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DISRUPTION

A BOON OR BANE

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CONTENT

VOLUME: 08 I ISSUE: 05

Stimulated by a range of new global shifts, the balance of power between existing and new players is shifting drastically as the geospatial industry moves towards innovation, convergence and transformation. In this changing scenario, industry leaders surely have lot to do, and say.

Geospatial World Leaders' Outlook, the first of its kind, seeks to provide insight into the great minds that are continuously shaping and redefining our industry. The edition focuses on capturing their outlook on technology landscape, changing business models and transformation.

We reached out to 125 industry leaders from across the world, covering all seven continents, for this survey. Our endeavor was also to reach out to a mix of companies, in terms of technologies as well as revenues. The leaders were given a detailed questionnaire to fill – both in multiple choice and elaborative format – and we acknowledge the time and patience showed by them while approaching the task. We are glad to feature the thoughts of 53 select leaders in the edition.

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Disrupting Geospatial Industry: Simplifying & Amplifying the Value Chain

With the advent of information technology in the past half century, geographic information has evolved as a common language of 7 billion people around the world. And disruptive tools have further integrated geographical information into broader IT and Engineering processes.

While disruption gets to be new normal, geospatial is getting ubiquitous, pervasive, and 'by default' in our daily living. As we prepare to enter the Fourth Industrial Revolution, driven by Artificial Intelligence, Big Data, Internet of Things and Robotics, geospatial aspires to be an integral part of this disruptive journey. However, in the process, it gets disrupted as well, opening its closely guarded boundaries to larger market drivers, and creating new growth opportunities, weathering through market forces and consumer behavior. A host of next-generation entrepreneurs are joining the innovation bandwagon and beginning to explore the hidden treasure of spatial thinking, empowering IT-enabled services and optimizing engineering workflows and business processes.

Disruption is not only all about technological innovation, but also cuts across complete value chain of the business lifecycle. While opening new market opportunities, the disruptions brought a whole set of new business model towards delivering tangible information services in user-friendly manner through a collaborative and interactive platform. Simplifying utility and value of geospatial knowledge for consumers became determining factor for successful business models.

At the same time, it also threatened the well-established heavy boundaries and challenged legacies of existing business ecosystems, leaving them with no options but to pursue transformation towards solutions-centric business models through collaborative platforms, embedding its capabilities with processes, workflows and systems of user industries, optimizing productivity and efficiency, and subsequently amplifying its value and impact in economy.

Though geospatial industry is growing exponentially in terms of market size and its value impact in the world economy and society, its journey hasn't been and going forward not likely to be smooth at all. The industry, which is very upbeat with technology innovation, rosy market prospects, defined value propositions and likely financial investments, is going through a churning process as it faces competition from unknown quarters, challenges from legacy practices, shortage of qualified manpower, deficit of market-driven leadership, and above all ruthless consumer behavior. Such a transformation process would attract few casualties, forcing market consolidation and portfolio integration.

However, this initial painful experience is opening avenues for a larger pool of innovators and business leaders, at the same time creating a collaborative environment to harness larger business goals. Undoubtedly, geospatial industry is at the cusp of a digital revolution, simplifying and amplifying geospatial practices and values in world economy and society.

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The Age of the Aquarius and Transformations

It is the Age of Aquarius; a time of change, of breaking of barriers, of new interactions, innovation and disruption towards a better world. Technologically, the Fourth Industrial Revolution holds promise for such a world of peace where humankind lives in harmony with nature. For geospatial systems it is time that it becomes a part of the mainstream which is good, but it is a time when it loses its identity as something different and standalone.

In the Fourth Industrial Revolution, geospatial is not just about location. It is more about how the information revolution will affect humankind and the surrounding environment. In fact as far back as in 1999 the University Consortium of GIS in defining Geographic Information Science stressed this very fact by stating that "… G I Science also examines the impact of GIS on individuals and society, and the influences of society on GIS. … It supports research in political science and anthropology, and draws on those fields in studies of geographic information and society."

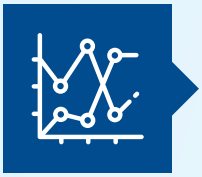
As geospatial practitioners we tend to get carried away by technological advances. These advances are indeed tremendous. Once analogue maps could be digitized and turned into two dimensional searchable and analyzable databases, the power of IT became available to the geospatial professional. Advances have followed in rapid succession as IT advances were absorbed and adapted for geospatial use. The World Wide Web became the basis for map publication and discovery and for standardization and interoperability. Today, the Cloud has become the norm for distributed access and Big Data Analytics has moved from the business arena to geospatial analytics. AI, Blockchain and the IoT are playing an important role in all this. This also meant the democratization of geospatial technology and its accessibility. From smartphone to self-driving cars and machines that think, this level of ubiquity subsumes geospatial systems into common everyday processes. There are two levels at which this is happening. In the first level there is convergence and consolidation of geospatial systems with other IT based systems like SCADA, BIM, BI, etc. At the other level we see the ubiquity extending into our daily individual lives through items of daily use and facilities with which we interact.

Internet is passé. Today it is the network, the fabric that is beginning to tie together humans and machines. Proponents of the theory that data is the panacea for all ills in society and the environment, are all for collecting data by mapping every centimeter of the Earth's surface and geotagging every object, animate and inanimate to the IoT. That is a huge amount of data. Data storage has long given up the struggle to cope with the tidal wave as more and more individuals and objects get connected. It is Big Data Analytics and Deep Learning that will rule the world.

This raises many questions. Do we see a robotized world in which humans just exist like in H.G. Wells' *Time Machine* or do we see a world where humans are central and technology serves to enhance their creativity, their empathy and helps to lift humanity to a different level of existence? This is a question that technology leaders, decision makers and administrators have to answer. The time of linear thinking is long gone. Thinking out of the box is the formula for success. Nowhere is this more true than in the world of geospatial technology and systems. *The Age of Aquarius demands it.*

IN A NUTSHELL

- Democratization of geospatial is providing new prospects for the industry.
- Location has become fundamental to business processes, leading to expansion of the market.
- Young leaders are excited about new breakthroughs and opportunities.
- Traditional companies are bound by legacy issues and lukewarm to transformations.



DISRUPTION CREATING NEW BUSINESS OPPORTUNITIES

- Emerging technologies from outside the core industry are enabling capabilities not envisioned just a few years ago, making the applications of geospatial technologies much broader.
- An overwhelming **85%** of the business leaders feel the geospatial industry has seen a disruption in past few years.

NEW COMPETITION A CHALLENGE

- While about **50%** of the business leaders welcome the changes as new growth opportunities, about **44%** also view them as increased completion.
- As much as **65%** of the respondents say much of the innovations and disruptions in the geospatial industry have come from outside the industry.
- Mostly traditional players view the new innovations as competition or threat.

COLLABORATION NOT A CHOICE ANYMORE

- Location technology is going into chipsets, cars, drones, enterprise software, traffic management systems, and collaborations have become essential.
- To thrive in the competition, businesses now need to build complete solutions, and **85%** of the respondents agree the most effective way that can be achieved is through collaboration.

TECH ADVANCEMENTS SHORTENING PRODUCT LIFESPAN

- Rapid introduction of new products in the market. About **85%** or the respondents feeling this cutting down gestation periods and shortening product lifespan.
- Consumers are continuously demanding whole, updated solutions and to stay competitive, most business leaders believe, organizations need to constantly innovate.

ROSY BUSINESS OUTLOOK

- Leaders are upbeat about the future since they see technology advancements increasingly making location intelligence fundamental to all business processes.
- The industry is infusing itself into new workflows, business models and possibilities.
- Geospatial industry will continue to see further consolidation in keeping with the consolidation process in the IT sector.

TRAINED WORKFORCE A BOTTLENECK

— Developing a trained workforce is a big challenge faced by the industry — **21%** list it as their biggest challenge and **11%** feel human resource is going to be their biggest investment in the next three years.

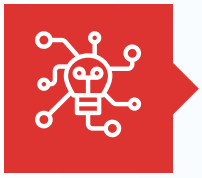
— More than **50%** feel acquiring new talents skilled in emerging technologies will be a challenge, **16%** feel reskilling existing workforce will be a bigger priority.

— Geospatial community needs strong data analysts and data scientists, mappers and cartographers, incredible story tellers, and imaginative software engineers.

LOCATION FUNDAMENTAL TO FOURTH INDUSTRIAL REVOLUTION

— **82%** agree that we are on the cusp of a true information revolution, with the rapid emergence (and reduced cost) of sensors, drones, and robotics.

— The geospatial ecosystem is evolving to support 4IR, and 4IR will, in turn, put new pressures on geospatial industry — particularly to support real-time data capture, fine-grain geolocation, rapid data analysis, and data synthesis across multiple sources.



UPBEAT ON NEW TECHNOLOGIES

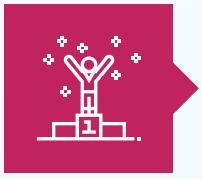
— Cloud, IoT, robotics & automation, deep learning & artificial intelligence, augmented reality and reality mesh are opening up new horizons, driving the geospatial industry, and at the same time getting enriched by it.

— Of the many technologies, smartphone and Cloud emerged as the two biggest game changers for the geospatial industry in recent times, closely followed by drones and AI.

FUTURE INVESTMENTS

— To stay relevant, the industry needs to invest in new technologies — through acquisitions of other companies, mergers, collaborations or companies developing in-house capabilities.

— **45%** of the leaders interviewed say acquiring new technologies will be their biggest investment in next three years.



CONSUMER IS THE KING

— The growth of the technology and its impact on consumer behavior has seen geospatial companies orienting their offerings based on clients' needs and patterns.

— The go-to-market challenge has also become more complex and requires a more tailored approach to ensure customer satisfaction.

— Majority of the business leaders say their focus is on multi-disciplinary implementation of customers' needs.

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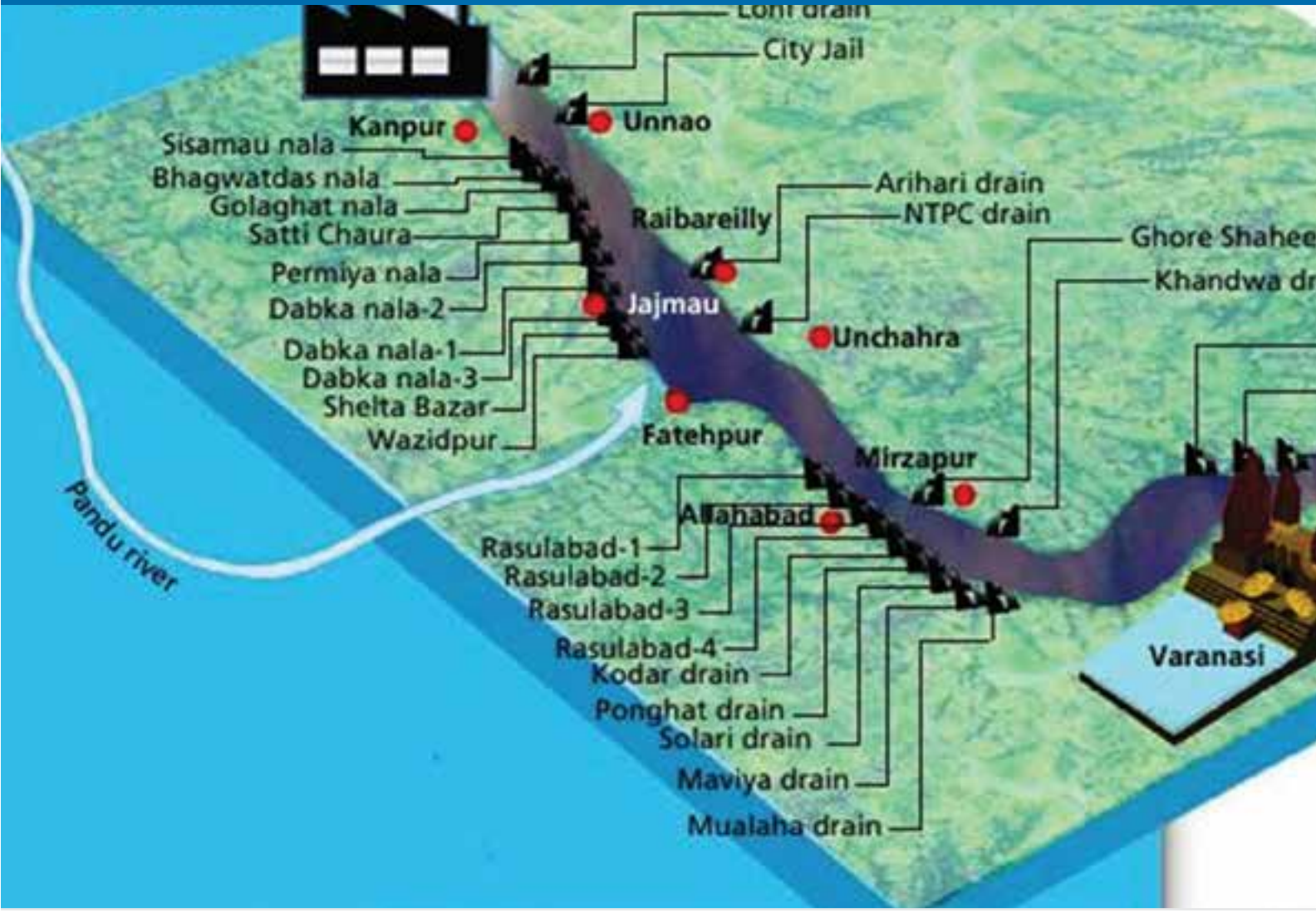

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JICA Assisted Ganga Action Plan II | *Varanasi, Uttar Pradesh, India*

On the west bank of India's holiest river, the ancient city of Varanasi attracts thousands of pilgrims but is ill-equipped to treat their waste. The city collects only 33 percent of sewage and discharges the remainder of the waste into the Ganges River and its tributary. Uttar Pradesh Jal Nigam retained NJS Engineers India Pvt. Ltd. (NJSEI) for an INR 450 crore project aiming to achieve a 90 percent treatment rate prior to discharge.

NJSEI analyzed more than 800 kilometers of sewer network and recommended improvements with Bentley applications. The team prepared a web-based GIS database, developed sewage zones, updated the sewerage network inventory, modeled existing and proposed sewerage systems, prepared system rehabilitation and expansion plans, and proposed more efficient operating strategies. SewerGEMS helped the team save 100 resource hours and INR 18 crore in project costs. **Project Playbook:** MicroStation, SewerGEMS, STAAD.Pro, Geo Web Publisher, AssetWise

FIRST AMONG EQUALS

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 everything. How do CEOs and geospatial business leaders view this progressively interconnected world and how are they adapting to the changes? **By Anusuya Datta**

Maps are not just driving apps today; they are driving economies too. Geography is a component of every major decision that organizations and individuals must make every day. So, it's only a matter of intuition for any forward-thinking company involved in technology today to incorporate spatial analytics into their offerings. "Location intelligence allows other capabilities to be what we call 'geo-enabled'. This means that normal business intelligence gets supercharged with a geographic component that allows a holistic situational awareness, providing real-time insights into operations and systems," explains **Jack Dangermond, President, Esri.**

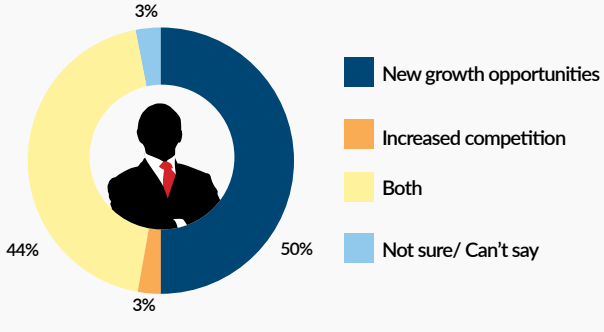
In the past one decade, core geospatial technologies have evolved exponentially, and they have rallied with a host of mainstream IT and digital disciplines to complete the puzzle. Specifically, the past four to five years have seen constant innovation and transformation in the geospatial landscape and business environment, simultaneously, giving birth to exciting opportunities and formidable challenges. This innovation cycle has further re-energized, reorganized and at times completely redefined the composition, character and business models of the geospatial industry.

"We have seen industry consolidation, technology integration, near ubiquitous connectivity and an increased focus on providing industry-specific solutions. I believe that this 'evolutionary process' has been primarily driven by data collection, analysis and project deliverables — where each of these phases were loosely federated and integrated," says **Steve Berglund, President & CEO, Trimble.**

Disruption: nudging forward or causing stress?

Industry leaders have mixed feelings about the technological disruptions — while 50% have welcomed them as new growth opportunities, 3% see them as increased competition, and 44% view

Graph 1: How do you view this disruption?



them as both *(Graph 1)*. An overwhelming 85% of the respondents feel that the geospatial industry has gone through a disruption in the past few years *(Graph 2)*. However, a number of people also called this transformation an "evolution" process.

While democratization of geospatial provides many growth opportunities, with those opportunities come new entrants into the market, both from established non-geospatial players as well as start-ups. About 65% of the respondents agree that some of the innovation, and much of the disruption, is being generated from outside the core geospatial industry — mostly by venture capital-backed start-ups. The start-up community has fostered a more rapid pace of innovation, and the Space 2.0 realm in particular, has challenged the incumbent cost structure for geospatial data and analytics.

While this is expanding the geospatial industry, our analysis of the responses also show young companies and leaders are excited about any new opportunity or innovation. A lot of traditional players seen to be bound by legacy issues and view outside innovations as competition. This is because a lot of these companies still have a product-centric approach and have not invested enough to move up the value chain. They lack deep pockets for total transformations to sustain the breakneck speed of technological innovations.

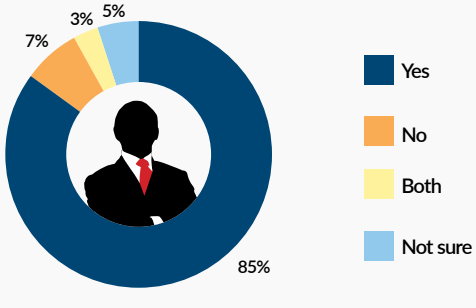
Collaboration the key mantra

Geospatial data capture and maintenance is in the process of being dramatically reshaped by ubiquitous sensing technologies, and the nature of geospatial data is radically changing also. Traditionally there have been barriers to accessing geospatial data, which have curbed the potential of innovation. However, in recent times open data movements and advances in managing large datasets such as satellite imagery and distribution have made it feasible for organizations to look for opportunities to leverage geospatial data and push the boundaries.

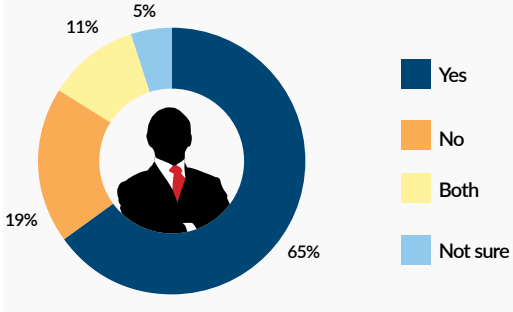
As **Ola Rollen, CEO, Hexagon**, explains: "We live in a data-driven world and geospatial data is critical to our most vital industries, including defense, oil and gas, agriculture, mining and smart cities. The proliferation of location-based technologies has raised awareness and accelerated the development of applications for user-based needs." Location technology is going into chipsets, cars, drones, enterprise software, traffic management systems, and collaborations are becoming essential.

To thrive in the competition, businesses realize they need to build whole solutions, and 85% of the respondents believe that the smartest, most effective way that can be achieved is through collaboration *(Graph 7, Page 15)*. Even though much of the industry is still product-centric, over 80% of respondents agree there is a clear demand from users for services, system integration and complete workflow solutions *(Graph 9, Page 15)*.

Graph 2: Do you think geospatial industry has seen a lot of disruption in the past few years?

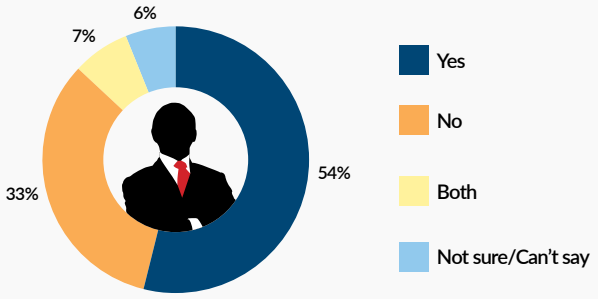


Graph 3: Do you think much of the innovations and disruptions in the geospatial domain in recent times have come from outside the geo industry?

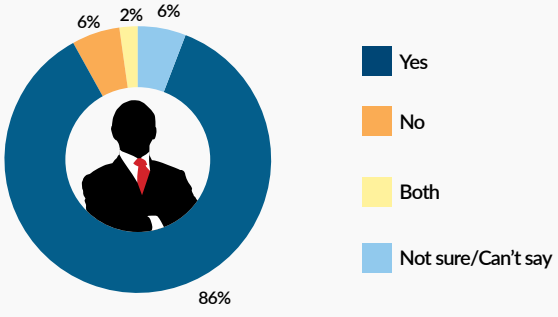


The increasing interests in the technology industry drives awareness amongst potential user communities, draws talented resources to enter companies and evolve the knowledge base, and creates advocates who are able to further promote the technology as a mainstream business solution, points out **Robert Laudati, Managing Director, Harris Geospatial Solutions**.

Graph 4: Do you think cost and ease-of-use still remain the restricting/limiting factors for exponential geospatial uptake?



Graph 5: Do you think businesses and governments have been able to fully leverage the power of the SMAC (Social, Mobile, Analytics, and Cloud) and location data?



IT companies and engineering firms are good examples of organizations who are being asked for geospatial technology embedded in their offerings and/or see competitive advantage to providing it. The geospatial industry leaders see this as a natural evolution of geospatial technology becoming fully integrated in business solutions. Meanwhile, technology advancements are cutting down on gestation periods and, as a result, shortening product lifecycle, about 84% of the respondents believe.

"That's good — especially for small, new companies developing new products," says **Matthew M. O'Connell, Managing Partner at Seraphim Capital** (a venture capital firm) and also the former CEO of GeoEye. The market for location information and products will continue to grow as the industry evolves away from data toward finished information and analytical products.

A number of important technology-driven trends are likely to have a major impact in the coming years, creating previously unimaginable amounts of location-referenced information. The Internet of Things, autonomous machines, artificial intelligence/machine learning will only accelerate this trend as more and more people come directly into contact with location information as part of their daily lives, believes **Francois Lombard, Senior Vice President, Head of Intelligence Business, Airbus**.

"Geospatial industry's strength lies in its ability to integrate technologies," points out Berglund. Cameras, satellite positioning systems, optics, and many others have been developed by industries outside for other purposes. Geospatial companies innovated by integrating these technologies to domain-specific workflows for meeting the needs of the industries or enterprises.

Low awareness the biggest hurdle

However, understanding the complexity and potential about this technology amongst those technology innovators is still limited. "The geospatial industry is still undervalued and underappreciated by the world at large. The onus is on us to collectively demonstrate how location data and tools can be applied to make dramatic improvements to society — from making every journey safer and our air cleaner to helping businesses operate more efficiently," underlines **Edzard Overbeek, CEO, HERE Technologies.**

As expected, lack of awareness — among users and policymakers — remains the biggest challenge for the industry, with over 38% listing it as a primary hurdle, and about 12% say lack of adequate government support and stifling regulations were holding them back *(Graph 14, Page 20)*.

Cost and ease of use remain another issue, with just over 50% leaders agreeing that they are restricting factors in the exponential uptake of geospatial technologies *(Graph 4)*. However, about 33% are confident that these were not significant causes holding them back.

"Cost and ease-of-use are important factors; however proven RoI, higher quality, safety, less waste, mitigating risk— these are the issues that our customers care about most," states Rollen. Lowering cost will accelerate uptake, and ease of use will accelerate adoption at a broader level, but the solutions must be effective.

About 86% respondents agree businesses and governments have not been able to fully leverage the power of SMAC (Social, Mobile, Analytics and Cloud) and location data *(Graph 5)*. This is because the products weren't sufficiently advanced and the users were stuck in traditional mindsets about how information should be created.

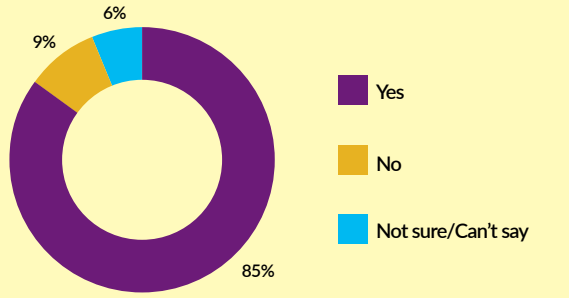
A number of technology-driven trends are likely to have a major impact in the coming years, creating previously unimaginable amounts of location referenced information, and dashboards to visualize information

HIGH ON DISRUPTIONS

The graph gives a broader outlook of the geospatial industry. As can be seen, disruptive technologies are giving thrust to new opportunities along with making companies go for collaboration within and outside.

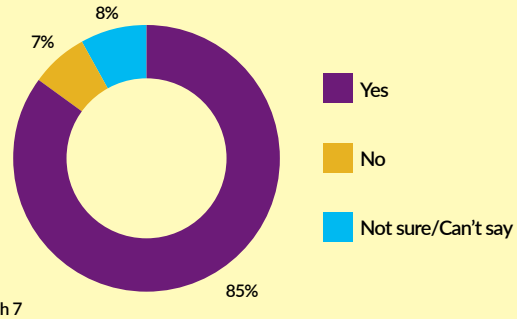
Before a business is able to fully realize the RoI on an existing technology investment, it is faced by a disruption. The smaller gestation periods in product lifespan is making it challenging for the industry to adopt new innovations and leverage the power of disruption fully. The industry, however, is buoyant, and sees this as a growth opportunity.

Do you think that constant advancements in technology are cutting down gestation periods and shortening product lifespan?



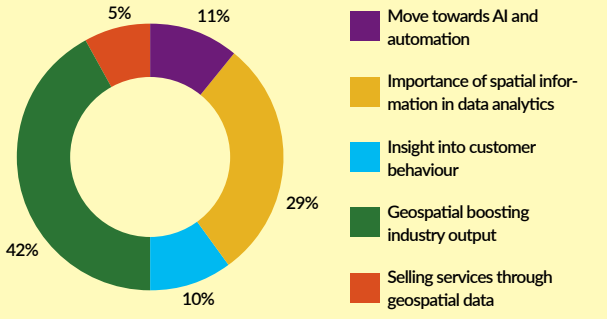
Graph 6

Do you think geospatial companies are going for collaborations within and outside the industry?



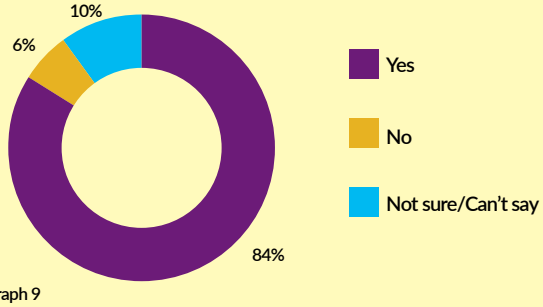
Graph 7

Why are IT and engineering firms developing their own geospatial capabilities or acquiring companies with spatial analytics abilities?



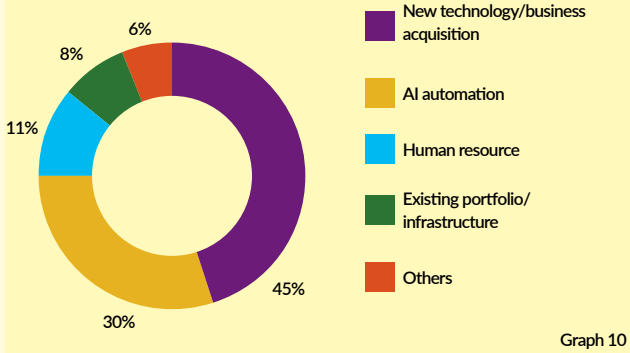
Graph 8

Do you think users are now demanding complete workflow solutions rather than standalone products?

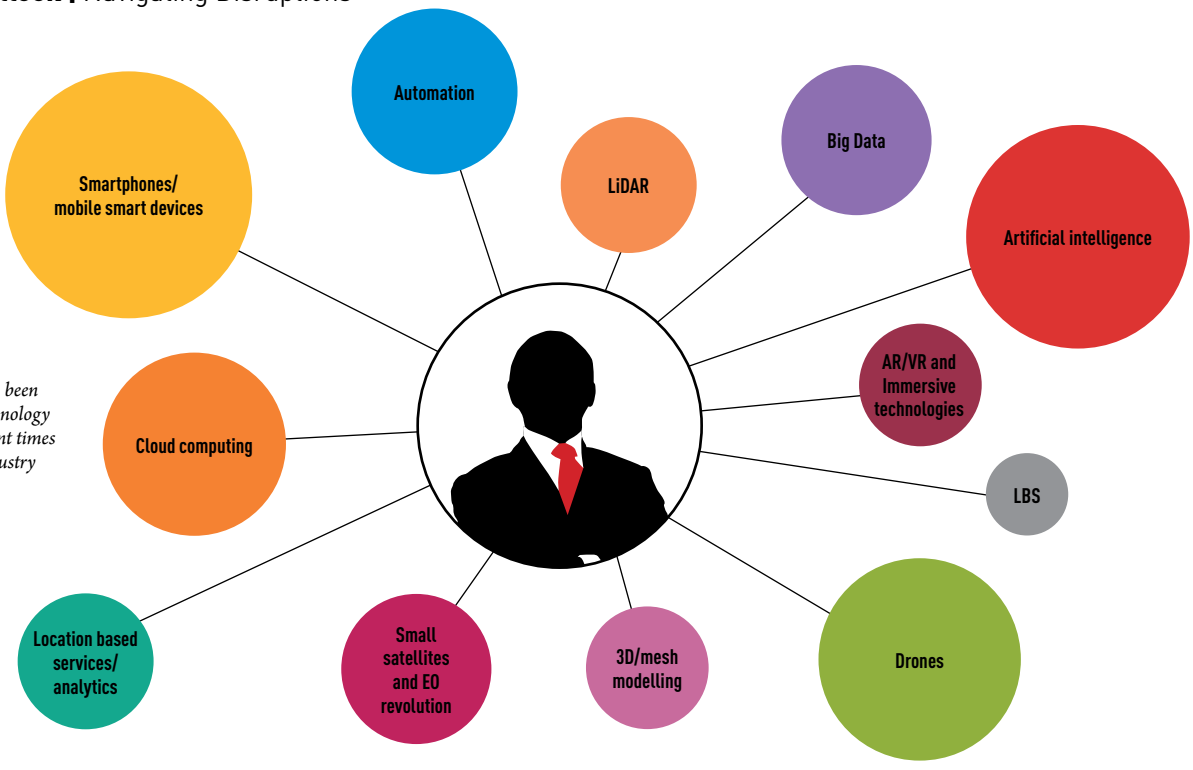


Graph 9

What will be your biggest investment in the next three years?



Graph 10



Graph 11: What has been the single biggest technology game changer in recent times for the geospatial industry and why?

"Many businesses and governments still put their spatial strategy in a 'corner' sticking with the tools skills and techniques of the past. Until these organizations free themselves from the shackles of this prior generation mindset, SMAC data will remain underutilized resource instead of a differentiator," thinks **Javier de la Torre, CEO, CARTO.**

How the future looks?

Disruption is not without its risks — especially in a fast-changing, cut-throat market when the majority of competitors are also planning to out-innovate each other. About 75% of the respondents expect the next three to five years to be of accelerating disruption, and a marked uptake in geospatial data and technologies.

"In the next three to five years, advances in sensors will enable Autonomous X, systems that enable us to understand and respond better to every change in the environment, and to engage in a broader variety of tasks. Computing will be pushed to the edge of the network, and connect with the Cloud to exchange information and learn collectively," Rollen elaborates.

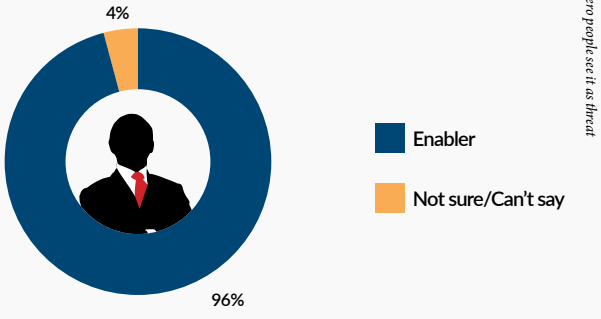
Cutting-edge technologies such as Cloud, IoT, robotics & automation, and artificial intelligence are opening up new horizons, driving the geospatial industry, and at the same time getting enriched by it. All the warnings and negative reports about artificial intelligence are not dampening the enthusiasm of geospatial business leaders for the still-evolving technology. A staggering 96% believe AI to be an enabler — something that can absorb the location/position data and convert it into actionable outcomes *(Graph 12)*.

"When combined with advances in artificial intelligence, AI, Cloud computing, and even Blockchain technology, geospatial data will have broad impact on human endeavors starting with utilities, the insurance industry, agriculture, conservation and national defense," emphasizes **Howard Lance, CEO Maxar Technologies.**

Smartphones/mobile smart devices emerged as single largest game changers for the geospatial industry in recent times, closely followed by drones and AI *(Graph 11)*.

Our survey suggests that technology advancements and disruptions are already influencing operating decisions. While business leaders can identify the trends, many of them are also reorienting their business strategies, consolidating or focusing on new technologies and markets. The demand for the analytics and real answers that geospatial industry can provide will significantly increase over the next few years and beyond. The market for geospatial intelligence is only at its beginning and tools like machine learning and artificial intelligence are driving the next generation of capabilities.

Graph 12: How do you view artificial intelligence?



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nrsc

इसरो ISRO

Indian Space Research Organisation

Department of Space

Smart Way to address Geospatial Quest

National level nodal agency for acquiring and distributing satellite data

Supporting specific user demands and disaster management through aerial acquisition

Bhuvan for Open Data & Value Added Products for users

NRSC Outreach Facility

National Remote Sensing Centre
Hyderabad, India

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data@nrsc.gov.in

New technologies like artificial intelligence, automation, robotics have all opened up a host of possibilities. To stay competitive and emerge as winners in this game, the industry leaders are thinking on feet, setting new priorities and rapidly adopting innovations. **By Shimonti Paul**

As new technologies and innovations are transgressing the physical, digital and biological worlds in ways that will transform the mankind; governments, public institutions and businesses are trying their best to keep up with these disruptions. And like all industries across the world, the geospatial services ecosystem is in throes of this change. They are together in their focus on innovation, convergence and transformation. Rethink and reprioritize seems to be the mantra of the industry leaders, with more focused on investing in innovation and collaboration, paying more attention to data and location intelligence, and staying focused on consumer expectations.

In the words of **Jack Dangermond, President, Esri**, "New Cloud and Web computing paradigms are enabling capabilities that were once thought to be unachievable. Today, the geospatial community will need strong and creative GIS analysts and data scientists, great mappers and cartographers, incredible story tellers, analysts of all stripes, and imaginative software engineers to help us collectively achieve our visions."

The leaders are upbeat about the future as the industry infuses itself into new workflows, new business models and new possibilities. Armed with technologies such as Cloud, IoT, deep learning and artificial intelligence et al, majority of the industry leaders feel that the geospatial industry will continue to see further consolidation in keeping with similar trends in the IT sector. Along with consumerization of geospatial, the industry will be driven by partnerships.

Investment in innovation

Majority of industry leaders are in favor of adopting a wholesome business approach to foster and leverage this innovation, from funding ***new R&D projects*** to understanding the capabilities and advantages of emerging technologies, to engaging with key clients on their digital transformation and innovation programs and providing thought leadership, to market research on the demand cycle in the growth sectors.

Business models

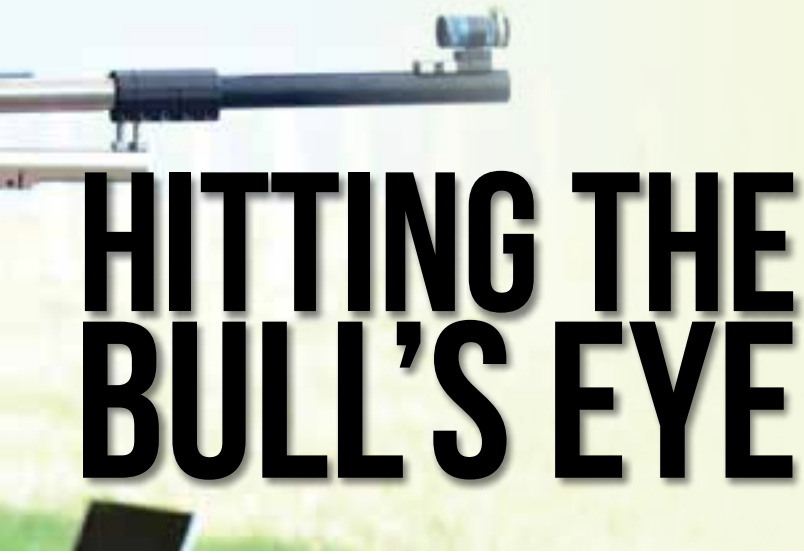
Democratization of geospatial has also added to consumerization of the technology. This is evident in the way majority of the respondents are enthusiastic about ***subscription-based business model***, which is beginning to be known as pay per use model. While the transition from a desktop perspective to mobile platforms and Cloud is driving this change, the fact that many non-geospatial players could provide a part of the software or solution that an end client may be looking for instead of a whole package is also pushing companies to go for this model.

However, with further integration of technologies and complete workflow solutions, we will see companies move towards offering **platform as a service** in the coming days.

Acquisitions and mergers

Industry leaders feel there will be more consolidation in the tech industry, particularly in the geospatial domain. Building of strategic

Democratization of geospatial has led to consumerization of the technology. This is evident in the way majority leaders are enthusiastic about subscription-based business model which is also coming to be known as pay per use model



HITTING THE BULL'S EYE

partnerships, co-creation of solutions, collaborative selling and partnering with prospective competitors are key for success in the new world. The acquisitions so formed will enable the businesses to provide a ***single platform*** to consumers, who are now demanding complete solutions. **Howard Lance, CEO of Maxar Technologies**, corroborates: "We formed Maxar Technologies to address the ways the industry is changing and to enable the growing demand for answers that can only be derived from persistent, high resolution imagery, and rapid and highly advanced data analytics." The combination of MDA with DigitalGlobe in 2017 created the leading global provider of advanced space technology solutions for commercial and government markets, bringing four cutting-edge satellite companies under one umbrella — SSL (satellite manufacturing and servicing), MDA (communication satellites and ground stations), DigitalGlobe (EO satellites and Big Data platform) and Radiant (data analytics).

As **Steve Berglund, CEO, Trimble** predicts, "The next three years should be somewhat similar to past several years where acquisitions have played a role in our strategy, principally as mechanisms to establish beachheads in new market spaces, fill in product line gaps or add new technologies to our solutions portfolio."

Biggest Investment on new technologies

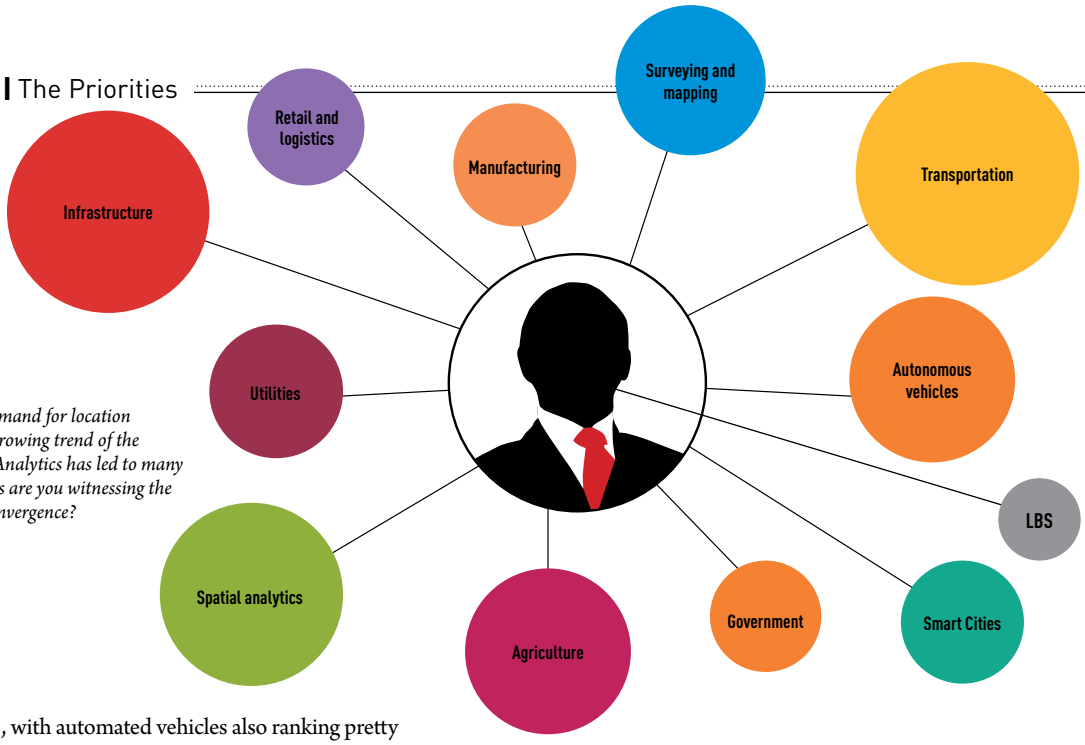
To stay relevant, the industry needs to invest in ***acquisition of new technologies***. About 50% of the leaders interviewed could not agree more — stating acquiring new technologies will be their biggest investment in the next three years. This could be through acquisitions of other companies, mergers, partnerships — inter- and intra-industry both — or by developing in-house specialized capabilities.

A good example of this is Hexagon's recent acquisition of Luciad. **Ola Rollen, CEO, Hexagon** explains: Luciad's visualization technologies support live connections to dynamic sensor feeds in a 3D environment. The result is a 5D digital reality — real-time, rapid fusion of multi-source content and the ability to perform analytics on-the-fly. This acquisition strengthens Hexagon's ability to deliver the smart digital realities for our SMART X Solutions, specifically enhancing our Smart M.App platform with 3D, 4D (real-time sensor feed integration) and 5D (dynamic analytics) capabilities. The ability to rapidly integrate sensor data in a visually compelling environment provides the location intelligence and situational awareness for mission critical operations.

Solution-centric approach

Consumers are continuously demanding "whole" solutions, making, greater integration in workflows a top priority for industry leaders. They are largely focusing on ***bridging the silos across all platforms and technologies*** like AI, Big Data, analytics etc. The go-to-market challenge has also become more complex and requires a more tailored approach to ensure customer satisfaction. The traditional criteria for engaging the market were formulated for hardware centric products. "A bundled solution, including both hardware and software, requires new criteria for elements such as training, conformity to workflow requirements and support," elaborates Berglund.

The market for geospatial intelligence is at its beginning and tools like artificial intelligence are driving the next generation of capabilities. The emerging demand for location data/technologies and the growing trend of the convergence of IoT, AI and analytics has led to many innovations. The leaders see the maximum impact of this convergence in sectors like transportation, Internet of Things, and infrastructure



Graph 13: The emerging demand for location data/technologies and the growing trend of the convergence of IoT, AI and Analytics has led to many innovations. In which sectors are you witnessing the maximum impact of this convergence?

(including smart cities), with automated vehicles also ranking pretty high on the list *(Graph 13)*.

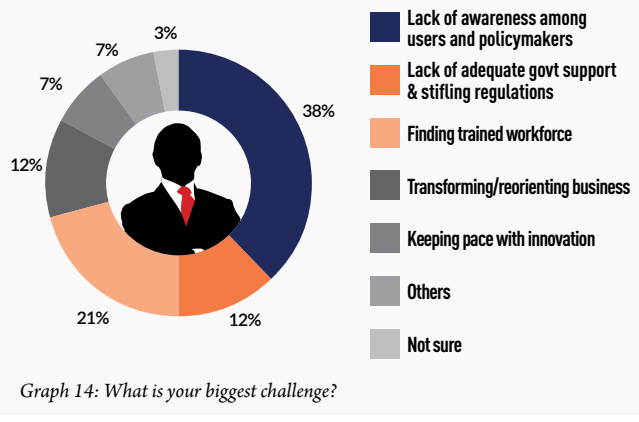
Becoming more data-driven

We see a huge interest among the industry leaders to become more ***data-driven***, since increased availability of data is creating more location intelligence opportunities. Consumers demand a level of personalization and geospatial answers the question of 'where' — accuracy and precision of those tools equates to a specific level of performance that's required to serve the consumers of today and tomorrow.

Geospatial data is increasingly recognized as a valuable corporate asset and organizations across industries are taking a more structured approach to stewardship. "Ultimately, the cost of location data will come down as it meets the 'Sharing Economy,' while the accuracy and accessibility of the data will increase with new technologies", stresses Rollen.

Consumer preference the top priority

Information products as required by the customers are need of the hour. ***Consumers are demanding a level of personalization***, and the industry is ***focusing on customer experience***. For most of the industry leaders, the vision is to make geospatial data real-time, accessible and usable for their customers, and they intend to design their future products to strongly support this vision. The leaders intend to keep the customer as the key priority and not lose the focus on this despite all the exciting technologies and developments that are arising.



Graph 14: What is your biggest challenge?

Overcoming the hurdles

While the path ahead is gaining clarity, companies are faced with new challenges that they need to address soon for better outcomes. The principal issues that the industry is facing include low awareness, restrictive regulations, lack of trained workforce, and the ever-increasing pace of innovation not giving the industry enough time to amortize investment in new equipment.

As *Graph 14* depicts, about 38% of industry leaders consider lack of awareness as the biggest challenge facing the industry. More so because the effect is spread over multiple segments making the growth enter into a vicious cycle of restriction. Lack of awareness among the governments is plaguing the industry with restrictive and ambiguous policies. This in turn is delaying user adoption. If at all any technology is getting adopted, the lack of trained workforce to carry out execution and updates at large scale is limiting awareness and usability. Currently, the industry is also not equipped to undertake capacity development at the scale desired *(Graph 16, Page 21)*. This is also limiting growth. However, the situation seems to be improving as more and more industry leaders are recognizing the need for investment in skills.

Challenges propel every industry to perform better. "There are many challenges for the world ahead, but we need to stay positive and channel the energies of the geospatial industry to addressing these challenges. I'm an optimist and I'm filled with excitement about the possibilities!" says **Edzard Overbeek, CEO, HERE Technologies**. After these exciting words, do we need to say more?

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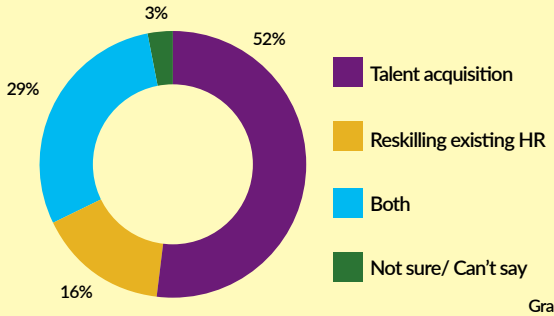
Are There Enough Industry-Ready Professionals?

Businesses thrive on innovation, but even the greatest innovation could remain stalled if there is no workforce to take charge, implement and carry it forward. Robots are yet to take over the world and the role of humans in bringing ideas to implementation and putting technology to actual use cannot be stressed enough. People are the backbone of any industry; the more skilled workforce an industry has, the more growth it is equipped to witness.

Talent acquisition

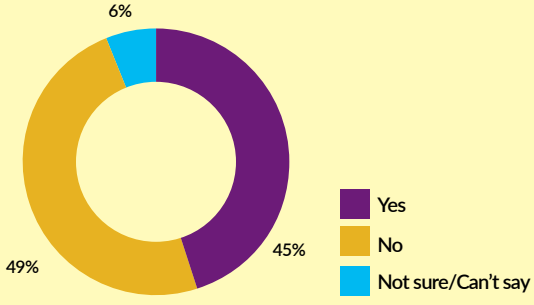
The geospatial industry has been an underprivileged one when it comes to having the support of a trained workforce, who could readily adapt to the changing scenario and even excel in it. The industry is ready to make investment in recruiting talents, but the availability of adept workforce to hire is an issue. As can be seen in Graph 14, majority (52%) of industry leaders identify talent acquisition as a major HR challenge, while 16% believe reskilling existing workforce is a big issue and 29% think both are key challenges.

What are the key HR challenge in view of emerging technologies?



Graph 15

Do you think academic institutes are churning out industry-ready professionals?



Graph 16

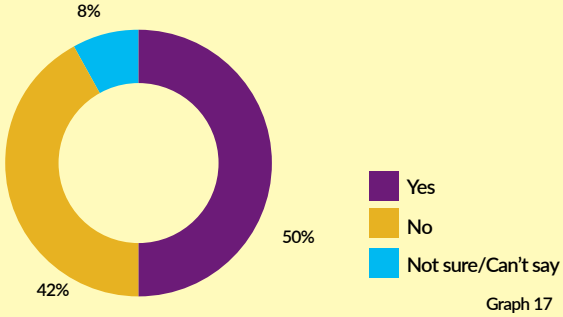
Academia needs to tailor courses

This gap is mainly due to lack of correlation between GIS and academia. Academia and industry share a symbiotic relationship; the former produces graduates who are absorbed by the latter. Research work in universities are taken up by the industry and turned into products and services. Industry on the other hand looks to academia for solutions to their concerns. Graph 15 shows a majority of respondents, i.e. 49%, view that the academia is not churning out industry-ready professionals, while 45% think the other way round. The industry would like universities to tailor their courses to turn out graduates whose skill-set are aligned to industry requirements.

Trained workforce

Graph 16 shows that over 50% of industry leaders think there is deficit of trained workforce, while 42% are satisfied. Further analysis of the survey data also showed that usually it is the big, established players of the geospatial industry who think that they have enough trained workforce to handle complex and ever-evolving technologies; the medium-scale or start-ups think the opposite. While this could be because of the brand name and payscale associated with big companies, but one thing is for sure — the fast-growing geospatial industry needs a constant supply of trained professionals.

Do you have enough trained workforce to work with the emerging technologies?



Graph 17

IT'S A DIFFERENT BALLGAME

Revolutions bring disruptions; disruptions bring opportunities. The Fourth Industrial Revolution is leading to a new set of applications, business practices and revenue models. As the world undergoes these dynamic changes, it is important for the geospatial industry to keep up with the new developments. **By Shilpi Chakravarty**

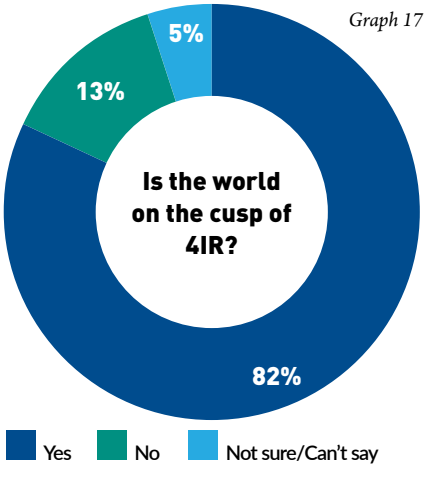
"This Fourth Industrial Revolution is characterized by a range of new technologies that are fusing the physical, digital and biological worlds. The impact is profound as this revolution is evolving with greater velocity, affecting various industries, economies, and countries across the world and calling for a total overhaul of the existing systems and processes."

— Professor Klaus Schwab, Founder and Executive Chairman, World Economic Forum

We are witnessing an unprecedented wave in digitalization, robotics, artificial intelligence IoT, and cognitive computing to name the most relevant. These are causing major disruptions in every field.

The term 4IR is the revolution of the current era, which is happening with the fusion of physical, digital and biological paradigms, impacting numerous disciplines and industries, and economies. The ability of machines, devices, sensors, and people to connect and communicate with each other is creating a level of interoperability, information transparency, technical assistance, and decentralized decision making that is driving this revolution.

Graph 17



A vast majority (82%) of geospatial industry leaders believe the world is on the cusp of Fourth Industrial Revolution *(Graph 18)*.

The world is currently deluged with data, and *Economist* is on the money 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.

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. The question is how are we going to handle this data and what we are going to derive out of this. This is where geospatial comes in.

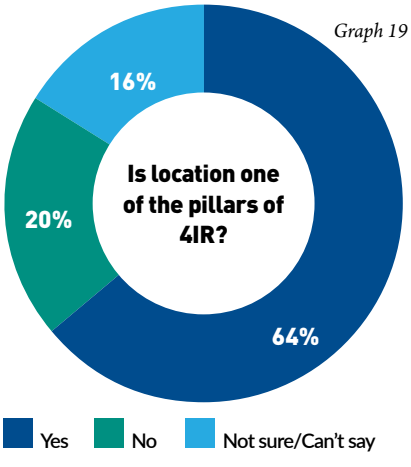
Location is fundamental to 4IR

Everything happens somewhere. Over the past many years, the ability to understand the "where" aspect of our everyday lives has become increasingly powerful.

While leaders are split on whether location is one of the pillars of the 4IR — 64% think it is and 20% *(Graph 18)* would like it to be called an enabler or a critical contributor but surely not a pillar — they all unanimously agree that as geospatial gets integrated with 4IR at a global level, the impact on outside businesses and governments will be profound. With the industry infusing itself into new workflows, new business models and new possibilities, ultimately the cost of location data is expected to come down as it meets the 'Sharing Economy,' while the accuracy and accessibility of the data will increase with new technologies. "In a few years, we will be looking at governments and industries wondering how they succeeded without fully leveraging this type of information," says **Ola Rollen, CEO, Hexagon.**

"We all recognize that at least 80% of these data feeds have a locational reference. It's obvious that all of these new IoT and Big Data

Graph 19



information feeds require a location context — a geospatial framework is needed to organize a framework for information management and access to these feeds in an integrated, orchestrated way," says **Jack Dangermond, Founder and President, Esri.**

Realising the importance of location in boosting businesses and tracking consumer demands, more and more companies are now integrating location into their business analytics and many are grounded in location data. Businesses like Uber, for example, wouldn't exist without it. "Consumers use location everyday — from checking the weather, to mapping out their route via GPS, or ordering their dinner online. It's become second nature to consumers, and it is quickly becoming second nature to businesses," points out **Greg Van den Heuvel, COO, Pitney Bowes.**

Geospatial getting remodelled

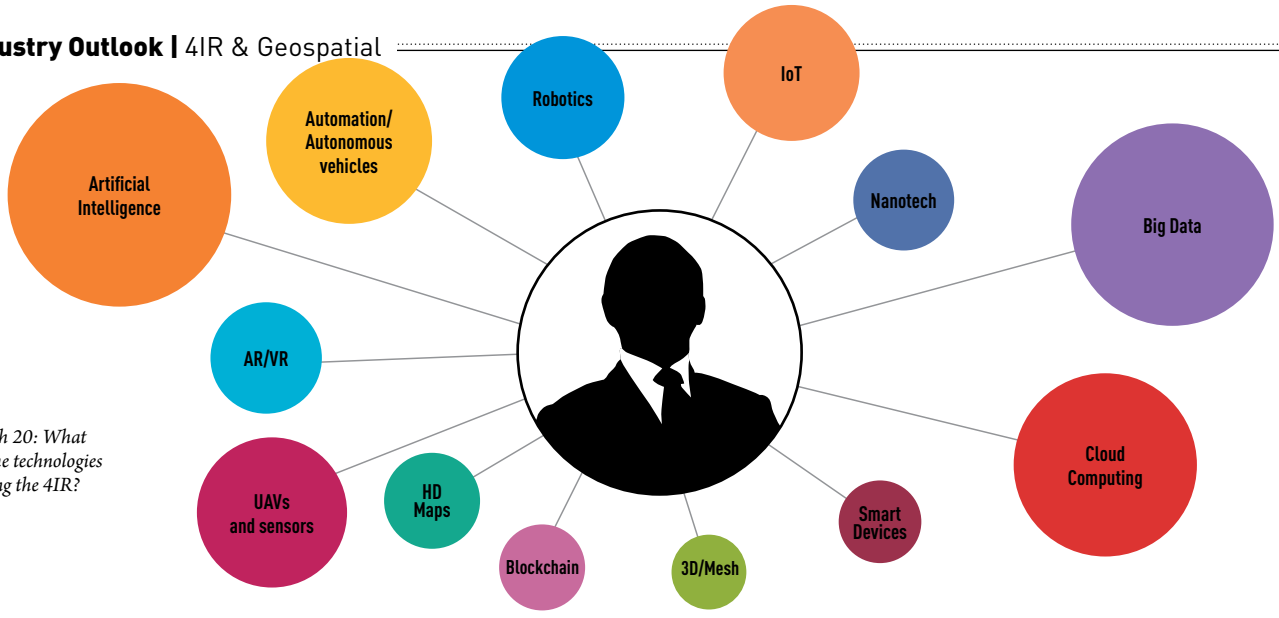
Majority of industry leaders (75%) think that the pace of the Fourth Industrial Revolution will transform and re-model everything, including the geospatial industry, and most of them the process has already begun *(Graph 21, Page 22)*.

"We will have to be alert to new partnerships and data flows at a scale and speed unseen in the past," says **Nigel Clifford, CEO, Ordnance Survey,** who feels location is a critical golden thread in this revolution that binds many different datasets concerning a single location and creates more value.

The geospatial ecosystem is being changed by the very same foundational technologies as 4IR. Base maps are helpful with existing autonomous vehicles, while robots in the future will increasingly have the ability to navigate in unknown environments. In the meantime, an intermediate, more expeditious step between these two will be to provide vehicles with previous knowledge of their environment so that they can focus on managing only the dynamic changes. This means that both indoor and outdoor geospatial data will be required. In turn, robots will be able to keep updating geospatial databases, thus creating a virtuous cycle. As a result, 4IR will expand both the breadth and the update rate of geospatial data and re-model the entire ecosystem.

"We are already seeing this in various autonomous vehicle initiatives where Simultaneous Localization And Mapping (SLAM) technologies are being deployed," explains **Nicolas Mangon, VP, AEC, Business Strategy and Marketing, Autodesk.**

Users are no longer constrained by traditional computing limits as in the past. Geospatial ecosystems will be organized around Cloud computing and virtualization



Graph 20: What are the technologies driving the 4IR?

with GIS and data being accessible anywhere (connected or wireless) via URLs with orchestrated analytics running across networks.

While the geospatial ecosystem is going through a transformation, what is driving this revolution further is the integration of geospatial technologies with IT, analytics and major business processes. The geospatial ecosystem will evolve to both support 4IR, and 4IR will, in turn, put new pressures and requirements on geospatial industry — particularly to support real-time data capture, fine-grain geolocation, rapid data analysis, and data synthesis across multiple sources.

As the demand for more consumer-centric services aimed at improvement of citizen and customer satisfaction levels increases, governments and businesses are being forced to ensure real-time access to data, and therein lies the opportunity for geospatial and 4IR to be optimized to meet this requirement. Typically in areas such as transportation, utility services, on-demand retail shopping, these technologies are impacting the way we traditionally have done things.

Instead of restricting geospatial insights to a set of trained power-users, the integration of geospatial and 4IR will accelerate the innovations that will improve the quality of living conditions and infrastructure in developing nations around the world.

Technologies driving 4IR

From a technology standpoint, Cloud, Big Data, Internet of Things, Artificial Intelligence and analytics are recognized as part of this transformation. The technology shift is also happening in the economy in form of digital currencies and Blockchain technologies.

Most of the respondents voted for AI, Big Data and Cloud as the top technologies that are driving the 4IR, closely followed by UAVs and autonomous vehicles *(Graph 20)*.

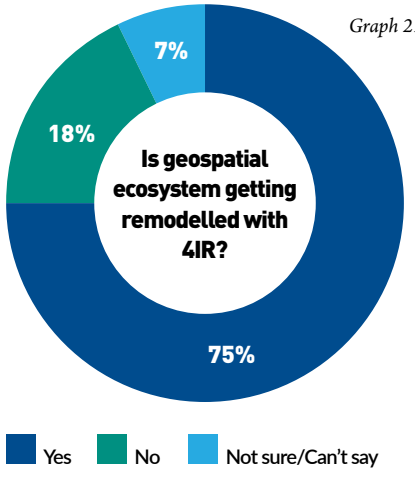
While Cloud has become pervasive, there is hype for the adoption of Big Data and IoT. AI and analytics, on the other hand, are stuck in infancy stage and are in dire need for human intervention for derivation of insights. The societal shift with these technologies poses a new challenge in privacy of a data-driven world. The main focal point of the Fourth Industrial Revolution is the various technologies that is driving the revolution.

Future trends

Immediate, real-time data is the future. Artificial intelligence will continue to develop, especially as more sensors are added to replicate what humans are capable of doing today. We will also see smart cars and homes created using the above technologiesimproving and become more commonplace, allowing companies to gather even more data to specially target new products to those consumers. As self-driving cars and smart city initiatives become more of a reality, it will be imperative to understand how all the location information can be used to make smarter decisions.

With 4IR being underway, changes will continue to accelerate in the industrial world

Graph 21



and it's important that companies, both geospatial and non-geospatial, learn to adapt rapidly. Also, businesses and governments need to adapt more quickly than ever before. They need to be as agile and flexible as possible as they are being asked to do more with less.

Geospatial organizations must take seriously their responsibility to turn these advancements into strategic advantages. There exists real opportunities to make an impact especially in developing countries. There is however, a great a need for organizations to collaborate to innovate and leapfrog technological advances in some regions. Outreach and sharing of experiences must be an important part of the overall development of the industry.

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GIS has Become Ubiquitous

JACK DANGERMOND
FOUNDER & PRESIDENT, ESRI, US

Geography is a component of every major decision that organizations and individuals must make every day. So, it's only a matter of intuition for any forward-thinking company involved in technology today to incorporate spatial analytics into their offerings. Location intelligence allows other capabilities to be what we call "geo-enabled"; this means that normal business intelligence gets supercharged with a geographic component that allows a holistic situational awareness, providing real-time insights into operations and systems.

Cloud computing, combined with IoT, devices, and apps, is beginning to enable an instrumented world — a digital twin in which computing can be harnessed to respond to new kinds of trends. New companies who understand these concepts, share a vision for them, and will envision and implement new kinds of geospatial solutions will ultimately emerge.

There is a massive opportunity for the GIS community in today's ever-changing world. And many of these innovations and disruptions are emerging everywhere — coming from inside as well as outside of the geospatial community, including many exciting startups.

Analytics and aesthetics

Four of the most revolutionary game changers for our industry have been: the enormous amounts of geographic information that is being generated continuously by all the organizations in the vast, worldwide geospatial community; the adoption of Web GIS in the Cloud; the motivation of the geospatial community to share data openly with one another; and the emergence of using maps for storytelling have created a revolution in effective communication using GIS.

In the past few decades, the reach of GIS has grown exponentially; it is both analytic and aesthetic, and is useful for supporting our work and our communities. It is being applied virtually in every field of human endeavor — from helping businesses identify new customers to making natural disaster response more effective — and it has been accepted as an essential computing infrastructure for every organization.

One example of an exciting global project is the set of 17 Sustainable Development Goals from the United Nations. GIS will be used for reporting and tracking progress on each goal using a series of 12 to 15 measures and indicators for each goal that communicate the status and progress in each country globally. National mapping and statistical agencies worldwide are collaborating on the use of GIS to communicate the status of these in their individual countries and to chart our progress on each goal as we move ahead.

IT will lead, and GIS will follow

The latest computing paradigm for Web, Cloud, and apps is a stable, next-generation platform where new capabilities are being added in each subsequent release. The transformational changes in technology are more incremental now than in past tech updates. The app pattern is being refreshed more rapidly because new and updated solutions are coming from many more small developers. This is virtually the same as consumer apps that you update on your smartphone where the tech continues to improve and evolve with each new version.

> **"GIS is being applied virtually in every field of human endeavor"**

We expect the reach and impact of GIS to continue to expand. Information technology will lead the way, and GIS will follow. We will see GIS ecosystems being organized around Cloud computing and virtualization with GIS capabilities, and data being accessible anywhere (connected or wireless) via URLs with orchestrated analytics running across networks. Thus, users will no longer be constrained by traditional computing limits as in the past.

The very same geospatial users who have been implementing GIS for decades will play a significant role in this evolution and transformation. They will be augmented by creative software engineers and systems architects who will build new Cloud-based geospatial solutions and smart device apps. GIS analysts and data scientists will lead the

way with exciting new breakthroughs in spatial modeling and location analytics.

Web GIS paradigm

At Esri we are working hard to move and evolve by applying planned and controlled patterns to the new Web GIS paradigm, and to enable our customers to make this transition when they are ready to do so and can see the benefits in their own work. The evidence in our customer base proves that this is not an either/or proposition but one that builds on and leverages traditional customers' great GIS work and data investments in the past three decades. We have focused on a comprehensive geospatial platform that anticipates and responds to all of these trends. Our solutions are intended to leverage the work and investments that our customers have made in their current GIS work, enabling them to be prepared and move into a future in which they can exploit many new capabilities that are coming in IT. In addition to enabling our customers to do their work at building and sharing their systems of record, we are also expanding the analytical and data science capabilities of our platform to enable organizations to create and share a system of insight.

GIS is a great and rewarding profession. And as a community of practitioners, our most interesting work is only beginning. New Cloud and Web computing paradigms are enabling capabilities that were once thought to be unachievable. Today and in the future, the geospatial community will need strong and creative geospatial analysts and data scientists, great mappers and cartographers, incredible story tellers, analysts of all stripes, and imaginative software engineers to help us collectively achieve our visions.

OLA ROLLÉN | CEO, HEXAGON, SWEDEN

The Move Towards Smart Digital Reality

We live in a data-driven world and geospatial data is critical to our most vital industries. The proliferation of geospatial technologies has raised awareness while accelerating the development of applications for user-based needs.

In times to come, as the accuracy and accessibility of the location data increases, its cost will come down as it meets the 'Sharing Economy', and its impact on businesses and governments will be profound. The impact will be an increase in safety for people everywhere, greater efficiency and productivity, and more sustainable business and agricultural practices. In a few years, we will be looking at governments and industries and wondering how they ever succeeded without fully leveraging this type of information!

Location data is a critical contributor to the Fourth Industrial Revolution, and technologies which will play a prominent part are autonomous X (automobiles, industrial vehicles, public transportation, UAVs, marine); edge computing; advanced analytics (AI, machine learning, advanced algorithms), and visualization technologies.

The geospatial industry needs to evolve with the industries it serves and create new applications. The rate of change is accelerating more rapidly than ever before, we

"As the accuracy and accessibility of the location data increases, its cost will come down"

need to look over the horizon and see the challenges — and solutions — before they are upon us. We need to do a better job at educating users of the potential of technology, and moving new solutions from the lab to the field. Everything happens in time and space — a car moves through an intersection, an earthquake shakes the foundations of a city, a purchase is made from a market — each has a location, from which we can glean analytics and insights to navigate from what is, the status quo, to what should be, a future that is better.

Staying ahead of the curve

Rather than 'tuning' ourselves to be in sync with trends, at Hexagon, our aim is to be the industry disrupter and to lead these trends. We have deliberately built upon a legacy of leadership in the geospatial industry, complementing our sensor domain expertise with enabling technologies that put data to work to do its greatest good.

Our R&D efforts, in conjunction with our acquisition strategy, have focused on investing in technologies that will bring about the digital transformation of vital industries and governments, empowering them to see the 'complete picture' and to develop enabling platforms.

At Hexagon, we call this approach SMART X — whether it is mining, manufacturing, oil and gas, defense, construction, agriculture or smart cities. SMART X solutions are a bold approach aimed at solving the most challenging problems of the 21st century — how to make our cities safe; how to sustainably farm and feed a fast-growing population; how to make refineries more efficient; how to mine responsibly and manufacture products faster, with less waste and higher quality.

In each case, the X is what we solve for, and X always equals a Smart Digital Reality. A Smart Digital Reality is much bigger than the digital twin and the Fourth Industrial Revolution driven by the Industrial IoT. Geospatial technologies are key to achieving a Smart Digital Reality.

SMART X Solutions are unique in that they are digital first. By this we mean intelligent industry-specific ecosystems — systems of systems. They work by integrating sensors and data with our enabling technologies and platforms to capture the entire ecosystem digitally. This provides access to the big picture which includes all physical assets — for instance, all the buildings and infrastructure of a city in perfect 3D reality, or every single part of an oil refinery, down to the last bolt. It also includes the terrain, the environment, documents, workflows; everything is digitalized.

Additionally, SMART X Solutions are completely connected. Unlike Smart 3D reality, or the digital twin, a Smart Digital Reality captures events as they happen in real-time and fuse that live data to a complete reality capture.

The result is a digital transformation of inefficient systems into smart, 5D digital realities, with real-time fusion of multi-source content, including location-based data, advanced analytics and powerful visualization that simplifies the understanding of complex Big Data.

Incurable optimist

I am a technological optimist. My outlook for the next three to five years is one of accelerating disruption, and a marked improvement in our most vital industries. There is more data and intelligence in the world today than there has ever been — and human ingenuity is our single inexhaustible resource. Historically, mankind has always invented its way out of problems and constraints, and I don't see that changing — quite the opposite — I see that accelerating.

The so-called 4IR is distinguished by the way it builds from a confluence of technologies, and from evolving harmonization and integration of R&D efforts. Nearly every new development in any field now leverages digital capability.

In the next three to five years, advances in sensors will enable Autonomous X, systems that enable us to understand and respond better to every change in the environment, and to engage in a broader variety of tasks. Computing will be pushed to the edge of the network, and connect with the Cloud to exchange information and learn collectively.

I expect the Smart Digital Reality to become a reality, and I expect populations to be safer, products better and the businesses that adopt these new capabilities to have a competitive advantage.

Along with these breakthroughs, there will be winners and losers. Those companies and governments that engage, adopt and adapt most quickly will excel and those who will fall behind may disappear.

STEVEN W. BERGLUND, PRESIDENT & CEO,TRIMBLE, US

Engage the Challenges of Change

The geospatial industry has experienced an evolution in recent times. We have seen industry consolidation, technology integration, near ubiquitous connectivity and an increased focus on providing industry-specific solutions. I believe that this "evolutionary process" has been primarily driven by data collection, analysis and project deliverables—where each of these phases were loosely federated and integrated. With the advent of the digitization era, productivity has been improved through advanced integration, connectivity and analytics.

Over the last few years, a combination of a significant technology developments such as sensor integration, connectivity and analytics have acted as game changers for the industry.

Sensor integration: Today, there are sensors that incorporate imaging, scanning and high-accuracy satellite or optical-laser positioning that enables geospatial professionals to collect highly accurate data using a single sensor. This integration has led to reduced rework by ensuring that data collection is comprehensive and completed "right the first time" without having to return to a project site to collect additional data.

Connectivity: Connectivity is now a commodity and has enabled the seamless integration of the data collection, analysis and deliverable phases. In addition, it has allowed more collaboration between organizations and project stakeholders to empower insight, auditing and decision-making capabilities in the process, reducing rework while improving transparency and productivity.

Analytics: Today, we are inundated with Big Data from many sources. Some of these sources are known and some are not. In addition, because we are so overwhelmed by the massive amount of data sources, at times we don't always use it efficiently to solve problems. Analytics, and specifically industry-focused analytics, enable users to make near real-time decisions.

How to respond to technological changes?

The response to technology trends has two dimensions—one is technological and one is the way in which we engage the market. The response to technological changes generally requires greater organizational adaptability and flexibility in establishing priorities and increasing the tempo of response. One aspect of this response is the need to determine whether to "make" or "buy" the basic underlying sensor technologies since the increased range of needed technologies makes it effectively impossible to master them all in house. Another necessary new behavior is the ability to integrate multiple technologies into a solution since emerging solutions typically include multiple sensors enabled by software.

The go-to-market challenge has also become more complex and requires a more tailored approach to ensure customer satisfaction. The traditional criteria for engaging the market were formulated for hardware centric products. A bundled solution, including both hardware and software, requires new criteria for elements such as training, conformity to workflow requirements and support.

The integration of geospatial into 4IR is an important enabler but perhaps not a primary transformative driver of global change. It has the aspect of a "grease and glue" element of the technology transformation underway. Concepts such as artificial intelligence have the ability to absorb the location/position data and convert it into actionable outcomes.

"Integration of geospatial into 4IR is an important enabler. It has the aspect of a grease and glue element of the technology transformation underway"

Ability to integrate technologies

The geospatial industry's strength lies in its ability to integrate technologies. Technologies such as cameras, satellite positioning systems, optics, and many others have always been developed by industries outside of the geospatial realm for other purposes. Geospatial companies have been innovative by integrating technologies while adding domain specific workflows to meet the needs of the industries or enterprises. For example, we didn't invent Bluetooth but we use the technology to remove cables for wireless data collection. The same can be said for wireless communications that were brought to market by telecommunications companies.

Since location has become fundamental to businesses as well as social activities, the geospatial community is collaborating as well as working with other industries. For example, augmented reality began in the consumer market and has migrated to the professional world.

For Trimble, the next three years should be somewhat similar to past several years where acquisitions have played a role in our strategy, principally as mechanisms to establish beachheads in new market spaces, fill in product line gaps or add new technologies to our solutions portfolio. More importantly, continued innovation and industry domain experience are the primary drivers that will allow Trimble to focus on organic growth as our principal strategy in our core market segments — building and infrastructure, geospatial, resources and utilities, and transportation.

Our outlook is framed around a number of themes — rapid technology change; changes in industry power relationships driven by technology capabilities; greater integration of workflows; and lower marginal costs of data acquisition.

The technology-enabled benefits available to us are potentially transformative, and unprecedented in scope. The beneficial outcomes will not be automatic and will require engaging the challenges of change. The winners will be those who persevere.

HOWARD LANCE
CEO, MAXAR TECHNOLOGIES, US

This is Just the Begining

There have been tremendous advances in the geospatial industry over the past few years — there is more demand for data and data analytics than ever before and we expect this demand to continue to grow. The demand is driving innovation and technical advances are enabling better imagery, faster ways to store and share it, and highly advanced analytical processes for putting the data to use.

Advances in integrating multi-source data collection and analytics are dramatically changing the usefulness of imaging data collected. Cloud services are also making vast amounts of data much more quickly accessible. Across our DigitalGlobe and MDA business units, we have an 18-year archive of high resolution optical and radar imagery. Thanks to advanced Cloud services, that data can now be accessed much more easily.

It's only the tip

Geospatial data is an increasingly essential element of the Fourth Industrial Revolution, not just because of the demand for analytics rather than just pixels, but because of the power it brings to applications that facilitate the Internet of Things and the ability to track consumer, government and business behaviors. When combined with advances in artificial intelligence, machine learning, Cloud computing, and even blockchain technology, geospatial data will have broad impact on human endeavors starting with utilities, the insurance industry, agriculture,

conservation and national defense.

The market for geospatial intelligence is only at its beginning and tools like machine learning and artificial intelligence are driving the next generation of capabilities. The demand for the analytics and real answers will significantly increase over the next few years and beyond. We are excited about the opportunities for growth in this area as we plan to integrate geospatial intelligence into the next generation of automation applications.

Cost and ease of use are limiting factors for all technology advances. However, for geospatial data, significant progress has been made in both the areas. For instance, Maxar's DigitalGlobe business unit provides direct Cloud-based access to a 100-petabyte optical imagery library. Our GBDX platform is a cost-effective subscription service for processing and analyzing geospatial data and allows users to build, access and run advanced workflows and includes tools that extract the important information needed from a Cloud-based, multi-source satellite image library to solve complex, global-scale challenges.

Rapidly evolving industry

One of the most significant trends we have seen is a lot of companies are developing their own geospatial capabilities, and collaboration and consolidation within the geospatial industry. This has been driven by the demand for answers. Our Radiant Solutions business unit has grown out of the acquisition of multiple companies with exceptional analytical capabilities. As a result, we can provide agile intelligence that helps national security analysts, operators and policymakers apply emerging technologies like machine learning and Big Data analytics to multiple sources of intelligence data to reveal geospatial insights that provide our nation a decision-making advantage.

Maxar Technologies was formed to address the ways the industry is changing and to enable the growing demand for answers that can only be derived from persistent, high resolution imagery, and rapid and highly advanced data analytics. The combination of MDA with DigitalGlobe created the leading global provider of advanced space technology solutions for commercial and government markets. We provide integrated systems including satellites, earth imagery, geospatial data and advanced analytics. Our end-to-end systems capabilities and integrated solution expertise positions us extremely well to further reduce product development times and provide the world's most advanced multi-source data collection, enrichment, and analytic capabilities.

For everything from satellite systems through to multi-source data collection, enrichment, and analytic capabilities that reveal unique geospatial information and insights, we are ready to meet industry demand where and when it matters the most. Our goal is to help national security and commercial organizations understand and navigate the changing planet and to integrate geospatial intelligence into the next generation of automation applications.

No other company has such strong roots in geospatial intelligence with our level of scale and commercial mindset. Our combined team of aerospace engineers, geospatial analysts, weather and ocean experts, software developers, data scientists, and DevOps engineers apply disruptive technology and our unique intellectual property to solve both national security and commercial problems. This is an industry that is rapidly evolving and Maxar is extremely well poised to advance the state of the art and to meet the demand for critical answers when they matter the most.

"The market for geospatial intelligence is only at its beginning and tools like machine learning and artificial intelligence are driving the next generation of capabilities"

WILL MARSHALL | CO-FOUNDER & CEO, PLANET LABS, US

Democratize Access to Data

Frequent imagery of the Earth can be a significant tool to address some of the biggest challenges of the world: from eradicating global hunger and poverty to addressing climate change. And this, having daily images of the planet, is going to dramatically help with those global challenges. Mapping rain forests, glaciers and coral reefs and improving disaster relief work are great examples of using the collected data beneficially.

> For better decision making, we need a lot of imagery and thus a lot of satellites, but they need to be affordable. This can only happen if we democratize access to data

For better decision making, we need lot of imagery data and thus lots of satellites, but they need to be affordable. This can only happen if we democratize access to data. To put it another way, we have to make data easy to access, use, and buy.

Breaking the cost barriers

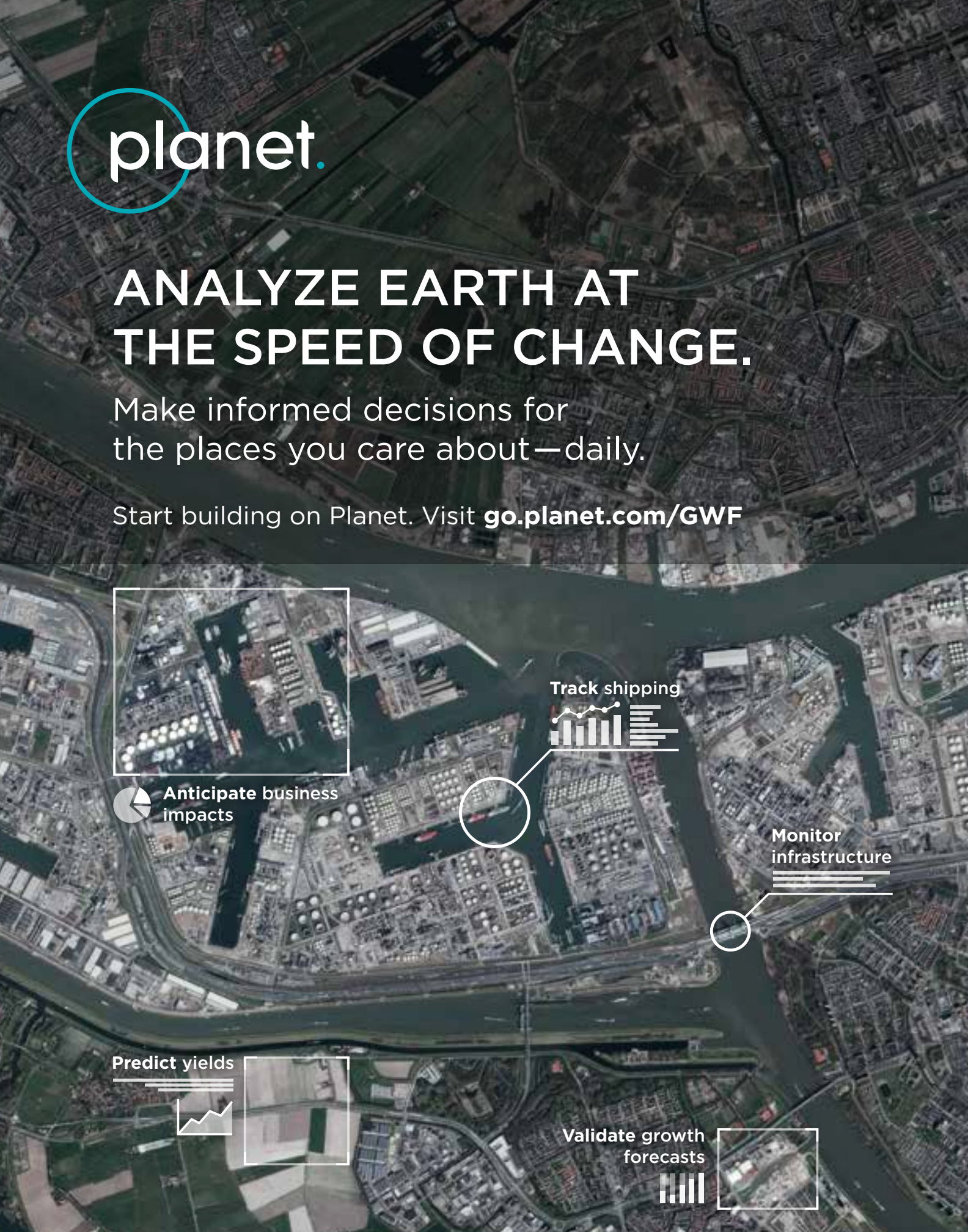
Cost and ease-of-use remained one of the biggest restricting factors in exponential uptake of satellite imagery; this includes cost of building big traditional satellites to launching them to accessing that data. Traditional satellites have done an amazing job in helping us understand our planet, but they were big, expensive and slow.

We launched Planet because we are passionate about using satellites to help humanity. We are space geeks. We not only care about what's up there, but we also care about what's down below.

From the day we launched Planet, our aim was to do space missions that were more affordable than the traditional NASA ones, which typically cost about $1 billion each. We wanted to build the satellites and systems, secure the launches, bring down the data to capture a daily image of the planet at high resolution, and make it easy to access for anyone. Six years down the line, we have launched over 300 miniaturized satellites, and operate 200 satellites continually photograph the 300 million square km of Earth's land mass.

We are going to launch 100 of these satellites over the course of next year. We've been pursuing Mission 1: to image the entire Earth's landmass every day. I couldn't be more excited to announce that we have achieved our founding mission.

Planet's data is part of a global sensing revolution that can help us to be better caretakers of Spaceship Earth. We're excited to work with UN member states, NGOs, and other private institutions, and I invite all other stakeholders to join us in making their data available to the societies they serve. In short, we're all here because we're committed to this agenda.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Track shipping
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Predict yields
Validate growth forecasts

The Power of Advanced Real-Time Tracking

EDZARD OVERBEEK
CEO, HERE TECHNOLOGIES,
THE NETHERLANDS

One of the biggest things transforming the geospatial industry has been connectivity. As vehicles, people and things connect to the Internet, the geospatial industry is able to access all kinds of new data sources which can aid mapmaking and the creation of new location services.

"Location will be at the core of many technology trends in the future – from AI and robotics, to data analytics to quantum computing"

Location technology is going into chipsets, cars, drones, enterprise software, traffic management systems, and everywhere. It's becoming ubiquitous. At the same time, companies and cities are also waking up to the potential value of the datasets in their position. What's driving this is the realization that location will be at the core of many technology trends in the future — from AI and robotics, to data analytics to quantum computing.

Location and location technology are at the very core of the next industrial revolution. And it will be primarily a combination of machine learning — AI more broadly — Cloud and edge computing which will be powering greater automation. The emergence of software start-ups looking to develop mapping for autonomous cars is testament to how important location data and technology is today and will be in the future.

Self-updating and self-healing maps

The days of offering a static map product are coming to an end. At HERE Technologies, our products are becoming services living in the Cloud, constantly adapting and evolving to meet the more discerning needs of customers and to support new use cases. And that's what it is all about — offering dynamic geospatial services.

Automation technologies are critical for us. For the map to become self-updating and self-healing requires applying machine learning techniques in our mapmaking process. We need to extract information from the physical environment — as observed through, for example, vehicle sensors — and process that data into new map updates as rapidly as possible. At HERE, we have more than tripled the amount of automation in our mapmaking process in the past 18 months, and are on course to be processing

95% of all map updates in an automated fashion by 2020.

If you look at just one of the technologies we are enabling — HERE Tracking — the opportunities to transform industrial supply chains and logistics are enormous. Being able to precisely track and more efficiently, everything in our supply chains — both outdoor and indoor, and in real-time — is going to dramatically change the way we make things and move them around the world.

Every new company entering the space needs a place to go for world-class location data and services, and the HERE Open Location Platform makes it easy for organizations and developers to access that. We have opened up our platform to allow developers and organizations everywhere to access our map infrastructure and technology and create new, differentiating and value-adding location-centric products of their own. In short, it enables organizations to monetize their most valuable asset-data.

Democratizing access to technology

Enterprises and governments are starting to take advantage of new technologies, but we are really only at the beginning. There are dozens of automakers, thousands of cities and countless on-demand service providers who are yet to jump in to using SMAC and location data to their full potential.

Our resources are scarce, and the planet's population is going to surge to 10 billion by 2050. We simply cannot afford to live as inefficiently as we do today. We must apply location technology to move goods, vehicles and people around more efficiently and safely. And it's not just us who are applying that technology, but businesses and cities too, and therefore it's vital that we democratize access to it.

The geospatial industry is still undervalued and underappreciated by the world at large. The onus is on us to collectively demonstrate how location data and tools can be applied to make dramatic improvements to society — from making every journey safer and the air cleaner, to helping businesses operate more efficiently. There are many challenges for the world ahead, especially in relation to climate change, but we need to stay positive and channelize the energies of the geospatial industry to address these challenges.

I joined HERE Technologies just under two years ago because I am aware of the huge and exciting potential in the location data and services space. I am an optimist, and I am filled with excitement about the possibilities.

NIGEL CLIFFORD CEO, ORDNANCE SURVEY, UK

Everything Happens 'Somewhere'

The geospatial industry is experiencing more of an accelerating evolution as we react and respond to new and emerging technologies and the different demands and opportunities these bring. With the emergence of technologies that have the potential to transform our world and the way we live and do business, I feel we are on the verge of something special. It will be a data-driven world where place is the common factor, which is going to be core to getting value from connected data. Location is one of the pillars of everything — everything happens somewhere. It is a critical 'golden thread' allowing many different datasets concerning a single location to be combined and create more value. In times to come, global citizens will benefit in many ways from these technology transformations. -

> **We are on the verge of something special. It will be a data-driven world where place is the common factor, which is going to be core to getting value from connected data**

Taking geospatial to masses

Digitization of geospatial data and serving it in easy access formats so that users can obtain its value through a computer or mobile phone with just a click of a button has been transformational in taking our industry to 'the masses'. Ordnance Survey was possibly the first national mapping agency to digitize its database, and the benefits of this felt by ourselves and customers has been huge. Today Great Britain has a 'one true digital source' for all its geospatial information to operate from, which other government agencies and businesses can confidently use. A consequence of this is how geospatial data use has increased, and in turn has unlocked a hunger for more detailed micro-geography, which in turn will act as fuel for the digital economy and will help our industry to grow and continue developing. OS has done a lot of work internationally that involves creating strategies and frameworks, data management, data modelling and special data infrastructure. Our approach is customer focused and entrepreneurial, and the offering is always expanding as we continue collaborating on ground-breaking Smart Cities, IoT, Connected and Autonomous Vehicle (CAV) and 5G projects. It is interesting, because many of these projects are becoming the catalyst for geospatial data.

Opportunities galore

The technology world is embracing geo. These are exciting times, but we need more collaboration between the industry on standards and how we can influence tech and emerging markets. We must not forget developing nations and how the community can assist in bringing geo to 'lift many boats' in local economies and hasten delivery of the Sustainable Development Goals.

Going forward, I think our focus should be on defining the standards for a safe, functioning 'connected world', further experimentation with 'digital twins', operating with greater levels of detail and with live or near live data feeds, and an increased emphasis on micro-geography.

I see all the transformations and changes as an opportunity for our industry. And it is something that as an organization we are very proud to have initiated long before 'innovation' became one of the current buzzwords in our industry — right back to the original Ramsden theodolite in the 18 century!

SANDEEP SINGHAL
DIRECTOR, CLOUD STORAGE, GOOGLE, US

Driving the Next Set of Industry Revolutions

We are witnessing a rapid change as new technologies enable geospatial data to be utilized in new ways across every industry. The proliferation of Cloud computing, infinite storage, low-cost sensors, machine learning, and fast networks are together bringing new power and relevance to geospatial data. Combined with the ability to rapidly collect, aggregate, process, analyze, and act upon this data, we are seeing transformation in every field, ranging from building management to agriculture to delivery of social services to defense. Today, the question is not whether geospatial data is needed but rather how geospatial will drive the next set of industry revolutions.

The importance of geospatial data and technologies can't be stressed enough to provide valuable insights into the businesses, identify potential areas that are worthy of analyses 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.

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 the right decisions. 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 for the geospatial industry to partner more effectively to deliver what customers really want — very effective and real-time services.

I believe that the most novel uses of geospatial technology are coming from new entrants who focus on creating customer value using geospatial technology as an enabler. They are embedding data, maps and imageries as part of their core applications; a key factor here is location intelligence. It is important to reach out to them with an objective to make geospatial data easy and quicker to access, and more effective in the applications that these companies are trying to build.

Geospatial and 4IR

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 conclusions, and then present that information very quickly in order to drive changes in how we manufacture, schedule resources and so on. I expect the geospatial ecosystem to evolve to both support 4IR, and 4IR will, in turn, put new pressures and requirements on geospatial industry.

Today, the question is not whether geospatial data is needed but rather how geospatial will drive the next set of industry revolutions

FRANÇOIS LOMBARD | SVP, HEAD OF INTELLIGENCE BUSINESS, AIRBUS, FRANCE

The Challenge is to Go Far Beyond What We Do Today

We have seen a lot of disruption in recent times. New large satellite constellations, laser communication in space, free data from EC Copernicus satellites, have all brought a level of disruption in the game. Historical players are taking this new competition seriously into consideration, and must demonstrate where their key differentiators are. We have also seen tremendous technical innovation from areas such as Cloud computing and machine learning.

Democratization of Cloud computing and hosting have made access to imagery and software capacity easy; progress in machine learning and automation are made rapidly to allow the industry and its customers retrieve more and more value from geospatial information on large scales, with less human intervention, opening up new markets in the defense and commercial world.

The dawn is already behind us

While there has been tremendous innovation within our industry, there has been much fusion with technologies from outside, for instance Cloud computing, digital services and mobile devices. This is a healthy trend and is important if geospatial aims to become more mainstream.

The Fourth Industrial Revolution is at the core of Airbus Defence and Space's strategy. We also need to lower the barriers to accessing our core products and present them with a simple and useable user experience. This forms the core of Airbus' OneAtlas digital services.

Keeping in tandem with the view, Airbus will deploy new optical constellation starting in July 2020 with Pléiades Neo, made of four identical VHR optical satellites that will offer enhanced performance and the highest reactivity in the market. The satellites will double the number of visits per day anywhere on Earth and offer a re-tasking rate which is five times higher than previous constellations.

While there has been tremendous innovation within our industry, there has been much fusion with technologies from outside also

Airbus is also looking at innovative platforms such as Zephyr, a High Altitude Pseudo Satellite. This way we will implement new technologies and tools allowing customers and partners to have direct and easy access to our products and services.

Taking a giant leap

The industry is developing based upon new advances in analytics and satellite technology to provide a greater understanding of complex and multi-source data. As an example we can look at Starling service launched last year by Airbus. This Cloud-based service benefits from the latest artificial intelligence tools. We have also partnered with the US company SpaceKnow which uses our satellite imagery, made available as soon as received via the OneAtlas platform, to support the development of new analytics, applications and services across a wide range of markets, such as finance, defense and construction.

Altogether, we have a continuous challenge for the industry which is to further develop new usages for the geospatial data, and go far beyond than what we do today. We need to grow commercial demand and stimulate the appetite of new commercial users for geospatial data.

THE BEST FORM OF DEFENCE IS INTELLIGENCE.

WE MAKE IT FLY

At Airbus, we employ an unrivalled team of intelligence experts to deliver insights from a variety of sources including satellite imagery. By pairing state-of-the-art technology with in-depth analysis, we ensure you are fully equipped to counter credible threats.

Insight. We make it fly.

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AIRBUS

RAKESH S | CHAIRMAN & MANAGING DIRECTOR, ANTRIX, INDIA

More Opportunities in a Connected World

The world is moving to information driven society. Broadband connectivity has become so common that now we have a connected world, thanks to the advancements in communication technologies. With the advancement of satellite technologies, geospatial information and solutions based on this, have become very much accessible to the common man.

Information products as required by the customers are need of the hour. To meet the requirement, Antrix is transforming itself from geospatial data provider to geospatial service provider. With the expertise available with ISRO on geospatial solutions, Navigation, Communication and ICT, ANTRIX would move towards providing variety of products/services to meet Indian and global user requirements.

Integration is vital

Digital transformation is the key for Industrial Revolution 4.0. While the western countries are largely adopting fourth IR, India is now gearing up. With 4IR, we are talking about integration of technologies, which is expected to transform the society in the way it interacts with various stake holders. Collaboration is the key. Bigger companies may go for acquisitions/mergers to complement or supplement their capabilities.

> **Data providers must move from selling images to solutions. Integration of multi-sensor data, and domain-specific tools is must to provide new services to users**

Data providers need to move from selling images or pixels to solutions and answers. We need to have collaboration amongst the data providers. Integration of multi-sensor data, developing domain-specific tools is required so that unique and new products/services could be provided to global users. New products will help businesses to take informed decisions. While the government will continue to focus on capacity building at all levels, we need to adapt to provide quick, user friendly, easy and ready to use products for the masses.

Our aim is to capitalize on ISRO's capability in Communication, Navigation and Remote Sensing to provide newer products/services. Antrix is committed to create a Space ecosystem in India under Make-in-India initiatives.

GREG VAN DEN HEUVEL
COO, PITNEY BOWES SOFTWARE, US

Growth Lies in Location

Geospatial technology is an absolute necessity for businesses today. Gone are the days of data spreadsheets. Processing location-based data in a consumable, visual format is how every successful organization will soon begin to make their business decisions.

The speed of service has increased immensely with the explosion of mobile devices, and in order to compete in the global economy, organizations need to provide better and faster location context; it's a critical component to delivering in a global economy and delivering the service consumers expect.

APIs are key

Syncing with industry trends is all about speed of the technology and delivering it through APIs (application program interface) and SDKs (software development kit) for various Big Data, IoT (Internet of things) and SMAC (social, mobile, analytics and cloud) applications.

APIs are key to remain aligned with the industry trends. We are exposing both our software and data assets through APIs to allow more users access to capabilities. Similarly, we are taking parts of our Spectrum technology and wrapping it into software development kits that can be embedded into Big Data frameworks.

We are also incorporating microservices through development of APIs, allowing developers to create specific services that are agile and scalable. One of the largest social media platforms recently used one of our microservice APIs to provide better emergency response services to its users.

> **The speed of communication and the amount of data is unprecedented. This can now be used for predictive services that the world hasn't seen before**

More data means more location intelligence

We always have to think with a global perspective because we work with multinational organizations that are looking beyond their own space in technology.

In times to come, we will be focused heavily on how we help our clients utilize SMAC and delivering the ability to process both the amount data and the speed at which data is flooding into organizations. This will come through our APIs and developer tools that allow people to process and analyze data, as well as our solutions that support Big Data frameworks like Hadoop. As more companies consume data, we will always be looking to support them, and we don't see this trend diminishing — more the data, more location intelligence opportunities. We will also look to rapidly expand and deploy microservices across all industries, including the public sector.

The speed of communication and the amount of data collected every second is unprecedented. These data can be used for predictive services that the world hasn't seen before. For example, a house may be running energy through non-energy efficient appliances; by being able to identify any inefficiency within a specific appliance within the home, smart technologies can notify the homeowner of existing recalls around that appliance, or potential rebates or promotions for upgrading that appliance to an energy-efficient one.

Consumers today demand a level of personalization, and geospatial answers the question of 'where'.

RAKESH VERMA
MANAGING DIRECTOR, MAPMYINDIA, INDIA

Cost and Ease of Use are Primary Factors

Location and precision is becoming a part of every workflow in today's world — be it IT solutions or engineering solutions. Whether you talk about economy mainly driven by financial parameters, or analytics on Big Data for any industry vertical, all have to be derived keeping in view the location element. In such a scenario, integration of geospatial content rich data becomes critical. The trend will directly impact businesses and governments in taking decisions for growth, profitability, serving their respective geographies and also in reaching out to new geographies. At a time when we are entering a new industrial revolution driven by technologies like Big Data, IoT, artificial intelligence and machine learning, Cloud and analytics, we see location also becoming an integral part of this transformation.

The demand for location information has also seen IT companies and engineering firms alike either develop in-house geospatial capabilities or look for acquisitions, because when they take the services of any geospatial company for their end solution, they have to understand, implement and maintain the systems that have geospatial built as the baseline. In my belief, looking at the growth trend, it is high time that players in the geospatial industry need to partner and collaborate to meet the challenges and increasing demand.

Cost and ease of use

For any geospatial solution/intake — whether in business or government — as per the current prevailing trend, cost becomes the primary factor, followed by ease of use and technology. This is more so because most projects in today's world are not geospatial projects, but geo-enabled solutions driven by a mass user base. Here, ease of use and cost becomes the driving factor. We at MapmyIndia are always sensitive to this issue and all our solutions and products are designed keeping in view cost and ease of use, so that they can be used right from startups to national level implementations.

We started our business with digitally mapping India at a time when not many people in the country had even heard of digital maps and the Internet. As a company, we have always given due importance to the trends in the global arena and aligned our plans and development with what would/could be the best for India vis-à-vis the international technology trends.

> At a time when we are entering a new industrial revolution driven by Big Data, IoT, AI and Cloud, we see location also becoming an integral part of this transformation

As a 'Make in India' and 'Made for India' organization, we are aligning ourselves with the needs of our users to provide solutions that would make it easy for the governments and businesses in India to implement location-based solutions with a faster turnaround time and avoid recreating the same base location data. Our Digital Map Data, MAP APIs, Map Engine with Data and API as an in-premise deployment, eLoc (6 digit alpha numeric code as identity of our addresses), InTouch IoT platform are a few solutions that are easy to use and in line with user needs.

I am sure that geospatial industry is all set for a high exponential growth and we at MapmyIndia are fully geared to be a part of this growth story.

DR JOHANNES RIEGL | FOUNDER & CEO, RIEGL, AUSTRIA

There is Automatization Everywhere

Digital content is growing at an incredible pace. A fundamental way to keep track, organize and identify data is by temporal attributes and geo-location. This is not new. The oldest records of the human race we know (cave paintings) refer to a certain location and time (season).

The mobile phone no doubt has been the single biggest technology game changer in recent times for the geospatial industry. With the availability of digital content almost everywhere and any time, geo-located data was soaked up by the mass market. The rising awareness of geo-content led to transformation of the geospatial industry (and it is still in transition) from a special service industry to one of the fundamental data providers for digital content.

It can be discussed whether we face a cumulating third revolution or if the digital information age qualifies for a Fourth Industrial Revolution. Whatever it is called in the end, we can't deny the way digital information and its consumption has significantly changed the way we spend our work-life today.

> Quick, comprehensive acquisition of the environment in 3D is of utmost importance for robotic assembly lines or autonomous transportation

Situation awareness is the key

Location is key for a number of different aspects of this industrial revolution. Situation awareness of autonomously driving/flying/acting machines will be an enabling factor when it comes to efficiency, safety, and capability. This applies to different scales from high-accuracy, high-resolution 3D indoor surveying (for example, factory level automatic line operation) to wide are outdoor mapping for navigation of vehicles. Quick and comprehensive acquisition of the environment in 3D is of utmost importance for robotic assembly lines, autonomous stock room management and autonomous transportation at any scale.

High-quality surveying data acquired beforehand and with dedicated surveying instruments forms a sound baseline for autonomous navigation of vehicles with their multitude of comparatively low-grade sensors. The real-time data is compared to the reference data and thus safe and smooth navigation is achieved.

UAVs, a significant development

The introduction of UAVs in the geospatial sector has been quite a remarkable development. UAVs have been around for many years but performance, price and form factor have prevented the entrance into the price competitive survey/geospatial area. RIEGL has been a pioneer in the development and research of new UAV-based platforms fully integrated with tailored LiDAR solutions for these platforms. Significant increases in LiDAR performance (range, accuracy, speed) have increased productivity dramatically and opened up new areas of applications.

To keep up with the developments, the geospatial industry needs to embrace non-geospatial technologies, including communication technology, sensor fusion et al. The way data is processed will change — data is no longer fed into software but software will be moved to data for processing. In terms of hardware, sensor fusion and connected sensors will drive the technology breakthroughs. On the software side, I see mass data processing, increase of Cloud computing, deep learning and AI-based technologies playing a significant role.

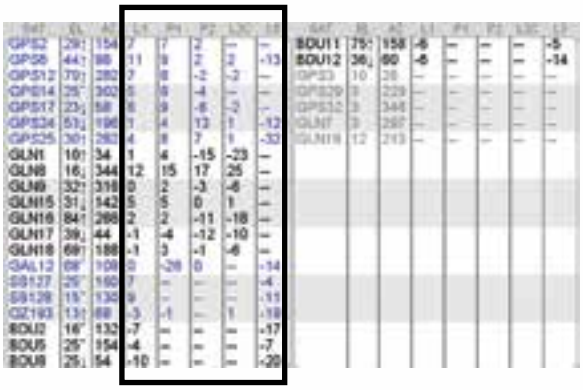
Push for innovation

Constant change is needed to develop new technologies and advancements to make steps forward to change the world. Historically, RIEGL has been at the forefront of technology and is a pioneer in geospatial industry. It is in our company culture and DNA to constantly push for new technological advancements.

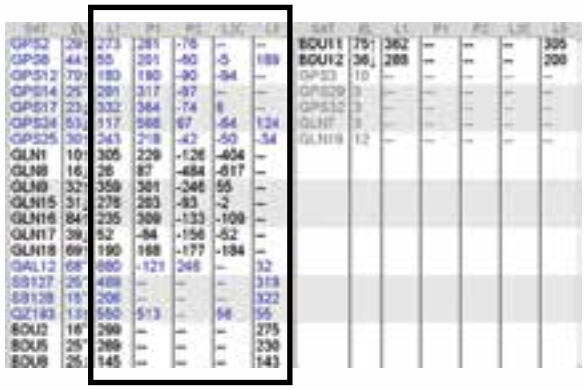
In the next three to five years, we plan to further blur the lines and push the boundaries for new innovations. We see a worldwide market expansion happening for our organization with production capacity increases due to new facilities planned in both Austria and the United States. These expansions will put RIEGL in a position to continue to come up with the most sophisticated LiDAR hardware and software for the industry (design, develop, and to manufacture).

MULTIPATH BUSTERS

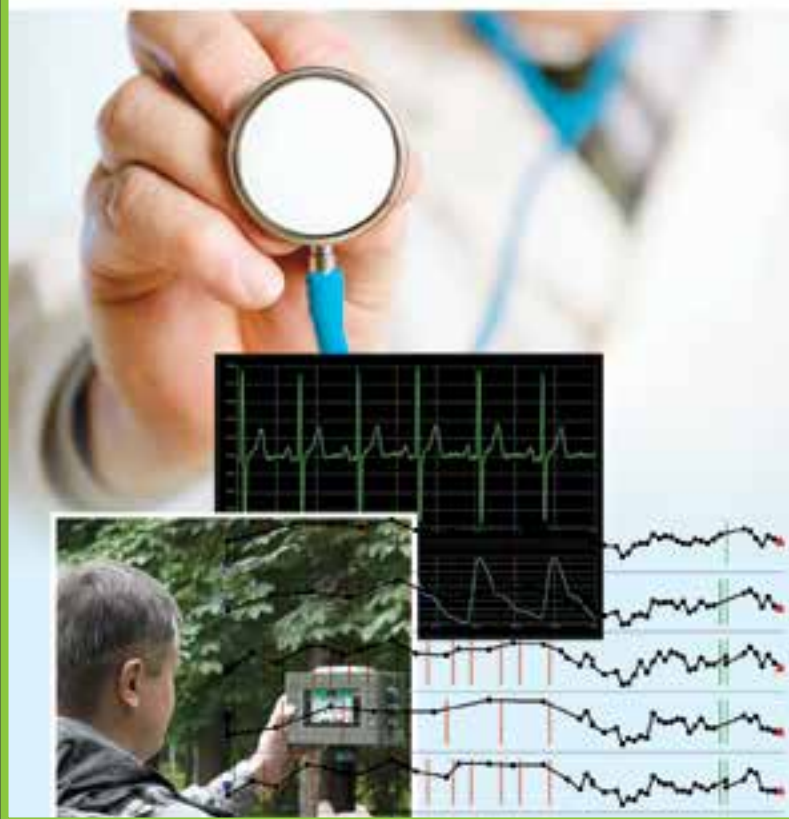
Multipath appears like a **ghost signal** that degrades the accuracy of your shots. We **detect and bust** these ghosts by sophisticated signal processing techniques in our **TRIUMPH** chip. We also show the **signature** of these ghosts that we bust. Below are two screen-shots from the TRIUMPH-LS.



In each column the relative amount of multipath ghosts that has been detected and busted from each signal **carrier phase** is shown (in millimeters). In the carrier phase it is up to a **quarter of a cycle** (wavelength).



In each column the relative amount of multipath ghost that has been detected and busted from each signal **Code phase** (range) is shown (in centimeters). In the code phase it is approximately **several meters**.



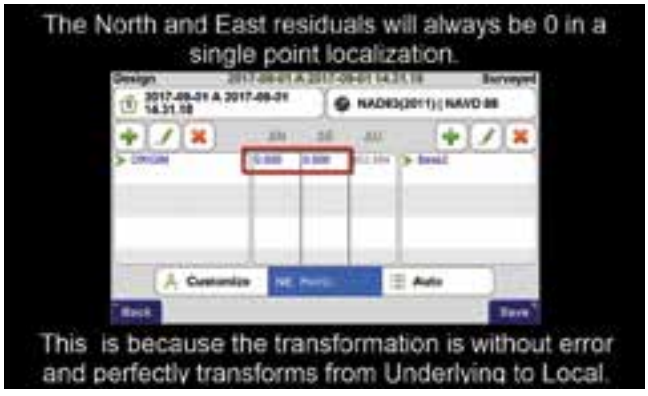
Verify, Monitor, Record, Present and Defend

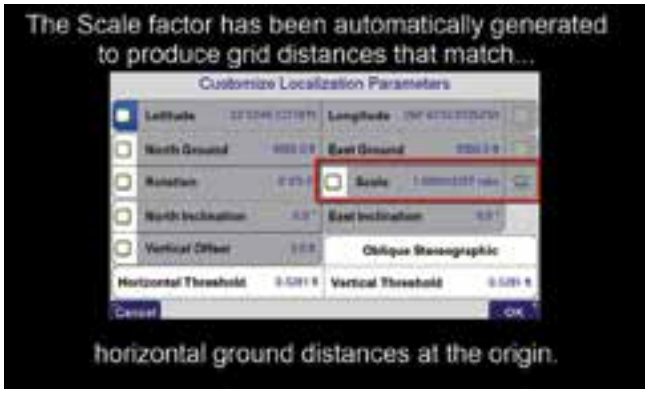
RTK is a statistical process by nature and needs **verification**. TRIUMPH-LS has **six different RTK engines** and extensive automatic verification to ensure your shots are 100% reliable (see www.javad.com).

It also has many tools to **document** the process of your shots for **presentation** when you need to **prove** and **defend**. The screenshots can automatically be recorded and attached to each point and easily **exported to HTML format**.

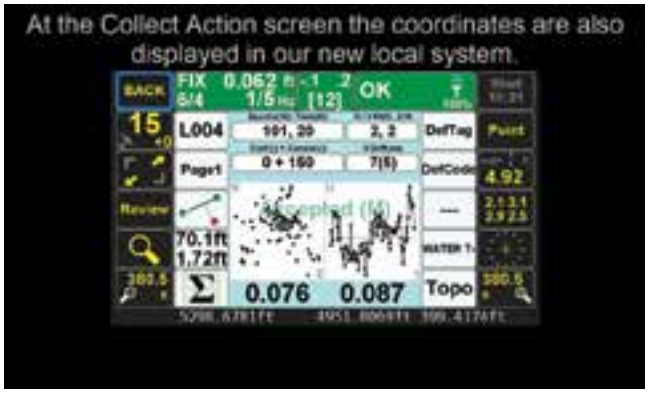
Single Point Localization

Surveyors often find it more convenient to work with a custom coordinates system than a predefined projection, such as SPCS or UTM. The reasons may be many, but often it is desirable to utilize a coordinate system with a low scalar difference from ground based measurements or to have the bearing relation closer to geodetic North.





The Localization application in J-Field on the TRIUMPH-LS is capable of producing useful Low Distortion Projections in seconds. The application is producing a new Oblique Stereographic or Transverse Mercator projection.



J-Tip

Integrated Magnetic Locator

$850

No need to carry heavy magnetic locators any more. The J-Tip magnetic sensor replaces the tip on the bottom of your rover rod/monopod. Its advanced magnetic sensor send 100 Hz magnetic values to the TRIUMPH-LS via Bluetooth. TRIUMPH-LS scans the field and plots the 2D, 3D and time view of magnetic characteristics. It also shows the shapes and the centres of the objects under the ground and guides you to it.

PATENTS PENDING

J-Tip advantages:

• J-Tip does not have “null” points around the peak and will not produce false alarms.

• J-Tip is fully automatic for all levels of magnets. There is even no “Gain” button to adjust.

• J-Tip senses the mag values in all directions. You don’t need to orient it differently in different searches.

• J-Tip gives a 2D and 3D view of the field condition when you have RTK and will guide you to the object. You can actually see the shape of buried object.

• J-Tip, In Time View, shows positive and negative mag values of the last 100 seconds and the Min and the Max since Start.

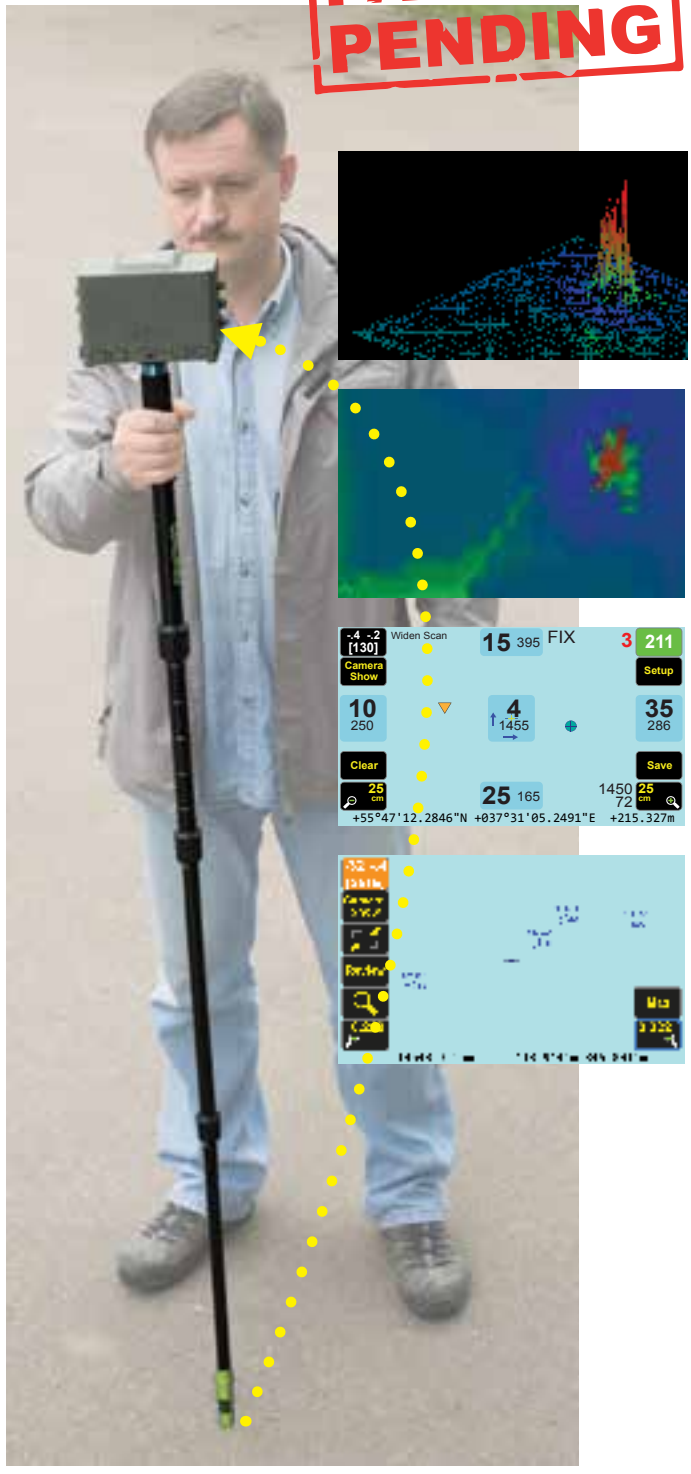
• J-Tip shows the instantaneous magnetic vector in horizontal and vertical directions.

• J-Tip works as a remote control for the TRIUMPH-LS

• J-Tip weighs 120 grams and replaces the standard pole tip. In balance, it weighs almost nothing.

• The built in camera of the TRIUMPH-LS documents the evidence after digging.

• And... you don’t need to carry another bulky device.



J-Pod

$850

A rugged Transformer-Pod

J-Pack

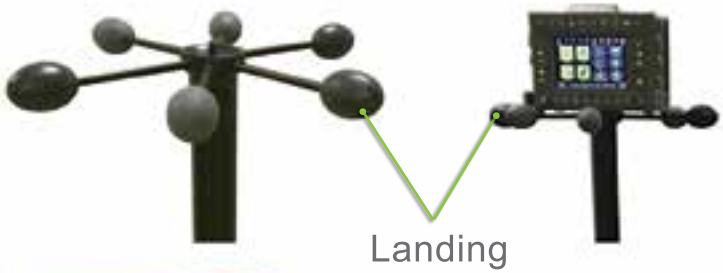
$290

Convenient survey bag

Javad.....Bravo!!!!

The J-Pack is nicest bag I have ever seen for surveying. I especially like the pocket in the back and all of the places to tie down equipment and stuff.

Adam Plumley, PLS



Landing Pads

J-Pod Inside bag.

Monopod >>> to + Bipod >>> to + Tripod…
On demand.

J-Field

Application program of TRIUMPH-LS

Who moved my base?

It is well known that having your own base station near your job site provides you with faster, more accurate, more reliable and less expensive solutions. If you don't know the accurate position of your base, our DPOS service will find it. Read details in the following pages.

After you start your base, If during your survey somehow your base is moved, all your rover points will be inaccurate to the amount of the base movement. But...

...But! Don't Worry, Be Happy:

We will let you know instantly during your survey if your base has moved. We use:

1. Inclinometer which shows the tilt value.
2. Accelerometer which shows motion and shocks.
3. We calculate displacement. This value is accurate to 2 cm.

By the way, a must read book for adult professionals

1) Set the displacement threshold here. "Off" means ignore displacement. Our default is 5 cm.

2) Click the "Start Base". it will change to "Stop base."
RTK corrections as well as motion values will be transmitted to the rover.
Maximum values of the motion parameters will be kept at all time.

3) Maximum values of the three sensors can be shown in a white box in the action screen. Top left is the acceleration in milliG, bottom left is tilt and bottom right is displacement in centimeter.

4) If any of the threshold values exceeds, a pop up will alert you and shows the maximum value of the sensors since you started the base. The bottom number is time since the threshold(s) exceeded.

5) To setup for base movement alert, go to base rover setup screen and click on the left side of the screen.

6) You can set up threshold limits for accelerometer, inclinometer (tilt) and displacement values to create alert when these thresholds are exceeded.

7) Set Acceleration limit here. The units are in milliG (mG). G is acceleration in free fall. "Off" means ignore this sensor. Our default is 5 mG

8) Set the tilt threshold here. Units are in degree. "Off" means ignore tilt.
Our default is 5 degrees.

1


2


3


4


5


6


7


8


Receivers

TRIUMPH-1M

$8,990

864 channel chip, equipped with the internal 4G/ LTE/3G card, easy accessible microSD and microSIM cards, includes “Lift & Tilt” technology.

TRIUMPH-2

L1 $1,990

L1/L2 $3,490

with RTK $4,990

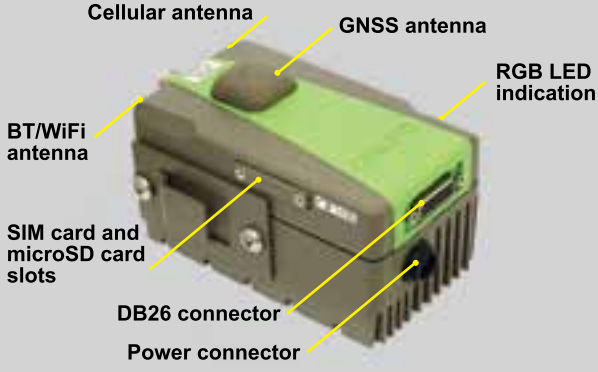
Total 216 channels: all-in-view (GPS L1/L2, GLONASS L1/L2, SBAS L1) integrated receiver.

The one and the only Digital Radio Transceiver in the world!

Unique adaptive digital signal processing, which has benefits: the full UHF frequency range and all channel bandwidths worldwide • the best sensitivity, dynamic range, and the highest radio link data throughput • embedded interference scanner and analyzer • compatibility with another protocols. Cable free Bluetooth connectivity with GNSS receivers and Internet RTN/VRS access via embedded LAN, Wi-Fi, and 3.5G

*Power, data cables and antenna are included.

And all this with competitive prices!



JLINK LTE*

$1,499

Connects all types of devices via UHF, WiFi, Bluetooth, and 4G/LTE for reliable IP communication in the field.

HPT401BT*

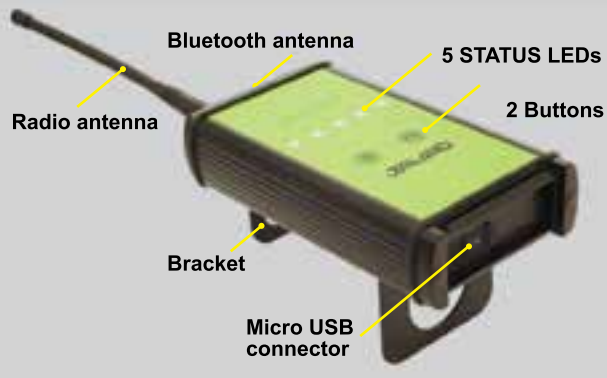
$2,010

1 W UHF transceiver with internal battery. Suitable for TRIUMPH-2 Base or as repeater.

HPT435BT*

High power (up to 35 W) UHF transceiver. Suitable for TRIUMPH-1M/ TRIUMPH2 Base or as repeater.

$2,710



JRADIO*

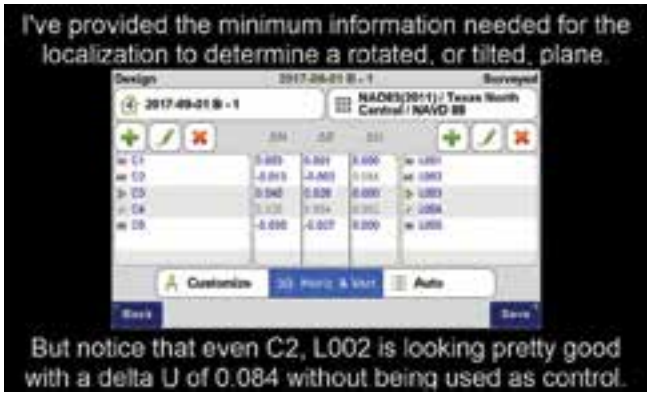
$1,190

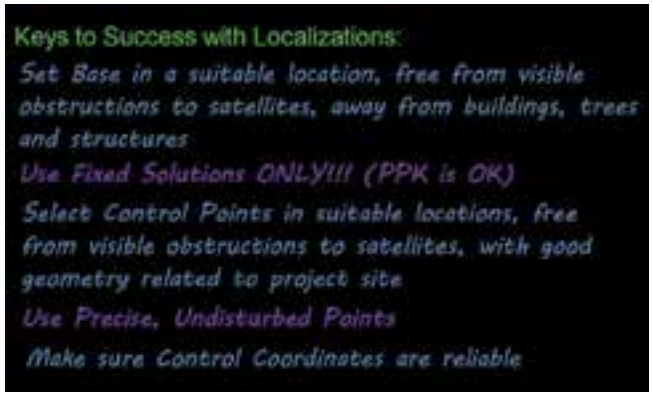
Tri-band UHF receiver with Bluetooth, USB, and internal battery. Suitable for TRIUMPH-2 Rover.

Modems

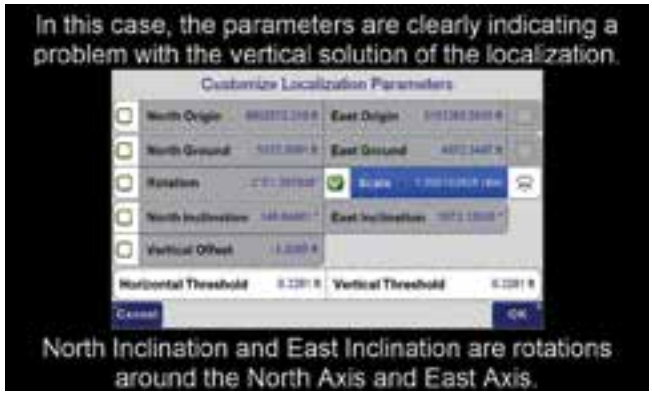
Multi-point Localization

Useful for relating RTK points to a local system of points with an unknown relationship to the Earth, such as a terrestrial survey. Also it could be leveraged to perform quality control analysis on points used in the localization as well as pitfalls that can occur with using a tilted plane.





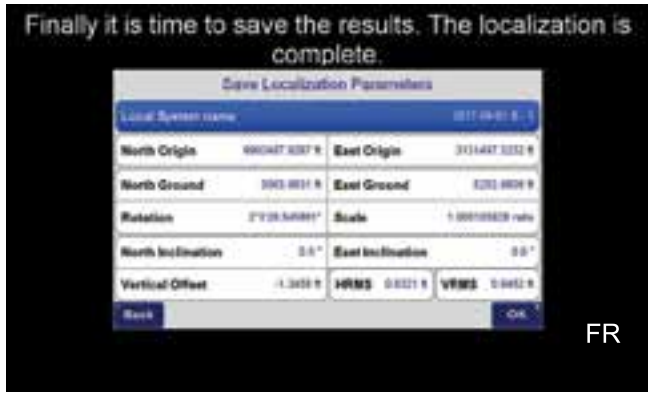
Localization with high residuals should not be used to determine design coordinates for the reestablishment of missing monuments. If a pair of points is suspected to be the cause of the high residuals, the association between the pair of points can be changed to a Check type of control.



In addition to residuals quality control as your source of confidence always look at the parameters under Customize.

See full video at www.javad.com

While the Scale factor is based upon a best-fit solution of the localization points, grid distances between points may not match total station distances. To fix that issue, check the box beside Scale and then tap the Grid-to-Ground button. It will automatically calculates the average grid to ground factor of the survey points used in the localization.



I am on a job now with 143 iron pins found so far. The J-Tip has been awesome for me.

I was out with another local surveyor on this same job last Saturday, and he carried his classic Schoenstedt. There were signals that his detector did not really give a definite reading on, that the J-Tip did. There was also a railroad spike 6 inch deep in the road that the J-Tip missed, and his Schoenstedt did find. When I put the J-Tip over his spot, I only had a 1.8 positive reading, which did drop back to zero when I moved away. When the spike was exposed, the J-Tip reading was 11 while in contact with the spike.

I am also getting good at judging depths before we dig in the road. I am usually within an inch.

John Evers

As for the performance, you can't beat it. However, I want to put out a kudos to the support team from Javad. My LS had a hiccup a couple weeks back. John Evers worked tirelessly into the evening trying to fix it. When it came time to send it in for repair, Michael Glutting sent me his personal LS to keep me going for the few days until the rental unit arrived. THANKS. I don't think you would see that kind of service from any vendor any where.

Bob Farley

I needed it, the LS and the J-tip found it. Another game changer from Javad.

David M. Simolo

Here is an interesting shot. I wanted to shoot the rebar, on the ground. But, post was in the way. I drove a 16d nail, with it's head cut off, (leatherman did that) and used a plumb bob to get it just right. Then, took the LS off the pole, and there is a small hole in the "handle" which I placed over the headless nail. It sat and shot it, while I did other things.
As you can see, by the tree, and shade, this is not a shot for just any GPS.

Nate

SW Arkansas, USA, Planet Earth

JAVAD ASHJAEE | CEO, JAVAD GNSS, US

Technology in the Hands of All People

Advances in any technology comes from two sources. First, improvements in the technology that we benefit from. Examples are more powerful and faster processors, better display technology, better batteries and all others similar to what is used in mobile phones and other electronic items. Second, advances come from the core technology, which in our case is better satellite signal processing and application programs.

Assigning 'location' to 'actions' and 'information' is receiving more attention from all across since location information is inevitable

Assigning "location" to "actions" and "information" is receiving more attention from all across since location information is inevitable for having a complete database. This trend has also seen a lot of big IT and engineering firms building their own geospatial capacity.

Cost and ease-of-use still remain the restricting/limiting factors for exponential geospatial uptake. Increasingly, a lot of non-technical people are using technology, and most of them don't have the patience for learning difficult aspects of products or reading long users manuals. We must put our technology in the hands of all people and make it simpler and easy to use. The industry also must join forces to educate the public and make it easier for them to correctly understand each technology and have reasonable expectations.

VALRIE GRANT | MANAGING DIRECTOR, GEOTECHVISION, JAMAICA

We are at the Edge of 'Where'

Geospatial technologies are driving major disruptions and we are at the edge of 'where'. We will see a convergence of geospatial technologies with all these other technologies. Several opportunities exist to capitalize on these exciting developments to create innovative solutions.

Geospatial organizations must take seriously their responsibility to turn these advancements into strategic advantages. There exists real opportunities to make an impact especially in developing countries. There is however, a need for organizations to collaborate to innovate and leapfrog technological advances. Outreach and sharing of experiences should also be an important part of the development of the industry.

There has been increased recognition of the value of location, thus creating a demand for location information and technologies. To keep up with the technological transformations, we are dedicating time to research and development, training and reskilling existing staff, talent acquisition, development of innovation strategy and process, development of implementation road maps, technology build-out.

In future, integration of geospatial and 4IR will help to define and redefine business models such in terms of strategy, customer engagement and operations. The integration will enhance efficiency, provide a competitive advantage, thus leading to profitable results in businesses and help governments act more efficiently.

Integration of geospatial and Fourth Industrial Revolution will help to define and redefine business models such in terms of strategy, customer engagement and operations

JAVIER DE LA TORRE | FOUNDER & CEO, CARTO, US

Data is the New Global Currency, Location the New Gold Standard

New software, based on open source code bases and modern user interfaces, has opened the door to geospatial for a much broader set of users than ever before. This massive new user community brings new demands for solving business challenges with geospatial data. Rather than a niche market with a small number of highly trained users addressing geo-centric challenges, we now have a mass-market using geo data and tools to tackle everyday business challenges. Our customers and partners are some of the most progressive organizations in the world when it comes to turning location data into business outcomes.

We are entering a Fourth Industrial Revolution where data is the new global currency, and location data is the gold standard. Location is 'the' foundation of the 4IR. Removing the "fourth wall" of space frees up a 10x growth in innovation, commerce, transit, and government. This has already started happening — legacy, desktop-based GIS tools are giving way to on-demand access to spatial insights training an entire new generation of users, including business analysts, developers, and data scientists. At the same time, the mapping software itself is undergoing a transformation with more real-time updating capabilities, 3D basemap renderings, and predictive model simulations to name a few examples.

> **In the next few years, geospatial analysis will go from being the secret sauce for the innovators, to being adopted by people, cities, and companies across the world**

Democratizing geospatial

Instead of restricting geospatial insights to a set of trained power-users, the integration of geospatial and 4IR will accelerate the innovations that will improve the quality of living conditions and infrastructure in developing nations around the world. Similar to the Internet, but with space as the primary axis, there are no physical barriers keeping geospatial from reaching all ends of the earth. And by democratizing access (vs restricting to a set of trained power-users), technologies will gain adoption quickly. This will speed up innovation and quality of life and infrastructure in the underdeveloped nations. I believe in the next few years, geospatial analysis will cross the chasm — it will go from being the secret sauce behind the scenes for the innovators, and quickly being broadly adopted by people, cities, and companies. It will be a seamless part of everyday life, business, transit, and more.

We at CARTO are excited to be part of the modern ecosystem of geospatial technologies. Ease of use is paramount to us, and our strategy is to design products for multiple, different, specific users. This includes data scientists, data analysts, product managers, GIS experts and more. For each of them, the usage paradigm, analysis types and questions being answered are radically different; as are the expectations for usability. By building products for these users, versus marketing one product to all of them, we can quickly gain market share.

We are open to new partnerships and collaboration; and we urge the society to join us in thinking about how to use this innovation for good. Our customers and partners are some of the most progressive organizations in the world when it comes to turning location data into business outcomes. We embrace the open-source movement as part of our product development strategy. This allows us to rapidly iterate and incorporate trends into our tools because we can partner with other individuals and companies that are all working to create the modern ecosystem of geospatial technologies.

JOSEPH AREZONE
CHIEF COMMERCIAL OFFICER, FARO, US

A new Location Centric Metrology is Evolving

Real time location adds unique value to facilitate a more confident analysis and as a result, significantly reduces the risk of taking a less than optimal action. In short, the baseline driver is risk mitigation in the sense that there is now the opportunity to not only to get it right the first time, but to get it right every time.

Solutions, not just products are needed

We are in post-hardware world where end users demand the flexibility to customize the output and "have it their way". FARO, is actively delivering new solutions that decrease the cycle time to bring new products to market; improve the quality of the end output; reduce the end-to-end costs of rework; and assure higher levels of confidence by highlighting potential risk areas early in the process whether it involves quality management in a manufacturing environment or driving a complex construction project. This includes, for example, an enhanced portfolio of high value, next generation measurement and 3D imaging solutions that, for example, facilitate the end-to-end manufacturing inspection process and enable real world comparisons in immersive 3D for construction projects.

Geo4IR is the future

It will soon be more appropriate to logically bind together the concept of geospatial and 4IR into a new compound term "Geo4IR". Without the logic of real-time place, the "smart factory" could never be truly smart and the beneficial concepts of ubiquitous connectivity and better asset management could never be realized. At a higher level, given history and how the business community typically leads in driving adoption of new technology, we expect that the greatest, early impacts and benefits will be realized by manufacturing concerns. We are already seeing the evolution of new location-centric metrology methods, involving more non-contact and in-process techniques, that remove human intervention and that, connected to a Manufacturing Execution System, for example, can receive, validate and pass the measurements automatically. Looking forward, it's virtually impossible for the two to be uniquely separate concepts.

> Without the logic of real time place, the 'smart factory' could never be truly smart and the beneficial concepts of ubiquitous connectivity

The road ahead

FARO emphasizes on the word "solutions" rather than products. In concert, we are actively investing our intellectual capital into developing comprehensive software platforms that enable our customers to optimize the functionality and beneficial use of our hardware.

Where we will be in a few years is probably well beyond what we could have imagined. That said, with history as a backdrop, the road ahead will include a number of unforeseen challenges, but it is very clear that we will have forward momentum. While we may not know exactly "what" and "when", we no longer need to be in a conditional mindset of "if". Finally, at the end of the day, winners and losers will be separated by their ability to deliver a best in class customer experience. Given the staggering number of uses we can dream up for these exciting technological advancements, we must never lose sight of that basic fact.

From a FARO-centric perspective, we are enthusiastic about the unique new efficiencies that the fusion of our unique measurement and 3D image core competencies, artificial intelligence, robotics and 3D printing will deliver across a range of applications including manufacturing, construction and even public safety forensics. It's difficult to correctly predict the future with a high degree of accuracy on the timing, of course, but we are directionally confident in this outlook given how these advanced technologies are being embraced today.

NICOLAS MANGON | VICE PRESIDENT, AEC BUSINESS STRATEGY AND MARKETING, AUTODESK, US

Location and Spatial Awareness Impact Everything

Organizations realize that location-based data and the ability to leverage this information within their core business is essential for them to stay competitive. This information is required not only to differentiate them from the competition but to be in a position to respond to market trends and demands. Knowing the impact of 'where' will be just as relevant to business strategy as knowing the business requirements for what a company offers.

The AEC industry is facing great demand to build efficient and sustainable infrastructure due to population growth and urbanization. This is challenging as all of us to deliver more and better infrastructure with less resources. The AEC industry is embracing technologies that underpin a process our industry calls Building Information Modeling (BIM). The market demand and growth potential for a BIM-compliant process is tremendous.

Autodesk is embracing this change throughout its portfolio of products. It has helped pioneer the process of BIM within the AEC community, and is currently evangelizing the benefits of connecting BIM to the Cloud (Connected BIM) to facilitate real-time information sharing through a Common Desktop Environment. Autodesk is also working to bring the BIM data seamlessly together with location-based GIS data so that customers can take full advantage of the detailed asset information along with the complete understanding of how this asset connects to other assets and/or the local community.

Innovation and collaboration is the key

It is evident that the AEC industry cannot meet the rising demands for buildings and infrastructure using today's technology and processes. Innovation is necessary. Next, the efforts made by the private sector must be substantiated with government initiatives. Governments must play a more active role in ensuring that BIM mandates and overall technology adoption mature. To be able to comply with these mandates and to deliver the efficient, high quality, and sustainable projects that all stakeholders demand, companies must be prepared to invest in technology and digitize the workplace. Things seem very optimistic regarding both the short-term and long-term growth potential for the AEC industry; however, to meet the rising demands, we need to continuously upgrade ourselves.

Seamless integration of GIS and BIM provides detailed asset info along with complete understanding of how this asset connects to other assets and/or the local community

Everyone needs to adapt

Within the AEC industry, integration of BIM and GIS serves as a catalyst within the 4IR. Governments, citizens, and businesses will have to adapt to the vast amounts of accurate BIM and GIS data collected and distributed in real time. AI, machine learning, predictive analytics and the Cloud are going to become more mainstream new ways of working. Privacy laws, data ownership, and monetization models will need to adjust to keep pace with 4IR. Information, including geospatial data may take on many definitions pertaining to such parameters as static versus dynamic, useful life span, and fit-for-purpose to support varying levels of decision making. Collaboration and cooperation will be fundamental to the future success of companies offering data and services.

ANNE HALE MIGLARESE | CEO, RADIANT.EARTH, US

Geography is a Denominator for Our Most Crucial problems

Geospatial technology is fundamental to improved decisions and faster growth. In the near future, geospatial technologies will be embedded in many of the workflows that support the Fourth Industrial Revolution and therefore will be invisible to the end user or customer. That means the application is a success, no longer requiring human expertise and intervention at every step in the process. At the end of the day our problems need answers and the people who need the answers are seldom well equipped to deal with or even interested in the complicated and laborious workflow of how the analysis was done.

There is a move by large IT and engineering firms to acquire geospatial technology companies. This is because these corporations see major market opportunity on the horizon and want to enhance their capability offering and/ or acquire a broader customer base. This is just another indicator that geography is a denominator in the equation of society's most crucial problems. Autonomous vehicles, Internet of Things and climate change mitigation strategies are major market opportunities for large engineering firms over the next decade and all of these demand geographic data and analysis as major components of the work.

We think there will be countless opportunities for the commercial sector to grow based upon the innovation being driven by a few fundamental technologies. Taking into account just the general global trends around machine learning, one cannot help but be excited by what discoveries and analytics can be driven by earth observation data. Further, the fundamental positioning required by autonomous vehicles will drive tremendous market opportunity for mapping and geospatial firms. These two trends alone should significantly increase market opportunity.

Working for a cause

Additionally, with the barriers to entry lowered and the improvements in analytical capability, we are very optimistic about the ability of governments and non-profits such as Radiant.Earth, to put geospatial technology to work for our missions and customers. These missions are directly focused on supporting people and places in need of necessities, to improve the quality of lives across the globe. The trends in open data and government transparency will further fuel additional data driven analytics to support the delivery of government services and transparency.

In addition to tremendous financial savings, the speed at which we can now compute makes some of our most demanding remote sensing computation work seem instantaneous. Radiant.Earth's entire computing infrastructure is Cloud based and we have partnered with Amazon Web Services for this capability.

Radiant. Earth has begun to ready the platform for machine learning workflows and we are investing in image label libraries to support machine learning. Finally, we hope to launch a Blockchain proof of concept project in the next year to investigate the utility of this new technology in geospatial data sharing between non-profits and the commercial sector.

> We are optimistic about the ability of governments and non-profits to put geospatial technology to work for our missions and customers

MARY GLACKIN | VICE PRESIDENT
WEATHER BUSINESS SOLUTIONS &
HEAD OF GOVERNMENT AFFAIRS, IBM, US

The Geospatial Revolution is all about Making Smarter Decisions

The rapidly evolving technology landscape opens up huge opportunities for communities and businesses. Evolving technologies like Internet of Things and artificial intelligence are making the processes more tangible and easy to adapt for communities, which means we are only going to get better outcomes.

The revolution within geospatial is all about improving efficiency and making smarter decisions. We are at a point where productivity gains are focused on making smarter decisions based on what's happening on the planet.

Geospatial in weather business

The weather business is a global business. Much of this has been enabled by government organizations, but with the emergence of new technologies we are increasingly seeing private sector companies, like IBM, play bigger roles and pushing for improved outcomes to benefit global citizens and communities.

IBM's purchase of the The Weather Company was driven by its recognition of our superior forecast. Using a Cloud-based platform that pulls in machine learning, analytics and 162 individual weather models, we arrive at a single forecast that provides the best accuracy possible.

Fundamentally, weather is a geospatial science. Whether we are serving business clients or consumers, we are always providing a forecast with precision, based on what they need. When we provide a forecast, it's done at an extremely precise, local level. Increasingly we are providing forecasts of impacts and recommendations for actions, and this is unlocking much more value for our customers. Weather impacts every sector of the economy. It is the largest external swing factor in business performance, responsible for nearly half a trillion dollars in economic impact in the US alone each year. Every business and community can benefit from knowing the forecast to help prepare for it and make the best decisions whatever the weather.

Weather impacts every sector. It is responsible for nearly half a trillion dollars in economic impact in the US alone

Collaboration is necessary

To truly serve citizens we require stronger partnerships between the public and private sectors, and more direct involvement of citizens. Our network of personal weather stations is enabled by citizens. This partnership between our company and citizens allows us to provide very precise forecasts back to the citizen.

Our mobile apps constantly update to deliver an accurate update in real time, while our technology allows individuals to receive alerts even if they don't have access to a network.

We believe the public and private sectors can work together efficiently to imagine a much improved response to and recovery from weather disasters. We are now deeply engaged with select central, states, cities to chalk out a proactive plan, to manage any weather-based disruption by automating standard operating procedures for public works departments to action all preventive measures. This will help give timely relief in the short and long term and has potential to prevent business losses and potential life threats.

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- University of Southern California, **USA**

ANIL NANDURI | VICE PRESIDENT, NEW TECHNOLOGY GROUP & GENERAL MANAGER, DRONE GROUP, INTEL, US

Accurate Location is Key to Automation

Accurate location data is a key ingredient for automation. As machines including automotive cars and drones, get smarter and more self-aware, they will be using lot more location-based information, and automated processing will help provide inferences and analysis to assist us in various ways. There is already remarkable advancements happening in the field of artificial intelligence to help assist humans with lot more insights.

We have definitely entered a Fourth Industrial Revolution which will primarily be driven by artificial intelligence, robotics, Internet of Things, and biotechnology. As the integration of geospatial and 4IR accelerates, more and more large sets of data will be generated and flowing through everyday business processes. This is going to require a lot more computation and processing power, and overall investment into IT infrastructure by businesses and governments. In addition, there will be need to enhancements in security, and potentially some form of regulation and standardization so that all parties involved are meeting the same security criteria.

Not all can keep up with latest technologies

In general, large business and governments tend to be slower to adopt new technologies into their workflows. Some of the reasons are maturity of new technology, regulatory processes. In some cases, businesses that adopt new technology could potentially disrupt the incumbents.

Intel recognizes that not all businesses can keep up with the latest technologies or are ready to digitize their data. We are tuning the way that we do business to offer complete drone services and solutions, as well as data analytics, processing, and reports to help these businesses transform without needing to make the large capital investment. This includes data acquisition by drones, including the pre-flight planning, secure data storage if chosen by the client, and processing of data and analytics, and reporting.

The use of drones as a data capture tool for more effective, efficient, safer, and more accurate way to do survey, mapping, asset management and progress reporting has been a big technology game changer for the geospatial industry. As tools like drones are used for geospatial data acquisition, vast amounts of data from high-resolution RGB sensors need to be processed and analyzed. Data from drones can range anywhere from a few GB to over 50GB of data per flight, and a fleet of drones for commercial use could be capturing up to 18TB of data per day. Managing these vast amounts of data require lot more compute and need to be secure and fast.

As an industry, we need to partner and come together to bring social awareness to the technology that we are working on. It is important for all of to show that we are conducting business responsibly and that the technology can be used to do a lot of good for our society, for instance in areas such as disaster recovery, environmental research, animal research, search and rescue and others.

Use of drones as a data capture tool has been a big technology gamechanger for the geospatial industry in the recent times

MATTHEW ZENUS | GLOBAL VP, DATABASE & DATA MANAGEMENT, SOLUTION GO-TO-MARKET, SAP, US

Bridge the Silos Across Platforms and Technologies

Integration of Geospatial and enterprise data is real and it's happening now. The combination of the two provide better insights, improves business decisions and drives innovation.

Organizations realize that the insights available to them through geospatial analytics possess significant value, providing useful information that enables them to cut costs and work more efficiently. Additionally, as artificial intelligence plays a larger role in the analysis of large swaths of data, artificial intelligence and machine learning technology will become more integrated in existing geospatial analytics solutions. Geo-referenced data is everywhere, but it still is not fully leveraged in the business world. The rise of AI across industries will likely inspire its growth within geospatial analytics and drive organizations to further develop their own geospatial capabilities.

Evolving geospatial analytics

According to Forrester, geospatial analytics in the past focused on mapping data from Geographic Information Systems (GIS).

Today, they see an expanding array of sources of geospatial data connecting customers and locations. Forrester forecasts a 10% compound annual growth rate in geospatial analytics over the next five years and that enterprises are just beginning to harness the power of geospatial analytics, expanding adoption and innovation.

We at SAP recently partnered with Esri ArcGIS to deliver the platforms, applications and ecosystems needed to empower organizations to leverage location information to uncover new insights from business, social and sensor data. This information allows employees to work more efficiently and identify new revenue opportunities and areas in which to cut costs. One example of an organization leveraging SAP and Esri technology is the city of Cape Town, South Africa. The city's Emergency Policing and Incident Command (EPIC) program is its first-ever, fully integrated public safety and emergency management suite running on SAP HANA. The program leverages both SAP HANA and Esri technology, as well as real-time spatial mapping to integrate the six emergency and policing services onto one common platform, enabling collaboration and coordination across multiple agencies. We are also providing cloud freedom by supporting mutli-cloud and hybrid deployments.

> Integration of geospatial and 4IR will provide ecosystems necessary to help organizations uncover new impacts

Silos must be bridged

Until recently geospatial was very niche but we now use maps every day. We need to embed maps and geospatial thinking into all applications and solutions making it simpler to consumer and collaborate from within and outside.

Our outlook for the near future is to continue to bridge the silos across all platforms and technologies including drones, AI, Machine Learning, Blockchain, IoT, Geospatial, democratization and operationalization.

The integration of Geospatial technologies and 4IR will provide the platforms, applications, and ecosystems necessary to help organizations leverage the innovations in location to uncover new impacts from business, social, and sensory data. Armed with this ability, people can work more efficiently, and organizations can reveal new revenue opportunities and realize significant cost savings with increased efficiency and automation across business processes.

STEVEN HAGAN
VICE PRESIDENT ENGINEERING - SERVER TECHNOLOGIES, ORACLE, US

All Applications have a Location-Aware Element

Geospatial capabilities have transitioned from map UIs, to essential elements in providing personalized, targeted content and services in most applications and systems. Products are participating in the Internet of Things services, machine learning is enabling predictive and user aware offerings, and new facilities, physical plant and services are context aware. As such, geospatial capabilities are essential and assumed. A decade ago, maps and visualization were the standard for how geospatial technology was consumed; today real-time positioning and location-based actions are core to products and services.

Virtually all applications and services now have a social and location-aware element.

Cloud-based spatial analysis: A necessary shift

Cloud computing is a tremendous opportunity to broaden the uptake of geospatial technology. The Cloud also lowers many of the technology and business barriers to adoption of geospatial technologies.

Oracle believes the shift to Cloud computing is a fundamental paradigm change as significant the influence of the emergence of the internet at the turn of the century. Cloud-based spatial analysis and mapping services are an essential and integral part of Cloud platforms and services either as discrete spatial service offerings, as API-driven services, or incorporated into other Cloud services like: Analytic Cloud, IoT Cloud, Adaptive Intelligence.

Within the next three to five years, all Cloud-based business systems will incorporate geospatial capabilities. This will lower costs, reduce complexity of adoption, and improve the quality of service. Wider industry adoption of machine learning will enable delivery of autonomous systems (devices, manufacturing processes, workflows, etc.). For most industries, the Cloud will become the computing platform for hosting and consuming IT services.

The future is autonomous

The development of autonomous services has arrived. These technology innovations will require adaptation in public policy, education, and the way business and manufacturing gets done. No doubt, 4IR advances will create yet unforeseen challenges and opportunities for government, and businesses, and the general public.

The Fourth Industrial Revolution is about fusion of cyber networks with physical networks to create new autonomous systems. Similar symbiosis is taking place between autonomous systems and Cloud computing. Oracle has been at the forefront with innovations like the world's first Autonomous Database and Autonomous Data Warehouse. Unlike traditional Cloud services with complex, manual configurations, autonomous systems are no-code/low-code environment that provide developers, analysts and users with simple "load and go" services. Users specify tables, load data and then run their workloads in a matter of seconds — no manual tuning is needed. These will be the architectures for geospatial analytic and operational systems of the future.

Within next 3-5 years, all Cloud-based business systems will incorporate geospatial capabilities. This will lower costs quickly, improve quality of service

MATTHEW M. O'CONNELL
MANAGING PARTNER, SERAPHIM CAPITAL, US/UK

Use of Location Information will Expand with IoT

The commercial world has undergone a revolution in its awareness of the importance of geospatial information in the past dozen years. Google Earth showed the world the importance of location information in context.

Once people got used to using digital location information for the personal lives, they realized the added efficiency and insight it could provide to the operations of their governments and their businesses. Businesses and governments now routinely include location information in their analysis of many sorts of problems and the planning of their operations.

Location has become all pervasive

People now routinely use digital location information. Before they go shopping, they look at a digital map to find the store nearest them, then they plan their route using that digital map. They do this on their personal devices — phones, laptops, tablets — and they do it in their cars. Car navigation systems are relatively recent.

Using more location information has already increased the efficiency of our transportation and travel choices. Geospatial information has always affected our real estate choices. The advent of ubiquitous, easy to access and manipulate location information has made our choices more informed. In choosing where to live, young families can easily study the transit options to work, the educational options for their children, the proximity to quality medical care, etc.

As we move to more autonomous vehicles — cars, planes, ships — the use of highly accurate and frequently updated location information will be even more critical. The Internet of Things will expand even further the use of location information. Vehicles will communicate with each other, hopefully reducing the occurrence of accidents.

More consolidation on cards

Technology costs will continue to decrease, so the pace of technological development will continue to accelerate. Geospatial information will become easier to use and more products and services will flourish. Governments, businesses and individuals will incorporate geospatial information and technology into their lives and decision-making.

Geospatial companies will continue to innovate. There will be more consolidation in the tech industry, especially in the geospatial industry. Satellite companies will combine — some of the big satellite telecommunication companies will merge, GEOs will merge with GEOs, MEOs and LEOs. In the geospatial industry, bigger companies like Rolta and Maxar will buy companies that have developed products and services because that is faster and more efficient than trying to build them themselves. Many

> **Technology costs will continue to decrease, so pace of innovation will accelerate, and geospatial data will become easier to use**

of those consolidations will reward investors handsomely. For instance, we grew GeoEye from a value of $30 million to $1.3 billion in 10 years, and sold it to DigitalGlobe, which sold four years later to MDA, now known as Maxar.

The geospatial industry will continue to create value in many ways. It will create a lot of jobs that pay well and involve interesting work; it will create wonderful new products that make our lives easier, our countries safer and our consumption of natural resources more efficient. In doing the foregoing, some companies will generate fabulous returns for their investors.

KEITH NICHOLS
MANAGING DIRECTOR, GOVERNMENT, TAX & ACCOUNTING BUSINESS, THOMSON REUTERS, US

There has never been a more exciting time

Geospatial technology is ubiquitous and easier to use now more than ever. This has led to a much broader use of the technology than ever before. It is a bit cliché to say there has never been a more exciting time for the collective geospatial industry, but it is true. The demand for location-based data will continue to explode, and the need to simplify complex data to find answers has never been greater. Geospatial information and tools will continue to be the basis of, and add value to, many of the technology solutions for the future.

Consider a valuation office: in the past, a typical government office would need geographic information systems support from the GIS office. But today, thanks to Web applications, a valuation office can access maps, data and imagery without the need for in-depth geospatial expertise. Likewise, geospatial tools are more accessible and familiar to a growing number of users, including the public.

We see an opportunity for more transparency and trust in the industry for the future. Geospatial technologies have a unique role in this regard, as the ability to deliver mapped information is both powerful and meaningful. In other words, people can quickly relate to the information they see on a map and how it impacts their place, or location, in this world.

The right partnership

We believe that governments embrace social and mobile data as a means of communication because it is easy to see the power of distributing information quickly. When it comes to analytics and Cloud data, we see that governments are just scratching the surface.

In terms of analytics we don't think governments fully realize the power of the information they possess, and therefore, they don't invest enough in this area. The volume of data that the public sector is tasked with managing is daunting, and this doesn't even get into how they approach or analyze this data. But we believe that by partnering with the private sector, governments can unlock the power of data

We will continue to see a greater need for technology to solve our problems. Data analytics through artificial intelligence and automation will increase in importance

Solving complex issues

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We will continue to see a greater need for technology to solve complex problems. To that end, data analytics through artificial intelligence and automation will continue to increase in importance. Datasets in every industry will only grow and get more complex, and so the ability to unlock answers from the vast ocean of data will be key.

Corporations, governments, and citizens/consumers will get used to instant answers and continue to demand more and more information at greater speed and accuracy.

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MASSIMO C COMPARINI | CEO, E-GEOS, ITALY

Everything is Going to be Reinvented

Space technology and Cloud systems are just the fuel of the transformation engine in geospatial sector. Advanced algorithms (machine learning, deep learning and even artificial intelligence) and Cloud-based large computational capabilities represent a real game changer in the geospatial sector.

The geospatial ecosystem will definitely remodel with 4IR. We are addressing a whole new generation where the previous theories are going to be reengineered to reach an unmatched velocity to process a large amount of data. e-GEOS has a long standing experience and legacy in the geospatial business and of course its strategy is completely embracing the trends in place. All our application platforms to deliver added value services are migrating on information products taking benefit of data analytics and big data integration. As a leader in space- based radar applications, e-GEOS is also taking full benefit of the high level of information today we can extract by radar images and by combining them with optical and other assets. New technology trends need as well a new paradigm in the innovative momentum in order to integrate open innovation approaches and to be fast to convey new solutions to the market.

> The potential of analytics to derive useful information for existing and new vertical markets will open plenty of new opportunities

A new youth is emerging

The border of the impact of integration of geospatial and 4IR is surprising because from marketing to defense, the products and the access to the services have to be remodeled, so everything is going to change or at least reinvented. Location based information combined with high temporal resolution and Big Data certainly are key pillars of 4IR.

We are taking about a complex market vent larger than the single geo industry. We are talking about "space" segment where the new breeze generated by the startups is cleaning the dust of a solid and scientific approach of this segment. A new youth is emerging.

Big Data, evolution of three dimensional elevation models, NewSpace constellations of mini/nano satellites with very high temporal resolutions, data fusion are just the ingredients of a paramount of new applications in support to new space economy and the Fourth Industrial Revolution.

The power of Big Data

The potential of analytics to derive useful information for existing and new vertical markets will open plenty of new opportunities in the coming years. The power of the Big Data also through social media and mobile devices will completely be understood and embraced by institutions and governments.

In the future, we plan migration of portfolio of solutions to information-driven solutions and Big Data analytics, integration of complementary space assets (multi sensors, multi-dimensional high spatial resolution, high temporal resolution). The industry needs to be extremely innovative and open to cooperation across the industrial sectors and the value chain.

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JOHN RENARD | PRESIDENT-UTILITIES AND GEOSPATIAL BU, CYIENT, UK

Location is at the Heart of Digital Economy

This has to be one of the most exciting times to be in the geospatial industry. Not since the early adoption of digital mapping in the 1980s and the subsequent emergence of GIS as a powerful decision support and planning tool, has the industry been so relevant, visible and of interest to so many new entrants and players. Location has come of age and has rightly taken its position at the heart of our increasingly digital economy and society.

User expectations are evolving. Firstly, they aspire to see measurable value and return on their technology investments. This has prompted many companies to move from product-centric and service-centric approaches to solution-led initiatives, often requiring geospatial capabilities. Secondly, geospatial technology is increasingly finding traction in other industries as a horizontal capability and no longer finds itself in a specialized category. For this reason, a large corporation (IT or engineering) which plays in several industries is developing geospatial capabilities in-house or through acquisition.

> **4IR is defined less by individual technologies and more by the interlock/interplay of digital technologies with the physical and biological/ecological systems**

Building capabilities is the way forward

The technology landscape is rapidly evolving and keeping up with that pace are client expectations. A company that constantly strives to live up to client expectations has innovation as its bedrock and industry best practices as its brick and mortar. It is persistent on improvements to make sure it leads the change.

We have adopted a 'S3 Strategy' of offering a strong and evolving mix of 'services, systems and solutions'. We are investing in developing new capabilities in platforms for the IoT, RPA, machine learning and operational technologies as we believe building capabilities proactively at various levels is the way forward for companies like Cyient.

Technology Integration: A game changer

The Fourth Industrial Revolution is defined less by individual technologies and more by the interplay and inter-lock of digital technologies with the physical and biological/ecological systems and the consequences of the convergence. In that respect, the integration of geospatial data with other technologies will prove to be a game changer for organizations — both public and private.

Take the case of electric utilities. The impact of natural disasters on utility infrastructure is potentially devastating and often causes severe disruption to the continuity of energy supply to consumers. In the past 12 months, natural disasters around the world have cost utilities an estimated $10 billion in repairs and fines.

A Cloud-based solution could potentially leverage machine learning and Big Data analytics to improve forecasting and response planning in the event of natural disasters. When integrated with GIS, outage management, mobile workforce management and social media platforms, such a solution creates an end-to-end schema that allows utilities, emergency response services and disaster management authorities to coordinate efforts in real-time — seamlessly. This is the power of technology integration.

MARC MELVIEZ | CEO, LUCIAD, BELGIUM

The Only Constant in Life is Change

With the increasing use of smartphones, location intelligence has turned into a consumer-product and significantly widened both the awareness and use of geospatial technology beyond the sphere of professional geospatial users.

The opportunities and benefits that geospatial technology can provide are so large that a race to gain market share has started, and the "make or buy" decision that new entrants are faced with creates opportunities for investors in GIS companies that are ready to sell.

Machine learning will start to permeate the GIS data production and analytics marketplaces. This means that geospatial companies will need to ensure that they are hiring people who understand machine learning techniques, are able to develop applications which utilise them and are able to explain the benefits of machine learning.

Protecting privacy of data

Integrating geospatial data will add additional requirements for transparency and privacy given that geospatial data can contain personal information. That's one of the reasons why the EU decided to introduce General Data Protection Regulation (GDPR), which will affect any company doing business in or with European Union (EU) organizations or advertising to EU citizens: without these strict rules, privacy would be easily breached, given that companies are now able to collect large volumes of personal geospatial data. Telecoms provides a clear example of this, given that they are able to collect data on the movements of their customers, which they can then use as movements of people are becoming apparent to telecom companies and their corporate clients.

In line with the above trend, in the recent past there has been an exponential increase in faster and greater volume of data that needs to be tackled. For example, MicroSats, CubeSats are creating an abundance of data at a much faster rate as compared to traditional satellites. This explosion of data needs to be addressed by the geospatial industry as this will lead to a breakdown of the existing workflows and architecture, creating a need for new technologies and approaches.

Driving force

Luciad is leveraging its experience in the defense world, which is accustomed to very dynamic environments and masses of data, in order to create high performance applications for the commercial world. Our platforms are fault tolerant (corrupted or partial data will not stop the application from functioning) and provide high performance even with low or no connectivity. What was cutting-edge in the defense world five years ago is becoming mainstream commercial software, as businesses now face data analysis and management issues that have already been encountered by defence organisations.

The opportunities and benefits that geospatial technology can provide are so large that a race to gain market share has started

MARK FREEBURN | CEO, AAM, AUSTRALIA

New Ways to Seek Answers to Old Problems

Awareness of geospatial is paramount in the global business community. Sectors like banking, insurance, manufacturing now see geospatial as a core enabler of their business or a key insight into customer behavior. In the times to come, geospatial information and systems will be ubiquitous and used in processes and outcomes we have not yet imagined from social welfare to food distribution, from equity in education to leisure design. It will be everywhere.

Geospatial provides access and means to businesses both large and small. It provides new ways to see answers to old problems. Geospatial has grown on the back of disruptive technologies like computer gaming, graphic processing, non-relational data structures, extended markup languages and Web browser intelligence, just to name a few.

> Geospatial data and systems will be ubiquitous and used in processes and outcomes we have not yet imagined

Cloud computing is the game changer

Cloud automation and improved visualization have changed how we, and more importantly our customers, perceive geospatial technology. For much of the world the disruption to traditional desktop and client/server geospatial models has only just begun. The game changer has been commercially available Cloud computing. Big Data, and more specifically, big geospatial data is really only conceivable on large and scalable computing environments, which in turn provides access to analysis at a scale not envisaged only a few years ago.

We are evolving in two ways. Smarter content and smarter access to that content. Content must be relevant, reliable, timely and in forms that could be easily used. Access to the data must be immediate, predictable and multi platform.

Business and government know they need to reduce costs and still be even more productive. To do this they must find ways to balance security, custodianship and fixed corporate structures with accessibility, agility and responsiveness. Commercial Cloud, exploiting data and platform as a service, provide a way to achieve that balance.

Businesses need to build whole solutions and the smartest, most effective way that can be achieved is through collaboration.

Progress is taking place at a fast pace

Clearly the geospatial world is being rebuilt. From faster, more agile acquisition from UAVs and micro satellites, to comprehensive feature recognition and global datasets, the components and the ecosystem in which they exist, are expanding daily.

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ROBERT LAUDATI | MANAGING DIRECTOR
HARRIS GEOSPATIAL SOLUTIONS, US

The Transient Advantage Paradigm

Over the last several years, geospatial technology has continued to expand its potential as a means to help solve complex business problems in industries far beyond the traditional "mapping and GIS" user base. In the remote sensing and earth observation niche of the geospatial industry, Cloud infrastructure has caused a revolution.

To serve a larger number of users, the need moves beyond raw technology and towards answers to business problems, requiring an array of technology including data, analytics, and delivery mechanisms. The geospatial industry is collaborating at a higher level than ever before, and democratization of the technology is a key driver in this. Many companies see collaboration as a means to get to market faster, pairing their expertise with other components to create an overall solution in a timely manner.

> **The geospatial industry is collaborating at a higher level than ever before, and democratization of the technology is a key driver in this**

Evolving ecosystem a growth opportunity

Leveraging AI technology to branches such as deep learning to automate geospatial analyses is a game-changing technology that is driving the demand for new forms of geospatial data at higher volumes. As an evolving solution provider, Harris' biggest challenge is the purposeful application of this advancing technology in a way that is meaningful for end users. This requires a blend of geospatial technology expertise and industry subject matter expertise. Moreover, given the acceleration of technology innovation and the need to collaborate, we are aggressively driving and supporting standards including OGC and STAC.

We are addressing issues such as ease of use and ease of access through the purposeful shift of our business model away from providing technology products and towards the delivery of industry solutions. Our deployment methodology is rapidly evolving from standalone workstation products to Cloud-based applications that have integrated data, analytics, and user interfaces.

Developing insights, not data, the key

Many research organizations have predicted that over the next several years, there will be an oversupply of geospatial data, and that the key value proposition for the industry will turn to developing insights through information products (IP) and value added services (VAS). The flow of investment into new data forms and analytics development validate the prediction, but the successful geospatial organizations will benefit most from the growth of the technology evolution by finding ways to penetrate the global economy, through capabilities such as standardization of data and analytics; flexible pricing models/options; and solving business answers for a long tail of consumers.

Dr Rita Gunther McGrath has done quite a bit of research on business strategy in uncertain and volatile environments, and I believe her work is directly applicable to the geospatial industry today. In short, her thesis is that the traditional business model of establishing a unique competitive position and sustaining it for long periods of time is no longer relevant. Instead, organizations need to embrace the concept of "transient advantage" and learn to launch new strategic initiatives again and again, creating a portfolio of advantages that can be built quickly and abandoned just as rapidly.

PETER BATTY | CO-FOUNDER & CTO,
GEOSPATIAL DIVISION, UBISENSE, UK

Ubiquitous Sensors Reshaping Industry Ecosystem

Geospatial data capture and maintenance is in the process of being reshaped by ubiquitous sensing technologies, even as the nature and availability of the data is radically changing. Geospatial databases are rapidly evolving to become "digital twins" of the real world, updated in real time, in 3D and with extraordinary amounts of historical data. This will enable many new opportunities, as well as raise complex issues around privacy, while completely new system architectures will be needed to handle these changes.

It is almost meaningless to try to define "geospatial" as an industry any more, as it becomes an aspect of so many different mainstream technologies. A huge majority of innovation in the geospatial space is already coming from outside traditional GIS companies, and many new geospatial technologies and approaches today are significantly different from what has been done before. Further, many aspects of traditional geospatial technology have become commoditized as they are absorbed into mainstream IT as the capabilities and robustness of open source software continue to grow. Advancements in mobile applications, which have dramatically changed in capability, also played a major part in this shift, driven by modern smartphones and tablets combined with huge improvements in cellular networks.

Self-driving car to drive much of this

Over the next three to five years, we will see dramatic changes in terms of how geospatial data is created and maintained, as technologies for reality capture develops at an amazing pace. Much of this is being driven by the self-driving vehicle industry, where there is a huge investment going on. The latest Tesla cars include eight high-definition cameras providing 360-degrees of visibility, 12 ultrasonic sensors and a forward-facing radar. The software in these cars can recognize and pinpoint the location of cars, people, street signs, traffic signals and more. We are not far away from every car on the road being like a Google Street View car, capturing and analyzing huge amounts of data every second. Proliferation of smartphones and other smart devices will only be driving this trend where the whole world slowly turns into sensor web.

> **We will see dramatic changes in how geospatial data is created and maintained, as technologies for reality capture develops**

In this background, geospatial companies will have to collaborate with a broad range of other companies and technologies to be successful. This may be difficult for some traditional GIS companies who have a culture of developing everything themselves. Ease of use remains another challenge for many traditional geospatial projects. However, a number of companies are delivering simpler-to-use geospatial solutions taking a lead from Google Maps.

Business-oriented geospatial solutions

At Ubisense, we have been implementing large rollouts of new generation Web and mobile applications at the top-tier communications companies and utilities. We have seen a lot of interest in applications that use their existing legacy GIS data but make it easily accessible and usable throughout their enterprise via simple Google Maps style applications. We are focused on providing business-oriented geospatial solutions for communications and utility companies.

ANDY DEARING | CEO, BOUNDLESS, US

The 'Where' Aspect Helps Us Understand Our World Better

Technologies like the Internet of Things, autonomous vehicles and sensors are capturing information that has never been captured before — they are creating entirely new avenues for geospatial data collection.

Additionally, traditional geospatial work is also experiencing a shift. This is visible not just in visualization of the data itself, but we are also seeing a heavier emphasis on using GIS for analysis. We are using it to answer questions and make critical business decisions in a greater capacity than before.

Enabling better decisions

There are many breakthroughs and success stories in the geospatial industry right now that are propelling the science forward more rapidly than ever before. Integrating IoT data, mapping drone information, autonomous vehicles, analyzing imagery from smallsats — GIS is at the root of these technology trends, and we are only beginning to really understand how these new sources of information can help us make better decisions.

With the proliferation of IoT and connected devices comes a rapidly growing source of new data streams as well. As a result, location-based analytics and platforms that can process and detect trends and provide intelligence are emerging as a popular trend. With self-driving cars and smart city initiatives becoming more of a reality, it will be imperative to understand how all the location information can be used to make smarter decisions.

Additionally, open source technologies have become essential for modern IT enterprises striving to gather, organize and connect the dots between the vast amounts of spatial data at our fingertips. Open source enables these organizations to harness limitless scalability to understand and solve emerging business challenges.

Next-generation of GIS is taking shape

Many geospatial industry veterans would say that GIS helps us better understand our world. Over the past 20, 50, 100, even 500 years, the ability to understand the "where" aspect of our everyday lives has become increasingly powerful.

Many mainstream IT companies realize that (a) location is important, (b) geospatial technologies will enable and add value to their companies, and (c) building it on their own requires something they don't have, and the best way to get it is through acquisition.

For those developing their own geospatial capabilities, they are often enticed by the open source tools on the market (which are more affordable, scalable, and flexible than proprietary tools), but they don't necessarily have the in-house resources required to obtain the full benefits of open source. As a result, they turn to companies like us for that support. We have expanded our offerings with a family of commercially supported, open source products that constitute the next generation of GIS.

This has become necessary as organizations are not only beginning to understand the "what" behind location content, but now also understand the "why". This is a great time to see the next generation GIS taking shape and what it will become in the years ahead.

With self-driving cars and smart cities becoming a reality, it will be imperative to understand how location information can be used to make smarter decisions

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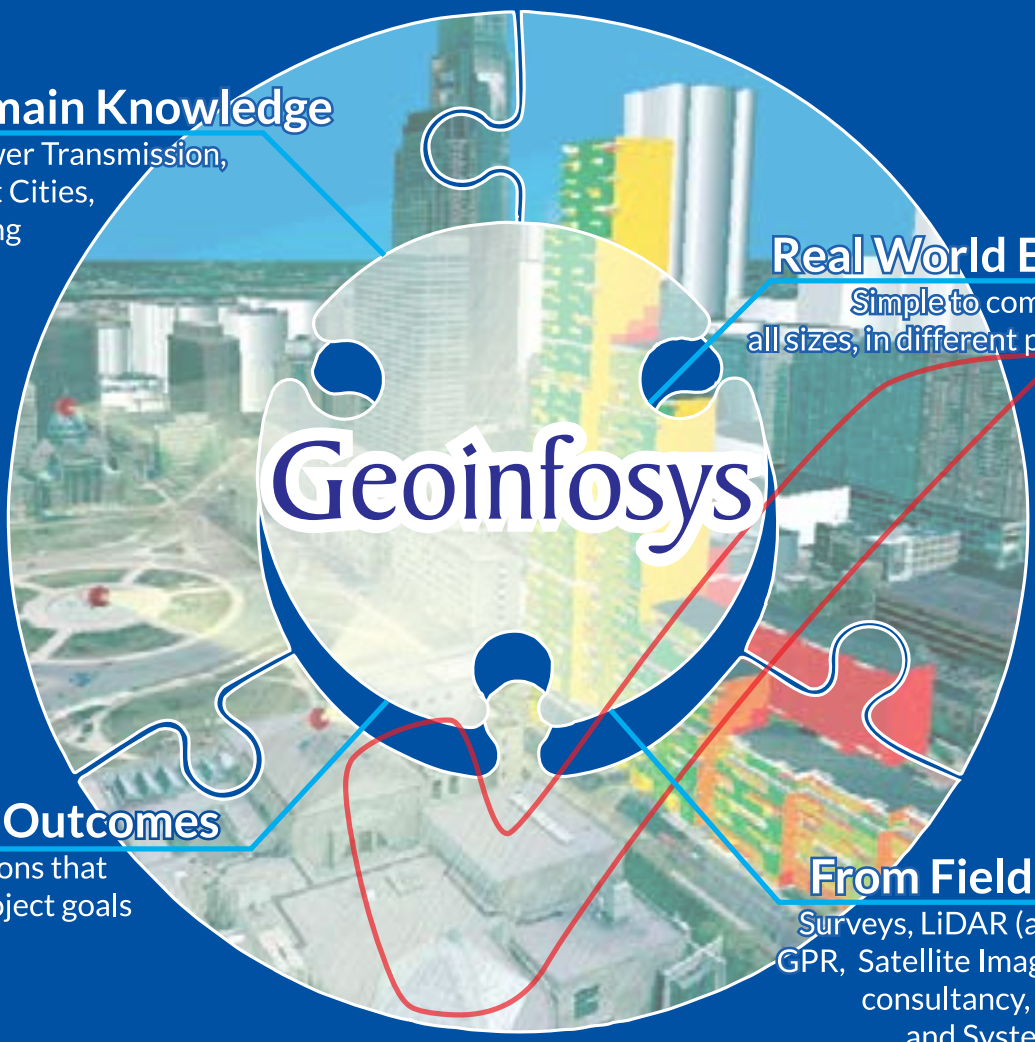

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JEAN-CHRISTOPHE ZUFFEREY
CEO, SENSEFLY, SWITZERLAND

Drones have Made Aerial Imagery Affordable and Easy

We're at the dawn of a revolution in the geospatial industry. More data, more frequently and at higher accuracy levels is changing how we work. It enables us to have maps and terrain models evolve in near-real time and, in turn, that enables the industries depending on geospatial data to make better decisions. Professionals need to embrace these new technologies; for example, by moving from traditional surveying methods to drones with onboard RTK technology to make surveying easier, faster and highly accurate.

Innovate in short cycles

Agile development methodologies clearly allow shorter innovation and product development cycles, so it becomes easier to release new products faster. This is also what we see in the market: new versions of major technology projects are coming out almost every year. Robotics — not just drones in particular but all kinds of connected devices, equipment and machinery — are allowing us to make processes more automated and efficient than ever before. We already have fully automated factories and production lines in certain industries including FMCGs and mining, but we will see much more in the future.

We are driving these trends and also benefiting from them as they allow us to continuously remain at the forefront of the industry. By being able to innovate in very short cycles, we remain at the forefront of the drone and geospatial industry. We are constantly feeling the pulse of our customers, speaking with them and learning what works well and what new features they need to be able to become even more effective in their work.

> **We already have fully automated factories and production lines in certain industries such as mining; we will see much more in future**

Automation is driving the world

Knowing the location of assets is already a key requirement in many industrial processes. It allows reducing inventories, enables just-in-time logistics, warehouse automation, traffic avoidance and autonomous driving. With high accuracy GPS and precise indoor navigation, more automation becomes possible.

In future, we will have a higher degree of automation in all aspects of our daily life. From autonomous drones to autonomous vehicles to automated factories, we will also see construction sites without workers doing manual tasks over the years.

Drones have made aerial imagery affordable and easy to obtain, and as a result, have replaced terrestrial data acquisition in many cases. We expect to see continued adoption of high precision drones in the geospatial industry as well as in related industries such as agriculture, construction, mining, energy and more. Today, our technology allows customers to perform their work more efficiently than ever before. It saves them time and provides better results. While a lot of surveyors and customers have started to adopt senseFly drones, overall market penetration of drones is still comparatively low. As regulation becomes clearer and our technology even simpler to use, we will see an increase in the coming years.

"senseFly's eBee has given me **the best R.O.I.** of any surveying tool I own"

Prof. Tosa Ninkov Ph.D., Owner, GeoGIS Consultants

"This is great for surveyors … they can **spend less time collecting data and more time using it"**

Iain Allen, Senior Manager of Geographic Information Systems, Barrick Gold

WHAT ARE YOU WAITING FOR?

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Joe Drew, Director of Technical Services, Vista Sand

"The drone is the best money our survey department has ever spent"

Nick Kelly, Chief Land Surveyor, GRAHAM Construction

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"For a surveyor to get close to the same level of detail using terrestrial methods would probably take two to three weeks"

Aidan O'Connor, Managing Director, ASM Ireland

senseFly

RAJESH ALLA | CHAIRMAN & MANAGING DIRECTOR, IIC TECHNOLOGIES, INDIA

The Future is in IoT, AI, Robotics

Our lives today, and in the future, will necessarily pivot around the digitization of objects in the universe, through the efficient land, sea, and aerial surveys. The data collected will embed locational intelligence that will help us create maps with enhanced and meaningful spatial properties. These maps will form the substrate upon which the DNA of physical objects and their thematic properties will be seamlessly interwoven. The resulting rich datasets will become amenable to real-time analysis through Cloud computing that can be shared anytime, anywhere!

Temporal resolution of the data is going to be crucial for real-time and near-real time applications and thus controlled crowd sourcing with automated validation tools is bound to lead to more opportunities. Drones with improved payloads and endurance enable data acquisition and maintenance will lead to new areas such as geospatial inventory and resource management for increased productivity in various sectors such as agricultural crop management and warehouse management.

Automation and robotic operations will proliferate

Geospatial companies are striving to move up the value chain. Companies that started as collectors of spatial data found value in utilizing such data for analysis and delivering value-added services. For instance, IIC Technologies has moved up the value chain in the absorption of geospatial technologies and successfully delivered diverse projects worldwide, covering areas such as hydrographic surveying, 3D modeling and eGovernance solutions for smart cities, coastal zone management, and niche GIS-based applications.

Integration of geospatial with 4IR will essentially result from diverse sensor networks, miniaturizing of technologies, crowdsourcing, and use of social networks to collect real-time data on the one hand, and dynamic intelligent data processing and modeling on the other. The analyzed and filtered information will find wide-ranging decision support applications that will enable us to utilize natural resources optimally, and address the challenges of protecting our environment.

Opening doors to innovation

Automation and robotic operations will proliferate as never before. Predictive smart data analytics will be increasingly used both in businesses and the government, and eGovernance will become the norm in government administration across the world.

In the Indian context, the government initiatives, catalyzed through Digital India, provide an impetus to much-coveted smart cities program, skill development, Start-Up India and Make in India, which provides the geospatial industry an opportunity to excel and absorb emerging technologies.

On the marine front, the focus on establishing marine spatial data infrastructure, coastal zone and waterways management, biodiversity protection in the sea and productive fisheries, and above all, disaster management and climatic change studies, opens new vistas for hydrographic services.

The geospatial industry should become nimble to absorbing new technologies and methods, and the future is in the realm of IoT, deep machine learning, robotics, and artificial intelligence.

Integration of COTS and open source solutions in a seamless manner as a part of Geo ICT along with cyber physical systems will ensure enhanced security. After missing the bus in smart cities, geospatial should form the backbone for the next level 'smart habitat' concept.

> **Temporal resolution of the data will be crucial for real-time applications and controlled crowdsourcing with automated validation tools will lead to more opportunities**

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CLAIRE MILVERTON | CEO, 1SPATIAL, UK

These are Exciting and Challenging Times

These are exciting times for spatial data specialists. There are more devices producing more data more cheaply than ever before and that data is being put to more useful purposes as the value of geospatial data in underpinning effective decision-making is recognized. There are challenges too, of course. Geospatial data proliferates in a variety of formats, held in different places and of different — too often, unknown — levels of quality. Geospatial data is increasingly recognized as a valuable corporate asset and organizations across industries are taking a more structured approach to stewardship. Data management is therefore now being treated as an ongoing process rather than a one-off exercise so that valuable data is available for continued interrogation.

> **Making information available and ubiquitous, and lowering barriers to entry will require imagination and bringing together of many different technologies**

Organizations need to be able to rely on their data and be sure that their decisions are always based on the highest quality information available. Taking an automated, rules-based approach means even the most complex processes for the management, integration and manipulation of spatial data can easily be achieved and maintained. Today, with an ever increasing reliance on geospatial and location critical data, these really are exciting times for our industry and demand for our expertise has never been greater.

Innovations will drive competition

Stimulating greater economic productivity has brought into sharp focus the urgent need for increases in skills and innovation which will continue to drive competition in our sector in the next three to five years. The winners during this period will be those which successfully adapt to the new reality of bringing information of real currency and value to users and eliminating clutter. Making information more available, more ubiquitous and lowering barriers to entry will require imagination and the bringing together of many different techniques and approaches, both from within and outside our sector. The next generation of intelligent, location-enabled, information services is upon us and we look forward to being part of its delivery.

We adopt a whole business approach to fostering and leveraging innovation, from funding new R&D projects to understanding the capabilities and advantages of emerging technologies, to engaging with key clients on their digital transformation and innovation programs and providing thought leadership, to market research on the demand cycle in our growth sectors. By synthesizing all of these together we form a stable view of the investment road ahead.

User preference needs to be in focus

Geospatial data and technology will be progressively integrated with 4IR pillars to enable new classes of application. These new applications will leverage the users' preferences, habits and current context to provide new location-aware virtual assistants and other smart notification services which follow the user as they roam between environments and devices.

Next-generation apps will roam with the user, bring their data and services to them without being asked, and do this whether at home, in the car or in the office. Awareness of a user's situation and context including their location and the dynamic resources around them will become ever more important to being able to deliver the right information to them at the right time.

RISHI DAGA | CEO, EAGLEVIEW, US

Real-time Data is the Future

Nearly everything we do has a geospatial component. If you aren't utilizing location to understand what's driving or affecting your business then you are missing opportunities for either growth or process improvement, which other companies will eventually capitalize on.

Change will continue to accelerate in the geospatial world and it's important that companies learn to adapt rapidly. We will no longer have a year-long horizon of what's to come. Instead, there will be game-changing disruption to our business practices, but as difficult as that may be, we will surely see some incredible innovation stem from it all.

Find your USP

It is important to be focused and yet agile at the same time. As a company, EagleView is focused on what is it that makes us unique and ensuring that we continue to be the best and most innovative at that. At the same time, it's also just as important to listen to our customers and let them know that our core capabilities are delivering solutions that meet their necessities. For example, we saw the need for quicker, up-to-date data, so we adopted artificial intelligence into our process. Here at Eagleview, we are constantly evaluating our processes to ensure that data coming from the market is continually aligning with our core strengths to deliver great products to our customers.

> If you are not utilizing location to understand what is driving your business, then you are missing opportunities for either growth or process improvement

AI will empower geospatial ecosystem

Immediate, real-time data is the future. Artificial intelligence will continue to develop, especially as more sensors are added to replicate what humans are capable of doing today.

We will also see smart cars and smart homes (semi-autonomous devices) created using the above technologies improving and become more common place, allowing companies to gather even more data to specially target new products to those consumers.

As technologies like automation and machine learning improve, there could be a serious shift of economies away from the support of low level work to fully automated and autonomous machines. At this point, economies will have to adapt just as in the past ages when humans were replaced by machines during the agricultural and industrial revolutions. Privacy concerns about past and present locations are also important to consider here.

MARK JOHNSON
CO-FOUNDER AND CEO, DESCARTES LABS, US

The New Frontier in Sensor Data

The years ahead will be extremely transformative for the geospatial industry. There will be confluence of three major technological trends that are at the heart of this exciting era — the rapidly proliferating fleets of sensors, the maturation of commercial Cloud providers, and advances in machine learning and computer vision.

We see geospatial data playing a much broader and visible role. Industries that have traditionally harnessed geospatial data will see more use cases unlocked by new sensors and algorithms. But we can also expect geospatial data to become far more visible in new industries as well, including consumer, health care, robotics, personal transportation, and beyond.

Overcoming barriers for innovation

Traditionally there have been barriers to accessing geospatial data, and these have slowed innovation. Recently, advances in managing large datasets such as satellite imagery and distribution made it feasible for organizations to look for opportunities to leverage geospatial data. As they discovered value, they sought to push the boundaries as to what can be done, and this meant bringing capabilities in house. However, the technology landscape will continue to evolve. Cloud computing and machine learning are trends that help leverage large data sets of all types, and geospatial is not an exception.

The key to staying relevant is to experiment, discover value, and act quickly to harness new ideas. This rapid cycle of innovation can be aided by tools. The best tools aren't those used by a single person, but that enable collaborative experimentation. The hallmarks of these tools are cheap iteration, on-demand data and elastic computing resources, robust management of experiments, and ability to track successes and failures. The goal is to move from experimentation to a product offering that offers significant value, and to do so quickly at a cost commensurate with the value of the output. Companies that prioritize innovation, adaptation, and efficiency will win over those that focus on a static array of products.

Fusion is the future

Recently we have witnessed machine learning and artificial intelligence thriving. The new frontier is sensor data, which enables models of the physical world. In the next three to five years, new commercial and public satellites will increase resolution, observation cadence, spectral density, and introduce RF, SAR, and other modalities. Every day at Descartes Labs, we discuss disruptive applications that would be possible if the right sensors were available. The good news is that those sensors in most case are already scheduled for launch.

I think the industry has woken up to the fact that a huge opportunity exists to fuse different types of data — both sensor data and other data modalities (such as social) into a single computational environment. It is the coupling of different datasets that will unlock analytics that surpasses what has been available in the past.

> Geospatial data will become far more visible in new industries such as consumer, healthcare, robotics, personal transportation, and beyond

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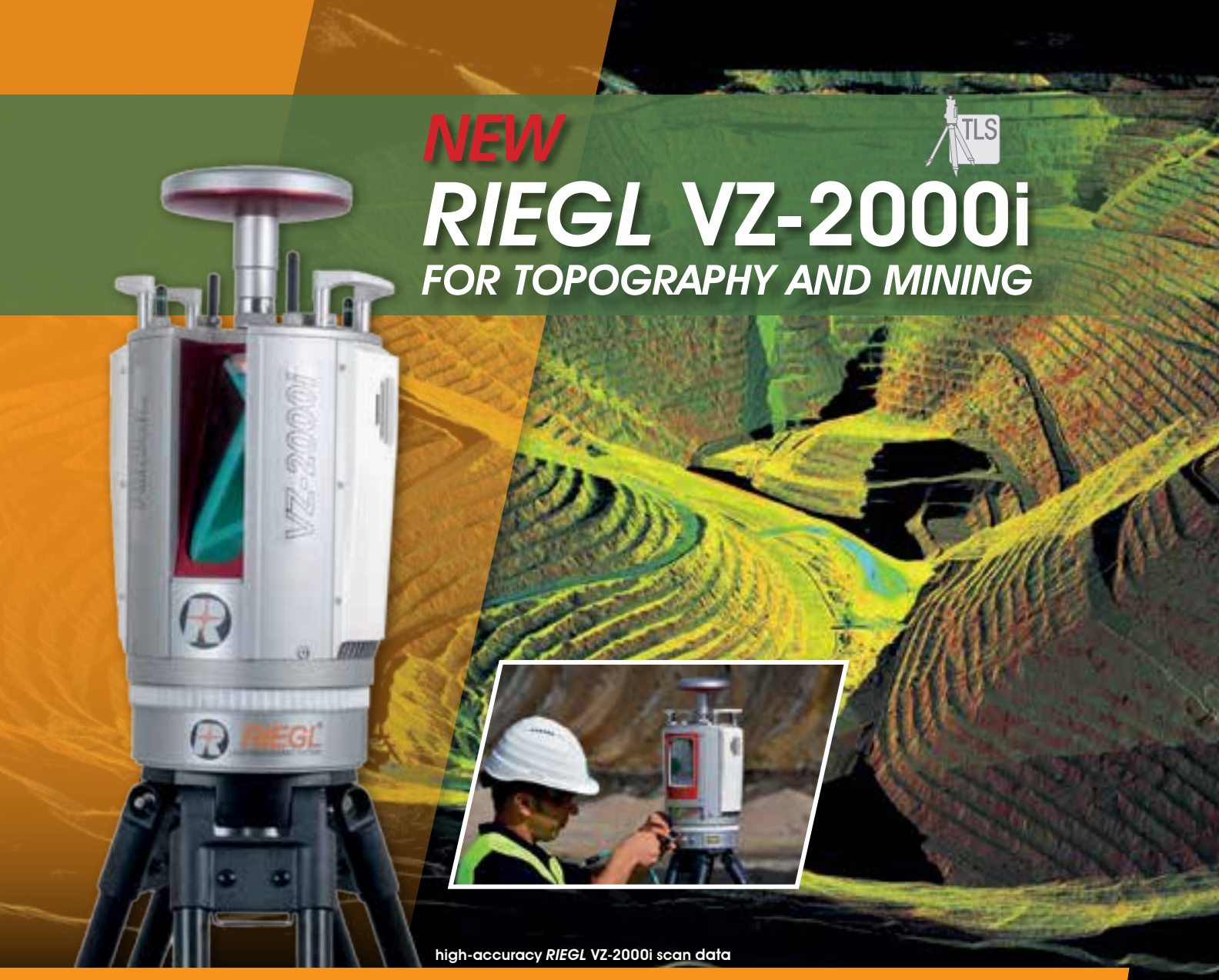

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KATHERINE BRODER | PRESIDENT, GEOMAX, SWITZERLAND

4IR is a Strong Driver

The smarter and ongoing integration of geospatial and 4IR will strongly impact the business and decisions on country levels going forward. It's key to deliver accurate and precise information in real time to reduce waste and inefficiencies. Legislation will follow soon to institutionalize even stronger.

Organizations need to keep the customer as the key priority. We are strongly driving differentiation to ensure we keep the customer in focus and achieve development in the different market segments. We will continue to manage the stretch of developing high tech systems, usable and efficient for the end user.

> **Being able to master geospatial and mapping, data analytics either directly or indirectly will be a key to success going forward**

Usability is of utmost importance

All our future products are designed to strongly support our vision to make geospatial, real time data accessible and digestible (usable) for our customers. With our GeoMax X-PAD software solution which wraps around all our sensors we fully tie into the digital world. Our customer base has grown and is embracing our software and all the data analytics that come with it due to its user friendliness. We have built our software structure directly with users to ensure we cover all the needs from the base. Our strong focus is on customer experience — the journey any of our target customers have with GeoMax every day.

The 4IR is a strong driver and with it the growing need of people and economics towards real time, accurate information and communication. Being able to master geospatial and mapping, data analytics either directly or indirectly will be a key to success or even to stay in the business going forward.

DR STEVE MARSH | FOUNDER & CTO, GEOSPOCK, UK

More Data, Less Focus on Mapping, More Contextual Understanding

Geospatial analysis is the key to understanding context; once the context is deciphered in real time, outcomes can be influenced and optimized. For the geospatial industry, availability of GPS chips in every mobile device has been the single biggest technology gamechanger in recent times, opening up immense multi-sector opportunities. The prevalence of vast amounts of geospatial data naturally is a relatively recent phenomenon and we are now understanding the incredible value that can be derived from this data. However, extracting this value is very difficult and many companies are looking to acquire geospatial capabilities to rapidly bring new solutions to market. We see a massive growth in geospatial data and with it a new range of products and services which are contextually tailored for each user.

> **We see a massive growth in geospatial data and with it a new range of products and services which are tailored for each user**

Current solutions are very expensive to run and hard to use effectively. However, we see this as a big opportunity and our approach is to democratize geospatial analytics capabilities and remove those barriers to innovation. We know that the amount of real-time contextual data that is being generated is only going to get bigger, so as a company we are always building towards an extreme-scale data processing solution which is going to be crucial in capturing the full value of the data and enable next-generation use cases.

There is massive amount of upside and new business opportunities for those who are able to effectively extract the value from the underlying data so make sure you have systems in place which can scale and allow swift innovation.

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MIKE WINN | CEO, DRONEDEPLOY, US

Democratizing Geospatial Data with Drones

The geospatial industry has seen innovation in three key areas in the last few years—satellite, drones and artificial intelligence. Most notably, these technologies have become more accessible than ever before due to advancements in the technology itself, and the costs associated with it. This has opened up new opportunities for the industry and its customers, making geospatial data a key part of everyday business workflows and decisions. More and more companies are creating software that relies on geospatial data because it's how we interact, operate, and engage with the world around us.

Before the Internet, computers were isolated, and location determined much of what was possible. Today, we are connected to everything and communicating more than ever before. This allows us to monitor and measure more frequently. If you can measure everything, you don't have to check on it—you can just act. The location of things is also becoming more accurate. The next generation of GPS will be accurate within centimeters. This, combined with a robust IoT network means that soon drones will be able to move about automatically and collect information on their own. No longer will ground stations or checkpoints be needed to capture data in different locations.

> **Drones have unlocked the ability for anyone to capture aerial data, create maps, generate models, and make decisions from that data**

Drones have unlocked the ability for anyone to capture aerial data, create maps, generate models, and make decisions from that data. To date, accessibility was the largest blocker to wider adoption in the geospatial industry. Now companies of all sizes can leverage geospatial data to generate actionable insights to power their businesses. Businesses and governments alike are able to make smarter decisions faster than ever before. Drone data and software is easy to use and can provide unprecedented value to every industry.

Lower cost and adoption barriers

Consumerization of technology has reduced the time it takes for a new product to be adopted. Consumer technology like smartphones, tablets, and drones have made their way to the enterprise quickly because they present a lower cost and adoption barrier from being produced at scale first for the consumer market. Consumer-first tech gets integrated rapidly and therefore evolves just as fast as the initial adoption.

To date, DroneDeploy customers have mapped more than 25 million acres of drone data on our Cloud-based platform. We are using this data repository to better understand customer needs and improve our product through the application of AI, computer vision, and machine learning. This has enabled us to simplify workflows, lower costs, and drive productivity for our customers. A recent example of this is our new self-serve ground control point (GCP) workflow. We reduced the time it takes our customers to upload and tag GCPs by leveraging machine learning to identify ground markers automatically—making it possible to produce survey-grade drone maps in minutes, not hours.

We are just seeing the beginning of what's possible with drones. In the next three years, we expect drones to be present in almost every industry, operating autonomously on schedules to produce highly accurate data in real time.

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RSI SOFTECH with its parent company RSI is a 33 years old company and a leading provider of GIS, Remote Sensing, GPS LIDAR, GPR and UAV hardware and software products and related services to clients in India, UAE, Nepal, Bhutan and Bangladesh. RSI SOFTECH business encompasses software development, sales, technical support, training for numerous geospatial applications, custom geo applications development, project consulting services, software product sales and marketing.

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Chennai the First Indian Metro to go for complete city 3D Modelling using the Drone Technology with the approval of concerned authorities. Watch the Video by scanning the QR code.

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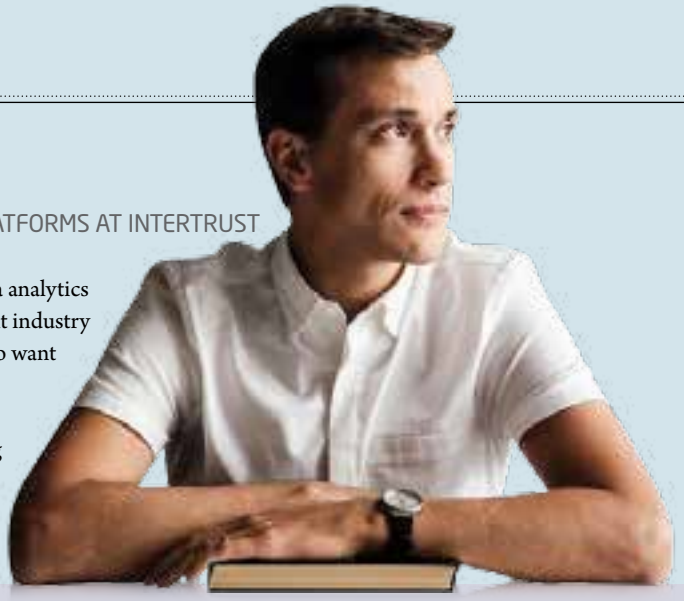


RAINER STERNFELD | FOUNDER OF PLANET OS, GM OF DATA PLATFORMS AT INTERTRUST

Integrating Geospatial into Workflows

Software and Big Data-driven platforms have made geospatial applications available for almost everyone. The best example is the GPS ability included in almost every smartphone. On the enterprise level, the abundancy of satellite derived geospatial data, together with Cloud-based Big Data applications, has made Big Data analytics available for everyone, making it industry standard for the companies who want to stay in competition.

The nature of the geospatial industry and its focus is shifting along with the embracement of the Big Data technologies across various industries.

> The nature of geospatial industry and its focus is shifting with the embracement of Big Data technologies across industries

In sync with the trend

The acquisition of Planet OS and its products is a good example of how the importance of geospatial technology is acknowledged across different industries. Planet OS Datahub is aiming to be one of the key data platforms within the geospatial industry, making it easy to access and use any relevant weather, climate, and other environmental data.

Companies need to become more data-driven and therefore secure, interoperable data governance will become a key aspect in virtually any internet-connected device that has a location attached to it.

BILL BROWN, CEO, MATTERPORT, US

Robust Analytics Fosters Growth

Spatial analytics provides insights into how people engage with real world spaces at scale. We are able to draw out interesting details about how to engage with a space, where users are spending most of their time, and what objects in the space they find the most interesting.

More and more companies across all industries are being met with increased demand to incorporate robust analytics into their offering in order to compete. At Matterport, we recognize our customers' need for analytics tools to better understand their business. We are constantly innovating our technology to ensure we stay at the forefront of the various trends. We want users to have the flexibility of being able to utilize the right mix of field systems depending on the project requirements, ensuring they can always use the best tool for the job.

We are excited to be part of the next generation of 3D reality capture technology and have taken the approach of merging 3D modeling and 2D imaging into a new media form.

> The Fourth Industrial Revolution continues to evolve as physical elements and digital elements fuse together to create something new, both real and digital

Achieving more with AI

We are making major investments in deep learning and AI over the next few years. Given our technology's ease of use, speed of capture, high visual quality, and automated processing, the geospatial industry stands to see increased productivity and efficiency in future.

The Fourth Industrial Revolution continues to evolve as physical elements and digital elements fuse together to create something new, both real and digital, impacting not just businesses but entire economies worldwide. We are excited to be developing technology which fuels 4IR.

LILY XU | CEO, SPACE VIEW, CHINA

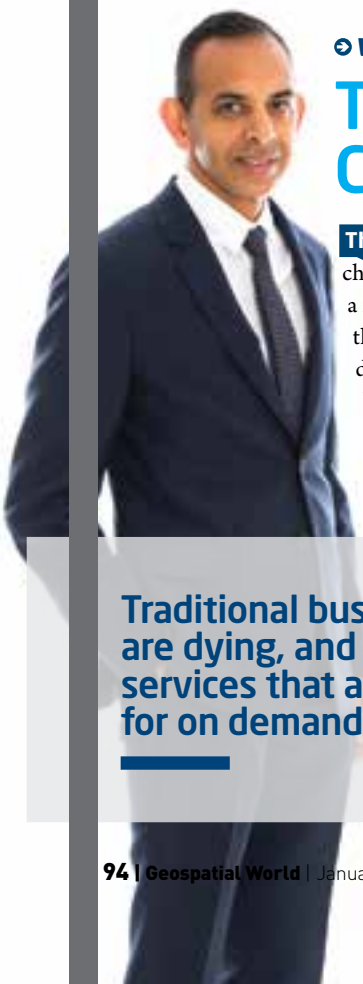
Location has become Essential for Businesses

The vertical market is excavating the "application" technology. Remote sensing information has been used in various vertical markets as reference information for decision makers. If we explore deeply, we will find more chance in each vertical market and meanwhile to take the advantage of Big Data/Cloud/mobile device to integrate the remote sensing information or location-based data into daily operations of the industry. Geospatial information must be converted from "reference" to "mandatory".

The cross market is accelerating the "information extraction." Currently, the information extraction is mainly relying on manual vectorization. It is the main barrier for the industry development. AI could open the door of industrialized information extraction. It will push Beijing Space View convert from satellite imagery distributor to geospatial information provider.

The industry is promising, and the approach is challenging. Big Data, Cloud, AI, etc. will bring both opportunity and change.

Information extraction is main barrier for industry. AI could open the door of industrialized information extraction



WILLY GOVENDER | CEO, DATA WORLD, SOUTH AFRICA

The Future is Both Challenging & Positive

The world has changed, the way we communicate has changed — the demand for instant information is now seen as a right and not a privilege. Business houses need to adapt to this change. This means rethinking our business models, and deliver outcomes based platforms to customers. Traditional business approaches are dying, and platform-based services that are used for and paid for on demand will lead the way.

LBS and AI require accurate and real-time data which provides exceptional competitive advantage to businesses. As the demand for more consumer-centric services aimed at improvement of citizen and customer satisfaction levels increases, governments and businesses are being forced to ensure real-time access to data. Therein lies the opportunity for geospatial and 4IR to be optimized to meet this requirement. Typically, in areas such as transportation, utility services, on-demand retail shopping, these technologies are impacting the way we traditionally have done things.

Traditional business approaches are dying, and platform-based services that are used for and paid for on demand will lead the way

At Data World, we are developing mobile-based services and gearing towards XAAS subscription-based revenue models. Additionally, we are also looking at how some applications can be made free to use.

The future is both challenging and positive. The explosion of IoT devices will be the greatest challenge as we will have to choose the appropriate technologies to meet the various applications out there. Governments have been slow to adapt, and therein lies the opportunity for disruption that should be grabbed by the private sector. This will lead to some consolidation in the businesses as the scale of rollout will require massive investment and integration and aggregation of technologies.

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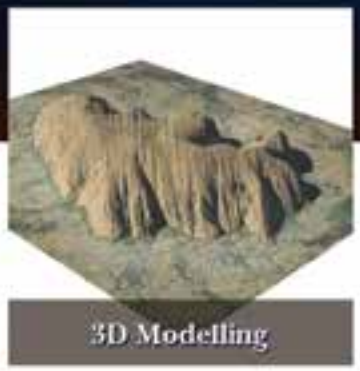
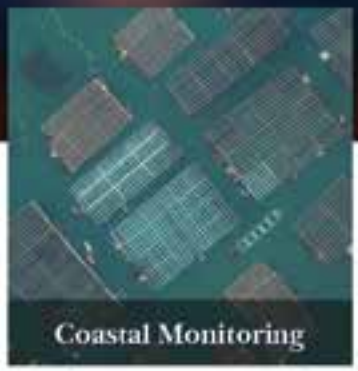
- More follow-on satellites join in the constellation up to 2022, ensuring continuity of Earth optical imaging services up


3D Modelling


Coastal Monitoring


City Planning


Smart Agriculture

About the Company

Space View is a leading provider of remote sensing satellite data and geospatial information services. The company business covers optical and SAR satellite imagery, data processing, value-added products, solutions, software and GIS platform. As the operator of SuperView, not only does Space View manage the imaging services, but also promotes construction of direct-receiving and virtual stations around the World.

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MICHEL STANIER | EXECUTIVE VICE PRESIDENT AND GENERAL MANAGER, TELEDYNE OPTECH, CANADA

Disruptions are Both Threat & Opportunity

The rapid expansion and commoditization of 3D imaging technologies, resulting in ubiquitous geolocation and interconnectivity, can enable not only the automation of individual activities, but also mutual awareness and collaboration among robots performing various tasks. This is already happening within many production plants and is expanding into open environments, thanks to robotic vision/sensing and increasingly sophisticated, constantly learning algorithms. Artificial intelligence, 3D sensing/imaging, interconnectivity, Cloud and, of course, robotics are all foundational technologies for the

Location is critical for letting the digital world get to work with the physical world. Many industries, such as manufacturing, transportation and logistics are already embracing these radical changes. Governments, in turn, are being forced to deal with these technological advances in areas such as regulations and legislation (e.g., UAVs, autonomous vehicles, workplace safety) or with drastic changes in urban/infrastructure planning and management.

Democratizing geospatial industry

A great deal of innovation in the geospatial industry has come from within, but external drivers such as UAVs or autonomous vehicles have also created a new type of demand for geospatial data and spurred further innovation and disruption. LiDAR has gone from an arcane, very niche technology to being a critical part of the broad consumer market in a very short time, thanks to 3D printing and the push for autonomous vehicles. In the process, they are pushing LiDAR manufacturers to radically reduce size, weight and power consumption of their instruments. This is democratizing the geospatial industry, and driving innovation at both ends of the spectrum — high-accuracy data over national-scale areas, as well as low-accuracy local data at a very low sensor price.

As with any technological disruption, disruptions in geospatial domain create both a great threat and a great opportunity — just read Clayton Christensen's *The Innovator's Dilemma* to see how threatening, even deadly, disruption can be even for very strong, established players. And the pace and extent of disruption nowadays is much greater than it was 20 or 30 years ago. However, the positive side is that the demand for all types of geospatial data is rapidly increasing, so there is undoubtedly a great opportunity as well for the companies who are nimble enough to embrace or, if possible, drive these disruptions.

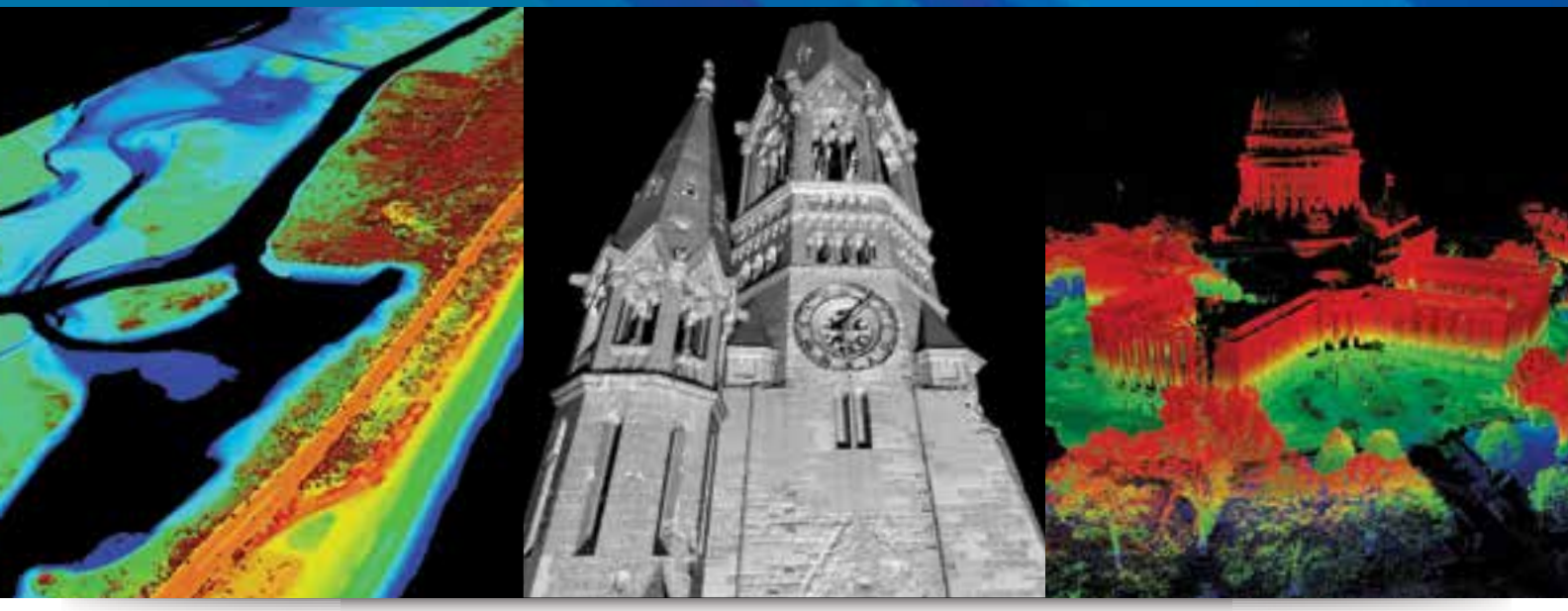
Geospatial industry is moving in the same direction as every maturing market — users are looking for end-to-end solutions

Demand for well-integrated solutions

The geospatial industry has been moving in the same direction as every maturing market, i.e., users are starting to look for end-to-end, well-integrated solutions. For sensor manufacturers, this clearly creates a challenge. Teledyne Optech has been working to meet customer expectations by integrating third party software into our processing software so as to provide a single interface to the user. We have also partnered with downstream software providers to offer a seamless data transfer through a loose integration. Finally, with the acquisition of Caris, Teledyne is enabling us to provide a complete, compelling workflow in the bathymetry market segment.

There is no doubt that product lifecycles are getting shorter, and this is a source of concern for many service providers. Competitive technology innovation and new entrants are driving companies like us to accelerate and expand our innovation roadmap. We are also looking beyond traditional market segments and partnering with innovators to co-develop new products quicker than before. To successfully execute this challenge, we are redefining our product development and production processes and are investing in better collaboration tools to more effectively engage partners within and outside.

OVER 40 YEARS OF LIDAR TECHNOLOGY LEADERSHIP



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RICHARD BLAIN | CEO, EARTH-I, UK

In This Era of Change, Location is a Critical Pillar

Rapid growth in the types and diversity of sensors available to collect data — from ground sensors, to drones, to rapid advancements in satellite technology — and the application of machine learning and AI is set to radically change the way geospatial data is used.

The increase in demand for location-based services, and the need to analyze, understand and interpret geospatial data from many different sources, plus the urgent need to address fundamental environmental and economic challenges on our planet, shows how critical a pillar location is in this period of change. Just think of the revolution automated cars will bring and the importance of location in realizing that opportunity. Or the importance of location data in analyzing and understanding critical supply chains and energy security. There will also be a radical increase in the application and usage of social, mobile, analytics and Cloud (SMAC) and location data to power a wide range of analytics, insights and new governmental and commercial services.

There is not a single industry today that is not touched by geospatial. We have also seen information technology companies and large industrial houses developing own geospatial capabilities or acquiring companies with mapping or spatial analytics abilities. This trend is driven by the increasing need to anchor data analytics and insights into a geospatial framework. Customers are increasingly turning 'data agnostic', and looking for analytics and insights, not the raw data or imagery. As data and technology becomes more affordable, intelligent platforms are developing fast to deliver data as a service and insights-ready products.

Inevitably, the geospatial industry must adapt to and adopt the technological changes. Partnering and collaborative working have long been a part of our industry, but new commercial opportunities and greater innovation will inevitably accelerate the need for more collaboration.

The geospatial industry is already on the threshold of a transformation and I think the reason is a mix of the industry innovating from within and the impact of new ideas and start-ups from outside. Many of these start-ups have come from within the industry rather than completely fresh from outsiders. Earth-i itself is a collaboration of outsiders and industry experts.

Small satellites a big game changer

In the earth observation space, the single biggest technology game changer in recent times has to be the change in the economics of commercial space brought about by the radical reduction in the size and cost of EO satellites. This enabled us plan to build a large constellation of small EO satellites. The Earth-i constellation — first to offer full-color, full-motion video — will collect high resolution imagery with high frequency revisits to anywhere on Earth, and rapid tasking and download of data in near real time.

Together with the development of our analytics and insights platform, utilizing machine learning and AI, this stream of high spatial and temporal resolution data will enable the application of planetary Big Data to unlock powerful insights about our planet for a wide range of industry sectors and governments.

> Collaborative working have long been a part of our industry, but new commercial opportunities and innovation will inevitably accelerate the need for more collaboration

Our outlook is very strong and carefully planned. We are set to deploy the first batch of five satellites next year. It is a hugely exciting time in our industry; we expect growth to be rapid in the technology, the applications and in the types of customers for data and derived insights.

JEFF YATES | GENERAL MANAGER, DAT/EM SYSTEMS INTERNATIONAL, US

Knowing 'Where' is Essential

Any AI being or cataloging system needs to know "where" they are in the world. This location data can assist all businesses and governments in optimizing their production or maintenance and ultimately help make important business decisions.

IT and engineering firms are some of the groups that can benefit the most from adding location to their workflows. IT companies are moving a lot of data around to various hubs and they are also managing users and servers in different locations. Engineering firms have enormous amounts of infrastructure that they build, manage and inspect. By visualizing this data in their real, 3D, physical location, it makes management easier and ultimately saves time.

Rapidly changing technology is going to benefit those individuals and businesses that can adapt, re-educate, choose the right course and ride the wave of new technologies. Higher wages and a higher standard of living will come to those who adapt and train for the future.

Technology is ever evolving

As technology itself changes so do the entry points to geospatial technologies. Take basic photogrammetry for example. Decades ago the hardware to produce a photogrammetrically compiled map was so specialized it required specially trained technicians to install and calibrate 'analogue'. By contrast, a modern, PC-based digital photogrammetric stereoplotter, both hardware and software, can be installed in a couple hours by a reasonably trained IT person.

Similarly, UAV technology for mapping purposes has already become a lower-cost alternative to traditional aircraft so that engineering firms that used to contract for their flying are performing that function internally. In the process they are saving the cost of hiring a manned aircraft and bringing new revenue to their firm. VR is another exciting new technology that holds tremendous opportunities for both the entertainment and engineering communities.

> **IT and engineering firms are some of the groups that can benefit the most from adding location to their workflows**

As the use of geospatial information spreads to other industries, there will be an ever-increasing requirement for the software to keep improving due to customer demands and expectations. DAT/EM serves its 500 plus clients in more than 70 countries by building and maintaining valuable systems, staying alert to industry trends and advances, and always leading by example with quality products and services. We hope our clients and partners will join us in embracing the 4th industrial revolution and leading the world to utilize location data in responsible and thought-provoking methods.

DR SAMANTHA LAVENDER | FOUNDER & MD, PIXALYTICS, UK

Geospatial is Moving Beyond the Experts

The combination of a significant increase in the available geospatial data, improved Cloud computing for storage and processing together with the introduction of machine learning has resulted in a significant step change for the geospatial industry.

We are in an age dominated by computers, with our everyday lives entwined with them. One factor which is omnipresent within the 4IR is location. All of the developments and applications within the 4IR will have location as a fundamental component along with Cloud computing, Big Data, artificial intelligence, machine learning, augmented reality and robotics. We should stop putting ourselves into silos – you don't need to be an expert to work with geospatial data, and many who use the data will never consider themselves as part of the geospatial industry. However, this doesn't mean experts aren't important and so we need to share knowledge that in turn allows us to better understand the requirements.

> Geospatial is moving beyond the expert community, resulting in significant effort and developments outside the traditional geospatial community

Geospatial is moving beyond the geospatial expert community, through its adoption within many applications or technologies linked to smartphones, resulting in significant effort and developments outside the traditional geospatial community.

ALEXANDER WIECHERT | CEO, VEXCEL IMAGING, AUSTRIA

Location Integral to Businesses

Geospatial has become an important aspect in many business or applications outside of its core world. This requires for geospatial companies to look over the fence for co-operations and vice-versa, and makes non-geospatial companies add geospatial to their portfolio. If it is important for your business, you either rely on partners or get the knowledge in house through own development or acquisitions. And big companies tend to own key technologies to control and adopt them completely.

> If it is important for your business, you either rely on partners or get the knowledge in house through own development or acquisitions

We have always offered non-stop solutions and we will continue doing that. We can't let the customer dealing with the bits and pieces on his own and let him figure out how it works in his application. Innovation was always key for us at Vexcel and we just recently have launched new programs to address hot topics such as high definition maps or smart cities. With our current company structure, we are in a great spot: small enough to stay nimble and big enough to go after big tasks. Geospatial is great industry with huge potential.

DR MANOSI LAHIRI | FOUNDER, ML INFOMAP, INDIA

Location is Everywhere, but is Unobtrusive

A host of technologies such as IoT, artificial intelligence, robotics, nanotechnology, 3D printing has unleashed a technological revolution. Also, miniaturization, faster computer processing and broadband network expansion are playing a big role in all this. As these technologies mature, they will have great impact on the agriculture and food habits, climate and environment, medicine and health, and much more. I believe all that is identifiable as local and regional will be better understood in the Fourth Industrial Revolution. To be pragmatic in preparing for the 4IR, we must begin to align with businesses that complement in capabilities and resources to better face the changes when they come.

> Google has shown the remarkable ability to use geospatial to dominate; this has more to do with its business model than innovation

Google has shown the remarkable ability to use geospatial to dominate; this has more to do with its business model than innovation. Today, location information has penetrated all spheres of our lives, but in an unobtrusive way. Till recently, before the advent of Cloud platforms, IT and engineering companies had to share internal data with geospatial companies to generate maps and reports. And this was usually a situation that these companies did not want. Today, that is changing, and you will find many big companies developing their own geospatial capabilities.

JOHN ALLAN | VP, SALES & MARKETING, GEOSLAM, UK

Geospatial Information Affects Everybody

People now realize that geospatial information affects everybody in all aspects of their life — home, work, on the move — right down to the individual level. To stay relevant, the industry needs to stay agile and able to take advantage of the new technologies as they appear.

In times to come, smartphone platforms will become more common, making everyone into a sensor, able to capture data and transfer it seamlessly into a Digital Twin representation of the real world. Impact will be down to how people embrace apps that benefit them and the rest of the world. The geospatial industry needs to gear up accordingly.

Focus should be on usability

If the geospatial industry continues to build highly technical products for specialists, it will have little impact at the global level. There is obviously still a need for the specialist data collection/creation tools, but the massive growth will be in those areas where that data can be converted to usable knowledge rapidly so that non specialist can make decisions where geospatial data is just one input.

Our approach is to bring in consultants who are specialists in those areas to advise and help us implement new processes both internally and for customer engagement.

We currently are focused on data collection and we see a rapid move to non-specialists being able to collect and use 3D data.

> The industry needs to keep it simple – focus on the benefits to the end user and make the best use of the new technologies

BRIAN L. SOLIDAY | CHIEF REVENUE OFFICER, aWHERE, US

Everything is Some Place

The advent of open source geospatial tools that allows cross-organizational sharing of tools and technology, rapid acquisition of high resolution satellite and drone imagery, and IoT device proliferation, has made geospatial intelligence the foundation for many new technologies, and extended the reach for many others. I believe we are already seeing rapid changes in how organizations incorporate geospatial into their daily workflows. The new licensing mechanisms and SaaS are pushing all technology providers to rethink how they interact with, and provide to, their ultimate end customers. The consolidation of several major players and acquisitions has been disruptive for both customers and business partners.

We have already seen a significant technology disruption in the 21st century, but today it is quite different. In the previous industrial revolutions, societies and individuals had extended timeframes to adapt to the changes presented to them. Today, however, the change is universal and immediate. It arrives in Ghana, Brazil and the US all at once, with limited time-lag. Today, the incorporation of geospatial technologies into business and government services can be fast-tracked and achieved with limited downside.

I see the continued expansion and proliferation of smart devices, especially across the developing world. This extension of sensor networks and the resulting increase in access to a broad base of content will provide access to a much broader community of potential geospatial intelligence users.

In previous industrial revolutions, societies had extended timeframes to adapt to changes, but today the change is immediate

WOUTER BROKX | PRESIDENT, IMAGEM, BENELUX

Coordinates are the Universal Building Blocks

Location intelligence is merging with multi-source data and other IT systems to produce concise and streamlined solutions. It is no longer considered to be only used in the geospatial domain, rather it is a used as a building block to solutions. Citizens have become sensors and governments are responsible for the environment. Location is what enables both worlds to connect, sharing not just information but knowledge through communication. With the integration of geospatial and 4IR in governments, decision-making and policy implementation will become much more streamlined and easy to monitor.

Soon, information systems will be required to evolve in knowledge systems, and develop from descriptive in predictive. Although artificial intelligence will play a crucial role, the basis will be formed through collaboration between systems using interfaces. This will allow the software components to communicate seamlessly and systems to develop even further into prescriptive and cognitive to increase efficiency and profitability.

The geospatial industry has to learn to shake off its legacy. The systems in geospatial that embrace changes in the larger IT landscape will have a bright future, becoming part of a much larger ecosystem. Location in time is the only way to being relevant.

Location intelligence is no longer considered to be only used in geospatial domain; it is used as a building block to solutions

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