

IAC-16.E3.3.12

## FUTURE INDIAN SPACE - PERSPECTIVES OF GAME CHANGERS

**Mukund Kadursrinivas Rao<sup>a</sup>, K.R. Sridhara Murthi<sup>b</sup> and Baldev Raj<sup>c</sup>**

### Abstract

\*

In the past 50 years, Indian Space has seen many successful milestones – demonstrating excelling Indian technology and widespread utilization of space services in different areas of national economy. Present capabilities and capacities of Indian Space are mainly in the unitary capabilities of the national space agency – this has enabled the nation to significantly achieve about 10-12 high-quality missions every year. Meeting future domestic needs AND benefitting by access to large global market of space will require a quantum jump in capabilities and capacities to be served.

Another important development is the aspirational growth of Indian economy and the people. With a GDP growth hover around 7-8% and a few trillion dollar economy, the nation has launched important developmental initiatives - Digital India, Make in India, Smart City, Swach Bharat, National Education Mission and National Skill Mission programmes. Thus, demands for diverse applications of space technology are inevitable – integrating across geographical, sectoral and temporal domains of the country.

In an earlier suo-moto study, we have outlined the future 10-20 years of policy perspectives for Indian Space development and also outlined the perspectives of how a National Space Eco-system would emerge – evolving from the present national space agency into a “public-private-academia triad”.

Looking ahead of such a national eco-system, we now visualize critical developments that will bring impacting and paradigm shifts to holistic Indian Space through the “triad” – Game Changers. With about 100-150 possible missions in coming 10-20 years – encompassing EO, satellite communications, positioning, space science, planetary missions, operational and advanced launch access missions and the initiation of a human space flight programme, the “critical shifts” would be not just technological advancements but organizational re-structuring from emerging newer organizational arrangements, industrialization and emergence of private space industry, deeper penetration of space services in Indian society, increasing global presence of Indian players and a vibrant cooperative and collaboration at international level.

What will drive these game-changers? Cost efficiency will be one key driver - amply demonstrated in many sectors for global markets, this will impact global space markets and bring a “levelling effect” across global markets. Indian skills and human resources will be another driver – with Indian scientists, engineers and managers playing a major role in national and global space. Third will be “Indian innovation” – ability to improvise and innovate with simple, low-cost BUT effective solutions. These 3 drivers will bring a new economic model that balances systems, costs and performance.

The paper provides a perspective of future Indian Space and outlines “game changers” impacts that will emerge for space activities in India. The paper also discusses how, in an integrated manner, Indian Space can and should reach greater heights by key policy, strategy and actions for the coming few decades.

### 1. Introduction

India is on a path of tremendous progress and growth. With annual GDP of around 7.5% in past few years, it is

set to become the third largest economy in the world by 2030- powered largely by domestic demand and the transformation to a highly industrialized and technologically advanced economy. With such a level of

<sup>a</sup> National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore 560012, India, [mukund.k.rao@gmail.com](mailto:mukund.k.rao@gmail.com) \* Corresponding Author

<sup>b</sup> Jain University and National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore 560012, India, [krsmurthy09@gmail.com](mailto:krsmurthy09@gmail.com)

<sup>c</sup> National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore 560012, India, [baldev.dr@gmail.com](mailto:baldev.dr@gmail.com)

economy, developmental activities in India demand a new paradigm and Governance regimes will need considerable change – moving from the traditional allocation systems to determining equitable systems. What is required is GAME-CHANGERS - a vastly different technology and management regime to arm itself for meeting the challenges of a trillion-level of economy - bringing rapid development needs, bridging disparity and gaps, bringing equity, transparency, inclusivity and citizen participation.

In such a scenario, Indian Space cannot remain in a different mould. In the past 50 years, Indian Space has seen many successful milestones – demonstrating excellent Indian technology and widespread utilization of space services in different areas of national economy. Present capabilities and capacities of Indian Space are mainly in the unitary capabilities of the national space agency – this has enabled the nation to significantly achieve about 10-12 high-quality missions every year. Meeting future domestic needs AND benefitting by access to large global market of space will require a quantum jump in capabilities and capacities to be served.

GAME-CHANGERS are called for in Indian Space.

## 2. India's space program – Upto the Present

Indian space activities 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 founded the ISRO - first led by Prof Satish Dhawan way back in 1970s.

As of 2016, some of the major achievements of Indian Space include<sup>1</sup>:

- Present annual budget of 2016-17 FY for Indian Space through ISRO is INR 75.09 billion. Over the past 40 years, as against a cumulative budget of about INR 930 billion allocated, the actual spend/utilisation has been INR 612 billion.
- India has realised 137 missions (80 Spacecraft; 54 LV; 1SRE; 1 CARE; 1 RLV-TD). India has presently successful missions in Space exploration (MOM & ASTROSAT), Satellite Navigation (IRNSS & GAGAN), Satellite communication (13 satellites; ~240 transponders), Earth observation (11 LEO + 3 GEO) in orbit.
- Independent access to space is realised through a reliable and operational PSLV launch vehicle and a proven operational indigenous 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 and astronomy studies
- Wide use of INSAT communications systems have resulted in the wide outreach of TV signals to almost whole of the country and growth of large-scale DTH and VSAT data communication business.
- IRS images have provided great thrust to use of images and geographical information techniques 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 have derived a great boost from the availability of INSAT and Oceansat images/data on a variety of ocean and atmospheric data.
- Forays in planetary missions have been made through Chandrayaan-1 and MOM-1 for advanced scientific studies.
- Global commercial operations of Indian space through 74 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 100 billion over the past 20 years, although only a part of the capacity created was available to the commercial activity.

### 2.2.2 Looking Ahead

Looking ahead, ISRO's direction is to undertake the missions that have been approved and planned in 12<sup>th</sup> FY Plan and meet the national needs.

Some of the short-term challenges that Indian Space has to counter include<sup>2</sup>:

- A sustained and operational GTO space access system with a fully operational GSLV
- Next-generation robust and sustained multi-level space access capacity

- Satellite communications - bridging the large gap in quick availability of satellite communication transponders that has started stifling the service segment of DTH and large demand for social and commercial services.
- Advanced and Next Generation high capacity Satellite Communications technology
- EO – instant powering a nation-wide GIS with a Suite of advanced high spatial-, temporal- and multi-spectral EO constellation capability:
- Development of an indigenous Indian global positioning system to achieve autonomy in access to global satellite positioning capability
- Long-term Planetary Missions plan with continuity and dove-tailing of missions to develop a knowledge base for planets, landing, habitation and other human activities.
- Building a robust national private sector space industry that can design, manufacture, own and operate space assets for India:
- Yet another challenge is also in future activities of human space-flight programme – not just technologically but also from investment and sustenance point of view.
- Intensifying a two-way international cooperation – 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.
- Indian 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.

At the side-lines of the recently concluded Bengaluru Space Expo, 2016, ISRO is quoted by NDTV that “we are seeing a spurt in activities at the government level, demanding greater services using space resources, because they (departments) are realising the potential of geospatial technology, communication, crowd sourcing and earth observation capabilities,” and admitted that there was capacity shortage in providing an array of

public services and “...the country would have to double the number of satellites in the near future to give a reasonable level of service to the citizens”. ISRO goes on to say that “... are in the process of increasing our launch frequency though we have a long way to go as the present supply chain is inadequate to meet our growing demand for more satellites and space-based services,”<sup>3</sup>

In the present context and looking ahead, certain imperatives for considering and justifying game-changing actions are:

- In next 20 years, to meet national (and global market) needs, India would have to triple its annual space mission accomplishments - from its present ~8-10 mission level to almost 25-30 missions annual in next 8-10 years (in an initial estimate done by NIAS we have determined that almost 200-300 space missions would be manifest in next 10-15 years)? The sheer tripling of annual space missions capability calls for game-changing actions – which are far different from present space capability systems and calling for much elasticity and bandwidth in manufacturing?
- With an estimated possible investment of INR 2 to 2.5 trillion in next 15-20 years for Indian space, what structural changes would be required for near-tripling of present level annual spends (INR 75 billion INR in 2016-17FY) – both from public and private funding of space missions?

### 3. Future Space Eco-system

In our view, the above challenges require a new and a larger National Eco-System for Indian Space – which expands from the present single-agency (centric) system to a multi-level framework and position an investing private sector and an innovative academia/research sector.

Indian Space industry need to be an important part of the larger eco-system that can address Space Assets Manufacturing, Private Ownership of Space Assets, National-level Space Services and Global Market Access

Importance of Academia and institutional research in Space is extremely important. This element can address cutting-edge R&D capability/capacity in space, science missions and knowledge as users and research, industrial research and space education for R&D.

The national space agency, ISRO, must take on a larger role of the “mature partner” in the new eco-system and become a “fulcrum and hub” of space knowledge enterprise. It has a major role to play for industrial

development of space and innovative methods. ISRO could easily take on a more challenging and responsible role in advanced technology development in satellites/communications/EO, complex development of human space-flight technologies operationalisation, continued space missions for planetary and space science, critical international cooperation development for 2-way benefit and developing crucial applications demonstrators for future. International cooperation must be the regime of ISRO and enable the national space eco-system with best of external technology and inputs.

In the new order, a national regulation for space would be called for. Increased competition for orbital resources – for slots and frequencies particularly would call for increased level of coordination and sophistication would be called for in order to ensure interference free communications. India should also be participating actively in global fora which lead regulatory developments and protect Indian interests over India but also in the world.

#### 4. Game-Changers – Forward Action

Looking ahead of such a national eco-system, we now visualize critical developments that will bring impacting and paradigm shifts to holistic Indian Space through the “triad” – Game Changers. We visualize following scenarios to develop as a “game-changing” plan:

- A **National Space Policy (NSP)** will be the foundation for future space activities – consolidating the achievements and envisioning the future 20-30 years of space activities and the positioning of the New Space Eco-system. Without a NSP, achieving annual and 5-year targets would not bring the game-changer environment for the future 20-30 years. Indian Government has a tremendous opportunity to roll out the NSP with a process of wide-ranging consultation amongst space experts, user community and political system. In 2014, NIAS<sup>4</sup> had analysed policy scenario of Indian Space and had proposed the comprehensive Indian Space Policy – these can be further updated/modified and transformed into NSP through a process of studies/analysis, consultation and Policy Definition tasks.
- **(Goal Setting) National commitment to procure or “buy-back” from 2022 onwards all domestic communications satellites (aka INSAT), domestic EO satellites (aka IRS) and respective PSLV launch services from Indian space industry** – a time-bound strategy of “license-buyback” model of thrust for private-sector manufacturing, ownership and operations of Indian space assets is an important step<sup>5</sup>. Thus, when INSATs, IRSs and PSLV will be

only PROCURED from industry by the Government (and any other commercial users), private sector space assets manufacturing will get a big boost. This goal fits well into the MAKE IN INDIA drive of the Government. Thus, over the next 5-6 years, the action would be towards:

- setting into motion the industrialization of space with focused private manufacture of space asset, ownership and operations in India. This industrialization/privatization effort can be a major GAME-CHANGER – it would bring in substantial (initial risk covered) private investment into space assets manufacturing and operations for domestic market and leap-frogging in the global space industry for India.
  - setting a target period of 5 years for national space agency (ISRO) to “transfer” its operational manufacturing “know-how” of INSAT/IRS/PSLV to Indian space industries – thereby, enabling national space agency to concentrate on its advanced space technology and applications development role in the New Space Eco-system. This would be a GAME-CHANGER for the national space-agency to morph away from operational production to more challenging technology development. In view of increased work content this should be pursued without loss of any existing jobs but with a substantial growth in higher level jobs.
- **(Goal Setting) National Drive for spurring space academia and research** - a major step for expansion and qualitative developments in space technology and spread of research activities and a healthy competitive-spirit among academic research organisations for space research. In due course, this would ensure for substantial ingest in human resources that would be essential for developing advanced programmes and industrialisation.
  - **(Goal Setting) Future Direction for National Space Agency** – chiseling the National Space Agency into a futuristic, challenging and responsible role in advanced space technology development in satellites/communications/EO, new and complex development of human space-flight technologies operationalisation, continued space missions for planetary and space science, hand-holding and transfer of “know-how” to Indian Space industry, critical international cooperation development for 2-way benefit and developing crucial applications demonstrators for future. This will be a GAME-CHANGER for the future role of ISRO and bring the high-technology focus that is required for next 20-30 years vision of Indian Space.

- **(Goal Setting) New Governance Structure for Indian Space under NSP** - essential to position a top-level National/Government focus on space technology, space industry, space academia and space applications. Inter-departmental framework, space industry forums, space academia committees and larger user involvement is called for. Much debate/thought is required for defining this in the long-term perspective.

What will drive the above game-changers?

National-will and action to look far ahead into 20-30 years domain for a pragmatic and visionary National Space Policy (NSP) (moving away from the present annual profiling through National 5-year plans). Under the visionary and enthusiastic drive of Prime Minister Modi, the long-term vision of NSP can get defined with the specific goals set into traction. Indian Space must dovetail into “Make In India” AND also a game-changing Space Privatization Programme.

Cost efficiency of Indian private sector for space manufacturing will be another key driver – this cost-effectiveness has already been amply demonstrated in many other sectors of Indian economy (IT, BT etc). Such an effort by private sector will make Indian privatization effective and also bear on global space markets by bringing a “cost-advantage effect” for space manufacturing in India. Organisational innovation involving integration across aeronautics, civil space and relevant defence related industry, supply chain rationalization and lean management skills should be considered.

Indian skills and human resources will be another driver – with Indian scientists, engineers and managers playing a major role - not just for domestic markets but also vanguard role in global space markets.

Finally, it will be “Indian innovation” that will make a revolutionary change in space manufacturing and market delivery. The ability to improvise and innovate with simple, functional, high quality, low-cost BUT effective solutions for space manufacturing, marketing and applications will play an important role in global space market.

## 5. Conclusions

India’s ambitions for space activities and its emerging needs for next few decades for services and infrastructure development present an unprecedented opportunity. Yet, there is a foreseeable way in which the government can pursue such diverse and growing space programme needs – it has to outline a long-term National Space Policy; involve a risk-sharing industry for space assets manufacturing/ownership; challenging national space agency-ISRO for advanced space technology development/planetary missions/human space flight missions and invigorating research and academia for front-ranking research in space.

Establishing regulatory framework as well as regulating mechanisms for space activities under NSP is an essential need.

In past 40 years, great heights have been achieved in India in space endeavors through unfolding the utilitarian and pacific visions of Space.

If India has to expand its horizon and enable a major space thrust for domestic and global markets, it has to position “new rules of the game” and transition the present space activities and bring a global foray of Indian space in next 2-3 decades. Game-Changers!!!!

## Acknowledgements

The authors wish to express gratitude to National Institute of Advanced Studies (NIAS) and Jain University.

In particular, the authors express deep gratitude and thanks to Dr K Kasturirangan – a visionary of Indian Space and with whom the authors have had the privilege of engaging for many years. In fact, much of the paper is based on intense discussions and engagements with Dr K Kasturirangan.

## **REFERENCES**

- 
- <sup>1</sup> INDIAN SPACE – TOWARDS A “NATIONAL ECO-SYSTEM” FOR FUTURE SPACE ACTIVITIES - Mukund Kadursrinivas Rao, Sridhara Murthi K. R. and Dr. Baldev Raj. Paper selected/to be presented at 66th International Astronautical Congress, Jerusalem during October 12-16, 2015. Available at <http://eprints.nias.res.in/887/>.
  - <sup>2</sup> Ibid (1)
  - <sup>3</sup> NDTV quoting Chairman of ISRO on September 2, 2016 - <http://www.ndtv.com/india-news/india-to-use-more-satellites-for-public-services-e-governance-isro-chief-1453469>
  - <sup>4</sup> 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 and accessible at <https://iafastro.directory/iac/paper/id/20955/ext/appendix/IAC-14,E3,2,7,x20955.pdf>
  - <sup>5</sup> PRIVATISING SPACE MISSIONS – A CRITICAL ROUTE TO BOOST INDIAN SPACE ECONOMY - K R Sridhara Murthi and Mukund Kadursrinivas Rao. Paper selected and presented at 66th International Astronautical Congress, Jerusalem during October 12-16, 2015.