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ENABLING DIGITAL TRANSFORMATION

P8

CORNER OFFICE

MASSIMO CLAUDIO COMPARINI
Director Line of Business Geoinformation, Telespazio (Leonardo) & CEO, e-GEOS

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Changing the mindset!

Prof. Arup Dasgupta
Managing Editor,
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Data is the new oil, but oil is a non-renewable resource, while data is ever growing. The plethora of imaging platforms from satellites to UAVs, location data from GNSS systems and in situ data from sensors are flooding the market with more and more data. As we go through our daily routine we are spraying out geotagged data on Facebook, Instagram, Twitter, WhatsApp, emails and more. We leave a trail with online and plastic purchases. In fact, we would have drowned in data but for the advances in Cloud computing, Big Data handling and analytics, AI and deep learning.

Today, these advanced technologies are transforming the geospatial landscape. Better weather prediction, tracking the effects of Climate Change, improving agriculture through better and timely information, implementation of smart cities and more meaningful engagement with the public through location based apps. As these apps are data hungry the deluge of data is being well utilised. This is what we see on the surface. But there is a darker side.

There are many systems that prefer to remain hidden for privacy and security reasons. Health, legal, government and academia are some such systems, referred as the Deep Web. They are perfectly legal but open only to authorized users. Then there is the dark web of hackers and unethical users.

Coming closer home, what is the situation in India? As far as satellite data is concerned it is reasonably good though there are limitations at the sub-meter resolutions which are needed for Smart Cities, infrastructure, precision farming and crop insurance, to name a few. UAVs are in limbo pending the clearance of the UAV policy. A National Geospatial Policy is still hanging fire. Meanwhile users have to tackle 15 different regulations, many at cross purposes with each other. The recently announced Map Policy 2017 is a typical example. Even the Space Act remains in the discussion stage. Clearly there is torpor when it comes to critical areas.

Regulations and resistance to change are holding back the realization of the full potential of geospatial systems in governance. While there are pockets such as power distribution and land records where geospatial has made a mark, many other areas are still to adopt these methods. A strong push by the government resulted in 160 projects being identified nearly four years ago but their impact on the ground is yet to be felt.

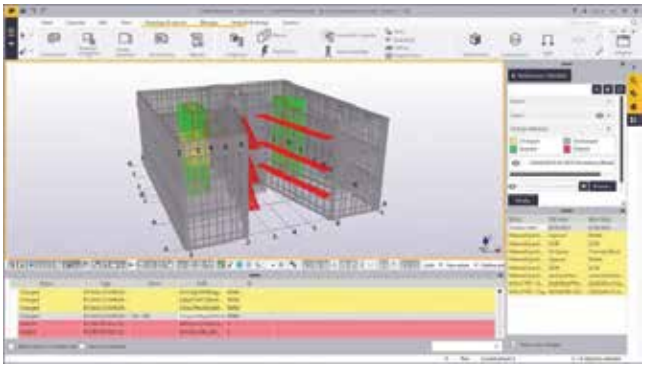
Even for demographic analytics, personal data has been harvested and willy nilly exported to companies in the UK and USA for analysis, illustrating the paucity of local talent. There is scant respect shown for such data misuse. Satellite data is restricted to bonafide Indian citizens but personal data of bonafide citizens is free for all it appears.

According to a survey by *Times of India*, the country is expected to grab 20% of the global IoT market and 32% of the Big Data market by 2025. But the picture of readiness for modern techniques is dismal. In manufacturing import seems to be the chosen path and so, presumably, will it be in other areas, especially geospatial systems. Modern methods are likely to hit the job market very hard but the vocational training facilities in India cater to just 0.8% of the workforce as against China where the percentage is 11.5. Add to this the percentage of skilled workforce at 4.7 as against 24 in China and 96 in South Korea, which leads one to wonder at those numbers predicted for 2025.

There is however, a silver lining in the form of a group of young entrepreneurs who look upon space as a commercial opportunity. These people who form NewSpace India are setting the stage for a more forward looking and enlightened approach to the commercial utilization of space, both upstream and downstream. Their efforts will, amongst others, propel geospatial systems in India to a new level.

NEW BIM SOFTWARE SOLUTIONS FROM TRIMBLE

Trimble introduced three new versions of its software for structural engineering, fabrication and construction teams — Tekla Structures 2018, Tekla Structural Designer 2018 and Tekla Tedds 2018. These solutions provide increased control and improved documentation through constructible Building Information Modeling (BIM) workflows for stakeholders in structural steel and concrete, including designers, detailers and fabricators, concrete contractors, general contractors and structural engineers. The software solutions will bring improved productivity in daily work.



KEY FEATURES

- **Tekla Structures 2018:** Brings faster 3D modeling processes, more precise detailing, better control over changes and quicker production of drawings with less effort
- **Tekla Structural Designer 2018:** Delivers new features and enhancements focused on structural design workflow productivity
- **Tekla Tedds 2018:** Introduces a variety of new calculations that enable improved productivity for civil and structural engineers

TOMTOM INTRODUCES NEW GPS DEVICE FOR TRUCK DRIVERS

TomTom has announced the launch of the new TomTom TRUCKER — a GPS navigation device specifically developed to help truckers get to their destination more efficiently. The new GPS device, which comes in two sizes, comes with a Lifetime TomTom Truck Maps subscription for the US and Canada, now updatable over Wi-Fi, as well as tailored routing which guides drivers to carefully selected points of interest (POIs) for trucks such as fuel stops and travel centers. The TomTom TRUCKER is compatible with Siri voice recognition software and Google Now — allowing truckers to access their personal assistant with their smartphone safely tucked away.

KEY FEATURES

- The GPS device includes over 1,500 travel center POIs. Ensures efficient journeys by providing customized routes for a truck's dimensions
- Traffic, both on highways and secondary roads, can be avoided with the TomTom TRUCKER, and alerts for imminent traffic ahead helps avoid sudden braking
- The GPS navigation device shows how far ahead the stopped traffic or accident blackspot points are, as well as locations where accidents are more common

DJI METRIC CAMERA FOR AERIAL SURVEYING

DJI has launched X4S camera, a lightweight version of the large aerial cameras carried in manned aircraft. An aerial mapping camera is primarily designed to have a low distortion metric lens and reliable construction to maintain its calibration. To achieve this, the camera has very few moving parts, particularly those that would affect the lens focal length. Aerial camera lenses are very high quality and virtually distortion free. Constant lens focal length means that every pixel is in the right place. 3D mapping from photogrammetry is based on the position of each pixel, and a displaced pixel will mean a loss of accuracy in the model.

KEY FEATURES

- The X4S has a leaf shutter. It opens from the centre outwards and captures every pixel at the same instant
- The X4S sensor is large, 1" enabling more data to be captured. It it creates a reliable and economical package
- Each camera is supplied with a certificate of calibration. It enable users to achieve unprecedented absolute geo-positioning accuracy

FARO RELEASES BUILDIT CONSTRUCTION

FARO has released BuildIT Construction, a comprehensive verification software solution that enables confident management of all quality assurance and quality control processes throughout the building and facility lifecycle. For the first time, construction professionals are fully empowered to continuously monitor a project with real-time comparisons against CAD designs with complete 3D data from the FARO Focus Laser Scanner. FARO BuildIT Construction, with FARO 3D laser scanning, is the first consolidated software and hardware solution designed from the ground up as an end-to-end, fully integrated Building Lifecycle Quality Assurance (QA) and Quality Control (QC) management tool.

KEY FEATURES

- Accurate comparisons to the original design files or BIM documentation, including as-built positional changes to floors, steel beams, walls, columns, windows and doors
- BuildIT Construction leverages 3D metrology capability derived from 20 years of proven expertise in delivering best in class measurement solutions to the manufacturing industry

Hexagon Geospatial: Harnessing Geospatial Intelligence to Power Smarter Cities

A robust municipal infrastructure is vital to health of a city. It provides a clean and sustainable environment and bolsters the quality of life for the citizens. The groundwork for a healthy infrastructure begins with the city's initiative to quickly and efficiently gather information from multiple sources. This is not enough, though. The data must be transparent so that businesses and citizens can benefit from it. Core city elements are all spatially interconnected. For example, a change in utilities (water, power, or telecom), can have repercussions on sanitation (solid waste management), transportation, housing, environment, public safety and security, health and education.

With such an intricately interconnected network, organizations need insight into their infrastructure. Gurgaon-headquartered Hexagon Geospatial provides solutions to fuse geographic sensor data with business information and transform knowledge and workflows into an intelligent information ecosystem. Our solutions enable cities to quickly sense, decide, and act as the city grows and changes. Hexagon's Geospatial portfolio gives total control of workflows to the city stakeholders involved in important decision-making processes. In simpler terms, we give you confidence in your decision by enabling you to transform location-based content into actionable information.

Transforming Raw Geospatial Data into Relevant Information

For years, geospatial technology has been isolated from decision-making processes. The traditional domains of remote sensing, photogrammetry, GIS and mapping were siloed as viewed primarily as support for back-end processes. The advent of the Internet of Things and increased role of location-based intelligence is changing that.

City planners and designers need sophisticated yet simple analytical tools to deal with managing the complex challenges associated with operating a smart city. By integrating real-time dynamic data from multiple sensors, Hexagon Geospatial's solutions assist cities in managing their spatially distributed assets, resources, networks, and incidents. Our simple approach entirely integrates with other city systems and helps smart cities plan, design and manage the diverse city networks.

From preparing precise master plans, to creating and monitoring land use maps and flood planning and safety models, to detailed 3D city models for evaluating new construction projects, Hexagon Geospatial's Producer Suite empowers you to collect, process, analyze and understand raw geospatial data, and ultimately deliver usable information. The Platform Suite delivers information through a web, mobile, or smart solution. It allows building and extending customized geospatial apps and solutions with a sophisticated set of developer-focused technologies. Provider Suite gives you the power to organize all geospatial and business data into one centralized library, and deliver it to others easily. The tool's powerful compression technology optimizes disk space requirements and ultimately reduces the total cost of ownership.

With a knowledgeable and qualified partner network, Hexagon Geospatial has all the tools and platforms that can revolutionize the way geographic sensor data is utilized to make smart decisions for enhanced livability, workability and sustainability.

NewSpace is about democratization of geoinformation

The quantity of data available today is humongous. In order to get good services, we need to invest in new algorithms that can manage such quantity of data in real time, believes **Massimo Claudio Comparini, Director Line of Business GeoInformation, Telespazio (Leonardo) and CEO, e-GEOS**

e-GEOS has a long-standing experience and legacy in the geospatial business, what are your core offerings?

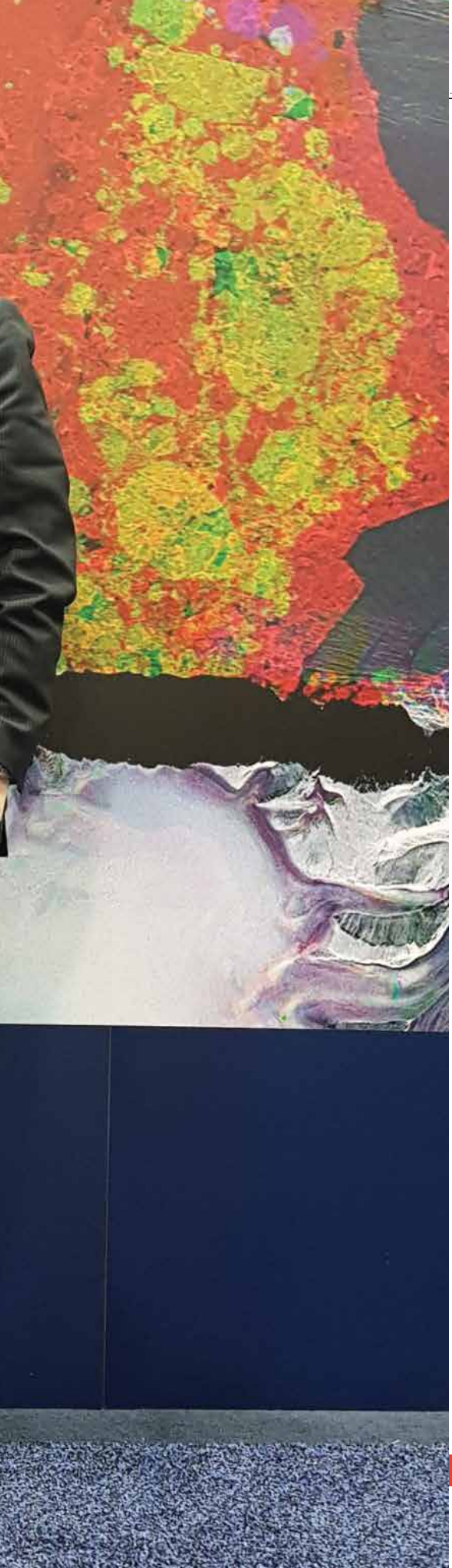
e-GEOS, a joint venture between Telespazio and the Italian Space Agency, is a global hub for geoiniformation data, application, service, information products and near real time reports based on earth observation information and IoT (non-earth observation) data. The company is the global distributor of COSMO-SkyMed (the largest Syntethic Aperture Radar systems today available with a constellation of four satellites) and we can grant access to the most of the commercial satellite operators, thanks to a global partnership with DigitalGlobe, IRS, DEIMOS, ALOS and the others.

From last year, more emphasis has been given on the evolution of application platforms for all the verticals — defense and intelligence, agriculture, emergency and risk management, asset and infrastructure monitoring and management, etc. — towards information products and solutions integrating the power of data analytics.

The #RapidMappingTeam is also our key strength. With the help of the team, the company is able to support emergency authorities in case of hazards like floods, earthquakes, volcano eruptions, etc., delivering detailed damage assessment maps within few hours from the first activation. The largest customer of this service is the European Commission's COMPERNICUS EMS rapid mapping service. The h24 team, together with our EU partners, has been involved in more than 100 activations all over the world. e-GEOS is able to map everything on the globe in the shortest time possible — from the number of cars in parking lots in urban areas to the damaged buildings in a remote area.

What are your immediate priorities for e-GEOS?

The company's mission is to promote the adoption of radar data, combined and fused with all other EO data sensors, as live data for monitoring. There is a lot of potential in the geoinformation market and hence efforts are being made to fully exploit it. e-GEOS is in the middle of a transformation like all other earth observation companies. We are moving from a one-to-one request to a platform SaaS business model. The main objective is to allow right access to the information in the shortest time possible.



The real change is coming from non- EO customers like the new start-ups purely dedicated to data analytics. We are considering radar data and EO reports as live ingredients of the new dashboard, dedicated both to the decision makers and infield operators. The Defense market is also definitively opening to the support coming from trusted companies. Our pathfinder in this respect is European Union Satellite Center (SatCen) and we target to cooperate in the world to share this experience with other institutional centers in order to bring the value of our COSMO-SkyMed Data and of our dedicated platforms like SEonSE and BraInt.

There is an ongoing debate about whether smaller satellites can meet mission needs. What are your views?

The large number of new constellations based on micro/mini-satellites seems to be the challenge of the NewSpace industry during these years. This will represent an important asset to deliver fresh information flow. I think those new systems will be an important complement to the high-end, high-performance sensors, not at all a possible replacement.

e-GEOS is managing the largest radar constellation of four big class1 satellites. We now know perfectly how this class of sensors is fundamental to deliver high-resolution and very high-quality data. Today small satellites with medium resolution are changing the monitoring market paradigm, hence giving companies like us, the opportunity to have daily or even better revisit time. This fantastic quantity of data is opening new scenarios but need also to reflect on the real costs of the solutions. We are investing on AI and Cloud system to rethink all the algorithms to deal with such amount of data and at the same time we are interrogating ourselves on the revolution in the business approach that is required to serve customers with the best results at the right cost and price.

Our Matera Space Centre, one of the most important EO data hub in the world, is ready for this mission and the company is investing in new antennas to be able to gather data along the Mediterranean region.

> The real change is coming from the non-EO customers like the new start-ups dedicated to data analytics. We are considering radar data and EO reports as live ingredients of the new dashboard, dedicated both to the decision makers and infield operators

How e-GEOS is emerging out as an important contributor in space technology?

Each of us is a game changer and a key player in this deep and fast transformation. We have been in the market since the early '80s (as Telespazio). This experience gives us the opportunity to work with the medium-resolution with a long-standing experience that is not common today. We have a perfect mix of young engineers who know the new technologies, and senior data experts who are able to read the data and teach machines with their human knowledge.

More people and organizations are participating in the space industry. Do you think we are on the verge of a NewSpace race where the players, technology and services are as diverse as it is innovative?

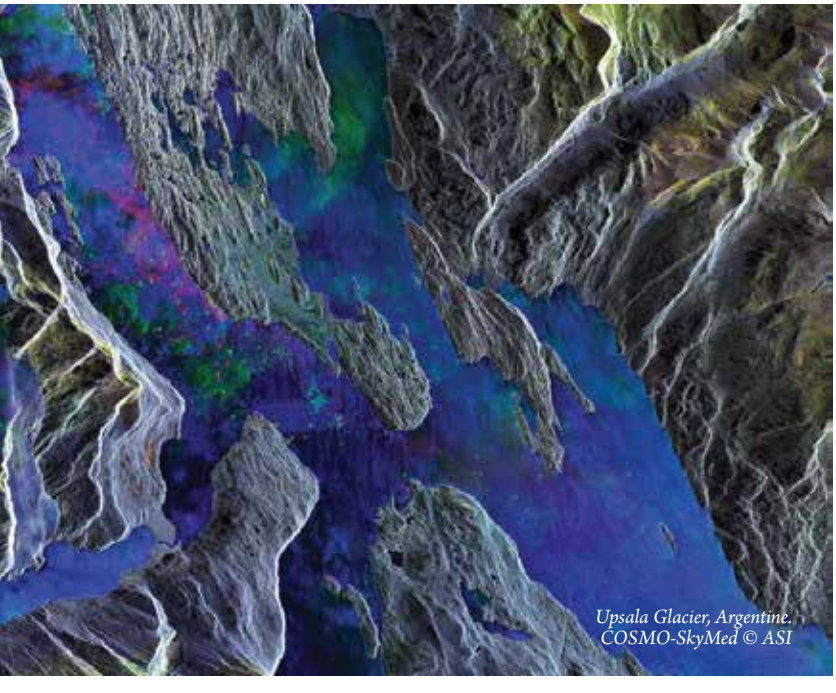
We are part of the so-called space alliance between Leonardo and Thales, and with their joint ventures Telespazio and Thales Alenia Space, we cover all the value chain of space systems. A breeze of novelties in each of the single step of the chain is required to speed up the traditional science to this new era of the space market. We observe a sort of democratization of the geoinformation domain in the up-stream and in the downstream part. It started with Google Earth some years ago, was boosted by Amazon AWS and today we are part of this wide and growing market

Today small satellites with medium resolution are changing the monitoring market paradigm, hence giving companies like e-GEOS, the opportunity to have daily or even better revisit time. They are a perfect complement to high performance, state-of-the-art large EO satellites

together with the main software vendors, GIS players, data and solution providers. The big IT/ ADV companies are investing in space and we are benefiting out of it.

Do you think cheaper launches, better communication services, easy dissemination of information and new technologies like artificial intelligence have made data cheaper and more accessible?

The combination of all those elements is really a revolution in the space sector. Global SatCom connectivity combining HTS and LEO/MEO constellations, global Earth monitoring, location-based services and location analytics, and the combination of all this is pushing a real democratization of space. The quantity of data available today is humongous, EO data latency will collapse. A continuous stream of information will be generated, a new generation of services is conceived now and it will be available for a better life on Earth. To catch this challenge we need to invest in new algorithms that can manage such quantity of data in real time and to derive information flow for a broad range of user communities. We are hugely investing more in algorithms, learning techniques, automatic processing and in a complete and wide dataset.



Upsala Glacier, Argentine. COSMO-SkyMed © ASI

The merger between MDA and DigitalGlobe was unique in a way it brought all diverse sections of the satellite industry — manufacturing and servicing, communications, earth observation and data analysis — under one single umbrella. Do you see further such consolidation in the satellite industry?

This trend has been there in Europe since years. The European commercial space sector sees integrated players like the Space Alliance, between Leonardo and Thales, and Airbus as the key global actors. The Space Alliance with its joint Ventures Thales Alenia Space and Telespazio, covers the entire value chain of space systems from technologies and manufacturing to space systems operations and global services delivery in all domains SatCom, EO, Satellite Navigation and positioning. In this picture e-GEOS (the joint venture between Telespazio and the Italian Space Agency) covers the complete downstream earth observation domain. The Maxar merger represents just another step in this integration path and verticalization process.

You are chairman of the space innovation technology platform in Italy, national expert in the space configuration of the European Horizon 2020 program while leading e-GEOS as the chief executive. How do you manage so many roles simultaneously?

Space has been a passion since my first year in university. My long run in the space sector, for many years in what is today Thales Alenia Space and now in Telespazio and e-GEOS, both in technology and service and operations helped me to get a complete perspective of the industry. The vision of our industry must be highly innovative and we must be able to connect short and long-term R&D strategies with business development.

My leadership is energetic and strategic oriented. I am a good listener and open to suggestions, respectful of hierarchy in the organization but I always speak my mind out, openly and sincerely. Even though I am tough with my team members, they know I am there to guide them whenever needed. One thing which is imperative is to work hard.

My main aim in business is to build partnerships, execute with perfection to deliver, network to gather best ideas in action.

Personally, I love to enjoy life to the fullest, visit good places, have quality time with friends, love to read interesting books, sometimes I try my hands in cooking and love to pen down my thoughts about good wines as well.

EYES ON THE EARTH

e-GEOS is a leading international player in the Earth Observation and Geo-Spatial Information business.

e-GEOS is the global distributor for the COSMO-SkyMed data, the largest and most advanced Radar Satellite Constellation available today.

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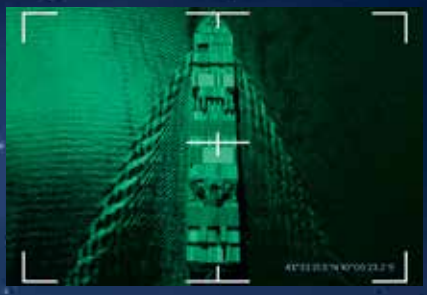

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BLOCKCHAIN amplifies location based advertising

The new technology effectively addresses security drawbacks in centralized content hosting. It makes storing information and value on the network safer than ever.

By Shilpi Chakravarty

While Location Intelligence is being used by various companies to boost their business by innovative measures, it is an integral component of location-based advertising (LBA). In the past few years Location Intelligence has been actively used to provide accurate offline attribution mechanism for digital campaigns.

Many companies these days indulge in providing discounts or coupons on various products as part of advertising gimmick based on the location of customers. While the customers can be easily be misled by these advertisements, there is an equal pressure on businesses to optimize these discounts so that money isn't lost when customers redeem them.

So then what is the solution? Blockchain can be a major help for some of the problems that LBA entails. Before we discuss on the topic further, let us look at what is LBA and Blockchain in nutshell.

What is LBA?

Imagine you are passing by a mall and you get a message of 40% off on H&M clothes. The probability of you visiting the store becomes much higher than you being at home or some other place. Thanks to location, advertising at the right place and moment is possible now. All this is done while you share your location with the apps in your mobiles.

With the increasing use of smart devices, especially smartphones, location-based advertising (LBA) has gained momentum and popularity amongst marketers in leaps and bounds.

It has opened doors to a vast array of opportunities for advertisers to personalize their messages to people based on their current location in real time. Using a person's location data, obtained from their mobile device, advertisers can send different messages to people depending on where they are.

What is Blockchain?

The Chain in Blockchain is the chain of transactions in the form of ledger entries about assets which could be money, imagery, data, maps, documents, etc. In reality what is actually transacted are tokens containing the metadata of the assets. The actual physical transfer happens separately. Block refers to the grouping of transactions related to each other. A way of looking at a Blockchain is to consider it as a ledger where all transactions are entered. This technology can be used in various applications.

How can Blockchain help LBA?

Due to Blockchain's unique infrastructure, the technology can effectively address security drawbacks in centralized content hosting. It makes storing information and value on the network safer than ever.

The technology uses cryptocurrency as a medium of exchange for whatever is being transferred between the network's users, like space on a Cloud storage platform, bandwidth on a decentralized VPN service, or digitized money in solutions like Bitcoin or Ethereum. Middlemen have no place on Blockchain as there are no gates between users and content providers where fees or tolls can be installed.

Cryptocurrency acts as a type of monetary reward but can be customized to incentivize stake-

How is LBA Effective?

Location is all pervasive and this element has found new home in marketing as brands tighten their targeting on in-store shoppers. With the increasing popularity of smartphones and continuous advancement in location technology and GPS-enabled apps, brands can now send real-time, relevant ads to shoppers about to buy.

Tapping the right audience

- Hyper-targeted offers are delivered to the users' phones in store as they walk past displays.
- Marketers can better understand behavior by analyzing real-time location specific data
- Firms can provide consumers with product/service information and recommendations in real-time, based on location

Blockchain can offer merchants access to irrefutable data that can optimize their efforts. Because of the way the technology is built — with transactions being recorded in an immutable and open ledger — user data remains protected.

WHEN TO USE BLOCKCHAIN?

A multi organizational network that needs to work without intermediation, where the members do not know each other sufficiently to be able to assign trust a priori and yet the network requires openness and is not performance driven, then it would be an ideal candidate for Blockchain implementation.

APPLICATIONS OF BLOCKCHAIN

Despite of the use of Bitcoin, Blockchain users have grown exponentially

holders only for the activities that benefit others in the ecosystem. Location-based advertising is a pertinent application for this technology because it can better align the interests of those being targeted and those doing the targeting, nurturing a mutually beneficial connection between them. Innovative companies are pursuing this concept with enthusiasm.

A win-win situation — rewards through tokenization

One thing which can largely be beneficial is companies tokenizing their services. Businesses reward people in their local area who complete tasks that inherently create value, like posting on social media, writing a brief review and so forth. LBA platform tokens can be spent at these retailers like cash, with more freedom than a mere coupon. Those consumers who work hard to contribute, participate and spend their tokens frequently are tracked by the immutable ledger and given a score which allows them to borrow more tokens to use in their favorite stores.

Now merchants don't have to breakeven to win loyal business, and can get tangible advertising results in exchange for a small discount. However, Blockchain can offer merchants access to irrefutable data that can optimize their efforts. Because of the way the technology is built — with transactions being recorded in an immutable and open ledger — user data remains protected. It also offers businesses the ability to fully trust their results as there is no middleman or filter distorting the view. This gives merchants the ability to better fine tune their promotions, and offer more relevant deals to customers based on transparent data.

What does it lead to?

By tokenizing services we can see more transparency in location-based advertising. It also provides better reach for local businesses and offers customers a better deal in exchange. With a steady increase in smart phones, mobile devices have the capability to be a portal to the best local experiences. Thus, Blockchain is paving a smooth way where local customers can quickly find the local establishments most enthusiastically chasing after their business.

Shilpi Chakravarty, Assistant Editor
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HOUSTON, WE HAVE A PROBLEM!

Even though heavy infrastructure push from the government has opened up great opportunities for the geospatial industry in India, the country can't optimally leverage the benefits of this cutting-edge technology unless there is a studied, concentrated effort to collaborate — and naot compete — open up data and stop obsessing about policies. **By Anusuya Datta**

In 2012-13, the India government's annual Economic Survey had called for "careful mapping, assigning of conclusive titles to facilitate land leasing, and creating a fair but speedy process of land acquisition for public purposes." Earlier, McKinsey Global Institute's report had highlighted that land market distortions in India lead to 1.3% loss in GDP annually. This amounts to $34.45 billion each year at current values (Indian GDP is currently valued at $2.65 trillion). In other words, effective use of geospatial and digital technologies in India's land records management has the potential to unlock $34.45 billion. This is almost equal to the FDI equity inflows into the country between April and December 2017, making India one of top foreign investment destinations in the world.

That was then. And even though we have extrapolated the old Mckinsey estimates on current GDP (in the absence of any recent estimates), it would be safe to assume that with the massive infrastructure development works happening all over the country, the figure would have gone up by several times. And before we proceed, let's get this clear — this is *only* the amount lost because of land market distortions. Now, if we add other sectors, and various stages of infrastructure development, the final figure could be mind-boggling. So, let's not even get there.

Let's look at something else. India is among the key engines of global economic growth and progress on development goals. It is the world's seventh-largest economy, growing second fastest among large economies after China, and is projected to be the world's second-largest economy (behind China again) by 2050. However, the Indian geospatial sector ecosystem, despite its long history of survey agencies and globally visible accomplishments in Space and ICT domains, stands "below-par" and "under delivering to national growth and development objectives", as per the *Countries Geospatial Readiness Index* (CGRI) 2018 brought out by Geospatial Media & Communications.

India ranks 26th among 50 nations covered in the CGRI 2018, and as a major economy fares much poor compared to other emerging nation economies — including China (Rank 6) — which are key to shaping the future of global economy and development *(See on Page 18)*.

"Geospatial data plays a vital role in the decision-making process across a range of industries. Therefore, accessing, sharing and using the geospatial data forms the essence of the geospatial infrastructure," says **Sujeet Kumar, Vice President & Head Asia Pacific – Utilities & Geospatial, Cyient.** If a country doesn't hold a framework, naturally the growth of the geospatial industry will suffer, eventually hurting national interests.

India has for long been using remote sensing and GIS and other geospatial technologies for planning and development. However, the renewed focus on big-ticket infrastructure projects brings the focus back on updated maps and spatial technologies. In every major national program, including Digital India, Smart Cities, transportation and highway development, river linking, industrial corridors, smart power, and agriculture, geospatial technologies are poised to play a critical role. Acknowledging the fact that infrastructure is the growth driver of any economy, Union Budget 2018 made an all-time highest allocation of INR 5,970 billion ($91.7 billion) for infrastructure spending in the country.

That is not all. As with other countries, digitization presents India with a rare opportunity to make swift economic progress all across. There is a vision for speeding up the digital revolution and accelerate this transformation to yield up to $1 trillion of economic value by 2025, benefitting 55-60 million workers.

New-age technologies like IoT, Artificial intelligence, Cloud, Wireless & Broadband and Big Data are empowering the assimilation of spatial information into existing business processes. Analyzing data using a geographic information system is becoming a critical core strategy for successful decision making in an increasingly competitive global economy, highlights **Atanu Sinha, Director, India and SAARC, Hexagon Geospatial.** "This trend is being driven by many factors, like reduced technology costs, free mobile apps, social media platforms, Cloud computing and effective ways of managing high volumes of data."

Geospatial data usage in India is supported to a large extent by initiatives set out by the central government through its ministries and various departments, especially in 160+ projects, wherein the departments concerned have been asked to closely work with Indian Space Research Organisation (ISRO) and its data center National Remote Sensing Centre (NRSC). These initiatives, along with states and local level initiatives, have the potential to transform the very future of India.

In this background, "an enabling geospatial content policy will act as a catalyst in embedding geographic information into various government processes and building powerful decision support systems — the foundation for achievement of the goals of the Digital India Program", feels **Agendra Kumar, President, Esri India.**

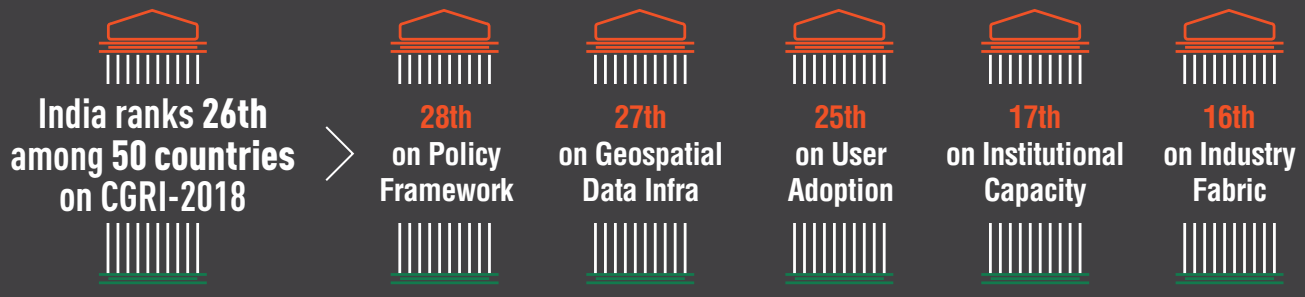
So what are the hindrances?

While base data availability has improved in growth markets, the real challenge still lies in **generating a reliable base data** that is up-to-date and contextual. "This is imperative for development and growth in these regions," hammers out **Anup Jindal, CEO and Joint Managing Director, RMSI.**

A case in point is the United States where base data is maintained centrally by the government and updated regularly. The information related to monsoon, acreage etc. is regularly shared with farmers and private sector. Similarly, in India, the private geospatial players are consumers to a lot of information/data generated by the government. There is a pressing need for all of this data to be unlocked and made accessible to the private sector, as this data forms the core for their innovation.

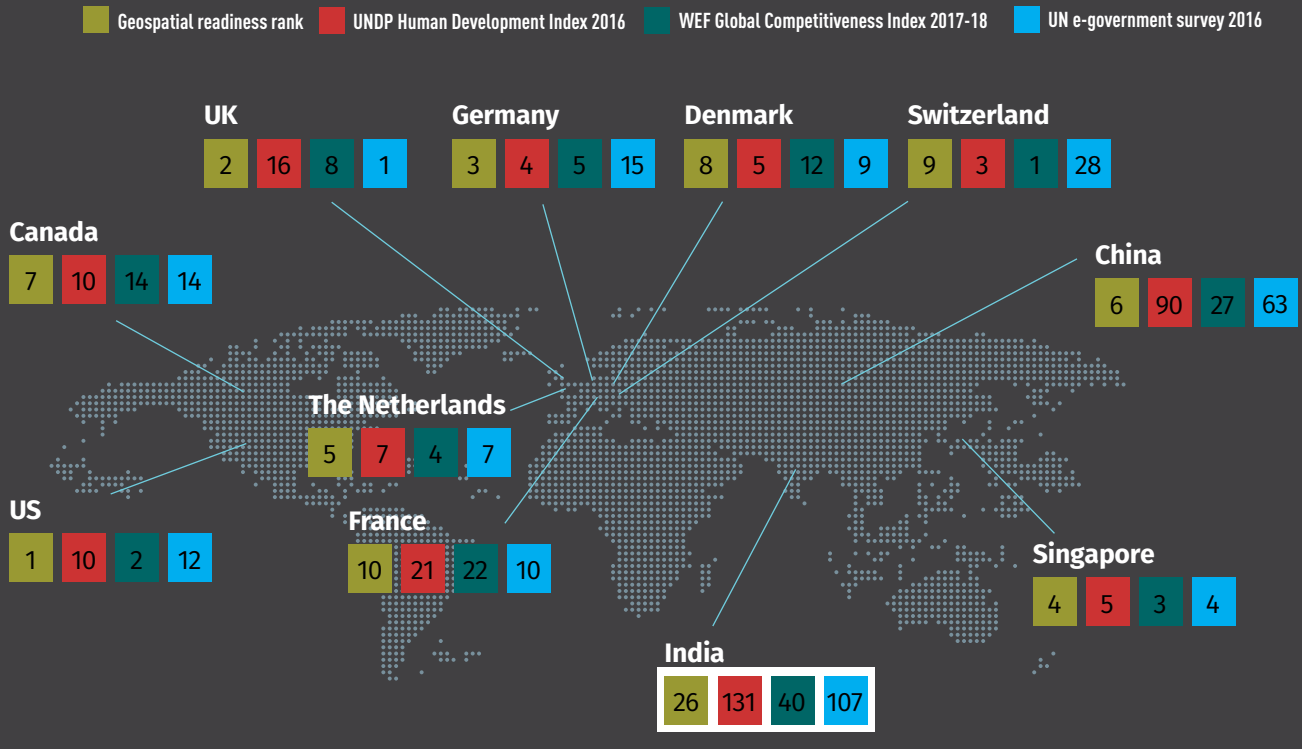
The absence of a comprehensive policy on the use of geospatial data and technologies had been the biggest contention for the country, more so with a number of old obsolete policies — restrictive and overrun by security concerns — hindering the efforts. Consider this — there are a total of 15 national-level policies and rules, with four in draft stage, dealing with geospatial data, under as many as six ministries/departments!

Any important industry needs government support initially in the form of a



INDIA'S RANK ON VARIOUS PILLARS

A glance at the CGRI-2018 finds close correlation between the leaders and those ranking high on UNDP's Human Development Index.



**UNDP's HDI index ranks 188 countries. UN e-Government Survey is among 193 countries. GMC's CGRI is an index of 50 countries selected on the basis of their GDP, population and geographical spread.*

relatively straightforward and supportive policy framework to encourage innovation in the industry from start-ups and big companies alike, spells out **Rajan Aiyer, Managing Director (SAARC), Trimble Navigation.** "These policies should foster easier data acquisition, data management, data processing and analytics. India definitely needs a simplified, practical, innovation-friendly geospatial policy framework to be constantly monitored by a nodal set of agencies that can modify to suit the current needs of the industry," he adds.

"The biggest role that the government can play is in the implementation of a National GI Policy. Over the years, various aspects and components of GI policy frameworks have been put forward with a piecemeal approach. We have come across national policies of Remote Sensing, Maps, Data Sharing Principles, Security Classification … that too are dated now. It is time to examine these silos and harmonize these discrete policy elements into a comprehensive framework," adds Jindal.

In 2012, National Institute of Advanced Studies, IISc, Bangalore was given the first charter to release a draft geospatial policy. Since then, the country is striving to put forth a comprehensive policy and to date, only a draft version of the National Geospatial Policy (NGP) is in place. Even though **Dr Bhoop Singh, Head of NRDMS, Department of Science and Technology,** is optimistic of the NGP — which is currently being examined by various departments — taking shape within the next four

to five months, it is easily quite some time before it sees the light of the day.

"To facilitate wider and faster adoption of geospatial technologies it is necessary to revisit these policies and evolve a unified geodata policy which will satisfy development and civilian applications while at the same time address the national security concerns," **Abhay Kimmatkar, Joint Managing Director, Ceinsys,** rightly points out.

Realistically speaking, it may not be possible to bring all the geospatial-related policies under only one umbrella. Even the National Geospatial Policy draft doesn't strike out any of the existing policies but is in "harmonization of these existing policies". However, they can surely be amalgamated into a maximum of two-three policies for ease of implementation. Further, taking lessons from the developed countries, there is also an urgent need for one ministry/department to be nominated as the nodal ministry and all other ministries should legislate/make rules after referring/seeking approval of the nodal ministry.

Another issue is **each organization generating data also wants to regulate it**. The result is a plethora of policies working at cross purposes. A typical example is the Remote Sensing Data Policy and New Map Policy, the former dealing with satellite data from ISRO, while the latter deals with maps produced by Survey of India — two critical data-generating organizations that rarely interact.

Additionally, there are **no clear-cut guidelines on data sharing**. So, when a department creates any data for its own use, despite the existence of the National Data Sharing and Accessibility Policy 2012, most of that lie in silos, because of the absence of one single platform, which can then be used by another department to put that data into, and which can further contribute in enriching this dataset.

Acquisition of land and marine data, for example, is a cumbersome process involving huge cost overheads and investments, points out **Raj Alla, Chairman & Managing Director, IIC Technologies.** "The cost of survey equipment and platforms like survey-boats and aircraft are still at the higher end. Utilization of such high-cost equipment and platforms remain sub-optimal owing to large wait-times between approval and clearances from the competent authorities to the actual conduct of surveys. This naturally adds to cost and time overheads. In some cases, although, easy-to-use survey options are available, for instance UAVs and drones, their deployment for land and coastal surveys are subject to government policies and security clearances."

"Forget about cross-department data sharing. Many a times departments/organizations don't know what they themselves possess," says an irate source in the government. He gives the example of how the Ministry of Urban Development (MoUD), which had already initiated the 1:2,000-scale mapping for some cities under the National Urban Information System (NUIS) in 2006, approached Survey of India again recently to create the same data for another project.

In developed nations, there is a regulation under the free data sharing policy that mandates all government departments and public organizations to publish their datasets to a centralized authority, ensuring seamless access to standardized datasets. Likewise, it will help to have a national consortium for geospatial data in India with a charter to organize and maintain uniform, standardized seamless spatial data, which will also ensure that the database provides access of the same set of data to every stakeholder, feels the industry.

Multiple agencies generating independent datasets without a common guideline are leading to problems of **data quality, authenticity, interoperability and convergence**. Often, no two datasets sit on each other. So, who will check and clear the quality and authenticity of data that is generated? The need for an independent agency to ensure the accuracy, standards and quality is felt more now than ever with the growth and reach of technology. A centralized agency on the lines of National Accreditation Bureau for Laboratories of Department of Science and Technology could be the answer, a mechanism which has worked well in other areas such as education.

Absence of a single window clearance delays projects. This again is majorly owing to the varied number of the departments controlling permission, and the knee-jerk tendency in the Indian government corridors

GEOSPATIAL RELATED NATIONAL LEVEL POLICIES

Ministry of Defense

1 Restriction of Sale, Publication and Distribution of Maps 2017
2 Policy on Digital Data of Topographic Maps 1967
3 Policy of Aerial Photographic Survey Aircraft Borne Remote sensing 2006

Department of revenue, Ministry of Finance

4 Rules Prohibiting Export of all Maps of 1:250K and Larger Scales 2005
5 Courier Imports and Exports (Clearance) Amendment Regulations 2010

Ministry of Science & Technology

6 National Map Policy 2005
7 National Data Sharing and Accessibility Policy 2012
8 National Geospatial Policy (Draft) 2016

Department of Space

9 Remote Sensing Data Policy 2011
10 Space Activities Bill (Draft) 2017

Ministry of Home Affairs

11 The Criminal Law Amendments Act 1961, Act No. 23
12 Geospatial Information Regulations Bill (Draft) 2016

DGCA, Ministry of Civil Aviation

13 Civil Aviation Requirement 2012,
14 Operations of UAVs-Air Transportation Circular 328 2016
15 Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS) (Draft) 2017

to be restrictive the moment geospatial data is mentioned. Involvement of so many different departments make decision-making slow, and by the time the clearances are issued, changes in landscape are observed and the imagery data many a times loses relevance, adversely affecting project implementation, points out **Manosi Lahiri, Founder, ML Infomap**.

A solution to this issue can be provided by Survey of India by providing certified boundaries of India to the industry, instead of it playing a policing role of checking and certifying privately created maps — a process that takes several months.

The **L1 process for tendering** (lowest of the bids bags the contract) followed in most government departments is another major concern. **Technical understanding of the scope of work and ownership of implementation** from the government stakeholders is very poor, adds Sujeet Kumar. This results in awarding of contracts to companies bidding unrealistically low, leading to shoddy work and failure of many projects. "Also, unrealistic project timelines, lack of support and lack of vision for utilizing the output in day-to-day governance and scope creep in due to change in priorities."

Additional challenge is that in India , which is a price sensitive economy, organizations typically tend to look at the initial cost of capital investment only versus the total cost of ownership of the project.

"In some sectors such as transportation and logistics, there are quite a few fly-by-night operators who over-promise and under-deliver leaving a bad customer experience and therefore disbelief in the geospatial technologies," says Aiyer.

The other major challenges include lack of exposure to benchmark cases, inadequate capacities to design procurement guidelines and high cost of procurement, implementation and maintenance.

More so, none of the existing policies focus on start-up entrepreneurship promotion programs such as incubators, investment funds, accelerator programs, support structures for market and data access, industry partnerships, center of excellences from use-case perspectives etc. All geospatial agencies in developed economies have such programs in place. Also there is a big need to focus on professional certifications, skill development to address the demand-supply skill gap.

India spends approx INR 50 billion on various spatial data generating organizations/programs in the country, including EO and other application areas. Not even 10% of that goes for Survey of India

Unshackle Survey of India

The biggest issue of all is that Survey of India, has consistently failed to upgrade its maps, which are dated and available at 1:50,000 scale. This, despite it announcing plans for mapping the country at 1:10,000 scale as one of its primary focus areas back in 2012.

Today, digital maps at 1:50,000 scale are available from SoI, but not on the NSDI portal. While old paper route was the only way to place orders for digital data till 2016, it was only last year SoI launched its digital platform — Nakshe Portal — where it has made the provision of Open Series Maps at 1:50,000 free for download. However, the maps are available only in PDF format. One can always convert the pdf map into a GIS-usable map by using on-screen digitization, but that will result in hundreds of 'digital' maps of the same mapsheet, which was sought to be avoided with the National Map Policy 2005 that promised digital OSM maps.

Further, most of the maps are dated and useless except for the authoritative coastline, National waters, EEZ boundary, international borders, district and taluka boundaries and standardized place-names. Natural and manmade features are better depicted in remotely sensed imagery from satellites and aircraft and are therefore up to date. Merging such data with the artefacts mentioned above can easily be done by the users on a GIS. All SoI therefore needs to do is to just issue maps in digital form with these artefacts.

To be fair, it is not that Survey of India doesn't have its own share of problems. It has an existing staff strength of only about 4,000

as against the sanctioned 11,000. To add to its woes, in the absence of regular infusion of new blood over the years, most of the staff are aged and generally resistant to try out new technologies. "The agency is going through the same phase that say nationalized banks went through when computers were introduced. It needs a complete mindset change. Look at how Ordnance Survey phased out the old crop and overhauled the entire organization to emerge as one of the most competent survey organizations in the world today," points out a source.

A major issue for the national mapping agency has been its lack of autonomy. It is housed in the Department of Science and Technology, whose mandate is simply to "provide central direction, leadership and coordination of scientific and technological efforts and ensure that the results therefrom are geared and utilized in areas of maximum economic and social benefits for the people". Survey of India is the only organization in this department whose mandate is delivery. Naturally, there is a huge gap in mindset. Further, over the years, too many officials in DST have meddled in SoI's affairs. For instance, when the NSDI was set up back in 2006, there was no reason why it was not put under SoI, and DST had to launch a separate setup to manage that. "Our national mapping agency is still a subordinate office of the Government of India even after 250 years of its existence," **Dr Swarna Subba Rao, then Surveyor General of India,** had publicly lamented last year.

In contrast, Department of Space (which houses ISRO) is an independent department directly reporting to the Prime Minister's Office. Similarly, IT has for years been an independent department. In fact, to empower it further, in 2016 the government further carved out a separate Ministry of Electronics and Information Technology (MeitY) Communications and Information Technology.

Even when one looks at the budget, SoI's budget at about INR 4 billion is about one-third of that of Geological Survey of India's INR 11 billion. What makes it worse is that about 85% of this INR 4 billion goes into paying salaries. A simple back of the envelope calculation reveals that Indian government spends about INR 50 billion combined on various spatial data generating organizations, including earth observation and other application areas. Not even 10% of that goes for the premier national mapping agency!

In the absence of concentrated focus and recognition, Survey of India today is a sad shadow of its glorious past. "Everybody knows this harsh reality, but no one accepts. Nor the Minister, neither its Secretary or anybody of that level. And they continue to do so, and the whole ecosystem is suffering. They should have enabled SoI long back," says the source.

With so much of backlog and very little field to play, SoI should change its mindset about starting things from scratch. For quick delivery, it should look at outsourcing its mapping work to industry players on a PPP model, which it has already initiated as part of some of the commendable projects — mapping the entire Indian coastline under the Integrated Coastline Zone Management, National Hydrology Project, or its active involvement in the Smart Cities and AMRUT projects. It can even mull giving away state-wise mapping to companies, and let them create the maps, and sell them for a royalty to government users in those states. These companies can also work as quasi authorities under the supervision of SoI as a state actor and help in ensuring data is created where it is most needed.

"The government should get rid of this fear that data will go into wrong hands if private industry is involved. There are many Indian companies who are working for so many sensitive projects for countries like US, UK etc. sitting here in India, so why can't they do the same for Indian government?" asks an industry person requesting anonymity.

Further, what government agencies forget is people are always looking for easily accessible data, and they should work with this one goal of making data accessibility — and not data creation — their highest priority. "Your data should be so easily accessible that when a user does Google Search, it should be among the first ones to come up. That is where the world is moving," he adds.

SoI could instead concentrate all its energies on quickly creating a geodetic network of control points which are needed for precise location and research in tectonics. A PAN-India Continuously Operating Reference Station network will require

THE MISSING LINKS

- **Policy Framework**
  - Integrated National Geospatial Policy
  - National level geospatial sector coordination mechanism to enable integrated programs/strategy/guidelines
  - Reference state geospatial policy and nodal implementation mechanisms i.e. department/division
  - Ecosystem development for geospatial industry, startup entrepreneurship and Innovation, R&D promotion
  - National guidelines on data sharing and standards
- **User Adoption**
  - Industry partnered geospatial technology use mandates in mission-mode programs
  - Industry partnered Centre of Excellence in key mission areas like railways, smart city solutions.
  - Incentive-reward programs
  - Benchmarking reference examples
- **Institutional Capacity**
  - GIS skill development: GIS certificate courses, optional courses available in every engineering college, undergraduate and postgraduate education institute for interdisciplinary development
  - National Geospatial Education Policy
- **Geospatial Data Infrastructure**
  - Base maps
  - Modern geodetic references.
  - Modern and precision Ground positioning infrastructure i.e. CORS network
- **Industry Fabric**
  - Startup accelerator, incubation programs, innovation challenges
  - National, regional or functional awards programs with industry-institute participation
  - Geospatial equity investment/ debt funds
  - MSME/Innovation cluster programs

WHO IS DOING WHAT

Department of Science and Technology (DST)
- → Formulation of science and technology policies
- → Entrepreneurship and innovation promotion
- → Survey of India*
- → National Atlas & Thematic Mapping Organization (NATMO)
- → National Spatial Data Infrastructure and promotion of GIS

***Survey of India (SoI)**
- → Geodetic control, surveys
- → Topographical control, surveys and mapping
- → Tide Tables

Geological Survey of India
- → Geoscientific information and mineral resource assessment
- → Multi-disciplinary, glaciology, seismotectonic studies and fundamental research

Forest Survey of India
- → Spatial database on forest resources
- → Research on applied forest survey techniques
- → Assessment of forest cover & change monitoring

National Remote Sensing Centre
- → Providing Earth Observation (EO) Data
- → Develop technologies & applications for Natural Resources Management
- → Support for disaster monitoring & management
- → Capacity building for utilization of EO data

DEITY-NIC
- → ICT Infrastructure
- → Implementation of e-Governance Projects
- → Framework products and services
- → Consultancy to the government departments
- → Research and development
- → Capacity building

State DoIT&C
- → State IT Policy
- → NeGP projects in the State
- → Standardization and Security Aspects
- → Capacity Building
- → End-to-end service delivery of (G2C) (B2C) and (G2G) services

around 550-600 CORS towers, which costs approximately INR 3,300 million at 1:10,000 scale.

Here too, there is a spoiler. While SoI invited an expression of interest from concerned parties in 2016 for launching a pilot project for CORS, it is still awaiting government nod. "Even Pakistan has implemented CORS and we have been chasing the government to use this technology for years now, but to no effect," Dr Subba Rao had pointed out last year.

Too many cooks spoil the broth

DST is hard-selling the National Geospatial Policy as a single policy that would synergize various departments towards ensuring quality, accuracy, interoperability and commonality. It will not. NGP doesn't address any of the restrictive measures that are part of the old data policies, including National Map Policy 2005 and Remote Sensing Data Policy 2011.

Also, before we get gung ho about a new policy, let us remember this is not the first time we are talking about this issue. The demand for clearer data-sharing mechanisms to ensure quality and availability has been there for some time and there have been multiple attempts to address the issues.

The National Spatial Data Infrastructure was mooted in 2000 and launched in 2006 under DST. The project envisioned a national infrastructure for the availability and access to organized spatial data and use of the infrastructure at all levels for sustained economic growth. Today, 16 years later, NSDI is a toothless body which has not achieved much, not even managed to get complete metadata in one place. Since departments were not mandated to share data, some did, many didn't.

Even as the NSDI was struggling to take off, in 2013 the government did what India is famous for — forget the existing arrangement and propose a brand new one! It proposed a new National GIS (NGIS) project. The NGIS was pushed through the Planning Commission and was considered to be a pet project of Sam Pitroda, the then Adviser to the Prime Minister on Information Technology, and was sanctioned INR 30 billion (approx $461 million) under the XII Five Year Plan 2012-17. There were even plans to establish a separate Indian National GIS Organization committed to further the use of GIS in governance. However, owing to changes in the Planning Commission and after several inter-department turf wars, the project was handed over to the DST. So, there are now two agencies working towards the same goal under the same department! Years down, NSDI is still floundering, while NGIS remains only on paper.

Meanwhile, ISRO went its own way and launched Bhuvan in 2009. To its credit, Bhuvan is regularly updated, and also boasts of a rich ensemble of datasets and analysis models. Others will take years to reach such a level of sophistication. But, Bhuvan has its limitations. The fact that it caters to 1-meter data makes it good only for thematic visualizations, not engineering grade work. Further, it is devoid of elevation data and ground-verified attributes which SoI alone can provide.

Ideally, Bhuvan assets should form a part of any national level platform where all spatial datasets — be it SoI maps, forest data, geological data, or those generated by other government departments (states or federal) — are aggregated. But again, that is an ideal situation. In a real-life situation where every department is trying its best to compete and not collaborate, this is but a pipedream.

Then suddenly in 2015, MeitY launched its own National Center for Geoinformatics. To make matters further ridiculous, the National Informatics Centre under MeitY has created a multi-Layer GIS platform called Bharat Maps which claims to "depict core foundation data as NICMAPS, an integrated base map service using

1:50,000 scale reference data from SoI, ISRO, FSI, RGI and others".

If this isn't a free for all show, what else is!

Get out of policy making mode

Ever since Google brought maps in every hand, the importance and availability of geospatial data have grown manifold. The reality today is that anybody can now see a very detailed map, and a very detailed satellite imagery or aerial imagery openly on the Web, and the world has moved beyond restrictive policies.

Further, an un-enforceable policy is a waste of paper. "We have a National Data Sharing and Accessibility Policy (NDSAP). How many are aware of it? How many abide by it?" points out a geospatial industry veteran on the condition of anonymity. This is simply because a policy is not mandatory–so one gets away by not following the NDSAP — but a law is. But any law must have an understanding of ground realities, must be open and encouraging for industry and users.

All around the world governments are increasingly taking on the role of enablers and less of regulators. "Policies by nature are restrictive. Governments should enable what private industry and public can do, rather than focus on what they can't do. Also, regulations should be applicable only with respect to data that directly affects the security and sovereignty of the country," says **Lt Gen Chandele, Advisor, Ashok Leyland Business Advisory Committee.**

A typical case in point was the ill thought out Geospatial Information Regulation Bill that was suddenly unveiled by the Ministry of Home Affairs in 2016, which created such an uproar that even the common man on the streets was also forced to take note of the importance of map data. The Bill, since put in cold storage, not only proposed to impose heavy penalties on sharing of map data that is not vetted by the government, but also sought to put heavy controls on how geospatial data is generated and shared, in effect sounding a death knell for the private geospatial industry in India.

It is not a geospatial policy but a holistic strategy that is the answer. "Look at all developed countries, they talk of visions and strategies, and how to open up data. And here we are still talking of how to restrict it," says the anonymous source. "Often, a policy document is about how to "not" do something. Instead, we should work towards having a vision document with an aim of how to do something."

Among the first things that need to be done are mandating all geospatial data generating agencies to collaborate and not compete, mandating sharing of all geospatial data generated by tax payers' money in one single platform, and most importantly empowering of Survey of India. While one may scoff at the last suggestion, but it is true that no other organization has the capability or the knowhow or even the mandate when we talk of vetting, aggregating and managing all kinds of spatial data. Let us also remember, a country can't progress geospatially if its national mapping organization is weak. Don't believe us? You can always check out the "Leaders" in the Countries Geospatial Readiness Index 2018! *(See Page 58)*

Back to School

Ready, Set, Go!

A big hindering factor is the limitations of existing capacities — both industrial abilities and trained human resources — leading to slowing down of projects.

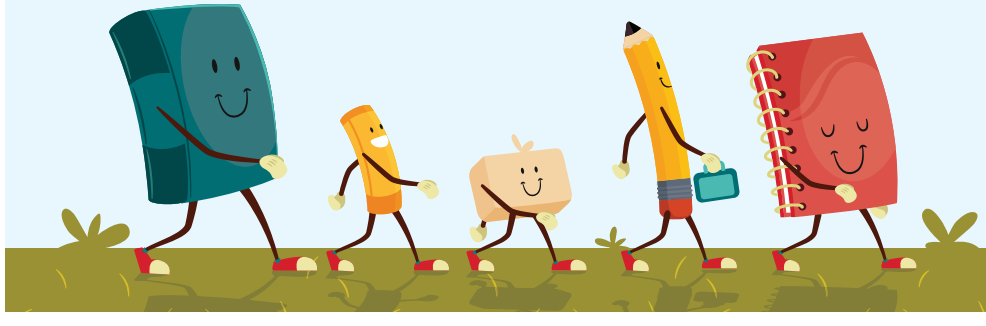
Back in 2010, the Ministry of Human Resource Development (MHRD) had constituted the National Taskforce on Geospatial Education under the chairmanship of former ISRO chief Dr. K. Kasturirangan. As part of its report submitted in 2013, the Taskforce had made four major recommendations — School Geospatial Education Project led by the Department of School Education; Geospatial University Networking Project led by the Department of Higher Education; Geospatial Training and Outreach Project led by DST; and National Institute of Geospatial Knowledge, Engineering and Management led by MHRD and DST.

There were also a number of suggestions such as inclusion of geospatial technology in middle and high-school curricula, development of prototypes of school geospatial kits, encouraging universities to standardize curricula and undertake faculty orientation, wide usage of low-cost, making geospatial technology and applications part of civil-services academies and re-orientation programs, coordination with federal ministries to ensure that training pools are dedicated to train government employees et al. The report is all but gathering dust.

The present RS&GIS courses are turning out jacks of all trades and masters of none. To make the young generation more geospatial ready, in schools we need to separate Geography from Social Studies and make it a part of Science at the Class X level. At XI and XII we need to introduce digital geography as an elective and thus introduce not just GIS but image analysis and location. Also brief introduction to simple spatial modelling should be provided.

At undergraduate level, we need to introduce patio-temporal modelling, visualisation and introduction to advanced techniques like BI, BIM, BDA and AI as applied to spatial data. This should be done for Commerce, Engineering and Science. There could be electives for Humanities and Medicine. We also need to introduce geospatial techniques as part of the curriculum in Central and State Administration Academies. This must be a part of the regular courses.

Geospatial systems are multidisciplinary and hence cannot be taught as a separate subject or course. There is a need to internalise the adoption of geospatial systems. This cannot happen unless we stop putting GIS on a pedestal. We need to make GIS fully integrated to other systems and that includes education and capacity building.



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Geospatial technology can help in resource allocation, decongestion, better planning, identifying specific problem areas, and faster solutions. It gives us a chance to converge efforts to make every project a success, says **Hardeep Singh Puri, Minister of State (Independent Charge), Ministry of Housing and Urban Affairs**

MAKING INDIA GEOSPATIALLY TRANSFORMED

How does geospatial technology help in better governance and maintenances of cities?

Geospatial allows visualizing essential aspects of cities, for instance the agglomeration of people, place and functions that create a city. This agglomeration requires a Bird's eye perspective of a city so that administrators and planners can understand it better.

Today every government office is using Google Earth as an indispensable tool. The ability to track various locations offers us opportunities for greater investment of resources and hence better outcomes. Also with the population increasing at a high rate, new measures are

required to handle the new challenges that are cropping up. Geospatial technologies can help in resource allocation, decongestion, better planning, identifying specific problem areas, and faster solutions.

To have effective outcomes, it is time that every piper stops playing his pipe individually and stops working in silos, collaboration and convergence can bring in huge benefits. The Ministry of Housing and Urban Affairs is actively working towards the convergence of ministries on the principle of Team India. Geospatial is the enabler of this convergence.

What are the recent initiatives involving geospatial technology in your ministry?

The Prime Minister Narendra Modi's three flagship programs — Swachh Bharat Abhiyan (Clean India campaign), Pradhan Mantri Awas Yojana (Housing For All) and Smart Cities program anchored in the Ministry of Housing and Urban Affairs are very good examples where geospatial technology plays a crucial role. Swachh Bharat mission is an ambitious project with an aim to make India an open defecation free country using 100% solid waste management technology by the end of October 2019. The program requires building of public toilets and individual toilets at home in both urban and rural areas. However, it is very important that these be geospatially mapped.

On the Swachh Bharat portal you will find every toilet marked. This creates greater transparency in government functioning and allows both governments and citizens to see what is being done for the public good. It gives us a chance to converge our efforts to make every project a success.

The Pradhan Mantri Awas Yojana scheme envisages home for every Indian by 2022. We have been able to sanction 5,000 homes using geospatial technology. We have mapped the entire scheme to have an idea about its progress.

We have chosen 100 cities out of the exisiting 4,041 to be developed as Smart Cities. It is a major beginning for us. The Smart City project is where geospatial has a great role to play. With the help of imaging and real-time data, we are able to map and monitor how each Smart City project is doing. The INR 1,400-billion program is just 2.5 years old.

Please elaborate more on the Smart City project.

The scheme was announced in June 2014. Till now, in total, we have identified 90 cities and have 10 more to go. These 10 cities will be announced shortly. The project is one of the fastest implemented schemes where each city is developing at a different level because they were announced at different points of time. In the first round, 20 cities were announced, so they had the advantage of time. For the development of each city, we are setting up special purpose vehicles. About 70 cities have SPVs and very soon other cities will have SPVs too.

When a city is selected for a smart city then it's a process of competitive selection. The good news is that from 14 countries, 42 top-class companies have already bid and won contracts. Smart City is not just an Indian project, it's a global opportunity and it's a win-win for everyone.

Today, our Smart Cities are going to have command and control centres for their transportation systems and public surveillance systems. Tomorrow, they will be monitoring the consumption of energy in every building.

What steps do you suggest for smoother and quicker urban transformation?

If we have to plan for an urban economy where there is greater symbiosis between the city and the village, we must use maps and analysis for our resource footprints as well as flows of labor and capital. The use of geospatial technology is therefore an essential element of the urban transformation that the ministry is promoting between the states and union territories.

This urban transformation requires cities to use geospatial technology to create e-governance platforms that allows our municipalities to get a holistic picture of what they are dealing with. A unified geospatial platform helps the city managers to construct a common operational picture and to treat his/her city as an enterprise so that he/she has the power to see and visualize, detect, locate and judge, resort and act. This makes the task of managing the cities more efficient and allows the managers to eliminate redundancy and optimize resource consumption.

I am sure there will soon be an urban world where everything has been geospatially marked. This will allow us to plan better, to spend money better and deliver services better.

Do you think India is in a position to leverage the power of the technology to the fullest?

The issue is that many of these technologies are new. However, it is something which is remarkable and cannot be ignored. Of late there is a lot of progress and the technology has caught on people now. There has been a realization that for efficient running or completion of a Smart City or any big project, it is beneficial to use geospatial technology.

There was a discussion in the year 2011 about setting up of a geospatial hub or an institute to study geospatial technology. I am very eager about the technology and will take this up so that we can persuade that each Smart City has a geospatial institute. We need to train people to understand the importance of the technology.

INDIAN SPACE STANDS AT THE FOREFRONT

India, unlike any other country in the world, has a wide and diverse application of space technology in developmental programs and infrastructure programs, believes **Dr. Jitendra Singh, Minister of State, Prime Minister Office, Department of Atomic Energy and Department of Space**

Space technology has become all-pervasive. How is it impacting Indians per se?

Space technology has become an essential part of the new developmental transformation happening in the life of each Indian. It is expanding its reach to every household in India now.

India has come a long way and has moved out from the narrow areas of simply launching satellites for the study of planets and stars. Whether it is urban development, Smart Cities program, real-time monitoring of railway tracks, tele-education, telemedicine or agriculture sector using soil testing, space technology is making its presence felt in every field.

We have a scheme called MGNREGA in India where the government was facing certain issues. But after geo-tagging it, there is absolute transparency, no pilferage and coupled with direct transfer. It is now being called as to GeoMGNREGA.

In Railways, we had a huge problem of unmanned railway crossings. We have signed a MoU with the Indian Railways where space technology will be used to give warnings at unmanned level crossings.

In the last few years. ISRO has come up on global stage like never before. What led to this?

In the field of space technology, the nation stands at the forefront. We have actually overtaken some of the advanced nations. The most evident example is the January 12 launch when 31 satellites were launched, out of which 28 satellites were from some of those countries who had started their space journey much earlier than us. We had satellites from the US, UK, Korea, France and Finland. This shows India's space capabilities have succeeded in achieving a kind of a trustworthiness that even the most advanced nations in the world feel confident to repose their faith in us.

I can say with confidence that India today is a leading nation as far as applications of space technology is concerned. No other country in the world has such a wide and diverse application of space technology in developmental programs and infrastructure programs.

Therefore, India needs to widen its sphere of activities. The involvement of other partners also becomes important. ISRO is taking calls on that. It may not be a typical Public-Private Partnership per se, but parties are being involved to further boost growth in the space arena. Of late we have seen some example of PPP models during the tenure of former ISRO Chairman Kiran Kumar. Partnerships of this kind will help the industry to generate revenue.

Prime Minister Narendra Modi's 'Start-up India, Stand up India' initiative is also going to benefit the space industry. The program will not only generate more jobs but will also pave the way to new innovations in every field, in the space sector too.

ISRO is closely working with 160+ projects across ministries to help them with satellite data. Please elaborate.

We feel proud that the space technology has virtually become part of the government's mission to transform India. It is no longer confined to studies of planets, stars and moon, though that part is also going well as ISRO is getting ready to land its very first lunar rover by this year.

The Prime Minister's personal interest has given a huge impetus to our space mission and space programs. In 2017, we created a world record of launching 104 satellites in one go, which nobody had done. We sent out the South Asia satellite that was dedicated to the world by the Prime Minister which will be of use to all the neighboring countries.

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Department of Space

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Understanding the Geospatial user adoption in India

The Indian geospatial ecosystem at the state-level is at the cusp of a technological and development curve. Leaders at the center and state-level are taking a planned approach to tap onto the many opportunities available.

By Ananya Narain

The Indian economy is at a pivotal point with the economy leaping forward to take over China as the world's fastest growing economy at 7.2%. A key engine of the global economic growth, India is currently the world's seventh largest economy, and is projected to be the world's second largest economy, behind only China, in 2050.

As one of the largest (and diverse) democratic country, India is constantly finding ways to comprehend and unravel solutions to bridge the disparity in its economic and social character. It is in this democratic

Particulars		States
State GIS Policy	3 States	Karnataka, Andhra Pradesh, Tamil Nadu
State ICT Policy - inclusive of GIS	14 States and 3 UTs	Rajasthan, Haryana, Madhya Pradesh, Tamil Nadu, Maharashtra, Bihar, Odisha, Kerala, Assam, Mizoram, Nagaland, Jammu and Kashmir, Manipur, Sikkim, Chandigarh, Puducherry, Delhi
State GIS Portal	18 States and 1 UT	Rajasthan, Uttarakhand, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Bihar, Punjab, Odisha, Jharkhand, Chattisgarh, Kerala, Assam, Uttar Pradesh, Gujarat, Telangana, Arunanchal Pradesh, Lakshadweep
State Spatial Data Infrastructure - Functional/ In-development/ Proposed	11 states and 1 UT	West Bengal, Jammu and Kashmir, Bihar, Karnataka, Madhya Pradesh, Delhi, Odisha, Uttrakhand, Haryana (semi-functional),Tamil Nadu, Mizoram, Nagaland
State Space Application Centers	22 states	Rajasthan, Haryana, Madhya Pradesh, Karnataka, Tamil Nadu, Maharashtra, Punjab, Odisha, Jharkhand, Chattisgarh, Kerala, Assam, Uttar Pradesh, Himachal Pradesh, Gujarat, Telangana, Mizoram, Nagaland, Manipur, Tripura, Sikkim, Arunanchal Pradesh

Table 1: *Capability status of States and UTs w.r.t geospatial-related policies, geo-portal, SSDI, and S-RSAC*

character, lies a critical need to develop an integrated and collaborative approach to harness the true potential of the geospatial sector for transforming governance, to drive consumer, business and societal benefits, and to promote and sustain innovation and entrepreneurship for national competitiveness in the Fourth Industrial Revolution (industry 4.0).

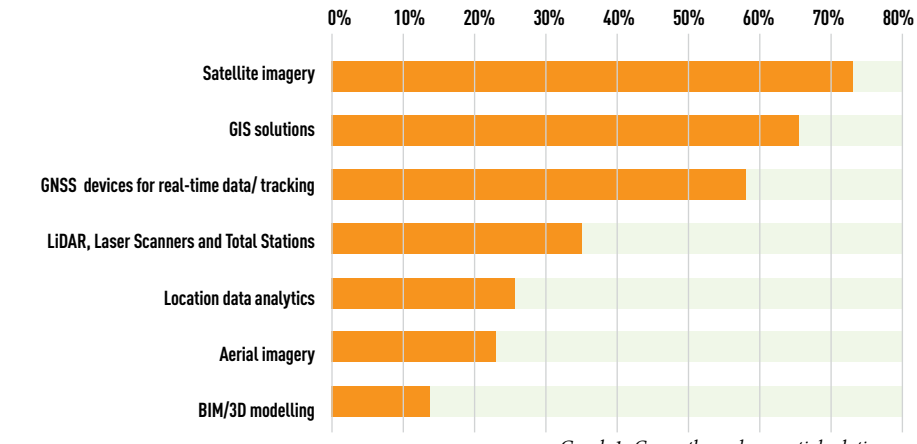
States perspective

India is often said to be 'not a nation of many states, but a state of many nations.' Comprising of diverse states and union territories (29 states and 7 UTs), divided and defined on their historical contexts and geographical uniformities, the magnitudes of adoption and integration of geographical solutions differs from state to state.

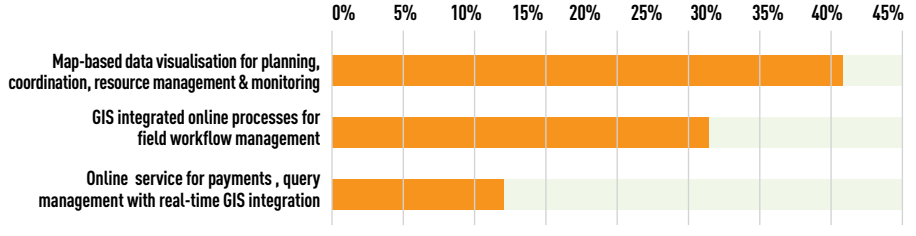
An overview of the 29 states and 7 UTs for explicit GIS policy/strategy document and an in-depth analysis of their ICT (or IT and ITes) policies found only three states with a GIS policy/or strategy document. Furthermore, only 14 states and three UTs were found to be having ICT policies mentioning geographical information, GIS or Remote Sensing *(Table 1)*.

Moreover, the geospatial ecosystem at the state level is at the cusp of a technological and development curve. Decision makers at the center and at state-level are taking cognizance of the integrated approach to meet the aspirational visions and distributed delivery structures for effective and efficient sustainable development and planning. To capture a rational perspective of state-level adoption, and as part of the **Indian Geospatial Economy** study, one-day workshops named, '*Geospatial Strategy Forum*', were conducted all over India to deliberate on critical need scenarios and socio-economic imperatives, the findings of which are presented hereafter.

At present, at a state-level, use of satellite imagery and GIS solutions for visualization, project planning and decision-making purposes lead the use for engineering level design and modelling software and location analytics by a huge margin. A case in point is the GIS mapping of all properties in 33 cities for property tax compliance. The base data for the map is to be created using satellite imagery by Maharashtra Remote Sensing Agency (MHRSA) with financial outlay of INR 2,600 million.



Graph 1: Currently used geospatial solutions



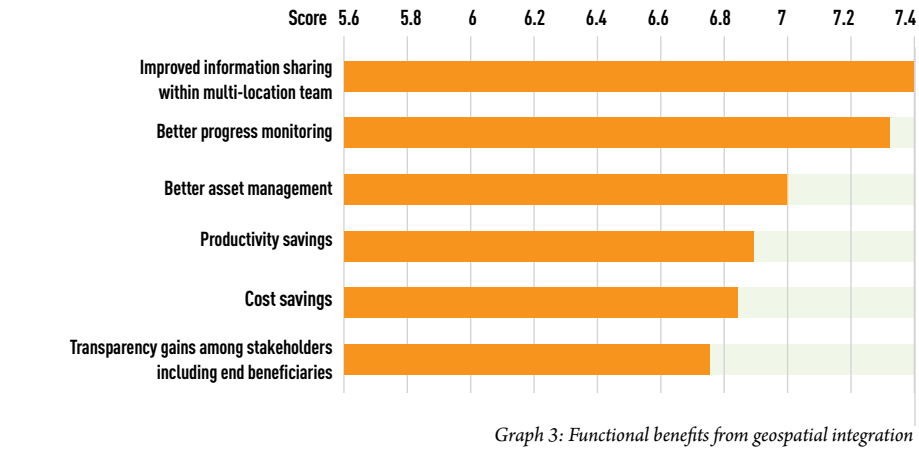
Graph 2: Online applications with geospatial integration

Furthermore, the relatively low use of location data analytics, BIM/3D Modeling and LiDAR and Total Stations (TS) at the department level showcases scope for deeper integration and embedment to derive productivity, cost and resource efficiency *(Graph 1)*. Steps are being taken for integration of BIM/3D Modelling in many states. For instance, Andhra Pradesh Capital Region Development Authority (APCRDA) which is responsible for the development of Amravati City, has prepared its base map using Worldview images (0.7 m resolution) and necessitated every building design to be BIM compliant.

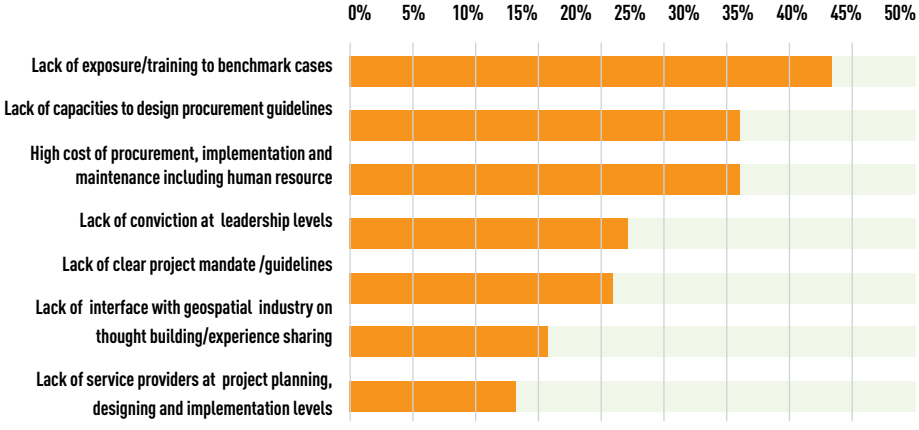
At state level, map-based data visualization for department level coordination, resource management and monitoring is of key significance. GIS integration for workflow management and GIS-based integrated citizen services is still at a nascent stage *(Graph 2)*. A case in point, is the Project Monitoring Information Systems (PMIS) mobile app designed to facilitate in-house monitoring of NHAI projects on mobile phone. Additionally, in a Government of India project, the UP Agriculture Statistic and Crop Insurance department is using Smart phone GPS for ground truth verification of crop area statistics of five crops — potato, paddy, wheat, sugarcane and mustard.

Benefits and challenges

The benefits of adopting geospatial solutions are many. Improved information sharing within multi-location team, better progress monitoring, better asset management, productivity gains and cost savings continue to be the primary benefits of integrating geospatial information



Graph 3: Functional benefits from geospatial integration



Graph 4: Challenges for enhanced adoption

management systems and technology solutions for the state departments. Enhanced revenue/fee collection, pilferage control, better human resource management and work allocation and transparency gains are benefits wherein the potential of spatial technology integration has not been tapped yet *(Graph 3)*.

Listing of major challenges in geospatial technology establishes maximum stress on 'lack of exposure to bench mark use cases and training' followed by lack of in-house capacities to design procurement guidelines and high-cost implications of adoption of geospatial technology. These challenges represent a situation of 'geospatial divide', as it becomes difficult to push for technology adoption due to combination of 'comprehension, cost perception, and skill constraints' *(Graph 4)*.

The challenges faced in every state at department level, showcases an opportunity for the technology solution providers (and also the decision makers at user end) to create structured interfaces such as industry work groups, institutional tie ups for knowledge resource centres, online query management systems, field demonstrations etc. to educate and engage stakeholders so as to expand the market opportunities.

In order to address the technology divide, the government and the private sector have already begun taking steps. For instance, the Maharashtra government has signed an MoU with Oracle corporation to establish a Centre of Excellence (COE) in Mumbai to design, develop and test new capabilities such as mobile platform to address service queries, unified app development, flexible and scalable frameworks, robust IT infrastructure to accelerate digital transformation initiatives.

The road ahead

The road ahead to build India as a 'geospatially ready' country is long and difficult but filled with opportunity at every turn. As the government mandates the use of geospatial information and technology in 160+ schemes and national programs, there lies an opportunity for the technology solution providers and decision makers to tap on to the true potential of geospatial information and technologies for accelerating the economic growth of the country. The geospatial industry is shifting from a 'top-down' to a 'bottom-up' driven industry as the dynamics of investment in geospatial data collection and application data becomes increasingly driven by digital governance and citizen services management.

In this regard, a study on the **Indian Geospatial Economy** is being conducted by Geospatial Media and Communications, for the invested stakeholder community to understand the geospatial technology ecosystem and reorient and reorganize themselves so as to enable and empower the country and its citizens to achieve their economic and social goals. The on-going study establishes the need of a broad consensus on the use and benefits of geospatial technology solutions across central and state government structures. For the same purpose, it is realized that individual state level geospatial infrastructure and policies are much needed for enhanced adoption so as to ensure a transparent governance structure, efficiency and effectiveness of government policies, schemes, and programs, and earn higher economic and development gains on public investments.

The demand for analytics and end-to-end geospatial solutions for a developing country like India is of great significance. The use of geospatial technology and solutions can significantly bolster economic resilience and development activities, and help address social and demographic challenges – creating a robust foundation for India to achieve the New India – Vision 2022.

Ananya Narain, Research Analyst
ananya@geospatialmedia.net

SPOOFERS REVEALED

We show those satellites that are:

Tracked
Used
Spoofed
Blocked/Jammed
Faked
Replaced

See details inside

Spoofers are not only of the Black Sea type, as reported in the press, kids are going that direction too. It is time to take spoofers seriously.

Spoofers are completely different from jammers that block GNSS signals. Spoofers create GNSS-like signals that fool receivers to provide false location solutions.

We combat spoofers in two ways:

1. Detect and alarm that spoofer exist. Then distinguish the spoofer signal, ignore it, and use valid satellite signals.
2. Help find the direction that spoofed signals are coming from.

Spoofer detection is available in all of our OEM boards too.

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Because it works where nothing else will and it has abilities and features that nothing else does.”

“I got some ridiculous ‘fixes’ today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it.”

“I had 100% confidence this RTK was good. As soon as I stored the shot I inversed to my design point at that location and got 0.06’. No second PPK necessary! Then for the cherry on top, I processed the PPK at the office at it was 0.05’ from the RTK I stored. Just an amazing Surveying machine!”

“Truly amazing with a 4” grape vine directly overhead and the tree cover.”

“This thing is bad ass!”

“Thank you for the most awesome set of equipment I have had the pleasure of running in my 41 years of surveying. I am having the most fun I have ever had!”

The LS has increased our productivity 2:1

FL

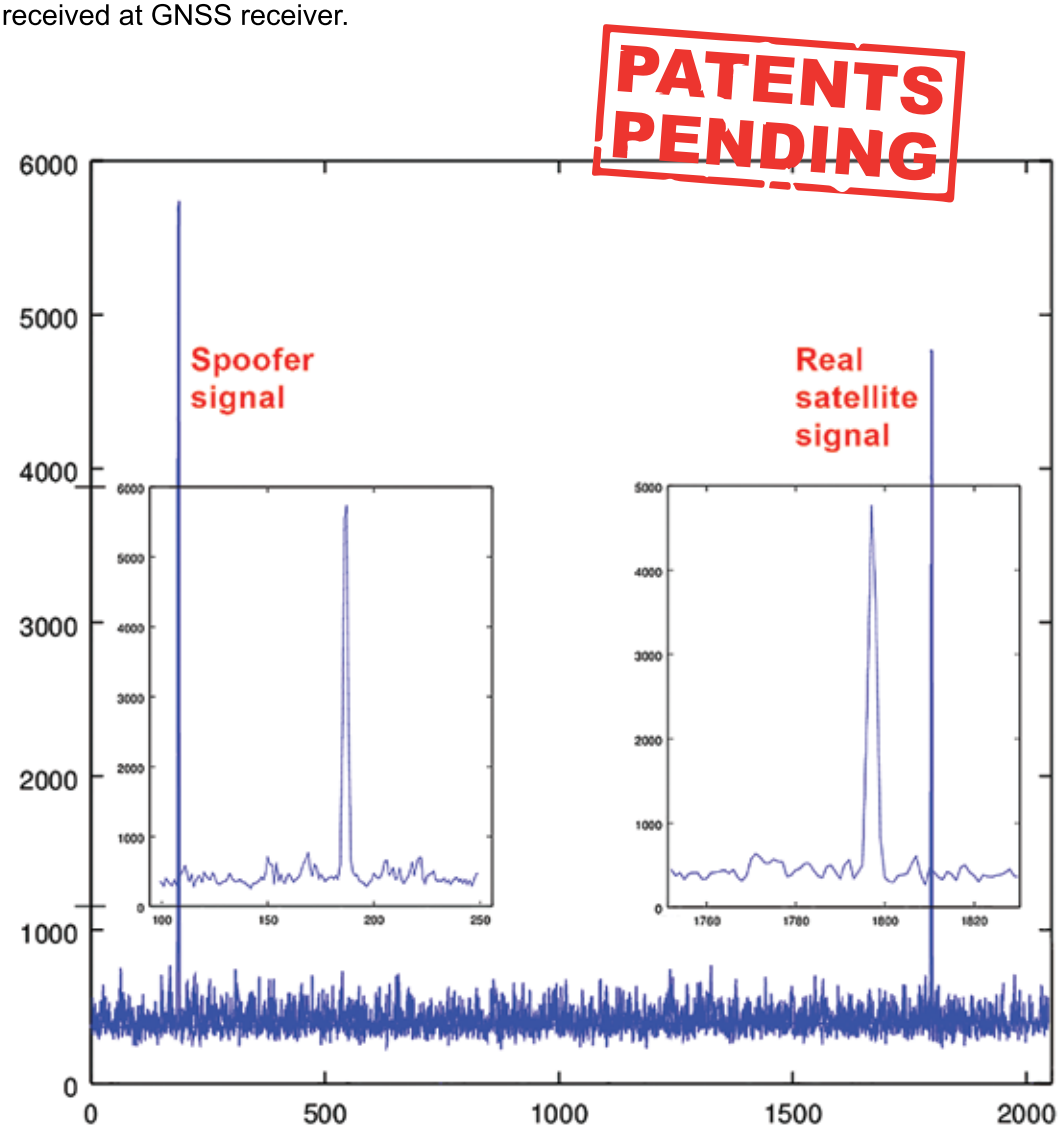
Spoofer Detection

With 864 channels and about 130,000 quick acquisition correlators in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS satellite PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofed signals.

When we detect that spoofing is in effect, we use the position solution provided by all other clean signals (L1, L2, L5, etc... GPS, GLONASS, Galileo, Beidou, etc...) to identify the spoofer signal and use the real satellite measurement. If all GNSS signals are spoofed or jammed, then we alarm you to ignore GNSS and use other sensors in your integrated system.

Figure below shows an example of a spoofer signal and a real satellite signal received at GNSS receiver.



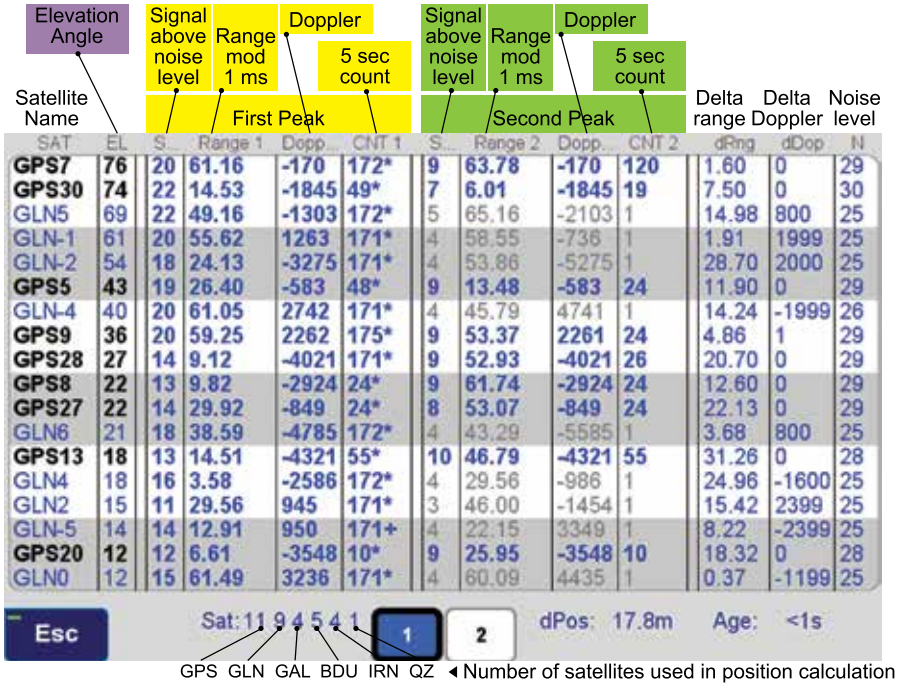
Satellite and Spoofer Peaks

The screenshots below are from a real spoofer in a large city. The bold numbers are for the detected peaks. The gray numbers represent highest noise, not a consistent peak. "*" symbol next to the CNT numbers indicate that signal is used in position calculation. Each CNT count represent about 5 seconds of continuous peak tracking.

SAT	EL	S..	Range 1	Dopp..	CNT 1	S..	Range 2	Dopp..	CNT 2	dRng	dDop	N
GPS5	33	16	61.14	1382	184*	4	25.95	181	1	29.32	1201	29
GPS7	51	21	14.39	1146	184*	4	18.21	-453	1	2.80	1599	29
GPS8	30	18	65.10	-918	184*	4	4.26	-1318	1	3.68	400	29
GPS9	12	14	40.46	2966	184*	4	2.08	3765	1	26.13	-799	29
GPS13	40	16	46.92	-3525	184*	4	8.21	-4325	1	25.80	800	29
GPS15	12	14	12.46	-4336	30*	5	33.00	-1536	1	19.52	-2800	28
GPS20	24	12	13.19	-1707	107*	4	29.32	-3307	1	15.11	1600	29
GPS27	16	11	10.26	1264	184*	4	43.55	63	1	31.22	1201	29
GPS28	53	19	9.41	-2724	184*	4	7.93	-4724	1	0.46	2000	29
GPS30	81	22	13.79	-332	184*	5	34.16	1266	1	19.35	-1598	28
GLN-4	54	20	62.08	1498	1158*	5	21.72	2697	1	24.16	-1199	25
GLN5	46	20	18.04	-2897	524*	4	26.26	-3697	1	7.20	800	25
GLN0	37	18	30.37	2355	1469*	4	38.37	1554	1	6.98	801	25
GLN-1	82	18	34.92	-776	189*	4	12.54	-1576	1	21.35	800	25
GLN-2	26	12	30.96	-4358	229*	4	11.80	-3158	1	18.13	-1200	25
GLN2	21	10	59.73	288	551*	4	47.55	1087	1	11.16	-799	25
GLN4	22	15	30.59	-3361	208*	4	11.74	-5361	1	17.83	2000	25
GLN-5	21	14	20.17	276	187+	3	25.45	2275	1	4.26	-1999	25

Esc Sat: 10 7 6 4 4 0 dPos: 19.0m Age: <1s

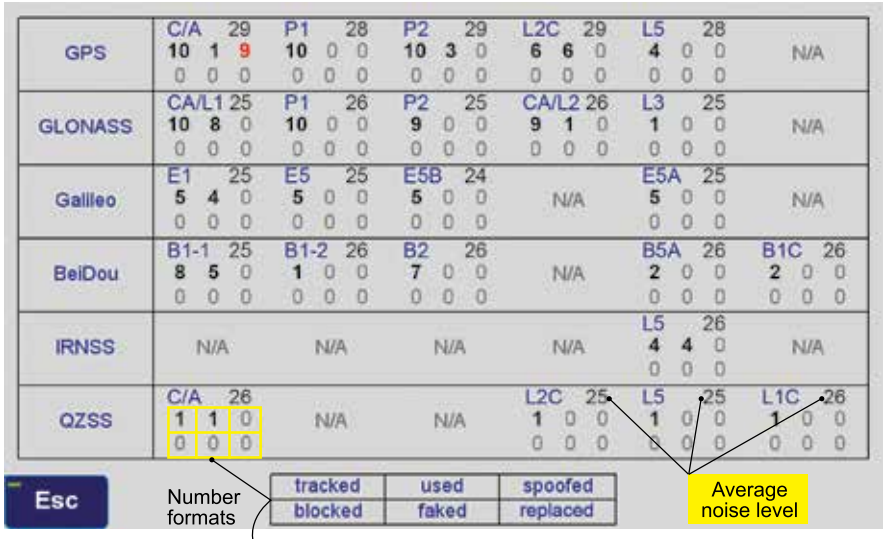
No spoofer. Only one reasonable peak for each satellite.



In the above screenshot all GPS satellites have two peaks and all are spoofed. We were able to distinguish the spoofer signal and use the real satellite signals in correct position calculation as indicated by the "*" next to the CNT numbers.

GNSS Overall View

The screenshot below shows the status of all GNSS signals.
The format and the signal definitions are explained below.



GPS L2C: L+M
GLN L3: I+Q
GAL E1: B+C
GAL E5: alboc
GAL E5B: I+Q
GAL E5A: I+Q
BeiDou B2: B5B
QZSS L2C: L+M
QZSS L1C: I+Q

Definitions for the number of signals:

Tracked: Tracked by the tracking channels and has one valid peak only.

Used: Used in position calculation.

Spoofed: Has two peaks. Good peak is isolated, if existed.

Blocked: Blocked by buildings or by jamming. If jammed, shows higher noise level.

Faked: Satellite should not be visible, or such PRN does not exist.

Replaced: Real signal is jammed and a spoofed signal put on top of it. Because of jammer, it shows higher noise level.

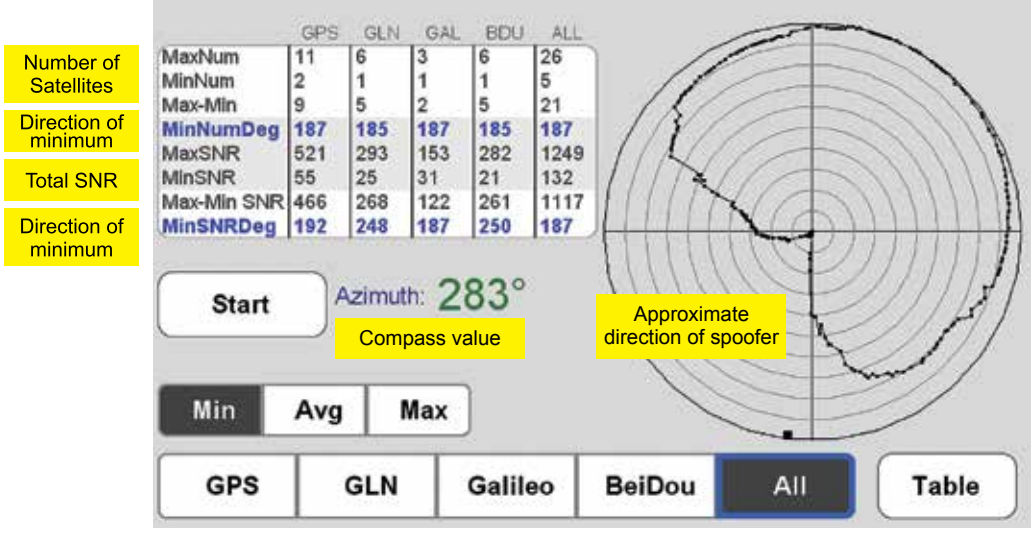
Spoofer detection available in all of our OEM boards too.

See details in GPS World expert opinions section “What is the biggest challenge facing designers of multi-constellation GNSS receivers today?” with Javad Ashjaee and at www.javad.com

Spoofer Orientation

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure below.



This screenshot is from the experiment within an anechoic chamber. That is why the picture is clean and smooth.

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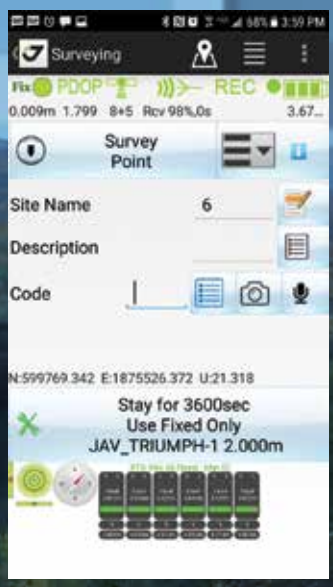
Javad Mobile Tools (J-Mobile)



Javad Mobile Tools (J-Mobile) is an RTK & static control software app which allows you to connect JAVAD GNSS receivers to Android™ or iPhone/iPad devices. J-Mobile includes a full set of RTK and static survey routines including, data collection (RTK and static), RTK stakeout, CoGo, localization and more.

I used "Beast Mode" on a small project yesterday and all I can say is WOW!!!! Did Javad and Red Bull team up to enhance RTK or did my system drink hypercaffeinated coffee when I wasn't looking? Amazing accomplishment/development Javad. I can't imagine using any other GPS equipment.

"I surveyed 20 acres today and never used the total station."

"Since I got the Javad system, I go places NEVER BEFORE possible, and WITH confidence, because, the quality checks are there."

"The only bitching now is for the crew that has to take out the Hyper V."

"Using licensed professionals for development has been a brilliant idea. Tip of the hat to the programmers and designers that put the original box together it appears to me that they knew where they were going with this years ago."

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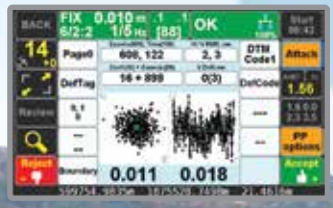
“More than just a ding, an RMS and here’s your answer, trust us. Complete Data Analysis for every shot.”

J-Field Software Features

864 Channels
RTK 6 Pack
BEAST MODE RTK

Only from
JAVAD GNSS



Verification
& Validation
Automatic

Only from
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Customer favorite feature #1

Hybrid RTK
Another check on the work
PPK Solution

Only from
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Customer favorite feature #2

RTK Rovers - On a Budget

TRIUMPH-2
Complete RTK
Network Rover

$5,680
with Budget Smartphone & JMT

$8,255
with Rugged Victor-LS & J-Field

TRIUMPH-2
Complete RTK
UHF Rover

$6,930
with Budget Smartphone & JMT

$8,265
with Rugged Victor-LS & J-Field

The Indian Space Research Organization plans to privatize the operations of its popular Polar Satellite Launch Vehicle (PSLV) by 2020

NEWSPACE INDIA

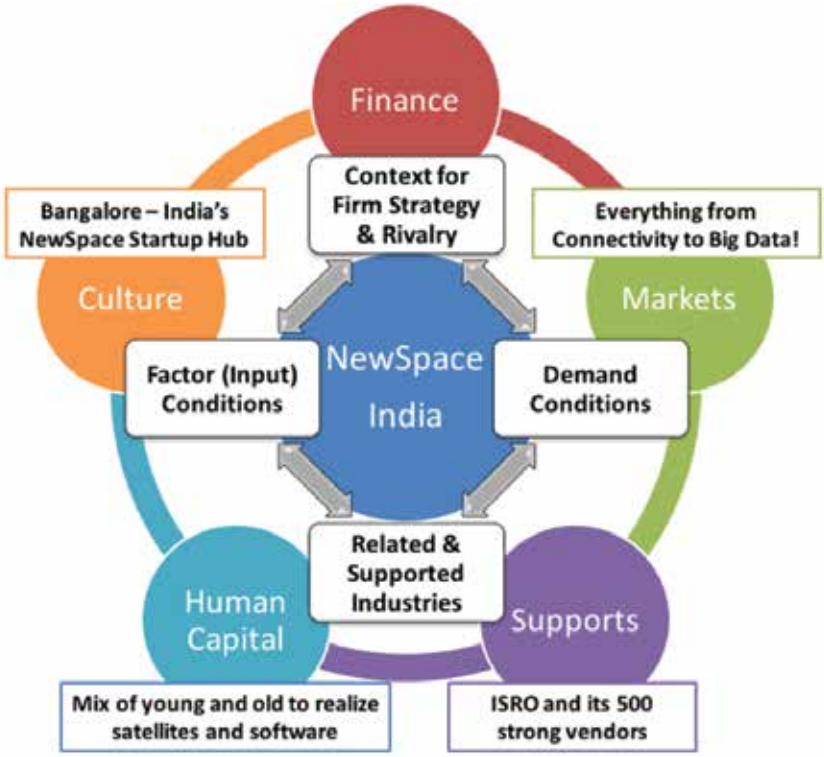
Opportunities | **Challenges** | **Hopes**

There is a growing trend of young individuals in India who are working on the NewSpace agenda with vision and drive, surmounting challenges they meet as they travel through uncharted 'space.

By Prof. Arup Dasgupta

In India 'Space' means Indian Space Research Organisation. However, space activities, especially the upstream ones, could not have been done without the involvement of Indian industry. Globally the technology is highly protected because of its dual use capability. Even if it was not, it would be prohibitively expensive. Thus, beyond a few Nike Apache and M-100 rockets launched from Thumba under the UN auspices, India had to look for solutions within India. This not only included big names like Larsen and Toubro, Walchand Industries and Godrej but countless MSMEs who turned out subsystems for launchers and satellites. Downstream as well, industry supports both satellite communications and remote sensing applications with hardware and software.

Of late this story has a new chapter, NewSpace. The NewSpace revolution began globally as entrepreneurs like Elon Musk and Richard Branson began talking of space activities as independent profitable commercial ventures. NewSpace is a jargon describing the disruption caused by commercialization of space ventures through reusable launchers and small satellites using COTS hardware which results in lowering of costs thus opening the field to many more players other than the government institutions and high net worth individuals. However, downstream, there is much more to NewSpace in terms of innovative technology, commercial applications and capacity building.



Courtesy: Satsearch

In India too there is a small but growing band of young and not so young individuals who are working on the NewSpace agenda with vision and drive, surmounting challenges they meet as they travel through uncharted 'space'. Most of them grew up as India began to take its first steps in space.

Education of the customer about space-based services is limited today, both in India and abroad. Unlike navigation services, which was valorized by the onset of the smart-phone, imaging and satellite communications are still limited in their reach

PRATEEP BASU
Chief Strategy Officer, SatSure

Interest in space

Prateep Basu, Chief Strategy Officer at SatSure Limited was in the first batch of students of the Indian Institute of Space Science & Technology (IIST). He was inspired by Dr. Vikram Sarabhai vision "that we should be second to none in the applications of space technology, and use space technology for national development". Basu says, "I found this concise statement by Dr. Sarabhai to be relevant even today, with the caveat that we should also be second to none in the commercialization of space technology, while continuing to walk on the path of using it for socio-economic development globally". **Divyanshu Poddar, Founder Rocketeers**, another IIST alumni says, "I was always interested in space and wanted to become a rocket scientist… hence took up IIST as the opportunity that would lead me to this industry". **Kiran Tikare, a member on the Space Generation Advisory Committee (SGAC) of the UN,** was enthused by Space after his stint as an intern in SHAR, ISRO apart from his interest in Physics and Astronomy.

Gadhadar, CEO, NoPo Nanotechnologies India Private Limited takes a philosophical view when he says, "I have always wanted to find answers to questions such as Why I exist? Why does the universe exist? I have been drawn to deep oceans and space from early childhood as they seemed to hold answers." **Narayan Prasad Nagendra, COO, Satsearch**, was drawn to Space through Space Sciences. In his words, "In my undergraduate studies, I had a chance to work with Indian Institute of Astrophysics in designing a structure for a micro-satellite which led me to loving the space sector and eventually traveling to Europe to pursue higher studies".

Kartik Kumar, Co-founder & CEO, Satsearch, had "always been fascinated by space since I was a young child. Having completed my BSc and MSc in Space Engineering, and approaching the end of my PhD, interest in space comes to me naturally". This fascination with space science also mirrors in **Rushi Ghadawala, Executive Chairman, BR Aerospace Group** who went on to study Aerospace Engineering. **Rohan M Ganapathy, Director, Bellatrix Aerospace**, was enthused by Neil Armstrong and Buzz Aldrin at a conference in Washington. "A meeting with Dr. Kalam inspired me to do something for the nation" he adds. For **Nikitha C, CEO of Society for Space Education, Research and Development**, the driving force was the poor level of education relating to space in schools and wanted to, "do something to spark that interest in space tech or science".

On the legal side, **Ranjana Kaul, Partner in the legal firm Dua Associates**, studied Air and Space Law at McGill University and was inspired by her professor, Dr Ram Jakhu.

The road to space entrepreneurship

Basu and Poddar did join ISRO briefly before the entrepreneurial bug bit them. Basu preferred the fulfilling experience of working on and realizing his own vision, rather than executing the vision of others. "It is the journey as an entrepreneur which counts the most, and hence my choice of treading this path (rather) than repenting later about lost opportunities," says Basu. For Poddar, "Indian industry needs and wants more than ISRO and I saw entrepreneurship as the way to go".

Other space entrepreneurs took a different

route. Gadhadar set himself an audacious goal that is slightly beyond reach and pursued it relentlessly because, "I figured that trying to realize the goal through a publicly funded organization reduces my chances of success significantly due to a large number of irrational unknowns". This view is also shared by Rushi who worked on projects with ISRO and DRDO but preferred the freedom to become an entrepreneur even when the word 'start up' did not exist. Rohan voices a similar philosophy.

Similarly Nikitha, an Aerospace Engineer, chose to work as a space entrepreneur in her own 'space domain', while Kumar wanted to "break new ground, be my own boss and challenge the existing structures within the industry, to try and push beyond the status quo". Tikare chose to become a part of the IT boom and remained there for 10 years before going back to his love of Space to become a space facilitator and mentor. **Govindarajan, President, Aniara SpaceCom**, was already in the satellite service sector for 20 years before taking the plunge into space entrepreneurship.

Kaul has consistently advocated an enabling and appropriate regulatory framework and institutional mechanism to harness the private sector which would enable growth and development of a balanced and robust space industry. She set up a Space Law practice in Dua Associates, a leading law firm.

Nagendra sums up the entrepreneurial drive succinctly when he says, "I saw the rise of NewSpace with several young folks trying to commercialise their experience of building small satellites. At the same time, the cost of access to space was plummeting, investors across the world started to become more interested in investing into space, which led to me to think if we can utilise India, the way IT industry did, in exporting space products. Doing this as a start-up was therefore a logical beginning".

Goals of NewSpace India entrepreneurs

These Space entrepreneurs have set goals that cover both upstream and downstream areas including capacity building and mentoring young students.

Govindarajan wants to "launch small GEO satellites under Indian Satellite System (ISS) License. Our idea is to launch small GEO satellites in a cost effective manner and gradually build them in India". Gadadhar has a single minded goal of developing and manufacturing "…a material that is significantly stronger than anything in use, radiation resistant and light-weight. Carbon Nanotubes are such a material". His ultimate goal is to use this technology in spacecraft that will take humans to Mars. Ganapathy aims to develop innovative solutions to provide affordable and reliable access to space.

Basu is keen on bringing together Space and IT and create a company that touches the lives of people while monetising Space assets. He says, "space assets are not only monetizeable, with the right understanding of the market gaps, but a space services business is also rapidly scalable". Ghadawala says, "My goal is clear and simple – develop and promote R&D and Innovation in Space, in order to make it accessible to everyone".

Kumar, through his company Satsearch, offers to "democratise access to the space industry, generate greater transparency within the supply chain, and ultimately help bring the sector closer to other mainstream high-tech industries".

Nagendra who returned to India to set up Dhruva Space in 2012 has set himself the goal of taking up "space-related activities that are more long-term projects that make a small difference to a lot of people and short-term projects that can help a sub-set of users". To this end he likes to take up different projects and also curate the NewSpace India community.

Nikitha and Poddar prefer to address young students and demonstrate that space is really within their reach. Nikitha's organization reaches out to all communities of students. Among other activities she plans to "…have SPACE STUDIO__INDIA, this is mainly to give the real feeling of technology development, Astronaut training, Micro gravity sensation, etc here in India at very affordable price".

Poddar wants to "build a space to build for space. A place where everyone can come and be a part of a community and learn and build for space and using resources and data from space for the world".

Ease and unease of setting up a space business

"In space, being an entrepreneur has unique challenges relating to funding, gestation period, mainstream understanding, and industry mindset. There are also great opportunities however, as the sector has only just started to break out of its niche. I think over the coming years, we're going to see the

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Founder Rocketeers

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CEO, NoPo Nanotechnologies India

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NIKITHA C
CEO, Society for Space Education, Research and Development

Space industry is capital intensive and upstream activities come with a long gestation period

ROHAN M. GANAPATHY
Director, Bellatrix Aerospace

space sector impacting other industries increasingly, and this will hopefully also help alleviate some of the challenges in building the next wave of ventures" says Kumar.

For Basu setting up a venture was easy but running it was a different story. His company, SatSure, is based in the UK and as a MNC, taxation, compliances, and labor laws are quite complex for a technology entrepreneur. That said, he finds that "learning about the necessary paperwork that comes with setting up and running a venture, which are life-long lessons in my opinion". He finds that having to route all satellite imagery acquisitions through NRSC is a drag as it takes up to 30 days and feels that ISRO needs to step up to global standards.

Gadadhar faced so much of resistance from experts and bureaucrats when he set out to develop and manufacture carbon nanotubes for Space use that he named his company NoPo, shortened from 'Not Possible'. He learned "… to fix negativity, I built my own ecosystem and extend it to nurture bold new Ideas". He invested private funds and once his development was successful he "could see people getting excited that significantly advanced tech was being developed in India. In 2017, we won the IIGP 2.0 and Elevate 100. In 2016, a stint at Singularity University opened flood gates of access".

Ganapathy says,"Bellatrix Aerospace has been a great journey. A major challenge in setting up a space business in India is funding. Space industry is capital intensive and upstream activities come with a long gestation period". The absence of an Indian Space Act, is a potential roadblock for commercialization. However, after producing a prototype they got an order from ISRO. Scaling up, international marketing and funding are challenges. Ganapathy is confident that Bellatrix will overcome these challenges in becoming a major global aerospace company in the areas of satellite propulsion and launch vehicles.

For Nagendra having a supportive international partner and like minded local partners helps to set up a space business. However, the Indian ecosystem has no incubation support nor pointers to seek support of leaders such as ISRO for space start-ups. "We had to learn how to do business the hard way".

Ghadawala too found better support in the UK where his venture was treated as a complement to big organizations and not a competitor. In India he easily set up relationships with academic institutions for industry based Space education. He established a few joint projects with other institutions but generally he found political and bureaucratic hurdles limiting his operations in India.

Poddar counted the ability to work on cutting edge technologies and the glamour of Space exploration as positive drivers but negatives were regulation, lack of support from ISRO and the government, and failure of the masses to understand the industry. Similarly for Nikitha had difficulties with the name of the organization and getting registration till the Kerala State Government registered them as an NGO.

The lack of clarity among the investors and lack of the ecosystem required for significant contribution leads Kaul to say, "there has been no progress at all in the matter. However, the government and think tanks are now open to discussing the question of whether India should have national space legislation. While, all agree with that proposition, the actual draft national space law bills presented at least on two earlier occasions do not support the spoken words".

Bengaluru-based start-up Bellatrix has developed a satellite propulsion technology that can make space missions cheaper

Market opportunities

Gadadhar feels that aping the developed countries is not a solution. India is the best market for breakthrough technologies that solve basic problems using new and cutting edge technology. The growing demand for satellite capacity in the SAARC and ASEAN regions will enable large users and small nations to use small satellites, as

cost of ownership reduce according to Govindarajan. Ganapathy is also upbeat. Bellatrix Aerospace is working on development of Microwave Plasma Thrusters, Hall Effect Thrusters and Green Mono-propellant Thrusters for satellite propulsion. They are developing 'Chetak', a reusable and affordable micro launch vehicle for India, SAARC and ASEAN from a launch friendly location operating out of India.

Nagendra of Satsearch has partnered with Antrix Corporation "…to bring Indian space products into the international market using our Electronic Datasheet (EDS) technology. We hope to help all emerging players in their mission, spacecraft and operations via the tooling that we are building". Adds Kumar, "Stakeholders within the sector struggle with finding the right products and services, irrespective of location. The market opportunities in Asia are tremendous. As new countries join the ranks of space-faring nations, there will be greater need for a consolidated supply chain platform like ours".

With SatSure working and engaging with various government stakeholders, Prateep sees, "…a huge market opportunity for our risk management and decision intelligence products, that make use of satellite Big Data, IoT, weather, and socio-economic datasets, among many. In India and APAC region the addressable market is about a billion dollars, as per market research firms like NSR".

Ghadawala says, "Our products and services have already been tested and/or been used by many developing nations across the globe. We aim to provide cost effective and innovative solutions to the present challenges of using space based technologies". A good market exists for customised and efficient solutions of earth observation at lower costs in India, and different countries. "We are already in communication with different countries in Africa, South America and Pacific, and we will be happy to explore ASEAN, SAARC and other interested countries, for joint ventures, with both government and private agencies," he concludes.

Poddar strikes a cautious note when he says, "Indian industry has the potential and capacity to lead the industry in the ASEAN ecosystem but ISRO and Antrix will have to take more pragmatic approach and be more industry friendly".

Kaul regrets that even though there has been attempts at 'satellite diplomacy' like the SAARC satellite, engagement with the UN in capacity building and support for cooperation in SAARC and ASEAN, "India would likely not be able to optimize the opportunities for its own industry and private sector without an appropriate institutional and regulatory framework".

Using satellite imagery-based information with ground data could improve the livelihood of farmers without directly working with them. Courtesy: Satsearch

The road traveled

Ghadawala, having set up his first company in the UK in 2008, in India in 2010 and now with operations spread out over UK, India, USA, Canada, Italy and Mexico, looks back and says, "In the last ten years the Commercial Space Sector has welcomed me with a warm heart! I learned new things from new challenges, this leads to innovation and finding effective solutions to push the limits beyond the boundaries. We have worked with various government and private agencies in India, UK and Europe under different consortiums for various application projects in Irrigation, Agriculture, Disaster Mapping, Propulsion, etc". Basu says, "We developed strong market traction in India and APAC region within a year of announcing our geospatial Big Data platform services. We are in the final stages of closing a MoU with Antrix, which is ISRO's commercial arm. Since our founding team is mostly ex-IIST/ISRO, we would love to engage more closely with ISRO, whose work in satellite remote sensing area set the foundation for home-grown companies such as SatSure to come up. We are also having ongoing discussions with couple of other space agencies to collaborate on research & development activities, since SatSure has legal entities outside of India too".

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>
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> Co-founder & CEO, Satsearch

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RUSHI GHADAWALA
Executive Chairman, BR Aerospace Group

panies in four continents apart from space agencies such as ESA, CNES, DLR, ISRO. We have a working agreement with Antrix Corporation of Government of India. Similarly, we are working with the Concurrent Design teams at CNES (French Space Agency) and DLR (German Aerospace Center). We are supported by the European Space Agency and we are exploring a number of projects with them too. We are also keen on working with new actors such as Portugal, Australia, UAE, which is in our pipeline at the moment. We have won various awards from being International Space University's Startup competition award, graduated from Y Combinator's Startup School, Startup Space Weekend award and recently we were the first startup to enter the European Space Agency (ESA) sponsored Rocket Program. As a start-up, we have been very lucky to work with small companies, large corporations, space agencies which bring us tremendous perspectives on their roadmap and requirements. Overall, it's been a fun ride and hope to learn more".

Adds Kumar, "So far it's been a true roller-coaster ride. We've learned a lot about how businesses in general work, and what's required to become a success in the space industry. We've also learned that you need patience, especially when you're building something that disrupts the way the industry works currently. Everyday is a challenge, which makes it a fulfilling endeavour for problem-solvers".

Ganapathy adds, "ISRO has been highly supportive to us. ISRO has placed a contract with us for development of Microwave Plasma Thrusters. This is the first time where ISRO is working with a startup company for joint technology development. We are happy to have more of such contracts with ISRO. We are also supported by DRDO. We are open to work with other government/space agencies".

Gadadhar is now working with ISRO-LEOS to create a new class of super black coatings for use on spacecraft. He feels that he will be able to work with more organisations because nanotubes have a wide area of applications.

Poddar plans to work with various emerging actors in space for capacity building and training. They are already in talks with Bin Rashid Space Centre in the UAE.

Currently Nikitha gets requests to conduct programs in schools but a major challenge is funds. Recently, their organisation has received best NGO award for their events aimed at promoting space education at the Corporate Volunteering Conclave 2018 organised by Youth for Seva, supported by Infosys and ONGC.

The road ahead

As we can see most of the NewSpace India participants are testing the waters. They have been learning by doing. Now the time has come for a more structured approach that enables better incubation. Fortunately, Antrix is open to such ideas. Various policies and acts need to change from being restrictive to being enabling.

Basu adds, "The education of the customer about space-based services is limited today, both in India and abroad. Unlike navigation services, which was valorized by the onset of the smartphone, imaging and satellite communications are still limited in their reach". He envisages a future where entrepreneurs and space agencies will increase the understanding of how space technology can improve the lives of people and businesses, "without having to send a sports car in deep space".

Kaul would like to see India as represented by ISRO-DOS and the Indian private sector in the international Big Boys Club! This requires that we 'connect the dots' "from school curriculums to university specialization in new ways and with new updated content". She stresses the importance of a regulatory framework which allows Universities to innovate and invent, transfer technology for commercialization, be joint patent holder/licensors and "benefit financially from the fruits of their genius and labour".

Kumar would like to see "increased awareness of what space can offer, as a place and an industry". The space sector must become more mainstream and more companies look at space as an opportunity for growth, thus accelerating growth of the sector for greater ROI, which in turn will attract more investors. "Ultimately, it would be great to see space as just another sector within society, rather than a niche area off in the corner".

Prof. Arup Dasgupta, Managing Editor
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THE MAN WHO CAN CHANGE SURVEY OF INDIA

Once a soldier always a soldier. The turf may change, but the skills army training inculcates, makes leading from the front, taking up challenges and finding solutions, a natural instinct. The theory gains strength as we indulge in a candid conversation with **Lt. General Girish Kumar, Surveyor General of India,** and explore his urge to make a difference in the Indian geospatial scenario, even when the odds are high.

You took over as the Surveyor General of India in October 2017. Under your leadership, what all new projects is Survey of India (SoI) planning to undertake?

Our main aim is to generate large-scale data for the entire country. As of today, we have printed maps at 1:50,000 scale, and now we want to upgrade the same maps at 1:25,000 scale with updated content and within the framework of all national policies. These will be available in printed form. We need to print maps as they are used by many departments, including the defense forces, paramilitary organizations etc. However, the data content will be much finer than 1:25,000 scale.

Digitally, we are targeting data at 1:10,000 scale; and urban areas will be mapped at 1:2,000 and even 1:1,000 scale. Recently we carried out a pilot project with the Government of Maharashtra where we used drone mapping. Now, we will take up mapping of 38,000 villages in the state. There are other such projects in the pipeline.

All these map generation work -- be it 1:25,000 or 1:10,000 --is planned to be complete within the next two to two-and half years.

We are also working on an integrated G2G platform for sharing data generated by Survey of India for various government agencies. This is in accordance with the government's data sharing policy. This will benefit all government agencies since it will be accessible to all user departments.

Further, we are actively reaching out several ministries and government agencies such as the Ministry of Home Affairs, Indian Meteorological Department, National Disaster Management Authority, Indian Railways etc for helping and enabling them in their projects.

SoI has also been playing a significant role in the National Hydrology Project, which is one of its kind. Please tell us more about it.

The National Hydrology Project of the Ministry of Water Resources involves gathering hydro-meteorological data which will be stored and analyzed on a real time basis. This is a World Bank aided project and envisages covering the entire country. Roughly, 8 lakh sq. km area will be covered under this project.

Survey of India will give them data at 1:25,000 scale with digital elevation model with 3-5 meter accuracy. They have asked for very high-resolution elevation model with 0.5 meter accuracy for about 60,000 sq km. We will be conducting fresh surveys for all this work. Since the requirements are immediate and huge, we will be outsourcing it, and agencies will be selected on the basis of open bids.

> We are having a very positive dialogue with the Department of Science and Technology. The DST Secretary has given his full support, and there is also full support from the minister

What is the progress on CORS-network?

The CORS [Continuously Operating Reference Station] network is an important project for the country. The proposal has been submitted to the government and it is awaiting final nod. Though there is no in-principle disagreement at any level, we need to fine-tune certain requirements. I am confident of rolling out the project by the end of this year. CORS needs around INR 1,000-1,200 million to cover the entire country.

As we understand, there is a serious human resource crunch in Survey of India. What are the reasons and how do you plan to tackle this issue?

For every government recruitment, there is a recruitment rule that has to be finalized in consultation with a number of departments and ministries, and then the rules are gazetted, following which you can call for recruitments. Survey of India recruitment rules were very old and therefore posing problems. Now, we have revised the rules in consultation with Department of Science and Technology, and new recruitments will soon take place. The department has been very supportive in these endeavors.

Funds allocated to SoI are very low as compared to other geospatial data generating agencies. What's your take?

Departments project their demands to the government almost a year in advance. Since at that time SoI didn't have many projects under consideration, the demand raised was less.

Now, we that we are engaging with various departments and undertaking new projects, we have submitted a separate proposal seeking about INR 4.97 billion. As soon as the schemes are approved, the funds will be released. This INR 4.97 billion will be over and above our annual allocation of INR 4 billion. Of course, this money will be spent over the next two-three years as part of progress of the projects. Fund crunch will not affect the work of SoI.

You have also been talking about empowering Survey of India. How can that happen?

Since I have taken over, we are having a very positive dialogue with the Department of Science and Technology. The DST Secretary has given his full support, and there is also full support from the minister. The ministry has already initiated few proposals to empower the Survey of India in terms of manpower, resources, policies, and guidelines. There is also a proposal to increase SOI's power at regional level. I am very sure that with this support, the organization will achieve its goals. The process has at least begun.

Do you think India needs a proper national geospatial strategy to move ahead?

A single geospatial policy framework needs to be debated upon. Integration of all policies under one umbrella is a good idea from the industry point of view, but this needs to be taken up at the highest level. It needs to involve all stakeholders keeping in mind the pros and cons of a single policy and its implementation as well as mandate and business rules for various ministries.

BUILDING A GOOD ECOSYSTEM TOPS THE PRIORITY LIST

There is a need to make space-based technologies available to the Indian industry to capitalize on their strengths so that the knowledge and technologies that are available with ISRO are exploited in a better way, highlights **Rakesh S, Chairman & MD, Antrix**

As the commercial arm of ISRO, what is your outlook on the demand for space-based technologies in India and worldwide?

Antrix has the responsibility of leveraging on the technology and products of Indian space program to generate revenue for the government. If you look at the space scenario today, a lot of changes are happening. We are in the middle of a transformation in terms of technology and applications, and there is a growing demand of both in India and globally for space-based technologies. Antrix has a very important role to play in these times in making space-based technologies available to the Indian industry to capitalize on their strengths so that the knowledge and technologies that are available with ISRO are exploited in a better way — both to solve the needs of the country and create revenue for the government.

Today, we have a great opportunity for commercializing the technologies and monetizing it due to the developing market in India. Towards this, Antrix has embarked on an active interaction with ISRO to identify specific technologies, address some of the policies and bring market information to ISRO and Department of Space. The company has been engaging consultants to analyze the market for deep insight on the

Indian market. The information gathered can then be used to develop products and services in future.

With a plethora of opportunities to commercialize and monetize technologies, does India have a strong ecosystem to support this?

This cannot be done by ISRO and Antrix alone. There is a need to have an industrial base. A good ecosystem building is an immediate priority for Antrix. Firstly, we need to make the technology available to the industry so that they can leverage on it and make them capable to build products. Secondly, the market that is evolving needs to be made available to the industry. The information we collect from this can be utilized appropriately to upraise the industry.

Which are the big revenue generator verticals of Antrix?

The main revenue earner for Antrix is the SatCom vertical (transponder provisioning services). However, our launch services is doing very good too, and seen a huge market growth. This has been taken up with ISRO to have some specific commercial offerings like a specific launch vehicle to address this market. Rather than being dependant on spare capacity that will be available in the national missions using PSLVs, etc., we need to have focused offerings for the market.

What has been driving the growth of ISRO's launch services?

The fact that we are doing well explains that we are commercially very attractive to our customers. There are not too many players in the launch market. The requirement of the small satellite industry is burgeoning and that keeps us going. As said earlier, we need to have focused offerings to address this market in future.

Do you think ISRO's plans for a small satellite launch vehicle will be commercially viable?

Antrix is working on this and right now the market looks positive. Given the track record and knowledge ISRO has, it seems it will be possible. Antrix is doing a detailed analysis of the market and the small satellite launch vehicle itself. This will help to determine if it is commercially viable and profitable in the future. Post that, the company will be embarking on it.

What is your take on the reusability concept of launch vehicles?

ISRO is working on the concept. There is a lot of hope that this technology will prove its worth in the near future and that it will bring in further commercial value to the propositions that Antrix is offering to the customers. It is still in the developmental phase and commercial application has to be worked out after due analysis.

What is the progress on the heavy lift launchers and has Antrix started marketing it?

ISRO has developed a new heavy lift launcher. In the near future, it will have 4 tonnes and later on 6 tonnes launch capabilities that will meet future requirements of ISRO. Antrix is probing market opportunities and require a commercial launch for it. Unlike PSLVs, this will require a full launch vehicle being bought by a customer and for this the launch vehicle needs to be available to us. So right now, there is a lot of requirement for meeting the domestic demand itself. The company is in discussion with potential customers and seeing where in the next three to four years we can have a launch.

What is your take on the Space Activities Bill, 2017?

The policy has been a long awaited one. I am happy it has come out now and we need to work closely with the private industry. It should be an enabler. There has been a lot of scepticism from the industry about the Act. But I would like to take this opportunity to say that the Act will have many clauses that is only to meet various eventualities that may come in such kind of business. Hopefully, in the near future we should be seeing the Act coming in.

INDIAN RAILWAYS CHUGS ON GEOSPATIAL

GPS-based mapping of Indian Railways assets on GIS platform likely to help improve maintenance, plan new projects, monitor encroachment and avert mishaps, says **Sanjaya Das, Additional Member Railway Board (Computerization and Information Systems), and former Managing Director of Centre for Railway Information Systems**

How is the Indian Railways utilizing geospatial data and technology?

Indian Railways has used geo-fencing for unreserved ticketing. Two other major projects have also been undertaken where there is extensive use of geospatial technology. We are contemplating mapping the entire stretch of Indian Railway, tracks with geospatial coordinates. Then we will follow up with mapping of all Railway asset. Once this is complete, we will be able to know exactly what is the maintenance situation regarding the tracks, signals and overhead equipment (OHE). The data will be used to improve maintenance, planning new projects and also to monitor movement of trains.

Which are the important projects?

The first is mapping of the entire railway asset infrastructure – which is in two phases; the first is the mapping of the entire track network in the country, and in the second phase we will do mapping of railway land and other assets along the tracks. We are working in-house for the mapping of the data and have developed a GIS module for this.

We have got satellite imagery data from National Remote Sensing Centre (NRSC) and we also conduct manual surveys using GPS devices. Track maintenance trolleys are fitted with GPS, so that when the inspectors use these trolleys for regular inspection, their coordinates are recorded and database of the entire track is created on section wise basis. After tracks, we will cover land and buildings along the tracks.

As part of the second phase, an MoU has been signed between ISRO and Centre for Railway Information System (CRIS) to develop this application. In this application land plans of Indian Railways will be available for viewing overlaid on satellite imagery. The INR 320-million asset mapping project began in April 2017.

We are collaborating with NRSC for this project where they have provided us with Cartosat imagery and Bhuvan data for making the maps. In addition, we are also flying drones to map the tracks. The progress is a bit slow as we are doing everything in-house. Things can expedite with better interaction with the private industry.

The second important project that we are working on is the real-time tracking of trains. Under this, NavIC devices will be installed in the entire fleet of about 12,000 locomotives to locate each train accurately. Railways is again working with ISRO on this project. This data will be put into our control office application through passengers can get updates on real-time position of trains.

This application will ensure higher safety — once the exact location of a defective train is determined, we can immediately take action to rectify the problem, and thus avert any mishaps. The technology will also be used to give warnings at unmanned level crossings.

Besides this, all the 2.5 lakh wagons of the Indian Railways will be tagged with radio-frequency identification (RFID) to keep a track of each wagon. The GPS-tagged loco will tell you where the locomotive is, but if some wagon gets detached, or is in the shed, or has been stolen, the RFID tag would help us track it quickly.

Railways is also thinking of 3D mapping of all the stations. Under this project, six stations have been chosen as pilots. Here also NRSC is involved and they have mapped two stations, including Varanasi and New Delhi. Once the 3D mapping is complete, we will develop an app through which passengers will be able to visualize the entire station in 3D and thus locate any services at the stations. Here too, we hope that the private players will play an important role in future.

Real-time tracking of trains had started 10 years ago, and is still in process. What has been the cause of this delay?

In 2009, trials were conducted for real-time tracking of trains in Secunderabad division and subsequently further trials were conducted in Chennai. Even IIT-Kanpur undertook a project of tracking trains using GPRS devices between New Delhi and Kanpur. The Real-time Train Information System (RTIS) is today using the learnings gathered from these trials. If the country's geospatial infrastructure had been good, these applications would have been rolled out faster. I would say Railways was thinking ahead of times when we envisioned some of these projects and it is only today we are in a position to implement them.

Can you give an idea as to how much of Railways IT budget goes into geospatial data and technology?

Only about 1% of Railways' annual IT budget is allocated for geospatial. The work on this had started many years back but the progress has been little. Only if there is a rapid process in this area, we will be able to scale up the funding.

The RTIS is being done in phases. The cost of the Phase I is about INR 1 billion. For GIS mapping, the budget is not coming from IT but from other department.

As a major user of the geospatial data, what has been the biggest challenge of the Indian Railways?

The biggest challenge is that the government departments are working in silos. There is need for a system of information exchange so that the data collected by one agency is not on a different system of reference. For instance, the surveys done by Railways can be integrated with the work of other survey agencies like Survey of India, as well as by state governments. This will remove the need for reconciling data standards, prevent duplication and needless expenditure on data, and also ease development of applications that Indian citizens can use to get government services as well as services from corporates.

We have Survey of India and NRSC which are key players in this framework. However, there is a need for scaling up operations and giving more power to these agencies so that they can contribute more effectively to the rapid induction of geospatial technologies for the service of the citizens of India.

How can private players work in tandem with government agencies so that citizens can benefit the most?

Private sector will have to play a very important role here. They should work as knowledge partners with the government so that the problem of delivering to citizens can be solved and they have better access to services ranging from ticketing, logistics, subsidies and schemes. Moreover, the services then could be better targeted towards the citizens.

Indian Railways has entered into contracts with many private providers of geospatial services. We are using drones and radars for mapping of railway tracks. These are contracted through tenders.

NEED TO WORK IN TANDEM WITH RELEVANT DEPARTMENTS

The Department of Science and Technology is making efforts for identifying the geospatial data requirements for various government schemes, and working on the National Geospatial Policy to make data sharing easier in India, says **Dr Bhoop Singh, Head – NRDMS, Department of Science & Technology**

The role of geospatial data is vital in good governance. What role DST is playing in enabling this?

The Department of Science & Technology (DST) has a concrete program for developing state spatial data infrastructure. At present, 10 states including Karnataka, Chhattisgarh, Haryana, Orissa, Madhya Pradesh, Punjab, Uttarakhand, Jammu & Kashmir, and north-eastern states including Nagaland and Mizoram, have been taken up on priority basis and on cost saving basis with the state governments and DST at the ratio of 30:70. This condition helps in realising the importance of geospatial data and applications in good governance in the state governments.

By giving solutions for area-specific problems, their data requirements are being met from the state geoportals developed under DST supported by state National Spatial Data Infrastructure (NSDI) programs. All the state geo portals have been linked to the NSDI portal so that users can easily access the data from a single window from NSDI portal.

We are making efforts for identifying the geospatial data requirements for various schemes at state level so that geospatial science/technology can provide a uniform development and help in development activities in the country.

In the next couple of years, DST will be in a position to cover all the states in the country where geospatial science and technology would play a vital role for implementing good governance.

All our efforts are going to be conversed through Digital India and will help in implementing other flagship projects of the government. Our efforts would be complementary in nature with the other departments. Apart from this, there is a need to share geospatial data by all the data generating agencies among themselves and also with the common citizens. For this purpose, the government has already approved National Data Sharing and Accessibility Policy. This needs to be brought in practise because otherwise the departments will carry out applications in silos.

> There is a need to develop our capabilities in making seamless geospatial data available for the entire country

The announcement of National Geospatial Policy has been due for quite some time. What's the progress in this area?

DST is in the process of developing the National Geospatial Policy. At present, the policy draft is being examined by various departments. Once it is completed, it will be submitted for government approval. This entire process will take another 4-5 months.

How do you think such a policy will facilitate easier use and regulation of geospatial data?

A lot of infrastructure development has made geospatial science very easy to use and find out targeted solutions. A National Geospatial Policy would help in regulating all the datasets which are coming through geospatial science, and thus create a balance between development activities and national security.

To control geospatial data, sharing and misuse of the data, the policy will have a National Geospatial Authority which will guide and vet all the data before anything is shared with anybody. It will also help in implementation of the policy.

What steps DST is taking to promote geospatial science and technology?

Being a scientific department, DST has to promote geospatial science, research and capacity building, and also develop national geospatial data infrastructure.

Perhaps, our efforts will lead to an in-depth national level institute on geospatial science and technology which will be exclusively supporting advance research, applications and capacity building in geospatial science. There are various government departments like Survey of India, Geological Survey of India, Department of Space, etc. which are also making concentrated efforts in contributing to the growth of geospatial science, data, services and applications.

In order to compete at the global level, what steps should be taken to achieve higher standards in the application of geospatial science and technology?

For promoting geospatial science and applications, one needs very accurate topographical maps which are being invented by Survey of India. SoI is in the process of developing web maps and features map service. They have already covered couple of states, and I am hopeful that in the next six months or so the entire country will be covered. Once the WMS and WFS are ready, the sharing of data will get accurate and it would be easier for other departments to attend applications using geospatial technology as per their requirement.

There is a need to develop our capabilities in making seamless geospatial data available for the entire country, in open series on 1:50000 scale, and zoom in and zoom out up to 1:10,000 scale, which will have district, block, panchayat/village with their current boundaries and geographical maps. Once this data is ready, we can update this with latest satellite images of high resolution and update the boundaries. We can also replace the use of Google maps with this dataset and attend to all the routine day-to-day needs of various agencies. This data can also then serve as base information for developing various apps for planning on smartphones or smart systems.

We have to work together with relevant government departments like Survey of India, National Informatics Centre and Department of Space to make this a national mission. This would be a big strength for the government to develop its own indigenous geospatial development model rather than depending upon Google data and their server which is not located in India.

GEOSPATIAL
A CRUCIAL COMPONENT OF THE INDIAN ARMY

Like any reckonable army, various technologies like 3D modeling, flythrough, heatmaps of various incidents, etc. have been incorporated into our Decision Support Systems, highlights **Lt. Gen. Anil Kapoor VSM, Director General Information Systems, Indian Army**

With advancements in technology, and at a time when data and information is more important than valor to win a war, do you think the role of DGIS has changed over the years?

The role of Directorate General of Information System is to realize the Net Centricity vision of the Indian Army through synergized implementation of all Information System Projects. As part of this charter, the directorate is on a fast track to transform the Indian Army into a fully net centric force by end of 13th Plan. However, challenges do arise because of disruptions and emergence of new technologies. The DGIS is fast adapting to these challenges by carrying out internal restructuring of the organization. Agility is an important criteria required to overcome the disruptions that are taking place in technological space. We at DGIS are striving to become more agile in our approach while developing and fielding Info systems. The directorate is constantly embracing new technologies to further improve the situational awareness and enhance the decision-making of the Commanders.

The role of geospatial data and technologies in geo-intelligence is undisputed and well established. How has DGIS used the new technologies as part of its workflow to empower the Indian Armed Forces?

Geospatial data and technologies form a crucial component of our information systems. The spatial data will be ingested in our systems through the Defence Series Maps. Also, the information will be updated directly by field formations and then will be provided to our Decision Support Systems. Like any reckonable army, various technologies like 3D modeling, flythrough, heatmaps of various incidents, etc. have been incorporated into our Decision Support Systems. Assistance from DRDO, CAIR, SAG is being sought and best industry practices incorporated along with security requirements while utilizing COTS products.

How would you compare the information system of the Indian Army to the developed world?

Network Centric Warfare (NCW) capability has proved to be an essential component of a nation's war fighting ability in the present battlefield milieu. We are aware of the manifested benefits of a network centric capability of the US Army in 'Op Iraqi Freedom' and 'Operation Enduring Freedom' that resulted in successful Joint Operations against Iraq and Afghanistan. Concentrated efforts are being made to realise the network centric vision of the Indian Army.

Today, we stand at the cusp of being 100% network enabled and vigorous efforts are being made to ensure completion in an early time frame. At the same time the systems being developed are secure and state of the art to meet automation requirements of the army. One of the major drawbacks that existed in the past was development of applications in isolation. Now mechanisms have been put in place to integrate developed applications. Cyber security is another major issue that is being considered with the seriousness that it requires. Necessary precautions are being taken while developing the applications to prevent any cyber breach in the information systems.

How crucial is GIS in your area of work? What is being done in the field of GIS by the directorate?

GIS is an important facet of all Operational Information System (OIS) being developed by the directorate. It is crucial as all geo spatial analysis required for OIS applications are carried out based on the GIS and the processed information is displayed to the Commander. DGIS is in the process of developing OIS applications which are at various stages of development, the key issue being interoperability of data.

Considering the importance of GIS, deliberations are being carried out with leaders in the field of GIS and the issues are marked to the highest level in the army hierarchy. The directorate is presently analyzing options of ensuring interoperability of data thus giving flexibility in choosing the best suited GIS by the user versus a common GIS for all OIS components, which would give an opportunity to optimize and build a strategic partnership with GIS developer. The directorate is also making efforts towards exploiting the GIS for in-house software development for the OIS application software and is aspiring to make itself as a Centre of Excellence for GIS in Indian Army.

Do you think that the biggest challenge facing any organization is to integrate them with other systems in a seamless manner?

The Tac C3I systems were developed as independent verticals with no provision of exchange of information initially. The major challenges in integration of system are the heterogeneousity of system, and the system being at different stages of development. However,` a seamless integration by leveraging contemporary technologies has been envisioned and achieved when the systems were recently deployed in test bed formations. The future vision is to seamlessly integrate Operational and Management applications through a comprehensive Indian Army Information System (IAIS) which would be an army wide application catering for all operational and peace time functions of the IA. Integration has come to stay in IA. Hence, we have developed in-house capability to leverage APIs for integration solutions.

For an effective NCW, one requires equipment and weapon systems which are network enabled. While the Indian Army is already doing that for its existing weaponry, how is it ensuring that future purchases integrate seamlessly with its existing systems? Does this form a part of its RFP for any future purchases?

Upgradation of existing systems are being carried out to make them future ready and are perused at all levels of hierarchy. Interactions are being carried out with industry/academia experts to enable interaction/interoperability of legacy systems with future systems. All future systems are being developed keeping in mind the legacy systems. Requirements of integration with existing Information Systems do form part of SQRs being formulated for future systems. Today's integration solution such as middleware (Message Oriented Middleware, MOM), ESB, etc. enable seamless integration with legacy systems. These are being constantly evaluated and embraced.

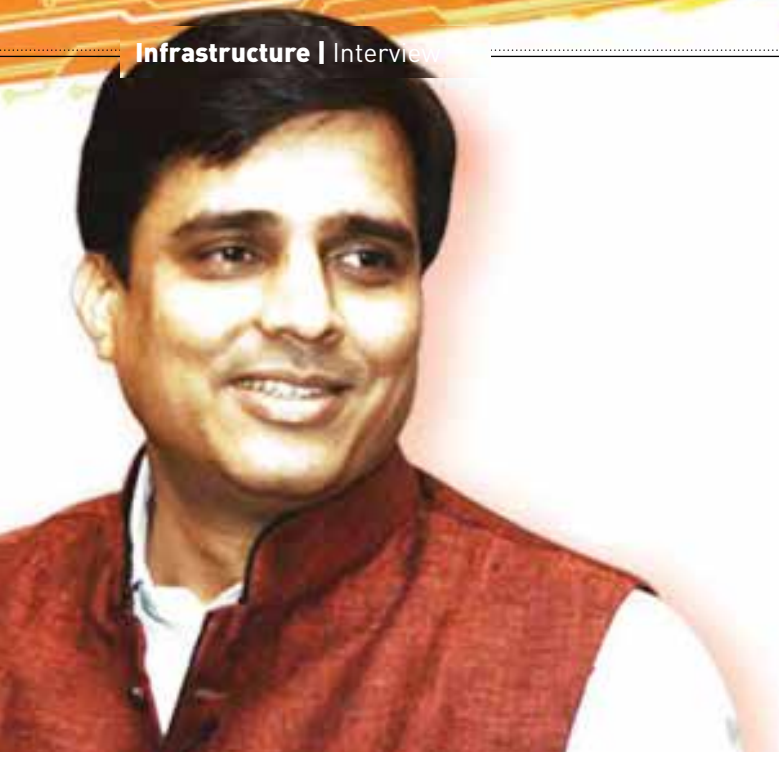
> The three services have made rapid advances in automation to keep pace with the technological disruptions and derive digital dividends

Interoperability between the three services is a problem faced by all armed forces around the world. How exactly are you planning to resolve the problem?

The three services have made rapid advances in the field of automation to keep pace with the technological disruptions and derive digital dividends by leveraging contemporary technologies, however, seamless interoperability between the services is still a niche area which requires focused efforts. The vision to achieve a common network and interoperability between tri-service developed systems is under progress. Interactions and joint studies are also being carried out to resolve issues between services on interoperability. Interoperable GIS and APIs/ Enterprise Integration Architecture is the way forward.

What do you think is the future paradigm for any organization developing information systems?

Recent years have yielded significant advances in computing and communication technology, with profound impact on Armed Forces. It necessitates the understanding of future paradigm that is going to shape any organization that are involved in development of information systems. In my view, there are seven pillars that are central to successful development of information systems. Firstly, Disruption is a phenomenon that's changing the way business is being done in digital world. It creates a new market and enhances the value of a product through innovation. We are adopting the technological changes through Agility, by embracing the change and delivering products effectively and efficiency. Another paradigm that we are looking for any future organization is the availability of creative manpower inherent to an organization. These capabilities needs to be tapped by creating opportunities through start-ups and giving them basic infrastructures and resources. Looking into future, dissemination of crucial information to users through apps also needs to be considered by any digital organisation. Future Technologies are being developed and embraced at a fast pace world over. Some examples being Blockchain, Robotics, Artificial Intelligence, Internet of Things (IoT) etc. These technology needs to be incorporated to make the information systems current and efficient. With the explosion of data, Big Data and Analytics are arguably going to be one of the most important technology in the times to come. It can be used to reveal patterns and trends that might otherwise be invisible. Army needs to harness this technology to stay ahead of the competitors' decision loop. With the proliferation of digital technologies, the associated cyber threats have also increased at all levels. To combat these existential threats, a comprehensive Cyber Security strategy incorporating the recent trends is a security and functional imperative that needs to be developed.



NEEDED: DETAILED DISCUSSION ON GEOSPATIAL POLICY AT NATIONAL LEVEL

Today, India is standing at a crossroad where either it takes advantage of the technology or lags behind, believes **Vinit Goenka, Member Taskforce (IT) – Ministry of Shipping, Road Transport & Highways**

What is the importance of geospatial technology in Digital India?

Geospatial technology gives details up to granular levels and hence the decision makers, planners and architects all benefit through the technology. It brings in speed because you can forecast, foresee and preconceive the challenges which are going to come in way, and that eliminates chances of error and delay. Transparency is also achieved because decision making and calculations of cost can be done better. This is going to be a technology of tomorrow.

What role do you think the government should play for a wider adoption of this technology?

In India, infrastructure has been largely government's baby; be it on sea, that is ports, or on land, that is roads or highway. It may be waterway projects, aviation, or town-planning, the government undertakes citizen services like water, electricity, drainage, sewage collection. They all are largely with concerned central, state and local government bodies.

Let's take an example, a house is being brought down and a building is being constructed over it. When they start the construction, they realize there are various small things to be considered like the location of the sewerage lines, gas pipeline, water pipeline, electricity lines and many others.

Naturally, cost escalation happens because the calculations were not done properly at the planning stage. Now, if you have a geospatial model of the area, you know where the nearest water point or gas point is or how the sewerage line runs; and all this gives an added advantage to the planner. Money and time are saved with smart use of geospatial data.

If you have geospatial data, major mistakes like creating railway line over slumps or dumping areas can be avoided. Geospatial technology gives you contour-level details, using information which is above and under. It also tells you about the nearest existing points. I think overall this technology is necessary and the central, state and local governments must take cognizance.

Now whether the maps or the details will come from Survey of India or whether private players should create that can be debated, and policymakers at the highest levels have to decide that. But they will have to bring in precision-based information as part of our everyday workflows, which we don't have at present.

We have about 15 policies dealing with geospatial, which are often conflicting and mostly restrictive. They do not also address the data sharing and standard issues. Do you think we need one enabling policy?

As any technology ripens or becomes mature and the world changes, there is a need for a relook at some of the policies. That happens with any technology, not just geospatial.

When information technology was introduced in the '80s, there was internal conflict in the minds of planners and the government and even users on how to implement it. But over the last two decades, we can see that everybody has moved. Hence in the months to come, every infrastructure project will have to have details from professionals of geospatial industry.

Today, we are standing at a crossroad where either we take advantage of the technology or lag behind. Now there is a need to consolidate policies and come out with a comprehensive detailed discussion on this policy at the national level.

Also, we should have advisories for the state and local governments, and we should push state governments adopt the central line and discuss about what can be the regional needs of that particular part. However, whether there should be a special department for this

or Surveyor of India should do it, or whether it should come under any particular ministry, that is a subject matter of experts and the government. But it's time we have an independent discussion on these issues.

I personally feel we should have an independent geospatial commission that will have ownership of all maps and all geospatial data. Planners and citizens should be able to subscribe to that data by using information technology or applications. For instance, consider a scenario where a farmer can subscribe to one of the applications for a charge, put his longitude and latitude details, and it gives him the exact location for drilling for water. Now this will help him not only to save money because he has the exact location to drill, but will also save time, protect our natural resources, and with eventually increase the country's agricultural production.

Another example is of mines — whether a mine should be open cast or closed one. An independent geospatial commission or authority or a department can decide on that.

What are your views on data security?

Technology helps you to reduce errors and forecast in precision. But with IT coming in, there will be challenges of data security and data sovereignty. Data can always be used by ulterior motives by some people. So while we talk about geospatial, there should be a commission, authority or department, as decided by the Cabinet or the Prime Minister, who should unilaterally decide on which data to be shared. There should certainly be an element called data sovereignty and the data generated within the country should remain within the country, in the controls of the Indian authority and Indian laws should be applied on them.

How do we protect data in the digital age?

We can do that by putting relevant clauses in agreements and also making sure that the data does not flow out. The clauses — both legal and technological barriers — can be put in. For instance, ISRO has developed this one facility in Hyderabad where any individual can go with proper permission, and access all the raw data from ISRO. They can sit there and work on it to develop further applications or solutions. People can take their solutions out, but not the raw data. This ensures that the raw data is secure and you don't have to incur cost once again to create it. These kinds of arrangements should be replicated in major cities so that people don't have to rush to one particular location. Data sovereignty and data localization are the only answers for this kind of technology.

There is a need of a comprehensive policy which determines the do's and don'ts and also recommends penalties and punishments for the offence. However, the state should provide enabling/alternative infrastructure so that research and industries don't suffer.

Along with a policy, we also need capacity building measures. We need close collaborations with academicians and universities to have courses in this field, such as a B.Tech degree in geospatial. We can train lawyers on updated geospatial laws, and engineers on these modern technologies. There needs to be a focus also to make geography attractive at primary education levels.

Which are the World's Most Geospatial-Ready Countries?

The United States and the United Kingdom retain their position as the leading geospatial ready countries in the Countries Geospatial Readiness Index-2018. **By Ananya Narain**

The global economy is at a pivotal point and as economies realize the importance of leveraging geospatial technologies to stimulate economic growth and bridge the evident socio-economic gaps, the need to assess and evaluate the geospatial preparedness of country becomes imperative. A composite index, the readiness index provides context and guidance to the government to optimize the benefits derived from spatial analytics, and location intelligence technology to create both economic and social value for better governance by 2025.

In its second edition, the Countries Geospatial Readiness Index (CGRI-2018), build on the 2017 edition, has not been necessarily undertaken to assign 50 countries with a definitive rank, but to develop a comprehensive understanding of the decision makers to formulate an inclusive and collaborative geospatial ecosystem strategy. The Geospatial Readiness Index is a blueprint for stakeholders (decision makers both public and industry) to use to develop efficient geospatial capabilities so as to maintain a global competitive advantage – and to deliver better geo-enabled services to consumers – contributing to robust national growth and development. In perspective, the CGRI-2018 establishes USA, UK, Germany, Singapore and the Netherlands as the leading geospatial ready countries.

Not surprisingly, all the 10 leading geospatial ready countries share key traits. The United States of America (USA), retaining its rank from last year, stands on top as the most geospatial ready country. Leading in all five pillars of assessment, the United States of America is at the forefront of the geospatial data infrastructure. With its' NSDI in place and timely updating of high scale (1:200; 1:250 to 1:5000) thematic layers, the country sets a precedence for its counterparts. The country was also the first to establish the Global Positioning System (GPS), which is being used widely across the world. Furthermore, foreseeing an enabling policy framework for commercial growth of geospatial information and technologies, a National Geospatial Bill is submitted to the Congress for approval in 2017. Few of the landmark policies of the country include National Geospatial Policy, Open Data Policy, National Space Policy (2010) with the National Space Transportation Policy (2013) and the Commercial Remote Sensing Policy (2003).

In fact, all the leading geospatial ready countries have an enabling national geospatial policy framework (inclusive of data dissemination and data access) supporting the implementation of National Spatial Data Infrastructure, surveying and mapping policies, open data policies for geospatial data and otherwise, and Space policies.

These countries are also rich in institutions offering distinctive courses for higher education and research, developing a highly knowledgeable and talented pool of human resource for overall user adoption, industry and entrepreneurship and innovation advancement in the country. For instance, most universities in these countries have a dedicated doctorate, postgraduate and graduate programs for pure geospatial education. For instance, University of Twente, Netherlands, offers a Ph.D. in Geo-information and Earth Observation, and Ph.D. in Acquisition and Quality of Geospatial Information. Also, these countries have a wide range of inter-disciplinary courses inclusive of a GIS or a remote sensing elective. These courses range from M.Sc. Agricultural and Biological Engineering (Space applications with NASA at Kennedy Space Centre) by the University of Florida – to B.Sc. Civil Engineering (emphasis on Geomatics), at Marshall University, U.S.A., and many more such courses.

Furthermore, the users of these leading geospatial ready countries, both government and private are able to derive multifold benefits as they have the capability to integrate geospatial information with applications/ hardware and software of different ecosystems such as IT and Engineering. Spatial integra-

LEADERS

Rank 2018	Country	Score
1	USA	67.777
2	UK	40.633
3	Germany	37.540
4	Singapore	34.977
5	The Netherlands	33.352
6	China	32.171
7	Canada	31.963
8	Denmark	31.376
9	Switzerland	30.673
10	France	30.625

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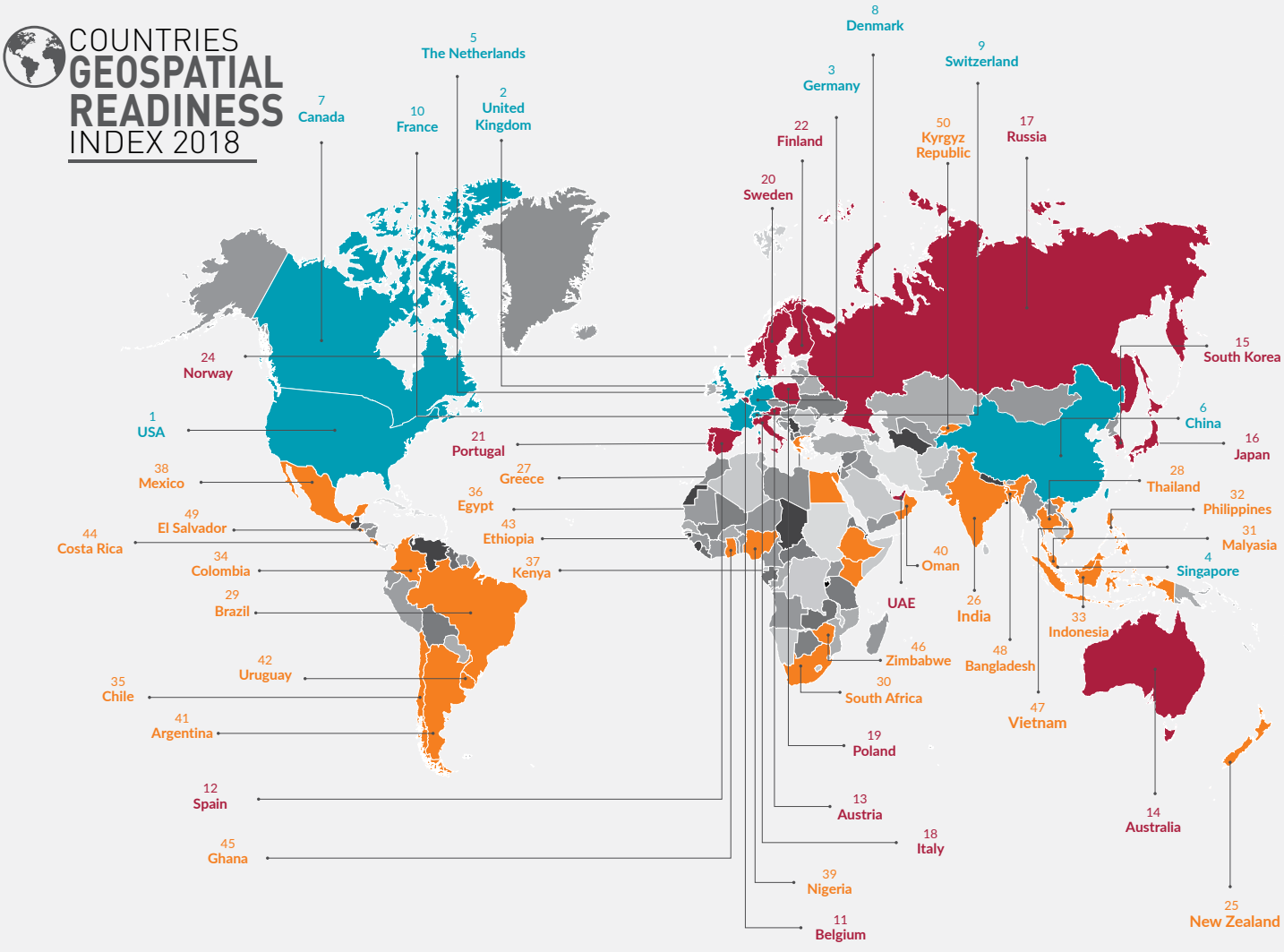

tion, with the digital ecosystem, leads to the creation of unique solutions generating huge economic and social value for an economy.

For examples, USA, Singapore and the European Bloc are using maps as a highly advanced tool for decision making. Maps in these countries are digital and interactive and are used for effective visualization, and communication of analysis, in an engaging way. These countries propel the use of geospatial information and technology in workflow management, and at an enterprise level to provide wholesome solutions to the users. The use of these solutions is not limited to traditional sectors like agriculture, construction, and disaster management, but is applied in specialized sectors like real-estate, building engineering, architecture, banking and financial services, retail and logistics, forestry, among many others. Not surprisingly, these economies are developed and are able to sustain their position as leaders of the world economy owing to their apparent inclusiveness of geospatial strategy in all workflows.

Furthermore, these leading geospatial ready countries have a vibrant geospatial industry ecosystem. These countries have dedicated geospatial technology business incubation programs as part of national programs. For instance, UK-Catapult Centers focus on satellite applications among other areas; Geovation Hub, UK, is focused on property and location innovation; Space startup incubator of the USA and the Start-up Delta and Top Sector Alliance for Knowledge and Innovation (TKI) program of the Netherlands are of utmost importance to further the innovation and entrepreneurship landscape in the geospatial domain. Additionally, these countries have well-diversified representative industry bodies, professional member networks, and institutions along with a diverse spread of the geospatial industry players in products (hardware, software, and content), services and solutions categories for various geospatial technology domains.

In conclusion, while the developed countries lead the Countries Geospatial Readiness Index (yet again!), continuously developing a holistic outlook for framing and implementing geospatial strategies in tandem with expected digital transformations; it is the 'Challengers' and 'Aspirers' that hold the promise for future market growth – commensurate with the extent to which geospatial industry solutions will be strategically deployed to address the socio-economic development challenges in these countries.

To know more about the Countries Geospatial Readiness Index and where your country stands in the index, download GeoBuiz-2018 (geobuiz.com/geobuiz-2018-report.html).

Ananya Narain, Research Analyst
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GEOSPATIAL AND 5G ROLLOUT

WHY THEY ARE CRITICAL FOR EACH OTHER

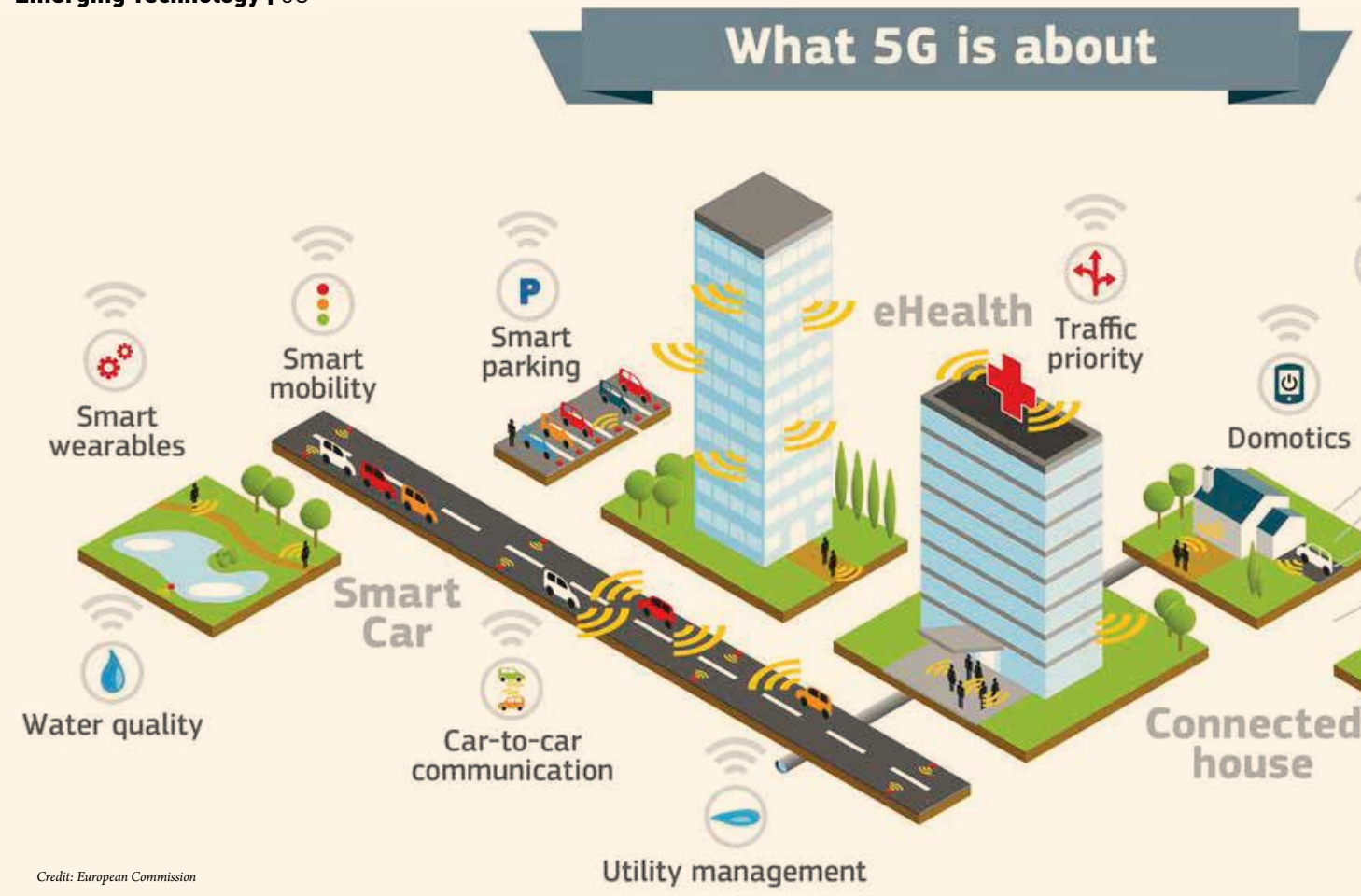
Ubiquitous connectivity, low latency and incredible bandwidth of 5G will present businesses with an innovation platform to help drive new revenue opportunities. **By Anusuya Datta**

5G — the next generation of mobile internet connectivity — is the next buzzword. Promising to offer faster speed and more reliable connectivity, 5G will accelerate the move towards digital as a transformative ecosystem that combines Big Data and Cloud, virtualization and augmentation, automation and intelligent machines, distributed computing and artificial intelligence to derive insights from data that is generated by billions of connected devices. Its ubiquitous connectivity, low latency and incredible bandwidth will also present businesses with an innovation platform to help drive new revenue opportunities leveraging that data and enabling whole new experiences, according to Cisco.

Now that we have established 5G is the critical link for automated machines, driverless cars, Smart Cities, robotics, and many things more — in other words — a connected world, it would be prudent to explore the spatial aspects to it. To put it concisely, how geospatial and 5G will impact each other?

Accurate spatial data is key to 5G

Geospatial and 5G are interconnected. Accurate location information helps governments



Credit: European Commission

design better cities, focus public services and engage with citizens. And as cities get smarter, much of this location data have to be in real time. 5G's higher frequencies — which is needed to carry huge amounts of data — have very short range which can be impacted by smallest of the obstructions. The signal is so sensitive that it can be blocked by the palm of your hand, or even a raindrop. Therefore, accurate, authoritative geospatial data is fundamental here.

5G will also require denser telecom network — more towers placed selectively and strategically. Not just accurate geodata but advanced spatial analytics from tools like those from Esri is also crucial to planning placement of such infrastructure.

Recently, Ordnance Survey came up with a report that said the most cost-effective and simplest way for the UK to adopt 5G is through the creation of a "digital twin". The report highlights the significance of appropriate spatial planning to make a cost effective 5G network, including high-resolution geospatial data integrated with a range of other information types served via a functionally-rich planning tool. Physical features not currently considered in network planning — including street furniture and vegetation and weather conditions — have a significant role to play here.

For instance, Ordnance Survey has created a "digital twin" of Bournemouth, which incorporated over 30 datasets to create a single 3D view of the town. This was integrated with 5GIC's radio propagation model and overlaid with Met Office weather data to create a "live" digital environment, thus allowing the authorities to understand and address all the challenges of rolling out 5G from behind a desk.

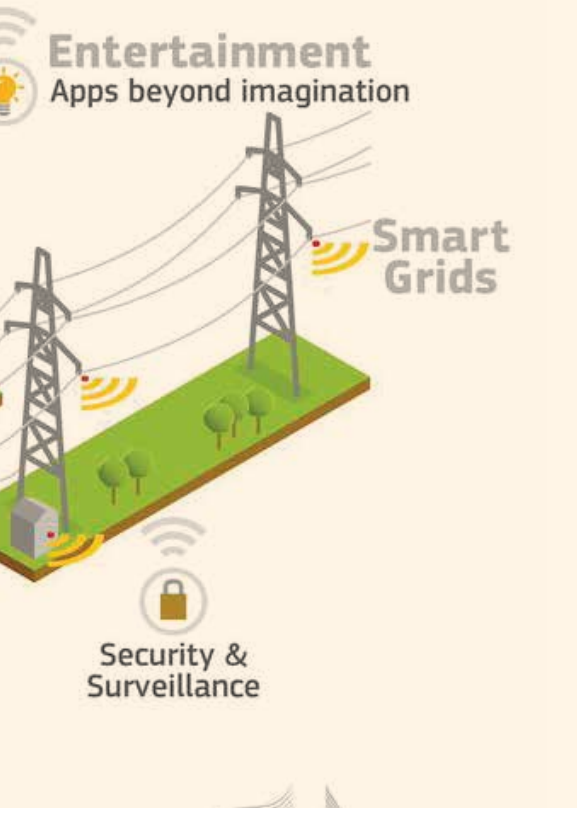
DigitalGlobe is already working with the major telco operators in US on this. In addition to real-time, very high-resolution satellite data, it is delivering cutting-edge 3D models, DSMs, DTMs and more to make them ready for the roll out.

5G key to accurate spatial data

You read it right. The reverse is also true. 5G wireless promises higher capacity, more reliability, lower latency and improved coverage, thus bringing greater accuracy in positioning services. Telecom-based positioning technologies requires telecom stations to be synchronized to nanoseconds relative to each other.

With positioning expected to improve to sub-meter accuracy to even support 3D location estimates, technologies like autonomous vehicles and smart transportation and intelligent traffic systems will naturally get a boost.

5G will also usher in new technology trends that will significantly impact the overall mobile network architecture, thus influ-



encing the traditional positioning concepts as well. With location becoming fundamental to governance and all business process, the value of location-based services for industries such as advertising and marketing, transportation, retail, will only increase since the 5G rollout and its subsequent expansion will enable more mobile interaction opportunities.

Further, as wearable devices gain popularity, an increasing number of wearable technologies will be connected to the network, providing healthcare management, improve quality of life, and work efficiency, predicts Huawei.

As Cisco says, the appeal of 5G is that it isn't just a new technology for service providers to upgrade their network but also it is about what it can do for their customers on their path to digitization.

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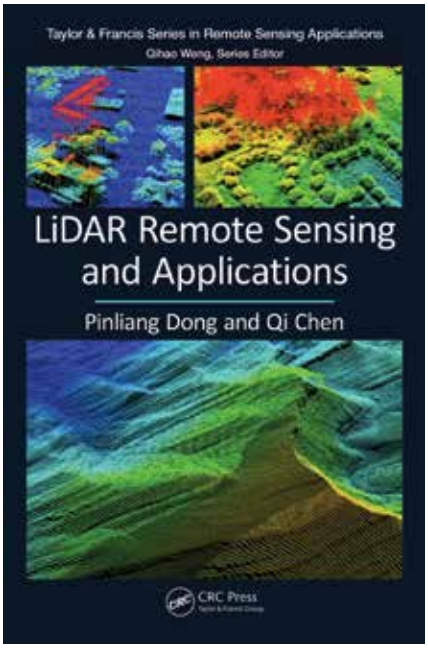
anusuya@geospatialmedia.net



Making LiDar More Understandable

Book Review By
Prof. Arup Dasgupta

Authors
Pinliang Dong and Qi Chen

Publisher
CRC Press Taylor & Francis Group in 2018.

This is a good book for those who would like to understand the applications of Lidar without going into the technical details of Lidar technology, data pre-processing and processing. Chapters 4,5 and 6 of LiDAR Remote Sensing and Applications provide an excellent insight into LiDAR data applications in forestry, urban and geoscience. Each chapter includes projects which illustrate specific applications and the processing steps for various outputs of relevance to the chosen topic using ArcGIS.

The principles of Lidar data processing is well covered in Chapter 3. Beginning with a general description, the chapter goes on to explain TIN-based and raster-based filtering. Principles of DTM, DSM and DHM are explained both theoretically as well as with two detailed examples using ArcGIS. The classification of non-ground points and the use of interpolation to create surfaces are discussed. However, only IDW is explained and not other interpolation methods.

Chapter 4 on forestry addresses area wise as well as individual tree level applications. The discussion on the canopy mapping is quite exhaustive and brings out the limitations of IDW. Several new methods are illustrated but the common ones like beta spline and Kriging. Individual tree mapping and mapping of understory is also explained. While it is mentioned that full waveform analysis is used in forestry applications, it is not clear if the following examples use full waveform processing or discrete returns processing.

Chapter 5 deals with Lidar for urban applications. One of the unusual applications is the correlation of population from building profiles. Other than this, the chapter deals with road extraction as well as disaster mapping after earthquakes through change detection. Chapter 6 is perhaps the best coverage of geomorphology and geology using Lidar data. The examples are also very good illustrations of the techniques used for this purpose.

Chapter 1 covers the fundamentals of remote sensing including optical and microwave radar remote sensing. However, since the book is on LiDAR applications and essentially covers 3D aspects it would have been better to introduce photogrammetry with which LiDAR has a greater relevance. Coverage of both digital optical photogrammetry and SAR Interferometry would have been more appropriate.

Chapter 2 jumps on to the LiDAR fundamentals but the concept of the point cloud is not explained properly. The listing of LiDAR software misses QGIS which includes SAGA which is perhaps one of the best LiDAR software I have come across. The use of case studies to explain some of the basic concepts is appreciable as it will help the reader to understand the fundamentals. However, this will also require the reader to repeat the process on live data. It is not clear if the book is accompanied with a DVD containing the datasets.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- Market size of geospatial industry is approx US$ 300 bn, likely to grow at 13.6% CAGR, touching almost US$ 439 bn by 2020
- Asia Pacific region is going to be the fastest growing Geospatial market at a CAGR of 18.2% during 2017-2020
- GIS and Spatial Analytics market will grow to US$ 88.3B by 2020
- USA, UK, Germany, Singapore, Netherlands, China, Canada, Denmark, Switzerland and France lead the CGRI-18
- UK - Catapult Centres, Geovation Hub; USA - Space Start Up Incubators; Canada - Tecterra Initiative; Australia - DeltaV; The Netherlands - Start Up Delta, TKI program are examples of Geospatial innovation promotion

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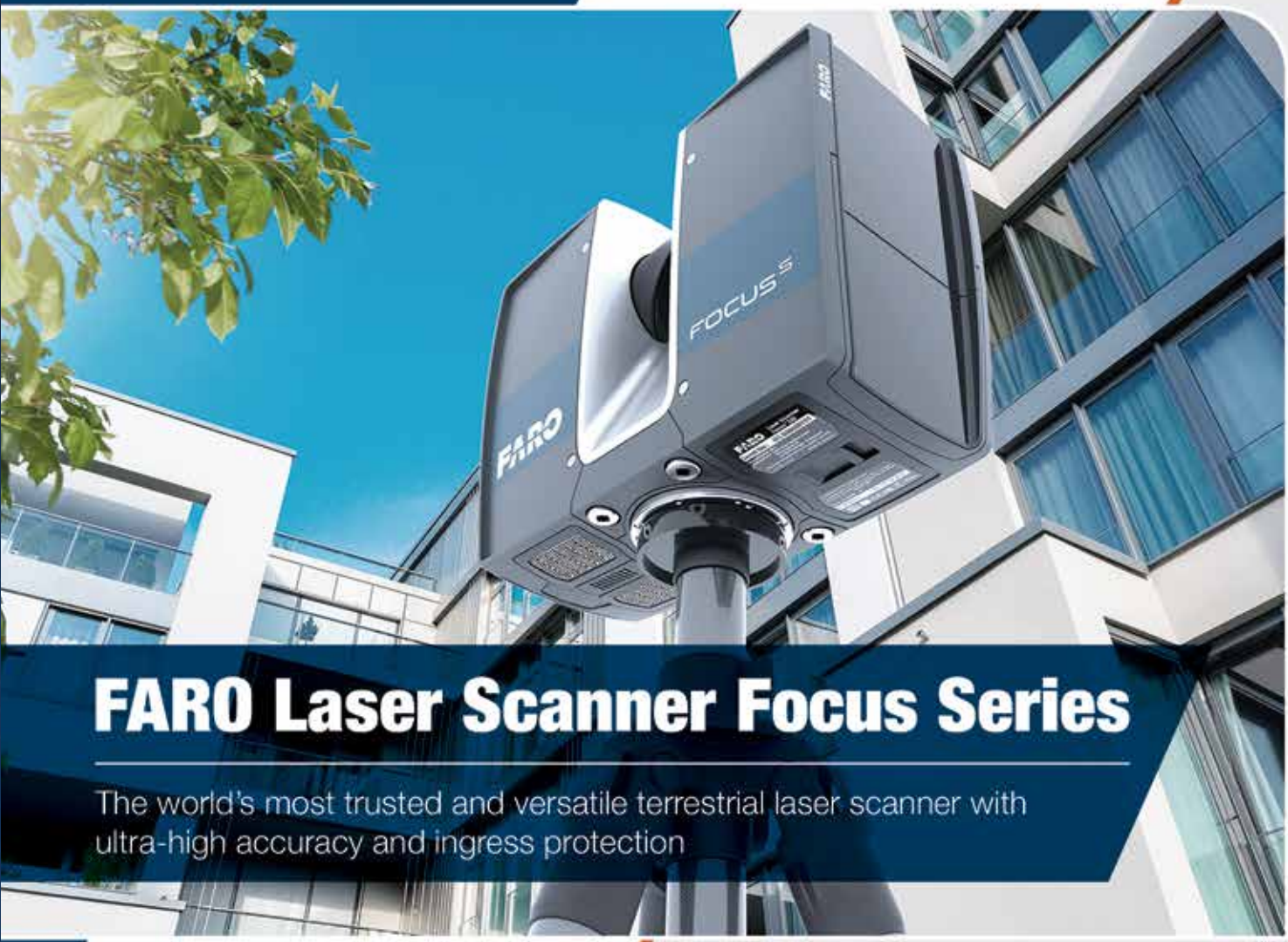

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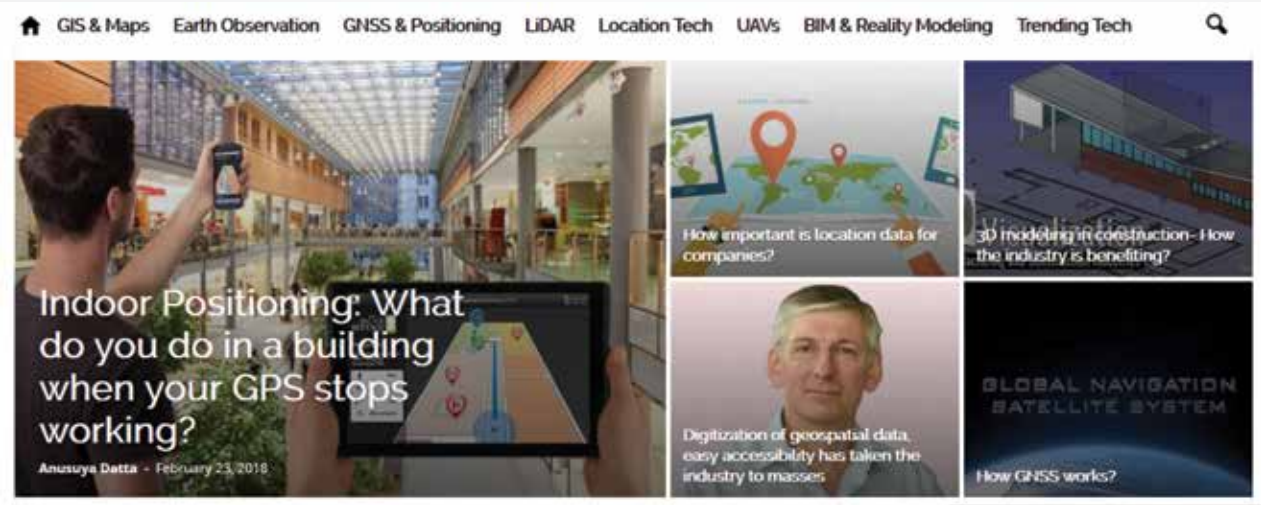

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