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DEMAND ASSESSMENT OF RS AND GI IN INDIA – OPPORTUNITIES FOR INDUSTRY SERVICES

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ABSTRACT

There is a new scenario developing with the advances in the Earth Observation, Positioning and Geographical Information (GI) domain – as observed in different parts of the world and even in India. On the one hand, the power of ¨EO and GI" is changing the way governance, commerce, resource management, environmental protection, aviation, security and even a citizen's life is impacted - either in a direct or indirect manner. On the other hand, the images of the earth are now being collected from variety of easily-operable platforms – satellites, aircrafts and Unmanned Aerial Systems (UAV) or Drones owned by both government and private actors. Till the mid-2000s almost all of EO and GI data holdings were mainly in government domain in India – but now large number of private-sector EO and of GI data holdings are a reality. MapMyIndia, Google and many EO and GI solution enterprises have emerged as solution-providers, offering value-addition to EO images and developing down-stream GIS applications.

This shift of a government- and private-ownership of EO and GI applications; the availability of the high resolution EO images (presently 0.3m from satellites and even 0.1m from UAV platforms) in the commercial domain; high-level Positioning services across the globe and easy fusion of geo-tagged GIS data is bringing in a new paradigm. Even while Indian EO data are "subsidised" and costs are low, there are demands and preferences for commercial EO data whose costs are high but offer better capability. Another change is the progressive blurring of divide among the "free access" societal EO and GI requirements for supporting developmental activities; the "commercial access" of EO and GI for enterprise and business applications and the "restricted" security requirements for human security and intelligence applications.

Seamless fusion and integration is becoming easy on hand-held devices - interoperability, integrity, reliability and better positioning and location accuracies are driving EO and GI into every citizen's hands and also bringing greater efficiency in governance, society, commerce and improved public and private decision making – thereby boosting demand.

There are also important policy issues emerging such as protection of privacy at various levels down to an individual citizen; and easy access rights to EO and GI data held by the government. National security considerations will still be important – even as use of EO/GI information could be thwarted by improperly devised and highly restrictive policies.

This paper will discuss several of these current demand related, technological and policy issues in India – specifically their impact on the EO and GI commercial opportunities.
Keywords: RS and GI applications in India, RS and GI industry, RS and GI policy

1. INTRODUCTION

Tremendous developments had been witnessed in the field of space based Earth Observations (EO). Improved quality, access and affordability of Images from space had been spawning a large array of applications and these images have indeed become part of many human activities, benefitting the society in a substantial manner. EO data have helped create valuable geospatial content across the world and have become mainstay for many Geographical Information Systems (GIS) applications. Operations from positioning satellites like GPS, Galileo and GLONAS and easy availability of positioning information through inexpensive user devices including mobile

telephones – and integration of position data with EO images into GIS has opened up new avenues of applications across the world. Through converging EO, GIS and Positioning technologies, many innovative and beneficial applications are being developed bringing benefits of timely, easily accessible and user friendly services.

A new breed of entrepreneurial services, representing "NewSpace" era, with the initiatives from private sector have been globally impacting this field as these focus on low cost space technology, diversification of sensing instrumentation, new forms of visualizing and representing information, extensive use of modern analytics and experimenting with disruptive concepts in technological, organizational and market services domains. Remote Sensing data sources are also greatly impacted by alternate platforms like unmanned aerial systems and revolutionary changes in technologies of access to information.

2. EXPANDING HORIZONS OF EO and GI APPLICATIONS

Information has become key driver for economic growth and social wellbeing as all institutions, industries, businesses and governance activities depend upon timely, accurate and relevant information for their survival as well as efficient delivery of intended outcomes. Information is demanded on an instant basis – be it about disasters, environment, businesses or trade, social transactions, security, threats like pollution, resources and many others. There is no denying the fact that an ability to better understand the world and its events is fundamentally changing, just as the way humanity continuously takes decisions for meeting the ever increasing needs and challenges. Spatial dimension of information has a predominant bearing for quality of decision making since most decisions concern with physical entities-living or nonliving, and spatial dimension is one of the fundamental characteristics, apart from causal and temporal dimensions for manifesting and vitalizing information.

EO images for any part of the globe is accessible at the click of a button. The technological and market driven developments are vastly influencing and forcing transformation of the traditional views of governments for dissemination and use of these images. The world has moved from an era where only a handful of governments had access to high-resolution imagery to one in which every government, every enterprise, every nongovernmental organizations, every public group and even every citizen has access to these images. This access has deeper implications as it can bring transparency which can be beneficial to the citizens, societies and nations across the world and even now governments are grappling to prepare for the era of global geo-spatial transparency. This situation also underscores the urgent need for evolving regulatory measures in different nations of the globe to ensure that the new powerful tools which provide wider access are used in a manner to result in the maximum wellbeing of their societies.

In tandem with advances in imaging, a major technology area that has changed the scenario is the Geographic Information System (GIS) – which allows for handling maps in the digital domain and allows powerful integration of various maps and non-spatial datasets to create newer visualization of information and simulation of patterns that enhance knowledge. Thus, GIS can handle different sources of Geographic Information (GI) and these include images, maps, positioning data etc. Increasingly, GIS constitute the core of the information management systems of nations and their entities. The data and processing capabilities offered by the technology also constitute a significant component of the emerging national information infrastructure in many nations. The use of spatial data promises greater efficiency in commerce, improvements in the environment, health, and safety, increased convenience for consumers, more citizen participation in governance, and improved public and private decision making generally.

The third major technology that had impacted is the precise Positioning and Navigation datasets through satellites that use radio ranging to fix precision position of moving or stationary objects. The precision of position is so high and so easy to obtain using a device that the dataset is a major GI input for a variety of aviation, surface transport or water navigation and personalized navigation systems. Coupled with terrestrial or satellite communications systems, these technologies are being used in automobile navigation and information systems, fleet management systems, asset tracking systems and other consumer and commercial applications. Location-enabled cell phones are common now, and location technologies, wireless devices and the Internet are converging to become one of the hottest commercial technology sectors. There are many different markets for location technologies at various levels, including that of OEMs, system integrators, value-added resellers, etc., each with its own unique risks and business models. End users range from consumers to municipalities to international shipping fleets. Fortunately, this technology does not present insurmountable legal obstacles that will prevent its further development and widespread commercial application.

The convergence of these three important technologies – EO imaging, GIS and Positioning has been greatly impacting the thought and decision-process – much of human thought is slowly becoming "geographical" or "geo-spatial" – the spatial relationship is becoming extremely important characteristic of any information – be it natural resources, environmental, social, economic, financial, cultural or any other dataset.

As we have observed at the beginning of this paper that spatial and temporal dimensions are the fundamental dimensions inherent in information. These are instrumental in improving capabilities for understanding, measuring, analyzing, organizing, comparing, modelling, predicting and regulating activities or phenomena. These processes are performed in conjunction with the third dimension of information, namely the causal dimension in order to derive the maximum value. This fundamental relation of spatial and temporal dimensions to "Information" and coming together of Imaging, GIS and positioning technologies with their global outreach have tremendous implication for growth potential since modern Information and Communication Technologies had been continuously advancing and their applications are impacting diverse spheres of economic, political, social, cultural and environmental aspects of our planetary state. It is now witnessed that beyond the fundamental integration of imaging, GIS and satellite based positioning domains, Geo spatial information and their delivery are driven by many emerging areas of ICT including smart sensors and systems, new generation of analytics, Cloud technologies, Internet of Things and so on which basically interface the information with systems for automated decision making and intelligent actions or Decision Support Systems involving designs of large/complex systems/ projects demanding sophisticated visualization of behavior.
This environment is opening up several new avenues for diversifying the geospatial services, industries and markets.

3. KEY DEVELOPMENTS AND CHALLENGES ON SUPPLY SIDE

Over the years the supply side has seen many key global developments that affect demand on EO and GI.

The foremost trend is a large proliferation of Earth observation missions. Imaging Satellites have become smaller in size and cheaper. Commercial small satellite imaging market is projected to grow from 15 million USD in 2015 to 164 million in 2020[1]. During the decade of 2016 to 2026, an average 200 small satellites for earth observations are projected to be launched annually. Today, a large number of nations have built/operate EO systems and almost all nations utilize EO technology in a variety of applications. Thus, the scope of EO has expanded vastly and much focus is being placed on global missions, international cooperation, newer EO instrumentation and wide range of local/regional and global applications.

Advances in sensors offer wide range of data through high and medium resolution optical imagers, thermal imaging sensors, hyper spectral imaging instruments, multi band passive microwave radiometers, Alti-meters, Polari meters, active sensors like Synthetic Aperture Radars in different bands of microwave spectrum, scatterometers and LiDARs (mounted on aircraft). These advances expand capabilities to optical, IR, Microwave regions of the electromagnetic spectrum with extensively improved geometric resolution, spectral resolution and radiometric sensitivity – apart from temporal coverage.

Today, a diverse constellations of multiple satellites from the traditional players/ space agencies including Landsat 7/8 from US, Radarsat of Canada, Resourcesat, Cartosat and Radar Imaging (RISAT) satellites from India; Sentinel series from Europe as well as many Chinese, Russian and Japanese satellites orbit the planet collecting multi-band images of the earth's surface, adding several million square kms and peta-bytes of data every day.

Emergence and increasing commercial EO satellites that provides global coverage of valuable EO data and caters to many national and international requirements. Commercial EO satellites (DigitalGlobe, SPOT, Pleiades, KOMPSAT-3, TerraSAR-X, RapidEye, Imagesat and more recently Skybox, PlanetLabs, UrtheCast, Spire, BlackSky, Planetary Resources and many others), their operations, data distribution and civilian/business applications are major topics of discussion in EO. Many businesses (like Google, DigitalGlobe, ESRI, Microsoft and many others) support/provide value-addition to EO data and development of down-stream EO/GIS applications.

Constellations are order of the day. The DMC (Disaster Management Constellation) offered an

[1] See Bhavya Lal et.al, Trends in Small Satellite Technology and the Role of the NASA Small Spacecraft Technology Program, March,2017, https://www.nasa.gov/sites/default/files/atoms/files/nac_march2017_blal_ida_sstp_tagged.pdf accessed 8-9-2017

international program led by SSTL (Surrey Satellite Technology Ltd) and is a network of five affordable LEO microsatellites. The programme provides a daily global imaging capability at medium resolution (30-40 m), in 3-4 spectral bands, for rapid-response disaster monitoring and mitigation, Land cover and vegetation information, Hydrology mapping, Fire and burn scar mapping, Flood monitoring etc.

Progressive evolution of Indian EO programs over time, from the 36/72m resolution image from IRS 1A, in 1988, to the current day 1m and better resolution imagery from Cartosat-2 A&B – a suite of EO systems like Resourcesat series, Radar Imaging Satellites, Oceansats and payloads offering global coverage. The roadmap of India indicates further advancement in the EO technology leading to 0.3m resolution imagery by 2017/18, in addition to a high resolution geostationary imager proving constant vision of the this part of the Earth.

Space technologies in the process of revolutionary changes brought-in the new class of operational mini and microsatellites and constellations - smaller, lighter, more inexpensive satellites- to collect observations from space. Radical miniaturization of integrated subsystems and relatively favorable prices of commercial components (COTS – Commercial Off-the-Shelf Components) have enabled considerable lowering of costs for development, launching and EO satellite use. These fundamental changes have redefined the space business once reserved only for big research and development institutions from select few countries.

Improved data communication technologies, including the INTERNET revolution, have made it very easy to deliver large volumes of EO data to users on a near-real-time basis – so that instant use of EO data can be made for many mission-critical applications and brought EO data to the desk of citizens across the world.

Advances in digital data analysis and geo-spatial data fusion – with data mining and data analytics have enabled quick and rapid information extraction from EO data and enabled the emergence of a vibrant geospatial industry. At same time, large scale hardware implementations (e.g. Cloud Computing) and capable software that process EO data ingest critical geo-spatial information into GIS applications.

EO applications have opened up in many new areas – which impact citizens, societies, enterprises and governments in a major way - enabling the sustainable development plans for our Earth. Today, most nations use EO data for inventory/mapping, improved statistics, improved decision making and managing disasters and many other national development and global collaboration activities.

EO has spawned the growth and usage of geo-spatial technologies and applications. EO images/data and GIS have become so “coupled” in the user domain that without EO images/data GIS decision-solutions are almost impossible and, conversely, wide GIS usage is creating newer and innovative demand on EO technology. This strong position of EO technology, however, in the most recent times has been challenged by alternate platforms like Unmanned Aerial Systems and changing user preferences.

The easy-generation of geo-spatial information sets across the world has driven GIS database activities in a major way – we now see vast amount of “integrative” GIS datasets across the world – both in public-free, public-commercial and “restricted” domain. Geo-spatial data have had substantial impact on government and business throughout the world. Increasingly, spatial data constitute the core of the information management systems of both private companies and public agencies. The spatial data and processing capabilities supplied by the technology also constitute a significant component of the emerging National GIS and even elements of a Global GIS.

A number of inter-governmental programmes around EO/GIS have emerged and are coordinated through forums like UN-OOSA, GEO, ISPRS, and GSDI, and, these efforts have made phenomenal advances in regional and global applications development of EO and GIS.

4. COMMERCIAL AND NATIONAL CONSIDERATIONS IN INDIA

Demands for RS and GI in India manifests along two branches- one related to applications programs directly implemented by the government institutions such as the centers of ISRO, Survey of India, National Informatics Centre or the space applications service centers of the state governments and the other through activities undertaken by commercial industry In accordance with Remote Sensing Data Policy 2011[2] and earlier policies, Government of India recognizes

[2] http://www.isro.gov.in/indias-space-policy-0 last accessed 10-09-2017

that Remote Sensing Data provides much essential and critical information, which is input for developmental activities at different levels and is also of benefit to society. Accordingly as a national commitment and as a 'public good" it assures continuous and improved observing/imaging capability from its own Indian Remote Sensing Satellite Programme. Indian Earth Observations Programme had been undertaking over the decades the development and operations of a space segment which now comprises of ten state of the art satellites that provide a strong resource for a variety of data to Indian users and also to users in some other parts of the world too.

As the quality and range of data from Indian Remote Sensing Satellites as well as commercial systems of other nations steadily grew over decades, demands in India had steadily seen an upward trend. All satellite remote sensing data acquisition, distribution and licensing of data for use within India has been centralized through the National Remote Sensing Centre (NRSC) of ISRO. NRSC maintains BHUVAN[3], which is ISRO's Geoportal providing Geospatial services and Earth observation data to users in public domain. The portal also services several users for the remote sensing application needs. Bhuvan has more than 50,000 registered users and has been continuously expanding its nodes, suite of services and customized Apps to different users in the government and provides support to decentralized and transparent governance. A substantial amount of data are shared on Bhuvan on open access basis as public good.

The demand for remote sensing data is varying from year to year, although long term trend shows upward movement over a decade. While the number of data products disseminated by NRSC[4] during fiscal years 2011-12 to 2015-16 were in the range of about 200,000 to 490,000, with an average annual demand of 250,000 products. Two thirds of the data usage was towards resource management applications like agriculture, forestry, water resources and ecology. Of these products which were disseminated during the said period, commercial sales ranged between 40,000 - 80,000 products, while the rest were shared on open access basis. The main demand among the data sold belonged to High resolution data, such as panchromatic data of 1 and 2 meter resolution (Cartosat 1&2) and 23 meter multi spectral data and wide field sensor data (from Resourcesat). Further, High resolution data to the extent of a million square kilometer (area) annually had been acquired from foreign satellites operated by DigitalGlobe and others. India's Data demand in terms of commercial volume could only give a partial picture due to aforementioned policies, but yet an estimate of commercial data demand from domestic as well as overseas could be in the range of 20 to 30 million USD and most of this value resides in the available highest spatial resolution.

The Remote Sensing application activities undertaken and implemented by the government institutions cover a wide range of disciplines and sectors. The inter-ministerial coordination is provided under the aegis of National Natural Resources Management System, whose secretariat functions under Department of Space. The major applications[5] include Agricultural crop inventories (in participation with Mahalanobis National Crop Forecasting Centre under the Ministry of Agriculture), Agricultural Drought Monitoring, forest fires, Landslides, flood mapping and monitoring, Gas pipeline monitoring, ground water prospects mapping, Periodic Land Use/Land Cover mapping, Monitoring of Glaciers, lakes and water bodies; GI support and operations of Decision Support Centre for disaster management; assessment of irrigation potential; Space based Information Support for Decentralized Planning; city GIS for infrastructure development in 500 cities (AMRUT); Integrated watershed management program extending over 86000 watersheds; tracking the progress and asset creation monitoring for Mahatma Gandhi National Rural Employment Guarantee Act scheme; maintaining Geospatial database for Emergencies Management ; medium range flood forecast modelling and many others.

The work of institutions under the government including the space agency and other user departments in the government resulted in the development of methodologies and software for applications, which are highly relevant in the developmental context. These developments offer tremendous future scope for scaling them up for national level. When assimilated into user organizations, they can bring about process reengineering in the users' organizational frameworks, improving efficiency of their deliveries and saving on resources. As the users in government have burgeoning needs, they are also creating greater demand for services by industry.

[3] http://bhuvan.nrsc.gov.in/bhuvan_links.php# last access on 10-09-2017

[4] https://nrsc.gov.in/sites/all/pdf/UIM%202016_Aparna_4.pdf last accessed 10-09-2017

[5] http://www.isro.gov.in/annual-report-2016-2017-english access 10 9 2017

5. OPPORTUNITIES FOR INDUSTRY SERVICES

The vision document[6] on National GIS for India observed that India will require a vastly different information regime to arm itself for the trillion-level of economy – powered by very efficient national information systems that will have to be the foundation for the governing and the governed – bringing the assessment of development needs, bridging disparity and gaps, bringing equity, transparency, inclusivity and citizen participation. Advanced information systems with technologies of metrics and measurement of disparity /needs/ plans/ implementation etc; advanced computing and data mining; special technologies of databases etc will be extremely important.

Geographic Information System is one such field that brings its great power of integration across time, space and knowledge dimensions to provide prediction and decision support in a wide range of economically and socially vital sectors. GIS is being used in many sectors in India already including agriculture, forestry and environment, urban development, telecommunications, oil & gas, security, infrastructure, land information etc. The major segments of industry are hardware, software, data and services. Leading international companies have presence in India in the hardware and software segments. A large number of Indian companies including a few Indian IT services companies operate in the services segment. The International companies based in India provide geospatial data and software development services for international organizations, primarily in North America and Western Europe[7]. Market reports of recent times[8] have indicated that the size of geospatial market in India to be about 4 billion USD with an annual growth rate in the range of 12-15%. Three fourths of this opportunity emanate from the governmental demands and services has been the major growth area.

While analyzing future scope for sustaining growth of GI industry and expansion of services, the major factor is the consistent economic growth (7-8% in past) which will trigger the growth of aspiring and consuming middle class population (547 million by 2025). India's mobile phone subscriber base had crossed one billion mark already and her smart phone imports are around 100 million a year. There will be rapid growth of urbanization placing tremendous pressure on infrastructure development. Turning to transport infrastructure alone, the total value of transport infrastructure projects, as of 31, Aug 2016, was 14 Trillion Indian rupees[9]. Some part of this market in future of will be shared by the new feature phones although. The service sector in India contributes to 66.1% of GDP. Today it is one of the sectors of Indian economy which has significant potential to grow.

In the growing economy of India, major demand for geospatial program therefore comes from services. As the focus is on information which is of value to a specific customer or a range of customers, the service industry would need access to Image data with least hassles, with widest possible choices on a global basis and with the least cost option. Service industry therefore would not care to distinguish whether the data came from national satellites or foreign satellites. Further, the developments in platform technologies like UAS permit now to obtain or generate data locally with less expense and quick turnaround. Hence space based earth observations will be compelled to share the market with others like Aerial Sensing or UAS survey to develop high quality data at lower investments and greater imaging flexibility. For this to happen still policies have to be developed and put into place.

The major drivers for services market today in India comes from E-governance programs being implemented by states and in the central government for asset mapping, inventory and monitoring, change detection and many Location Based Services. Transformation is rapid in urban and semi urban areas and there is great demand for up to date digital land record information, urban properties and land use which have implications for taxation. Infrastructure and facility management applications too are demanding rapid services. This transforming market scenario calls for large increase in demands for information in support of development and commercial services. There will be higher demands for data in the higher resolution range with minimum lead

[6] https://ncog.gov.in/documents/2015/national_gis.pdf last accessed 10-09-2017.

[7] Arup Dasgupta, Make it in India, Geospatial World https://www.geospatialworld.net/article/make-it-in-india/ accessed on 29 08 2017

[8] 'Geospatial technology here to stay', The Hindu Business line report datelined Jan 23, 2017, accessed on 13/7/2017, http://www.thehindubusinessline.com/news/national/geospatial-tech-here-to-stay/article9497917.ece

[9] Association of Geospatial Industries, Geospatial Information Adding Value to Indian Economy

time, in order to satisfy demands on services such as GIS based decision support systems, mobile multimedia, positioning and navigation services, disaster management support, rural connectivity and national security related applications. This GI information/ services needs to be delivered across various platforms of software as well diverse user devises. Security needs also would constitute an important segment. Indian Government has launched important developmental initiatives such as Digital India, Make in India, Smart City, Swatch Bharat, Housing for all, Clean Ganga, National Education Mission, Integrated Watershed Management Programme and National Skill development Mission programmes. These in turn make demands for diverse applications of space technology and GI inevitable – integrating across geographical, sectoral and temporal domains of the country.

6. CONCLUSION

In conclusion, there is emerging scenario where GI industry can play a bigger role through its interfaces with mainstream IT and mobile communication, positioning and image technologies. Opportunities are unfolding in all the market segments like Consumer services, Government, Enterprise / business. Following major fields of services hold high potential;

- Urban development applications
- Agriculture and water resources
- Land Management
- Infrastructure and utilities
- Business and enterprise level applications

What will drive the future growth of GI services are many new technology areas like cloud, new generations of analytics, IoT, Virtual Reality and mobile communication developments. More knowledge based applications like modelling, auto change detection and triggering corrective actions, assets management, work flow and business process improvement, analytics applications in forecasting, management of large complex systems, and a host of customized applications at business enterprise level. Thus, the increasing needs from government as well as markets in the setting of an economically growing resurgent India presents a unique opportunity over the next one to two decades. Policy renewals to create an environment for burgeoning growth of services and capacity building is a priority that needs urgent attention to utilize the full potentials of this opportunity

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