New Extension of Commercial Space Apps:
Broadband, ICT and Geomatics: India
By Sanat Kaul

Space Applications have thrown up tremendous opportunities for commercial utilization as well as tools for planning and implementation for governments. Already broadband internet has changed the living and working style in developed economies. With ICT convergence of telephony, computers and extending to smart gadgets the lifestyle has changed in a short period of a few decades. Geomatics with space based applications is changing the traditional work style with satellite based land surveys, remote sensing, cartography, GIS, photometry, geophysics earth mapping hydro-graphics, Earth Mapping, LIDAR based applications for archaeology, geography, geology, geo-morphology, seismology, forestry remote sensing etc.

While commercial space flights, space tourism or sub-orbital flight is still in its infancy, commercial use of space assets is becoming very common. A common man is not even aware of how remote sensing or communication satellite has changed the world in which he lives. Space based applications can be numerous, but we can divide them into a few types. One type can be called Remote Sensing based applications; another can be categorized as navigational while a third type can be called communication-based applications. Presently, most satellites are publicly owned but private satellites are entering the market and are fast catching up. However, these applications are gaining popularity in the private sector all over the world. Commercial use of satellite, however, needs regulation.

India: Background to Space Activities

By late 1960s, India established a programme for experiments in basic technology for space systems by establishing Indian Space Research Organization (ISRO) in 1969. With self-reliance as a goal, the space programme was based on the premise of 'end to end' system concept. This premise enabled the Indian Space Programme to overcome numerous hurdles and challenges in leaning and experimenting with new technologies.

The Indian Space programme was started by addressing India's development needs[1]. This started with satellite based instructional television. The first was the Satellite Instructional Television Experiment (SITE) for which telecommunication satellites. By 1970s, India had procured its own communication satellite 'Aryabhata', a 360 kg satellite named after an Indian astronomer. It was, however, launched by Soviet Union. India by then

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

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

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

In the third phase starting in the year 2000, India had achieved the basic technological maturity required for developing a space system. However, India also announced around this time its augmentation satellite to compliment GPS in GNSS and further announced seven satellite based Indian Regional Navigation System known as IRNSS. It also started planning for an unmanned mission to Moon with Chandrayaan I, which was successful in 2008-09.

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

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

- A full space infrastructure has been built up over half a century.
- Approval for 200 missions has been accorded by Indian government but 125 missions have been accomplished – out of which 111 missions have been successful.
- Leading satellite capability that covers a wide variety of applications satellites. These can be grouped in five categories i) satellite communications, ii) Broadcasting satellites, iii) Remote Sensing (Earth Observation), iv) Location and Timing Satellites, v) Metrological Satellites.
- Use of INSAT communications systems have resulted in the wide outreach of TV signals (from early 1980s onwards) to almost whole of

the country and growth of large-scale DTH and VSAT data communication business has been achieved.

- The availability of low-priced and easily available IRS images (from about 20 IRS missions) gave a great thrust to use of images and geographical information techniques into many governance and national building activities, including disaster management.
- Weather and ocean services modeling have derived a great boost from the availability of INSAT and Oceansat images/data on a variety of ocean and atmospheric data – thus consolidating the scientific services of meteorological department and Earth Sciences.
- Forays in planetary missions have been made through Chandrayaan-1 and MOM-1 to establish the technological capability of Indian space to undertake far-reaching planetary exploration and also undertaking advanced scientific studies.
- Unique missions for astronomical observations – Astrosat and operational Positioning Services – through Indian Regional Navigational Satellite System (IRNSS) constellation of seven satellites have been planned for late 2015. Astrosat has multiple imaging methods: ultra-violet, soft x-ray and hard x-rays. This will involve expansion of space applications for ISRO.
- The next lunar mission by ISRO is being planned for which ISRO is developing a Rover, a lander and orbiter.
- ISRO has another major mission in mind: Aditya I or a satellite to look at the Sun.
- Global commercial operations of Indian space includes 43 commercial/foreign satellites launches; sale of IRS images and value-addition services and lastly more lucratively, transponder lease business in India. This has estimated to have resulted in revenue earnings of about INR 50 billion over the past 20+ years.

Commercialization of Space Apps in India: Antrix Corporation 1992

By 1992, the government had realized that the potential of Commercial space activities and set up a wholly owned Antrix Corporation in that year to market Indian space capabilities developed by ISRO globally and thereby creating a revenue models for it.

Antrix Corporation has access to specialized design, test and manufacturing facilities in ISRO staffed by 16000 strong and experienced scientists and engineers with in depth knowledge of the crucial parameters of the space industry. Antrix Corporation has focused on enhancing functionality and value to the customer. Antrix offers satellite systems and sub-systems with proven performance in space and incorporating advanced features of power & reliability and long life. The earth observation data services powered by a state of the art constellation of Indian remote sensing satellites (IRS) and a network of ground stations provide a valuable and assured resource for

business to customers worldwide. Antrix facilitates the utilization of Indian Space assets in the field of telecommunications & broadcasting for a variety of services including TV feed, DTH, VSAT, mobile communications and socially relevant services such as Telemedicine and Tele-education. A track record of successful space launches in a variety of earth orbits through India's PSLV and GSLV launch vehicles has made Antrix a choice for many customers. Antrix counts on the unmatched knowledge and experience.

Antrix Corporation has already achieved: -

- Successful supply of reliable satellite systems and sub-systems. Some of *Antrix*'s better known customers are Hughes,Matra Marconi, World Space etc.
- Successful Commercial Satellite Launches of Kitsat (Korea), Tubsat (DLR - Germany), BIRD (DLR - Germany), PROBA(Verhaert, Belgium) aboard the ISRO's Polar Satellite Launch Vehicle (PSLV).
- Execution of many support services to International Space Agencies. Some of the customers using *Antrix* services are World Space PANAMSAT, GE Americom, AFRISTAT etc.,
- Successful launch of TecSar(Israel).
- Two satellites; one from France and another from Japan were launched in September 2012.
- Successful launch of five satellites, including French SPOT 7 satellite on 30 June 2014

Business Agreements

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

Size of Indian Commercial Space Industry: Need for Private Sector Initiative

It is estimated that while the global space economy is worth $314.17 billion which includes $226 billion is commercial, Indian Space industry is, however, worth only $1.1 billion of which private commercial space economy

consisting mainly of Space SME sector is only $48 million. It is felt perceived Antrix Corporation, as a commercial arm of ISRO will not be flexible enough to compete in the world space market. The need for small, lean, young, flexible organization is felt.

Growth areas of Space based activities in India are disaster and flood management, Tele-medicine, Tele-education, vehicle tracking, women safety, management of land issues, remote sensing for minerals, urban development and creation of smart cities.

Meanwhile, India issued two policy documents: Satcom Policy in 1999 and Remote Sensing Policy in 2001

Analysis of Satcom policy (1999) and Remote Sensing Data Policy (2001 & 2011)

a) Satcom Policy on 1999 while stating the usual goals also mentioned that it would encourage and promote privatization of satellite communications in India by way of encouraging private sector investment in space industry and also attracting foreign investments

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

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

The Satcom Policy gave preference to Indian Satellite Systems (ISS) while giving service licenses – thereby ensuring "protective cover" for INSAT for Indian services against global commercial systems. However, the Satcom Policy does not in any way prohibit the use of foreign satellite systems – which, after a due process, can be treated on par with ISS for service licensing in India. This has not happened – mainly due to deficiencies of appropriate procedures in implementation and subsequent emergence of canalization of lease of foreign satellite capacity through Department of Space nominated agency – which has brought bureaucratic impacts.

Conversion of space technology platforms has also led to e-commerce startups offering services of online shopping, to locating taxis, restaurants etc. Use of SMS alerts by banks, airlines has become common. Use of SMS to inform value of shares and other financial services are gaining momentum. But more important is the use of GIS in integrating information relating to land ownership and physical features (water bodies, roads, forests etc.). These can be super imposed on basic top sheets as has been done by the Government of Gujarat. The state government has also enacted a law for institutional framework for use of GIS. E-governance has now been made a policy by Government of India leading to growth of e-kiosks in small towns and villages. In the recent budget, funds have been allocated to lay out a National Optical Fibre Network Programme of 75000 kms to connect 250-1000 villages. This is a part of the 'Digital India' strategy.

b) The Remote Sensing Data Policy (RSDP) defines the Indian regulations for acquisition, dissemination of satellite images in India – earlier, RSDP-2001 and now RSDP-2011 governs how satellite images are to be acquired and distributed – allowing up to 1m images to be openly dissemination to users. The RSDP embeds the concept of "regulation" to address the dissemination for 1m images[2].

The RSDP-2001 provided the basic "framework" for a comprehensive imaging policy. Remote sensing was identified as a "public good". The RSDP introduced the concept of "one-window" access to any image (Indian or foreign satellite) – which today appears to be against "free market" concept. Concept that RSDP-2001 brought in was mainly to prevent access to 5.8m images that could become a security concern. The RSDP also required foreign satellite images to be routed through the national agency – National Remote Sensing Centre (then Agency), NRSC. Thus, even though the RSDP, 2001 clearly emanated from the competitive challenge of US 1m images against the Indian 5.8m IRS system in the Indian market – it was certainly a protective regime for IRS till it could also match with commercial 1m image availability from IRS systems (which happened only in 2006).

By 2005-06, India also launched 2.5m and 1m images but by then the larger proliferation of 1m images from US commercial satellites had also happened. Thus, the 5.8m thresh-hold of RSDP-2001 as "regime for non-discriminatory access" became irrelevant. Consequently, in RSDP-2011 the bar was lowered for "non-discriminatory access" to 1m while fully retaining all other aspects of RSDP-2001.

Because US 1m images became widely popular in India as against 5.8m/2.5m images and very limited 1m images from IRS systems RSDP 2001 was a failure. With NRSC the "sole agency" for distributing images, it had become further monopolistic as it adopts IRS-centricity and pushed 2.5m and limited 1m images – thereby denying Indian users 0.3m level

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

images for national development. At the same time, India was unable to match the resolution quality of US commercial systems (that have reached 0.3m level in global market) and had planned for a 0.5m imaging IRS in 2017 time-frame.

Shortfall of ANTRIX Corporation

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

Upgrading Satellite Manufacturing & Launching

The successful launch of GSLV-D05 using an indigenous cryogenic engine in January, 2015 was a critical milestone for ISRO's communication satellite program. Routine operation of GSLV Mark 2 will help ISRO in achieving self-reliance for launching satellites now in the pipeline for Direct to Home television (DTH TV) and broadband communications. The development of the GSLV Mark 3 with its capacity of 4,000 to 5,000 kilograms should accelerate in the coming years after success with the indigenous cryo-stage, which has been a bottleneck in ISRO's geostationary launcher development program over the past 20 years. In future, therefore, India should be able to launch heavier satellites[3].

Future of Commercial Space Apps in India

Euroconsult has predicted in its recent study "India Satcom Markets 2014," an average growth of 8 percent per year in commercial bandwidth demand driven by DTH satellite pay-TV platforms, cable television, cellular backhaul and enterprise and government VSAT, or very small aperture terminal, communications networks has been predicted. To meet growing commercial demand, ISRO has engaged in foreign subleases in the past 10 years, especially for Ku-band, though it considers those subleases as gap-fillers until sufficient domestic capacity becomes available. However, it is highly likely that ISRO's dependence on foreign operators will continue, as it has not been able to launch more than one communication satellite per year in the past. Also, ISRO has to reserve capacity for government users such as the Department of Telecommunications, All India Radio, Prasar Bharti and the military that account for more than one-third of its current bandwidth supply, therefore limiting the capacity available for commercial users.

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

Regulation still limits market growth, as all Ku-band leases have to go through ISRO/Antrix in a process that is often lengthy and cumbersome for operators, including strict price regulations, royalty fees and service-level license regulations by the Department of Telecommunications and the Ministry of Information and Broadcasting. Some of these regulatory restrictions are likely to be revised in the country's new satcom policy expected to be released shortly[4]. Expectations are high from satellite operators, equipment vendors and service providers alike.

ISRO to scale up outsourcing to private industries

In a recent statement, Chairman, Indian Space Research Organisation (ISRO) had stated that India would significantly scale up outsourcing to industries to meet the shortfall in demand and to fuel the quantum jump in the programmes being undertaken by it. It has also proposed to have a risk-sharing model, as more than 500 industries (micro, small, medium and large) already account for 60 percent production of the space agency's programme and their share would further go up. ISRO is witnessing a quantum jump in the production of rockets (Polar Satellite Launch Vehicle) and satellites, in the last two-three years.

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

ISRO has also mooted an idea for industrial partners that they can work in consortium mode if they wish — like coming together of players in the field of electronics, production, metals and precision fabrication, among others.

GNSS & GAGAN: Navigation

c) In 1994, ICAO took a decision to shift from terrestrial navigation to satellite based navigation worldwide in future and accepted the offer of US GPS in 1994 and Russian GLONASS in 1996[5]. European Union announced setting up of a third satellite constellation called Galileo. This also started the need for an augmentation satellite. While US set up WAAS over their region and EU announced EGNOS over Europe, India took the initiative to announce GAGAN, as an augmentation system over South and East Asia. GAGAN satellite has come up as a joint venture between ISRO and Airports Authority of India (AAI) is now ready for implementation. GAGAN also takes care of the ionospheric disturbances over Indian Ocean. The commercial

[4] India is still working on The Indian Telegraph Act of 1885, The Indian Wireless Telegraphy Act, 1933 and the Cable Television Networks (Regulation) Act, 1995. There is a dire for a new legislation on the subject.
[5] ICAO Doc 9750

potential of GAGAN is immense but there is yet no effort on the side of AAI to encash it. India is however setting up IRNSS-a seven navigational satellite constellation over India. Four satellites are already up in their positions.

Future of GNSS market: GNSS has created tremendous scope for commercial application. From aviation navigation to marine and surface navigation, the scope is unlimited. While market assessment is any ones guess, early forecast were put at $5.7 billion in a 1991 study. However, with the growth of new applications sky is the limit. Smartphones using GNSS signals are growing by the day. According to ABI research GNSS market will be worth $25 billion by 2018 and total sales and survives at $250 billion. While all this data cannot be taken on its face value, it can be safely assumed that GNSS market will grow exponentially. Further, US Commerce Secretary has said that the GPS technology has already surpassed $20 billion a year with 95% of the GPS units sold are for civilian use. The best growth areas are Cell Phones and followed by recreation and asset tracking equipment. Vehicle and cell phones form the backbone amongst other users. The Indian market for GNSS based applications is expected to grow exponentially over time.

Broadband, ICT, Geomatics and GNSS: GAGAN & RNSS

Aviation sector will be a major gainer from GNSS from the point of view of technology advantage. However, it is the airlines which need to find funds to equip their aircrafts to use Satellite based navigation. Most landings made by aircrafts are precision landings. While precision landings is possible with Augmentation satellites like GAGAN, WAAS and EGNOS, it is the oceanic airspace which greatly enhances the use and need for satellite based navigation as existing land based equipment fails to deliver over ocean.

Still the major market for GNSS applications would be land based like cars and other vehicles, and cell phones. GNSS is becoming all pervasive. Navigation and timing signals have entered every facet of modern life. The problem of GNSS is its fragility. Modern financial transactions are based on GNSS. IT systems, cell phone networks, electric grids depend upon GNSS signals. Agriculture is reputed to be 30% more efficient and productive in many places due to GNSS technology. GNSS signals are getting essential for modern transportation systems and networks. Use of synchronized traffic lights in cities is being done through GNSS. Commercial use of GNSS will only increase with time. In India too, use of GNSS is increasing every day. India has produced its first GIS map based real estate for Chennai real estate market titled “Real Insights 2014: Annual Reality Report.” In Surat the Municipal Commission has launched a GIS portal for the public to gain access to town planning maps and apply for development permission for a plot or property. The National Remote Sensing Centre of India has covered the floods of Uttrakhand State with 24000 photographs uploaded in real time to help direct relief operations. NRSC also used an anroid app and crowd-sourced over 3000 photographs of cyclone Hudhud of Andhra Pradesh thereby helping the government to assess the damage. ISRO in collaboration

with many states has set up space application centres. These centres are engaged in research, development and demonstration of applications of space technology. Such centres include training courses with students.

India's Space enabled industry and startups:

In spite of the fact that ISRO and the Department of Space remain a very closed government group with no Space Policy or Space legislation, a handful of tiny startups have started to make their presence felt. A small company called Druva Space has already signed a collaboration agreement Berlin Space Technologies, a German company to manufacture small satellites. This will be India's first satellite manufacturing factory in the private sector with a capacity to manufacture 10-12 small satellites in a year. Meanwhile, some young Indians calling themselves as Indus Team and belonging to Axiom Research Labs have won a prize worth US$ 1 million out of a $30 million Google XPrize competition after competing with 17 competitors from various countries. Their mission is to land a Robot on moon by 2016. Similarly, another startup called Aniara Space is developing communication satellites for broadcasters and has already signed up with a UK company Dauria Aerospace for two small geostationary satellites[6].

Future potential for private sector space industry in India is encouraging as India has young entrepreneurial talent. However, due to lack of a government policy on the subject, it is discouraging for private sector to take up the initiative as ISRO is the monopoly purchaser in India. As Susmita Mohanty, CEO and co-founder of Earth2Orbit, India's first private sector startup to offer launch facilitation states that "regulatory and business environment in India is discouraging for space entrepreneurs".

Geo-spatial technologies have taken center stage in India in urban design. An excellent example is the new lavasa township[7]. India's geo-spatial industry is in a healthy growth path both outsourcing and domestic. The domestic segment is funded largely by national and state governments.

Meanwhile, India's ecommerce business has taken a major step towards growth. Flipkart.com, India's largest e-commerce firm has made it to the top five global billion dollar startup club with a valuation of $11 billion based on a report published in World Street Journal and Dow Jones Venture Sources on 19.02.2015. It rival Snap deal ranks number 30 with a value of $2 billion in a list of 73 companies which feature other Indian startups like InMobi, an online ad company and Ola cabs, an online taxi service provider[8].

Foreign Limited Partners, Hedge Funds and Pension Funds are showing interest in Indian Startups as India has a well-developed IT industry with a

[6] For detailed description see Economic Times 30th Jan, 2015, page 16
[7] Geo-Spatial World, September, 2010 (Page 7)
[8] www.livemint.com 20.02.2015

revenue of about US$ 150 billion and over $100 billion of exports. It employs four million professionals directly[9].

Why India needs a Space Policy

India does not have a formal National Space Policy or Legislation that has been legislated or formalized into a public-domain document. A lack of such a policy was not felt till such time all activities were within the government sector. However, with growth in Space activities in India, there is a thriving private sector waiting to enter this sector. However, before this sector is allowed to expand it is essential to have a Space Policy which is friendly and positive to the Indian private sector. The need for space policy and space legislation is manifold. A space policy gives a direction to future activity. It provides direction of how to go about it. If India wants private sector to enter space industry it should be said so with the policy and provide a level playing field. It is, however, understood that work on space legislation has started.

A policy also needs to be backed up by legal framework. The space law needs to provide dos and don'ts on the subject. For example, GNSS signals are poor and jamming and phishing is possible. The law has to provide preventing misuse of GNSS jamming. Individual Personal Protective Devices (PPD) are available in the market and are quite cheap. These devices can operate from a small battery on a vehicles lighter/power outlet. Many are able to completely disrupt GNSS reception within 100 meters. Such PPDs are becoming popular with people who do not wish to be tracked. However, such PPDs can be very damaging to the society also. Such devices have been responsible for interfering with airport systems, cellular communications and stock exchanges. In Newark International Airport in the US, the Aircraft Landing System was disrupted by such a PPD. Airports detect everyday jamming devices passing by on a nearby highway road. The French authorities have recently monitored over 2000 jamming incidents in the last six months. Potentially more dangerous and problematic is spoofing. Spoofers have effective assumed control of both surface vessels and unmanned aircraft by transmitting signals only slightly stronger than GNSS. As a result, spoofing can be potential problem for many years to come. Only a few governments have recognized the importance of jamming and spoofing. The government should protect their citizens by preventing adverse incidents and also respond to damage control and restore things to normal when it takes place. Government should consider prevention of these incidents similar to prevention of a hazardous chemical spill and control this critical infrastructure from damage like they do for their electrical insulations of water supply. Therefore, law could make manufacture, sale and possession of jamming and spoofing devices as an offence under the law. The law

[9] See Finance Minister of India's Budget speech of 28th Feb. 2015 where he proposed to reduce the rate of income tax on royalty and fees for technical services from 25% to 10% - Sunday, Pioneer, 1st March, 2015, page 9

enforcement agency should be capable of rapidly locating and identifying the source of disruption including mobile platforms. This would involve declaring, positioning, navigation and timing of GNSS services as critical infrastructure subject to similar laws as for other critical infrastructure[10].

As GNSS based positioning, navigation, and timing services are becoming critical to national security and sovereignty, it use, manufacture, import, export should be regulated especially for jamming and spoofing devices. Government should also establish a network to detect such jamming and spoofing to prevent future problems. It may be pointed out that many large commercial organizations are getting dependent upon uninterrupted positioning, navigation and timing systems and they also need protection.

Future of private commercial participation in space applications in India

"Indian government is trying to bring E-governance and G-governance together – Geo-Spatial technology is fast becoming an engine of growth for businesses and is already a formidable force in the global as well as Indian economy[11]". While defence is a major user of geo-spatial technology, now solutions such a decision support systems, asset management, risk management etc. have opened up areas for this technologies in almost all sectors. Schemes such as maintenance of roads, railways, waterways, civil aviation, public utility services, education, health, command area development, flood management programmes, urban renewal, urban water supply, rural water supply, integrated watershed management are all using geo-spatial technologies. It may also be pointed that Indian capabilities in earth observation are world class.

India's private sector participation is mainly in telephony and TV. Communication satellites play a major role in private sector. However as disruptive technologies grow, the role of SMEs takes a special place in this scenario. While the Silicon Valley in US is the place where big cyber based companies are spending large amounts buying up startups, recently big India software companies have also started going to Silicon Valley to look for buying up startups. Indian digital based companies managed to raise $30-40 million funding in the last six months. They are now eyeing small acquisitions or acqui-higher (where companies are bought for their teams) and are backed by investors. In the recent Indian budget of 28th February, 2015, the Finance Minister as proposed Atal Innovation Mission with an initial fund of Rs.150 Crores for R&D. This will include space based R&D[12].

[10] For details see "Positioning, Navigation & Timing (PNT) Governance-require improvement by Dana Allen Gobard, President, Resilient Navigation and Timing Foundation, USA in Coordinates, 2nd February, 2015 (pages 8 to 12)

[11] Mr. Prithviraj Chauhan, Minister Science & Technology, Government of India, quote from Geo-Spatial World, September, 2010

[12] See Budget Speech of Finance Minister of India, 28th February, 2015 – Asian Age, 1st March, 2015 (page 2)

Social improvement through internet and space applications are also taking place in India, which will also involve commercialization of space applications. Apart from information regarding social issues like weather, crop details, India has taken a giant step towards online voting. The initial step has been taken by Gujarat Election Commission for Municipal Elections in which voters will vote from home after they have registered with the Election Commission of Gujarat with a physical verification by local officers along with biometric details. Voters will have to use the same hardware for which the verification has been done. At the time of voting one time password will be sent to their mobile phone, which should be followed by verification online. Then the voter will be allowed to cast the vote online[13].

Future of Space Apps in India

We visualize 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. It is, therefore, necessary to create new institutions necessary to meet the large scale demands of diverse sectors and removal of disconnects that afflicts efficiency of delivery system.

Satellite services are critical for India's economic and social development and society/citizen services. The digital divide in India between the users and non-users is narrowing as younger generation becomes more savvy and starts using smart phones. The digital divide is also narrowing as remote areas get covered through satellite and cellular telephony through funds created by the government called Universal Service Obligation Fund which subsidizes telephone companies to go to unviable remote areas. The government has already announced a National Optical Fibre Network (NOFN) to be covering 250,000 villages by March, 2016 with 750,000 kms of optical fibre wiring. The purpose will be to connect remote villages with easy access to health, education and business[14].

The need for space research in India

India will have to build and encourage Indian private sector research 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. It will need a level playing field as well as a financial support system. The level playing field would be based on a policy which will not discriminate in favour of public sector Antrix Corporation.

Policy towards Startups: Technology startups in IT sector have played a massive role in the US economy. Microsoft or Apple were start up only a few decades back. Now they are buying up startups to remain in the frontier

[13] Indian Express, 20.02.2015 Page 1, See website http://sec.gujarat.gov.in/

[14] The government determination to have a National Optical Fibre Network is part of Digital India Programme to make India into knowledge and innovation based society. See Hindustan Times, Sunday, 1st March, 2015

technology. These companies are also entering space activities. SpaceX, a company floated by serial entrepreneur Elon Musk is current offering the cheapest launches in the world. Startups are coming up in with regularity in remote sensing (or earth observation as it is known now). Antrix Corporation is so far not affected by SpaceX as SpaceX is not in polar base launching. It is therefore felt, that while Indians have done well in startups like in the US, they have just taken off in India[15]. Lack of Angel and Venture capital is a major handicap. Indian private businesses do not support technology startups. Well-established India IT companies have not supported or bought out startups in India. While many of these companies have bought small companies in Europe or US, mainly to enter these markets, they have not tried to encourage small technology companies in India by purchasing them or part purchasing them[16].

Why India should enter the world Space market in a big way: the cost advantage: -

MOM has shown the world the cost advantage India enjoys over other countries. Space will have to be developed as a vital tool for national security interests and safe-guarding Indian national interests. India needs a National Space Policy with a commercial space policy built into it and a 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. The Prime Minister of India has announced the concept of 'Digital India' and therefore the involvement of space applications has now got much greater emphasis.

Conclusion

Satellite communications has been 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 – tele-education as a medium of next generation education services, boost telemedicine for contributing to securing health in society, DTH broadcasting for TV and mass media communication, for virtual private networks of government, banks, railways, defence, aviation and other areas. At same time, space will also play a critical role in times of national emergencies, disasters, special events; national security and defence;

Ultimately, citizen empowerment is most critical and efforts must be to bring space benefits to every citizen of the country. Thus, an inclusive process involving citizens especially the youth in space is most essential and important.

[15] See Times of India 20th Feb. 2015 (page 26) for a description of Indian start-ups
[16] See Economic Times 11th Feb. 2015 for a description Indian Acquisitions in Space Enable IT Business