary missions and scientific endeavours through the space agency, universities and academia. Space is also essential to grow science and knowledge endeavour for next generation.

Space will also need to be justified as a national technological capability – because it has immense capability to build technological excellence and capabilities in various fields – electronics, computers, networking, chemical sciences, mechanics etc and spur an industrial capability of high-level. In fact, **SPACE CAN EASILY REALISE THE MAKE-IN-INDIA VISION** and bring a large industrial and privatisation impetus for future space in India – thereby creating a large-level of manufacturing capability in the country.

Justification for international cooperation will be most essential for future of Indian space. While international cooperation could be the basis for science and planetary missions, regional space cooperation to share experience and knowledge will enable India to build a more comprehensive space regime in global efforts. In recent announcement, Hon'ble PM of India has made an announcement of India offering a SAARC-satellite and enabling sharing of Indian experience – a classic example of international cooperation tool of space.

Finally, citizen empowerment will be most critical so that space benefits must reach every citizen of the country – for his acceptance of the benefits of space will be the ultimate mark of success. Thus, an inclusive processing of involving citizens – especially the youth in space will be most essential and important.

5. CREATING A PUBLIC-PRIVATE "(NEW)SPACE ECO-SYSTEM"

A Space Industrialisation Policy is critically relevant for India - that envisions developing and positioning a vibrant and superior Indian space industry capability which can simultaneously undertake full-scale space missions development for national needs and global markets.

As of now, domestically the national space agency ISRO is the sole agency having space development capability and plays the only dominant role in Indian space. In the initial 50 years, this single-point scenario was advantageous to establish and found organisational structures, facilities, technology development and build the pillars of space capabilities and applications. Even though the drive to space commercialisation started in 2000s in ISRO, today much of it is sub-contracting tasks to industries. Thus, the production and manufacturing is still "within ISRO" and an effort to enable industries to manufacture total space systems with their own investments is required. If we look at past 12 years (from 2002) mission performance, ISRO capacity has produced around 65-70 domestic missions (of satellites and launchers) – an average of about 5-6 per year!! Would this be adequate for the future needs of next 10-15 years?

Looking to the future 10-15 years, it is (projected) that India could be addressing levels of around 150 missions (communications, EO, positioning, science, HSF and launch for domestic needs and some levels of global market) with a possible investment (projected from 12th Plan figures) to almost INR 1000 billion or more. This investment will be for operational space missions to meet governance needs of the country – but will include advanced and newer missions for HSF programme, planetary missions and advanced developments.

This raises an important question – will ISRO as the sole agency be able to meet the requirements of such a space growth (a doubling or tripling of its existing capacities) AND why cannot Indian operational space systems – like, operational communication satellites (INSAT-class) OR operational imaging systems (IRS-class) be built, owned and operated by Indian private sector under a good "regulatory/licensing" regime? Similarly, why cannot operational PSLV-variants be fully manufactured, assembled and launched by Indian private sector under appropriate supervision and authorisations by the government, meeting international law and obligations? In fact, this would not only create Indian industrial capability in space but also make it globally competitive for large-scale business acquisitions and at same time help address the "gap in capacity problem" in the country that exists today of transponders, images, launch systems etc. On the other hand, some Indian industrial capabilities are building full satellites for other markets or young entrepreneurs are building a rover for the Moon for a commercial prize. 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.

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. The effective direction for the mid-term is public private partnership.

One major requirements will be to move away from just involving industries as "contractors" to ISRO but to develop independent and high-quality space industries that can, alongwith ISRO, be a part and parcel of Indian space eco-system. Thus, if public-agency sheds time-and efforts investments for routine PSLV/INSAT/IRS class of activities, then it can play a larger and more effective role in advanced technologies and newer developments required for national needs of future, planetary missions and HSF. This may require careful planning and may have to be evolved over time – but this would be the requirement for the future growth of Indian space. The major role that one could foresee for Indian Industry in this field is their integration and moving up the value chain. India 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.

The need is to usher in a good public-private regime for Indian space – a (new)Space for India. This will require some innovative actions, including:

- Reform is 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.

- An 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.

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

6. GROWING AND SURVIVING IN A GLOBALISED WORLD

The Indian Space program has excelled in many dimensions and has also contributed to international dimensions through its commercial and cooperative endeavors. 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, India 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 for industries to produce state-of-the-art, cost competitive satellites on one side and manufacturing of launch vehicle and providing launch services on the other 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

7. CONCLUSIONS

Great heights have been achieved in the post independent India in space endeavours through unfolding the utilitarian and pacific visions of Space. India must expand its role into the next stage of of space to scale newer heights and become a significant contributor to meeting national needs, cater to global demand, explore beyond in space and be in the lead of Global Space Efforts . This would require a turn to public-private space eco-system in India – a (new)Space model that is on the backbone of a visionary National Space Policy

This paper is a result of a study undertaken by NIAS to demonstrate a unique and rational approach which integrates scientific analysis of all core issues and over-arching assessment of staking issues in the development of the necessary space policy tenets. The perspectives of policy brought out by the study, although depicted in the national context of India, are highly relevant to different regions of the globe since they strike at the roots of fundamental issues that characterise the structures in which generation and applications of space are being pursued.

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