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The Great DISRUPTION

Transformation and evolution of the industry has democratized geospatial, but what is this fostering — enhanced collaboration or identity crisis? ***Page 16***

Special Feature

BI and Spatial Analytics: **The Twain Shall Meet** ***Page 24***

P08

CORNER OFFICE

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Managing Director, Commercial Products & Solutions,
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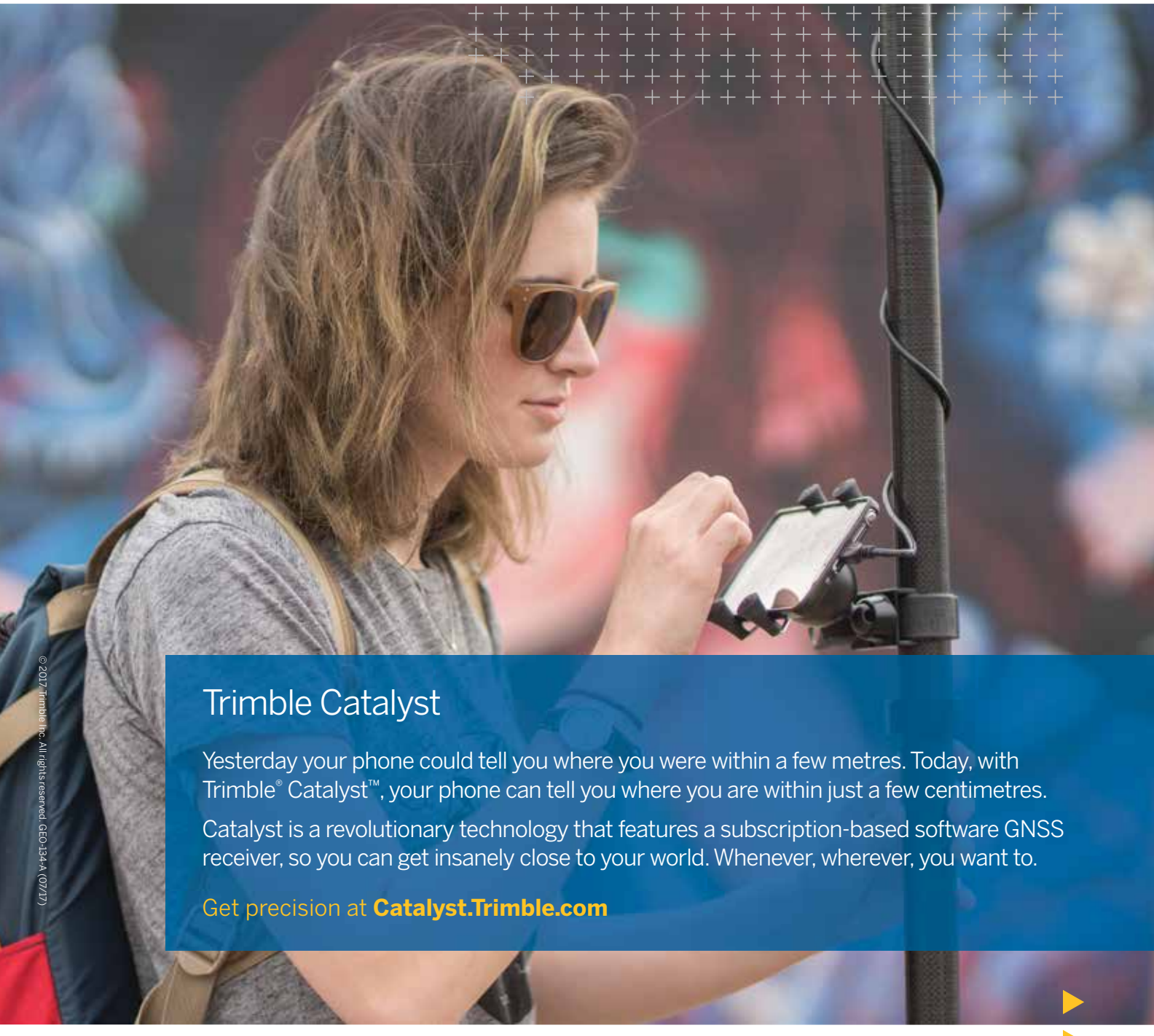

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CONTENT

VOLUME: 07 ISSUE: 03

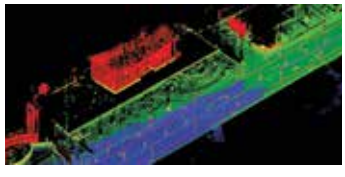
SPECIAL FEATURE

Sandeep Sighal
Director, Cloud Storage
Google, USA

SNEAK PEEK

REGIONAL FOCUS

USEFUL INSIGHTS



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NEW TOOLS SPEARHEADING GEOSPATIAL REVOLUTION

Prof. Arup Dasgupta
Managing Editor,
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"The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance," says Klaus Schwab, Founder and Executive Chairman, World Economic Forum. How do geospatial systems fit into the scheme of things in this revolution?

Geospatial systems are solutions in search of problems, or as David Schell of the OGC puts it more elegantly, application of geospatial technologies is limited only by our imagination. We cannot imagine self-driving cars if there were no maps. In fact, it is maps, those earliest attempts at modelling the world, that gave rise to exploration and discovery which in turn fueled the previous revolutions. Today, maps are but one item in the tool chest of the geospatial professional. Interestingly, most of the others are borrowed from other technological advances and adapted to the needs of spatial information management.

Take the case of Blockchains which emerged as an Internet application for financial transactions but is now being considered for adoption into geospatial transactions. If one looks back, one can see how advances in ICT have been similarly adopted and adapted — Internet, Cloud, Big Data Analytics, AI, to name a few. Another technology that has had a big influence is space. Remote sensing and GNSS are synonymous with geospatial even though these technologies were originally developed for military use.

The question that begs itself is what will be the role of geospatial in the Fourth Industrial Revolution? Here we begin to face uncertainty. While it is true that developments like Google Earth, Google Maps and Location Based Services as well as the proliferation of smart handheld devices have revolutionized the adoption of these technologies by the person on the street, the same cannot be said for government institutions and businesses. The penetration of geospatial systems is yet to realize its full potential.

A major cause is the explosion of spatial data and the means to handle such data becomes problematic. Entrepreneurs are harnessing tools like Big Data Analytics which were being used on transactional data to handle geospatial data and further merge such data with transactional data and even unstructured data from social media. Mladen Stojic of Hexagon calls these 'smart maps' which provide a dynamic information experience by delivering contents using business workflows communicating analytics through user experience that is modern and also makes sense.

It is moot that such a fresh view of geospatial information has registered with the majority of government institutions and businesses. Maps are no longer things that hang on the office wall or pop up when you click on Google Maps. They are a part of your living experience, like as a self- driving car which does not 'look' at a map but uses it to navigate from point A to point B as it deals with a plethora of real time data coming from its body mounted sensors and also received through the fabric of the IoT.

Take the case of crop insurance. While the governments are still coping with conventional satellite imagery interpretation, many young entrepreneurs have taken the problem by its horns and are marketing innovative solutions using not only remotely sensed imagery but a huge amount of data gathered from sources, both planned and opportunistic. A key factor in such solutions is the need for satellite data.

Unfortunately, a few governments are yet to take up the issue of open data and availability of data for free, primarily due to cost issues and regulations.

However, Geospatial leaders are confident that better days for geospatial are just over the horizon. It will take a much greater effort to enjoy the sunrise. That effort has to be towards making geospatial ubiquitous.

FARO UNVEILS FOCUSS 70 LASER SCANNER IN MARKET

FARO has announced the latest addition of its FARO Focus Laser Scanner portfolio. Similar to FocusM 70, the FocusS70 also delivers industrial grade performance with an exceptional price/performance ratio. This includes an Ingress Protection (IP) Rating of 54 for use in high particulate and wet weather conditions, HDR imaging and extended temperature range.

Additionally, users will continue to have unrestricted freedom of choice to leverage the software tools most beneficial to their own workflow, including FARO SCENE and 3rd party software solutions such as Autodesk ReCap.

The FARO FocusS 70 also delivers a set of incremental, value-added functionality that makes it a perfect fit for those applications that require the short range scanning power of the FocusM 70, the next level accuracy of the FocusS 150 or FocusS 350 and the unique power of real time, onsite registration.

This high value functionality enables the 3D scan data, whether it be from a single scan or multiple scans in process simultaneously, to be wirelessly transmitted (i.e., no SD cards needed) directly to an onsite computer workstation/PC in real time.

"We were overwhelmed by the positive response and adoption of the FocusM 70," states Joe Arezone, Chief Commercial Officer, FARO Technologies. "That has validated our hypothesis that there would be significant enthusiasm for an affordable, short range, industrial scanner that was backed by FARO's trusted, best-in-class quality. We have continued to keep our ears close to the ground with our customers and as a result can now offer the FocusS 70 as a higher accuracy companion to the FocusM 70 and a logical fit across the Focus Laser Scanner portfolio. FARO is uniquely positioned to address the wide variety of performance requirements across all market segments and applications that leverage 3D scanning data".

The FARO FocusS 70 Laser Scanner is available for immediate quoting.

KEY FEATURES

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- More data captured faster
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- Improved productivity and confidence
- Supports the real time, onsite registration functionality recently announced by FARO with the introduction the SCENE 7.0 software suite

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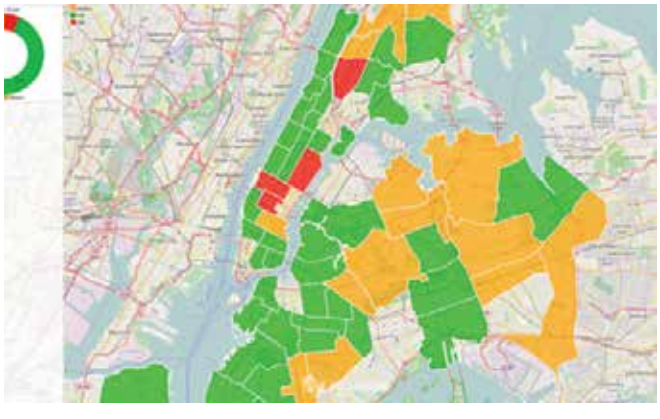
With the M.App Enterprise platform, user can build and deploy its own geospatial applications, called Hexagon Smart M.Apps, to solve the organization's business problems. Hexagon Smart M.Apps are Cloud-based targeted, lightweight, and dynamic apps that provide answers and present information in a visual and compelling way. M.App Enterprise delivers a privately hosted solution for organizations that want to realize the value of a Smart M.App deployment, but stay within the confines of their enterprise network.



KEY FEATURES

- Use tools that incorporate the core components of vector, 3D, point clouds, and analytics to create focused apps
- Create a desktop-like application, browser app or mobile app to provide the best tool based on user requirements. Administrators can also configure different data sources and feature classes, and how each will be distributed
- Create typical workflows that are run day-to-day in the enterprise environment
- Because M.App Enterprise is data agnostic, you can connect to any spatial data source to leverage existing geospatial data
- Users can easily see and access apps assigned to them

Launch of ISRO's first privately manufactured satellite fails

In a rare occurrence to launch the eighth regional navigation satellite, ISRO's IRNSS-1H was declared unsuccessful on August 31 after the satellite's protective heat shield, which is expected to separate and drop off after launch, failed to separate.

However, the post failure findings have revealed that the scientists are strongly suspecting the failure of pyro elements for the non-separation of heat shield from the rocket's [Polar Satellite Launch Vehicle (PSLV)] XL variant.

As a result of the heat shield not separating, the 1,425-kg navigation satellite got stuck inside, leading to failure of the INR 250-million ($3.9 million) mission.

The satellite was launched on board ISRO's old workhorse PSLV, on its 41st mission. The only other failure of PSLV was on September 20, 1993 when the rocket had failed to ignite after the second stage separated.

IRNSS-1H was the first one that was manufactured by a private company. Alpha Design Technologies, a Bangalore-based defense equipment supplier was leading the consortium of private space industry players to build it over the past eight months. A team of 70 scientists from ISRO had been supervising the operations. Alpha Design Technologies has also been tasked to make the next one in the series, expected to be finished by April 2018. Eighth in the NavIC series, the launch of IRNSS-1H was necessitated after all three rubidium atomic clocks on the first satellite in the series, IRNSS 1A, failed around mid-2016.

When asked if this would in any way hamper ISRO's efforts to support commercialization of space activities in the country, Kumar said the matter needs to be studied separately. In the past one year, ISRO has been trying to build and nurture the private industrial capabilities in the country to support its activities.

On August 28, ISRO Satellite Centre (ISAC) invited single or combined bids from private players to build up to 18 spacecraft a year starting mid to late 2018. Already around 80% of the development work on launch vehicles had been outsourced, with ISRO just doing the supervision work. Even Chandrayaan II, scheduled to be launched in early 2018, has many sub-systems developed by private players. "ISRO is encouraging a lot of private industry to come up, as we believe in indigenizing technology and its transfer," Uday Raj, General Manager RRSC–South and Associate Program Director, Space applications, ISRO, had told *Geospatial World* on the sidelines of a seminar on location based services, organized in New Delhi in June. "We are allowing private players to join hands with us to develop some product and services."

Other than outsourcing manufacture of satellites, the Indian space agency is also making focused efforts to consolidate and enhance participation of Indian industries for production of hardware required for satellites and launch vehicles, such as rocket engines, propellant tanks etc. The biggest announcement so far had been the intention to privatize the PSLV operations by 2020.

In a written reply in Parliament on July 20, Dr Jitendra Singh, Union Minister of State (Independent Charge), Atomic Energy and Space, had said that ISRO is in the process of exploring the possibility of involving Indian industry in a greater role to meet the increased national requirements and possible commercial demand for launch services. The main advantage of privatizing the PSLV operations is to increase the rate of launches from 12 to 18 per year.

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The main focus now is to bring together the right information for the right problem, believes **Robert Laudati, Managing Director, Commercial Products & Solutions, Harris Geospatial Solutions**

Harris Geospatial Solutions is known for its contributions towards solving real-world problems. How would you describe the journey so far?

Harris Geospatial's mission has been to look beyond its tools and contribute towards solving real-world problems using technology. The journey so far has been highly exciting. Some of the works of the company include everything from helping utilities to get a clear understanding of the condition and location of their infrastructure to helping agriculture businesses tailor crop management decisions to boost yields and profits. Technology develops at a rapid pace, and to remain relevant and shine through, one needs to continuously evolve. Thankfully, we have been able to keep up with the pace, and at the same time, make significant contributions to the change. Harris Geospatial Marketplace was one such important effort. It came into being when an organization called MapMart.com was acquired by Harris in 2014. The vision was to put together data and analytics to provide real-world solutions.

What is unique about Harris Geospatial Marketplace? How is it different from other imagery providers?

Since its inception, the platform has progressed a lot, engaging many of the leading data providers to provide their data through the MapMart marketplace portal. Taking the technology further, the platform is providing both very simple and very complex solutions so that the customers do not have to worry about where the data is coming from or how to install products locally. They just get access to the solution that they need to solve their problem.

The purpose is not just to provide an ecosystem to access data. While the customers can continue to buy data from our marketplace, the main focus is now moving towards bringing together the right information for the right problem. This way it differs from many of the other ecosystems and platforms out there. The company is really focused

Recent years have witnessed a shift towards commercialization of deep learning and we have come across some very interesting and unique applications of deep learning in the imagery space.

on providing answers that manage and simplify all the complexity like — do I need optical imagery or do I need multispectral imagery, is radar data the right data for the solution? So, Harris has developed a technology that allows users to focus on the business problems they have. They do not have to worry about the technical complexities of imagery data. With a better focus on business problems, the businesses are able to make better decisions.

With an explosion in remote sensing, imagery data is now playing a more important role in solving real-world problems. Do you agree?

Yes. At the Esri User Conference 2017, you could see that there is fundamentally an explosion in the interest and the use of imagery. Historically, vector GIS was very important and people were making incredible and rich maps. But now, you can see Esri is very involved with us in the imagery space and trying to move in analyzing and using imagery for more than just the base map. With that, there is an explosion of sensors that are available. Now we are talking about WorldView-4 from DigitalGlobe and new smallsats from Planet and others. So, the whole rise of radar and SAR as a viable technology is enabling use of imagery data to solve more real-world problems.

What is Harris Geospatial's contribution in this developing scenario?

Harris Geospatial has a variety of products that include some of the portfolios that came from the Exelis acquisition in July 2015. The company has a broad array of commercial products, best known for tools like ENVI and IDL, which are still market leaders in the industry for imagery analytics and visualization. Harris Geospatial is also complemented by a rich array of IP capabilities and product offerings in the government systems space.

In the near future, Harris is seeing a tremendous opportunity in taking advantage of not just a single data type, but putting more than one or maybe two or three data sources together to solve complex real-world issues. It is a real opportunity for Harris to bring together its expertise in all of these specific data types and present them in a way that can be used to resolve and fundamentally change how people use imagery.

Remote sensing with AI and machine learning is the new buzz. How is Harris Geospatial contributing to the revolution?

Harris Geospatial has been heavily involved with deep learning for many years with some internal and government-funded projects. Recent years have witnessed a shift towards commercialization of deep learning and we have come across some very interesting and unique applications of deep learning in the imagery space. Harris technology continues to be a differentiator in terms of many things that you read about today, such as machine learning and AI. These concepts are very broad, but the applications to imagery are quite specific and it goes well beyond what typically you will see around object detection. Harris has been using AI for applications like finding cars and understanding where airplanes are, but what we are moving towards is using deep learning technology to actually extract information and be able to use it and analyze it. For example, Harris has recently prototyped and delivered a solution using deep learning to extract features from LiDAR point Clouds and that is really a disruptive use of AI technology for a specific imagery focused use. We are very excited about the potential of using deep learning as a way forward to manage complexity.

Do you agree that we are on the cusp of the Fourth Industrial Revolution? What major developments in the geospatial industry do you foresee in the near future?

In terms of where this industry is going and the revolution that might be happening with respect to imagery, in particular, I do see the advent of the Fourth Industrial Revolution. I have a long history of GIS and geospatial technology and until very recently, with all the technology that's been available, the output and the delivery of GIS information have primarily been through a hard copy map and a digital map. Now you see that revolution is made possible by the increase in sensors and the increase in the analytical tools. It is really about moving from data to answers. Geospatial technology needs to evolve to be able to provide answers to people who have no experience with GIS; they may not even have an understanding of the concept of location. We can increase the complexity and still keep the end user application quite simple.

I think over the next few years these platforms and marketplace will really become scalable and distributed around different industries. We are going to see an explosion in usage of that information. All of us in the industry from sensor developers to software providers will witness a rising wave of democratization of GIS and geospatial technology. Everyone will be using these technologies in some form or the other, but they don't have to be experts in the field to be able to process the information.

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UN-GGIM reflects on major achievements

In its quest to boost the efficiency of the Working Group, the UN-GGIM committee agreed on developing an easy-to-understand guide that facilitates the use of the principles and instruments for those users who are not familiar with geospatial information management concepts.

The UN-GGIM Seventh Session took place from July 31 to August 4 in New York.

The Seventh Session of the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM) was successfully concluded on August 4, 2017, in New York. The formal committee session was opened by the Under Secretary General of DESA, Liu Zhenmin, who welcomed almost 400 delegates from about 90 countries and international organizations active in the field of geospatial information management. The committee focussed on 17 crucial agendas, including: the contribution of regional committees and UN-GGIM networks to the global geospatial information agenda; strengthening geospatial information management; a global geodetic reference frame; land administration and management; national institutional arrangements; global fundamental geospatial data themes; geospatial information and services for disasters; national geospatial data and information systems; marine geospatial information; legal and policy frameworks, and implementing the 2030 Agenda through geospatial information and its integration with statistics.

Some of the major decisions taken in the session are:

Global geodetic reference frame

The committee emphasised on the formal establishment and composition of a subcommittee on Geodesy and agreed with the proposed Terms of Reference and transition plan. It also encouraged further membership from developing countries with the assistance of the regional committees. On the same lines, the panel supported the planned activities of the subcommittee, including: the development of the roadmap implementation plan; the development of the position paper describing the appropriate governance arrangements; building the GGRF web of communication experts; and developing a five-year strategic plan.

Determination of global fundamental geospatial data themes

The committee adopted the proposed minimum list of Global Fundamental Geospatial Data Themes, subject to minor suggested amendments. It supported the offer of UN-GGIM: Europe, including domain experts, to continue the work to develop more details for each theme, and to work with the Secretariat and other groups to draw up plans for promoting and socialising the proposed minimum list with the wider community, including the non-geospatial community.

National geospatial data and information systems

The committee welcomed the numerous offers of cooperation and support by Member States as collaboration is much required to develop an overarching geospatial framework that goes beyond just technical matters. Countries should be able to refer to the efforts made by others when implementing integrated, evidence-based decision-making solutions that maximize and leverage national systems tailored to their own situations.

The committee also reinforced the need to leverage and build upon the ongoing activities of the Committee and Member States, including guides, standards and frameworks, and the sharing of good practices and experiences in the development of the country level action plans and roadmaps to operationalize and ensure the sustainability of the geospatial framework.

Trends in national institutional arrangements in global geospatial information management

The committee in its quest to boost the efficiency of the Working Group agreed on developing an easy-to-understand guide that facilitates the use of the principles and instruments for those users

INDIA PUTS ITS BEST FOOT FORWARD

An Indian delegation team comprising of representatives from Survey of India (SoI), Department of Science and Technology (DST) and National Security Council Secretariat (NSCS) attended the Seventh Session of UN-GGIM. This was a significant step as India's participation came after a long gap and was widely appreciated for its efforts. In order to achieve excellence in geospatial information management in the Indian context, the delegation made the following interventions:

(Left to right) Surveyor General of India Maj, Gen. V.P. Srivastava , Joint Secretary, DST, B.S. Rawat, DST Scientist 'G' Dr. D Dutta and Defence Specialist, National Security Council Secretariat, Wg. Cdr. Satyam Kushwaha were part of the Indian delegation which participated in the Seventh Session of UN-GGIM.

Contribution of regional committee and thematic groups to global information management

India suggested that it would like to participate actively in Working Group and sub committees like Global Geodetic Reference Frame (GGRF), Integration of Geospatial and Statistical Information, Geo Information for SDGs, Disaster Management, and Marine Geospatial Information. It would also extend its collaboration to United Nations Group of Experts on Geographical Names (UNGEGN) and in capacity building activities.

Trends in national institutional arrangements in global geospatial information management

India is also in the process of upgrading its institutional framework in alignment with UN-GGIM SDGs framework. In this connection, India is of the opinion that Working Group of SDGs should be established for the Asia Pacific Region, to facilitate more focused attention towards diversity knowing the fact that a major part of global population resides in this region and has a big scope to be fully enabled with benefits of geospatial technology. Another objective of this step is to bring the common man under the geospatial ambit, thus bringing in facilities in galore and this would also increase job opportunities.

Legal and policy frameworks, including issues related to authoritative data

India is presently upgrading its policy frameworks, so as to bring convergence, interoperability, ease of business, standardization and technological relevance to meet present and future needs. It is also focussing towards creating high quality authoritative data and making it more accessible and affordable. It is planning to create geospatial eco-systems, with a citizen centric approach, so as to make both technology and geographic data, easily accessible and affordable, to enable easier absorption and adoption of geospatial processes.

It is also supporting the setting up of a Working Group on Legal and Policy Frameworks and intends to actively collaborate with other countries. India would focus on issues that would include description on what constitutes open data, mechanisms that prevent unauthorized data acquisition and distribution as well as misuse of data for unethical purposes.

Integration of geospatial, statistical and other related information

One of the major challenges faced by various governments is integration of huge volumes of non-spatial statistical data with geospatial data and other relevant information. In this regard, India has requested sharing of technical tools and process that could ease the conversion efforts. India is already engaged in R&D work with the UN statistics department, which emphasised strengthening this engagement more with active participation in Working Group and Expert Group.

Geospatial information and services for disaster

India has taken affirmative initiatives in terms of rolling out an updated National Disaster Management Plan which is in tune with Sendai Framework. It has also created a web based geospatial national repository of data called the National Database for Emergency Management, which aids in providing Geospatial Information for Disaster Risk Reduction, Faster Mitigation measures as well as improvised early warning mechanisms. In this regard, the delegation suggested creation of a document to elucidate all dimensions of Disaster Management which includes Geospatial Infrastructure requirement, best practices, lessons learnt, etc. This document can serve as a reference guide for other countries.

Another important point that the delegates suggested was initiation of discussion on creation of a Working Group on aviation to address the present gap. Aviation is significantly important as it is the fastest mode to reach anywhere in the world. This uniqueness is most relevant in terms of both logistics and disaster management. India has taken an important step towards the integration of Maritime Geographic data through the creation of a Working Group.

Over the years India has emerged as a technological giant, especially in the Asia Pacific region. Actions taken on the above given interventions will place the country at a much stronger position in the geospatial world and especially amongst some of its neighbors.

The committee welcomed the alignment of GGIM's Strategic Framework with the 2030 Agenda for Sustainable Development and discussed ways to support the alignment

who are not familiar with geospatial information management concepts. The panel also noted the suggestions to consider linking together the independent efforts and documents of the activities of the committee's Expert and Working Groups – in particular the global geodetic reference frame, fundamental data themes, geospatial standards, legal and policy frameworks, shared principles, and national institutional arrangements – so that they provide a coherent overview of fundamental geospatial information development.

Legal and policy frameworks, including issues related to authoritative data

The committee endorsed the establishment of the Working Group on Legal and Policy Frameworks for geospatial information management, its Terms of Reference and initial composition as proposed, and encouraged the participation and contribution of Member States to the Working Group, noting the need for appropriate expertise and diversity.

It also requested the Working Group to develop mechanisms for Member States to build capacity to address the legal and policy matters that have an impact on the collection, dissemination and application of geospatial information, and in this regard, appreciated the development and preparation of the Compendium on the Licensing of Geospatial Information, and that the Compendium has had wide reviews and consultation.

Integration of geospatial, statistical and other related information

Importance was given on the Statistical Commission's objective to strengthen the mandate of the Expert Group to become the overall coordination group for all activities in the area of the integration of statistical and geospatial information and for regional statistical bodies to develop and strengthen partnerships with the regional committees.

The committee supported the proposal that the Expert Group should actively contribute to the work of the 2020 Population and Housing Census to promote the integration of statistical and geospatial information and the implementation of the Global Statistical Geospatial Framework, and to build and strengthen knowledge management and capacity in developing countries, especially the small island developing States.

Geospatial information for sustainable development

The committee welcomed the alignment of GGIM's Strategic Framework with the 2030 Agenda for Sustainable Development and discussed ways to support the alignment.

In opening remarks to the Seventh Session of GGIM, Liu Zhenmin, UN Under-Secretary-General for Economic and Social Affairs, observed that the committee's agenda includes items that are "closely aligned" to the needs of the 2030 Agenda and the 17 SDGs. He noted that the broad and integrated nature of the 2030 Agenda requires innovative ways of tackling development challenges, and highlighted that the ways in which countries collect, process, and manage data need to undergo a similar revolution, to ensure the monitoring and evidence-based decision making for the SDGs.

The committee, acknowledging that the global geospatial information environment is one that is dynamic, innovative and with new technologies, methods and processes emerging, agreed that data availability and quality remains one of the biggest challenges for Member States, and when available, must also be accessible, consistent and sustainable for the production of indicators to inform on the agreed goals and targets, in accordance with national priorities and needs.

Geospatial information and services for disasters

The Working Group on Geospatial Information and Services for Disasters (WG-GISD) has published a "Strategic Framework on Geospatial Information and Services for Disaster" to guide all stakeholders and partners in the management of geospatial information and services in all phases of disaster risk management.

The committee agrees that the framework will ensure the availability and accessibility of quality geospatial information and services across all phases of the emergency cycle, and as a means to reach out and engage with decision-makers, and endorsed the consideration for drafting a resolution, presenting the Strategic Framework, for adoption by the Economic and Social Council.

Marine geospatial information

The committee gave a thumbs up to the Terms of Reference and establishment of the Working Group on Marine Geospatial Information, and welcomed the participation and contribution of Member States to the Working Group, noting the need for appropriate technical expertise, and good geographic representation. It also noted that, given the complexity and broad scope of marine geospatial information, it is critical to ensure that the Working Group engages with the appropriate subject matter experts to ensure that the Working Group remains focussed, within scope, not political in nature, and connected to the activities of other UN-GGIM Working Groups where and as appropriate.

Overall, one year on from the adoption of the Economic and Social Council (ECOSOC) resolution, at the Seventh Session of UN-GGIM, the delegates expressed great satisfaction with the efforts of Member States in taking strategic actions to implement the resolution and strengthen geospatial information management. The committee foresees more worthwhile efforts from the Member States to have a stronger geospatial information management framework in place in near future.

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The Great DISRUPTION

"We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another."
Professor Klaus Schwab, *Founder, World Economic Forum*

As new technologies and innovations are transgressing the physical, digital and biological worlds in ways that will transform mankind, governments, public institutions and businesses are finding it difficult to keep up with the pace of disruptions. How is the geospatial industry faring?

By Anusuya Datta & Meenal Dhande

For centuries now, maps have played a crucial role in shaping the human civilization. Then came satellite imagery. Since the times of the iconic Blue Marble photograph in 1972, satellite imagery has always produced a startling effect in people. But ever since Google Earth opened our eyes to what maps could do, things have never been the same.

And things have never been the same for geospatial industry as well.

The power of the World Wide Web, automated machines and smartphones in every hand have made the world a big sensor network — bringing location to the center of every thing. The map has become a toothbrush now; we use it for all kinds of decision making — from parking to disaster management — without even realizing the complex geospatial layers and technologies underneath it.

Maps are not just driving apps; they are driving economies too. As new technologies and innovations are transgressing the physical, digital and biological worlds in ways that will transform mankind, governments, public institutions and businesses are finding it difficult to keep up with these disruptions. Old school businesses, run by established leaders, are disappearing in a flash, as new age innovators take the world by storm. And like all industries across the world, the $500-billion geospatial services ecosystem is shaken and stirred. Stimulated by a range of new global shifts, the balance of power between existing and new players is shifting drastically as the industry is forced to move towards innovation, convergence and transformation.

We are starting to see the expansion of the industry to cover a lot more in application types than it traditionally did, points out **Sandeep Singhal, Director, Cloud Storage, Google.** "Companies like Uber and Lyft are being part of geospatial industry as consumers of geospatial products. We are also seeing geospatial industry expand to include infrastructure provides such as Cloud providers who are really providing the core infrastructure for supporting geospatial services."

Where did it all begin?

The world is currently deluged with data, and *Economist* is bang on when it says data has replaced oil as the single most valuable thing in today's world. There are many sources that predict exponential data growth toward 2020 and beyond, and all are in broad agreement that the size of the digital universe will double every two years. This means roughly 50-fold increase from 2010 to 2020.

Technological advances in the collection, distribution and management have made access to this data easier. With the real and digital world coming together there is a change in how people interact with each other or the surrounding environment. What is more exciting is the limitless opportunity that is opening up with technological innovations in the field of digital world. Now, massive amount of data is being brought together applying technologies like Big Data analytics, deep learning and machine learning to fuse the data together, draw conclusion and then present that information quickly in order to drive changes in how to manufacture, schedule resources, monitor and so on.

Regardless of whether the famous quote "80% of all data in the world has a spatial relation" — attributed to various sources — is accurate or not, it is true that over the last few years, the world has seen an exponential increase in the amount of geospatial information available, thanks to smartphones, new and cheap sensors, and automated machines.

"Also, across the developed world, converging technologies are going to open up so many different ways of looking at what we do and in terms of really transforming," says **Mark Sorensen, President UAE-based GPC Group**.

The question is how are we going to handle this data and what we are going to derive out of this. "We need to also see how much of this data is useful, or accurate. For instance, just like the proliferation of fake news, fake or inaccurate data is making our lives more difficult. And that is where we will find the need of this geospatial industry," highlights **Willy Govender, CEO, Data World.** "Our job is to make the world better understand the data we are producing, better acknowledge that data and verify that data, so that based on this data critical decisions can be taken."

$270bn

The projected value of geospatial industry as estimated by Oxera in 2013

$500bn

The current estimated value of geospatial industry

15%

The estimated rate of growth

Substantiates **Anne Hale Miglarese, CEO, Radiant.Earth,** "Data is a big part driving the digital world. And we absolutely have a role to play. Our expertise in analyzing is what brings us to the table. We should embrace it fully."

Geospatial is the golden thread

Traditionally the geospatial industry comprised of people who built maps, models, collected data, presented that data and provided services to understand geospatial information. Now, there is an exponential growth in both the number of data capture methods and, perhaps more significantly, in the amount of data being generated and captured. Naturally, the industry is now expanding to include people building tools for analyzing geospatial data. Further, from offline analysis about once a year or so, spatial data analytics today is all about real-time access to information and analysis of that data.

Ordnance Survey CEO Nigel Clifford is upright when he calls geospatial a fundamental part of the ongoing digital revolution. "If you look at the revolution that is going on in terms of affordable massive technological shifts, geospatial is the one really significant golden thread that is been enabling all users to find sense in some of the huge changes that are going on."

Cloud, IoT, robotics & automation, deep learning & artificial intelligence, augmented reality and reality mesh are opening up new horizons, driving the geospatial industry, and at the same time getting enriched by it. Besides, "massificiation" of maps has led to many more advancements and products around the location sphere.

Agrees **Agendra Kumar, President, Esri India,** "When we talk about a digital revolution, we talk about Internet of Things, augmented reality, machine learning, data captured through drones, Big Data analytics and such. In all these elements, geospatial has a role to play; it is infact an integral part of this. And it will be a key component of the new technologies."

Location intelligence along with business intelligence truly amplifies technology. "We must support business analysts with our new capabilities in utilizing Big Data frameworks in helping them get values and add to the business intelligence solutions that they are

> If you look at the revolution that is going on in terms of affordable massive technological shifts, geospatial is the one really significant golden thread that is enabling all users.

NIGEL CLIFFORD
CEO, Ordnance Survey

> Our job is to make the world better understand the data we are producing, better acknowledge that data and verify that data, so that based on this data critical decisions can be taken.

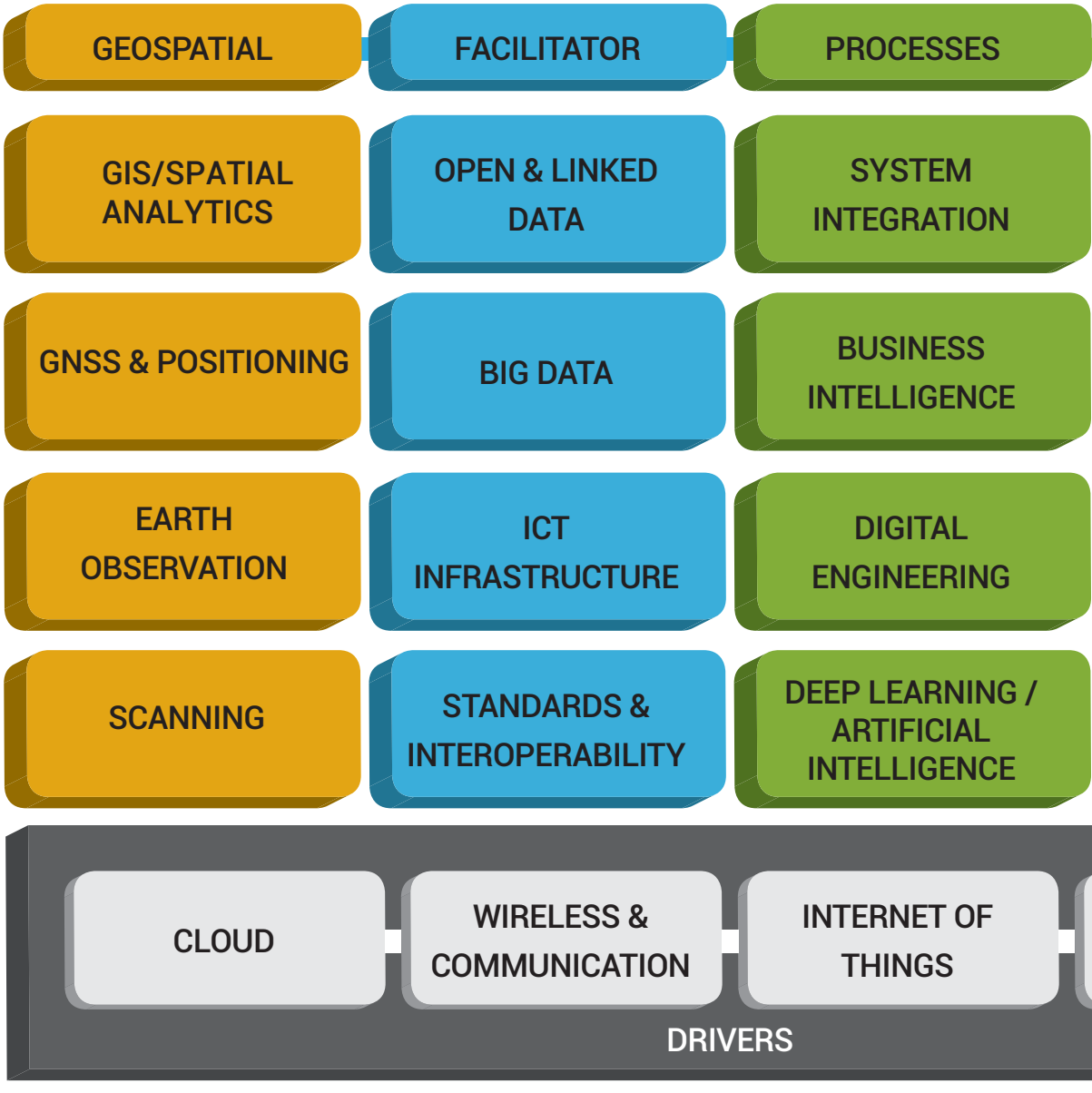
WILLY GOVENDER
CEO, Data World

"We must support business analysts with our new capabilities in utilizing Big Data frameworks, in helping them getting value out of the BI solutions that they are looking to find.

JOE FRANCICA
Managing Director
Pitney Bowes

"Geospatial industry has seen tremendous amount of innovation because these companies [the outsiders] brought their expertise to our applications. And we have further added value.

ANNE HALE MIGLARESE
CEO, Radiant.Earth



Geospatial Technology in Digital Ecosystem

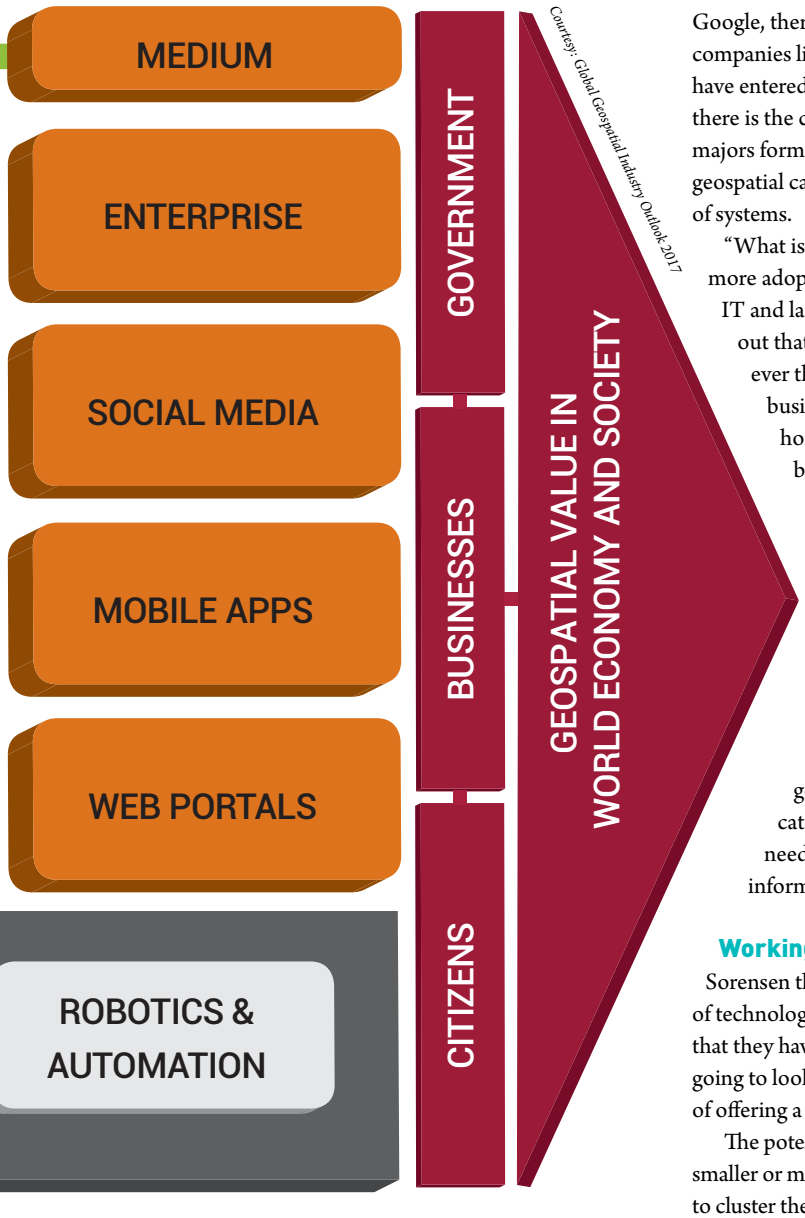
looking to find," feels **Joe Francica, Managing Director, Location Intelligence Solutions, Pitney Bowes.**

Naturally, companies like Google, Esri or Pitney Bowes are rightly seeing this as an opportunity for the industry to partner more effectively to deliver what customers really want — very effective and deep real-time services.

Why more and more businesses are eyeing 'location'?

Location provides the underlying fabric upon which governments or businesses can make smart decisions; it is really the lowest common denominator in that sense. Be it choosing the perfect location for setting up a new bank branch, hospital, or logistics and resource planning for agriculture, or disaster management, geographic information has become a core tool for decision-making. This trend is expected to continue as technology evolves, making capture and application of spatial data more and more cost effective.

"Location is the core route of the geospatial industry. After that each of the businesses are adding their special sauce to the mix," explains **John Ahlrichs, Vice President, Business Development, Planet.**



Courtesy: Global Geospatial Industry Outlook 2017

"For instance, Planet brings imagery, information associated with location survey or bring multimedia to location. That's a mix from us. But at the end everything comes back to location. We all overlap in varying degrees."

It's anybody's guess then why traditionally 'non-geospatial' companies are stepping into the core geospatial territory, primarily as an enabler for their own products and services. Big industrial companies' (like Siemens, ABB etc.) thirst for new, innovative technologies has been a core driver of current merger and acquisition activity in recent times. Besides Google, there are a host of major mainstream IT companies like IBM, Oracle, Apple or Microsoft who have entered the geospatial business. And of course, there is the curious case of a bunch of automobile majors forming a consortium to buy HERE. All across, geospatial capabilities being integrated into all kinds of systems.

"What is happening to the geo industry is that lot more adoption is coming outside the industry. The IT and large engineering companies have figured out that location is an important aspect of whatever they do — whether it is their workflow or business intelligence. Because we are seen as a horizontal technology, these companies are basically leveraging that horizontal capability for thousands of applications," explains **Dr Kumar Navulur, President, DigitalGlobe Foundation.**

Agrees **John Allan, Vice President (Sales and Marketing), GeoSLAM:** "IT and engineering companies have started to use more geospatial information. But, they are not geospatial companies. The importance of geospatial information in every single application is becoming critical. As an industry we need to provide the foundation of geospatial information that can be used by everyone."

Working in silos not an option anymore

Sorensen thinks clients are looking not for pieces of technologies in isolation, but answers to the issues that they have. "So if I have a problem or a vision, I am going to look to hire those organizations that are able of offering a full lifecycle of solutions."

The potential in terms of business aspects for smaller or more specialized entities is to figure out how to cluster their offerings and expertise with the larger players. "I think there is plenty of opportunity because no industry or organization will be able to keep up with all the fast-paced and diversified developments that are happening across the whole technology field," he adds.

Kumar of Esri too sees an opportunity in this. "IT and AEC companies have a basic level of geospatial component or the visualization part, and often they miss out on a lot of other features, which we can provide. It opens a big opportunity for the mainstream geospatial companies to collaborate with these companies to take them to the next step."

Indeed collaboration is the key to how geospatial industry thinks it needs to move forward as new

> A lot of adoption is coming from outside. IT and large engineering companies have figured out that location is an important aspect of whatever they do – whether workflow or business intelligence.

DR KUMAR NAVULUR
President
DigitalGlobe Foundation

> We need to reach out to senior decision-makers – because many of these people grew up in a world before the geospatial industry really existed as such and they don't understand what is possible with technology.

JOHN AHLRICHS
Vice President, Planet

> Today when people think about GIS or geospatial, they think it is a specialized industry. That perception needs to change, making it easy for non-specialists to be able to build applications.

SIVA RAVADA
Senior Director, Oracle

> If the geospatial industry aligns its identity and recognition with the extended ecosystem, it will become more lucrative for new players to align themselves to the geospatial umbrella.

KARTHIK RAMAMURTHY
Director, Ipsos Business Consulting

companies, technologies and business models threaten to disrupt the market. Collaboration is further driving new innovation as Miglarese points out. "The geospatial industry has seen tremendous amount of innovation because these companies [the outsiders] brought their expertise to our applications. And we have further added value."

Is there an identity crisis in this?

While the transformation and evolution of the industry as a whole has democratized geospatial, there is another side to this story too; a couple of hard-hitting questions that the geospatial industry needs to ask itself: Why are these businesses developing their in-house capabilities? Is the core geo industry not capable of meeting their demand?

Siva Ravada, Senior Director, Software Development, Oracle, doesn't think it's a technology issue. "The issue is how the traditional markets have grown — GIS industry grew its separate way and the engineering industry grew its separate way. If everybody is willing to build in a common platform — be it database or be it Big Data platform — then we see it easy to bring these two things together. But today everyone unfortunately try to build solutions from top to bottom and when they do that, they end up separating these two technologies into different categories."

Karthik Ramamurthy, Director & Regional Head (Middle East, Africa, India), Ipsos Business Consulting, is candid when he says it is the lack of required integrated ecosystem on the [geo] industry side and a defined industry identity. "End-user needs are evolving rapidly and geospatial context is becoming a key component of this definition. To keep up with that, considering the lack of an industry definition and capacity, allied industries are extending their envelope," he explains.

Agrees Ahlrichs. "I don't think we have made the products simple enough yet." For instance, while the

earth observation industry created products that are focused on the needs of image analysts, it hasn't taken it to the next level to bring it closer to the IT environment so that the imagery could be incorporated into an application without having to understand what the imagery is all about.

It is true that the geospatial industry, which has its roots in research labs, often tends to act nerdy, and this confuses a potential user. If a user doesn't have to know the complex technology that lies underneath the covers, he is more likely to use it than if he has to know about the technicalities. "A customer is just interested in solving his problem, he doesn't need to know the complexity of the solution that's been put together to solve that," says **Chris Gibson, Vice President, Trimble,** who is upfront that the geospatial community or capability within that is less important to the client than the problem is solved.

41%

Estimated impact of Big Data over the next 3 years

12%

Contribution of geospatial data in the above estimation

12%

Sensors to contribute in the Big Data movement

The industry no doubt needs to be more agile in terms of transformation; otherwise it's always a risk, especially in the fast-transforming field. If the industry doesn't innovate and not move along, others will pickup that and invent those wheels. The geo industry has a choice of ignoring the outside disruptors and innovators, or it can join them, and teach them, add value in the process and thus enable further innovation.

How to engage with the start-up community?

A cluster of business that is really leveraging the geospatial technology for humongous benefits — not only commercially but also socially — is the start-up industry. Born in the era of computers and tablets, the younger generation is more technologically adept, and their tendency to continuously innovate and explore have made them realize the potential of location intelligence more easily.

If a user doesn't have to know the complex technology that lies underneath the covers, he is more likely to use it than if he has to know about the technicalities

In these cases geospatial technology may not be particularly obvious — it might be behind the scene — but it plays an important part. As Allan points out, the people using geospatial information are not necessarily a part of the geo industry, but they rely on it. Companies like Uber rely on good maps, but that doesn't make them geospatial companies. "However, as an industry we need to provide them services which they can use."

Agrees Singhal: "It is important for us to think how to make geospatial data easy to access, quicker to access, more effective in the applications that those companies are trying to build."

And then there are start-ups who very much play within the core geospatial area and have completely disrupted the field. For instance, disruptions in the EO industry such as small satellites or image analysis via artificial intelligence came from start-ups before they were adopted by the core industry. This is enriching the industry — in terms of opening up new technologies, new possibilities and new perspectives.

"The whole NewSpace technologies you hear about where the industry is leveraging the latest and the greatest technologies to make space lot more economical. So, there is lot of innovation going within our industry," says Navulur. Where these start-ups are focusing on is the downstream segment or the analytics part of it. "Because we have been very focused on the horizontal capabilities, these start-ups are trying to figure out how do you take this horizontal technology and create solution for a specific application. That again is a natural progression of a technology from a very niche industry to ubiquitous technology to very specialized applications that become common players in the future."

"We need to figure out how to embrace these and how to integrate them into what we are doing, especially those of us who are involved in the development of government-wide solutions, company-wide or international organizational wide solutions," stresses Sorensen.

> Rather than just been an industry, geospatial is a capability that plays into multiple industries and how spatial capabilities can be integrated into a larger workflow that helps solve customer problems.

CHRIS GIBSON
Vice President, Trimble

> We need to figure out how to integrate start-ups into what we are doing, especially those of us who are involved in the development of government-wide or company-wide solutions.

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> IT & AEC companies have a basic level of geospatial component, and often they miss out on a lot of other features, which we can provide. It opens a big opportunity for mainstream geo companies.

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President, Esri India

> The importance of geospatial information in every single application is becoming critical. As an industry we need to provide the foundation of geospatial information that can be used by everyone.

JOHN ALLAN
Vice President, GeoSLAM

So how do we get the start-up generation engaged and involved?

Francica has the answer: "We need to expose to them our technology that we have traditionally created. We have to expose them to new tools like APIs. These start-ups are not necessarily GIS scientists. By helping them with the difficult part, we are just providing them a way to do geo-processing, and on their part they are helping the community of users who are looking for simpler apps."

Government agencies like NASA, ESA or Ordnance Survey have played a great part in mentoring and incubating start-ups that have brought on some of the biggest disruptions and innovations in recent times. Ordnance Survey's Geovation Hub is a great example of what mentoring can do. It is a safe space for start-ups who want to experiment with location information and technology to ensure that their businesses can really get off the ground. Clifford feels this is a model that could be copied elsewhere to encourage more entrepreneurs to come into the geospatial world.

Gibson thinks it is natural for an industry to evolve and transform, and if any player is coming up with any innovation, the industry will naturally adopt it. This further ensures those new players naturally migrate towards the core industry, which then adopts them and the together the industry as a whole continues to grow. "Start-ups have always been there; Trimble was a start-up many years ago and we transformed the survey industry when we introduced GPS in survey instruments," he elaborates.

In the end, the message is about collaboration, not competition. The industry needs to explain how it can add value in the larger ecosystem, but then leave the delivery to the end users.

"If the geospatial industry aligns its identity and recognition with the extended ecosystem, it will become more lucrative for new players to align themselves to the geospatial umbrella. To be differentiated and strong is in the interest of every player, but the industry identity has to be able to support that," says Ramamurthy.

Is better communication the key?

Most players feel the geo industry needs to communicate better. The industry needs to stop categorizing itself in boxes. To become part of the mainstream, it needs to speak the mainstream language. To break out into the world of logistics, health, epidemics, agriculture, it needs to explain the value of 'where'.

"Just making it more available to people will make it more appealing," stresses Ravada. Today when people think about GIS or geospatial, they think it is a specialized industry. That perception needs to change, making it easy for non-specialists to be able to build applications.

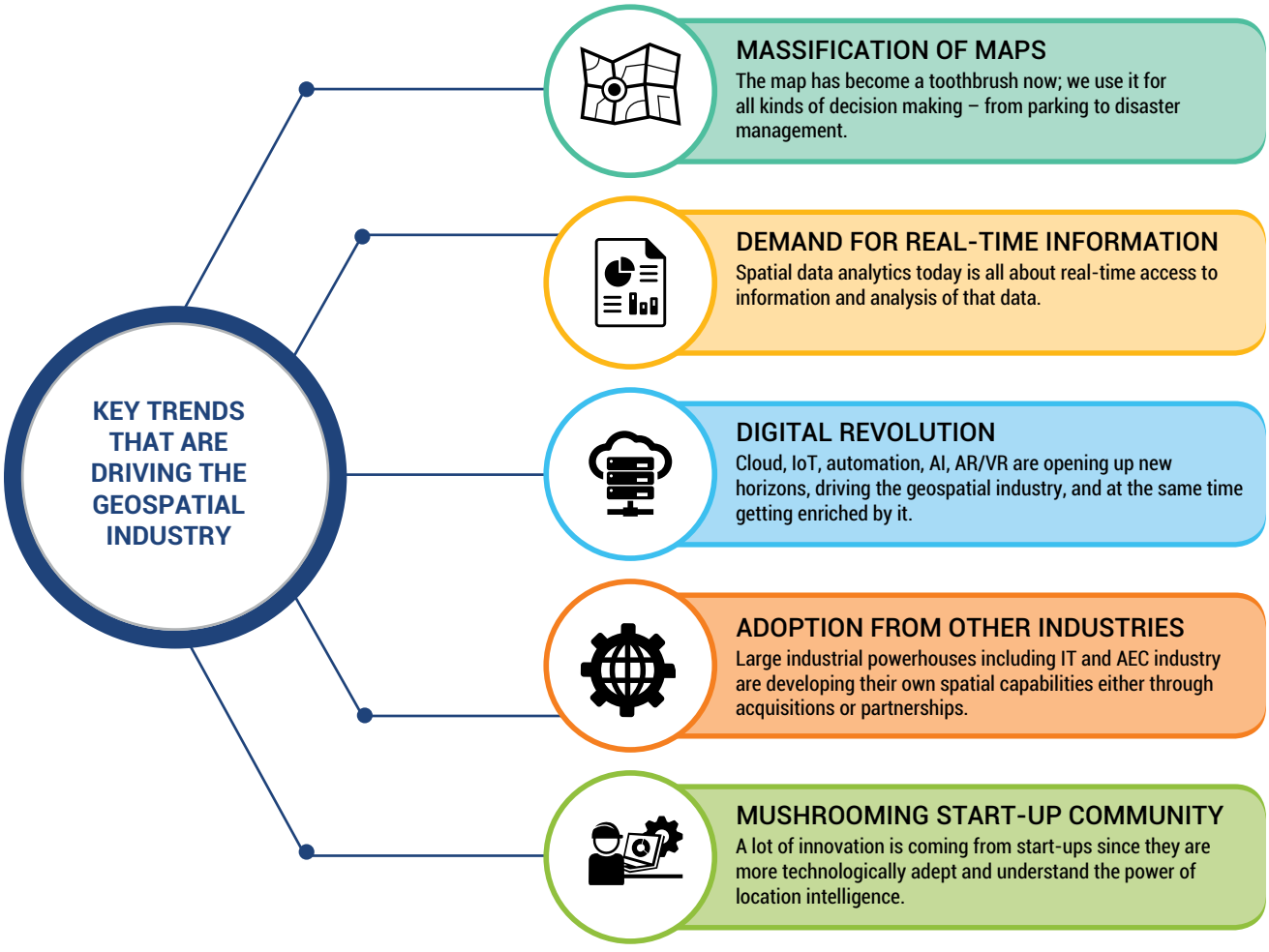
Interestingly, Gibson thinks that rather then just been an industry, geospatial is a capability that plays into multiple industries — government, private and the consumer — and how spatial capabilities can be integrated into a larger workflow that helps solve customer problems. Likewise, he explains that Trimble doesn't think of itself as geospatial company but an IT company that plays in five major industries and looking at another three or four as potential opportunities to grow.

"We need to have a really clear view of the value that we are bringing to the table. Therefore, focus on return on investment and use cases. Also, talking to policymakers and decision-makers in the boardroom is really important as well as having conversations around technology and data," points out Clifford.

The industry needs to reach out to the senior decision-makers — because many of these people grew up in a world before the geospatial industry really existed as such. "They don't understand what is possible before you even get to a discussion on RoI. I find this problem very common with in a government environment," explains Ahlrichs.

The market has changed dramatically over the past five to six years. GIS itself is becoming disruptive technology in many ways. Today, everyone including manufacturing to logistics or e-commerce businesses use a location; it has become core technology for businesses like IT. "I think the criticality of technology, the necessity to have a geospatial base has to come into the way we brand the industry. The brand should communicate the criticality of the technology for every possible business whether its private sector or government," says Kumar.

The geospatial industry needs to stop categorizing itself in boxes. To become part of the mainstream, it needs to speak the mainstream language



Miglarese is candid: "We spend too much time worrying about how to define geospatial. We can define it the way we want to, but its main focus should be on multi-disciplinary implementation of our customers needs."

What is the road ahead?

The future of geospatial is about becoming more relevant to more varied use-cases in different areas of societal benefits, which also means the industry needs to move towards automation and artificial intelligence and embrace the tech-tonic shifts.

Miglarese, who has been part of the remote sensing industry for 30 years, thinks the industry always had the vision. What has changed now is the speed of technology to do it. "With the innovation in sensors, Cloud storage and now with machine learning, I really see convergence of these technologies the possibility of making a difference just barely over the horizon."

There are number of industries where the geospatial capability has been fundamental to helping to transform the way that industry works and help it become more effective, more efficient and more predictable in its cost base and planning etc. "We will continue to see the integration of geospatial capabilities into everyday life and that will be in the way the governments operates and the way they start to plan out new initiatives like smart cities that have to have a huge geospatial component to it for it to be successful," says Gibson.

Geospatial will only become progressively ubiquitous with varied industries leveraging it. However, the moot question is whether the industry will stand on its own or whether it will get subsumed into a larger industry. Worst still, if the industry components will get fragmented and aligned to various industries.

Only time will tell us.

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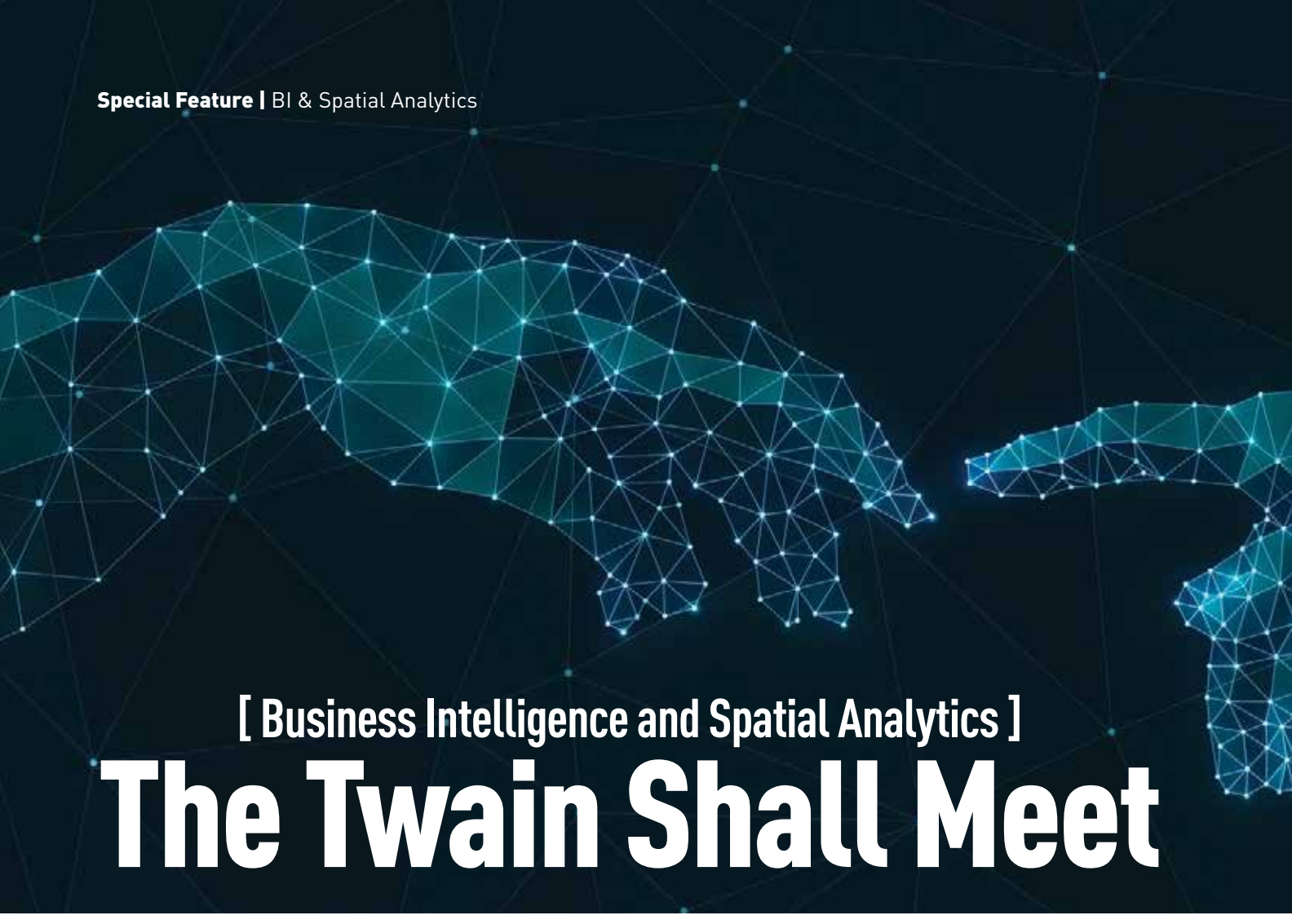


[Business Intelligence and Spatial Analytics]

The Twain Shall Meet

With businesses now focusing on the 'where' of things, the integration of spatial analysis and BI is helping companies to make more informed decisions, thus leading to better outcomes.

By Shimonti Paul

In today's highly competitive business scenario, it is imperative to continuously stay updated on technology. Almost every business works hard to achieve success, but what makes one stand out is the understanding which technology to use at what time so as to render maximum gains; gains not only in terms of money, but in terms of driving a change such that numerous lives are benefitted.

Organizations today are collecting data at every level of their business and in volumes that in the past were unimaginable. Datasets are stored in different database systems or in files with distinctive formats, all reflecting business process, application, program software, or information type dependencies.

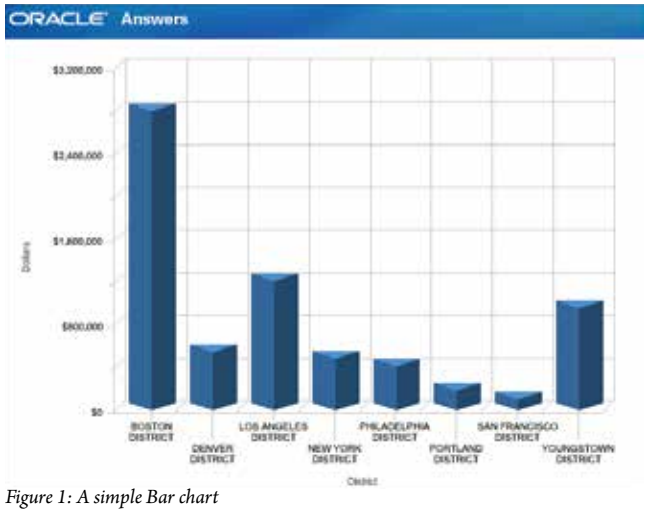
It is an accepted fact now that about 80% of all data has a spatial component. Traditionally such data would be presented to the user in the form of long reports, either with graphs and pie charts, or in a spreadsheet format. Now, given the complex interrelationships of multidimensional data, integrating spatial data and visualization technology has become ineluctable for offering an accurate, high impact insight to business intelligence users.

Spatial analytics are tools and techniques that employ statistical and quantitative analysis within the context of geography. As **Gary Sankary, Global Industry Retail Manager, Esri, USA**, points out "Some of the questions that spatial analysis can answer: Where are things located, including people, products, and assets like trucks and stores? What is the spatial relationship between these things? For example, how close or how far are they from each other? How dense are things like stores or people with a defined area?"

By carrying out spatial analysis of this data using varied business intelligence (BI) tools, decision makers are able to better understand the historical, current and future aspects of business operations, derive useful insights and make most effective decisions for their businesses.

How spatial analytics scores over traditional methods

While traditional methods used to represent information and gain insights have been helpful, they have been limited in capabilities when it comes to performing a quick visual decoding and compar-



Courtesy: Oracle

Figure 1: A simple Bar chart

ison of data. Even adding artifacts of presentation as shown in the bar chart in Figure 1 has not been able to add much value.

Humans think visually, therefore spatially. Data gains immediate visual impact with the help of maps, more emphatically true for data with a spatial dimension. Maps best represent spatial phenomena or relationships such as flow or proximity, while also facilitating visualization of statistical measures for an area or region. In addition maps allow for multi-measure displays. For instance, the visual impact and accuracy Figure 2 and 3 (in next pages) provide cannot be matched by any traditional method of data representation.

Agrees **Siva Ravada, Senior Director of Software Development, Oracle, USA:** " A lot of traditional visualization types that businesses use are charts and tables; they convey the message, but the minute you convey the same information on top of a map it makes very easy for people to understand what is happening with respect to the location and also gives us the additional ability to do location-based analysis."

Naturally, spatial data is becoming a boon to analysts, wherein the definition of a modern warehouse needs to include 'space-centric' along with traditional characteristics, such as, 'integrated' and 'time-variant'.

Spatial analytics as a serious business model

With location becoming all-pervasive in our everyday life, we are witnessing an exponential growth in both the number of data capture methods and, perhaps more significantly, in the amount of data being generated and captured. Maps are not just driving our cars. They are driving economies too. Even though the location theory in economics is quite old, going as far back as the 19th Century, it is only now that spatial analysis is increasingly being taken seriously around the world to derive new information and make informed decisions.

Not only traditional players of the geospatial industry viz. Esri, Hexagon and Pitney Bowes are working with spatial data on a large scale, hard-core IT companies like Oracle, Microsoft and IBM are also venturing into spatial analytics at full throttle. For instance, by integrating Esri's technologies into Azure IoT Suite's preconfigured solutions, Microsoft is enabling customers to gain valuable insights about where their assets are and what they are doing at all times, anywhere in the world.

"So many companies are relying on geospatial technology for so many things. We see lots of companies using geospatial data to disrupt everything from the humanitarian assistance to parking to how we drive etc. So geospatial data is becoming the lifeline of pretty much everything that people do and to that extent the industries future is very bright, says **John Allan, VP Sales and Marketing, GeoSLAM, UK**.

> "Some of the questions that spatial analysis can answer: Where are things located, including people, products, and assets like trucks and stores? What is the spatial relationship between these things? For example, how close or how far are they from each other? How dense are things like stores or people with a defined area?
>
> **Gary Sankary**
> Global Industry Retail Manager
> Esri, USA

Companies like United Parcel Service and FedEx are optimizing delivery routes using spatial analytics. Start-ups and mid-range companies are also not behind in the race; understanding the importance of location data in taking crucial business decisions, they are actively engaged in integrating spatial analytics in BI.

As **Sandeep Singhal, Director, Cloud Storage, Google, USA,** puts it, "A lot of innovation is coming from start-ups which are not building geospatial products, but are

users of geospatial in what they are trying to do. They are embedding data, maps, etc. in their products. Those companies are not trying to build anything geospatial. They only want to use this technology to build better experiences."

Is spatial analytics same as GIS?

So is spatial analytics same as Geographic Information System (GIS)? Some believe that it is; in fact there is a growing belief that the former is an evolved version of the latter. However, there is a fundamental difference between the two – GIS is just the set of software that enables spatial analytics. GIS represents an exciting and rapidly expanding technology via which spatial data may be captured, stored, retrieved, displayed, manipulated and analyzed.

"GIS describes the category of software that provides users the ability to consume geographic data in order to analyze and view that data geographically. From plotting an address to see where in the city it is, to tracking real time flood stage data from remote sensors to provide real–time view of conditions on the ground during a flooding event, the software used is GIS. Spatial analytics are the tools that exist within a GIS system and power the GIS system to perform analysis and mapping," adds Sankary.

> "So many companies are relying on geospatial technology for so many things. We see lots of companies using geospatial data to disrupt everything from the humanitarian assistance to parking to how we drive etc. So geospatial data is becoming the lifeline of pretty much everything that people do and to that extent the industries future is very very bright.
>
> **John Allan**
> VP Sales and Marketing,
> GeoSLAM, United Kingdom

Singhal thinks the importance of GIS is to provide both the insights for customers to try and identify potential areas that are worthy of an analysis and then as a way of helping to present those results of the analysis of the machine learning back to customers. "It is both a pre-analysis layer to understand what is happening and then a presentation layer to presenting it back to users. A lot of heavy lifting — the real work that needs to happen — is going to happen in the areas of analytics and machine learning using data that is pulled from the GIS systems and then delivered right back to the GIS systems," he adds.

Scope of spatial analysis

With businesses now focusing on the 'where' of things – where products are shipped, where product inventories are aging on the shelves of which stores, where products are advertised, or where products are consumed etc. the integration of spatial analysis and BI is helping companies to make more informed decisions, thus leading to better outcomes.

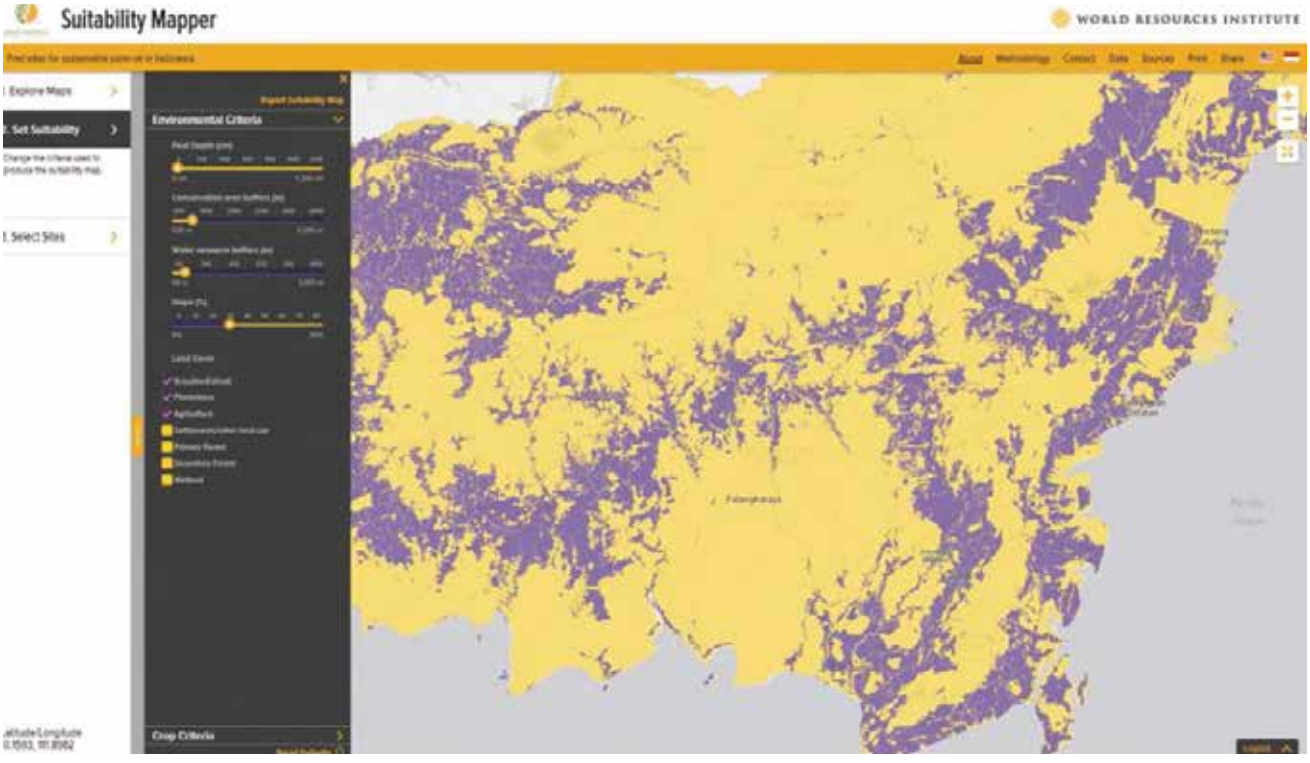


Figure 2: WWF mapped extreme weather events, rainfall, and drought in Brazil over three decades. The trends and patterns help identify areas for future conservation projects.

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IMAGING

Flexibility

UltraCam Panther enables your business to meet even the most demanding mobile mapping challenges: indoors, outdoors, everywhere.

Precision

The portable platform is simultaneously capturing georeferenced spherical imagery and video, precision LiDAR 3D data and highly accurate geopositioning information.

Versatility

Combined with its unmatched video capability and very high resolution imagery, the UltraCam Panther defines a new class of 3D capture systems.

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Figure 3: Lufthansa Systems uses a system with spatial capabilities to track global flight operations more closely and accurately

Spatial analytics is increasingly becoming essential for obtaining accurate and actionable insight, because there is a significant geographic dimension to every business transaction. No wonder that a study carried out by Dresner Advisory Services in 2017 reveals that among 30 technologies and initiatives strategic to business intelligence, spatial intelligence ranks 20th (Figure 4 on next page).

Organizations that are using spatial analysis within the BI framework are wide-ranging — local and state governments, national agencies, businesses of all hues, utility companies, universities, NGOs.

According to **Joe Francica, Managing Director, Location Intelligence Solutions, Pitney Bowes,** location-based data is recognized by everybody – it is recognized by the social media companies like Facebook and Twitter, and also by bigger businesses like insurers, banks and retailers who need to process that information, so that they can do a better job of servicing their clients.

"Location intelligence along with business intelligence truly amplifies technology. We try to support the business analysts with our new capabilities in utilizing Big Data frameworks, in helping them getting values add up the business intelligence solutions that they are looking to find," he adds.

So how industries are benefitting

Location is a unifying theme in business. Location can be an address, a service boundary, a sales territory, or a delivery route. Spatial relationships, patterns and trends reveal invaluable business intelligence and bring easy-to-understand visualization to business applications. Keeping in mind the benefits integration of spatial analysis with BI brings to business, more and more industries are adopting the approach.

Francica says we can break the industry into two categories. First set are businesses naturally rooted in geography like transport, telecommunication, or real estate, who absolutely depend on location-based information. The second set comprises of the group of users who not necessarily use geospatial data on an everyday basis but they still depend on it for better performance. These would be retailers, insurance companies and banks. "In businesses where location precision is very important like in an insurance company, they find real business value and RoI towards using high precision, high accuracy location based data, leading to decreased risks and better value to consumers," Francica adds.

> "Location intelligence along with business intelligence amplifies technology. We try to support the business analysts with our new capabilities in utilizing Big Data frameworks, in helping them getting values add up the business intelligence solutions that they are looking to find.
>
> **Joe Francica**
> Managing Director, Location Intelligence Solutions, Pitney Bowes

The major sectors that are actively bringing spatial analytics to BI

Energy: Spatial analytics is enabling the energy industry to discover patterns and uncover hidden insights in seconds rather than minutes or hours.

Transport and logistics companies: Be it determining the fastest transportation routes, enabling effective forecasting, optimizing warehousing processes and stock flows based on the

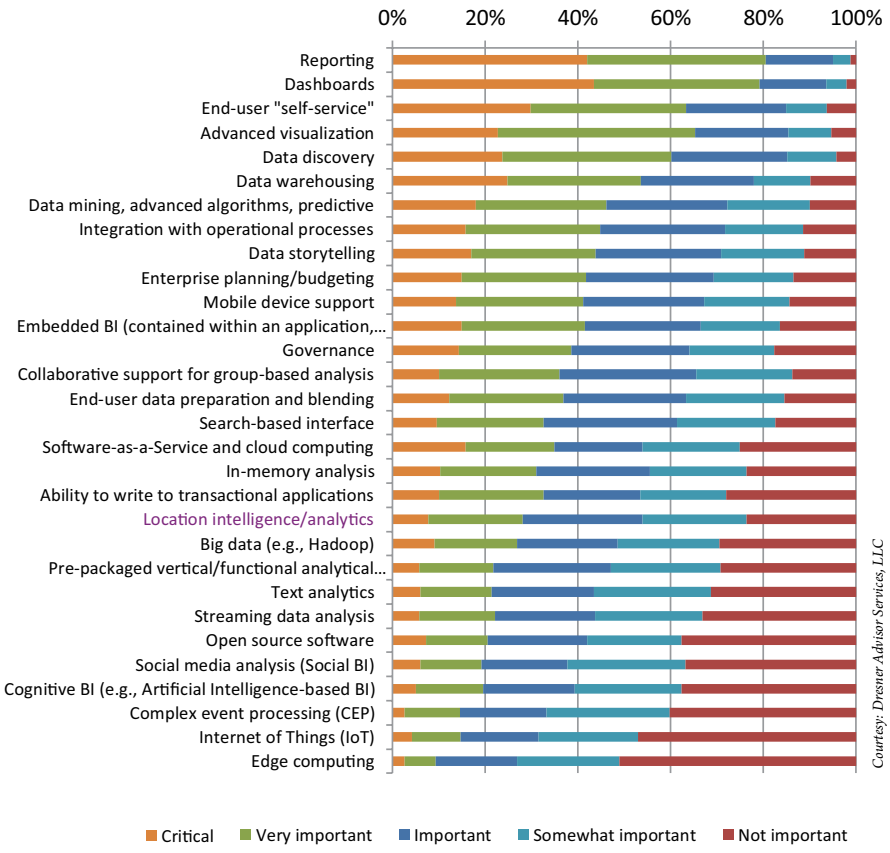


Figure 4: Location intelligence has come up as key, ranking on 20th spot in a list of 30 major technologies and initiatives strategic to business intelligence

consumption rates of particular products by locality, spatial analytics is helping the logistics industry to avoid delays and crisis and thus achieve better performance and customer engagement.

Real estate and commercial developments: Real estate is all about location because of the people served by that location. Spatial analytics facilitates research, analysis, and presentation of each prospective site. It helps in determining optimum sites for development.

Telecommunications: Spatial analytics enables the industry to assess strength of the current infrastructure, analyze competitor network coverage etc. Understanding which locations will provide the best network coverage at the lowest price possible helps the industry function more effectively.

Retail and wholesale industry: Along with physical store-level detail, spatial analysis is helping the industry to gain invaluable insights in stock delivery, store management, inventory management, marketing and sales.

Location is a unifying theme for businesses. Location can be an address, a service boundary, a sales territory, or a delivery route. Spatial relationships, patterns and trends reveal invaluable business intelligence and bring easy-to-understand visualization to business applications

How Location, Spatial Analytics Boost BI

What is Business Intelligence?

Business intelligence (BI) is the knowledge gained through the access and analysis of business information — spatial and non-spatial, or quantitative and qualitative. Basically it is a variety of applications used to analyze an organization's raw data.

What is Spatial Analytics?

"Spatial Analytics is a set of techniques devised to support a spatial perspective on data. To distinguish it from other forms of analysis, it might be defined as a set of techniques whose results are dependent on the locations of the objects or events being analyzed, requiring access to both the locations and the attributes of objects." — **Michael Goodchild.**

The two components that form the backbone of Spatial Analytics are Location and Visualization.

Location

Location forms the core of spatial analytics. It can be used across myriad of industries and workflows like including logistics, supply chain planning, management and optimization, warehouse management and transportation network planning and management, etc.

Traditionally, GIS technology was used to tap location and the data was depicted through bar graphs, pie charts, etc. However, with the growing demand of interactive maps, depicting location data interestingly has boosted the trend of visualization.

Visualization

Visualization helps in better understanding of spatial data. Analysis is conducted by viewing data points overlaid onto an interactive map interface. So, the heat map of a particular product used in various geographies can give a fair idea to both the company and customers using the product. A visual representation on a map gives a business leader much more insight into the data in hand than a simple bar or line graph.

> Lot of traditional visualization types that businesses use are charts and tables; they convey the message, but the minute you convey the same information on top of a map it makes very easy for people to understand what is happening with respect to the location and also gives us the additional ability to do location-based analysis.
>
> **Siva Ravada**
> Senior Director of Software Development, Oracle, USA

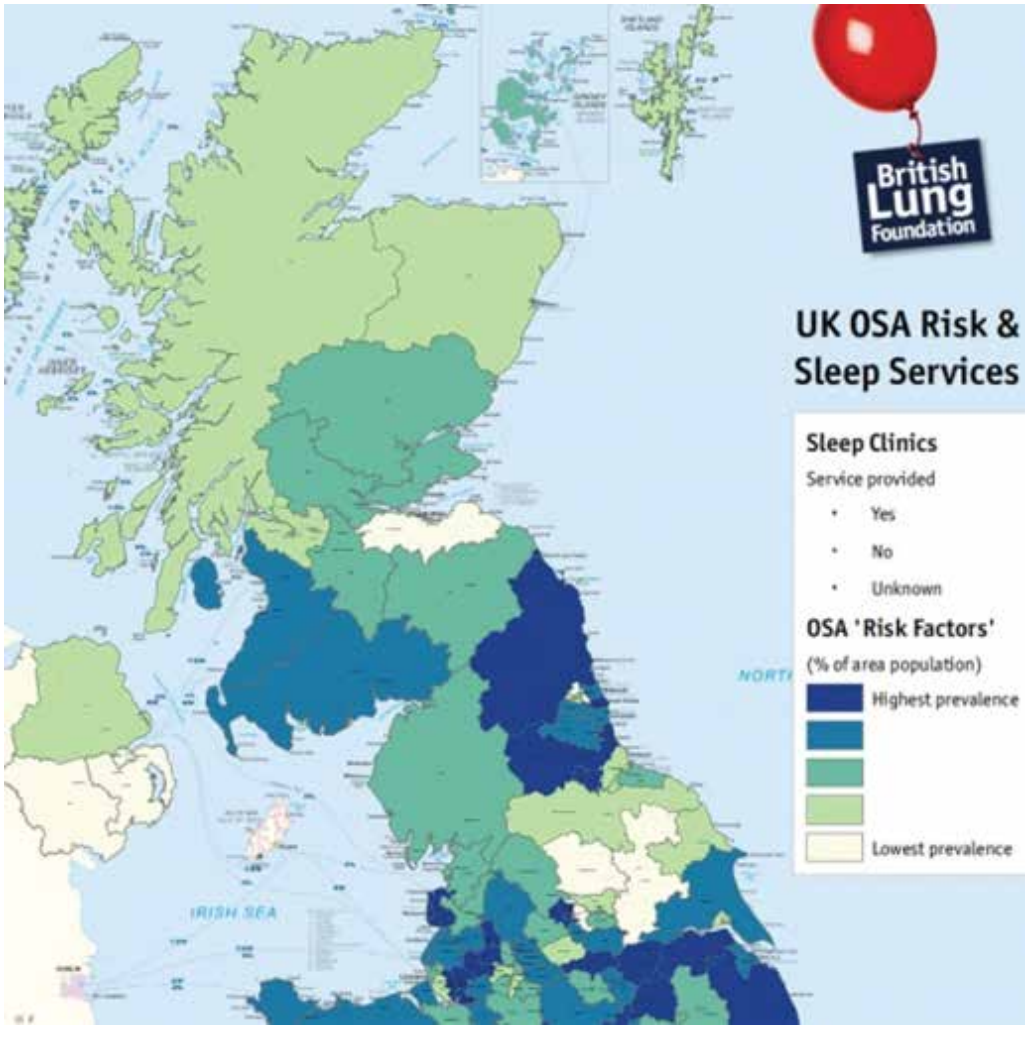
Healthcare providers: Healthcare providers use spatial analytics to see issues from a locational perspective, leading to more efficient practices and higher standards of patient care.

Insurance companies: Spatial analytics of location-based data, such as crime rates, weather patterns etc. is enabling insurers to identify high or low risk cases and develop marketing strategies, policies and pricing models accordingly.

Finance and banking sector: Location data and analytics of customers help banks to carry out effective customer segmentation and profiling, develop more successful marketing and sales campaigns, tailor products and services according to the customer base within each region or division and identify and actively retain and pursue profitable customers.

Airports and airlines: Airlines use spatial analytics to track flight operations more closely and accurately. Airport, meteorological, and fleet data is monitored in real time, and the operations crew reroute flight paths to optimize fuel and staff costs.

Education: Adding geographical components to student data enable higher education institutions to develop more effective marketing campaigns, understand better where to put facilities, and work on research grants.



British Lung Foundation (BLF) is using spatial analytics to identify areas where campaigns for raising awareness of Obstructive Sleep Apnoea (OSA) are most needed. Maps and datasets help BLF to learn about the state of knowledge on UK sleep service provision and distribution of OSA sufferers.

Like private enterprises, governments are also actively incorporating spatial analysis into decision-making processes. This integration is helping them in achieving speed, accuracy, and cost effectiveness in information dissemination, urban planning, and service delivery.

What is the future?

More and more industries are integrating spatial analytics with BI as such a system provides a wealth of information. Spatial analysis can be used to gain operational, transactional, and competitive advantages.

In the near future, industries are expected to benefit from emerging technologies like geospatial intelligence fusion, crowdsourcing, human geography, visual analytics and forecasting. And of course there are new evolving technologies like machine learning and artificial intelligence algorithms, which can give feedback on the location and behavioural pattern of people to build models for better in business intelligence. Business Intelligence will gain more power with technologies that will allow dimensional and spatiotemporal visualization and linkages between geolocation, social media, crowdsourcing, and spatial analysis.

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BLOCKCHAIN AND GEOSPATIAL SYSTEMS

Trustworthy and the potential to be a game-changer, the technology has the ability to revolutionize the future of geospatial world. **By Prof. Arup Dasgupta**

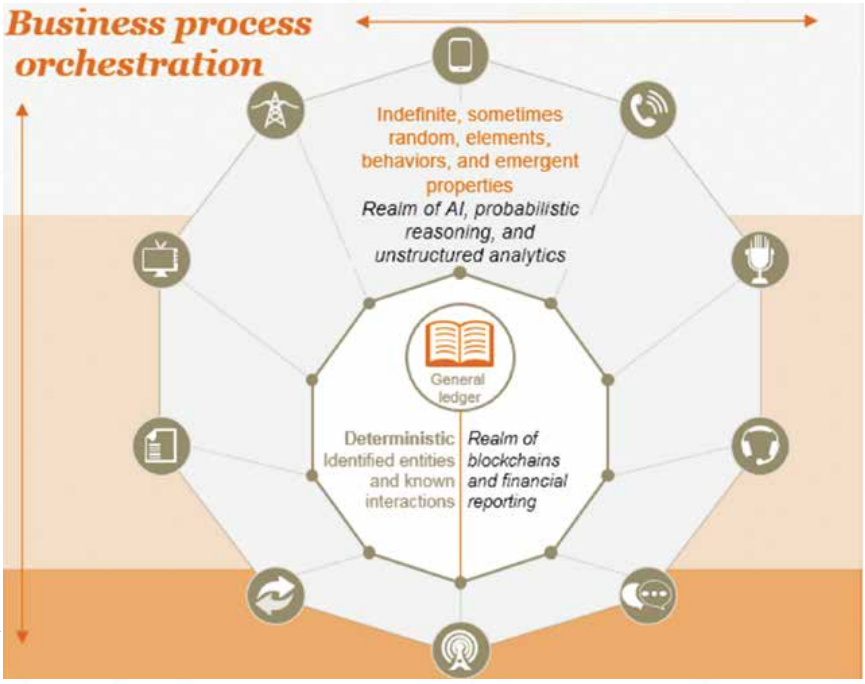
Of late there has been a lot of interest in Blockchain technology and many researchers are looking at ways in which Blockchain can be used in geospatial systems. This is expected because geospatial systems have made very good use of computing technology right from databases to networks and the Cloud. Geospatial technology is increasingly becoming embedded in other systems like BIM, BI, BPE and so forth. Therefore, it is only some time before it embraces Blockchain technology.

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. So in what way is a Blockchain different from a database?

Difference between Blockchain and database

Blockchains are open to all members, therefore the ledger of transactions are available to all members. There are no centralised administrators as it is a peer-to-peer network. Every transaction entered in the Blockchain is verified and approved by consensus among the members. However, there are validators called 'miners' who can review the transactions and validate them. The two key characteristics of Blockchains are trust and immutability. Just like in business where transactions are based on trust so also the members operate on trust. Immutability is ensured by the prevention of a record of a transaction being modified or deleted. When a member makes a transaction it is date and time stamped and is accompanied by a key generated by the computer using the members private key.

Every subsequent transaction is similarly stamped and a new key is generated which includes the earlier key. Thus any attempt to hack will require to unravel the transactions key by key which will be an impossible task. Assuming that even that happens, the hacked ledger will differ from the other copies and after a process of consensus, will be removed and replaced by the consensus copy. What happens if the change is genuine? Well, there is a possibility of 'forking' and the temporary creation of two networks from one. A fork can happen in two ways; if two miners find a new block at nearly the same time or if there is a change in the rules of validating a block. A soft fork happens if the new rules are backward compatible. A hard fork happens if a new software is introduced that is not compatible with the earlier software. A third fork called a User Activated Soft Fork, UASF is a controversial one because it means that software upgrades are initiated by the users and not the original developers. Reconciliation can take place, in time, in all cases.



Courtesy: PwC

When to use a Blockchain?

It needs to be understood that a ledger is essentially a database of transactions. A Blockchain makes sense if the ledger is shared and the entry of transactions can be made by a multiplicity of persons who may not be known to each other and therefore there is no inherent trust between them. The accepted solution in such a situation is to route such transactions through a trusted intermediary known to each person, but this adds to the cost and processing time. In a Blockchain such an intermediary is replaced by a peer to peer network in which authorization and validity of transactions is achieved through a process on consensus among the members. Therefore, 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. However, if there is a need for central control, confidentiality, fast performance and high scalability then it might make sense to go for a normal distributed database.

Private versus public Blockchains

There are two types of Blockchain, Public and Private. The most visible implementation of a Public Blockchain is the Bitcoin network. Here a potential member has to open a wallet to which the system assigns a private key. The member can now transact with others on the network, paying by Bitcoins for goods, services, data, documents, etc. We may soon see banks going the Blockchain way, not immediately but not in a very distant future either. Another use of Blockchain is the tracking of diamond trading where it is used to record transactions, act as a notary and store personal data.

The Public Blockchain has two drawbacks. The first is the validation process which can take time as there are many users. The second is the block size which cannot be too big, hence only the transaction details can be carried and not the object of the transaction, for example documents. On the other hand, Private Blockchains can be created and run by institutions like government departments, industries and companies, may be NGOs. Private Blockchain avoids these problems by restricting the number of users. A membership to a Private Blockchain is by invitation. Though others may be able to see the transactions they cannot participate in them. The rules governing the Private Blockchain can be changed easily by the administrators and backtracking of transactions may be allowed by them. The validators (miners in Public Blockchains) are trusted by the institution. Transaction costs are lower than in Public Blockchains and malfunctioning nodes can be quickly spotted and repaired.

Broadening horizon in geospatial

In geospatial terms two domains which attract Blockchain implementation are land transactions and data repositories. In the case of land records there is no established trust between the participants and there is a need for openness. The weakest link, the mediator in the form of the record officer (*talati* in India), can be eliminated,

EXPERT SPEAKS

"Bitcoin is a remarkable cryptographic achievement and the ability to create something that is not duplicable in the digital world has enormous value"

Eric Schmidt
Executive Chairman, Alphabet

"Blockchain will change a great deal of financial practice and exchange... 40 years from now, Blockchain and all that followed from it will figure more prominently in that story than will Bitcoin."

Larry Summers
Former Treasury Secretary, US

preventing spurious transactions by immediately trapping and replacing it with the consensus copy. In an ORF Occasional Paper on "Securing Property Rights in India through Distributed Ledger Technology", Meghna Bal has covered these aspects extensively. According to her, Estonia, Honduras, Georgia, Ghana and Sweden are looking into Blockchain-based land registry systems, and of these Sweden is well advanced with a Pilot Project.

Quoting from the paper, "Understanding the need for change", the Lantmateriet (the Swedish Mapping, Cadastre and Land Registration Authority) collaborated with Kairos Future (a consultancy), the Telia Company (Sweden's dominant tele-network operator), and Chroma Way (a Blockchain solutions firm) to develop an innovative way to address the issues plaguing the current land registry framework. They devised a plan to create an application that would use Blockchain technology to facilitate transactions. Communication between the various stakeholders (real estate agent, bank, buyer, seller, and the Lantmateriet) is conducted over the application. All information about the property (current owner, cadastral surveys, among others) is digitised and put into the Blockchain. Smart contracts then ensure that this digitized space is regulated by certain rules (i.e., Sweden's regulatory policies). The application is then used as an interface to facilitate all transactions concerning a particular property. The purchase agreement is distilled down to a unique hash code and put into the Blockchain. Banks, real estate agents, buyers and the Lantmateriet can substantiate the veracity of this purchase agreement and other documents through their unique digital

SPREADING ITS WINGS IN EVERY SPHERE

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

SMART CONTRACTS
Documents being digitized and proof of ownership for transfers

SMART PROPERTY
Assets being digitally recorded

STOCK EXCHANGES
Digital trading platform

HEALTH RECORDS
Decentralized patient records management

SECURE DIGITAL VOTING
Anonymous digital voting and fraud proof solutions

CROSS BORDER TRANSACTIONS
International financial transactions

B2B PAYMENT
Correspondent banking

- Peer-to-peer remittances
- Music distribution
- Ownership for digital content proof

"Blockchain is a vast, global distributed ledger or database, which is accessible on any device, and where anything of value — information, money, identities, even votes — can be moved, stored and managed securely.

Don Tapscott
Influential Author

"CIOs should still be concerned with whether the [Blockchain] platfrom that they want to consider has gone through sufficient levels of testing at scale, in earnest in a mission-critical environment.

David Furlonger
Analyst, Gartner

MAKING ENTRY INTO DIVERSE FIELDS

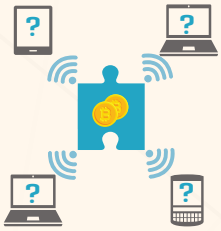
When to use Blockchain

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.

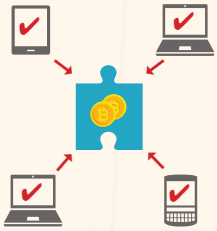
1 Suppose X want to send money, imagery, data, maps, documents, etc. to Y – also called Chain

2 The transaction that happens online is called Block

3 The Block then gets broadcast to every party in the network



4 The validity of the transaction is approved by those in the network



5 A transparent record of the transaction can then be produced by adding Block to the Chain

6 The data/ money/imagery etc. moves from X to Y smoothly

SCOPE OF THE TECHNOLOGY

While Blockchain is expected to be first and foremost adopted in financial services, it holds potential for a wide range of vertical industries.

IMPACT OF THE TECHNOLOGY

Experts predict that the list of blockchain use cases – and the technology's impact on society – will continue to grow.

signature (hash on the Blockchain). Banks can also ensure that the buyer has enough funds in their account to carry out the transaction. The Lantmateriet can then register and grant title to the buyer".

However, the author points out that in India, in spite of efforts of the Digital India Land Records Management Programme, land deals are fraught with errors and inconsistencies. While geospatial technologies have had a huge impact on the digitisation of spatial land records, the transaction data related to these records tends to lose synchronism as it is maintained in different databases. Typically, the 7/12 land records lie with the Revenue Department of the state, while the registration records are with the Department of Stamps and Registration, and spatial data are maintained by the Land Records Department.

The author outlines three important steps before the situation can be remedied. First, bring all the departments under a digitally secure environment through Public Key Interface. Second, evolve a protocol that links the buyer to the seller, the property, the payment, the bank, the smart contract, and the registry. Third, use suitably enhanced smartphones that can deal with digital signatures, PKI and phone to phone interaction through some form of authentication like the Aadhaar number. All this can operate in the framework of a Blockchain. Should it be Public or Private is a question not yet answered.

May be the answer lies in another implementation of Blockchain for land records management in Georgia. Here, a private Blockchain requiring access permissions has been integrated with the Georgian National Agency of Public Registry (NAPR). This is anchored to the Bitcoin Blockchain through a distributed digital time-stamping service. Distributed digital time-stamping allows NAPR to verify and sign a document containing a citizen's essential information and proof of ownership of property. The Republic of Georgia's recently implemented land titling system based on Blockchain technology has recorded over 100,000 title transactions within the first two months of its launch. This is an example of a hybrid implementation which protects the basic data while allowing anybody to view the data using the immutability and openness of the public Blockchain network.

Blockchain's big scope in IoTs

Another major area where Blockchain can be used effectively along with geospatial technologies is Internet of Things. Today, IoT conjures up a mental image of a complex network of humans and objects all passing data to each other. The questions are what data, how is it validated, how are things and humans protected from illegal access and processes? For example, could an autonomous delivery van, which depends on sensors be hijacked and driven to a wrong location? Consider the data carrying the instructions as transactions. If the network is on a Blockchain then the process of consensus would help validate the transactions and weed out the wrong instructions because the illegal transactions would be trapped. According to Alan Morrision, senior research fellow at PwC's Center for Technology and Innovation, "Blockchain and smart contracts could be the bones of a governed, transactional internet where machines abide by rules and algorithms provide the kinds of validation normally associated with a human third party. Business process management (BPM) could run each entity's internal process and act as the connective tissue on one side of the transaction or the other. Smart contracts would extend the capabilities of BPM beyond the four walls of an organisation, acting as mediator between two entities".

Geospatial bond with Blockchain

A very interesting development which ties together geospatial and Blockchain is FOAM, developed by Kristoffer Joseffson, Ekaterina Zavyalova and Ryan John King of Ethereum. FOAM is an open protocol for geospatial data markets on the Ethereum blockchain. Foam associates Blockchain 'coordinates' with each position location. These Crypto-Spatial Coordinates enables a vertical Z axis, which is the Blockchain token balance of the address and the stack of smart contracts that reference the address of the physical address. The Crypto-spatial layer contains the geospatial position location and the Spatial Wallet in that location. These Spatial Wallets are created using Native FOAM Tokens which also create space tokens. Space tokens create derivative utility tokens with unique coordinate addresses. How does this work?

Consider the IoT as an example. Imagine a traveller on a public transport system using a smart mobile containing space tokens. As the person boards a bus the crypto-spatial layer notes the point of embarkation and the point of disembarkation and automatically charges the fare from the spatial wallet of the traveller and credits it to the spatial wallet of the transport utility company. There is no need for cards to swipe or to recharge cards. The debits and credits are instantaneous and the transaction is automatically reconciled on the blockchain.

Movement of goods, transhipment can be traced and delivery costs calculated and debited automatically. Augmented Reality systems could be used for determining progress of work and authorising scheduled payments for major construction projects using smart contracts.

Perhaps the greatest application of interest is to data generators who could deposit data into a crypto spatial coordinate, back it with space tokens, and set pricing mechanisms for its use. Data could include satellite data, maps, land parcel data, 3D visualisation data, BIM and much more. Thus one could see a paradigm change in the way spatial data from satellites, UAVs and even in situ measurements from sensor networks could be easily monetised and distributed. Data security could be built in through the space tokens.

Blockchains are evolving and it would be wise for the geospatial world to keep abreast of the technology, try out pilot applications and thus get in at the ground floor of what today appears to be a future game changer.

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Business Intelligence and 4IR Go Hand-In-Hand

A lot of innovation is coming from start-ups who are not primarily building geospatial products, but are actually the users of geospatial in what they are trying to do, **Sandeep Singhal, Director, Cloud Storage, Google, USA,** highlights in an exclusive interview

GIS has long been playing a vital role in Business Intelligence. What are your views on this?

The importance of GIS can be stressed enough to provide valuable insights into the business, identify potential areas that are worthy of an analysis and then help present those results effectively back to customers. It is both a pre-analysis layer to understand what is happening and then a presentation layer to presenting it back to users. A lot of heavy lifting work is happening in the areas of analytics and machine learning using data that is pulled from the GIS systems and then delivered right back to the GIS systems.

Geospatial technologies are making Business Intelligence more intelligent, enabling businesses to take better decisions. What do you think the trends in this regard are?

The trend here is really towards deep learning and deep understanding of information, getting a large variety of information from different sources, ranging from small sensors to traditional mapping applications, and delivering that knowledge to enable you to make decision and make changes. Business Intelligence and the Fourth Industrial Revolution go hand-in-hand. There are tons of examples where companies are using images and image process to extract information from satellite imageries and drone imageries to understand various aspects like crop behavior — where does fertilization need to happen; what is really happening in the fields. It is important to bring in machine learning to understand what is happening to these images, add real-time imagery from drones and other local sources and then drive decisions that a farmer can take to optimize his crop yield. So, this is a form of Business Intelligence that takes advantage of all of these different components.

With the expansion of the geospatial industry, there is more and more inclusion of building tools for analyzing geospatial data. Many are of the view that the core geospatial industry is being nibbled on two sides by IT and large industrial powerhouses, with both segments developing their own geospatial capabilities. However, I feel that this is a great opportunity to partner more

effectively to deliver what customers really want, very effective and real-time services.

A lot of innovation is coming from start-ups who are not primarily building geospatial products, but are actually the users of geospatial in what they are trying to do. They are embedding data, maps, etc. as part of their core applications. What they are looking for is ways to build their apps more quickly, and more efficiently, and build better experiences by using geospatial technology. A key factor here is location intelligence**.** It is important to reach out to them with an objective to make geospatial data easy to access, quicker to access, and more effective in the applications that these companies are trying to build.

The trending here is towards making more geospatial data available to mobile devices whether using commercial or off-the-shelf consumer tools or commercial tools. The consumer of geospatial data is no longer confined to a PC or workstation.

How technological advances are facilitating use of spatial analytics in business intelligence?

Three factors are important here. One is the ability to capture data very quickly from lots of different sources. We are seeing a whole generation of small light-weight sensors coupled with communication capabilities that can move data in and out of everything, like from a piece of equipment to sensors embedded in ground or inside buildings.

Second is the effective infinite storage and computation power provided by the Cloud. The ability to take data from anywhere, aggregating it, and doing as much analysis you possibly want to do using Cloud provides computational power. There has been an exponential surge in Cloud providers who provide core infrastructure for supporting geospatial services.

The third key element is the growth of very rich analytics, Big Data and machine learning libraries that really democratize how you analyze data. The technology makes it possible to very quickly develop machine learning models based on the large volume of data that is being fused in the Cloud and draw conclusions that can be actionable. This combination of cheap sensors, ubiquitous sensors, massive amount of storage in computation and standardized analytics and machine learning are really powering this revolution.

Geospatial visualization and analytics have already made roads into a wider swath of industries. Do you still see some considerable challenges?

Geospatial visualization and analytics is becoming ubiquitous. We are seeing more and more users visualizing geospatial data either simply using standard off-the-shelf maps like Google Maps Engine, or Google Earth to visualize information, or using commercial tools like ArcGIS. I think the trend here is towards making more geospatial data available to mobile devices whether using commercial or off-the-shelf consumer tools or commercial tools. The consumer geospatial data is no longer confined to a PC or workstation. They want their data now, they want in their hand, they want it on a device which they are walking around with. So, the delivery is really shifting to very rich geospatial data in a mobile form factor in real time when and where people need it.

Are security and regulatory factor still barriers for Cloud implementation across verticals like government and financial services?

There are still regulatory requirements for any Cloud implementation. Some are industry specific like in the financial industry there is a number of regulations about data protection, data archival and data recording. Governments also have various requirements regarding privacy and security. So, regulations do exists. Most Cloud providers including Google, Amazon and Microsoft are working aggressively to make sure that their Clouds do support all of the active regulatory requirements both at industry level and at geographic level. So, the gaps are getting closed to rapidly. we are also beginning to see that almost every industry is recognizing that those gaps are no longer unsurpassable and they can actually begin to move critical workloads into the Cloud.

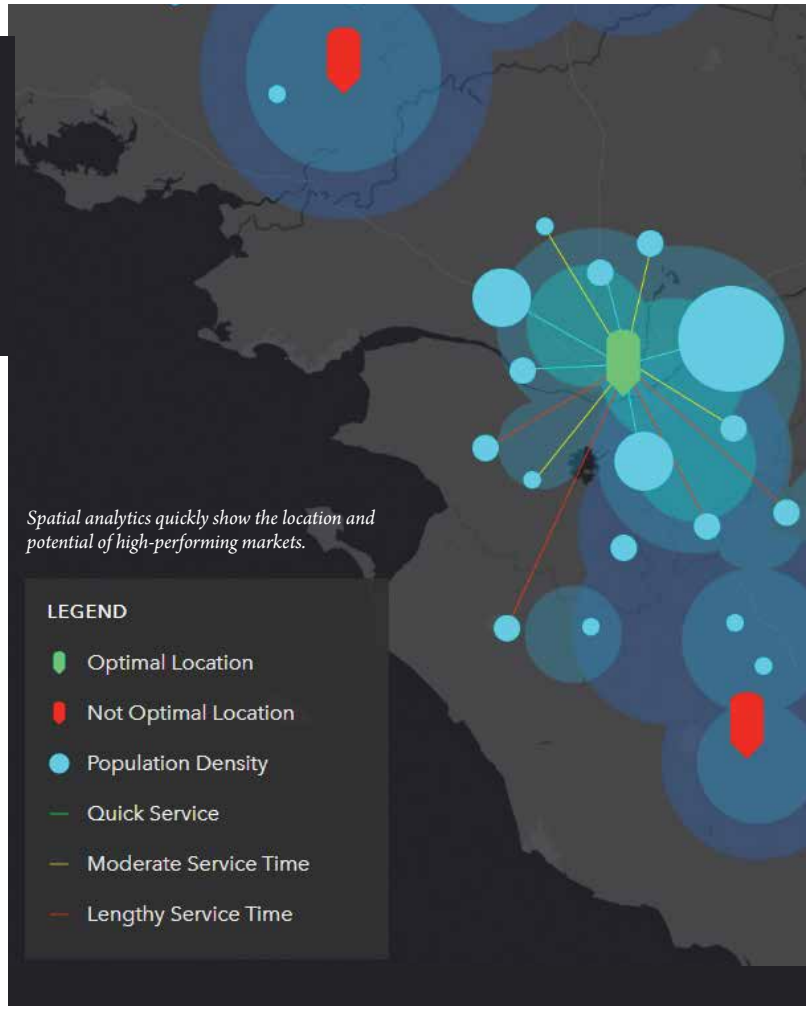
We are on the verge of the Fourth Industrial Revolution. What role will geospatial technologies play in this revolution?

The Fourth Industrial Revolution is the marriage of data, analytics and real-time presentation to allow customers to make decisions and improve the efficiency of their processes. The key enablement for 4IR is the fact that we are now bringing together massive amount of data, applying deep analytics, Big Data analytics and machine learning to fuse the data together and draw conclusion and then present that information very quickly in order to drive changes in how we manufacture, schedule resources and so on. This is a great fundamental shift.

A great example is a company called Cartogram, which is working in the medical sector, helping hospitals understand where their resources are — be it human resources or medical equipment such as X-rays machines etc. Using data about location and what procedures are necessary, an analytics can be carried out to understand the geometry of the venue and then a real-time guidance on how to move patients to the closest medical equipment can be presented. This helps in geting the right procedures done as quickly as possible. This is a great example of how data and analytics and presentation deliver a totally new way of delivering services.

How Spatial Analytics **Makes Business** Growth Faster & **Smarter**

Location Intelligence being an integral part of spatial analytics, allows businesses to identify areas with market commonalities using layers of data. **By Cindy Elliott**



Spatial analytics quickly show the location and potential of high-performing markets.

A 2015 Pew Research study found that roughly eight in ten Americans shop online. With this figure edging 80% of the population and rising, businesses must begin taking for granted the fact that real business growth today is a far riskier proposition than 20 years ago. It is not enough for a company to rest on its brand's laurels and head straight to market. Consumers are being offered products that are custom tailored to their specific needs, and sometimes even meet them right at their doorstep. With services like Blue Apron and Amazon catering successfully to a demanding and fickle buyer, retailers offering the traditional brick-and-mortar interface must be certain they are hanging out their shingles in exactly the right place with the right layout.

Knowing the best next location to open, expand, or redesign means being aware of many different data sets simultaneously, such as area incomes, education levels, and individual buying habits. The more data layers there are, the harder it is for companies to manually sort through them. So, most businesses don't perform the kind of holistic analysis necessary to understand what will make a new branch more successful in Fort Lee, New Jersey versus downtown New York City. These areas may be only ten miles apart, but the stark demographic differences between those ten miles can make or break a new coffee shop, franchise or grocery store. Spatial analytics automates the entire process of figuring out where to open and expand next by creating a digital workflow for placing consumer data into the context of location.

The big hassle of Big Data

The wide-scale accessibility of Big Data from consumers' demographic information is a boon to retailers, but it can also be a burden. The more data there is available, the harder it is to make sense of and put it to good use. And with more companies using Big Data to their advantage to increase profits, market data analysis is the only

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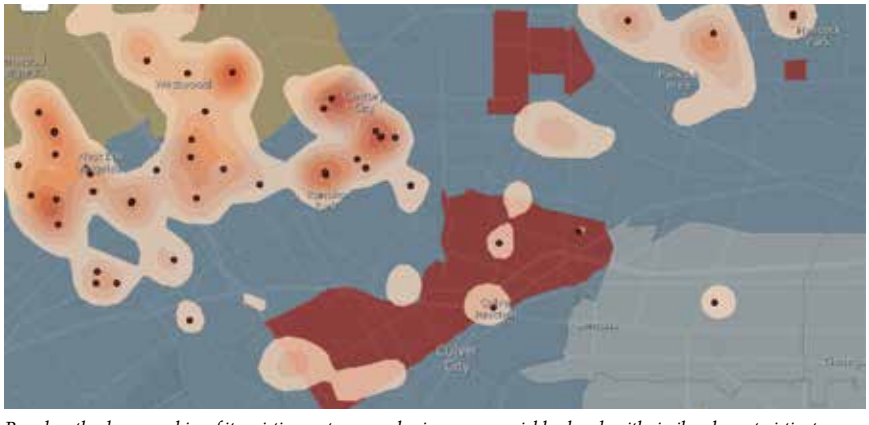
Managers visualize all aspects of a business supply chain to understand performance in real time.



Based on the demographics of its existing customers, a business maps neighborhoods with similar characteristics to see new customer potential and where to target advertising.

way for a business to ensure that it is playing on a level field. Whole Foods, for instance, before opening new stores, checks off a list of criteria that a potential area must meet to satisfy market demand. Any new candidate for a store location must be accessible to a population of 200,000 people with at least a college education, above average median incomes, and live within a 20-minute drive of the future store. But simply knowing these things is just the beginning. A top US car manufacturer recently piloted a car sharing service in America, and before launching, factored in consumer behaviors into its market analysis to paint a more holistic picture of where the best location to open would be as well as where not to open. Understanding all the elements involved combining demographics, consumer behaviors, and geography allowed this car company to move from good enough to finding the absolute best location.

Seeing data is understanding data

Location Intelligence allows businesses to identify areas with market commonalities using layers of data. The car manufacturer that launched a car sharing service in the US used spatial analytics to determine the ideal market indexes for their offer and then the best places within that city to launch. The car company automatically overlaid several index values related to consumer information on affluence, level of environmental consciousness, and rates of car ownership. Geographic information was also incorporated, such as locations of charging stations around the proposed area and available parking. A precise, automated map-based visual emerged of the perfect sites to locate the car sharing service to be ideally situated to profit and grow quickly and then expand into the next best neighborhoods. All business happens somewhere, so being able to see the factors that affect that business spatially beforehand in concert allows sellers to make predictive analysis, so they can reduce the risk involved in entering new markets or expanding existing ones.

Automating smart expansion

Spatial analytics also reveals new strategies that are tied to geographic relationships, such as partnerships. Starbucks, for instance, are beginning to operate inside other larger businesses such as supermarkets and big box stores, as well as locating themselves in proximity to competitors. This may seem counterintuitive, but seeing the data that relates to their customers on a map shows exactly where the best places are to be able to make the best profit. Technologies such as geographic information systems (GIS) facilitate this superior decision-making by integrating data analytics into automated, interactive maps that businesses can access on easy-to-navigate dashboards and even mobile apps.

Once a business knows where to open, spatial analysis shows how and where it is performing best. From there it can accurately make improvements where it is needed most, rather than general company wide solutions that are less cost-effective and inefficient. Spatial analytics allows retailers to automate the representation of market analysis combined with customer dynamics and the geographic nature of this innovation provides a formula for finding new market opportunities. The power of location intelligence enables companies to identify and increase where business performs stronger, and cut down on underperforming assets. The Science of Where is built into the GIS workflow, so businesses can concentrate on making location count in operations.

Cindy Elliott
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ECONOMIC EXCELLENCE OF THE COPERNICUS PROGRAMME!

The Copernicus Programme of the European Union is poised for growth. Spearheading the earth observation industry of Europe, Copernicus contributes heavily to the economic excellence of the Space industry. **By Ananya Narain**

66%
Proportion of EO companies exploiting Copernicus data in Europe

27%
Proportion of EO companies exploiting Copernicus services in Europe

8 million
Copernicus products downloaded on the Sci-Hub (September 2016)

51,000
Registered users in the Sci-hub (September 2016)

Recognized as a leader of development, the earth observation industry is creating both social and economic impact at the global stage. The commercial earth observation industry is generating high-resolution and multi-spectral data that is unprecedented in both magnitude and scope. Since the launch of the first civil imagery satellite system, LANDSAT, countries globally have understood the need for satellite systems to support policy objectives for sustainable development, national security and climate change. In this regard, the Copernicus Programme, fondly known as 'Europe's eye on Earth', is an Earth Observation Programme formed in collaboration by the European Union (EU), the European Space Agency (ESA), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and the member states. Also, known as Europe's leading and world's largest civil earth observation program; the satellites and insitu sensors, are focussed on monitoring the Earth and its diverse ecosystem to generate economic, social, environmental and strategic benefits globally.

Economic impact of the Copernicus

The Copernicus has four strategic components linked to its program which is inclusive of the Sentinel satellites, the ground and aerial based monitoring systems, ground segment, information and data management and core geoinformation services that assure data continuity and complete coverage. Contributing to the 'excellence of the European Space Industry', the Copernicus caters to the needs of its users, primarily the European citizens through providing earth observation data for six thematic layers (atmosphere, marine, land, climate, emergency and security) and the development of supporting applications for the same. It is, therefore, no surprise why the Italian Research Council estimates the potential economic impact of the Copernicus program on the European economy to be worth EUR 30 billion ($35.25 billion) in addition to the 50,000 additional jobs that will be created.

In principle, the Copernicus data is available for use to every European citizen for free and, henceforth, the applications created of the data contribute to the buoyant growth of the economy. **A study commissioned by the European Commission explored the key benefits of the Copernicus Program.** Supporting applications in a wide variety of domains, it is estimated that the investments in the program shall increase to EUR 7.5 billion ($8.8 billion) while doubling the economic benefit derived to EUR 13.5 billion ($15.8 billion) from 2008-2020. It is also seen that of every EUR 1 spent from the public funds in the Copernicus activities, the value addition to the whole economy is EUR 1.4 — a decent investment to benefit streak. It is also impressive to note that at present, more than 66% of the earth observation companies are exploiting Copernicus data in Europe, while, 27% of the companies are exploiting the Copernicus services. Moreover, more than 8 million Copernicus products have been downloaded on the Sci-Hub since September 2016. Does it not showcase the potential of Copernicus as a 'Big Data' hub? It most certainly does! With conflux of Big Data Analytics, Artificial Intelligence and deep learning, and innovations driving the earth observation industry, the Copernicus program is set to bring increased economic value addition to the European economy!

Economic benefits from the intermediate user segment

Benefiting citizens ranging from researchers, commercial to private users, the global scientific community and most importantly the policy and decision makers, the exploitation of Copernicus-enabled products are bringing multiple socio-economic benefits in various economic sectors. These include urban development, agriculture, urban monitoring, insurance, ocean monitoring, oil and gas, renewable energies, forestry and fisheries, and tourism, among many others. In 2015, the economic benefits derived from the downstream market of Copernicus were estimated to be approximately close to EUR 28 million ($32.9 million) to EUR 54 million ($66 million)! This is expected to grow at an impressive rate of 31% per year as the Copernicus begins to fulfil the gap realised

EXAMPLES OF EXISTING COPERNICUS BENEFITS

70%

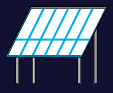
Cost reduction of a precision farming service in Austria, thanks to Copernicus

5%

Productivity gain for fish farmers, by monitoring toxic algal blooms

€ 60k

Yearly savings for each construction company using a work progress monitoring app



50%

Copernicus-based forecasts generate 50% more benefits to solar energy producers than traditional forecasts

60%

Higher accuracy for analysis of the impact of trans-boundaries pollutants on air quality

between the end user's specific needs for tailored products and available solutions. As the Copernicus program expands, a positive evolution and bullish growth is expected in the end user segment, especially, agriculture, insurance and ocean monitoring.

Agriculture: Earth observation has played a defining role in agriculture as precision techniques using EO data began to emerge as early as the 1990's. The major Copernicus applications in agriculture are precision farming applications, seasonal mappings of cultivated areas, irrigation management and drought monitoring, and food security monitoring. The typology of the users of Copernicus data and applications is balanced between the government and the private players. More often than not, the direct clients of the Copernicus products and services are agricultural cooperatives who further distribute these to the farmer segments they represent.

In 2015, the EO downstream revenue segment related to agriculture was valued at approximately EUR 70 million ($82 million). It has been seen that the applications developed on the basis of Sentinel-1 and Sentinel-2 data have helped farmers increase their productivity and efficiency up to 20%. More so, the use of Copernicus data in agriculture has led to increased job creation, along with additional business opportunities. As the Copernicus makes a significant contribution to the efficiency of agriculture practice, the economic impact of Copernicus in the agriculture segment is estimated to be around EUR 9.2 million ($10.8 million) to EUR 13.7 million ($16.1 million) in 2015.

Forestry: Globally, 90% of the end users of EO products and services in the forestry sector are the public players. Similarly, the intermediate user of Copernicus data in the forestry domain is dominated by the public research organizations, government forest research operations and private players. Both Sentinel-1 and Sentinel-2 provide valuable spatial information for the forestry value chain and, therefore, about 11.5% of the total amount of EO data used by service providers in the forestry value chain is accredited to the Sentinel data.

Furthermore, on the assumption that the growth in revenue generated by the EO imagery segment over 2015-2020 will be at a CAGR of 12.6%, it is estimated that the revenue generated by the Copernicus in the forestry sector will touch EUR 7.6 million ($8.9 million) to EUR 15.8 million ($18.5 million) in 2020. The launch of specialized platforms will enhance the impact of Copernicus for the forestry sector in the next five to ten years.

Urban Monitoring: Earth observation data is crucial for urban monitoring. The Copernicus applications for this segment include urban growth monitoring, 3D modelling construction, land use, change detection, environmental impact management, and transportation route mapping. The data from Sentinel 1-A has enabled the development of new products in urban monitoring while Sentinel-2 allows the Value-Added Service (VAS) companies of the sector to save time and money. In fact, it is estimated that approximately 15% of the revenues of VAS companies in urban monitoring is attributable to the Copernicus program.

The global EO downstream market revenue for urban monitoring i.e. EUR 47.4 million ($55.7 million) in 2015 showcased an exponential growth rate of 500% from 2012 to 2015. The contribution of Copernicus to this itself has amounted to EUR 7.11 million ($8.36 million)! The future too is significant. The earth observation market for urban monitoring is expected to grow from 17% every year from 2015 to 2020. With the Sentinel-3 soon to offer Land surface temperature data in a maximum of three hours' time, the Copernicus data too shall continue to grow in importance. The estimated value of Copernicus data for urban monitoring by 2020 is approximately EUR 12.6 million ($14.8 million).

Insurance: A recent trend seen in the earth observation industry is the use of EO products and services for insurance and (re)insurance activities. The data derived from the Copernicus is used for accurate

risk modelling thus lowering financial risk. Copernicus is also seen as the enabler for the development of index products and development of new addressable markets. The applications include tracking and forecasting of natural hazards, computation of indexes for parametric products for crops and livestock insurance, tracking of potential floods to send early warnings, and identification of initial and potential fire departures.

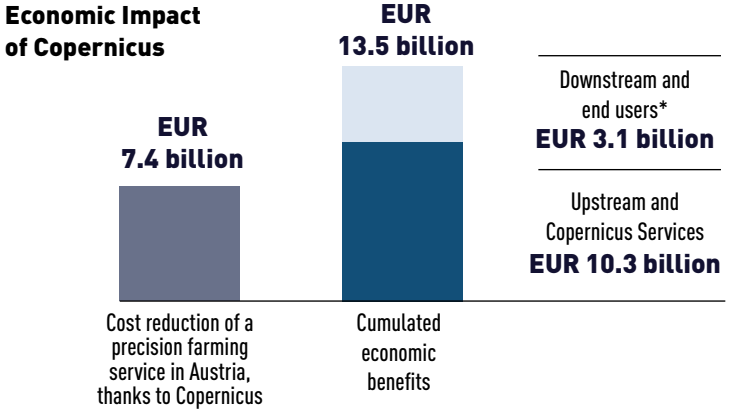
Speaking of economic impact, as of 2016, the benefit of Copernicus in the insurance and (re) insurance segment for the intermediate users has been limited to EUR 0.5 million ($0.6 million) to EUR 1.1 million ($1.3 million). However, the future is bright. It is estimated that the Copernicus-enabled revenue for downstream market in the insurance segment is expected to grow at 64% per annum i.e. up to EUR 13.6 million ($16 million) by 2020. In addition, the benefit for end users i.e. the insurance companies is expected to be as high as 186 million.

Oil and Gas: The oil and gas value chain is the most private sector oriented value chain with mostly private end users. The largest share of value derived from the Copernicus data and products is derived from the Oil and Gas companies themselves.

The potential value of Copernicus for the oil and gas value chain was already as high as EUR 115 million ($136 million) in 2015 of which EUR 107 million ($126 million) for the end user segment. This revenue is expected to almost double by 2020 i.e. become EUR 312 million ($336 million) of which EUR 300 million ($352 million) will be for the end user segment. The almost 50% increase is projected because of the higher penetration of Copernicus products and services which has been till now been low in the offshore fields and oil and gas companies. As the penetration soars, so will the revenue and the economic benefits that will be derived.

Ocean Monitoring: The integration of Copernicus data with ocean monitoring services and applications has increased productivity and caused significant cost savings. Sentinel–1 and Sentinel-2 data is being used extensively for various applications in ocean monitoring so as to measure water quality, detection of micro bacteria, mapping of fishing zones, monitoring of coastal erosion among many other applications. Also, the Sentinel-3 has technical specifications for ocean-monitoring related issues and will add significant commercial value to the segment. To further the dissemination of Copernicus in the Ocean monitoring segment, the Copernicus Marine Environment Monitoring Service (CMEMS) is set up inside the value chain. The CMEMS has about 5,000 – 6,000 users, 80% of which are public sector users who need the information provided on priority.

On a global scale, the earth observation revenue generated by the ocean monitoring sector was approximately EUR 104 million ($122 million) in 2015, of which EUR 5.76 million ($6.77 million) to EUR 8.76 million ($10.3 million) can be attributed to Copernicus alone. Thanks to the Sentinel-3 mission, the economic impact of the Copernicus is expected to grow up to EUR 58 million ($68 million) in 2020.



The earth observation market value chain accounts for approximately 58% of the global space economy, thus bringing in significant economic benefits

The future is bright

The earth observation market value chain accounts for approximately 58% of the global space economy, thus bringing in significant economic benefits. At present, innovations in the earth observation industry are driven by the exponential rise in EO 2.0 players. Additionally, to leverage on the creative ideas coming from these new entrants, and to tap into the new user segments, the European Union has made a commitment of EUR 4.3 billion ($5.1 billion) to the Copernicus during the period 2014-2020. Evident from the economic impacts of Copernicus on the key user segments of the European region, increased investments mean sound economic benefits. The European Union already has cooperation agreements on data sharing with Australia, United States and the Gulf. Collaboration of such sorts could open up the Copernicus to the world market for data driven products and services in global economic sectors like agriculture, ocean monitoring and urban monitoring. Such multilateral and bilateral agreements can increase the economic impact created by the program at a global scale. In the longer run, this will only create remarkable economic and scientific benefits for the global society, which could be a towering achievement for the Copernicus.

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FARO's FocusS 70 delivers industrial grade performance with an exceptional price/ performance ratio.

FAROS's FocusS70 can deliver industrial grade performance with an exceptional price/performance ratio

3D LASER SCANNING A BOON TO PLANT ENGINEERING

The primary trigger for innovation in a field is the passion to achieve greater excellence or perfection from what is already in vogue. This is true in the case of 3D laser scanner as the technology allows capturing complex objects with lightning speed and utmost perfection.

3D laser scanners measure fine details and capture free-form shapes to quickly generate highly accurate point Clouds. 3D laser scanning is ideally suited to the measurement and inspection of contoured surfaces and complex geometries which require massive amounts of data for their accurate description and where doing this is impractical with the use of traditional measurement methods or a touch probe.

Within this realm, FARO's latest ultra-portable FocusS Laser Scanner enables to capture fast, straightforward and accurate measurements of complex objects and buildings. The laser scanner can be used to record architectural façades, complex structures, production and supply facilities, accident sites, plant engineering and large-volume components.

3D laser scanning a blessing for industrial plants

While 3D laser scanning is used in various fields, the technology is widely used in Industrial plants. The ability to accurately map Mechanical Electrical & Plumbing (MEP) and structural components allows engineers to avoid conflicts that in the past would not have been caught until the construction phase. Utilizing 3D scanning in industrial plants is a drastic improvement from the conventional methods. The accuracy, time savings, and most importantly, safety; make 3D scanning the most complete way to as-built these facilities.

One such company which has used FARO's FocusS Laser Scanner successfully in all its verticals is Poporo Plant Co. The Japanese company engages in the survey and design of liquefied natural gas (LNG) terminals. It recently introduced the use of FARO Focus3D X 130 Laser Scanner to its processes after five years of careful consideration. Since then, the company has undergone rapid expansion due to new business areas like Virtual Reality (VR) collaborations and overseas survey projects, as well as the overall five-fold increase of its productivity in field surveys.

Five-fold increase in productivity

Commenting on the improvement of productivity, Mitsuhisa Maekawa, Managing Director, Poporo Plant, who supervises the company's field work, shared, "With the introduction of the FARO Focus3D X 130, our team can now complete the field survey for a plant mechanical room – which is a job that used to take us more than a week with two people on the task – in just one day. This effectively translates to less than one-fifth the effort."

"The reason we chose FARO was because of the superb data compatibility between PointSense Plant (FARO's proprietary point cloud processing software) and the AutoCAD Plant 3D (a 3D CAD software by AutoDesk), which we use for plant design," said Mr. Maekawa.

The team uses PointSense Plant to create 3D models from point Cloud, then imports it into Plant 3D with all attribute information intact, resulting in a more efficient workflow for Poporo Plant when creating models of existing plants.

With their sealed design, all S Laser Scanner models are certified via the industry standard Ingress Protection Rating, and classified in Class 54 for environmental protection.

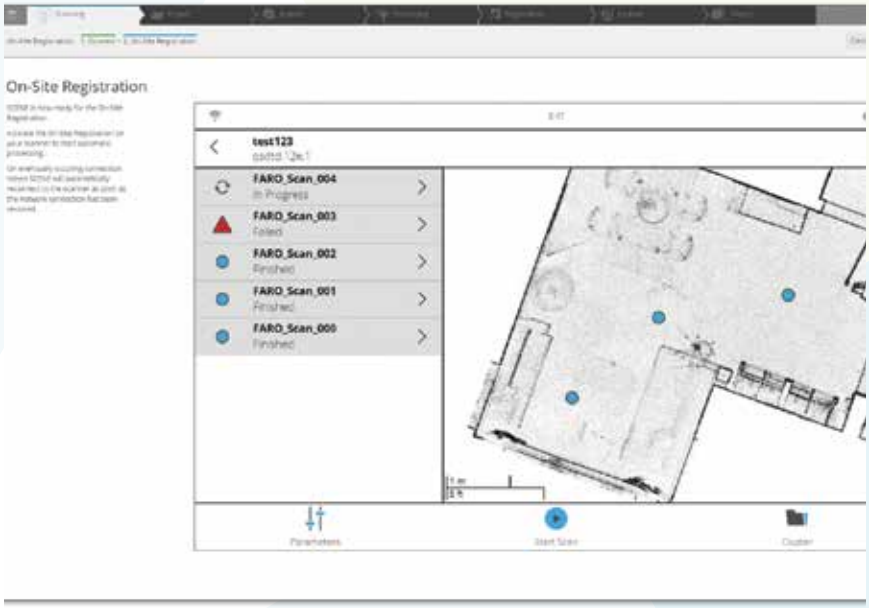
Advanced FocusS Laser Scanner

FARO's latest ultra-portable FocusS Laser Scanner enables users to capture fast, straightforward and accurate measurements of complex objects and buildings. The intuitive touch-screen of the FocusS models has been increased in size and clarity to deliver an extraordinary user experience. A built-in 8 mega-pixel, HDR-camera captures detailed imagery easily while providing a natural color overlay to the scan data in extreme lighting conditions. Familiar traits such as light weight, small size and a 4.5-hour battery runtime per charge, makes the FocusS Laser Scanner truly mobile for fast, secure and reliable scanning.

The FocusS Series consists of three laser scanners with different ranges: FocusS 350 for long-range measurements up to 350 m, FocusS 150 for mid-range measurements up to 150 m and the newest member FocusS 70, is perfectly suitable for short-term measurements up to 70m.

With their sealed design, all S Laser Scanner models are certified via the industry standard Ingress Protection (IP) Rating, and classified in Class 54 for environmental protection. The devices are built to safeguard against intrusions such as dirt, dust, fog and rain as well as other outdoor elements which typically occur in challenging scanning conditions. An extended temperature range allows scanning in extreme environments, like desserts. In addition, the laser scanners offer a future-proof interface to connect additional accessories to the scanner and provide a specific on-site compensation routine.

Next to the FocusS series FARO offers the FocusM 70 Laser Scanner, that features the same short-range distance as FocusS 70, being equipped with a less advanced features set and a lower level of distance accuracy. The device is ideal for indoor measurements and small area applications.



Activating the onsite registration on the scanner to start automatic processing.

Industrial plants require professional-grade laser scanners such as the FARO Focus S 70 for dependable performance.

FARO'S FocusS 70

Similar to FocusM 70, the FocusS70 also delivers industrial grade performance with an exceptional price/performance ratio. This includes an Ingress Protection (IP) Rating of 54 for use in high particulate and wet weather conditions, HDR imaging and extended temperature range.

Additionally, users will continue to have unrestricted freedom of choice to leverage the software tools most beneficial to their own workflow, including FARO SCENE and third party software solutions such as Autodesk ReCap.

"We were overwhelmed by the positive response and adoption of the FocusM 70," says Joe Arezone, Chief Commercial Officer, FARO Technologies. "That has validated our hypothesis that there would be significant enthusiasm for an affordable, short range,

> We have continued to keep our ears close to the ground with our customers and as a result can now offer the FocusS 70 as a higher accuracy companion to the FocusM 70 and a logical fit across the Focus Laser Scanner portfolio.
>
> — JOE AREZONE, CHIEF COMMERCIAL OFFICER, FARO TECHNOLOGIES. —

industrial scanner that was backed by FARO's trusted, best-in-class quality. We have continued to keep our ears close to the ground with our customers and as a result can now offer the FocusS 70 as a higher accuracy companion to the FocusM 70 and a logical fit across the Focus Laser Scanner portfolio. FARO is uniquely positioned to address the wide variety of performance requirements across all market segments and applications that leverage 3D scanning data."

The FARO FocusS 70 also delivers a set of incremental, value-added functionality that makes it a perfect fit for those applications that require the short range scanning power of the FocusM 70, the next level accuracy of the FocusS 150 or FocusS 350 and the unique power of real time, on-site registration.

Short range with best in class accuracy:

- Designed for both indoor and outdoor applications that require scanning up to 70 meters and with accuracy of +/- 1mm
- More data captured faster
- Delivers acquisition speed of almost 1,000,000 points per second
- Improved productivity and confidence
- Supports the real time, on-site registration functionality with introduction of SCENE 7.0 software suite

This high value functionality enables the 3D scan data, whether from a single scan or multiple scans in process simultaneously, to be wirelessly transmitted (i.e. no SD cards needed) directly to an onsite computer workstation/PC in real time.

SATELLITE IMAGERY + CROP INSURANCE = SMALLHOLDER FARMERS' GAIN

August is usually a tense time for farmers in Bihar, India. Having sown crops in July, they eagerly await the arrival of rains to sustain them. But Bihar is a flood-prone state. All too often, heavy rains cause floods that wash away crops, leaving farmers with no food and no produce to sell to earn a living.

This year, however, more than 200 of Bihar's farming households will be more relaxed. They are covered for flood damage to their crops by a pilot Index-Based Flood Insurance (IBFI) scheme launched by the International Water Management Institute (IWMI), with funding from the CGIAR's Climate Change, Agriculture and Food Security (CCAFS) and Water, Land and Ecosystems (WLE) programs. If the floodwaters are sufficiently extensive, the farmers will receive compensation.

The initiative is part of the efforts by IWMI to use the latest remote sensing data, Geographical Information System (GIS) technology and computer modeling to benefit poor and marginalized farmers. The approach called as AgRISE (Agricultural Remote sensing Insurance for Security and Equity) seeks to provide all farmers, no matter how small, with the security that insurance can provide.

Improvements in agricultural productivity in developing countries are thought to play a key role in reducing poverty. Unfortunately, farming outputs remain poorly measured throughout much of the world, hampering efforts to evaluate and target productivity-enhancing interventions. By using high-resolution satellite imagery, together with field data collected from thousands of smallholder plots in

Satellite intelligence is enriching new insurance products aimed at helping India's smallholders to withstand climate shocks.

By Giriraj Amarnath, Vairavamoorthy Kalanithy and Ashish Agarwal

A completely submerged village in Bihar, India. Farmers faced heavy losses after floods in 2016.

India, IWMI has been able to not only estimate and understand yield variation at the field scale over large areas, but also monitor flooding. This data has helped to develop various insurance products to safeguard farmers' outputs.

Developing the product

IWMI developed the IBFI for Bihar in collaboration with global reinsurer Swiss Re. The institute's scientists first examined past satellite images to identify historic floods and prepare a flood-risk map. Villages in three locations were selected for the pilot; one in an area at high risk of flooding, one in medium risk and one with a low risk of inundation.

A hydrological model was developed using 35 years of observed rainfall and discharge data from gauges. When contemporary rainfall data is input, the model is able to make predictions of where runoff will travel and collect. In other words, it can indicate where flooding is likely to occur.

In a survey, farmers from a few selected villages were asked about their recollections of floods that occurred in 2007 and 2013. Information that was collected from these villages on the depth and duration of flooding helped in validating the model. Also, gathered

IWMI is monitoring the monsoon very closely. If a trigger water level is exceeded in the model, the scientists of the institute will use 10 m-resolution satellite images from the ESA to verify the depth, duration and extent of the flooding

data on the levels of payouts made in those years helped to determine premiums at different levels of risk.

Once the IBFI was finalized and approved by the Insurance Regulatory Development Authority of India, IWMI partnered with the Agricultural Insurance Company of India (AICI) to enroll the farmers and implement the pilot. The scheme went live in July, with a total sum insured of around INR 5 million (approximately $78,000).

Awaiting the rains

IWMI is monitoring the monsoon very closely. If a trigger water level is exceeded in the model, the scientists of the institute will use 10 m-resolution satellite images from the European Space Agency to verify the depth, duration and extent of the flooding, and to identify those farmers who are eligible for payouts.

Any compensation payments will be made directly to the farmers' bank accounts. The insured period will extend until October 15, 2017, till which time harvest takes place. By this time IWMI would have also demonstrated the potential role that remote sensing data and modeling can play in supporting agricultural insurance schemes.

This is important as there is an increasing demand for this kind of product. Of $140 billion reported for damages in all economic sectors between 2003 and 2013, agriculture reports an estimated loss of $30 billion. Smallholders are particularly vulnerable to crop damage from extreme weather events, hence they stand to benefit greatly from affordable insurance products.

Insurance for all

In February 2016, India's Prime Minister Narendra Modi launched the Pradhan Mantri Fasal Bima Yojana (PMFBY — Prime Minister's Crop Insurance Scheme), which aims for more than half of India's farmers to have subsidized crop insurance within the next two or three years. The plan is that they will be covered for a range of disasters, including floods, drought, landslides and hailstorms.

Insurance company Bajaj Allianz approached IWMI for assistance with verifying claims made by farmers it had insured in Bihar under the PMFBY during the summer 2016 cropping season. For this, IWMI used satellite data to develop a 'crop health card'. By examining historic satellite images and information on related yields, scientists were able to accurately predict crop health and yield from current satellite images.

Satellite Imagery Giving Impetus To Crop Insurance

Scale	Crop attributes	Data Source	Spatial resolution	Temporal frequency	Mapping Scale	Monitoring cost	Product accuracy
Global/Regional	LULC classification, Crop / Non Crop, agricultural extent and changes;	MODIS Terra & Aqua Suomi NPP VIIRS IRS Resourcesat 1 & 2 (AWIFS)	> 1000m	Daily	> 1:50000,000	Low	Low
National	Major crop types; Identify area where ploughing or early crop development stages;	Landsat OLI-TIRS Landsat 7 SPOT IRS Resourcesat 1 & 2 (LISS IV) Proba-V	23m - 100m	5 - 25 days	> 1:50,000	Moderate	Moderate
Local	Crop specific types and variety; Crop pests and diseases; Crop yield and loss estimation; Supports in Crop Cutting Experiments, supports in product design for insurance application;	Sentinel-2 IRS Resourcesat 1 & 2 (LISS IV) RapidEye SPOT UK-DMC WorldView-3 GeoEye-1 Pleiades	10m	< 16days	< 1:25,000	Moderate	High
			< 5m	User defined	< 1:15,000	High	
		Unmanned Aerial Vehicle/Drone	< 1m		< 1:1,000	Very high	Very high

This meant it was possible to identify when crops were not healthy or had been damaged. During August 2016 flood, IWMI was able to provide crop damage estimates for rice and maize across an area of size little less than Kanpur city. In total, Bajaj Allianz had insured 307,677 hectares of farmland; the company reportedly covered loss of approximately $34 million.

IWMI went on to provide the same service for Bajaj Allianz for the winter 2016 crop, this time across the three states of Bihar, Haryana and Telangana. The company has a $7-million portfolio of insured farmers across this area. The institute is currently monitoring the 2017 summer crop. If through satellite images it is detected that the health of the crops has deteriorated, Bajaj Allianz will be alerted so that the company can investigate the cause of the issue on the ground.

Using Pléiades 50 cm-resolution global satellite imagery to capture healthy rice fields in 2016, in Bhojpur district of Bihar, India.

Valuable intelligence

There is clearly a useful role for the intelligence provided by remote sensing satellites, both within the insurance sector and for helping to support government schemes such as PMFBY. However, for crop insurance products to be reliable, the underlying data needs to be readily available and robust. Developing IWMI's IBFI, for example, required a high-resolution digital terrain model, observations from gauges on river levels and discharge, and village-level census data on farmer livelihoods.

New satellites are beginning to solve the resolution constraint. The European Space Agency's Sentinel-2 sensor provides 10 m-resolution data that can be used to predict smallholder agricultural productivity with roughly the same accuracy as survey-based measures traditionally used in research and policy applications. And multiple 'cubesat' companies are now providing data at a resolution of 5 meter or finer for much of the world at a much lower cost than previously available.

Scaling up pilot insurance schemes, so that they can cover several states or even countries will require data sharing between water resources, disaster management and agricultural coordination departments, both within states and potentially across state or national boundaries. Insurance products therefore have potential to promote cooperation between departments, states and countries, as well as between public and private sector organizations.

New satellites are beginning to solve the resolution constraint. The ESA's Sentinel-2 sensor provides 10 m-resolution data that can be used to predict smallholder agricultural productivity with roughly the same accuracy as survey-based measures traditionally used in research and policy applications

Around the world, governments and private sector can both benefit from successful large-scale public-private partnership insurance schemes. By building farmers' resilience to climate shocks, governments will have a greater chance of reducing risk from disasters and promoting economic growth. This can help them meet global development targets, such as those laid out in the Sendai Framework for Disaster Risk Reduction 2015–2030 and the United Nations Sustainable Development Goals.

The private sector will gain from up-scaled agricultural insurance schemes, as they will have a much wider pool of potential clients to sell policies to. And the more people they insure, the lower premiums will be, so government subsidies can be reduced too. It's a win-win situation.

However, the real beneficiaries will be the small-scale farmers, like those in enrolled in IWMI's IBFI. For the first time, they will have peace of mind that their families will be OK, come rain or shine. If the harvest is good, they will be well fed and might make some money selling their surplus crops too. But even if they have a disastrous harvest, they will be able to pick themselves up and use their compensation to get by until the next cropping season comes round.

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LUCIAD'S SMART CITY SOLUTION MAKES REAL-TIME DATA VISUALIZATION EASY

The smart city solution, Luciad Desktop, allows users to visualize data in real time

Success lies in efficient management of Big Data and the ability to share data in a meaningful, understandable way

Smart cities are not just about technology but also about transformation. With urban areas getting crowded each day, development of self-sustaining cities appears to be an alternate solution to this problem. Technology plays a vital role in self-sustaining cities. These cities enable automation and real time integrated city monitoring and management through a network of sensors, cameras, wireless devices and data centers.

Efficient management of Big Data and the ability to share data in a meaningful, understandable way is one of the key elements of a successful smart city. This trend has been effectively advocated by Luciad technology, which has partnered with Oracle to deliver a smart city solution, an application which supports cities with massively large amounts of data. The platform pulls together a citywide network of data from both human movement and technical sensors which constantly informs city leaders of what's going on in their communities.

Hans Viehmann, EMEA Product Manager for Oracle's spatial and graph technologies says, "The need for analyzing data has exploded. Organizations want to use geospatial data in conjuction with data from multiple sources, from crowd-sourcing to sensors to conventional reports."

The smart city solution — Luciad Desktop — uses 3D models of the city with thousands of textured buildings — stored and managed in Oracle Exadata Database Machine with Spatial and Graph in a scalable, highly performant manner

Viehmann further says, "Data needs to be pulled together into one environment to enable the analytics needed for many purposes."

How Luciad Desktop works?

The smart city solution — Luciad Desktop — allows users to visualize data in real time, using 3D models of the city with thousands of textured buildings — stored and managed in Oracle Exadata Database Machine with Spatial and Graph in a scalable, highly performant manner. Then, when it's time to plan security for a festival, redevelop a neighborhood or manage drone traffic, the city's IT team combines the 3D models with other data sources for applications. City managers and police forces benefit from the ability to quickly convey their message using the visuals of the smart city platform.

Why Luciad?

Commercial organizations and cities using Big Data turn to Luciad to visualize what they know. Harnessing and visualizing Big Data requires big thinking. Luciad developers are focused and flexible, qualities that make partnering with them a pleasure. Oracle has worked with Luciad for years.

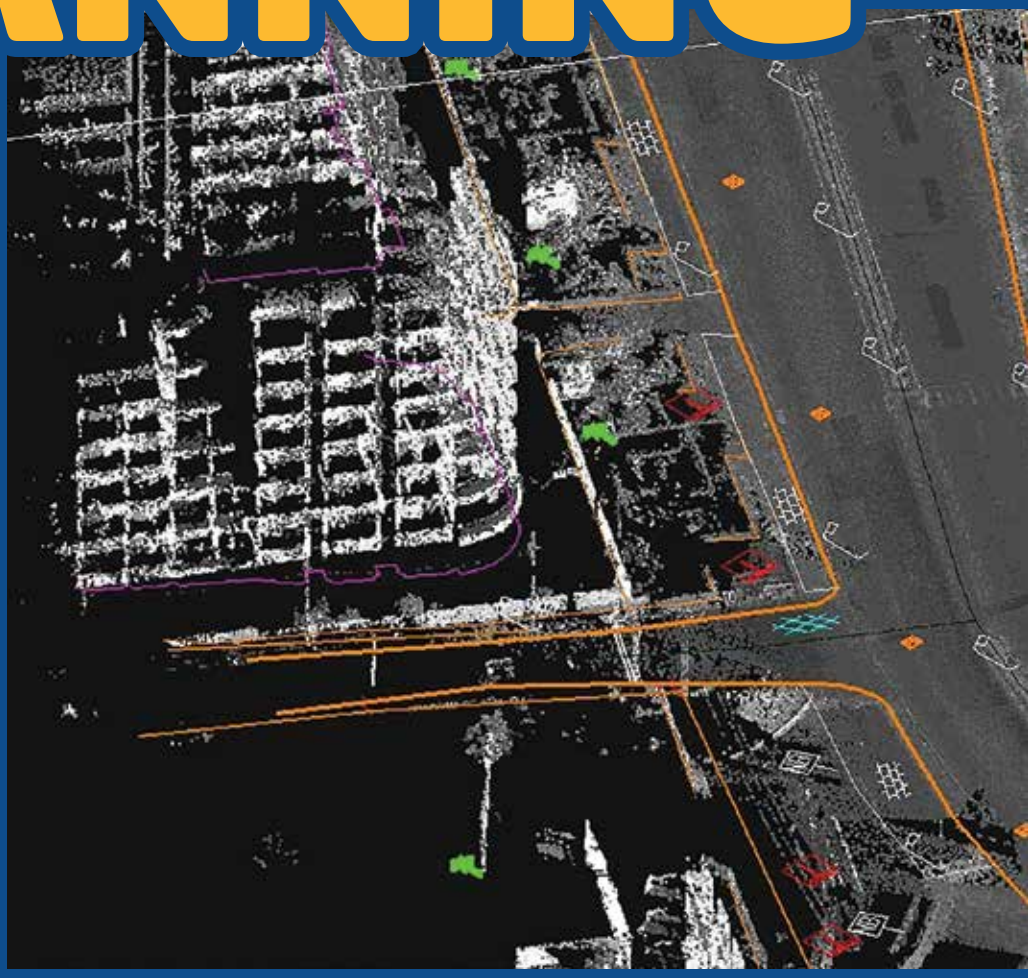
"Luciad and Oracle complement each other perfectly," Viehmann says. "We provide the infrastructure and the Luciad platform addresses the actual solution requirements."

Oracle recommends Luciad because of its exceptional capabilities in geospatial situational awareness solutions. Luciad is the world leader in geospatial solutions for business and mission-critical systems. Major clients include Boeing, Airbus, NATO and Eurocontrol.

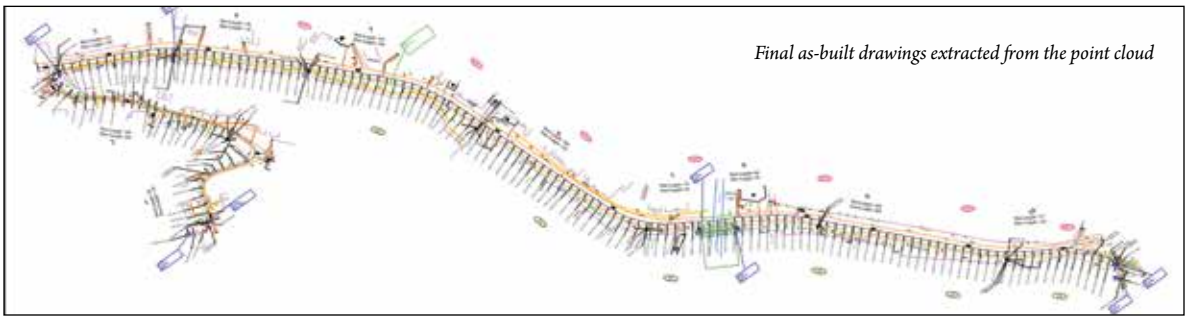
Courtesy: Luciad

DESIGNING OPTICAL FIBRE CABLE ROUTES BY MOBILE LASER SCANNING

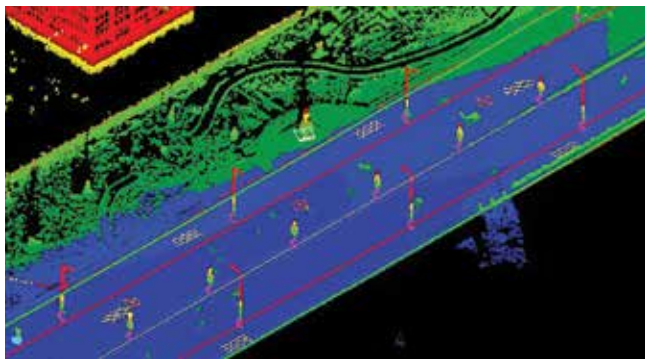
Modern communication infrastructure relies on OFC routes. While GPS can help map the obstacles, MLS is the key for immaculate results.

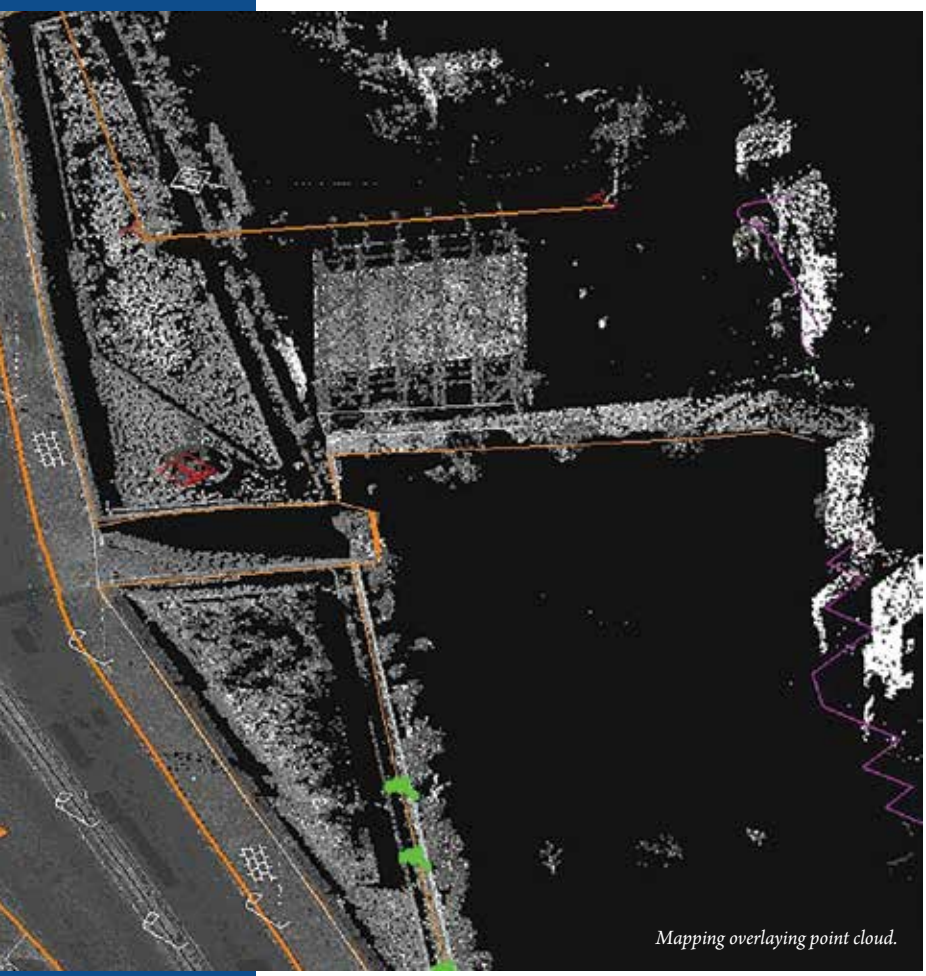


India is undertaking a major revamp of its communications infrastructure by laying over 100,000 kilometres of Optical Fibre Cable (OFC) across the country. AAM India's task was to map 2,500 km of proposed OFC routes across 33 cities to allow the contractor to decide where to lay the trench. All trenching is along existing road corridors, mainly in urban and semi-urban environments. The contractors needed mapping data with 50 cm absolute and 10 cm relative accuracy across all OFC routes to prepare accurate As Built drawings. The resulting maps needed to define all visible objects within 50 m from the road centreline, ensuring



Final as-built drawings extracted from the point cloud





Mapping overlaying point cloud.

telecom, utility assets and manhole covers were defined.

Situation

The conventional approach to this task is to deploy multiple field survey teams to map the obstacles to optical fibre cabling by Global Positioning Software (GPS) and/or Total Station methods. This project's aggressive timetable and dense mapping requirements led AAM to consider other approaches. Mobile Laser Scanning (MLS) offered the ability to map the road corridor at speeds, feature density and cost not possible by traditional methods. It offered additional benefits of increased project safety and avoided all traffic disruption.

Action

AAM India deployed their StreetMapper MLS unit, equipped with a Riegl LiDAR and spherical camera. Experienced survey design was required to ensure specifications were met, involving positioning capability of the StreetMapper system, rigorous system calibration, regular system initialisation, experienced acquisition techniques and prudent Ground Control.

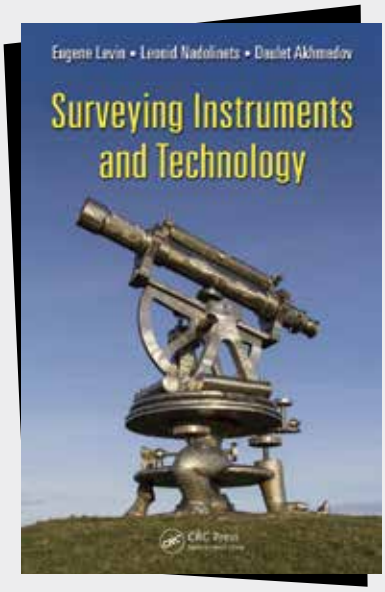
AAM processed the raw MLS data in secure premises to produce a dense streetscape point cloud, colour coded with the spherical imagery. Then AAM extracted all visible street assets within the corridor and delivered site-ready Street Maps in digital and PDF format.

Result

The client received an accurate, detailed and clear definition of the proposed OFC routes, in a timeframe, cost and level of detail which was not possible by conventional methods. The MLS point cloud remains a valuable asset to the project. Additional features can be extracted from the point cloud as required, without the need to send field crews back into the field.

The client has accurate As built drawings to optimise their trenching operations and a reliable record of the site before construction works.

Courtesy: AAM



SURVEYING INSTRUMENTS & TECHNOLOGY

Book Review By
Prof. Arup Dasgupta

Authors
Leonid Nadolinets, Eugene Levin, and Daulet Akhmedov

Publisher
CRC Press, 2017

One would imagine that a technology like surveying, being so old, would not have been touched by modern technology. Well, such an assumption would be wrong. The book, *Surveying Instruments and Technology* brings out the extent to which technology has impacted instruments being used in modern day surveying. It is an excellent treatise for students and a reference book for practitioners. The coverage is very wide from prehistory represented by a stone engraved map from Spain to the modern age of GNSS and UAVs with all other technologies in-between. This coverage of technology from the earliest days of surveying and its evolution into modern instruments is well covered.

The chapters on optical instrument ranging from levels to total stations cover the entire gamut from the simplest to complex instruments including laser assisted instruments and digital readout systems. The treatment of each device is discussed in therms of accuracies, reliability and limitations. Even instruments which are now becoming obsolete are given a fair coverage, thus the history of development can be traced by the reader and the improvements implemented in stages in the optical systems as well as in the readout technology using digital technology is clearly explained.

The treatment of GNSS is excellent. Starting with simple examples, the reader is led through the complexities at each step in position location using GNSS. The illustration are excellent and the section on geoids, ellipsoids and datums should be of use to geography students in general. Beyond the basic theories, errors and corrections, the chapter also discuss thoroughly the concepts of DGPS, SBAS and applications in location based services, and other applications. GPS instruments and their operation is also adequately covered.

The final chapter on using UAVs for surveying actually covers much more than just the survey. Starting with aerial surveys in general, the chapter extensively covers different types of UAVs, their classification, sensor payloads and the position UAV surveys in the field of aerial surveys in general. The issue of multiple image registration is discussed in conventional photogrammetry terms as well as using new techniques like Structure From Motion and SIFT algorithm. The planning of a typical UAV survey is covered in detail from initial preparation to detained planning and execution.

The book is well produced with excellent illustration and diagrams to support the text. A good addition to a surveyor's library.

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