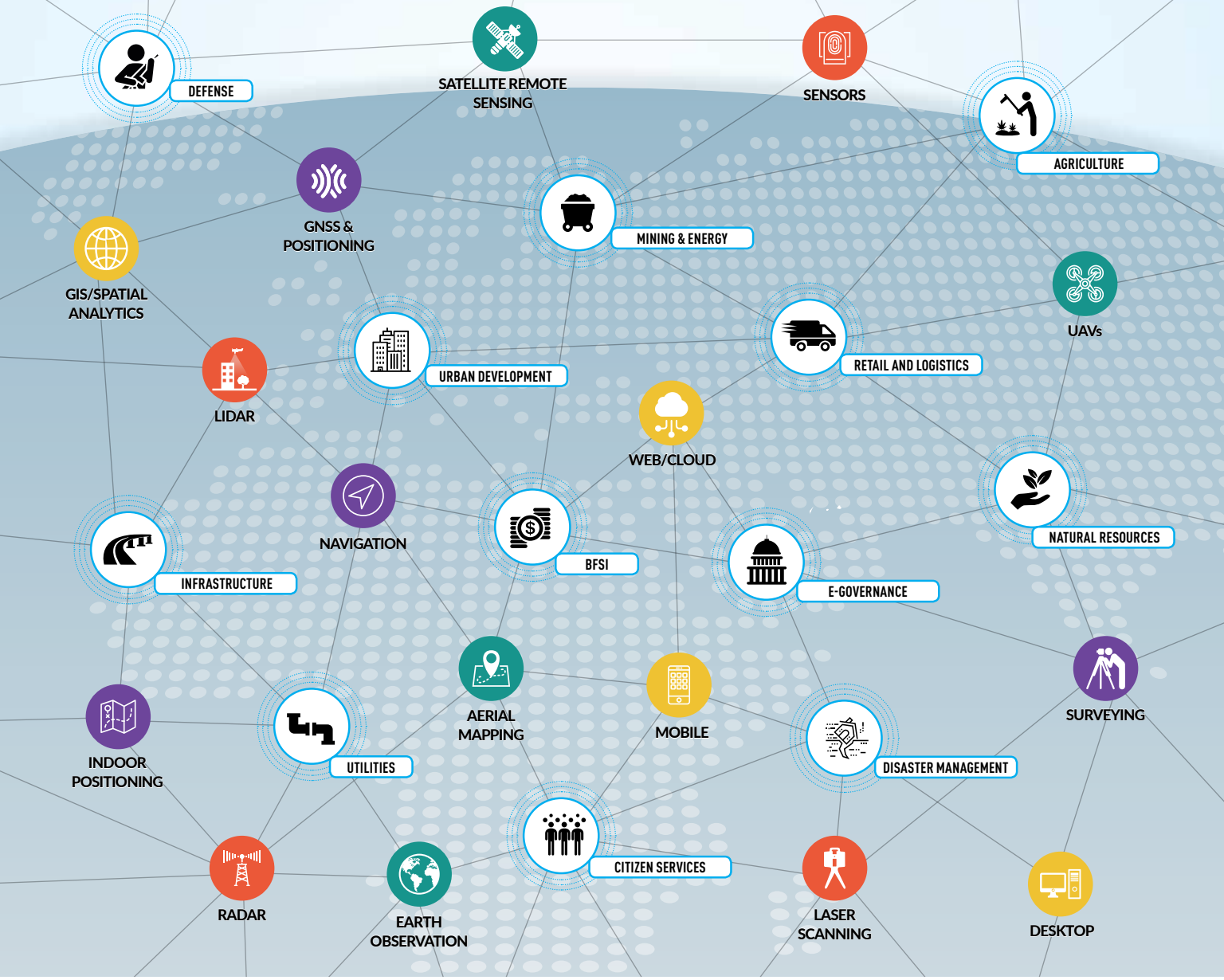
2018 Edition

GEOBUIZ

Geospatial Industry Outlook & Readiness Index



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Foreword

Geospatial Industry: Finding Mainstream in 4th Industrial Age

World economy and the markets go through fundamental changes periodically. However, they take a different course of direction each time, while aligning themselves with a revolutionary shift. Today, as global markets enter the Fourth Industrial Revolution, they are strongly driven by digitalization and interconnectivity.

The geospatial industry, in a nascent stage for decades, suddenly finds itself aligning with the mainstream market, adding spatial dimension and locational context to digital infrastructure, interconnected systems and business processes. The last five years saw a paradigm shift in the geospatial market. Technology innovations like Cloud, IOT, Big Data, Artificial Intelligence and Blockchain played multiplier roles in expanding the business portfolio of the geospatial industry, bringing in significant attention and investments from mainstream IT and Engineering Markets, and encouraging a host of startup entrepreneurs.

Mainstreaming of the geospatial market has created a big demand for geospatial content and solutions across governments, businesses and consumers; it has also helped scale up applications and value to much larger markets, amplifying overall impact and contribution of geospatial information in the world economy and society. Returns on investment get bigger and better with every added application and consumer. Though the geospatial industry has been growing at an average 14% CAGR, its economic impact on global GDP has been growing to the tune of 18% CAGR. Advent of a collaborative environment is giving a new paradigm to the geospatial business, opening possibilities of end-to-end solutions, system integration and platform technologies. Geospatial content, which remains at the core of collaboration, is fast becoming ultimate driver of evolution towards the solution orientation of the industry.

On the pathway ahead, geospatial readiness would lead to development strategies at national, regional and global levels. Key tenets of national and global geospatial frameworks and strategies would include ICT infrastructure, policy frameworks and institutional capacity.

International studies have established that geospatial readiness is a key enabler of digital innovation, contributing significantly to overall GDP directly as well as through optimizing efficiency and cost effectiveness of the fundamental pillars of the economy, namely infrastructure, energy, agriculture, financial services, retail and logistics, climate and environment, etc. With an estimated market size approximating US$ 300 billion, the geospatial industry is likely to grow between 15 to 20% CAGR over the next few years, touching almost US$ 500 Billion by 2020. Major growth is expected from Asia, probably equal to the North American market by 2020.

As we move forward, the geospatial industry is likely to get more and more commercialized and integrated with IT processes and engineering workflows, probably redefining its scope and business models, creating a few business casualties in the short run, but offering a much broader role and relevance in the Fourth Industrial Age.

Sanjay Kumar
CEO, Geospatial Media and Communications

Executive Summary

GeoBuiz - 2018 presents the geospatial industry market report and comparative assessment of 50 countries for their geospatial readiness to the global audience from industry, government, academia, development sector and other stakeholders at large.

The geospatial industry market report captures the global size, growth and value impact of the global geospatial industry till year 2020, along with key insights on technology drivers, business models, top user sectors, user benefits, major adoption challenges etc., as a whole, and for its four major technology segments which are GNSS and Positioning Technologies, GIS/Spatial Analytics Technologies, Earth Observation Technologies and 3D Scanning Technologies respectively.

The report brings forth a collective and harmonised view on the geospatial industry's global market size and value impact, its distribution across markets, geographies and industry segments on the 2013-2020 timeline. The data and estimates captured are from multiple markets and impact studies, which have been published in recent times catering to specific segments and aspects of the geospatial industry at national, regional and global levels.

To provide an integrated view which can be used with ease and referred to objectively, multivariate data analysis techniques has been used to draw intelligence and inferences in a meaningful way. The analysis from these multiple reports brings to light historical growth rate of the industry at 11.5 % (year 2013-2017), with a projected growth rate of 13.6 % up to 2020 (year 2018-2020).

Globally, the geospatial industry market is witnessing unprecedented growth in all geographies with high double-digit growth in the Asia Pacific, Middle East, Africa and South African regions, riding on demand from emerging market geographies. However, overall engine of geospatial industry growth as well as its readiness (Countries Geospatial Readiness Index -18) to meet current and future leadership remains with North America. This region will continue to maintain its market dominance riding on proactive initiatives to enhance commercialisation within the industry segments, (especially in the EO upstream value chain), and innovation led economic development model. At the same time, the growth in Asia Pacific economies is something to watch out for in comparison to European markets (in relative percentages). While the former has demographics and demand drivers favouring long-term higher growth rate to surpass European markets comfortably in the 2020-2025 scenario, the latter will remain a significant market and solutions provider at a global scale.

The key industry trends and drivers for the geospatial industry and its various segments have been captured from multiple focus group discussions, electronic surveys and interviews with industry leaders across industry segments, users, system integrators, solution providers in Geospatial, IT and Engineering domains. Together with the market size

and growth analysis; key industry trends present a wholesome perspective on geospatial industry and its value proposition to the global audience.

The second part of the report, i.e., Countries Geospatial Readiness Index (CGRI)-2018 presents the assessment of select 50 countries for their geospatial readiness, (current as well as future). The appraisal framework uses five assessment pillars: (i) Geospatial data infrastructure; (ii) Geospatial and enabling policy facilitation; (iii) Geospatial domain education and research institution capacity; (iv) User adoption levels at organization levels; and, (v) Geospatial industry capacity, i.e., industry strengths, representation and venture creation support eco-systems. The comprehensive framework has evolved on the first assessment exercise last year, i.e., CGRI-2017.

Data collection, analysis and an assessment framework with relative weightages has been made more comprehensive and refined for accuracy in capturing the comparative strengths and weaknesses at the national level.

The purpose and approach of CGRI-18 is to enable decision makers (both public and industry stakeholders) with actionable insights to (a) develop an integrated approach on advancing geospatial technology eco-systems crucial to maintaining competitive advantages globally and; (b) deliver better geo-enabled services to citizen-consumers.

CGRI-18 is not a ranking exercise but a tool to assist the development of a holistic outlook for framing a national geospatial strategy in tandem with advancing digital technologies. To help easy understanding, countries have been grouped as 'Leaders', 'Challengers' and Aspirers' in each of the evaluation index pillars with comparative insights, highlights accompanied with market geography- wise infographics.

On CGRI-18, the United States of America (USA) stands on top as the most geospatial ready country in the world leading in all five pillars of the evaluation framework. While developed economies in general lead on geospatial readiness, it is the group of emerging economies under 'Challengers' which hold the promise for 'future market growth' commensurate with the extent to which geospatial industry solutions will be strategically deployed to address the socio-economic development challenges in these countries.

Geospatial being the only technology capable of establishing interactions and inter-linkages between Bio-Physical, (i.e., geography and natural resources), and social elements (human civilization), over time and space, holds the key to efficient delivery of socio-economic benefits, taking governance to the last man across national economies. The effective use of its transformational potential rests on a proactive and integrated approach at individual nation levels.

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List of Abbreviations

AEC – Architecture, Engineering and Construction

AI – Artificial Intelligence

AR – Augmented Reality

BIM – Building Information Modelling

BFSI – Banking, Finance and Insurance Sector

C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance

CAGR – Compound Annual Growth Rate

CGRI – Countries Geospatial Readiness Index

EO – Earth Observation

ESA – European Space Agency

EU – European Union

GSDIA – Global Spatial Data Infrastructure Association

GAGAN – GPS-aided GEO Augmented Navigation

GIS – Geographic Information Systems (GIS)

GLONASS – Globalnaya Navigazionnaya Sputnikovaya Sistema

GNSS – Global Navigation Satellite Systems

GPS – Global Positioning Systems

IoT – Internet of Things

ICT – Information and Communications Technology

INSPIRE – Information for Spatial Information in Europe

IPS – Indoor Positioning

ISO – International Organization for Standardization

ISRO – Indian Satellite Research Organization

ISPRS – International Society for Photogrammetry and Remote Sensing

ITS – Intelligent Transportation Systems

HTS – High-Tech Strategy

KAAS – Korea Augmentation Satellite System

LEO – Low-Earth Orbit

MEO – Medium-Earth Orbit

MEMS – Micro Electro Mechanical Sensors

MTSAT – Multi-functional Transportation Satellites

NAVIC – NAVigation with Indian Constellation

NMA – National Mapping Agencies

NSDI – National Spatial Data Infrastructure

OGC – Open Geospatial Consortium

R&D – Research and Development

ROI – Return on Investment

SBAS – Satellite Based Augmentation Systems

SLAM – Simultaneous Location and Mapping

S&T – Science and Technology

UAVs – Unmanned Aerial Vehicles

UNGGIM – United National Global Geospatial Information Management

VR – Virtual Reality

WAAS – Wide Area Augmentation System

GLOBAL GEOSPATIAL INDUSTRY OUTLOOK

The geospatial industry market report brings forth a collective and harmonized view on the digital ecosystem, global geospatial industry's market size and value impact, its distribution across various markets, geographies and industry segments over the 2013-2020 timeline. The report categorizes the geospatial industry into four major technology segments which are GNSS and Positioning, GIS/Spatial Analytics, Earth Observation and Scanning Technologies respectively. With respect to these technologies, the global market size, regional market size and growth, technology drivers, industry segment drivers, recent technology and business innovations, benefits and challenges have been assessed. Furthermore, the report also brings out relevant trends of partnerships and acquisitions happening across and within the industry segments.

Research Methodology

The "Global Geospatial Industry" section of the report covers the industry landscape, market size, value impact, user benefits, drivers and challenges in the following five sections:

Global Geospatial Industry	GNSS & Positioning Technologies	GIS/Spatial Analytics Technologies	Earth Observation Technologies	3D Scanning Technologies

This section of the report can further be categorized into two sub-sections: a) geospatial industry dynamics and b) geospatial market size and its value impact.

Geospatial Industry Dynamics

The geospatial industry dynamics section captures top technology drivers, key end-use sectors, user benefits, challenges, upcoming business models, recent innovations, latest business trends, etc.

To collect information on all of the above, the research team at Geospatial Media conducted primary and secondary research. Under primary research, online surveys and face-to-face interviews were conducted with the following:

Product companies	Solutions providers	System integrators	Service providers	Consultants

To collect information from secondary sources, the team mapped the details of 51 companies (both geospatial companies as well as IT companies) to identify the trends in inter and intra-industry partnerships, collaborations and M&A activities. The following sources were used for this exercise:

Company websites	Press releases	Annual reports	Case studies	Independent analysis reports

Geospatial Market Size and Value Impact

The market size of the geospatial industry and its four technology segments (GNSS & Positioning, GIS/Spatial Analytics, Earth Observation and 3D Scanning) has been calculated primarily by collecting market estimate available in the secondary domain, breaking them down for individual technology segment and region, and then making suitable changes to present the holistic spectrum of geospatial technologies.

In the first phase, our team collected insights from the publicly available research reports and their press releases that provided the data points for specific technology segment/sub-segment and regions. These insights were used to understand the perceived market size of the several components of this industry, since most of these reports address only a specific technology segment or product. Similarly, for estimating the impact value of geospatial technology on the overall economy, first its impact on major economic sectors was estimated through secondary research. After aggregating them, the overall impact was estimated.

In the second phase, the research team conducted a focused bottom-up and top-down analysis for the market size and its impact value estimates to minimize variations.

In the third phase, the team conducted extensive consultations with industry thought-leaders and consultants to identify and address any loopholes in data collection and its further processing.

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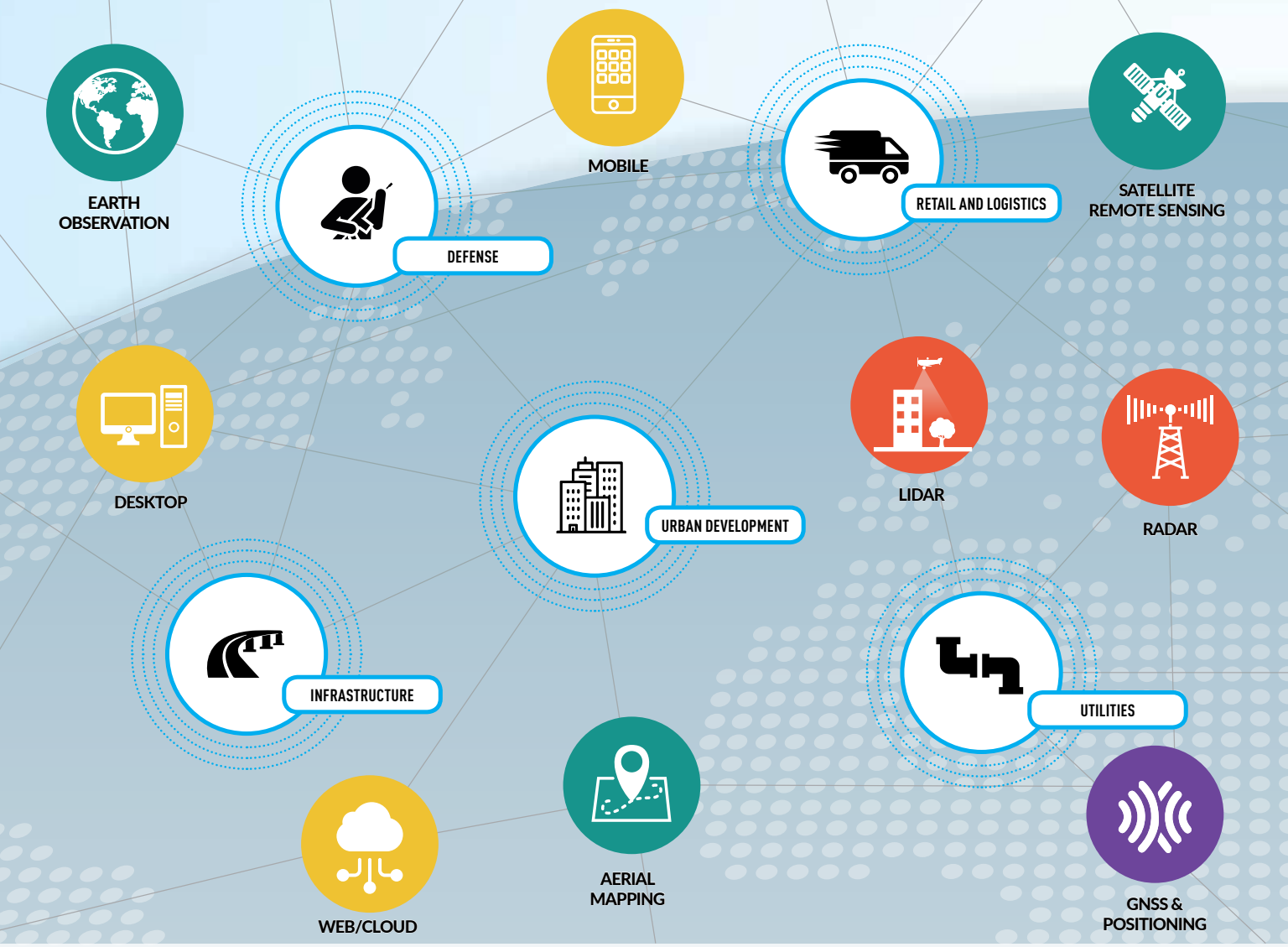
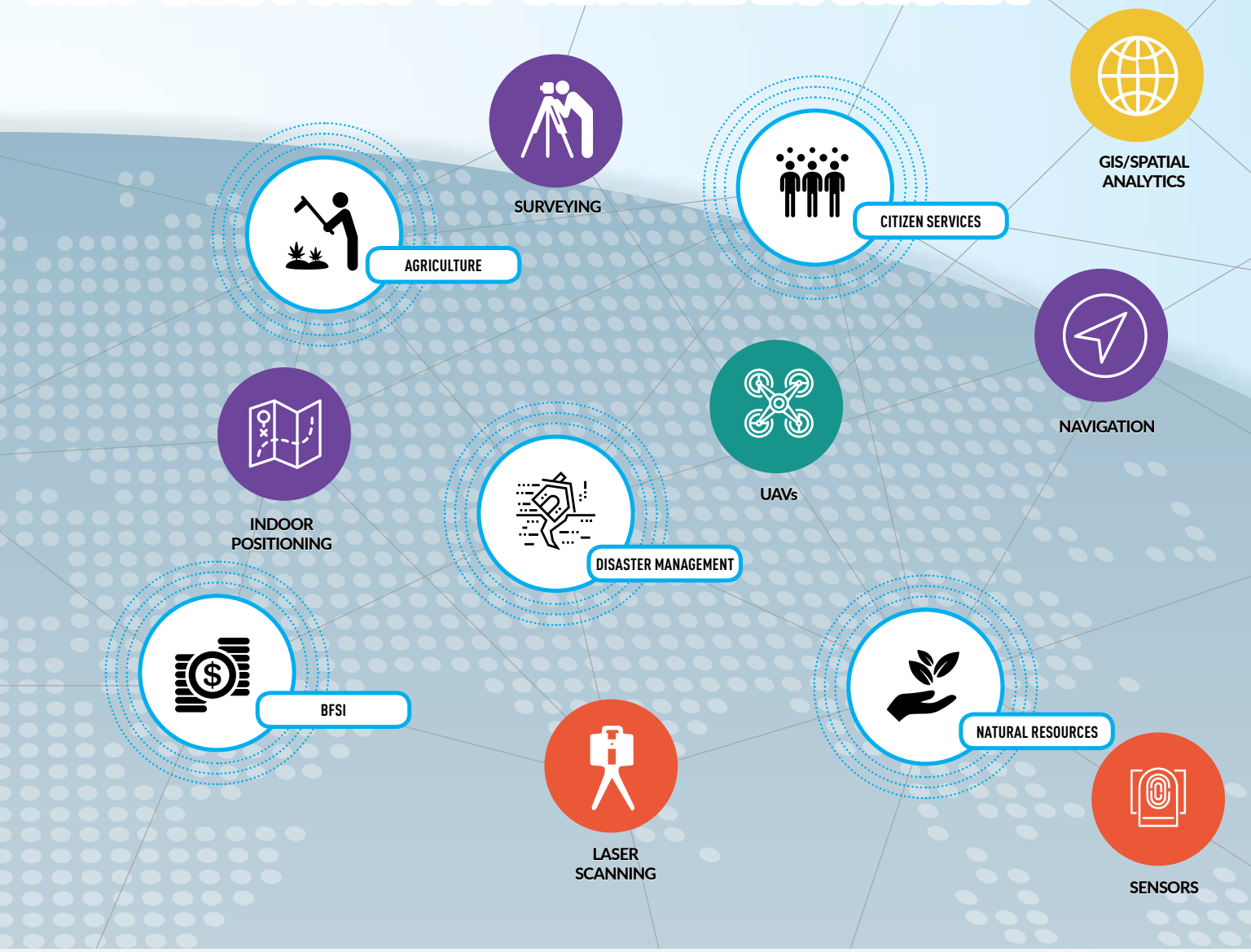


Technologies accelerating Geospatial Industry Growth

	Big Data	Cloud
Current Impact	Some of the technologically agile sectors such as BFSI, Smart Cities, Retail & Logistics and advertising have already started to harness Big Data for more targeted outreach.	Cloud computing is providing a range of benefits to organizations of all sizes in terms of lower investments in data storage, processing and ease of sharing.
Future Imperatives	As the amount of spatial and non-spatial data being captured increases from the network of smart devices, new business models and services will transform the way we interact and transact.	It will play a crucial role in emergence of platform technologies and business models that would greatly impact the market of analytics, e-commerce, navigation, engineering, etc., wherever data has a spatial dimension.

KEY SECTORS OF GLOBAL ECONOMY



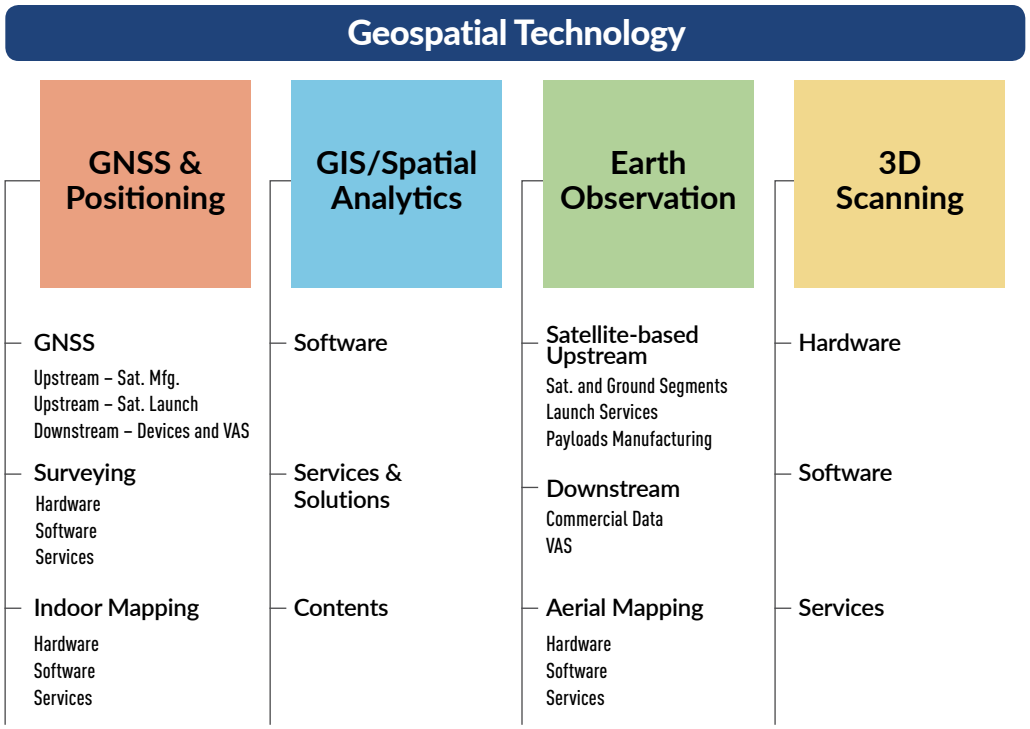
Artificial Intelligence	IoT	Wireless & Broadband
AI is helping us discern patterns and trends from huge sets of structured and unstructured data, flag events requiring attention, and take programmed actions.	The world of over 8 billion connected devices is growing at a rapid pace providing better and more streamlined information in consumer and business environments.	The entire gamut of ICT and geospatial technologies and wireless & broadband applications is playing a vital role as the backbone of today's digital ecosystem.
Expected integration of the AI with geospatial technologies will pave the way for better workflow automation, process and project management.	Exploitation of the location data component from IoT systems are dramatically impacting the market of geospatial technologies, especially GIS/Spatial Analytics and GNSS.	Its impact on empowering citizens is expected to expand further in the future as the developing countries prepare the necessary infrastructure to bridge the digital divide.

Geospatial Industry Overview

Industry overview and composition

The geospatial technology ecosystem is a complex entity with multiple interactive components. These technologies have evolved over many years and are broadly segmented into four categories: GNSS and Positioning, GIS and Spatial Analytics, Earth Observation and 3D Scanning. Encompassing various other technologies, these four segments are the key components of the geospatial technology ecosystem.

Figure 1.1 – Constituents of Geospatial Technologies



Source: Geospatial Media Analysis

→ **GNSS and Positioning:** A constellation of satellites, the Global Navigation Satellite System (GNSS), transmits signals from space to users with a compatible device to determine their position, velocity and time. Used in a number of applications, the GNSS industry is a composite of GNSS upstream and downstream markets, the surveying market and the fastest growing, the indoor positioning market. The GNSS upstream component comprises of entities that build the satellite infrastructure and the ground systems; the downstream segment includes products and services that use GNSS chipsets, system integrators and value-added service providers.

Surveying: Today, GNSS rovers and chipsets are revolutionizing surveying, making it cost effective, reliable and user friendly. The technology is being increasingly adopted by surveyors globally as GNSS provides position and precision accuracy, reduces field time to cover large areas, and provides accurate positional solutions in real-time.

Indoor Positioning: Indoor Positioning System (IPS) is a system to 'locate' objects or people inside a premise using radio waves, magnetic fields, and other sensory information.

→ **GIS and Spatial Analytics:** Geographic Information Systems (GIS) or spatial analytics is a system that is designed to capture, store, manipulate, analyse and interpret data relationships, patterns and trends. Available to consumers as software, GIS is categorized into three types: Desktop GIS which runs on a personal computer; Web/ Cloud GIS which allows the user to use the software on Cloud; and Mobile GIS which enables user to use GIS on a smartphone or a tablet.

→ **Earth Observation:** Earth Observation is a technology used to map the surface or the earth from above or from space. This includes remote sensing satellites and aerial mapping. The Earth Observation market is primarily composite of satellite-based upstream, downstream and aerial mapping.

The satellite-based upstream market is inclusive of satellites and ground segments manufacturing, launch services and payloads manufacturing. The downstream segment includes commercial data services and value added services (applications). The satellite segment is growing with Smallsat and Nano-satellites shaking the traditional earth observation market.

Aerial mapping is the mapping of the earth's surface from aircrafts, UAVs and other flying objects. Topographic mapping, contour mapping, site mapping, etc., are being carried out through aerial surveys. New UAV technologies are expected to boost the aerial mapping segment further in the coming years.

→ **3D Scanning:** The Scanning technology segment is currently the fastest growing segment comprising of LiDAR, Radar and Laser technology. These technologies are used to digitally capture the sphere of physical objects and environments by creating 'point clouds', of data from the surface of an object or data about the surroundings.

Integration of business processes with geospatial information going to drive the future of the industry

Geospatial Industry in Digital Ecosystem

As we usher in the age of the digital world, the relevance of geospatial information and technology continues to build on its growth momentum, adding spatial dimensions to all business processes. The traditional silos segmenting geospatial functionalities are being dissolved, with more and more spatial integration driven by digital technologies. This integration is shortening the time lag between data capture, processing, analysis and delivery of a unified picture of the real world. As the digital world empowers the geospatial ecosystem, and vice-versa, there shall be new opportunities, productivity improvements, and cost savings to realize.

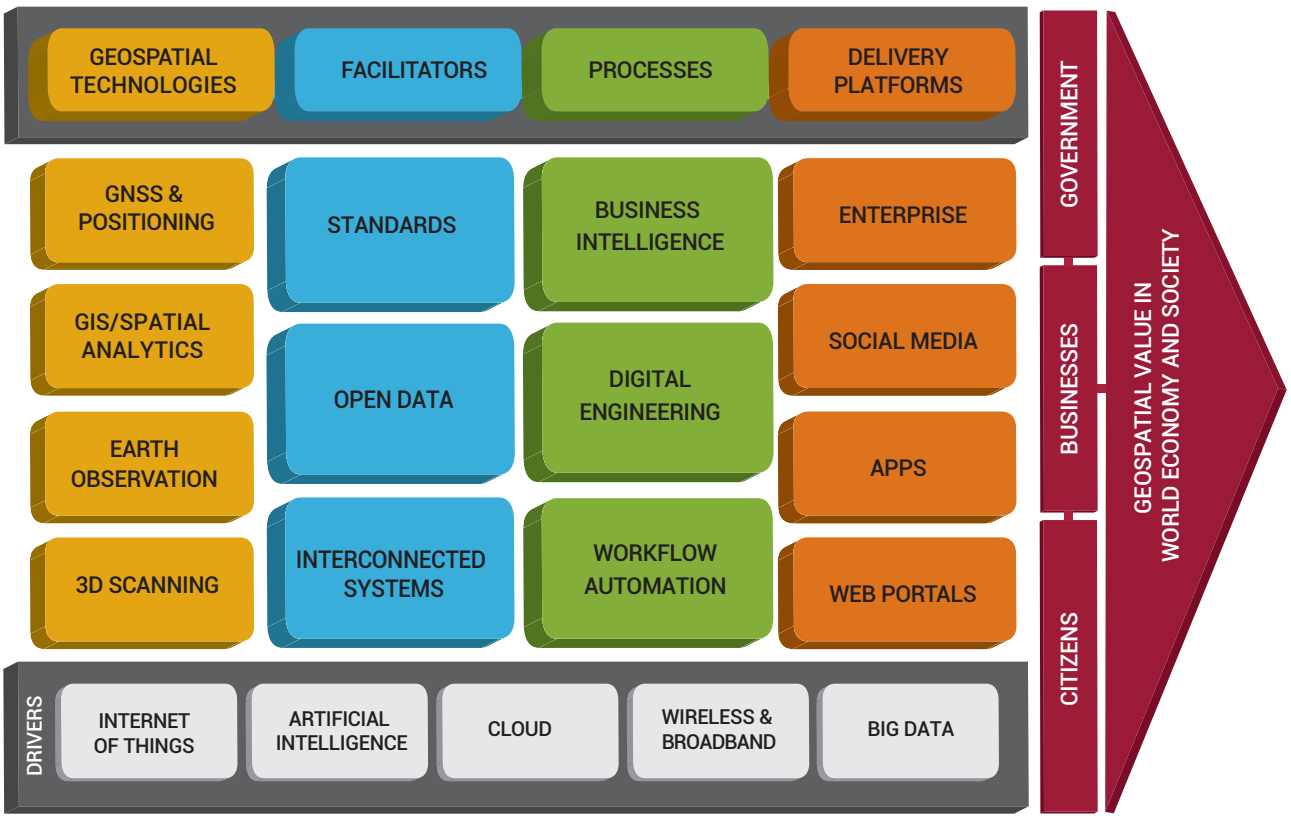
Technology breakthroughs such as Internet of Things (IoT), Artificial Intelligence, Cloud, Wireless & Broadband and Big Data are fundamentally altering the governance,

socio- economic interactions and business paradigms. These digital 'fabrication' technologies are empowering the assimilation of spatial information into existing business processes, enhancing overall understanding and comprehension of complex socio-economic environment for better results.

In the digital ecosystem, spatial data collection and analytics happens through the four geospatial technology segments, namely, GNSS and Positioning, GIS and Spatial Analytics, Earth Observation and 3D Scanning. For effective and widespread use of spatial information and analytics across user segments, it is necessary to keep them open i.e., accessible and usable to the best possible extent. Open data (both spatial as well as non-spatial) facilitates innovative usage of information to develop value added services and other applications. Furthermore, well-defined geospatial data management and analysis standards address the interoperability and redundancy issues with different datasets increasing overall efficiencies and effective utilisation for the stakeholders.

The digital world is enabled by a number of interconnected systems, acting as key facilitator of collection, processing and communication of georeferenced dataset. It is critical that different subsystems are integrated seamlessly to deliver the maximum value of location insights efficiently on time.

Figure 1.2 – Geospatial Industry in Digital Ecosystem



Source: Geospatial Media Analysis

Once a competent dataset has been derived, these are integrated in processes for business intelligence and workflow automation in real time. With cutting-edge technology drivers in support, integration of spatial information with business processes enables better business insights for decision making, effective management and monitoring of processes and stakeholders, also improving customer service (both internal and external).

Spatial technology is increasingly being embraced by the Engineering-Construction sector. Digital Engineering (most commonly known as BIM), builds 'visual world scenarios' by integrating data of building/engineering design with real-world spatial and non-spatial data. Digital Engineering enables efficiencies in complex project designing to execution stages in streamlining workflows and modelling scenarios. Workflow automation processes transform business activities from manual systems to centralized, automated structure to improve efficiency, reduce costs and promote operational excellence to support the needs of the digital world.

Finally, geospatial solutions deliver value to the end-users through multiple platforms such as enterprise systems, social media, apps and web portals. These end-users comprise of governments, citizens and businesses. The adoption of these technologies and solutions by these consumers brings huge social and economic impact to the society at large.

Geospatial market is expected to grow at 13.6% during 2017-20, significantly faster than the growth rate of 11.5% during 2013-17

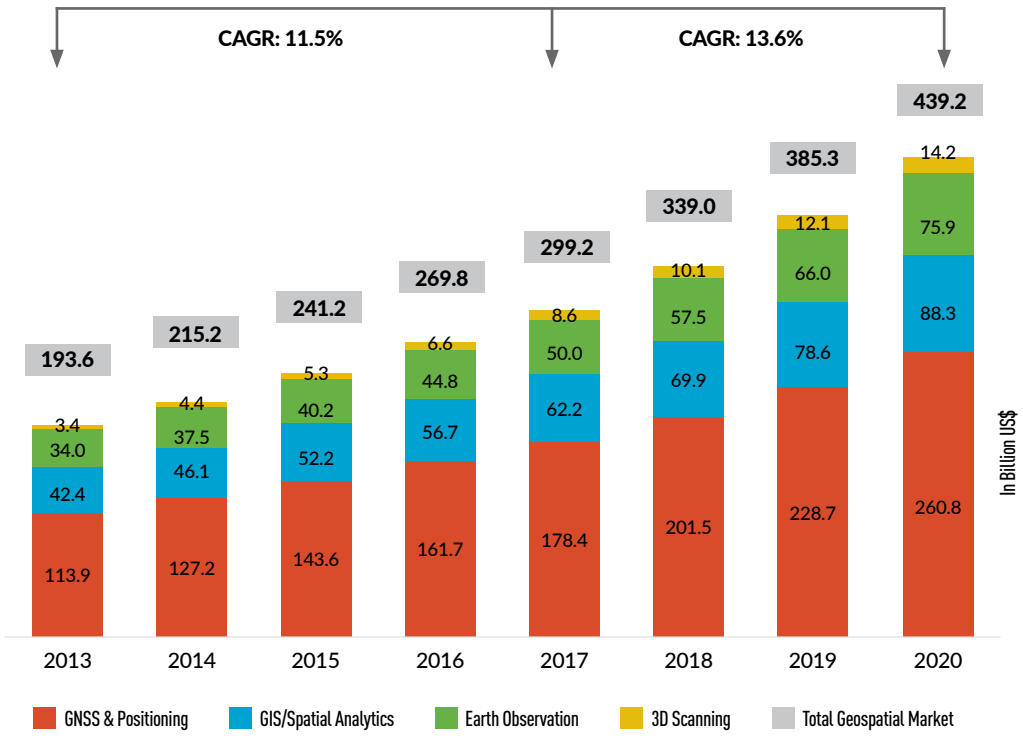
Global Market, Impact and Drivers

Global Market: Size and Growth

→ The cumulative geospatial industry was valued at an estimated US$ 299.2 Billion in 2017 and is projected to reach US$ 439.2 Billion by 2020, growing at a CAGR of 13.6%. This rapid rate of growth is an acceleration from the CAGR of 11.5% observed between 2013 and 2017. This growth acceleration can be accredited to the continuous technology advancements in the industry, democratization of geospatial information riding on integration with advancing digital technologies and resultant innovative business models.

→ GNSS and Positioning Technologies, the most fundamental set of tools that enable the rest of the geospatial industry, accounted for an estimated 59.6% of the total geospatial market in 2017 and it is expected to maintain its share in the global geospatial industry during the forecast period (2018-2020). The growing demand for location-based information, proliferation of mobile devices (i.e. mobile phones, tablets, etc.) and the burgeoning need of GNSS devices in various industry segments such as Agriculture, Aviation, and Intelligent Transportation Systems are the key drivers of the GNSS and Positioning segment.

Graph 2.1 – Geospatial Technologies: Global Market Size



Source: Adapted from Market Research Reports available in public domain (list available in the references section) and Geospatial Media Analysis

→ The market size of the second largest geospatial technology segment – GIS/Spatial Analytics – is expected to grow at a CAGR of 12.4% during the period 2017-2020 as it finds growing adoption in city planning, utilities management, e-governance, applications, retail and logistic sector, disaster management and various other applications. More and more business data integration with location information across enterprise level functions, engineering-construction-infrastructure sectors graduating to using spatial analytics, deepening integration of Big Data with GIS, the Spatial Analytics industry is poised for greater growth by the demand for adding location context to data.

→ The Earth Observation industry, estimated to be worth US$ 50.0 Billion, is expected to reach US$ 75.9 Billion in 2020, growing at a CAGR of 14.9%. With the Smallsat and Nanosat revolution in full swing, shift towards high-resolution and near-real-time data offering and expansion of value-added services, the demand for EO-data is set to increase significantly over the next three years.

→ The surging acceptance of 3D Scanning in Architecture and Engineering, Automobile and Aerospace Designing, the integration of indoor and outdoor spatial data environments is driving market growth of the 3D Scanning segment. The global 3D Scanning market is expected to reach US$ 14.2 Billion by 2020, registering an impressive CAGR of approximately 21.3 % during the forecast period of 2017-2020, thus rendering it as the fastest growing segment of the geospatial industry.

EO and Scanning are expected to emerge as the fastest growing segments

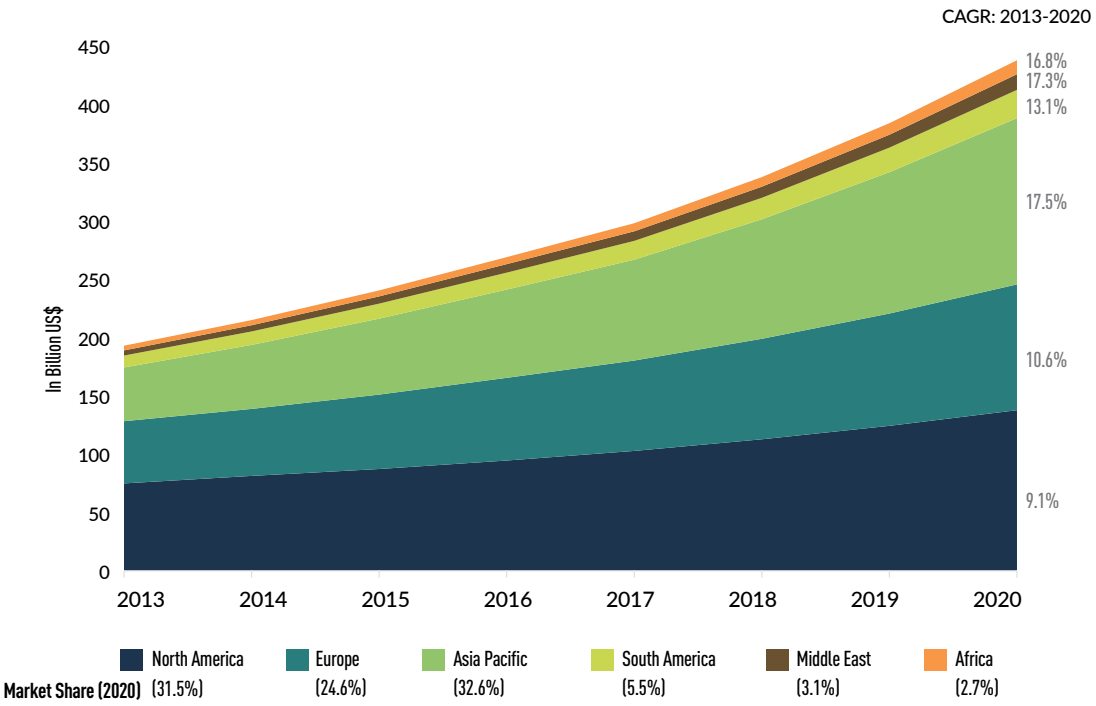
Regional Markets: Size and Growth

While globally the geospatial industry continues to gain relevance and maturity, and the overall market is expected to grow faster during the forecast period, the growth of the industry is not distributed equally across different regions. The regions with emerging markets are expected to grow significantly faster than those with relatively mature markets. However, what is most striking is how profoundly the market share in various regions will shift in the coming years.

→ The Asia-Pacific region is going to be the fastest growing region (in absolute market value terms) for the geospatial industry, while Africa is expected to grow at the fastest rate. The demand for geospatial data and services in these regions is going to be driven by sharp expansion of the user base – aided by numerous initiatives being taken by the governments in these regions to bridge the prevailing digital divide with respect to the developed countries.

→ The Asia-Pacific market is expected to grow at a healthy CAGR of 18.2% during the period 2017-2020, increasing its market share from 29.0% in 2017 to 32.6% in 2020, overtaking North America. China and India are considered to be the lands of opportunities in this region, owing to their huge populations, fast-growing economies and relatively lower levels of adoption of geospatial technologies at present. Singapore, Australia, New Zealand and Japan are some of the advanced countries in this region where adoption of geospatial information and technology by the user community is at an advanced stage.

Graph 2.2 – Geospatial Market: Region-wise Growth



Source: Adapted from Market Research Reports available in public domain (list available in the references section) and Geospatial Media Analysis

North America and Europe will lose some of their market share as growth slows down in the future

→ The North American region is the largest geospatial market at present, with an estimated market share of 34.5% in 2017. The market is expected to grow at a CAGR of 10.2% between 2017-2020 with advancement and integration of technologies being the main drivers of the market growth. As the 'location' component gets embedded in every sphere of the economy, the North American market will be one of the foremost beneficiaries driven by its strong institutional capacity, robust infrastructure, mature policy framework and advanced user adoption level. With the USA and Canada primarily leading the world in innovations, the region is also likely to continue to witness emergence of new ventures in upcoming technology areas, leading to enhanced utilization of geospatial information.

→ The European region has an estimated market share of nearly 26.0%, with a market size of US$ 77.7 Billion in 2017. The market in this region is expected to grow at a lower-than-average rate of 11.7% between 2017 and 2020. Its overall market share is estimated to marginally shrink to 24.6% by 2020. One of the key drivers for the market in this region is expected to be the integrated use of geospatial information for workflow management to deal with all aspects of urban and infrastructure planning and management to achieve higher levels of productivity and efficiency.

→ With an estimated CAGR of 16.8% and 17.3% between 2013 and 2020 for Africa and Middle East respectively, there is going to be a sharp increase in the usage of geospatial information and technology in these regions. However, despite the high growth rate, the market share of these regions is not likely to see major changes since the base value is low. At the end of 2020, Africa and Middle East are expected to have a market share of nearly 2.7% and 3.1%, respectively.

Technology Drivers

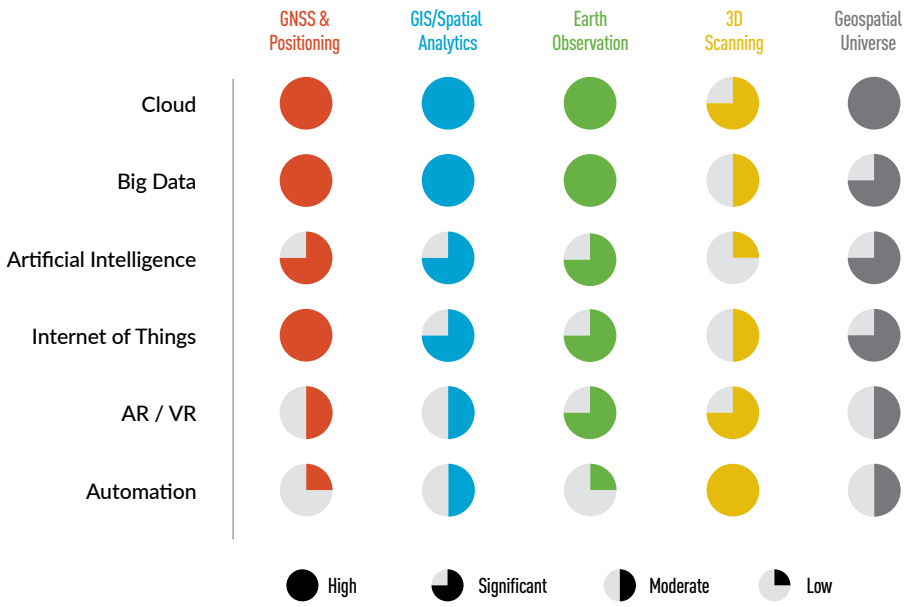
The technology landscape is ever-evolving with new and innovative products, services and business models. These are aided by developments both in geospatial technology as well as by the ones in digital technology ecosystem and sensors. Geospatial technologies are now getting increasingly integrated with ICT and other enabling technology elements in transforming businesses/organization workflows, creating a multitude of opportunities for all segments of the geospatial industry.

Large organizations expected to focus more on Asia Pacific which offer higher growth and large volumes

At the onset of the Fourth Industrial Revolution, the six evolving technologies that are going to have a far-reaching impact on the geospatial industry are Big Data, Cloud, Artificial Intelligence (AI), Internet of Things (IoT), Augmented Reality and Virtual Reality (AR/VR) and Automation. Just as these technologies are impacting the geospatial industry; geospatial industry solutions too drive these technologies.

Big Data and Cloud continue to be the two dominant technologies driving the geospatial industry. Geospatial information is the original 'Big Data', with data from multiple sources over space-time framework, i.e. earth observation, devices and

Figure 2.1 – Key Technology Drivers: Geospatial Industry



Source: Geospatial Media Analysis

Use of Cloud computing and Big Data by geospatial companies is transforming how solutions and analytics services are delivered

sensor networks, scanners etc. As huge volumes of structured and unstructured data are collected from various sources, efficient storage, processing and dissemination is crucial to realize true potential of geospatial technologies. Big Data Analytics and Cloud Computing are therefore expected to have a profound impact on the geospatial industry.

Big Data and Cloud are closely followed by Internet of Things and Artificial Intelligence in terms of the magnitude of their impact on the geospatial industry. Artificial Intelligence (AI) is seen to be a great tool to exploit the spatial Big Data using automation. AI-driven geospatial applications can aid end-to-end solutions in precision farming, disaster management, retail & logistics, navigation and several other areas where predictive modelling is/will be used. AI, at present, is a significant driver of the GNSS and Positioning, GIS/Spatial Analytics, and Earth Observation segments.

IoT is a crucial technology that integrates various digital devices over different networks, enabling collection and exchange of large volumes of data, its processing and seamless communication between them. IoT applications are evolving as a big demand driver for the GNSS and Positioning Technologies. Navigating and maintaining a world of connected devices and assets is also going to generate substantial demand for spatial analytics and solutions that integrate them.

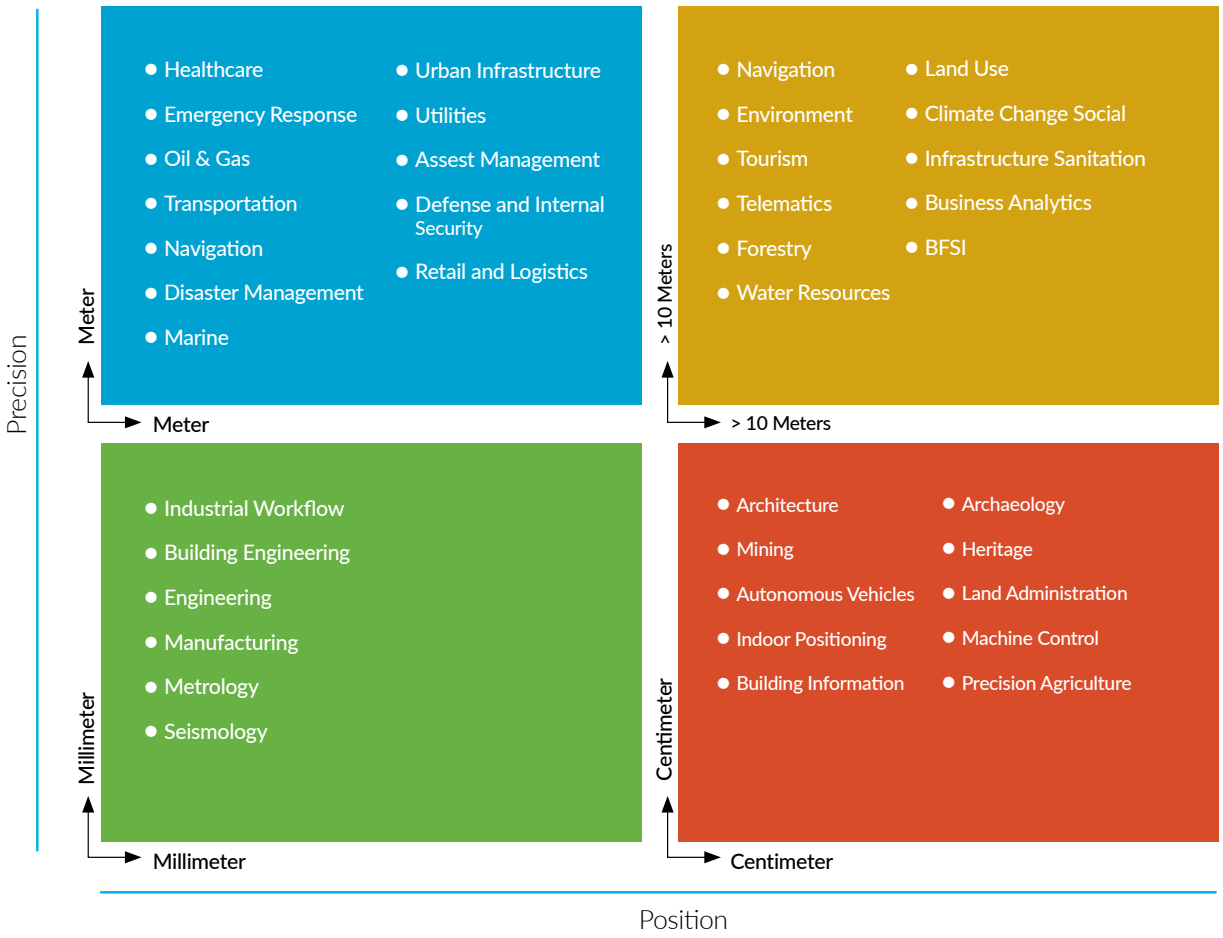
Augmented Reality (AR), Virtual Reality (VR) and Automation are significant growth drivers for Earth Observation and the 3D Scanning Industry, with moderate impact in GNSS and Positioning and GIS/Spatial Analytics segments. Automation is seen as a core driver for the 3D Scanning segment enabling time and cost efficiencies, high reliability and accuracy. Automation requires high accuracy of the data and context capture, necessitating the demand for 3D Scanning technologies in a variety of new application areas.

Geospatial User Spectrum

Geospatial industry is witnessing demand growth from more and more sectors integrating geospatial solutions in their daily workflow management. The burgeoning adoption of GNSS, location analytics, satellite imagery and geo-enabled mobile applications, makes geospatial information/data a core tool for getting the required precision regarding location. Seismology, Metrology, Manufacturing, Engineering, Architecture, Indoor Positioning, Building Information, Archaeology, and Land Administration are prominent user segments where use of geospatial information and technology is required. These application areas require position and precision accuracy of less than a meter (and in some cases millimeter accuracy), which highlights the need of geospatial technologies to capture such data for application purposes.

Today, the use of geospatial information and technology is not limited to the archetypal sectors like defense and internal security, urban development, infrastructure, disaster management. Location analytics is being used in varied areas, that may or may not drive the geospatial market directly but surely adds to the democratization of the sector.

Figure 2.2 – Geospatial Industry Applications: Position to Precision



Source: Geospatial Media Analysis

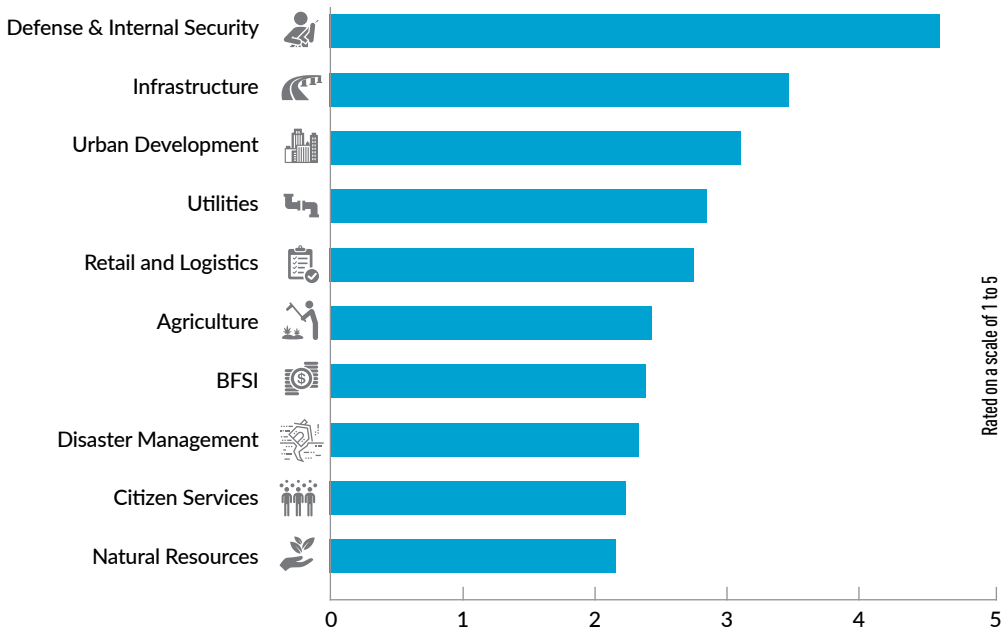
Industry Drivers

Increasing investments by government and private sector user segments, expanding digital services, and innovations in geospatial technologies have created new avenues for geospatial applications in the recent times. Satellite imageries, GIS/Spatial Analytics, Unmanned Aerial Vehicles (UAVs), GNSS and Positioning, and 3D Scanning are being used vigorously by various industries for geo-referencing, mapping, visualization and analysis for better decision making and workflow automations.

Use of GNSS and Positioning systems and satellite imagery by the Defense & Internal Security sector for strategic purposes shall continue driving the geospatial market growth till 2020. In a survey conducted by Geospatial Media and Communications, the Defense & Internal Security user segment was seen as the biggest industry driver for the geospatial market. Simultaneously, the Infrastructure and Urban Development sector, key investment drivers in the emerging economies, especially in the Asia Pacific region, will

Emerging sectors Such as BFSI, Retail & Logistics are growing much faster than their conventional counterparts like agriculture, utilities and defense & securities

Graph 2.3 – Top 10 Sectors Driving Geospatial Market Growth by 2020



Source: Geospatial Media Analysis

drive the overall demand for geospatial information and technology — making the Asia Pacific geospatial market the largest of all. Infrastructure and Urban Development will be the key industry drivers for geospatial market growth by 2020.

Retail and Logistics, Banking, Finance and Insurance (BFSI) and Citizen Services are sectors largely driven by the criticalities of 'location'. GIS, GNSS tracking and Location Analytics are used across the spectrum of these businesses, bringing strategic shifts to the way business processes were managed for customized and efficient service offerings.

As geospatial information and technologies are gradually getting imbibed in the workflow of these sectors, their impact on the growth of the geospatial market has increased considerably in the last five years. The results of our survey further corroborate their importance. While the volume of market revenue from some of these end-use sectors might be low at present, the rate at which they are growing will increase their market share and their corresponding impact on the growth of the overall geospatial market.

Traditional end-use sectors like Agriculture, Utilities, and Land Administration shall continue to drive the geospatial market as well, albeit slowly as compared to the aforesaid sectors.

The need for geospatial information and technology for disaster risk management, post-disaster assessment and creation of contingency plans have become the need of the hour with the number of natural disasters and their impact rising every year,

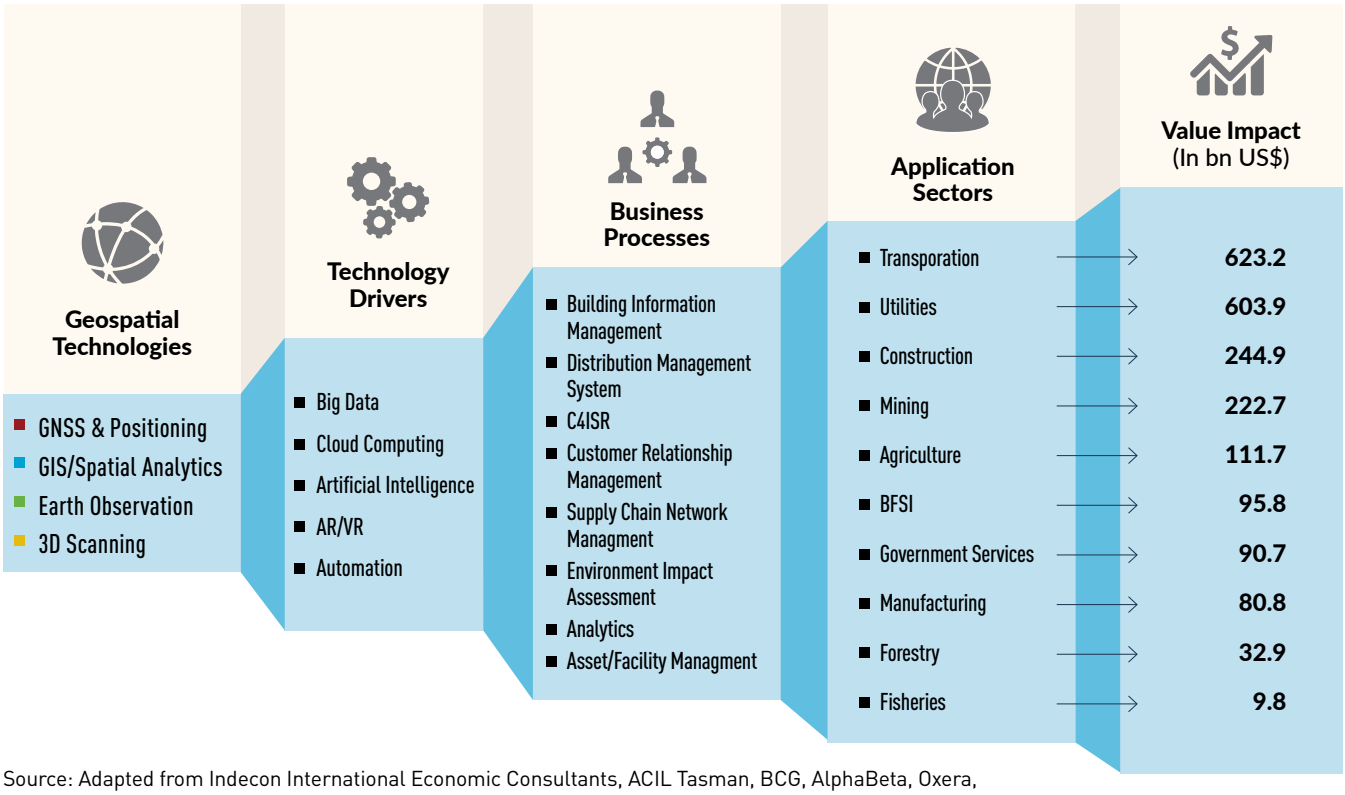
becoming a menace to the human habitation all over the globe. Surveying tools, satellite/aerial imageries, GNSS, Scanning and Spatial Analytics techniques produce visualization models both for preventive as well as post disaster management such as deploying rescue teams, facilitating evacuation/sheltering, conducting damage assessment, and undertaking post disaster reconstruction and rehabilitation. The increased focus of the governments and private business around the world on improving their disaster preparedness will make it a leading driver for the geospatial market by 2020.

Significant investments are expected from disaster management organizations towards geospatial uptake

Expanding Economic Impact

As the geospatial industry continues to grow and gets embedded in various business processes such as Business Information Management, C4ISR, Supply Chain Management Network, Environment Impact Assessment, Facility Management, among many others, its adoption in the key economic sectors continues to grow. Leveraging on spatial information, various traditional and emerging geospatial applications are improving the efficiency and productivity of these segments. These applications are finding varied use in Transportation, Construction, Mining, Agriculture, Utilities, Government, among many others, thus generating huge value impact for economies worldwide.

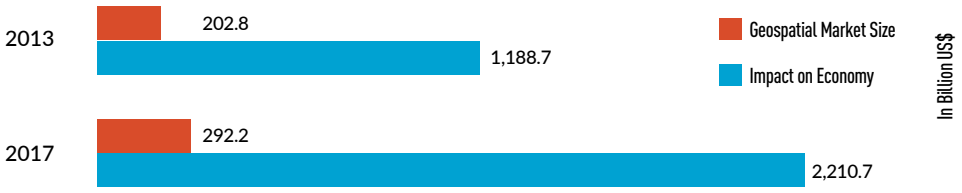
Figure 2.3 – Geospatial Technologies: Towards Creating High Value Impact



Source: Adapted from Indecon International Economic Consultants, ACIL Tasman, BCG, AlphaBeta, Oxera, Natural Resources Canada and Geospatial Media Analysis

With geospatial analytics being used globally for informed decision making, location analytics becoming pervasive in day-to-day activities, and satellite imagery being used extensively for disaster risk mitigation and climate risk management, the geospatial market continues to grow. However, what remains hidden is the substantial economic impact the technology generates. The economic impact of using geospatial information and technology is often underappreciated even though it extends well beyond the core geospatial industry.

Graph 2.4 – Trends in Impact of Geospatial Technologies



Source: Adapted from Indecon International Economic Consultants, ACIL Tasman, BCG, AlphaBeta, Oxera, Natural Resources Canada and Geospatial Media Analysis

Our study of several economic impact assessment reports showcases the expanding global economic impact of geospatial information and technology. The geospatial industry grew at a CAGR of 11.5% from 2013 to 2017, from US$ 202.8 Billion to US$ 292.2 Billion; sustaining the global economic slowdown, while on the other hand, the economic impact of the geospatial industry has grown from US$ 1,118.7 Billion in 2013 to US$ 2,210.7 Billion in 2017, at a CAGR of 20.9%. The economic impact of the geospatial technologies has grown at almost two-folds of the rate of growth of the geospatial market itself. This by and large signifies the role geospatial information and technologies play as an economic enabler. A relatively-less known industry that is growing at a brisk 11.5% CAGR has its impact value growing even faster.

Geospatial industry's economic impact grew at 20.9% between 2013 and 2017, nearly double the industry's revenue growth, indicating wider adoption and integration

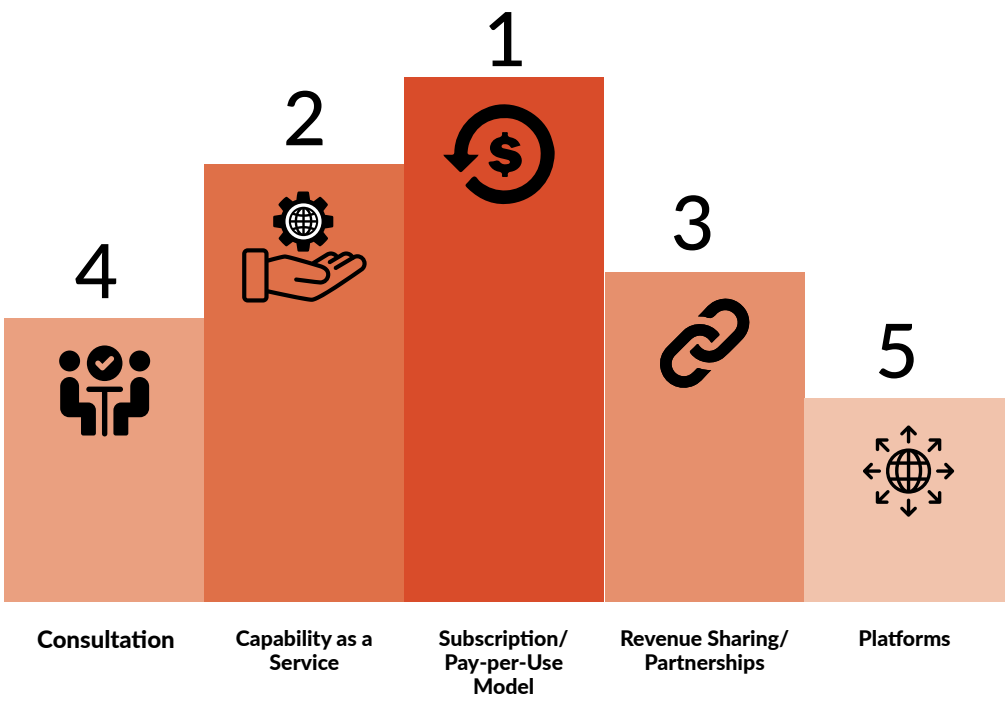
Notably, the impact value is assessed for the economic contributions only. Its societal impact, which has not been accounted for here, is expected to have far greater importance and value.

Emerging Business Models

The geospatial industry is essentially not being transformed by the new technologies, but by the emerging business models. As the user community of geospatial technology matures, the changing technology trends bring in a reduction in gestation periods and shorter product/solution life-spans, resulting in profit vulnerabilities. The industry in turn responds to these disruptions by adopting new business models.

The Geospatial Media research, through focused survey groups and one-on-one interactions with the geospatial industry leaders, finds that one of the foremost emerging business models driving the geospatial industry is the Subscription/ Pay-per-use model where the primary focus of the industry is to encourage the user

Figure 2.4 – Emerging Business Models in Geospatial Industry



Source: Geospatial Media Analysis

community/clients to 'subscribe' for content or analysis, software and hardware by essentially paying a small subscription fee. Because of the smaller upfront investment and low cost of upgradation, this revenue model has been highly effective in capturing the new consumer segments which were earlier not utilizing the potential of geospatial technologies on account of budgetary constraints.

Subscription/ pay-per-use model has gained quick traction by lowering the upfront investment for users

The Capability-as-a-Service model is gradually gaining prominence in the geospatial industry as well. Several segments of the geospatial spectrum have traditionally been product-oriented, which essentially offered piecemeal products, instead of end-to-end solutions. The end consumer was required to either develop in-house capacity or hire consultants or system integrators to help with its implementation, operations and maintenance. However, with the gradual realization of the consumer preferences/ limitations and increasing market competition, Capability-as-a-Service is emerging as the complete consumer-centric business model. And, it is expected to gain further momentum as these technologies expand their applicability and reach out to new user segments.

The other two business models seen to be fast emerging are Revenue Sharing or the Partnership Model and the Consultation Model. Under the Revenue Sharing Model, an increasingly larger number of companies in the geospatial domain are now entering partnerships to deliver better and customized solutions to their customers and to enter new markets, customer segments and regions. It also equips them to make better use of the economies of scale and scope.

The Consultation Business Model bridges the 'technological skills and domain expertise gap' that exists between the technology/product vendor and end user. It involves need assessment for the potential users, identifying the best possible fit available from the vendors and putting together a tailored, ready-to-use system for the clients. This business model is growing because of the fact that technology vendors do not adequately understand user-domain related intricacies, while the users are well- equipped to keep up with the plethora of technology options and development that are regularly being introduced in the market. This model will become all the more important in the future as the increasing pace of technology innovations further widen the 'technological skills and domain expertise gap'.

The fifth most important among the emerging business models is the Platform Business Model. It has already started to bring about disruptions in the geospatial industry. The Platform business model harnesses scalable networks of users, enables ecosystem-value creation, and drives innovation models bringing in an enterprise-wide transformation. This model is inclusive of the Platform-as-a-service model and the economic model of platform which is inclusive of apps, marketplace, and micro-services. Because this model requires huge resources to develop the necessary technology infrastructure and ecosystem, its adaption by the geospatial industry is expected to be slow.

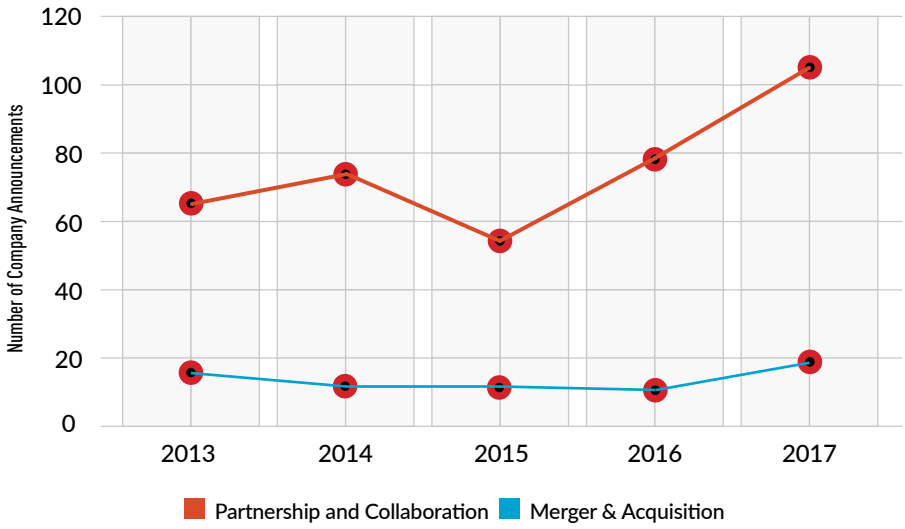
Partnerships, Mergers and Acquisitions

Growing realization of the importance of inter and intra industry collaborations – a steady rise seen during the previous five years

Similar to the overall trend in the technology industry, the geospatial industry is also witnessing a gaining momentum in inter and intra industry partnerships, multi-stakeholder collaborations, merger and acquisitions, venture investments and occasional hiving off of certain operations as appropriate business strategies to sustain and build competencies. The driving reasons for partnerships, mergers and acquisitions in the industry ranges from developing complex capabilities leveraging partner strengths in delivering 'wholesome' experience, to deliver 'end-to-end' solutions, to achieve economies of scale, for co-development of future products/ prototypes, and for consolidation of market and technology portfolio. Geospatial Media and Communications mapped company announcements and press releases of more than 25 leading geospatial companies over a period of 2013-2017 to understand and analyze the wider trends of growth facilitating strategic initiatives undertaken by the geospatial industry. Graph 2.5 illustrates the larger trend of partnerships and collaborations, merger and acquisition over last 5 years for the sampled companies spanning across various technology segments.

It may be observed that while Mergers and Acquisitions (M&As) have remained steady and stable over the last five years, partnerships and collaborations within the industry has intensified considerably. Partnerships and collaborations are more effective in taking care of the complexities involved in designing technology platforms, and solutions requiring deep domain expertise as well as pooling of resources for mutual gain. On the other hand, mergers and acquisitions quickens the development and innovation

Graph 2.5 – Business Trends in Geospatial Industry



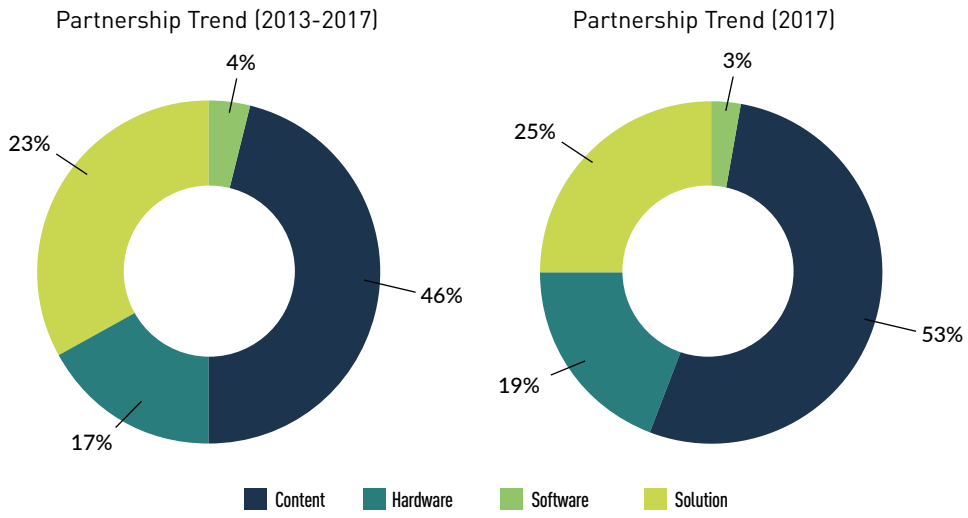
Source: Geospatial Media Analysis

cycle as well as keeps away competitors from both inside and outside the industry. It is increasingly critical for the companies (and is visible from the graph) to remain vigilant of innovations and disruptors from both inside and outside the industry and leverage them for the growth at earliest.

Partnership

A closer look at the spread of industry announcements of partnership and collaborations over the period 2013-2017 in the content, hardware, software, and solution industry segments is as below:

Graph 2.6 – Partnership Trends



Source: Geospatial Media Analysis

Key observations are:

→ The distribution of partnerships and collaborations across the four segments over a period of 2013-2017 and in year 2017 remains same with maximum partnerships happening in the content segment followed by software and hardware industry segments.

→ Inter-industry collaborations are gaining strength indicating the movement of the geospatial industry towards offering end-to-end solutions to meet user needs. Acting as a catalyst for innovation, inter-industry collaborations seem to be the way forward for the geospatial industry in the digital ecosystem. For instance, Esri and Microsoft have partnered to accelerate conservation planning through an aligned grant process allowing individuals to use Esri's GIS software as well as access Microsoft's cloud tools.

→ Simultaneously, intra-industry partnerships are also on the rise and demonstrate increasing confidence among the industry players to leverage each other's strengths not only in creating new product portfolios but integrating systems and respective domain expertise to create wholesome offerings for the consumers and reaching out to new market territories. For instance, Autodesk and Esri partnered in 2017 to better integrate their respective technologies so that industry professionals are able to synthesize information from both BIM and GIS for a more connected infrastructure setup. Similarly, HERE's partnership with NavInfo Co., a leading provider of digital maps and location services in China, allows HERE to extend its location services in the country.

→ Over the period 2013-2017 and specifically in 2017, the content companies continue to drive the action in partnerships and collaboration for new product portfolios, solutions and improving project delivery and performance. An interesting case in point is that of HERE Technologies strategic partnership with Fujitsu to link their respective technologies into powerful integrated solutions for developing advanced mobility services and autonomous driving.

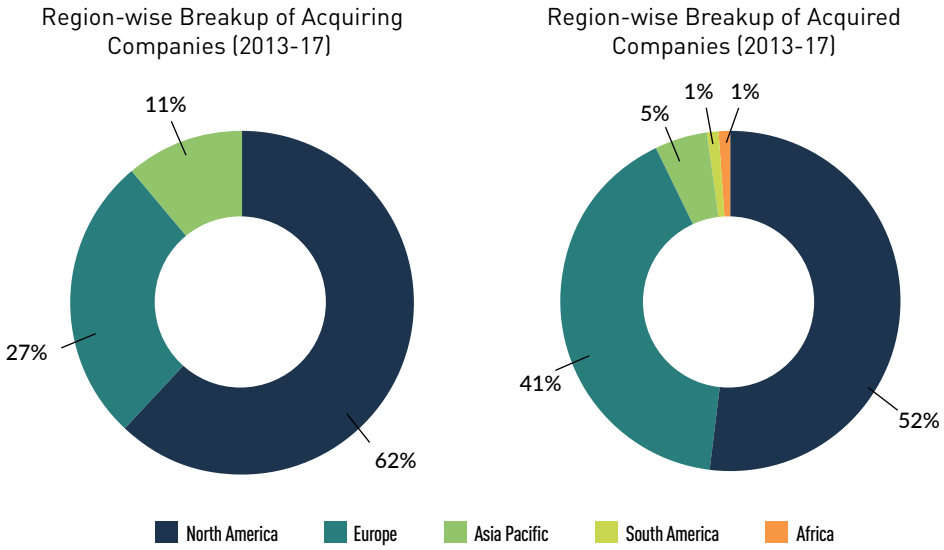
Mergers and Acquisitions

Mergers and Acquisitions, which have largely remained steady over 2013-2017, when analyzed further for regional distribution, brings forth the high concentration of the phenomena within North America and Europe regions. Key observations are:

→ The key reason for M&As to continue remains portfolio expansion (technology, product) followed by market consolidation. The in-depth analysis of the singular announcements demonstrate a focused emphasis on increasing product, service and technology capabilities by way of industry consolidation. A case in point is the acquisition of Digital Globe by MacDonald, Dettwiler and Associates Ltd. (MDA) in 2017. The merger creates an industry leader in satellite systems, Earth Imagery,

geospatial solutions and analytics for commercial and government customers worldwide. The merger brings with it a broader set of space-based solutions, increased scale and a diversified revenue base.

Graph 2.7 – Region-wise Breakup of Merger and Aquisitions



Source: Geospatial Media Analysis

→ A region-wise analysis of acquiring and acquired companies between 2013-2017 showcases that North America and Europe form a larger share of the acquirer's market share than their proportional share in the acquired companies landscape – pointing to their aggressive expansion plans for the future.

Mergers and Acquisitions, therefore, continue to happen, even if not as frequently as collaborations, to offer better suite of solutions by leveraging on the capabilities of both acquirer and acquiree. It has also been observed that the majority of M&As have been led by software companies who increasingly feel the need to integrate with either solution providers or with specialized user industry vendors. The entities created as such expands opportunities for the business on a whole, driving growth.

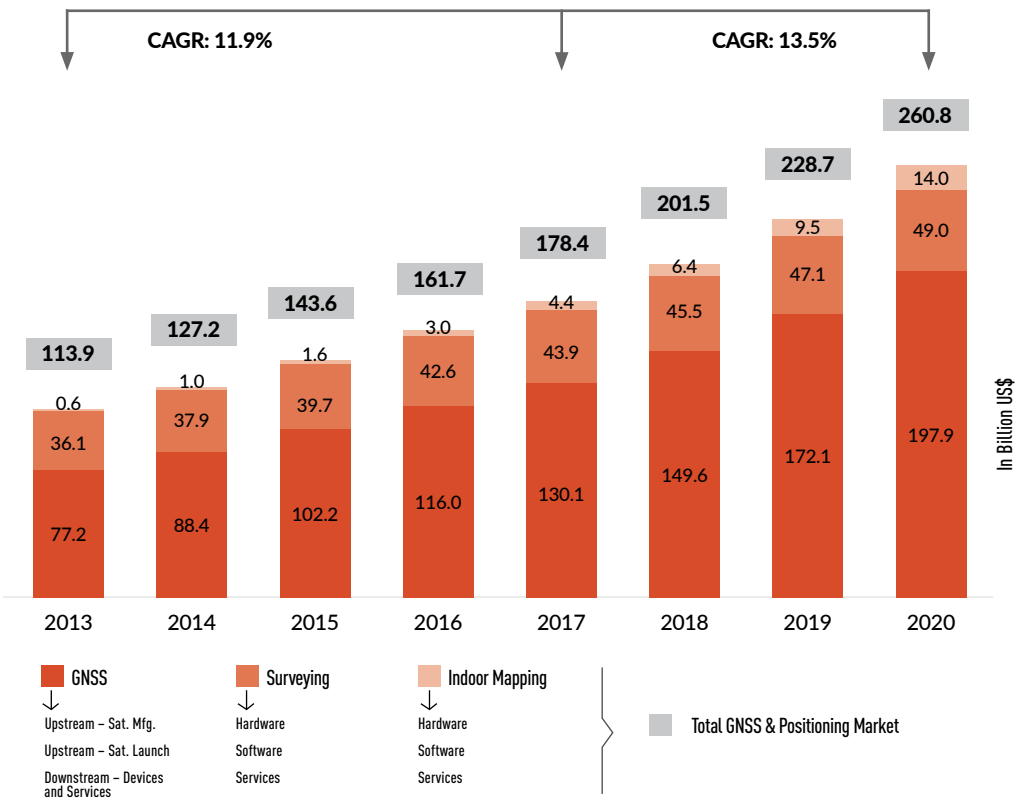
GNSS & Positioning Technologies

The term GNSS & Positioning comprises three distinct technology areas: navigation systems, surveying and indoor mapping. While indoor mapping is a relatively new entrant to this group of technologies, the rest of the constituents are some of the most foundational contributors to the geospatial industry. They form the basic infrastructure upon which the output of others is used to drive meaningful insights for industry professionals and end-users.

Global Market: Size and Growth

GNSS & Positioning technologies form the largest section (by market revenue) of the geospatial universe. In 2017, their estimated market size was worth nearly US$ 178.4 Billion, growing from US$ 113.9 Billion in 2013, which translates into a CAGR of 11.9% between 2013 and 2017. The rate of growth is expected to further accelerate between 2018 and 2020, and the total market size is expected to reach US$ 260.8 Billion, growing at a CAGR of 13.5%. This rapid rate of growth becomes all the more remarkable since the surveying segment of the market (which constituted nearly 25% of the total revenue for the segment in 2017) is expected to witness nominal growth.

Graph 3.1 – GNSS & Positioning: Global Market Size



Source: Adapted from Satellite Industry Association, European GNSS Agency, MarketsandMarkets, Statcan, IBIS World, Orbis Research and Geospatial Media Analysis

The largest market segment of GNSS & Positioning segment is represented by the downstream of GNSS which includes GNSS chips/devices and services, as well as value-added services. It accounted for nearly 71.5% of the total GNSS & Positioning segment in 2017 in revenue terms. With further expansion of the user base ensuring greater democratization of GNSS data and explosion in the value-added services, it is expected that this section of the market will gain even more prominence in the future. Consequently, the total share of the downstream section is expected to increase to 74.4% by 2020.

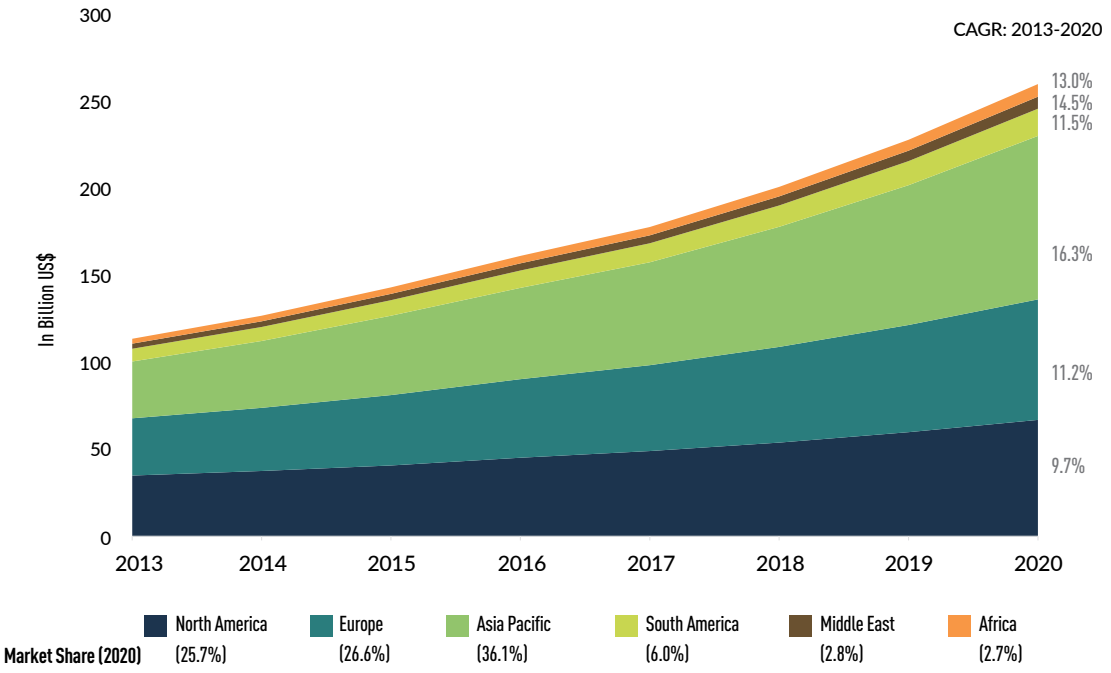
The large user base for the downstream services of GNSS is driving the growth in the Asia Pacific region

Indoor mapping had an estimated market share of only around 2.4% in 2017. Nevertheless, there are lucrative growth opportunities with a lot of consumer segments and demographics yet to be captured. The market for indoor mapping is expected to grow faster than the GNSS and Surveying segments.

Regional Markets: Size and Growth

Asia Pacific, Europe and North America had an estimated market share of 33.3%, 27.8% and 27.6% respectively in 2017. Since a large part of the market revenue in this technology segment comes from the downstream and value-added services where the number of consumers/users play a vital role, the market dominance is expected to gravitate further towards Asia Pacific.

Graph 3.2 – GNSS & Positioning Market: Region-wise Growth



Source: Adapted from Satellite Industry Association, European GNSS Agency, MarketsandMarkets, Statcan, IBIS World, Orbis Research and Geospatial Media Analysis

Most of the industry experts expect consumer IoT to lead the growth in coming years

The rate of growth in the Asia Pacific is expected to be the highest between 2017and 2020, during which it is expected to expand at a CAGR of 16.7%. The matured markets in Europe and North America are likely to grow at 12.0% and 10.9% during the same period.

South America had an estimated market share of 6.1%, which is expected to shrink marginally by 2020 as the growth rate during the forecast period for the region (12.7%) falls behind overall average rate of growth. The future growth in this region is expected to be driven by increased pervasiveness of GNSS-enabled devices, and improved connectivity of public, infrastructure and systems.

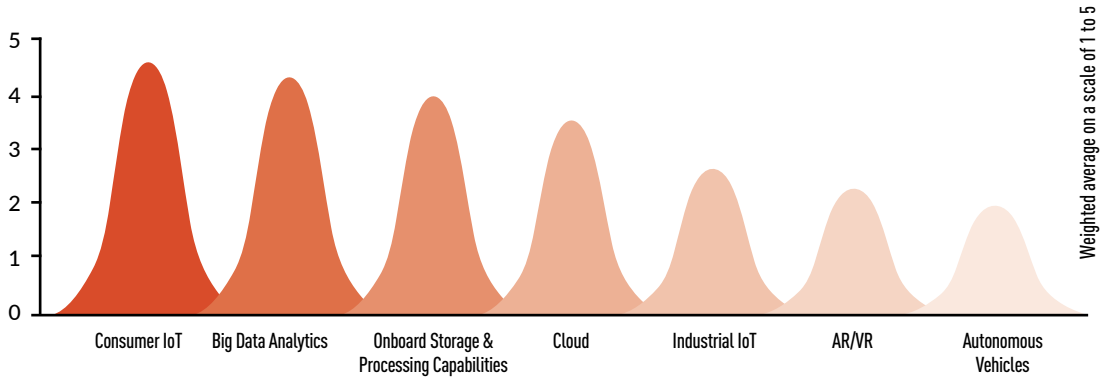
Technology Drivers

The advent of new technologies and disruptive business paradigms enabled by them has altered the conventional dynamics of this technology segment, both in terms of what the industry can offer and what the consumer demands. Geospatial Media and Communications conducted a survey to capture the industry leaders' views on the leading technology drivers for this segment of geospatial technologies.

The Consumer IoT, which represents the interconnected world of consumer electronics, devices and appliances, came on top among the most prominent technology drivers. The services sector in general deals with large amounts of user data.

Big Data analytics allows us today to use these datasets to draw meaningful and actionable insights for enhanced efficiencies and better customer experience. In our survey, Big Data was seen as the second biggest driver for the GNSS & Positioning Industry. As the application of the Big Data at enterprise level is set to grow in future with businesses turning more on data-driven insights for accuracy and forecasting needs, the GNSS and Positioning technology will be high in demand.

Graph 3.3 – Top Technology Drivers of GNSS & Positioning Market



Source: Geospatial Media Analysis

Cloud has substantially mitigated infrastructure constraints associated with storage, analytics and dissemination limitations of the conventional server-based options and has enabled new business and revenue models.

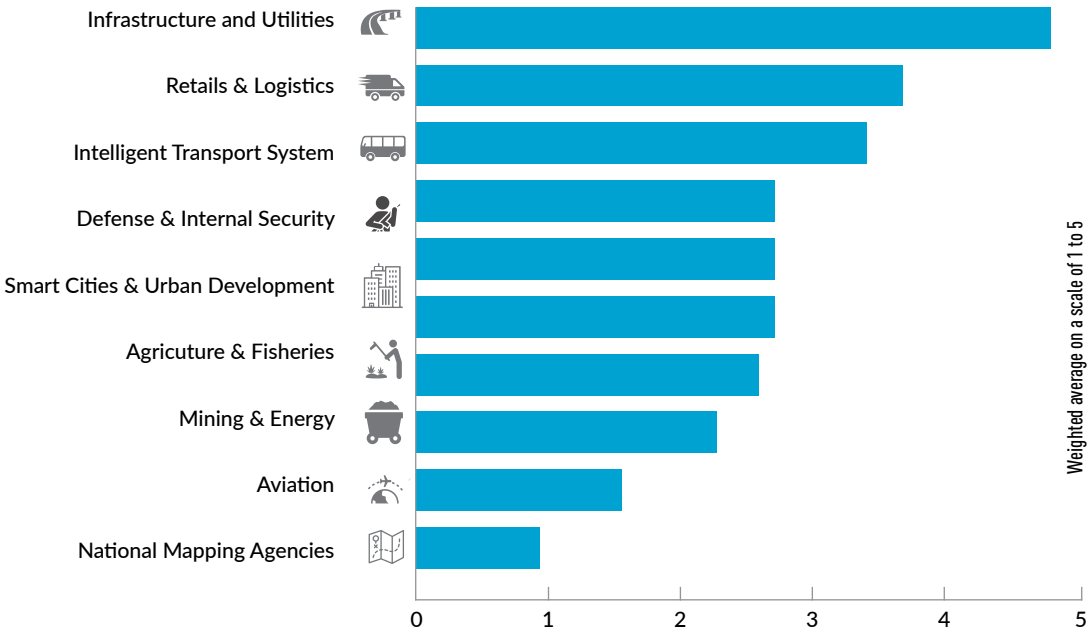
The burgeoning augmented/virtual reality (AR/VR) and autonomous vehicles technologies are also seen as major drivers for the future. Hugely dependent on location data and services, these applications will greatly add to the GNSS and positioning market. However, the impact is not expected to be substantial in absolute revenue terms till 2020.

Industry Drivers

Although GNSS and Positioning systems and solutions are being used across industries, the infrastructure and utilities segment is seen as the major contributor to the growth of the market till 2020. Globally, focus on smart cities by various countries along with infrastructure sector investments, are going to fuel the demand in the future.

Retail & Logistics and Intelligence Transport Systems are the next segments where GNSS-enabled navigation and tracking plays a crucial role. With the map data/ visualization and navigation services platforms improving, combined with their ever-expanding reach, the downstream market is expected to see a big jump.

Graph 3.4 – Top 10 Sectors Driving GNSS & Positioning Market Growth by 2020



Source: Geospatial Media Analysis

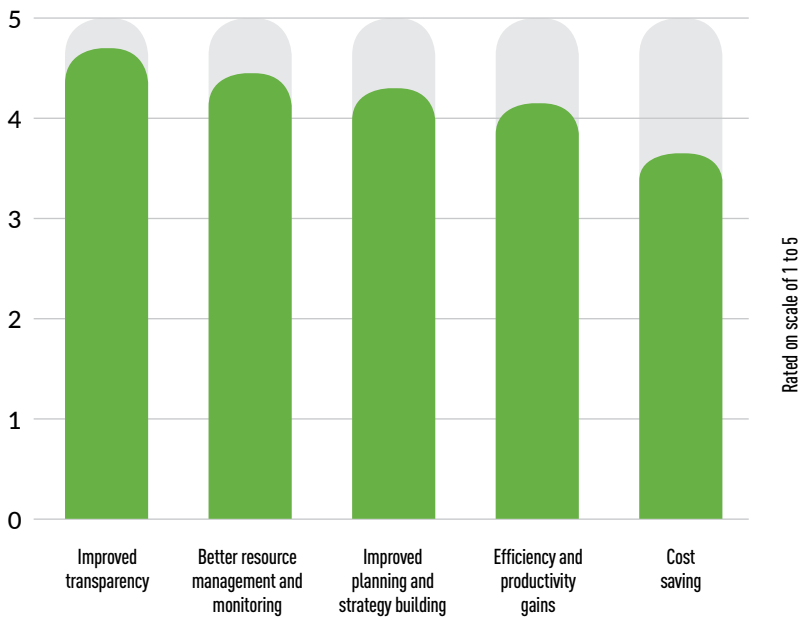
Other user segments like national mapping agencies, mining, energy, agriculture, etc. are likely to play a less crucial role in the growth of the GNSS & Positioning market. This can be attributed to the fact that these industries/segments themselves are expected to grow at a moderate pace.

Aviation being a rapidly expanding sector in many parts of the world is expected to contribute to the demand for GNSS & Positioning significantly. However, its overall impact on the market is expected to be less in absolute revenue terms.

User Benefits and Value

On key benefits of using the GNSS & Positioning technologies, 'Improved transparency in business operations' enabled by location awareness of assets and systems came up as the most important benefit instead of cost-savings. Transparency enabled by GNSS enhances the critical 'credibility factor' in operations, making management and reporting easier, which is of great value to business users.

Graph 3.5 – Top Benefits of Using GNSS & Positioning



Source: Geospatial Media Analysis

The next big benefits of using GNSS & Positioning, both of which essentially are built on improved transparency in business operations, are better resource managements and monitoring, and improved planning capabilities. Location services have dramatically transformed the way businesses are collecting georeferenced data and using it to design better consumer engagement and service models. Positioning is key in making several services (taxi, navigation, advertising, tourism, etc.), much more efficient and accurate.

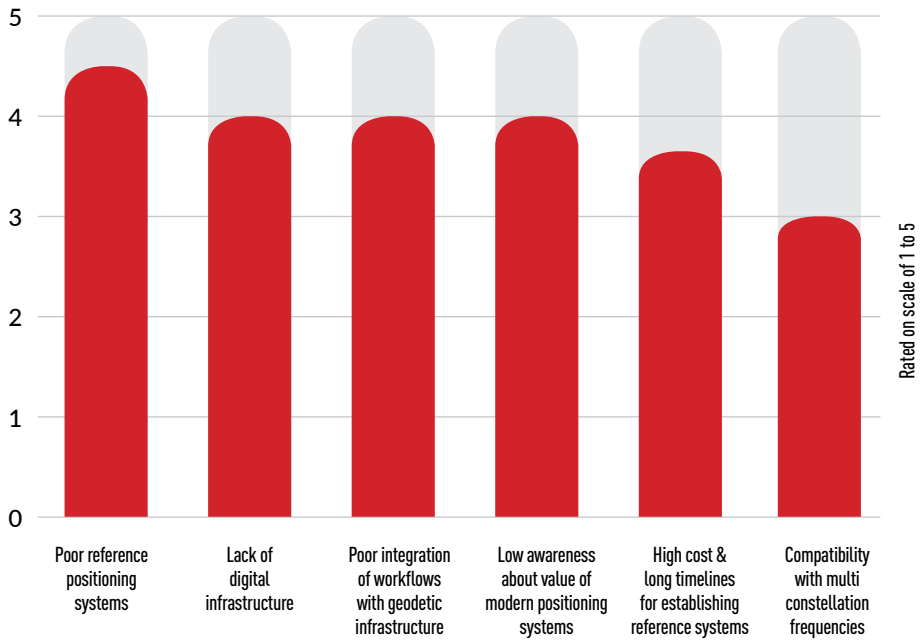
Challenges in Adoption

Certain factors limit the realization of the full potential of GNSS and Positioning technologies. These include a combination of larger geodetic framework capacities, the state of Information and Communication Technology (ICT) infrastructure with smart phone and broadband user base, as well as integration levels in business processes.

Apart from a few leading countries which have strong geodetic infrastructure, most countries still suffer from poor positioning reference systems. This greatly hampers the accuracy of the services attached to GNSS and Positioning solutions and doesn't allow the precision industrial and research/academic uses to flourish. Establishing a nation/region-wide accurate and reliable reference system is a strategic requirement involving consensus building at the highest level for decision makers, capital allocation and planning. The GNSS and Positioning industry sees it as the single biggest challenge today in many countries.

Governments need to invest in establishing a robust geodetic infrastructure, found lacking in many developing countries

Graph 3.6 – Top Challenges of Using GNSS and Positioning Technologies



Source: Geospatial Media Analysis

Lack of robust digital infrastructure including Internet connectivity and ICT infrastructure, are major limiting factor to the proliferation of digital, location-enabled services and business models. While many countries have made significant progress in building digital infrastructure with improved coverage and quality in the recent past, most of the developing economies are found to be lagging on this front. The absence of this fundamental pre-requisite known as 'digital divide' limits the stakeholder's ability to capitalize on many of the basic utilities of geospatial industries.

Poor integration of workflows with positioning infrastructure, i.e., lower adoption levels and the need of multi frequency, multi-constellation compatibility are other challenges that the GNSS & Positioning segment faces.

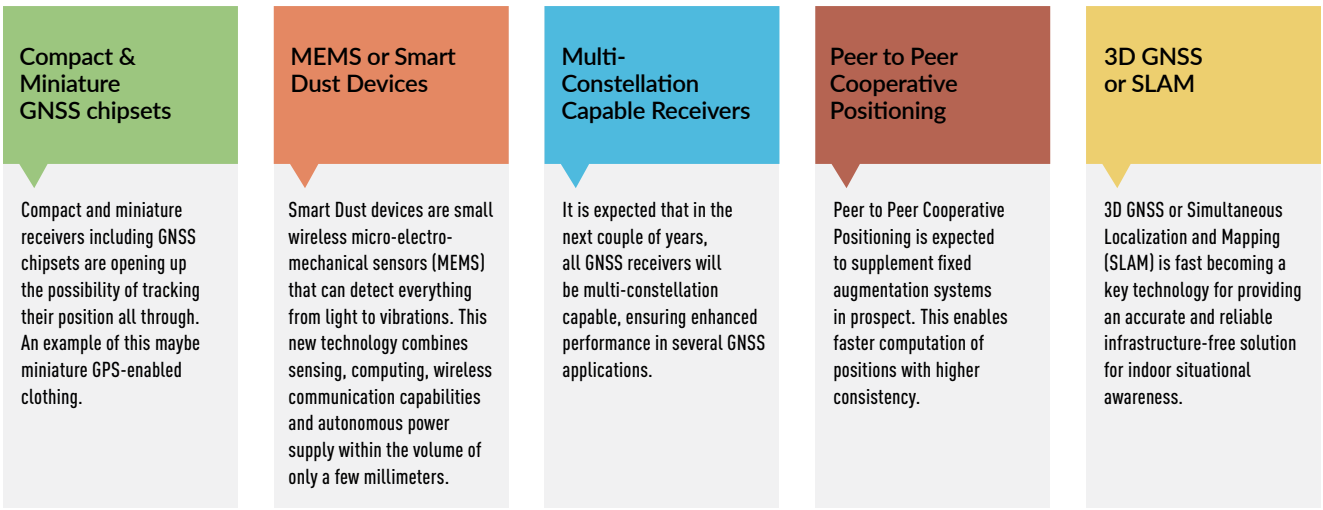
Recent Technology and Business Innovations

There are many technology and business innovations taking shape to meet the evolving needs of various application domains. These developments are miniature sensors, compact low power chipsets, Smart Dust devices, SLAM, etc.

Simultaneous tracking receivers are catching up to utilize multiple positioning systems, e.g. GPS+GLONASS, which greatly increase accuracy, reliability and flexibility. Dedicated positioning hardware is also being gradually replaced by devices which are enabled with software applications for specific purposes, like mapping apps in smartphones, replacing palmtops.

Further, with technology advancements and scaled up production, high-precision positioning which is currently achieved through dedicated professional solutions and are prohibitively costly for larger mass based consumer applications, is expected to become affordable, in turn enabling new business models like "positioning-as a service".

Figure 3.1 – GNSS & Positioning: Recent Technology and Business Innovations



Source: Geospatial Media Analysis

GIS/Spatial Analytics

Global Market: Size and Growth

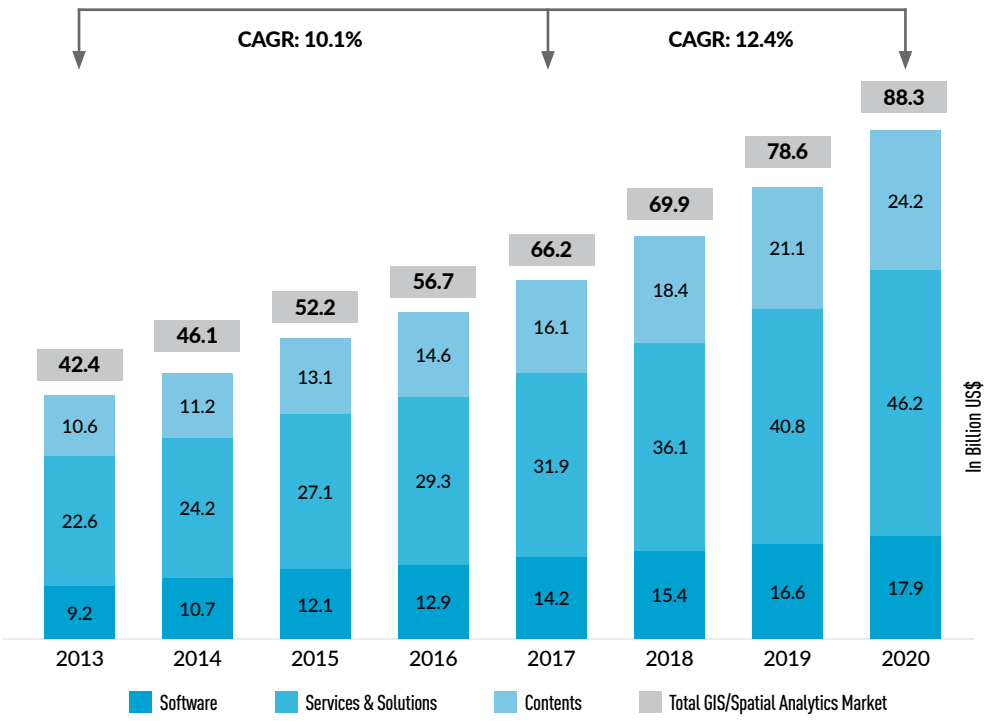
Services and solutions market is driving the GIS market, while revenues from software remain modest

The GIS/Spatial Analytics enables meaningful analysis and running case scenarios from spatial and non-spatial data for decision making. The genesis of GIS platforms (software/solutions), lies with capturing, analyzing and presenting earth observation data via satellite, aerial or terrestrial scanning with other spatial and non-spatial dataset integrations.

However, now the segment includes the fast-growing engineering and construction project designs, 3D modeling with spatial data (indoor and outdoor), integration platforms, field of location analytics, (i.e. content), as well.

It is the second largest technology segment after GNSS & Positioning and comprises of three sub-segments: software, services & solutions; and content.

Graph 4.1 – GIS/Spatial Analytics: Global Market Size



Source: Adapted from Inkwood Research, MarketsandMarkets, P&S Market Research and Geospatial Media Analysis

In 2017, the cumulative market for GIS/Spatial Analytics stood at an estimated US$ 69.9 Billion, growing from US$ 42.4 Billion in 2013 – a CAGR of 10.1% during the period. Among three sub segments, software revenues comprise about 22.9% of the total, while 'services & solutions' and contents contribute 51.3% and 25.8% of the market respectively.

While North America remains the market leader till 2020, Asia Pacific drives growth as it still has a large untapped user base

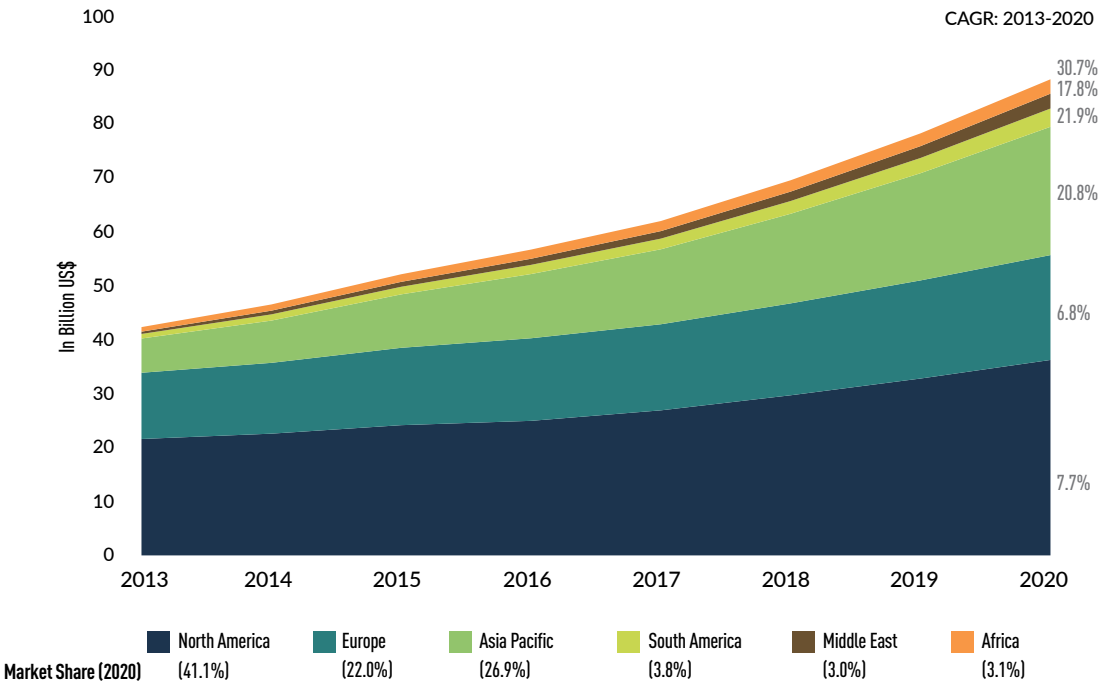
By 2020, the GIS/Spatial Analytics market is expected to reach US$ 88.3 Billion, growing at a CAGR of 12.4%. Although this rate of growth is slower than what is expected from other technology segments, it is still higher than the growth rate witnessed during the period 2013 to 2017.

During the forecast period, contents as well as 'services & solutions' segments are likely to grow much faster than the software business. While, the software segment is expected to grow at a mundane 7.9% CAGR, services & solutions and the content market are expected to drive the majority of the growth volume till 2020.

Regional Markets: Size and Growth

The GIS/Spatial Analytics market is dominated by the North America region followed by Europe. In 2017, the North American market had a share of nearly 43.2%, while Europe's was around 25.7%. Asia Pacific, Middle East and Africa represented 22.3%, 3.0% and 2.2% of the market respectively during the same year.

Graph 4.2 – GIS/Spatial Analytics Market: Region-wise Growth



Source: Adapted from Inkwood Research, MarketsandMarkets, P&S Market Research and Geospatial Media Analysis

However, with the North American and European markets maturing, the region-wise share is expected to shift in coming days. For future growth, the Asia Pacific market will play a vital role as it promises a combination of scale (unlike Africa, Middle East and

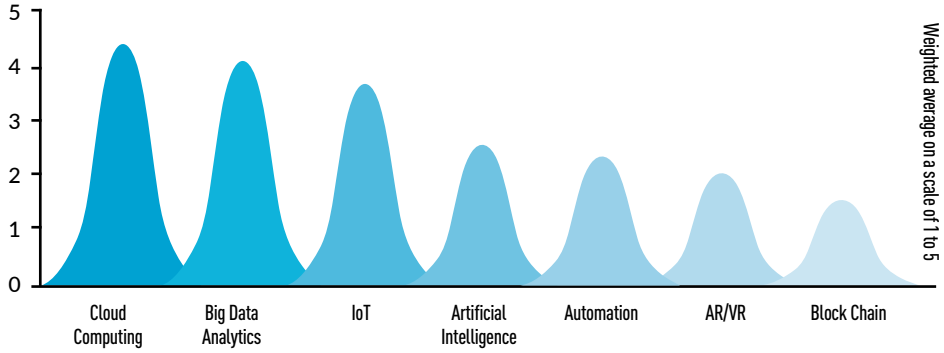
South America), and higher growth (unlike North America). This region is expected to post a remarkable 19.6% of CAGR between 2017 and 2020, as compared to 10.4% and 6.8% expected from North America and Europe respectively.

A world with over 8 billion connected devices are making GIS inevitable for majority of consumer centric business models

Technology Drivers

Cloud computing emerged as the technology driver with maximum impact in coming years. Cloud has enabled users to move away from server-based applications to web-based solutions without having to invest in data storage facilities, or worrying about data security.

Graph 4.3 – Top Technology Drivers of GIS/Spatial Analytics Market



Source: Geospatial Media Analysis

Big Data analytics came up as the next biggest technology driver for future market growth. As GIS/Spatial Analytics uses a large amount of spatial and non-spatial data to derive actionable insights, Big Data capabilities have expanded the scope of applicability for GIS-based solutions being integrated with multiple data sources for visual, location and environment contexts.

Internet of Things (IoT) comes as the third most important technology driver for the spatial analytics market, followed by AI, Automation, AR/VR and Blockchain.

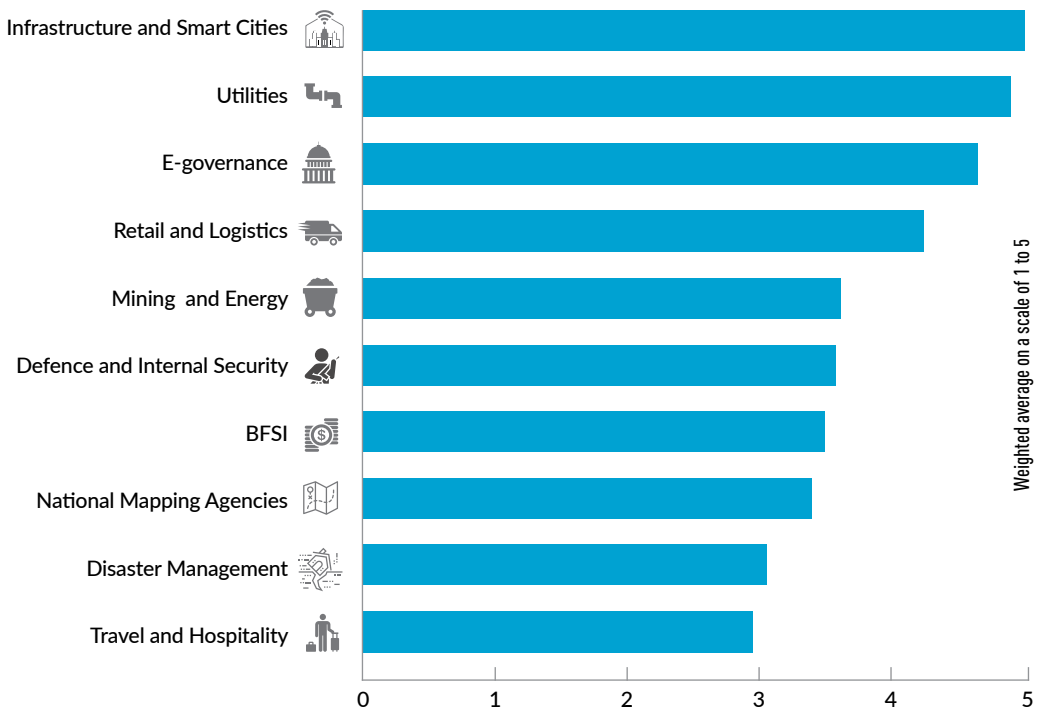
Industry Drivers

The GIS application is on the rise, capturing new user segments from various economic sectors realizing the gains from the integration of location/spatial analytics in their planning and workflows. Infrastructure and smart city projects are expected to be the largest business drivers for the GIS/Spatial Analytics market till 2020.

Utilities and urban administrative bodies as well as logistics companies are among the major traditional users of the GIS market, and are expected to continue contributing

to the market growth in future as well. The industry experts see utilities as the second most important end-user sector with likely future implementation by various utility departments in the developing countries.

Graph 4.4 – Top 10 Sectors Driving GIS/Spatial Analytics Market Growth by 2020



Source: Geospatial Media Analysis

Governments across the world are implementing digitization of their citizen services. GIS is seen as an important tool for e-governance initiatives, and to add transparent and efficient service deliveries. The BFSI sector, one of the latest entrants to the GIS market, is expected to grow significantly in the future. Being an advanced user of ICT and Big Data, integrating GIS with the existing business processes is expected to be quicker in this sector.

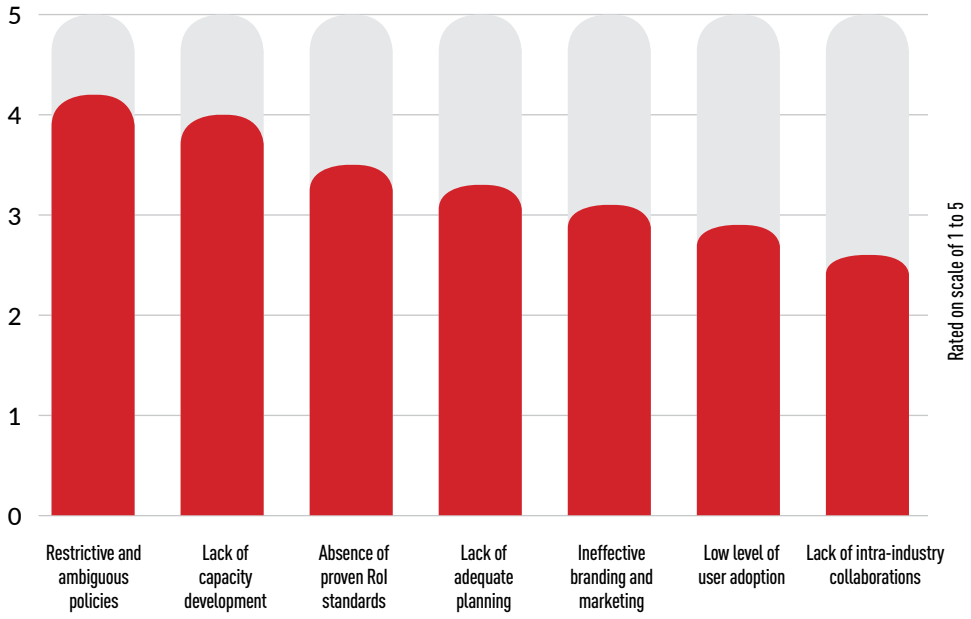
Disaster management applications are expected to increase significantly in the future. However, their overall impact will be small owing to the small revenue size.

Challenges in Adoption

The GIS/Spatial Analytics adoption challenges limiting growth lie with all three stakeholders, which are policy makers, users and technology providers. In our survey,

restrictive and ambiguous policies were seen as the biggest hurdle for the market. Overall, the government organizations are also found to be lacking clarity with respect to what data/information can be shared with a specific set of users. Both industry experts and users have opined that restrictive data /information sharing limits the implementation and usage of GIS.

Graph 4.5 – Top Challenges of Using GIS/Spatial Analytics



Source: Geospatial Media Analysis

An equally big challenge is the capacity constraint at the users' end, which hinders optimal usage of existing GIS setup, while affecting its integration with the core business processes of the user organizations.

Establishing Return on Investment (RoI) for the GIS implementation is another major challenge for market growth. Limited visibility on the RoIs that an investor should expect after allocating money, time and human resources weakens the conviction to go ahead with a GIS-based solution. Its impact is even more profound for those user categories where the use of GIS is not a mandate, but a choice driven by commercial sense.

Industry should focus on investing in demonstrable projects and establishing credible RoI standards

Recent Technology and Business Innovations

The GIS/Spatial Analytics industry is rapidly evolving keeping pace with emerging crowd data sourcing, need for real-time data integration/analysis and data capturing technology segments such as UAVs, smartphones, social media, IOT, etc.

→ Web/Cloud applications are enabling user access and processing of large amounts of spatial data in networked mode.

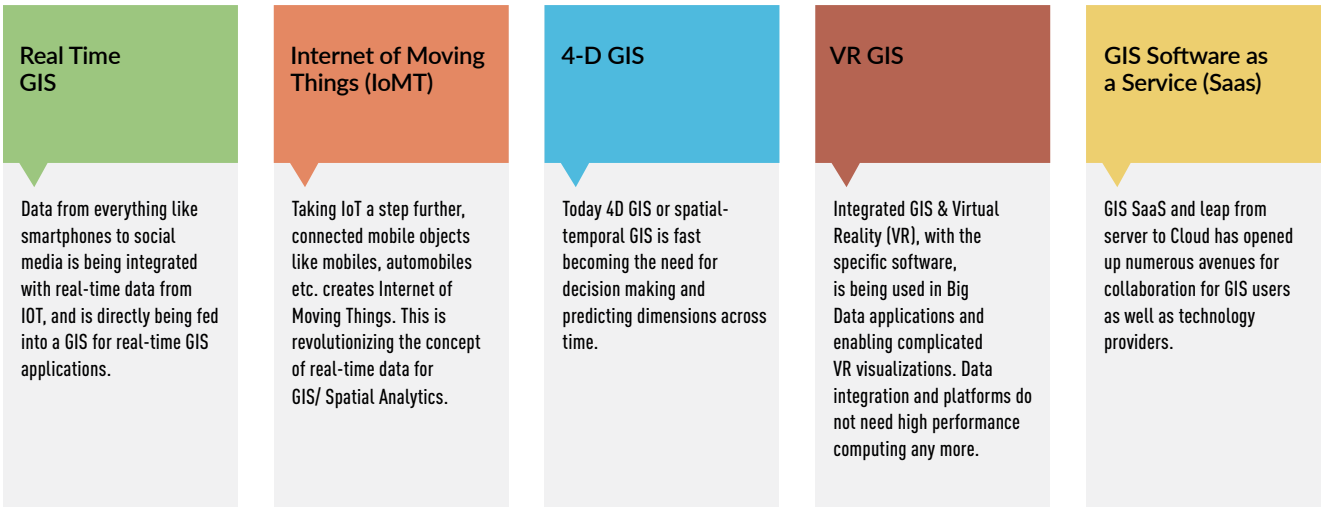
→ Today's gigantic network of connected devices is a continuous source of real-time data which is being incorporated into real-time online GIS applications for consumers and professionals.

→ Spatial Analytics today has also moved to the spatial-temporal domain which is essential where prediction of dimensions across time is needed.

→ Integration of GIS, 3D Modelling and Virtual Reality holds immense promise for domains like urban planning.

→ GIS software offered as a service is also expected to gain more prominence in the near future.

Figure 4.1 – GIS/Spatial Analytics: Recent Technology and Business Innovations



Source: Geospatial Media Analysis

Earth Observation Technologies

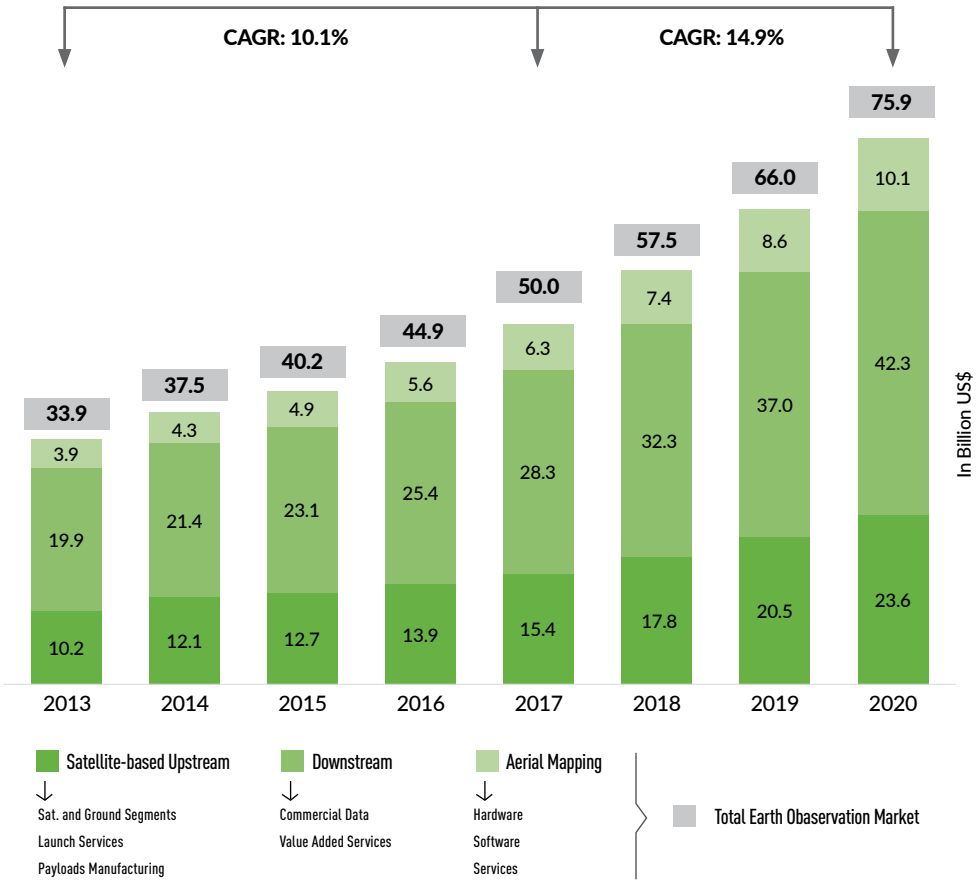
Global Market: Size and Growth

Earth Observation is used to gather information about planet Earth's natural resources and the environment using remote sensing technologies on platforms such as satellites in space and aerial systems like planes, UAVs etc.

The cumulative Earth Observation industry was estimated to be worth US$ 50 Billion in 2017, and is projected to reach US$ 75.9 Billion by 2020, growing at a CAGR of 14.9%; much higher than the CAGR of 10.1% during the period 2013-2017.

The growth momentum in the Earth Observation industry is driven by the unfolding of small and nanosatellite phenomenon, low-earth orbit and medium-earth orbit (LEO/MEO) satellite constellations, new map data services fueling demand for satellite imagery, analysis with end-to-end solutions.

Graph 5.1 – Earth Observation: Global Market Size



Source: Adapted from European Space Agency, Euroconsult, Northern Sky Research, KBV Research and Geospatial Media Analysis

The earth observation market is broadly divided into satellite-based Earth Observation and aerial/UAV based mapping. The satellite-based earth observation is categorized into a) EO satellite -upstream (which includes satellite manufacturing, ground based systems, launch services and payload manufacturing) and b) downstream which includes commercial imagery data, value added services.

The growth of the EO satellite-upstream segment is projected to grow at CAGR of 15.2% during the period 2017-2020, rising from an estimated US$ 15.4 Billion in 2017 to US$ 23.6 Billion by 2020. Some of the leading drivers for the EO satellite upstream segment in the next three years are:

→ Growing commercialization of the overall space value chain
→ Innovative space-satellite-sensor-analytics startups
→ Improved equity finance availability to startups/disruptive business models and
→ Collaborations between private and public sector stakeholders

The downstream segment is expected to grow from an approximate US$28.3 Billion in 2017 to a projected US$ 42.3 Billion by 2020. Steady growth of commercial EO data and solutions over the past decade has been enabled by increasing use of imagery data across economic sectors, web and Cloud-enabled applications and the emergence of startups in the imagery/map analytics market. (referred to as EO 2.0 actors), the rise of map-based navigation and larger trend towards open access to earth observation data. These trends are steadily gaining strength and shall continue driving the growth of the satellite based downstream segment by 2020.

Improved availability of public EO data expected to provide major boost to the VAS market

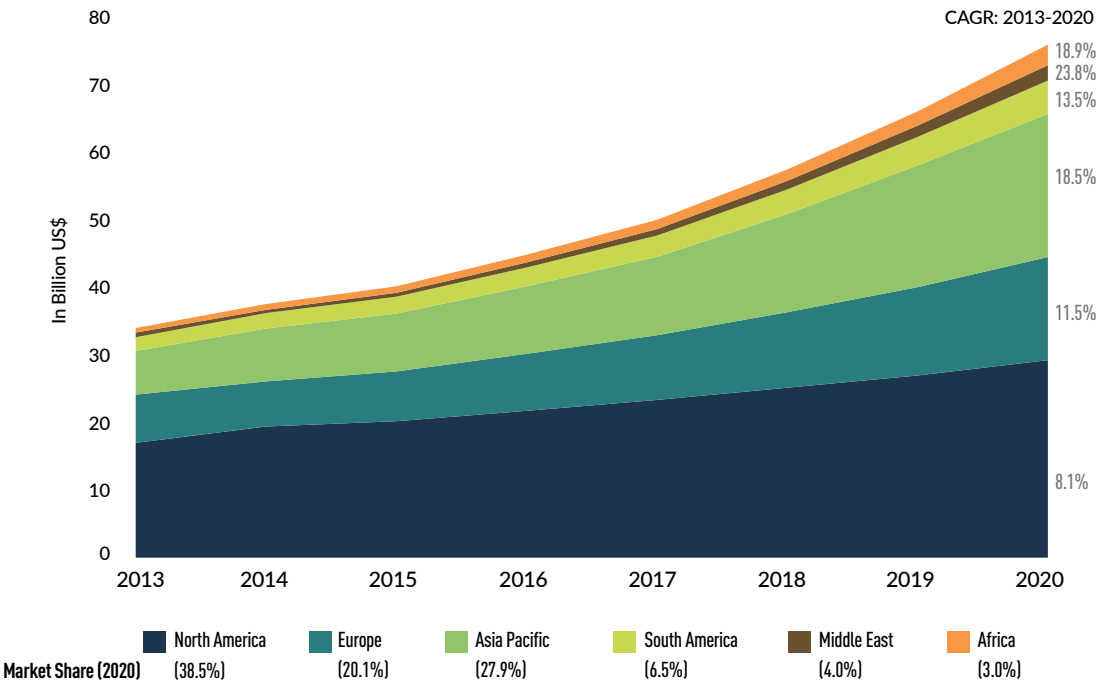
The aerial/UAV-based mapping market segment, inclusive of hardware, software and services industry is expected to rise from an estimated US$ 6.3 Billion in 2017 to US$ 10.1 Billion by 2020. UAV technology ecosystems and its integration with various traditional and new economic opportunities is an emerging phenomenon in this space. Worldwide, there is an increasing number of companies entering the UAV payload, software and data service space to serve the end-user requirements – making it a major growth driver for the earth observation industry by 2020.

Regional Markets: Size and Growth

The global earth observation market is expected to remain buoyant, with opportunities to spur growth distributed across all market geographies. The share of emerging markets such as South America, Middle East and Africa is expected to rise at a much faster pace as compared to the rise in mature markets.

→ The North American region is expected to maintain its position as the largest Earth Observation market in 2020 with a market share estimate of 38.5%, growing at CAGR of 7.8% between 2017 and 2020. Led by the United States of America, and Canada, the North American countries have proprietary high-resolution satellite imaging capabilities along with a huge market for EO solutions and value-added services.

Graph 5.2 – Earth Observation Market: Region-wise Growth



Source: Adapted from European Space Agency, Euroconsult, Northern Sky Research, KBV Research and Geospatial Media Analysis

→ Open Landsat data has enabled entrepreneurs and users both to develop value added solutions and services. Imageries from the longest running earth observation program are being used by application developers, scientists, researchers and enthusiasts creating both commercial and developmental use cases.

→ The Asia-Pacific region will be the second-largest earth observation market segment till 2020 with an estimated market share of 27.9%. Multiple drivers such as growing space technology capabilities, enhanced adoption of earth observation solutions, facilitated by national initiatives e-government initiatives, infrastructure planning, natural resources monitoring, and integrated development planning will support market growth in the region.

→ The European region is expected to witness a lower-than-average growth in the next three years, with its market share expected to decline to 20.1%. The market, however, continues to maintain a respectable CAGR of 11.5% for the period 2013-2020. The growth is accredited to R&D, space technology business incubation efforts to develop advanced remote sensing sensors, commercial adoptions of space technologies, increased adoption of satellite-based earth observation in disaster management, and open data policy framework.

→ In terms of growth, with a CAGR of 23.8% for the period 2013-2017, the Middle East is going to be the fastest growing region for the earth observation market. The

Asia Pacific will be the second-largest earth observation market by 2020, with an estimated market share of 27.9%

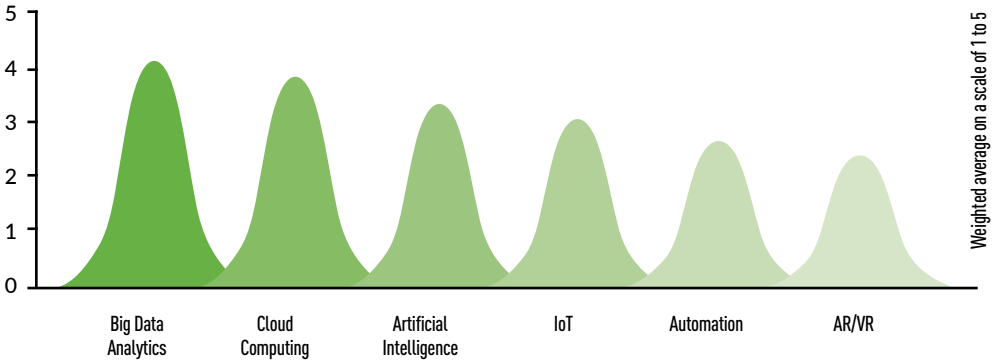
region is witnessing increased national investments in space technology, formulation of strategic plans for space activities for civilian and strategic purposes.

→ A CAGR of 13.5% and 18.9% for South America and Africa, respectively, for 2013-2020 reflects a robust growth in these markets The African region is a consumer of the Sentinel data of the Copernicus Program of the European Commission and European Space Agency (ESA) with a growing number of Africa based earth observation and geospatial private players over the years. The Latin American market is also witnessing a strong uptake of commercial data, end to end solutions from the commercial operators. The market share of Africa and South America is projected to be 3% and 6.5% respectively by 2020.

Technology Drivers

The Earth Observation industry sees six key technology drivers, i.e. Big Data Analytics, Cloud Computing, Artificial Intelligence, IoT, Automation and AR/VR transforming the way forward.

Graph 5.3 – Top Technology Drivers of Earth Observation Market



Source: Geospatial Media Analysis

Big Data analytics enable 'large' volumes of imagery data analysis unearthing the hidden patterns, correlations, market trends and other insights, which is more often than not complemented or supplemented by terrestrial mapping data and non-spatial data. The Cloud storage and access to this large data takes care of the infrastructure and resource constraints earlier associated with server based models. In addition to being a storage platform, cloud provides a computing platform for analytical visualization and decision support. Together, Cloud storage and computing are major drivers for the Earth Observation industry.

Artificial Intelligence (AI) has emerged as a major technology driver enabling the earth observation industry to process and identify trends and patterns from huge volumes of satellite and UAV imagery. One of the recent trends is the convergence of IoT and satellite imaging. IoT Data and EO imageries are being integrated creating high impact for the user segments.

Automation and AR/VR is also finding its way as an important driver of the earth observation industry. To lower and streamline maintenance costs and to operationalize the functioning of earth observation systems, automation and virtualization technologies are being embedded in the business workflows. Application of these technologies will further grow in the future and drive the earth observation markets to new heights.

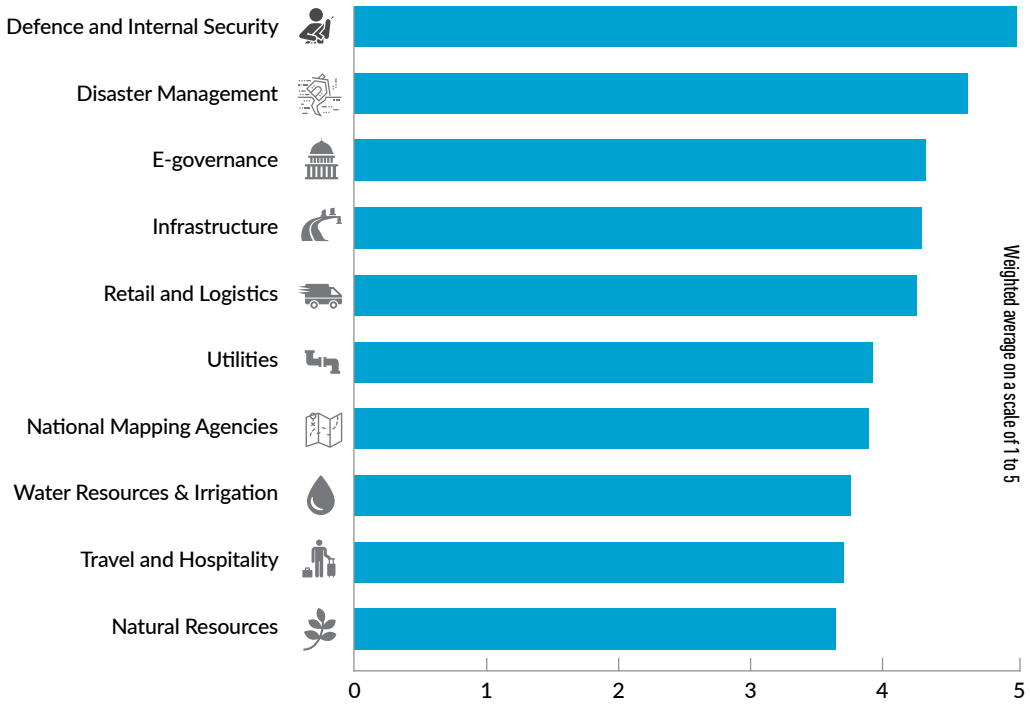
AI and Big Data enabling the dormant capabilities of EO by reducing the time required to process huge imageries data available

Industry Drivers

The earth observation industry is witnessing multiple technology, business model disruptions and policy developments transforming the ways spatial information is being captured, analyzed and made available to intermediate and end users. Geospatial Media has attempted to capture these dynamics impacting the EO market.

Defense and Internal Security, a strategic consumer of most advanced earth observation data and solutions, is going to continue driving the growth of the earth observation market till 2020.

Graph 5.4 – Top 10 Sectors Driving Earth Observation Market Growth by 2020



Source: Geospatial Media Analysis

Disaster Management is another sector where Earth Observation information and technology is key to planning and decision making. Earth Observation imagery is extensively used for prediction and detection of risks as well as post disaster rescue and recovery efforts, making it an important sector driver for the Earth Observation market in coming years.

Integration and use of maps and imageries in e-governance/digital governance initiatives across the world is making it a key growth promise area for the earth observation market.

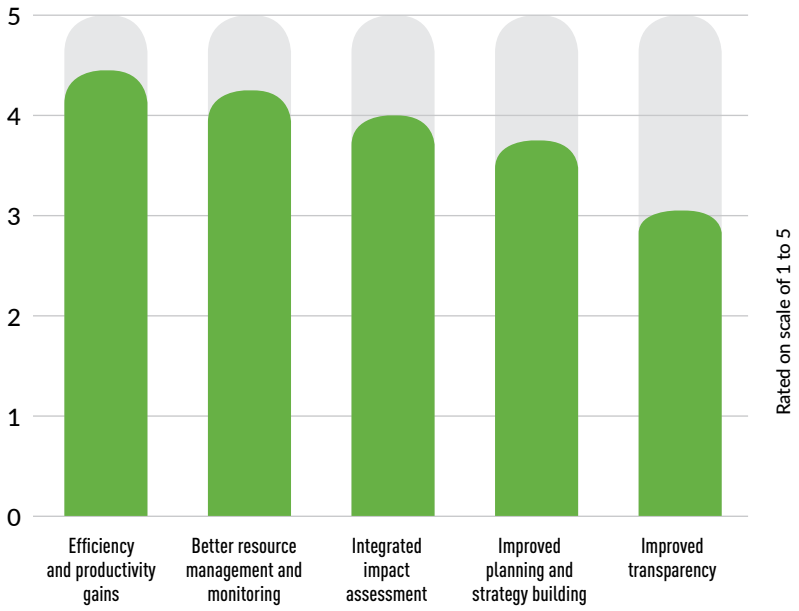
Infrastructure Planning, Urban Development, Utilities and National Mapping Agencies (NMAs) are the other traditional drivers of the growth of the Earth Observation market and will continue to be so until 2020. With the advent of aerial/UAV mapping enabling demand based, high resolution, localized data capturing relative to satellite imagery the adaptation of remote sensing data will be more ubiquitous contributing to market growth.

Retail and Logistics and the BFSI sectors are now using more and more EO imagery based tools and analytics for various applications. For instance, a California-based company dealing with satellite imagery and artificial intelligence was used to track 60 retail outlets analyzing the number of cars in a parking lot. Similarly, UAVs are acclaimed as the 'new drone insurance claim inspectors' making damage claim assessment/ verification fast and easy. These two sectors surely hold promise for the Earth Observation market till 2020 and beyond.

User Benefits and Value

The use of satellite and drone imageries enables wholesome understanding and establishes analysis based-imperatives for necessary decision making, bringing

Graph 5.5 – Top Benefits of Using EO



Source: Geospatial Media Analysis

together the bio-physical world and social elements. Whether commercial, strategic or developmental, the earth observation outputs are getting more and more enmeshed in every sphere of economic and social life on this planet, adding value at each stage.

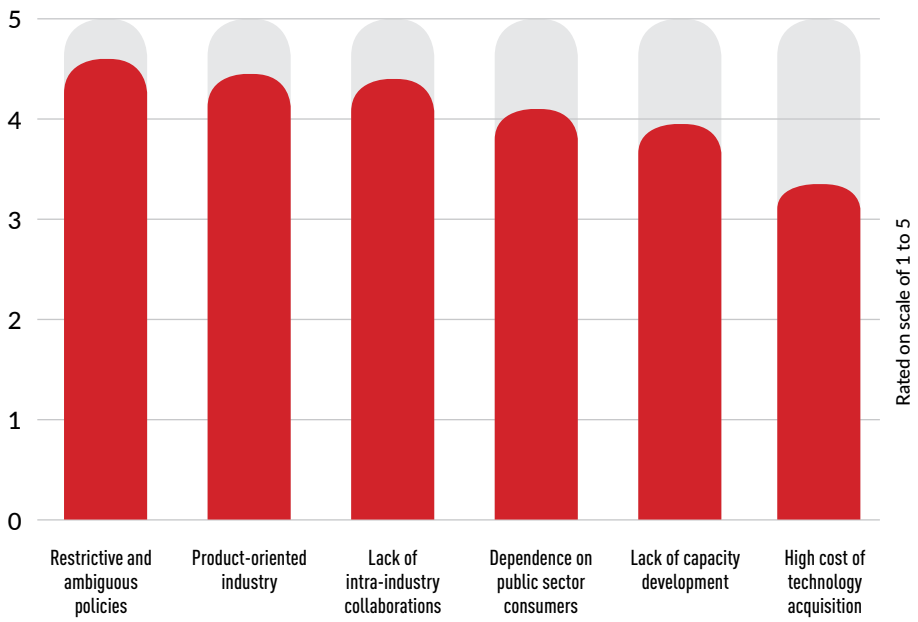
To start with, use of earth observation information facilitates improved planning and strategy building, better resource management and monitoring, and impact assessment on a space-time scale. However, specific productivity, cost and time efficiencies, transparent and participative processes are realized on progressive integration of the imagery information with enterprise wide work flows.

Policies restricting private sector participation in upstream, and marketability of EO data are major hinderances

Challenges in Adoption

The development, adoption and maintenance of earth observation capacities (both production and consumption side), is not easy. Individual organizations (commercial or developmental) and countries face challenges in establishing competitive and vibrant earth observation market ecosystems owing to limited funds, lack of domain knowledge and capability, limited geospatial industry capacities and the lack of a holistic geospatial strategy framework

Graph 5.6 – Top Challenges of Using Earth Observation



Source: Geospatial Media Analysis

In Earth Observation, restrictive and ambiguous policies came out as the biggest challenge for private sector participation and commercialization, especially so in the EO upstream value chain, to expand, diversify and innovate.

Secondly, the demand of consumers is shifting to 'wholesome solutions', i.e., analytically processed satellite or drone imagery for insightful decision making, instead of 'just data'. The changed paradigm is a challenge to the earth observation industry to develop solution centric approaches rather than continuing to be mere data providers.

Lack of intra-industry collaboration to promote use of earth observation information to strengthen earth observation portfolios, customer base and customized solutions, the high market dependence on public sector demand in many developing regions are the third and the fourth most important challenges for.

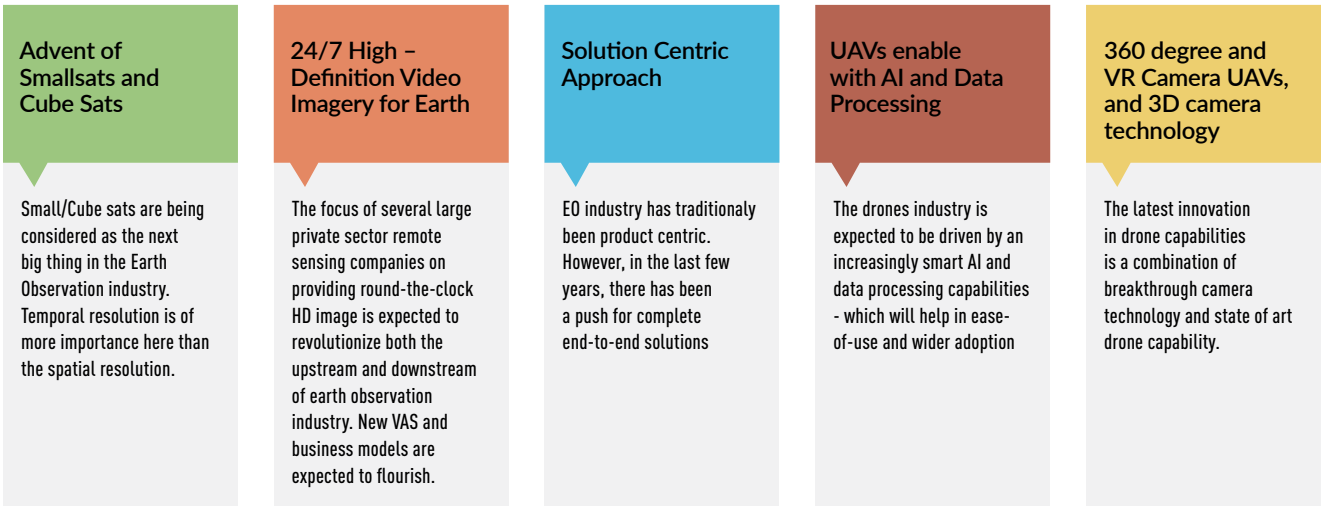
Challenges for the Earth Observation industry also include the lack of intra-industry collaboration to promote use of earth observation information; the high market dependence on public sector demand in many developing regions.

High sales costs due to uncoordinated procurement methods, absent user mandates, lack of skilled manpower and digital/ICT infrastructure constraints and also lower awareness among decision makers are other challenges faced by the earth observation industry.

Recent Technology and Business Innovations

The Earth Observation sector is evolving to move closer to the user need for solution. Earlier, the focus was primarily on collecting imagery and selling it as a product to anyone wanting it. The focus is now shifting to providing intelligence derived from those images. End to end solutions are being offered including digital mapping and mobile communications.

Figure 5.1 – Earth Observation: Recent Technology and Business Innovations



Source: Geospatial Media Analysis

→ Major investments are directed towards the development of next-generation satellites; value-added products and integrated services.

→ Small-sats and Cube-sats are gaining popularity owing to their lower cost and catering to the needs of temporal resolution.

→ Smart UAVs with transformative designs, thermal sensors, small accurate sensors, intelligent piloting modes, software and analytics for real-time data processing capabilities are revolutionizing the UAV industry.

3D Scanning Technologies

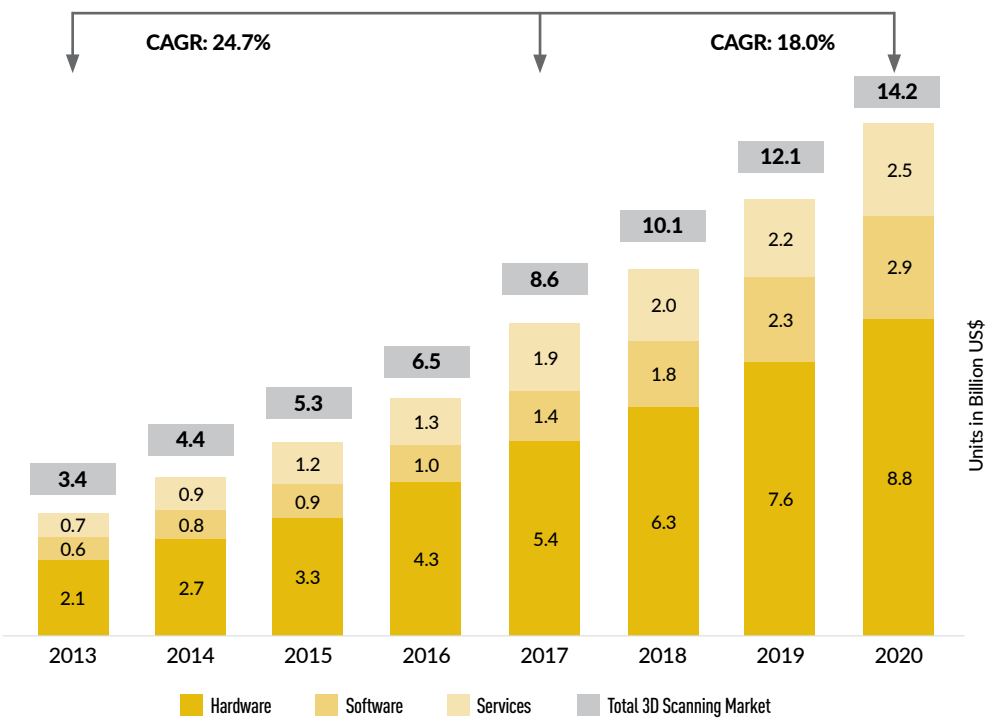
Global Market: Size and Growth

3D Scanning is the fastest growing segment of geospatial technologies – huge growth opportunities available for the future

3D Scanning refers to digital capturing of three-dimensional representation of physical objects, surface environments by using laser light generating point clouds (millions of coordinates), quickly and accurately. The speed, precision and accuracy requirements for digital mapping of complex and contoured objects, surroundings in fields of architecture, engineering and construction, 3D printing, precision manufacturing, autonomous systems - make it the fastest growing segment of the geospatial market until 2020.

The global 3D Scanning market is projected to witness growth at a CAGR of 18.0% from 2017-2020 to reach the total market size of US$ 14.2 Billion by 2020, increasing from US$ 8.6 Billion in 2017. Technology advancements that offer high resolution imagery and rapid scanning techniques are anticipated to augment the 3D Scanning market growth in the near future.

Graph 6.1 – 3D Scanning: Global Market Size



Source: Adapted from Zion Market Research, Transparency Market Research, Technavio and Geospatial Media Analysis

The 3D Scanning market is further classified into three sub-segments, i.e., hardware, software and services. The hardware segment, biggest by size, is projected to grow from an estimated US$ 5.4 Billion in 2017 to US$ 8.8 Billion by 2020; followed by the software segment which is projected to grow from the estimated US$1.4 Billion in 2017 to US$ 2.9 Billion by 2020. The services and solutions segment is expected to maintain

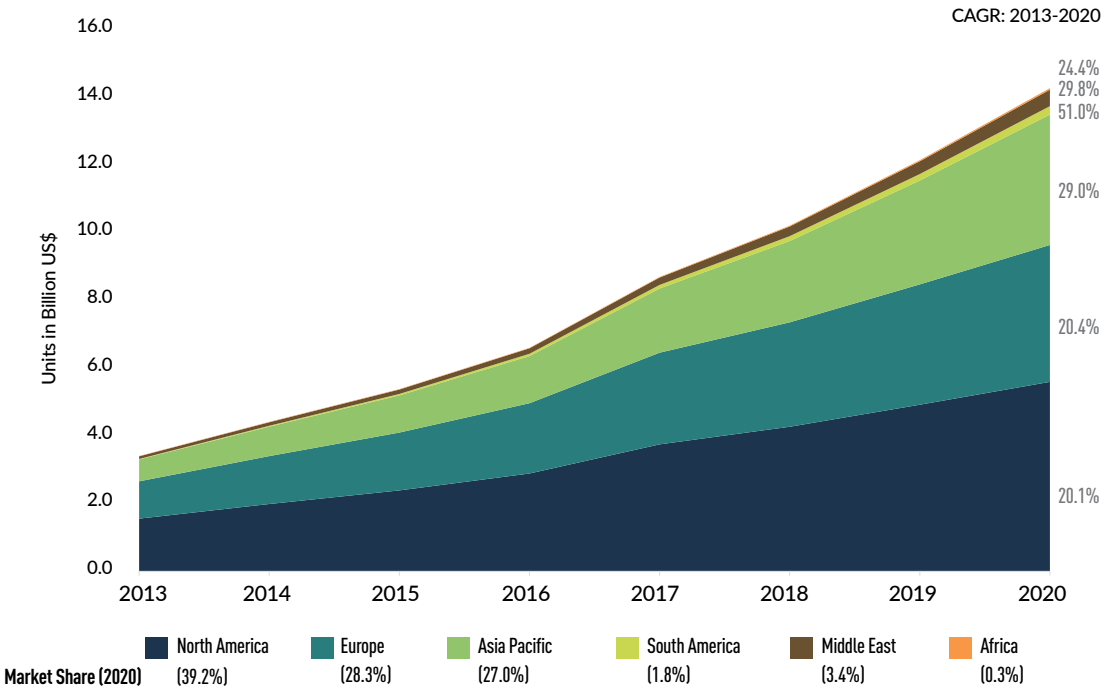
a stable growth rate, rising from the estimated US$ 1.9 Billion in 2017 to US$ 2.5 Billion by 2020.

Regional Markets: Size and Growth

The global 3D Scanning market is expected to witness high growth in all market geographies.

→ The North American region is expected to remain the largest regional 3D Scanning market with a share of 39.2% in 2020, growing at a CAGR of 20.1% in the period of 2013-2020. The United States of America will be the predominant driver of the 3D Scanning market, being both the technology leader as well as the early adopter in various applications such as oil and gas pipelines, construction planning, aerospace, natural resources scanning, entertainment industry, healthcare, etc., driving the market expansion in the region.

Graph 6.2 – 3D Scanning: Region-wise Market Growth



Source: Adapted from Zion Market Research, Transperancy Market Research, Technavio and Geospatial Media Analysis

→ The European 3D Scanning market is projected to be more than one-fourth of the total market by 2020, growing at a CAGR of 20.4% in the period 2013-2020.

→ The Asia-Pacific region holds huge growth opportunities in this sphere, and is expected to grow at a sharp CAGR of 29.0% from 2013-2020. The region is

Latest technology disruptors such as Big Data, Cloud Computing and IoT are seen as great enablers for 3D Scanning technologies

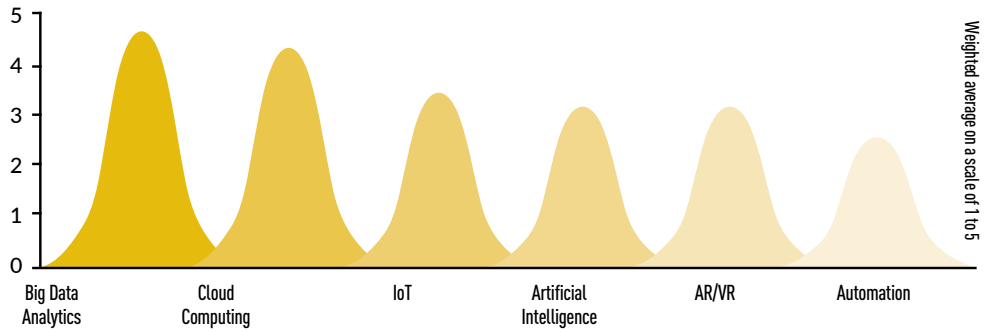
expected to have a market share of 27.0% by 2020. It is expected to be driven by the infusion of huge investments in infrastructure, construction and manufacturing sector economies such as China, India, Indonesia and several other South East Asian countries.

→ The South American market is expected to show the highest acceleration of all regions, expected to grow at 33.0% CAGR. Similarly, with a CAGR of 24.4% and 29.8% for 2013-2020, the 3D Scanning market of Africa and the Middle East region is expected to grow at a rapid rate.

Technology Drivers

The 3D Scanners generate millions of data points or 'Point Cloud' for further processing and analysis to bring digital models of the subject. Big Data and Cloud computing are the two key technologies which address the need for high computing resources, scalable storage and remote rendering of point clouds collected by the 3D Scanners to create visualization and 3D models, especially so when the data collected and stored is from multiple devices. Therefore, Big Data Analytics, Cloud, and IoT are the top three drivers of the 3D Scanning industry segment.

Graph 6.3 – Top Technology Drivers of 3D Scanning Market



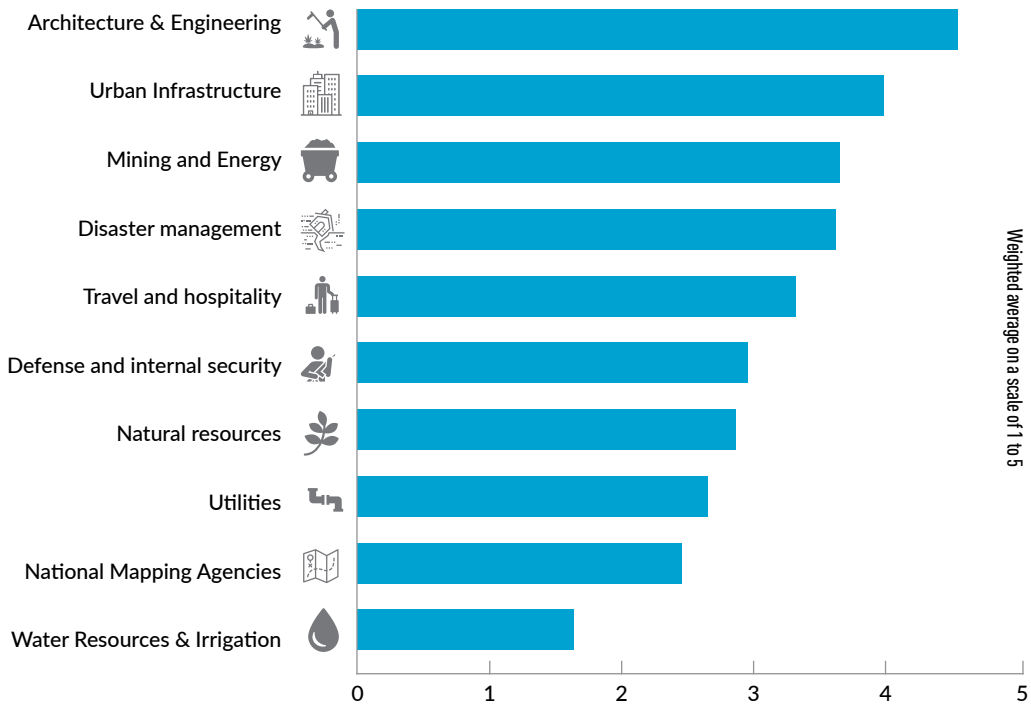
Source: Geospatial Media Analysis

The introduction of Artificial Intelligence in image processing (Cloud rendering) and analysis is a recent phenomenon. This integration is expected to increase the client base for 3D Scanning tremendously, automating the data capturing, correction and decision-making process. Augmented/Virtual Reality is another technology segment, which together with 3D scanning, will create new user experiences and hence demand areas.

Industry Drivers

The Architecture, Engineering and Construction (AEC) sector will account for the largest share of the 3D Scanning segment by 2020. The data that is obtained from scanning technology is used to build 3D BIM Models since it is more accurate, faster and ready to use.

Graph 6.4 – Top 10 Sectors Driving 3D Scanning Market Growth by 2020



Source: Geospatial Media Analysis

Urban Development (Infrastructure and Construction), Mining and Energy are other use segments which will adopt 3D Scanning and measurement technology for speed, reliable and accurate spatial information to enhancing time and cost efficiencies, as well as overall management/monitoring processes.

Disaster Management sector is expected to capitalize on the technological advancements in 3D Scanning, and therefore it is one of the top drivers for market growth by 2020. 3D Scanning is very useful to build a 3D model for morphological investigations of natural hazards and emergency situations.

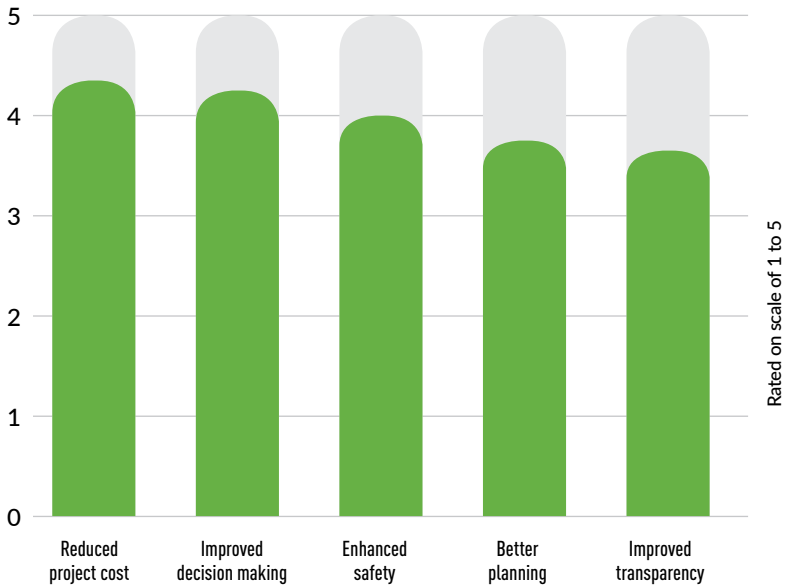
In addition, tourism, utilities, automotive industries, manufacturing industries, healthcare and entertainment sectors are expected to add further momentum to the market growth of 3D Scanning by 2020.

User Benefits and Value

3D Scanning is the fastest growing geospatial technology segment providing manifold benefits. It is simple to use, and can be applied at any point in time of the process value chain, saving time, money and material. 3D Scanning enables seeing design right at the conceptualization stage using reverse engineering techniques, speeding up the prototyping process, capturing critical geometry 3D scan data. It ensures accurate integration of hardware, easy comparison of 'as-designed' to 'as-built', along with fast and comprehensive quality control.

Cost reduction is seen as the most important benefit of using 3D Scanning technology. More so, the use of this technology empowers users to augment their decision-making prowess, with better planning of resources.

Graph 6.5 – Top Benefits of Using 3D Scanning



Source: Geospatial Media Analysis

Users see huge benefits in terms of cost saving, safety and improved decision-making

Use of 3D Scanning technology in Mining, Energy and Utilities Management ensures that strategic plans are made on the basis of the 3D models created. The 3D scanning technology and modelling software are often used together to create models of sites and workplaces to give decision makers a better understanding of the existing structures.

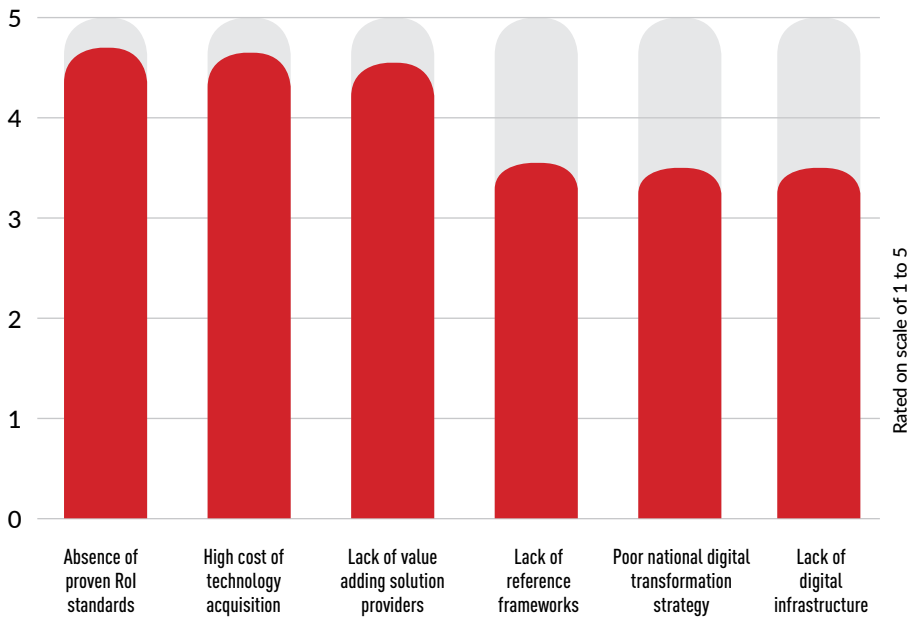
Mine and quarry users of 3D Scanning Technology are able to conduct site analysis for safety purposes prior to getting the work started. Similarly, for construction sites and engineering processes, managers can provide a safe work environment for employees using 3D Scanning solutions.

Challenges in Adoption

One of the major challenges to the industry in the adoption of 3D Scanning Technologies is establishing a Return on Investment (RoI) proposition to the decision makers when they compare it with the upfront costs associated with technology acquisition. Building awareness on RoI in a comparative, demonstrable, project life-cycle manner would be key to addressing this issue.

Lack of third-party system integrators, customized application developers and solution providers, who help derive maximum potential of 3D Scanners in end-use application

Graph 6.6 – Top Challenges of Using 3D Scanning



Source: Geospatial Media Analysis

areas, is also a major adoption challenge. Likewise, lack of ICT infrastructure and digital transformation, impedes the use of 3D Scanning Technology.

Recent Technology and Business Innovations

3D Scanning is witnessing a swift increase in its application, riding on the need for automation and reducing the scope of human error. Hardware and software with enhanced efficiency, affordability, better speed and accuracy is resulting in an accelerated adoption.

Figure 6.1 – 3D Scanning: Recent Technology and Business Innovations

High-end UAV platform-based Laser Scanning

Laser scanning utilizing high-end UAV/UAS platforms provides the capability to acquire data in remote and dangerous areas, while offering an excellent cost-to-benefit-ratio for numerous applications, e.g., precision farming, forestry, and mining.

3D Laser Scanning based Virtual Reality Models

Laser scanned environments are converted into a range of 3D model formats to which photo-realistic textures and rendering are applied to create virtual reality models.

Integrated 3D Laser Scanning Total Stations

With the precision of 3D Scanning, these wide ranging and accurate Total Stations are delivering unique capabilities in measurement technology.

Intelligent point clouds

Intelligent or classified point clouds are a bridge between the information-rich design model and actual as-built conditions. This is going to take use of Laser Scanning to a new level.

Hybrid Measurement Systems

It gives users the flexibility to:

- Obtain high accuracy at long ranges;
- Capture accurate short-range measurements, indoors and outdoors;
- Ensure targeting with bright HUD LED display.

Source: Geospatial Media Analysis

→ Development of UAV-based sensors, hybrid measurement devices giving users flexibility, high accuracy at long as well as short ranges, indoors or outdoors.

→ Increasing use of hand-held 3D scanners, new user segments, including applications in reverse engineering, quality control and visual simulation, are driving the market for 3D laser scanners.

→ 3D Scanning companies are seen aggressively partnering with GPS/GNSS and UAVs devices companies in order to deliver integrated products, solutions and services.

COUNTRIES GEOSPATIAL READINESS INDEX-2018

The Countries Geospatial Readiness Index (CGRI) is a comparative assessment of 50 countries spread across geographies, at different development stages, evaluated and assessed for their geospatial maturity. The index is an important tool for decision makers to comprehend the areas for developing geospatial capabilities for value-creation, economic growth, and overall national development. The index assesses a country's geospatial capabilities on the following pillars:

→ Data Infrastructure
→ Policy Framework
→ Institutional Capacity
→ User Adoption Level
→ Industry Fabric

Countries Geospatial Readiness Index – 2018

Geospatial Readiness Index provides a framework to decision-makers to formulate inclusive geospatial ecosystem strategy

The Countries Geospatial Readiness Index (CGRI) was first introduced in 2017 by Geospatial Media and Communications. The need to develop a comparative framework to assess countries on their geospatial readiness has been long felt by various stakeholders across countries, enabling them to refer and engage effectively on the key parameters for holistic development of the sector.

Therefore, the study evaluates 50 countries not with the ultimate goal of assigning them with a definitive rank, but with the aim of providing a framework to the decision makers in respective countries to better understand the imperative of developing an inclusive geospatial ecosystem strategy. The Geospatial Readiness Index can be used by stakeholders of a country to understand and identify the key areas for developing effective and efficient geospatial capabilities which could then contribute to robust national growth and development.

In its second edition this year, the Countries Geospatial Readiness Index (CGRI) has moved further to strengthen the evaluation framework established in the first edition, integrating new sub-pillars and factors. The improved framework deepens the assessment process and balances the trade-off among the pillars being assessed for overall geospatial readiness. The conceptual framework of the Countries Geospatial Readiness Index has evolved this year reflecting the enhanced micro-level understanding of geospatial information and technology in countries.

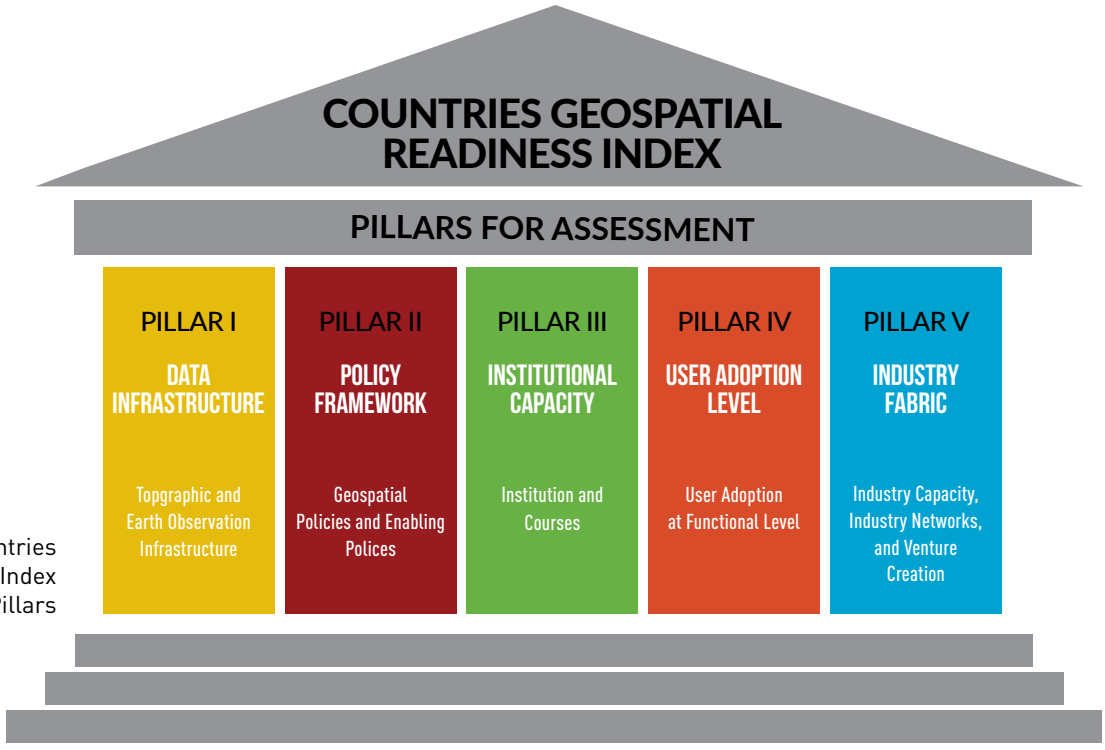
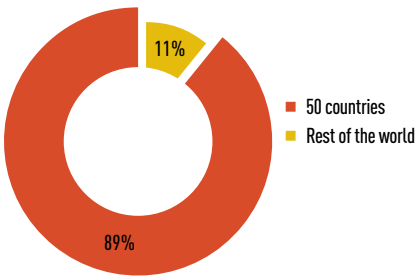


Figure 7.1– Countries Geospatial Readiness Index – 2018 Assessment Pillars

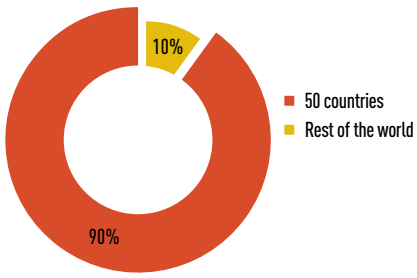
Countries Geospatial Readiness Index (CGRI) Framework

An evolving study, the Countries Geospatial Readiness Index, builds on the 2017 edition, incorporating additional sub-pillars and parameters to comprehensively determine the status of geospatial readiness in the selected countries. This year, the CGRI study covers the same 50 countries as were last year. Globally, these 50 national economies represent approximately 90% of the world population and 89.2% of the world's GDP (in current US dollars).

Graph 7.1– Share of select 50 countries in World GDP



Graph 7.2– Share of select 50 countries in World Population



Source: IMF, World Economic Outlook, October 2017

PILLAR I: GEOSPATIAL DATA INFRASTRUCTURE

An efficient geospatial data infrastructure facilitates access, distribution and use of geospatial data and information in a country. The governing structure, i.e. institutions responsible to enhance the integration of geospatial datasets in any country are primarily the national mapping and space agencies. These institutions are responsible for facilitating the other core geospatial infrastructure components in the country, which includes geodetic frameworks, platforms and portals, data delivery mechanisms, etc. The Geospatial Data Infrastructure pillar for CGRI-2018 assesses a country's capacities on the following sub-pillars:

→ Geospatial Data Infrastructure: Topographic Data Infrastructure, Earth Observation Data Infrastructure, and Open Data
→ Positioning Infrastructure: Positioning Systems, Augmentation Systems and Geodetic Infrastructure
→ Platforms and Portals: Geospatial Technology Architecture
→ Standards: Interoperability, Redundancy and Evolution

PILLAR II: POLICY FRAMEWORK

A conducive, facilitative and aspirational policy framework provides the necessary environment and reference guidelines for holistic development and adoption of geospatial information and technologies, as well as the development of geospatial data infrastructure in a country. The CGRI-18 assesses the policy environment in a country on the following sub-pillars :

→ Core Geospatial Policy Regulation Framework
→ Open Data Policy Regulation Framework
→ Space, Earth Observation, GNSS, and UAV Policy Regulation Framework
→ Enabling Policies Framework (Science & Technology, Innovation and ICT Policies)

PILLAR III: INSTITUTIONAL CAPACITY

A 'geo-intelligent' workforce and higher education institutional capacity is a key determinant of a country's geospatial domain strengths. To assess institutional capacity, the number of universities, colleges, number and types of courses (from certificate courses, diploma courses to graduate, postgraduate and research courses) offered by these universities/colleges in various streams of geospatial information and technology have been evaluated. Institutional Capacity pillar captures the number of universities and courses for:

→ Ph.D and Research
→ Post Graduate Courses (M.Sc., M.Tech.)
→ Graduate Courses (B.Sc., B.Tech)
→ Diploma and Certificate Courses

A 'geo-intelligent' workforce and higher education institutional capacity is a key determinant of a country's geospatial domain strengths

PILLAR IV: USER ADOPTION LEVEL

The use of geospatial technology solutions in various user segments and the integration level of solutions defines the user adoption of geospatial technology and information in a country. For any technology to flourish, and the industry to thrive, the user ecosystem of the country is a key determinant. The user adoption level captures the agility with which the users (government, and private) are adapting geospatial information and technology to enhance their productivity, efficiency, effective delivery, planning and monitoring, etc., of their functions. This pillar measures a nation's capability in leveraging geospatial knowledge and ICT for everyday activities of the major sectors. It comprises of:

→ Mapping or Service Level
→ Asset Management/ Business Process Modelling Level
→ Analytics and Workflow Level
→ System Integration Level
→ Enterprise Level

PILLAR V: INDUSTRY FABRIC

Globally the geospatial industry is acquiring a larger solution-centric role with location information getting embedded in a majority of services and applications across economic sectors . Technology solutions and services development, delivery capacities of industry stakeholders (commercial or business stakeholders), industry and professional networks for knowledge sharing and business development, new venture and technology commercialisation support eco-systems are key to assessing the geospatial industry ecosystem in each of the 50 countries. The pillar is assessed on the following sub-parameters:

→ Geospatial Industry Capacities, Critical Mass, and Diversity of Companies
→ Geospatial Ventures and Innovation Promotion ecosystems
→ Geospatial Industry and Professional Networks

ASSESSMENT FRAMEWORK

The research methodology for the Countries Geospatial Readiness Index 2018 is based on a combination of primary and secondary research methods. The study entails primary data collection through one-on-one interaction, focus group interactions, event surveys, with relevant stakeholders, and online questionnaires. The primary survey is further supplemented and validated through secondary sources (research papers, digital sources), to ensure authenticity of the data assessed and evaluated.

The analysis for the Countries Geospatial Readiness Index is extensively quantitative. The datasets have been analysed according to the five pillars, their sub-pillars, and the factors by assigning weightage to them at different levels, which are aggregated to arrive at the final score for the country. On the basis of the final score, the countries have been ranked to arrive at the Countries Geospatial Readiness Index 2018 (CGRI-2018).

The weightage assigned to pillars, and sub-pillars this year is different from the last edition. In CGRI 2017, equal weightage was assigned to all the pillars and sub-pillars, i.e. each pillar weighed 25% in the entire index. However, CGRI-2018, as mentioned above, is based on a more refined and broad-based framework; the weightage assigned this year reflects the additions to the pillars, while keeping all of last year's parameters with their weightages almost unchanged. It is to be noted that the weightage is assigned on our assessment of the relative importance of each dataset, each parameter, and each sub-pillar in evaluating the readiness score.

Table 7.1 – Comparative assessment of the weightage assigned to pillars in CGRI-2017 and CGRI 2018

CGRI-2017	Weightage	CGRI-2018	Weightage	Reason for Weightage Differentiation
Geospatial Infrastructure and Policy Framework	25%	Geospatial Data Infrastructure	20%	Policy framework has been separated from this pillar
Institutional Capacity	25%	Policy Framework	10%	(Re)-defining the policy framework with enabling policies (S&T, and Innovation and ICT Policies)
User Adoption Level	25%	Institutional Capacity	20%	(Re)-defining the importance of institutional capacity in a nation's geospatial preparedness.
Industry Fabric	25%	User Adoption Level	20%	(Re)-defining the scope of user adoption level as well as addition of two sub-pillars.
		Industry Fabric	30%	Venture and technology creations, Industry/professional networks have been added to Industry capacity.

CGRI 2018 Assessment Framework

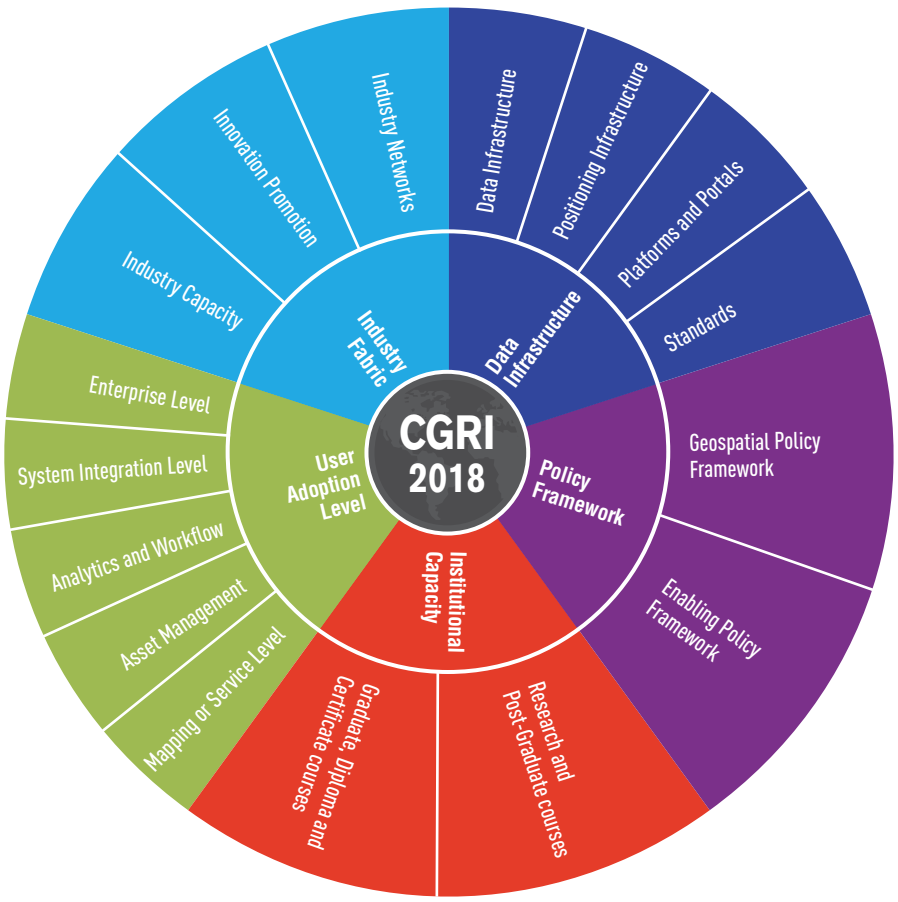


Figure 8.1 – CGRI Assessment Framework

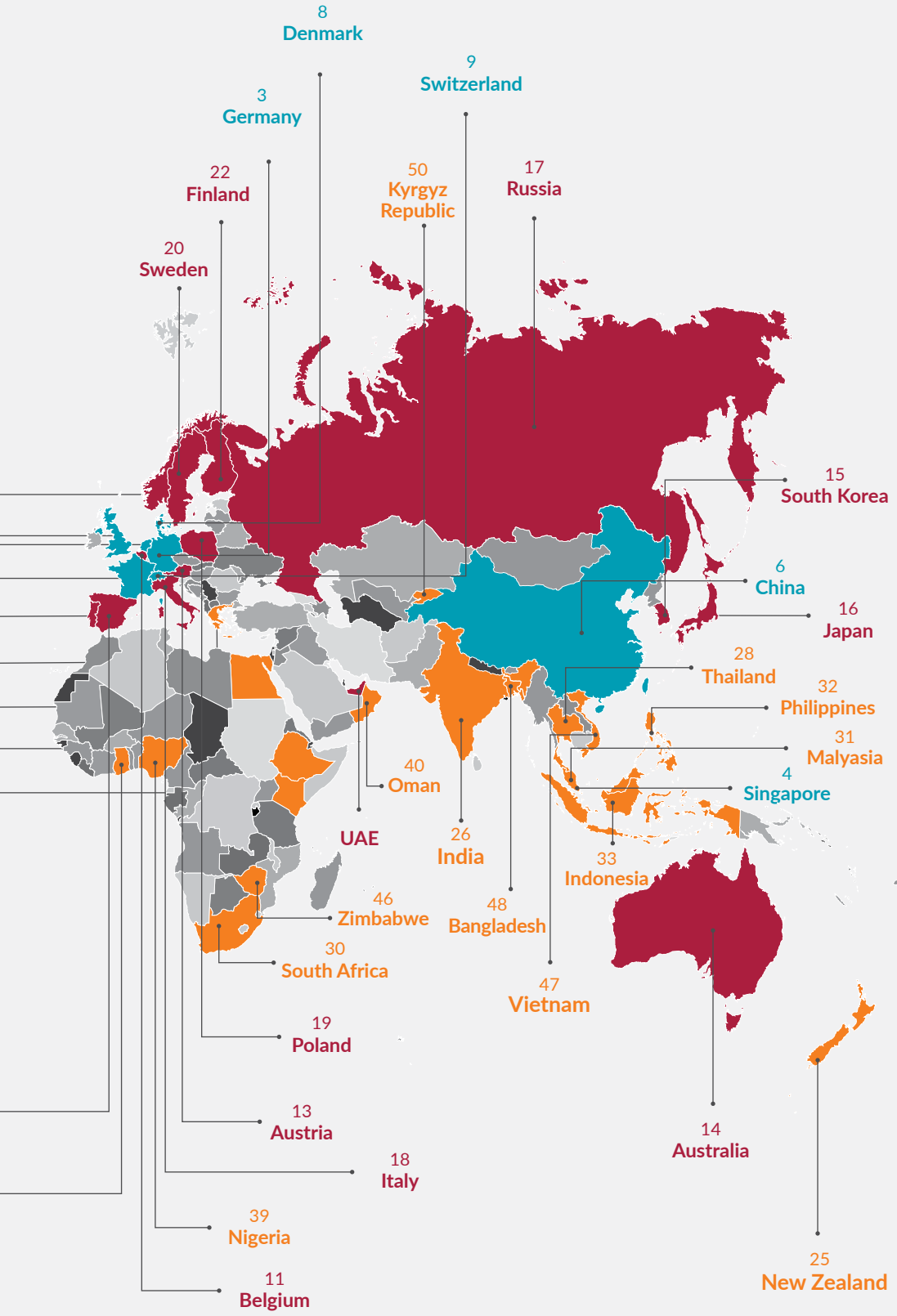
COUNTRIES GEOSPATIAL READINESS INDEX 2018

LEADERS

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

CHALLENGERS

Rank 2018	Country	Score
11	Belgium	29.972
12	Spain	29.722
13	Austria	28.888
14	Australia	28.804
15	South Korea	28.125
16	Japan	27.002
17	Russia	26.966
18	Italy	26.358
19	Poland	26.315
20	Sweden	26.181
21	Portugal	23.586
22	Finland	23.189
23	UAE	22.950
24	Norway	22.736



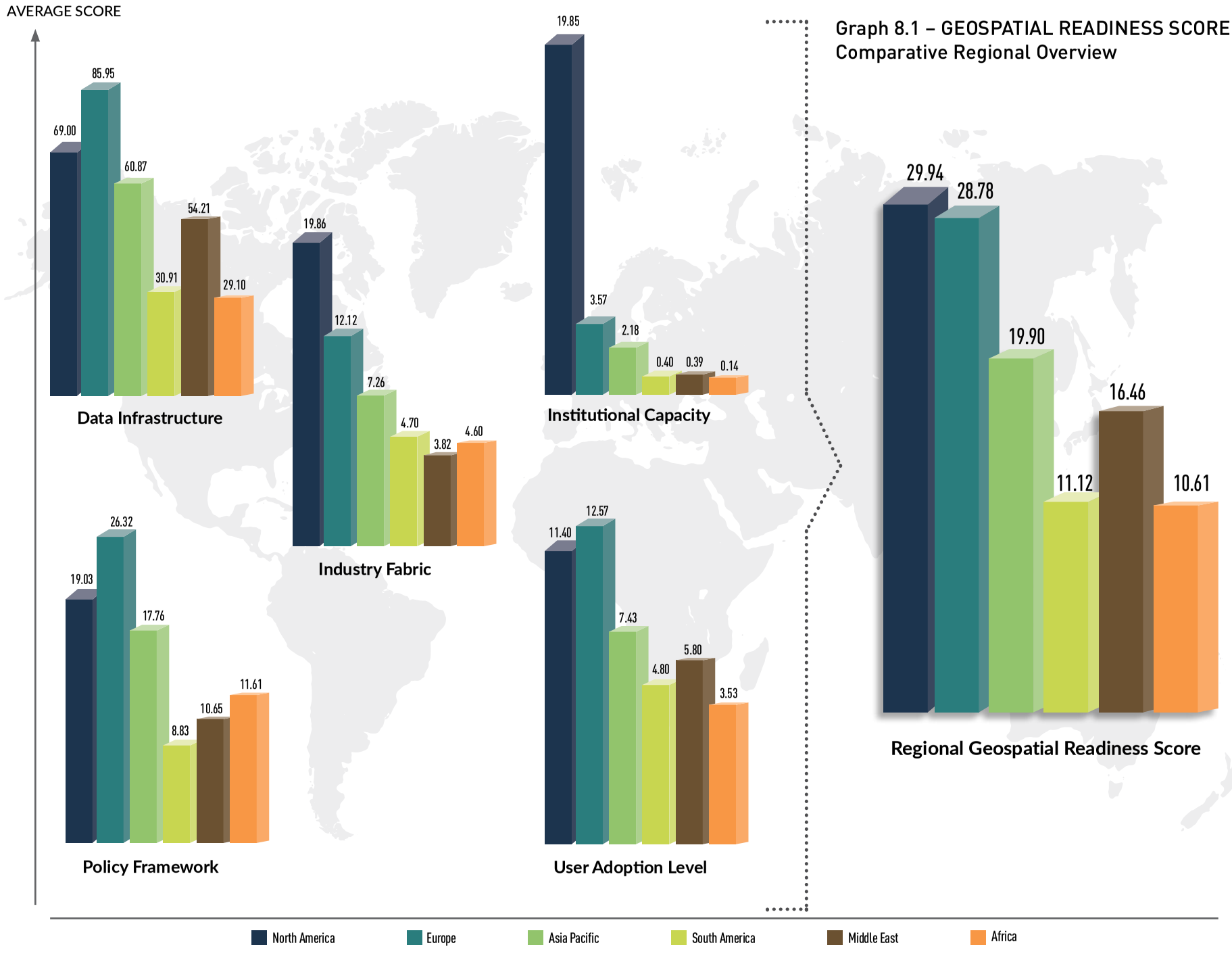
ASPIRERS

Rank 2018	Country	Score
25	New Zealand	20.695
26	India	20.523
27	Greece	19.722
28	Thailand	17.041
29	Brazil	16.757
30	South Africa	15.329
31	Malaysia	15.307
32	Philippines	14.396
33	Indonesia	12.921
34	Colombia	12.733
35	Chile	12.580
36	Egypt	12.452
37	Kenya	11.958
38	México	11.713
39	Nigeria	10.166
40	Oman	9.979
41	Argentina	9.724
42	Uruguay	9.555
43	Ethiopia	8.658
44	Costa Rica	8.334
45	Ghana	8.058
46	Zimbabwe	7.692
47	Vietnam	7.606
48	Bangladesh	7.259
49	El Salvador	5.415
50	Kyrgyz Republic	4.820

CGRI 2018 Ranking*

Rank 2018	Country Name	Total Score	Data Infrastructure	Policy Framework	Institutional Capacity	User Adoption	Industry Fabric
1	USA	67.77	27.94	3.23	13.51	6.62	16.46
2	UK	40.63	21.23	3.54	3.41	6.41	6.03
3	Germany	37.54	17.35	2.81	1.23	5.62	10.51
4	Singapore	34.97	22.47	2.68	1.41	6.05	2.33
5	The Netherlands	33.35	20.54	2.64	0.98	5.81	3.36
6	China	32.17	20.92	1.76	0.85	4.59	4.03
7	Canada	31.96	16.64	2.60	2.24	5.73	4.73
8	Denmark	31.37	21.08	2.69	0.36	4.33	2.88
9	Switzerland	30.67	18.71	2.61	0.75	4.92	3.67
10	France	30.62	17.83	2.62	0.31	5.77	4.07
11	Belgium	29.97	19.26	2.66	0.51	4.495	3.03
12	Spain	29.72	17.75	2.56	0.90	4.89	3.60
13	Austria	28.88	17.79	2.73	0.50	5.12	2.72
14	Australia	28.80	17.02	2.51	1.26	4.53	3.45
15	South Korea	28.12	18.62	2.39	0.36	3.98	2.75
16	Japan	27.00	16.11	2.59	0.61	4.54	3.13
17	Russia	26.96	17.14	2.78	0.22	4.56	2.25
18	Italy	26.35	15.87	2.77	0.27	4.10	3.33
19	Poland	26.31	17.75	2.99	0.21	3.2	2.15
20	Sweden	26.18	15.15	2.97	0.6	4.23	3.22
21	Portugal	23.58	14.71	1.92	0.39	3.48	3.06
22	Finland	23.18	13.10	2.36	0.47	4.32	2.91
23	UAE	22.95	16.20	1.68	0.11	3.61	1.32
24	Norway	22.73	13.37	2.43	0.35	4.36	2.20
25	New Zealand	20.69	12.49	1.26	0.73	3.94	2.2
26	India	20.52	11.97	1.79	0.42	3.37	2.94
27	Greece	19.72	13.47	1.85	0.11	2.87	1.40
28	Thailand	17.04	11.78	1.81	0.16	1.92	1.34
29	Brazil	16.75	10.06	1.46	0.21	3.16	1.85
30	South Africa	15.32	8.68	1.92	0.094	2.59	2.02
31	Malaysia	15.30	7.73	1.91	0.28	3.11	2.25
32	Philippines	14.39	8.66	1.94	0.03	2	1.62
33	Indonesia	12.92	8.15	1.37	0.08	2.08	1.21
34	Colombia	12.73	7.60	1.04	0.08	2.68	1.31
35	Chile	12.58	6.40	1.17	0.1	2.92	1.96
36	Egypt	12.45	8.42	0.48	0.03	2.58	0.92
37	Kenya	11.95	7.13	1.15	0.02	2.55	1.08
38	Mexico	11.71	6.21	1.24	0.08	2.71	1.45
39	Nigeria	10.16	4.47	1.66	0.01	2.49	1.52
40	Oman	9.97	5.48	0.44	0.04	3.04	0.96
41	Argentina	9.72	5.51	0.92	0.03	2.07	1.17
42	Uruguay	9.55	5.03	0.47	0.03	2.68	1.32
43	Ethiopia	8.65	4.95	0.29	0.009	2.39	1.01
44	Costa Rica	8.33	4.39	0.52	0.04	2.19	1.18
45	Ghana	8.05	2.87	1.39	0.01	2.70	1.07
46	Zimbabwe	7.69	4.21	0.48	0.004	2.11	0.87
47	Vietnam	7.60	3.19	0.74	0.05	2.34	1.27
48	Bangladesh	7.25	4.17	0.60	0.003	1.57	0.89
49	El Salvador	5.41	2.46	0.21	0.016	1.89	0.82
50	Kyrgyz Republic	4.82	2.13	0.44	0.005	1.28	0.94

*Weighted scores as per the respective Pillar weightages in Table 7.1


AVERAGE SCORE
Graph 8.1 – GEOSPATIAL READINESS SCORE:
Comparative Regional Overview
69.00
85.95
60.87
30.91
54.21
29.10
Data Infrastructure
19.86
12.12
7.26
4.70
3.82
4.60
Industry Fabric
19.85
3.57
2.18
0.40
0.39
0.14
Institutional Capacity
19.03
26.32
17.76
8.83
10.65
11.61
Policy Framework
11.40
12.57
7.43
4.80
5.80
3.53
User Adoption Level
29.94
28.78
19.90
11.12
16.46
10.61
Regional Geospatial Readiness Score
North America
Europe
Asia Pacific
South America
Middle East
Africa

COUNTRIES GEOSPATIAL READINESS ASSESSMENT FRAMEWORK

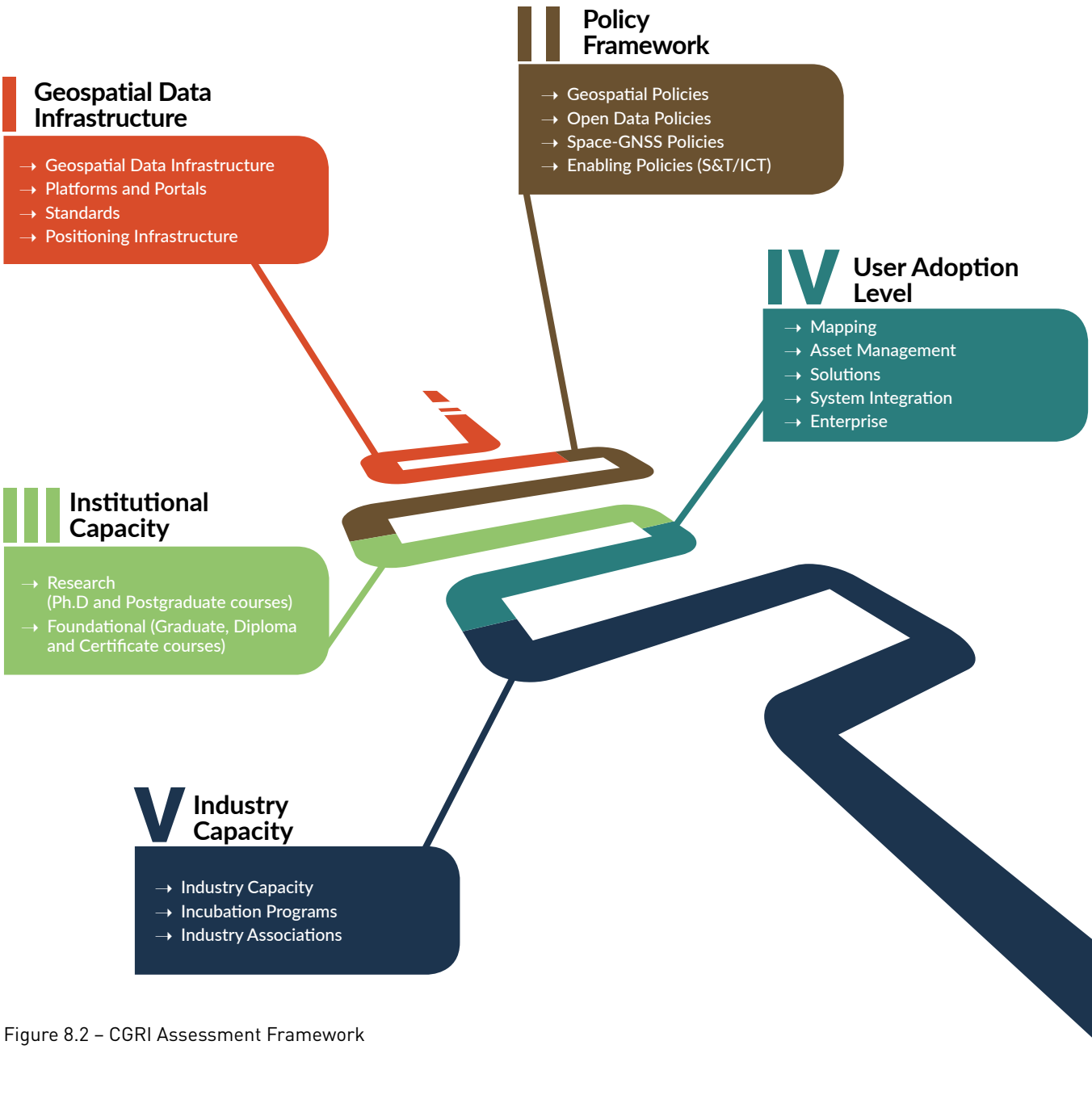


Figure 8.2 – CGRI Assessment Framework

Pillar I: Geospatial Data Infrastructure Index

Overview

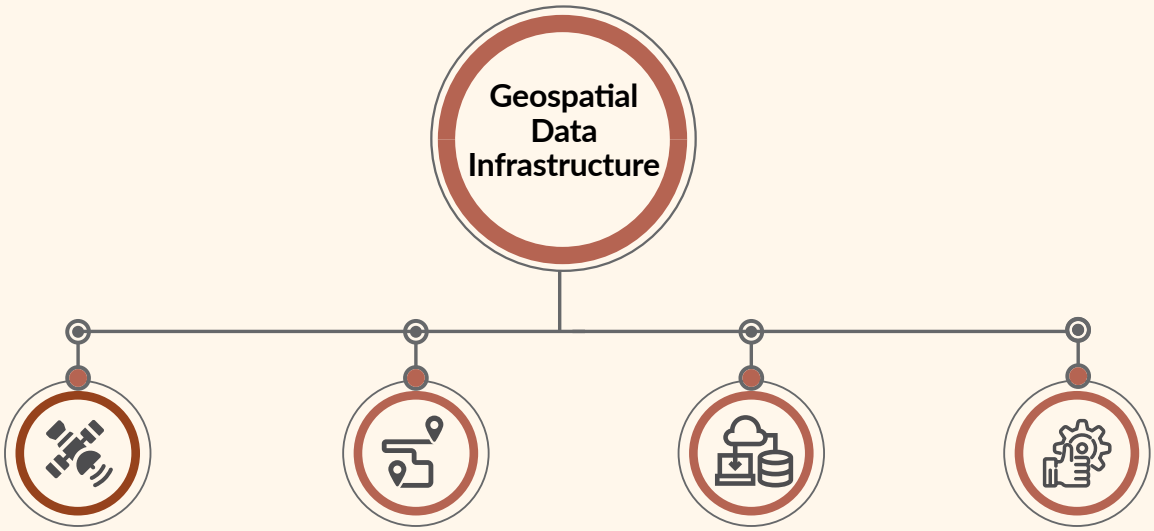
The Geospatial Data Infrastructure pillar assesses the select 50 countries on their relative strengths on:

(a) Topographic and Earth Observation Data Infrastructure: Information on existence and maturity of the National Spatial Data Infrastructure (NSDI), national mapping and survey agencies and remote sensing/ earth observation and space agencies; data availability and access modules, available scales and frequency of updation of the thematic layers, and resolution of the available earth observation imagery.

(b) Positioning Infrastructure: Positioning systems, Satellite Based Augmentation Systems (SBAS) and Geodetic Infrastructure (inclusive of RTK Base Stations and Ground Control Points).

(c) Platforms and Portals: Maturity level of the geospatial technology architecture, and data dissemination modules.

(d) Standards: Existence, evolution and integration of interoperable standards.



KEY INFERENCES →

Data Infrastructure
(Topographic and Earth Observation)

→ USA, Singapore, United Kingdom, Denmark and The Netherlands have a mature National Spatial Data Infrastructure (NSDI) with availability of high scale (1:200 - 1:500) and regular updation of thematic layers.

→ Leveraging the European Commission's INSPIRE initiative, the European bloc countries - Belgium, Poland, Austria, Germany, Spain, Sweden, Norway and Finland, have NSDI's at an advanced stage. The bloc is also at an advanced stage of earth observation data infrastructure setup.

Positioning Infrastructure

→ USA's GPS, Russia's GLONASS, European Union's GALILEO, Japan's Quasi Zenith Satellite System, and India's NAVIC are established positioning systems.

→ USA's WAAS, Europe's EGNOS, Japan's MTSAT, India's GAGAN, and South Korea's KAAS (under implementation), are Satellite Based Augmentation Systems.

Platforms and Portals

→ United Kingdom, USA and Singapore and the European Bloc countries like Denmark, The Netherlands Germany, France, Poland, Italy, Belgium, Norway and Finland have a defined operational geospatial technology architecture and are in the planning stages of creating their own Centralized Analytical Platform.

→ Developing countries like India, South Africa, Malaysia and Indonesia are in the initial stages of development of their platforms and portals.

Standards

→ Most countries follow/ adapt to international standards for geospatial data like Geospatial Data Quality Standards (ISO 19157)

→ In all countries, standards are mostly being adopted using international standards such as ISO and OGC.

→ China and Japan have stand alone domestic standards. China specifically has more than 250+ standards of its own for geospatial data and information.

Rank 2018	Country	Score
1	USA	139.74
2	Singapore	112.39
3	UK	106.16
4	Denmark	105.43
5	China	104.63
6	The Netherlands	102.74
7	Belgium	96.35
8	Switzerland	93.55
9	South Korea	93.11
10	France	89.18
11	Austria	88.98
12	Spain	88.78
13	Poland	88.77
14	Germany	86.75
15	Russia	85.7
16	Australia	85.12
17	Canada	83.22
18	UAE	81.03
19	Japan	80.57

LEADERS

→ Geospatial data infrastructure in these countries is at an advanced stage with a functional and effective National Spatial Data Infrastructure, National Mapping Agency and National Space Agency in place. The NSDI of the countries of this bloc are at Stage III (as per UNGGIM designations). A well-defined framework of information management policies incorporating geoprocessing (also known as geo-analytics), mobile applications and customized web applications exists in all these countries for leveraging nationwide geospatial information available from all distributed source agencies

→ The thematic layers such as cadastral, topography, utility network, transport network, soil and land cover are available at higher scales ranging from 1:200-1:5,000 with monthly to half-yearly frequency of update.

→ The resolution of the earth observation imageries provided by the designated agencies in the leader bloc is of the highest resolution, ranging from 1-2m or <1m for enterprise level use.

→ Geospatial data and information in these countries is largely open and freely available to its citizens and governments. If data is available on a paid basis, it is of the highest scale or high resolution.

→ The geospatial technology architecture of these countries facilitate an easy use of geospatial information and are moving towards the development of in-built centralized analytical capability in their platforms

Rank 2018	Country	Score
20	Italy	79.37
21	Sweden	75.77
22	Portugal	73.59
23	Greece	67.39
24	Norway	66.88
25	Finland	65.53
26	New Zealand	62.46
27	India	59.89
28	Thailand	58.94
29	Brazil	50.32
30	South Africa	43.42
31	Philippines	43.35
32	Egypt	42.10
33	Indonesia	40.76
34	Malaysia	38.68

CHALLENGERS

→ Countries in this bloc have set up their NSDI such that access to collection and aggregation of geospatial information (not only maps), is accessible over the web for online use, and downloading for offline use for distributed maintenance and use.

→ The data available through geoportals in these countries is partially open and free for citizens and government compared to the leader bloc countries. Datasets are also available on license or paid basis while many are restricted.

→ The technology architecture of these countries is well-developed. They have an integrated data center in place and are in the process of developing a functional clearing house.

→ The thematic layers such as cadastral, topography, utility network, and transport network are available at scales of 1:5,000 to 1:25,000 with frequency of updates at half-yearly or in a year.

→ The resolution of the earth observation imageries provided by the designated agencies in the leader bloc is of medium resolution, ranging from >2-5m or 1-2m. The European bloc countries like Italy, Sweden, Finland, and Norway also obtain earth observation imagery of resolution <1m provided by the European Space Agency (ESA).

Rank 2018	Country	Score
35	Colombia	38.02
36	Kenya	35.67
37	Chile	32.04
38	México	31.08
39	Argentina	27.58
40	Oman	27.40
41	Uruguay	25.15
42	Ethiopia	24.75
43	Nigeria	22.36
44	Costa Rica	21.95
45	Zimbabwe	21.08
46	Bangladesh	20.89
47	Vietnam	15.95
48	Ghana	14.35
49	El Salvador	12.33
50	Kyrgyz Republic	10.68

ASPIRERS

→ While some countries have NSDI at the basic level, other countries are still at the planning, designing and implementation stage.

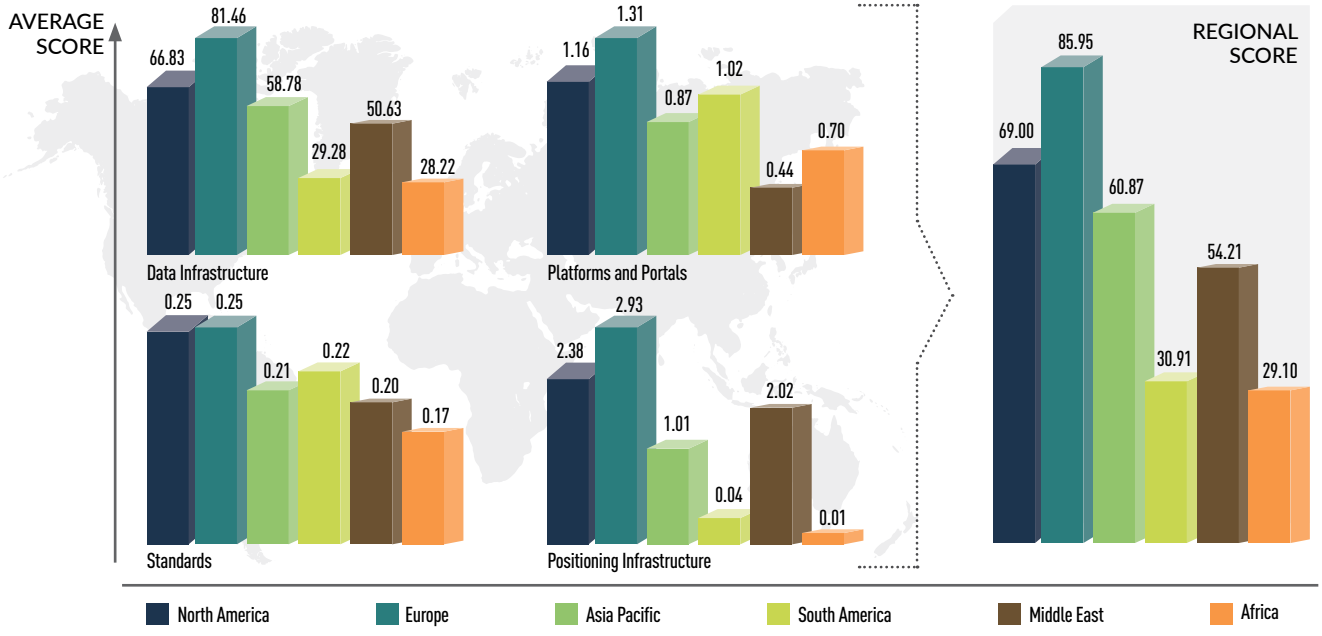
→ The thematic layers available in the country are not of high scales, and range from 1:40,000 to 1:250,000 or above. The frequency of updates also lags with most of the layers being updated after three-five years.

→ While most of these countries have a designated national space agency, more often than not these countries neither have earth observation satellites or launching capacities of their own. The earth observation data provided for use is of low resolution (>5m; >2-5m) in these countries.

→ The geospatial data architecture inclusive of platforms and portals is in the development stages for most countries. Some countries have view-only web portals with an integrated data center to be enabled soon.

→ Spatial data sharing is conservative and restricted, inter- and intra-data linkages are not encouraged. Data dissemination is limited to mostly traditional methods like CD/DVD and FTP, and the importance of data standards is yet to be realized.

Graph 8.2 – Geospatial Data Infrastructure: Comparative Regional Overview



HIGHLIGHTS

— United States of America (USA), is at the forefront of the geospatial data infrastructure pillar. With its NSDI in place, the country has thematic layers for topography, cadastral, transport, utility, agriculture, disaster management, hydrology, buildings and infrastructure – all at a high scale ranging from 1:200; 1:250 to 1:5,000. The country was also the first to establish the Global Positioning System (GPS), which is being used widely across the world. With the Satellite Based Augmentation System, Wide Area Augmentation System (WAAS), and an efficient geodetic infrastructure in place, USA sets the example for its counterparts in terms of data infrastructure, and its governance mechanisms.

— The European bloc countries set up their NSDIs under the Information for Spatial Information in Europe i.e. the INSPIRE Directive. The Directive served as a reference framework for the European Union member states to share 34 different spatial data themes with each other and 'guidelines' or 'implementing rules' to set up their own NSDI's. Following the INSPIRE Directive, all European countries set up their NSDI, and opened their datasets for easy access to citizens and governments. Simultaneously, with each country being a member of ESA, the countries have direct access to high resolution satellite imagery (<1m) disseminated through their own respective space agencies.

— The Indian NSDI story began with a directive issued by the Department of Science and Technology in 2000. Since then, the country has moved towards the formulation of a geoportal in 2008 which complies with OGC standards and hosts OGC compliant metadata. India's space agency, the Indian Satellite Research Organization (ISRO), has enabled a satellite-based regional positioning system called NAVIC and augmentation system called GAGAN. Bhuvan and Naksha platforms, geospatial data and information is made freely available to the citizens of the country.

— The Netherlands ranks higher for the topographic and the earth observation data portal, with free access to both raw and processed data. It is also one of the few countries to establish a cloud-based web portal for real-time satellite data access. The portal is an integrated data centre for Sentinel data and all data of the European Space Agency.

— Emerging economies such as Bangladesh, Vietnam, Kyrgyz Republic, Colombia, Ghana, and Nigeria, are at the beginning of setting up their geospatial infrastructure, i.e. NSDI, and a space agency. The national data infrastructure in these countries is still in the planning, designing or implementation stage. While national mapping agencies of these countries are custodians of a wide range of datasets, the scales at which most of the thematic layers are available is very low and most often than not, non-actionable for precision,and commercial uses. The development of geospatial technology architecture in these countries is also at an embryonic stage and has a long way to reach the level of its developed counterparts.

Pillar II: Geospatial Policy Framework Index

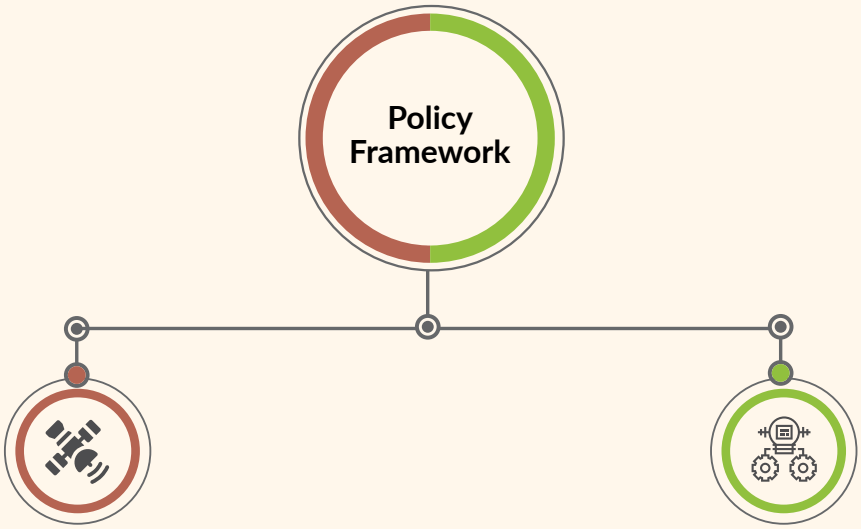
Overview

The Policy Framework pillar assesses the select 50 countries on their relative strengths on the basis of

(a) National Geospatial Policy Framework: Assessment of countries on the evolution of their respective national, political and administrative geospatial policy/legislations, rules and regulations, open data policies, and Space-EO-GNSS policies

(b) Enabling policies framework: Assessment of countries on the existence status of Science and Technology (S&T), Innovation policies and Information and Communication (ICT) policies.

The final assessment of the policy framework of 50 countries takes into account the global e-government development index and open data competitiveness index for understanding the assessment of the geospatial domain.



KEY INFERENCES

Geospatial Policy Framework

National Geospatial Policy | Open Data Policy | Space, EO, and GNSS Policy

→ USA, Russia, Japan, Canada, South Korea, Singapore and EU bloc countries are leaders with policies and legislative frameworks for integrated development and adoption of geospatial information and technologies

→ The adoption of collaborative frameworks/approaches by European Commission (EC), and the European Space Agency (ESA) in the last decade is the reason behind the overall leadership of EU countries in the policy domain. The leaders within the European bloc are United Kingdom, Germany, Austria, Italy, Spain, Norway, Sweden, Switzerland, France, and Poland.

→ Asian economies such as China, Singapore, Malaysia, India, and Philippines are moving forward on the development of a national level policy and legislation framework for NSDI, Space and space-related activities, and UAVs and Drones. For instance: Space Policies in India, Vietnam, and South Korea are in-process; national geospatial policies in Malaysia and India is under development; and there are rapidly evolving guidelines in China for geospatial information usage.

Enabling Policy Framework

Science & Technology (S&T), and Innovation Policy | Information & Communication Technology (ICT) Policy

→ Singapore, USA, South Korea, Japan, Canada, Australia, United Kingdom and leading EU block countries have advanced levels of national level digital governance initiatives in place, apart from strong Science & Technology and Innovation policies and legislative frameworks. These are backed by broad-based ICT infrastructure, stress on participatory and transparent governance.

→ EU countries like Denmark, The Netherlands, Germany, Sweden, Portugal and Austria have national Science & Technology and Innovation policies and strategies inspired from The National Research and Innovation Strategy 2020; and the Europe 2020 Strategy as laid by the European Commission.

→ Australia, South Korea, Mexico, India, Philippines, Canada and China outperform their developed peers in terms of enabling policy environment. With an increased focus on innovation, these countries are re-focussing their year-on-year strategies towards science and technology and innovation.

Rank 2018	Country	Score
1	United Kingdom	35.43
2	United States	32.32
3	Poland	29.95
4	Sweden	29.73
5	Germany	28.14
6	Russia	27.85
7	Italy	27.73
8	Austria	27.33
9	Denmark	26.96
10	Singapore	26.89
11	Belgium	26.65
12	The Netherlands	26.45
13	France	26.21
14	Switzerland	26.12
15	Canada	26.08
16	Japan	25.97
17	Spain	25.62
18	Australia	25.18

LEADERS

→ The leader bloc countries have an enabling national geospatial policy framework (inclusive of data dissemination and data access), policies supporting the implementation of National Spatial Data Infrastructure, surveying and mapping policies, open data policies for geospatial data and otherwise, and Space policies. For instance, Italy's Legislative Decree Number 32 (27.01.2010), which transposes the INSPIRE Directive into national legislation, and Japan's Basic Act on the Advancement of Utilizing Geospatial Information (2007)

→ These countries have specific policies for remote sensing and earth observation (separate from Space policy), GNSS and positioning policies. For instance, United States Commercial Remote Sensing Policy, and US Spaced-Based Positioning, Navigation, and Timing Policy (2004); and Japan's Basic Space Law, etc.

→ Dedicated year-on-year policies and strategies to encourage science and technology and innovation in their respective countries such as Germany's Federal Government's High-Tech Strategy (HTS), or Russia's Innovation Development Strategy 2020.

→ Future action plan and policies have been drafted and submitted for approval to the decision makers. For Instance: United States Geospatial Bill is submitted in the Congress for approval.

Rank 2018	Country	Score
19	Norway	24.35
20	South Korea	23.96
21	Finland	23.68
22	Philippines	19.42
23	South Africa	19.29
24	Portugal	19.23
25	Malaysia	19.14
26	Greece	18.52
27	Thailand	18.15
28	India	17.92
29	China	17.65
30	UAE	16.84
31	Nigeria	16.66

CHALLENGERS

→ The countries in this bloc understand the importance of an enabling geospatial policy framework. In some cases, the national geospatial policy is being incorporated in the national development plans while in others, a draft of the policy framework has been submitted for review. For instance, Malaysia is developing a National Geospatial Master Plan by 2018, and the Philippines Development Plan 2017-2022 is inclusive of the National Space Strategy (NSS).

→ These countries have Open Data strategies in place. However, these do not specifically relate, for instance, South Africa's Open Data Policy; Malaysia's Open Data initiative under the 11th Five Year Plan.

→ Countries in this region either have a specific Space policy or a dedicated earth observation or remote sensing data policy. These countries also have dedicated UAV policies and regulation. For instance, India's Remote Sensing Data Policy of 2011.

→ Dedicated policies for Science, Technology and Innovation and ICT exist in these countries.

Rank 2018	Country	Score
32	Brazil	14.60
33	Ghana	13.96
34	Indonesia	13.78
35	New Zealand	12.65
36	Mexico	12.45
37	Chile	11.75
38	Kenya	11.57
39	Colombia	10.46
40	Argentina	9.29
41	Vietnam	7.46
42	Bangladesh	6.03
43	Costa Rica	5.29
44	Zimbabwe	4.88
45	Egypt	4.88
46	Uruguay	4.76
47	Kyrgyz Republic	4.49
48	Oman	4.46
49	Ethiopia	2.90
50	El Salvador	2.12

ASPIRERS

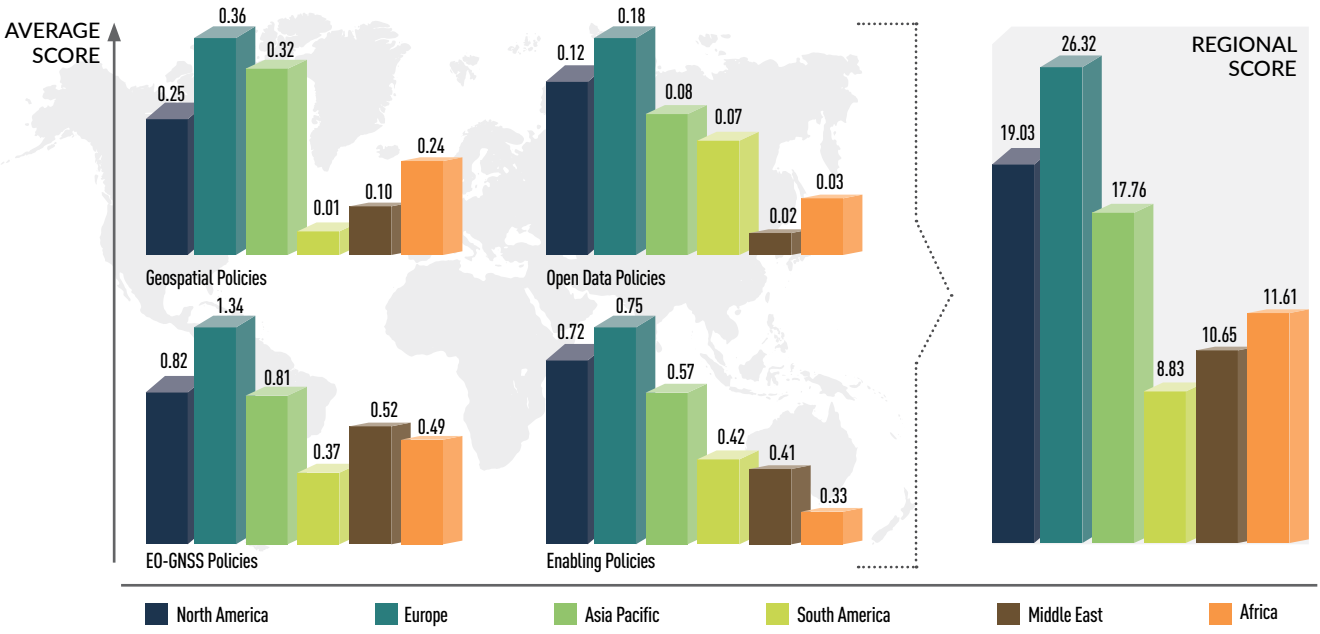
→ Countries in this bloc are either on the verge of developing their geospatial policy frameworks (except Indonesia), or are not taking an initiative to develop a comprehensive framework on the subject.

→ Most of the countries are at the initial stage of developing a comprehensive legal framework for Science, Technology and Innovation Policy and Strategy.

→ These countries do not have adequate aerospace capabilities and therefore, do not have a Space policy, earth observation and remote sensing policy. These countries also lag in policies pertaining to GNSS and UAV and drone.

→ Open data initiatives are in place in most countries; however, these do not necessarily pertain to the use of geospatial data and information.

Graph 8.3 – Policy Framework: Comparative Regional Overview



HIGHLIGHTS

— USA leads with advanced policies and strategies for tactical as well as commercial growth of geospatial information and technologies in the country. These include the National Geospatial Policy, Open Data Policy, 2010 National Space Policy with the 2013 National Space Transportation Policy, and the Commercial Remote Sensing Space Policy (2003), providing a strong national-level geospatial domain policy framework. In support, the Science and Technology and Innovation policy of the country facilitates the already growing geospatial segment in the country.

— There is a global recognition of a national geospatial policy or legislation for holistic management of geospatial information and technologies. USA has already submitted its National Geospatial Bill for approval in Congress; Government of India has proposed the Geospatial Information Regulation Act, 2016 ("Proposed Act"), and simultaenously the draft of Space Activities Bill 2017 is also up for review; Malaysia is all set to release its National Geospatial Master Plan (NGMP) in May 2018, and in Chile a National Geospatial Policy proposal has been submitted to decision makers in 2016, is awaiting approval.

— Vietnam, Bangladesh, Zimbabwe, El Salvador, Ethiopia, Uruguay and Costa Rica are few countries that which do not have any Space or Space related policy (inclusive of earth observation data sharing). While in Vietnam, the Space policy inclusive of GNSS is in progress, the other countries have no such initiatives at present.

— Australia, known for its advanced status in usage of geospatial information/EO data, is now focussing on enhancing its Space sector capacities by setting up its national Space agency. The country's Space Utilization Policy (2013) and the Australian Space Research Program (ASRP) sets out priorities for Australia's use of Space and Space-related technologies.

— USA, United Kingdom, Russia, Germany, Austria, Singapore, Spain, The Netherlands, Australia, Sweden, Japan, and South Korea are countries with dedicated innovation policies or a strategic framework to promote innovation. By and large most of the countries such as India have a single policy framework for Science and Technology which have been improved to cover innovation.

— Almost all the countries, barring El Salvador, have a National Information and Communication Technology (ICT) policy/legislation or strategy framework in place as a basic enabling framework for the development of information and communication infrastructure.

Pillar-III: Geospatial Institutional Capacity Index

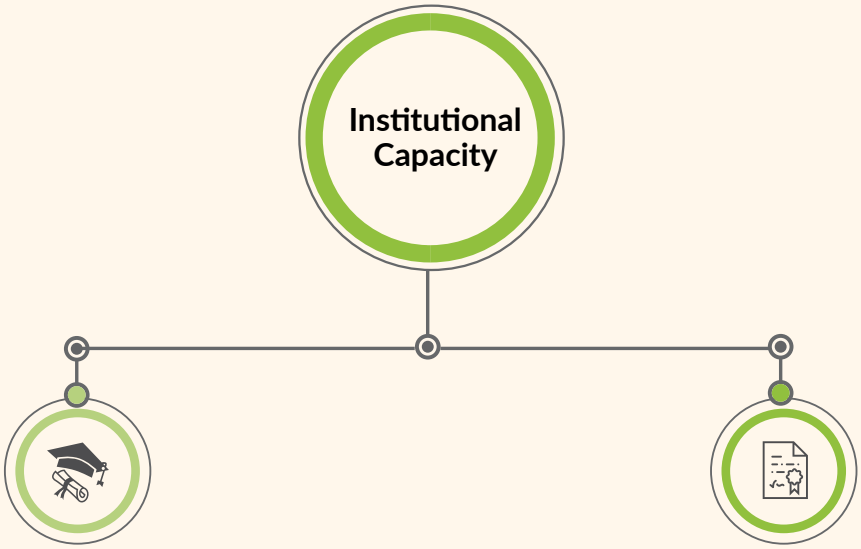
Overview

The Institutional Capacity pillar assesses the select 50 countries on their relative capacities in delivering the following:

(a) Geospatial Science and Technology courses at Post Graduate and Research (Ph.D.) levels.

(b) Geospatial Domain Graduation, Diploma (1-3 years) and Certificate courses (graduate and post graduate levels).

More than 1,300 institutions and 4,500 courses (yet not exhaustive) in these countries were mapped for various course levels as pure or interdisciplinary (electives of GIS, and remote sensing) offerings. The comparative assessments of the countries have been made on their relative strengths in geospatial domain science and research, application-oriented courses.



KEY INFERENCES →

Research and Post-Graduate courses

(Knowledge Creation)

→ USA, Russia, The Netherlands, Germany, United Kingdom, Japan, China and Canada stand out for distinctive courses in various geospatial segments such as Geomatics, Remote Sensing, Geographic Information Systems (GIS), and Geodesy, apart from a number of interdisciplinary course such as Engineering, Urban Planning, Marine Sciences, and Environment Sciences, among others.

→ The courses in the European bloc are comparatively more focussed on business and management studies than geospatial science, and research and graduation courses. However, these countries offer moderately adequate number of post graduate inter-disciplinary courses in geospatial domain.

→ Among Asian economies, India, China, Malaysia, Philippines, and Indonesia have high number of universities offering courses at all levels, i.e. doctoral, postgraduate, graduate and vocational training programs. However, even though the number of courses and institutes may be high, the quality of education differs significantly when compared to its western peers

Graduate, Diploma and Certificate courses

(Foundational Academia)

→ China, India, Philippines, Indonesia, South Africa, Brazil, and Kenya display significant strength in the availability of graduate-level geospatial domain courses, diploma and vocational training programs catering to the demand of entry level/field work force in these emerging economies.

→ The universities in USA have the highest number of certificate programs among the 50 countries. The certificate programs are specific to GIS, Remote Sensing, GPS, and Surveying, offering specific specialization to their students.

→ Many of the African and South American countries rank lower in this pillar compared to their peers due to very few single discipline geospatial graduate programs as well as interdisciplinary program choices. Strikingly, the number of diploma programs and certificate programs in the countries are also low.

Rank 2018	Country	Score
1	United States	67.583
2	United Kingdom	17.057
3	Canada	11.213
4	Singapore	7.088
5	Australia	6.339
6	Germany	6.150
7	The Netherlands	4.929
8	Spain	4.524
9	China	4.270
10	Switzerland	3.750
11	New Zealand	3.697
12	Japan	3.072
13	Sweden	3.001

LEADERS

→ Most universities have dedicated doctorate, post-graduate and graduate programs in the field of geospatial education. For instance, University of Twente offers a Ph.D. in Geoinformation and Earth Observation, Ph.D. in Acquisition and Quality of Geospatial Information and a Ph.D. in Spatio-Temporal Analysis, Maps and Processing.

→ Countries have a wide range of inter-disciplinary courses inclusive of a GIS or a remote sensing elective. These courses range from M.Sc. Agricultural and Biological Engineering (Space applications with NASA at Kennedy Space Centre) by the University of Florida – to BS.c. Civil Engineering (emphasis on Geomatics), at Marshall University, U.S.A., and many more such courses.

→ These countries also have a huge number of diploma and certificate programs catering to the development of application oriented expertise in techniques related to geospatial domain. For instance, the Geographic Information Science and Technology (GIST) certificate program of University of Southern California Spatial Sciences Institute; Diploma in Geoinformatics at Leibniz Universität Hannover.

Rank 2018	Country	Score
14	Belgium	2.562
15	Austria	2.543
16	Finland	2.391
17	India	2.136
18	Portugal	1.965
19	South Korea	1.842
20	Denmark	1.831
21	Norway	1.791
22	France	1.584
23	Malaysia	1.426
24	Italy	1.364
25	Russia	1.106
26	Poland	1.076
27	Brazil	1.064

CHALLENGERS

→ Geospatial Domain courses are being increasingly offered as an elective under School of Engineering, School of Architecture, School of Sciences, and School of Information Technology. The courses in these countries are mostly offered as elective programs with main courses. For instance, Bachelors in Engineering Geology in Civil Engineering by Seoul National University, South Korea; M. Tech. in Surface Water Hydrology & Ground Water Hydrology by IIT Roorkee, India; and M.Sc. Urban Planning (Geoinformatics) by University of Copenhagen, Denmark.

→ Samara National Research University of Russia is a unique University that offers specific courses in the GNSS domain. The University offers Ph.D. in GNSS Technology, Masters in GNSS Algorithms and Hardware and Masters in GNSS Positioning, Algorithms and Applications, among many other geospatial domain courses

→ Developing countries like India, Malaysia, South Korea, and Brazil are keen on opening up their universities to more geospatial-domain related and inter-disciplinary courses. These countries have adequate number of post-graduate and graduate courses, but lack in the number of Ph.D. and research courses.

Rank 2018	Country	Score
28	Thailand	0.843
29	UAE	0.573
30	Greece	0.551
31	Chile	0.500
32	South Africa	0.470
33	Indonesia	0.436
34	Colombia	0.420
35	Mexico	0.405
36	Vietnam	0.251
37	Oman	0.203
38	Costa Rica	0.198
39	Philippines	0.177
40	Egypt	0.175
41	Argentina	0.157
42	Uruguay	0.154
43	Kenya	0.133
44	El Salvador	0.079
45	Nigeria	0.074
46	Ghana	0.069
47	Ethiopia	0.047
48	Kyrgyz Republic	0.024
49	Zimbabwe	0.022
50	Bangladesh	0.015

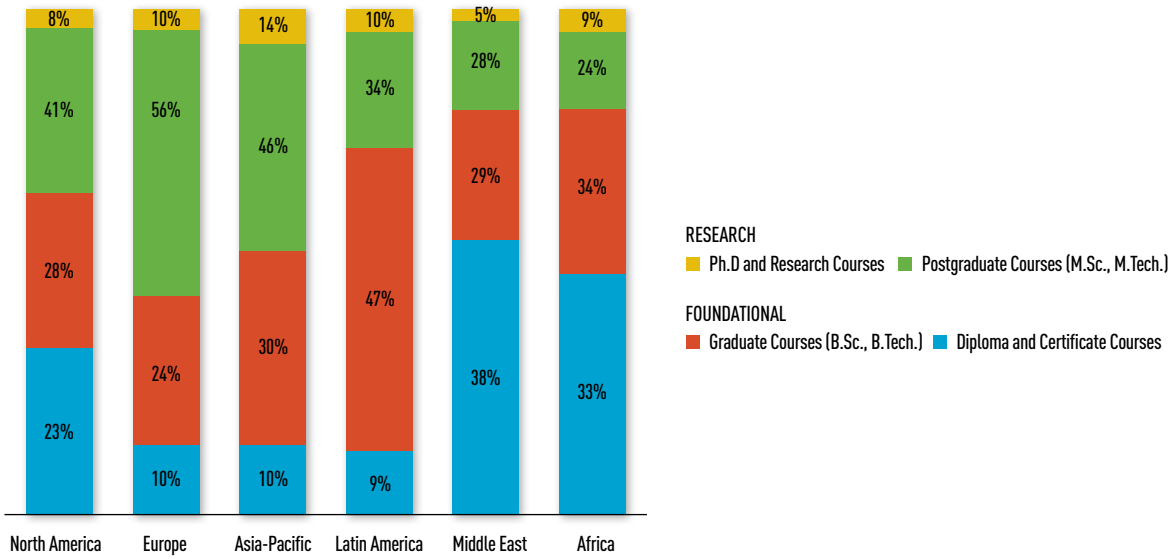
ASPIRERS

→ Universities in this domain are offering multiple inter-disciplinary courses with electives mainly in geographic information systems (GIS) and remote sensing.

→ The number of universities offering geospatial discipline courses is comparatively few in these regions. Spatial technology advancement is taking place in these countries but the qualitative education sector is still at a nascent stage.

→ Dominant courses in these regions are certificate and diploma courses to prepare skilled workers for on-field/spatial analytics/ sales jobs.

Graph 8.4 – Institutional Capacity: Comparative Regional Overview



HIGHLIGHTS

— The Russian University, Samara National Research University (Samara University), is one of the very few universities in the world that offers world-class education in aerospace engineering. The university provides a wholesome experience of engineering, developing, launching and operating a satellite on its campus. In addition, well-established courses in geospatial technologies such as GNSS hardware and software, space engineering, and cartography, are available in the country.

— USA, Germany, United Kingdom, Australia, Canada, Poland, Italy, Japan, Switzerland, China, and The Netherlands have strong science and research, and academia courses. With numerous doctoral and postgraduate programs in Geodesy, Remote Sensing and GIS, Geoinformatics, Engineering and Mathematical Science streams among others, available, these countries have a well-rounded geospatial knowledge and human resource creation capacity catering to overall user adoption, industry and entrepreneurship advancement.

— Middle-income countries such as India, New Zealand, Brazil, Indonesia, Malaysia, and Chile have an abundant number of universities offering both mainstream and interdisciplinary courses in almost all segments of education. It can be explicitly said that the adoption of geospatial technologies is rising in these countries in lieu of their economic growth, favourable demographics in turn contributing to demand of skilled human resource mainly in the service segments.

— The European Bloc inclusive of Sweden, Austria, Portugal, Spain, Denmark, Norway, Belgium, Finland and France, offer moderately adequate number of courses specific to geospatial domain and numerous interdisciplinary courses in both science as well as research and academia.

— An overall perspective of the 50 countries is that only a few of the leading countries offer single discipline-focussed geospatial courses. However, the need for integration of geospatial education such as GIS, or Remote Sensing in sectors such as Agriculture, Mining, Construction, Urban Development, Environment Sciences and Marine Sciences is being increasingly realised and the high number of interdisciplinary courses substantiate this.

Pillar - IV: Geospatial User Adoption Pillar Index

Overview

The User Adoption Pillar assesses the select 50 countries on the basis of 'stage of use' of geospatial information and technology in the country. These stages are broadly classified as:

(a) Mapping or Service Level: Digital map-based visualization and analytics communication.

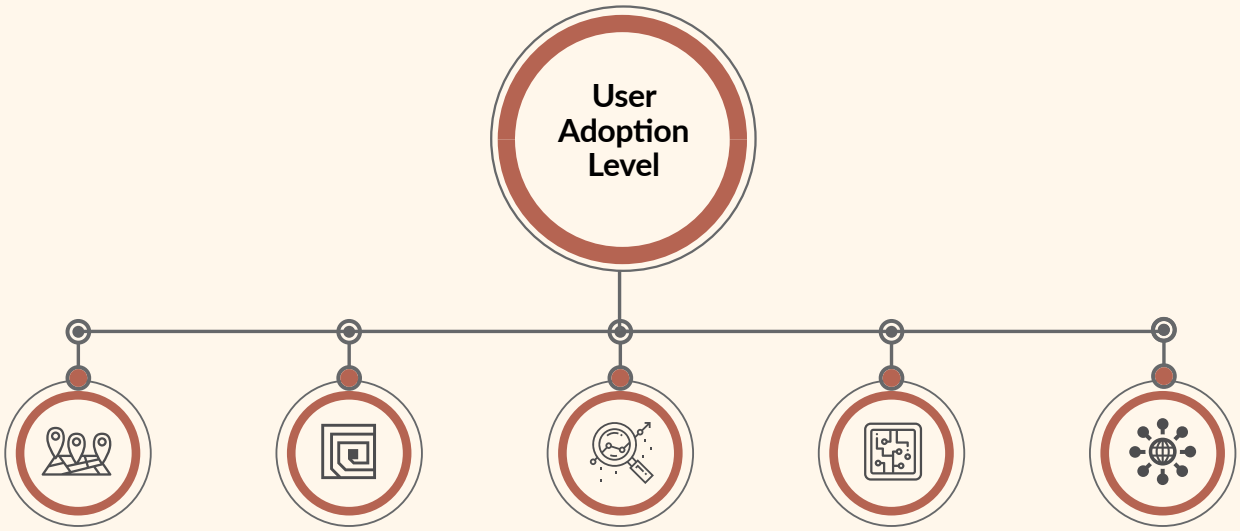
(b) Asset Management/Business Process Modelling: Asset mapping, monitoring and management.

(c) Analytics and Workflow Level: Integrating location information for business insights and process management.

(d) System Integration Level: Customized solutions involving integration of multiple platforms.

(e) Enterprise Level: Enterprise wide adoption in all business processes and stakeholders.

The final evaluation of the user adoption level takes into account a survey-based user perspectives on adoption level of geospatial technologies at their enterprise level, perception on national-level adoption, policy facilitation and decision makers understanding on value proposition and analysis of case studies in the last three years.



	Mapping or Service Level	Asset Management	Analytics and Workflow	System Integration Level	Enterprise Level
KEY INFERENCES →	→ USA, UK, Canada, Japan and leading EU countries such as Germany, Switzerland and The Netherlands among others are advanced digital and interactive map users for decision making.	→ USA, UK, Germany, The Netherlands, Singapore, France and Canada are countries where governments and management practises proactively encourage adoption of geospatial technologies to enhance efficient and productive resource utilization.	→ Government departments and public utilities department in Singapore, USA, The Netherlands, Austria, Norway, Canada and Germany use geospatial analytics extensively in planning and decision making using historical data and future modelling.	→ USA, United Kingdom, Denmark, Japan, Germany, The Netherlands, Singapore, other EU block countries lead in use of geospatial information in an integrated manner for customized solutions.	→ USA, Singapore, Canada, United Kingdom and The Netherlands are at the forefront of integrating geospatial solutions for all levels of organizations for informed decision-making, scalability, efficiency and higher returns on investment.

Rank 2018	Country	Score
1	USA	33.099
2	United Kingdom	32.084
3	Singapore	30.276
4	Netherlands	29.054
5	France	28.890
6	Canada	28.689
7	Germany	28.136
8	Austria	25.645
9	Switzerland	24.613
10	Spain	24.462

LEADERS

→ These countries demonstrate integration of geospatial information at all stages (i.e. use levels), across user segments. The scale and spread of use cases in these countries indicate advanced use of maps, geospatial analytics, integration of real time and historical spatial information using customized solutions to meet client needs.

→ Users in these economies are early adopters of advanced solutions developed by the geospatial industry to meet citizen/customer expectations, enables seamless integration of spatial and non-spatial data to deliver innovative solutions for entrepreneurs. The maturity levels of adoption of geospatial information are high in these countries.

→ Broad-based user segment inclusive of government, private sector, citizens, and academia and research.

Rank 2018	Country	Score
11	China	22.968
12	Russia	22.802
13	Japan	22.726
14	Australia	22.691
15	Belgium	22.476
16	Norway	21.805
17	Denmark	21.694
18	Finland	21.631
19	Sweden	21.157
20	Italy	20.541
21	South Korea	19.912
22	New Zealand	19.746
23	UAE	18.097
24	Portugal	17.441
25	India	16.885
26	Poland	16.001
27	Brazil	15.846
28	Malaysia	15.592
29	Oman	15.230

CHALLENGERS

→ The Challengers bloc comprises mostly of the emerging Asia-Pacific and the European bloc economies.

→ The users of these countries are proficient in integrating spatial information with mobile and web technologies and other workflow processes.

→ Rapidly expanding, digitally transforming economies of India, China (among others), are enhancing the geospatial user base substantially with visible pockets of excellence. However, these countries have a long way to cover for integrated promotion and adoption of geospatial solutions beyond basic use levels.

→ The adoption of geospatial information at the analytics and workflow management level is accelerating in these countries. Most countries are steadily moving towards the integration of geospatial at enterprise level.

→ Enhanced use of geospatial information for asset/infrastructure management is visible.

Rank 2018	Country	Score
30	Chile	14.643
31	Greece	14.385
32	Mexico	13.581
33	Ghana	13.535
34	Uruguay	13.445
35	Colombia	13.443
36	South Africa	12.973
37	Egypt	12.908
38	Kenya	12.761
39	Nigeria	12.466
40	Ethiopia	11.975
41	Vietnam	11.738
42	Costa Rica	10.965
43	Philippines	10.631
44	Zimbabwe	10.573
45	Indonesia	10.444
46	Argentina	10.356
47	Thailand	9.633
48	El Salvador	9.463
49	Bangladesh	7.890
50	Kyrgyz Republic	6.415

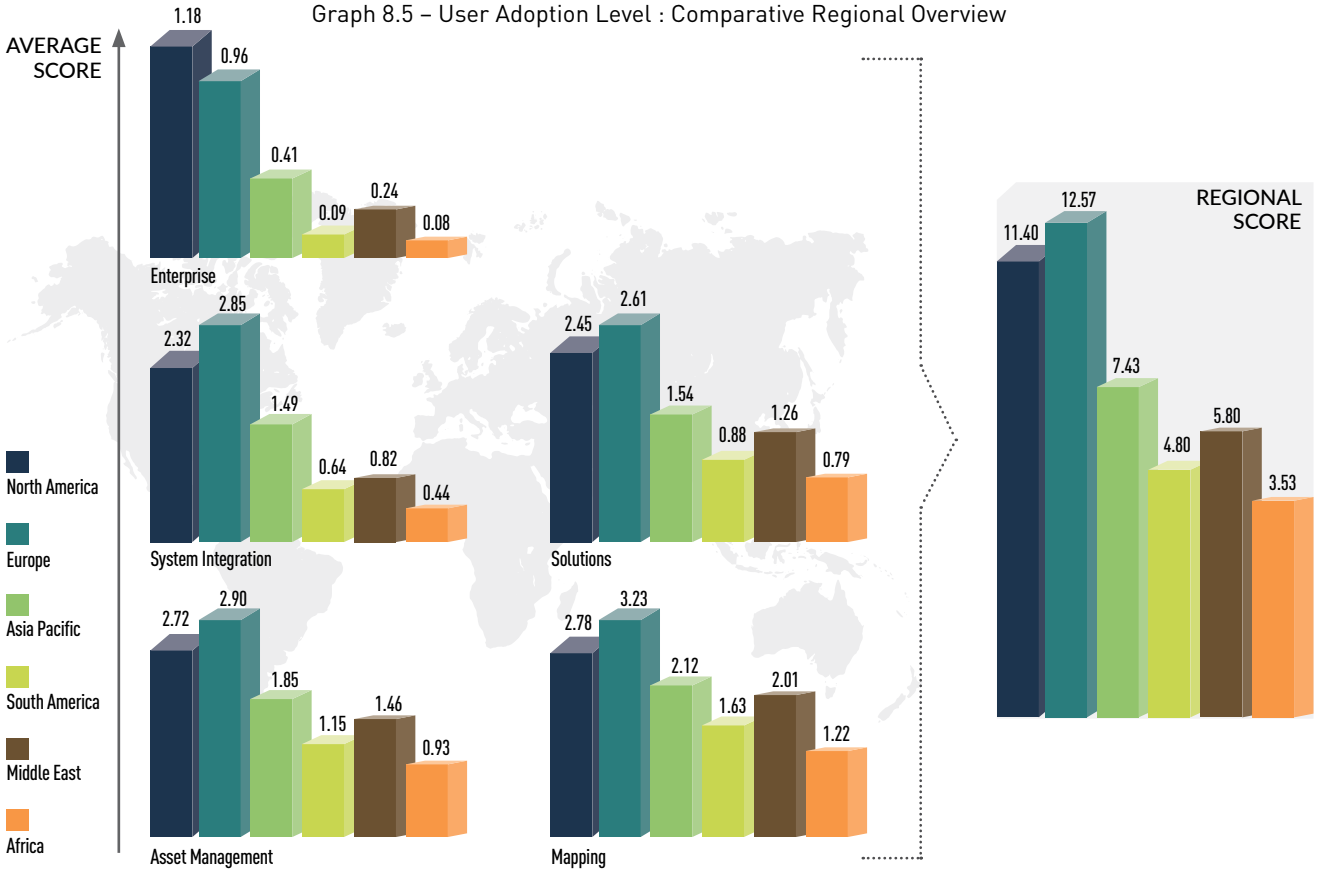
ASPIRERS

→ The adoption of geospatial information and technology is mostly limited to the government departments in these countries. The use of geoinformation by the private sector for planning is still at a nascent stage.

→ Most countries have not moved beyond the mapping level while some have initiated adopting geospatial information for asset management.

→ Adoption of geospatial information and technology at the system integration and enterprise level is absent in these countries due to lack of necessary domain knowledge, capabilities and infrastructure.

Graph 8.5 – User Adoption Level : Comparative Regional Overview



HIGHLIGHTS

— USA, Singapore and the European Bloc are using maps as a highly advanced tool for decision making. Maps in these countries are digital and interactive and are used for effective visualization, and communication of analysis, in an engaging way. Geospatial information and technology is being adopted increasingly for workflow management and at the enterprise level to provide 'whole' solutions. Geospatial technology is being increasingly used in specific application sectors such as real-estate, building engineering, fire evacuations, etc., apart from the traditional ones like agriculture, construction, and disaster management.

— The user adoption of geospatial information and technologies in developing economies like India, Malaysia and the UAE is at a moderate level. While the importance of spatial data is being increasingly realized in these countries, the adoption of the technology is insignificant at the higher levels of adoption, i.e., at system integration and at enterprise levels. An interesting transition is the steady move of these countries towards using geospatial technology for business intelligence, supply chain management, customer relationships management, etc.

— The users of developed economies like the USA, United Kingdom, Germany, The Netherlands, Canada, Japan, Singapore and France are able to derive maximum benefits as they have the capability to integrate geospatial information with applications/hardware and software of a completely different ecosystem. This being said, users of these economies are able to enable spatial integration with IT and Engineering sectors to provide a unique solutions.

— UAE is the leading country from the Middle East to have adopted geospatial information and technology at the analytics and work flow management level. Driven primarily by the government segment, the adoption of geospatial technology is being used in all sectors of the country,right from police work to infrastructure planning, asset management, inventory management, manufacturing, construction and oil engineering. The country is moving strategically towards adopting geospatial information at the system integration level to provide ready solutions for its problems.

Pillar - V: Geospatial Industry Fabric Index

Overview

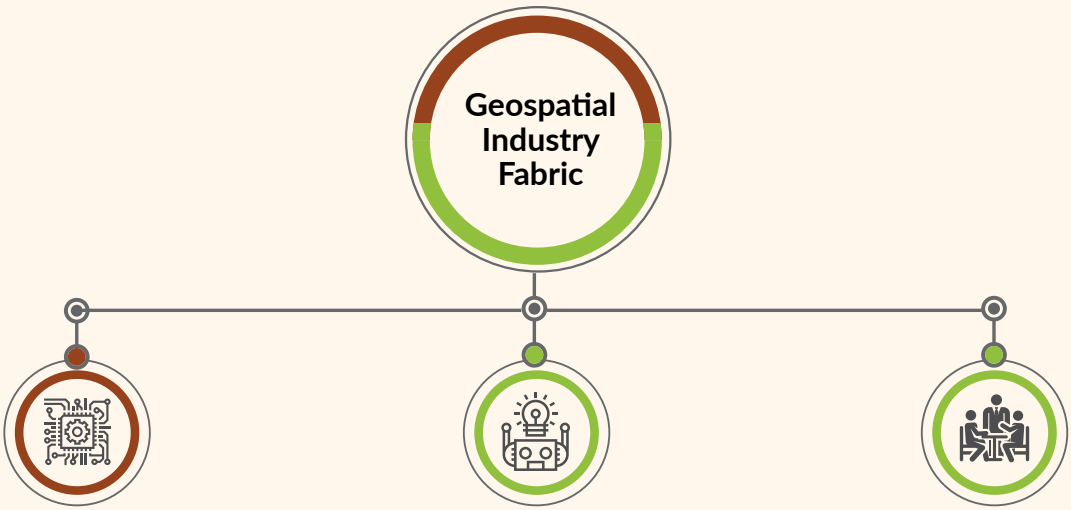
This pillar assesses the select 50 countries on their relative strengths on the basis of:

(a) Geospatial industry presence in the international arena (number of ventures and diversity),

(b) Geospatial domain-specific innovation/venture support programs, and

(c) Membership-based organizations/forums representing the local geospatial industry, institutions and professionals across industry segments.

A country's Global Innovation Index ranking has been included in analysis of geospatial domain-specific innovation support programs.



KEY INFERENCES →

Geospatial Industry Capacity

→ USA is the global leader in geospatial industry capacity across products/services and market segments

→ UK, Germany, Spain, Belgium, Canada, Japan,China, India, Portugal, Switzerland, Australia lead in geospatial industry capacity (after USA). However, their strengths vary across segments.

→ European countries lead as a bloc in their industry capacity scorecard owing to their enabling digital societies; collaborative political, institutional and industry frameworks; and their contribution to new product and service ventures in merging technology domains.

Geospatial Innovation Promotion

→ USA, Canada, Australia and European countries have dedicated geospatial domain startup creation and support programs.

→ European countries have programs dedicated for Space technology commercialisation ventures as part of the European Space Agency (ESA) incubation program.

→ National innovation programs like Startup Chile, French-Tech VISA, Startup VISA Canada, Startup Denmark, Hot DESQ Australia, K-Startup Challenge of South Korea, and Startup Brazil attract global innovators.

Geospatial Industry networks

→ USA is an unequivocal leader in geospatial industry and professional networks ensuring collective visibility, participation in knowledge, market, and policy development.

→ On a relative comparison, the geospatial industry in South east Asia, African and South American countries need to establish and strengthen industry networks for overall visibility and representation.

→ The presence of industry and professionals representative bodies serves as proxy for presence of critical mass, industry diversity and strength in specific segments.

Rank 2018	Country	Score
1	USA	54.87
2	Germany	35.06
3	UK	20.10
4	Canada	15.77
5	France	13.58
6	China	13.44
7	Switzerland	12.26
8	Spain	12.02
9	Australia	11.52
10	Netherlands	11.21
11	Italy	11.10
12	Sweden	10.74
13	Japan	10.24
14	Portugal	10.21
15	Belgium	10.10

LEADERS

→ Diverse spread of the geospatial industry players (companies, professional and industry membership networks and platforms), in products, (hardware, software, and data), services and solutions categories for various geospatial technology domains.

→ Dedicated geospatial technology business incubation as part of national programs such as Innovate UK-Catapult Centers have focus on satellite applications among other areas. Geovation Hub, UK, is focussed on property and location innovation, Space startup incubator of US, Tecterra initiative of Canada, Delta V of Australia, Start-up Delta and Top Sector Alliance for Knowledge and Innovation (TKI) program of The Netherlands are other examples.

→ These countries have well-diversified representative industry bodies, professional membership networks, and institutions belonging to various geospatial technology segments. These countries are also well-represented in international networks and platforms like FIG, Global Spatial Data Infrastructure Association (GISDA), and International Society for Photogrammetry and Remote Sensing (ISPRS).

→ Visible pipeline of emerging ventures founded in the last 10 years represents the future readiness quotient of these countries especially for the new technology areas.

Rank 2018	Country	Score
16	India	9.83
17	Finland	9.70
18	Denmark	9.63
19	South Korea	9.19
20	Austria	9.07
21	Singapore	7.79
22	Russia	7.53
23	Malaysia	7.51
24	NewZeland	7.50
25	Norway	7.35
26	Poland	7.17
27	South Africa	6.76
28	chile	6.56
29	Brazil	6.17

CHALLENGERS

→ Geospatial industry, professional and institution representation networks are present in these countries, while countries like India, South Africa, Brazil, Chile and, Malaysia are undertaking initiatives to move higher on the technology value chain adding strengths in their product and solutions domain.

→ European bloc economies like Finland, Denmark, and Austria are supported by the overarching European Union framework, and European Space Agency initiatives, including space technologies incubation programs to enhance geospatial industry capacity.

→ The industry, professionals and institutes in these countries are well represented through the presence of both international as well as nationallevel industry associations and networks.

→ These countries have well-defined Technology Business Incubation Support Initiatives aiming to foster entrepreneurship, such as The National Science & Technology Entrepreneurship Development Board (NSTEDB) of India; Global Acceleration and Innovation Network (GAIN) of Malaysia. However, dynamism and focus on geospatial domain with respect to leading nations is at an intermediate stage.

→ Overall industry representation, diversity, new venture creation capacities to ensure future geospatial readiness, human resource development and policy environment, has comparative weaknesses in one or more segments.

Rank 2018	Country	Score
30	Philipines	5.41
31	Nigeria	5.07
32	Mexico	4.85
33	Greece	4.68
34	Thailand	4.48
35	Uruguay	4.43
36	UAE	4.42
37	Colombia	4.37
38	Vietnam	4.24
39	Indonesia	4.05
40	Costarics	3.94
41	Argentina	3.92
42	Kenya	3.63
43	Ghana	3.57
44	Ethiopia	3.38
45	Oman	3.22
46	Kyrgyz	3.16
47	Egypt	3.09
48	Bangladesh	2.99
49	Zimbabwe	2.90
50	Elsalvador	2.76

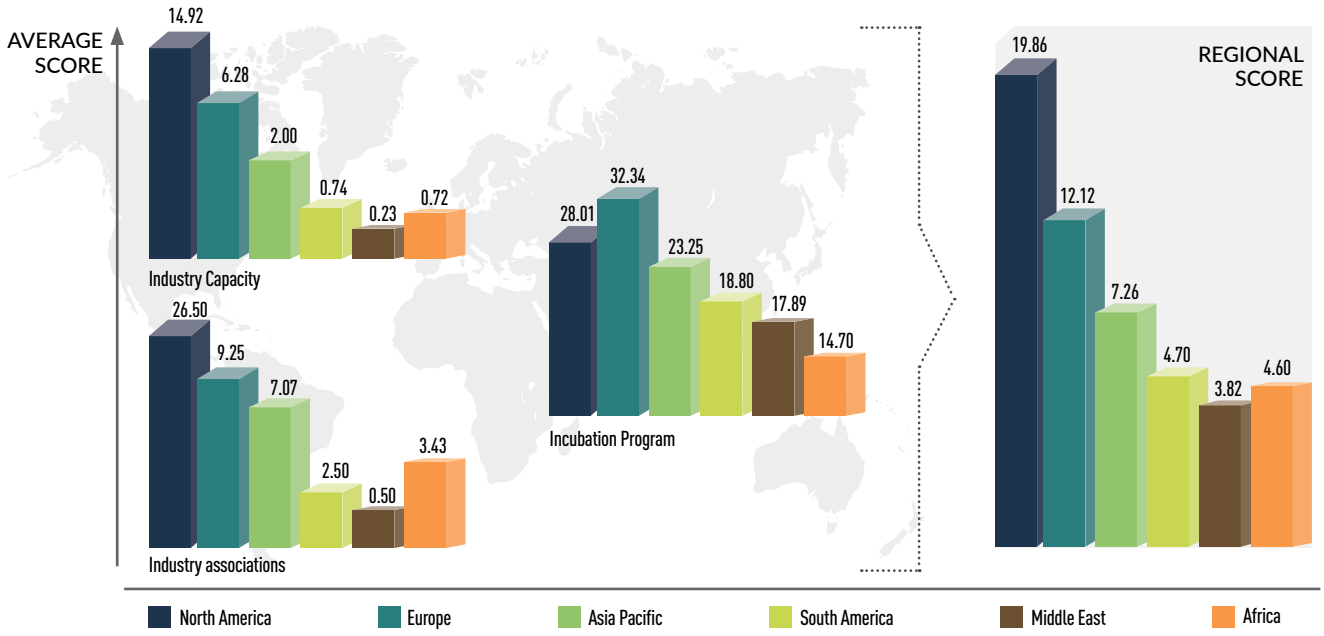
ASPIRERS

→ The geospatial industry in these countries is primarily in the service providers' category. The development of product and solution industries and new venture creation in these regions is quite weak or insignificant compared to the eaders. Membership networks in these regions are few and not necessarily active member/participants of international networks.

→ More often these do not have geospatial industry associations to advocate and represent their interests. For instance, countries like Egypt, Argentina, Kenya, Oman, Costa Rica, Zimbabwe, and El Salvador lack industry bodies and have lesser representation in international industry networks. In the absence of geospatial domain associations in countries like Bangladesh, Vietnam and Indonesia are part of general/apex industry chambers.

→ While some of these countries do have ICT venture incubation initiatives along with ecosystem players from private sector side, geospatial domain is not given much focus there, for example, Start-up Bangladesh and the Special Programme for Science, Technology and Innovation (PECITI) (2014-18) of Mexico. It is interesting to note, there are no specific incubation program in Kenya or Kyrgyz Republic.

Graph 8.6 – Comparative Regional Overview: Industry Fabric



HIGHLIGHTS

— USA is the undisputed leader in the industry fabric pillar. The American geospatial industry leads the global geospatial industry landscape with distinctive capacity across products, services, solutions segments and strong ecosystem capability to foster new ventures in the geospatial domain. The presence of various geospatial industry and professional networks in the USA mirror the industry maturity and critical mass across value chain/sector segments.

— The European bloc countries like Spain, Switzerland, Germany, Finland, Sweden, Italy, Belgium, France, Austria, Portugal and UK have Space technology incubation centres set up under the European Space Agency (ESA) framework. They also have their own national geospatial knowledge industry business incubation programs and active private startup ecosystem stakeholders' participation.

— South Korea, Japan, and Singapore have started taking steps towards attracting international participants to their innovation/incubation programs adding to their domestic talent pool and internationalization. However, there remains a lot to catch up in terms of program design, critical mass and appeal building overcoming their cultural and market peculiarities.

— The geospatial industry segment in China and India is continuing to expand due to an exponential rise in the number of technical and scientific research centers, aero-space domain strengths and national programs for startups/technology business incubation on their side. However, both countries currently lack dedicated innovation programs/incubation centers catering to commercialization of space and geospatial industry segments.

GEOSPATIAL READINESS MATRIX

Geospatial Readiness Matrix

	Country	Data Infrastructure				Policy Framework (Acts/Strategies/Programs)									
		NSDI	Augmentation Systems		Positioning System	National Geospatial Policy	Surveying and Mapping Policy	National Space Policy	GNSS Policy	Earth Observation and Remote Sensing Policy	UAV Policy	Open Data Policy	S&T and Innovation Policy	Innovation Policy	ICT Policy
			Ground Based (RTK)	Satellite based											
North America	Canada	✓	✓			✓	✓	✓		✓	✓	✓	✓		✓
	Costa Rica	✓	✓								✓		✓	✓	✓
	Mexico		✓			✓	✓	✓			✓	✓	✓		✓
	USA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Europe	Austria	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Belgium	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
	Denmark	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
	Finland	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓		✓
	France	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
	Germany	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Greece	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓
	Italy	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
	Netherlands	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
	Norway	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Poland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Portugal	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
	Spain	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Sweden	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓		✓
	Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	United Kingdom	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
Asia Pacific	Australia		✓			✓		✓		✓	✓	✓	✓	✓	✓
	Bangladesh		✓				✓				✓	✓	✓		✓
	China	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓		✓
	India	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓
	Indonesia	✓	✓			✓		✓		✓	✓	✓	✓		✓
	Japan	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	Kyrgyz Republic										✓		✓		✓
	Malaysia	✓	✓			✓	✓	✓		✓	✓	✓	✓		✓
	New Zealand	✓	✓			✓					✓	✓	✓	✓	✓
	Philippines	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓
	Russia	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Singapore	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	South Korea	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Thailand	✓	✓			✓		✓	✓	✓	✓	✓	✓		✓
	Vietnam					✓			✓		✓	✓	✓		✓
Middle East	Oman	✓									✓	✓	✓		
	UAE	✓	✓			✓	✓	✓		✓	✓	✓	✓		✓
Africa	Egypt						✓				✓				✓
	Ethiopia										✓	✓	✓		✓
	Ghana					✓	✓	✓			✓	✓	✓		✓
	Kenya	✓	✓					✓		✓	✓	✓	✓		✓
	Nigeria		✓			✓	✓	✓		✓	✓	✓	✓		✓
	South Africa	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Zimbabwe										✓	✓	✓		✓
South America	Argentina	✓	✓					✓		✓	✓	✓	✓	✓	✓
	Brazil	✓	✓					✓		✓	✓	✓	✓	✓	✓
	Chile	✓	✓			✓		✓			✓	✓			✓
	Colombia	✓	✓					✓			✓	✓	✓		✓
	El Salvador		✓										✓		
	Uruguay	✓	✓			✓					✓		✓		✓

Institutional Capacity				Innovation Programs		Geospatial Domain Networks									
Ph.D. and Research	Postgraduate Courses	Graduate Courses	Diplomas and Certificates	General Programs	Geospatial Programs	Professional Member Networks	Industry Networks								General Apex Associations
							Geospatial Inds. Associations	GIS	GNSS	Drones	LBS	Satellite	Space	Surveying & Mapping	
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- Above matrix is for indicative purposes only
- Blank cells represent absence or unavailable information from primary or secondary sources

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- INSPIRE Thematic Clusters Platform: https://themes.jrc.ec.europa.eu/
- ESA – European Space Policy: http://www.esa.int/About_Us/Welcome_to_ESA/European_Space_Policy
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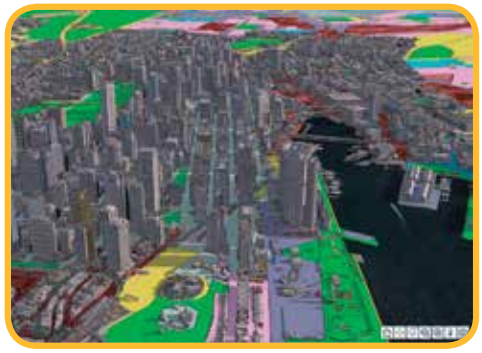
- EO Portal Directory: https://directory.eoportal.org/web/eoportal/satellite-missions
- European Space Research and Technology Centre: http://www.esa.int/About_Us/ESTEC/ESTEC_European_Space_Research_and_ Technology_Centre
- United States Geological Survey: https://www.usgs.gov/
- Websites of National Space Agencies, National Mapping Agencies, and Industry Association Network/Associations of all 50 countries
- Non-exhaustive list of universities (and courses within) for all 50 countries

PARTNERS PROFILES

ENABLING THE DIGITAL REVOLUTION



AAM's Geosolutions enable the Digital Revolution

Smart Cities, Big Data, Internet of Things, Digital Engineering. These technologies are changing the way in which we live and interact with the world. Driverless cars, augmented reality and on demand services powered by Smart Apps are set to further transform our lives. The Digital Revolution is truly upon us.

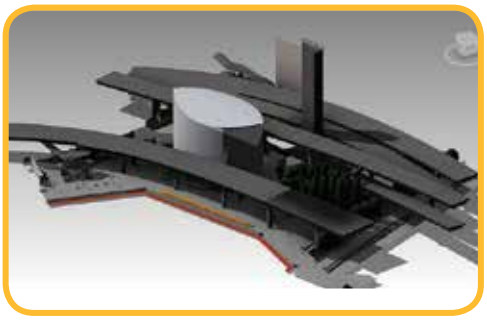
AAM's Geosolutions power the Digital Revolution.

Government

AAM Reality Modelling and 3D City Models provide the building blocks for Smart City applications. AAM's proven wide-area mapping solutions assist engineers, scientists and communities to manage and support our fragile environment, ecosystems and agricultural resources. From community engaged urban planning to supporting remote communities, AAM's Geosolutions provide the basis for informed decision making.

Power and Utilities

AAM's fleet of aircraft, drones and airborne sensors map tens of thousands of kilometres of power transmissions and distribution lines each year. We provide our services to network operators from Africa, to India, South East Asia and Australia. AAM's mapping solutions support vegetation management, condition and fault inspection, line modelling and new route design. Our GIS solutions support dozens of utility and network operators to better understand and manage their complex networks.



Infrastructure & Construction

The global population is undergoing an unprecedented mass migration from rural to urban environments. Super Cities are becoming the norm with massive demands on existing and new infrastructure. AAM's Reality Modelling services map as-built conditions to astounding levels of detail, at a fraction of the cost and time than was previously possible. Our Reality Modelling supports the full Digital Engineering (BIM) life-cycle approach to design, build and maintain critical infrastructure.

Our motto of Reality Capture, Certainty Delivered provides designers and constructors with the confidence and certainty that they can rely on.

Mining and Resources

AAM supports the world's largest resources companies to manage and optimise their production workflow. Our services range from rapid and repeat mapping of huge open-cut mines, to monitoring driverless trains and trucks across vast deserts or complex mine sites. With increasing pressure on commodity prices and environmental best practice, our mining solutions support smart and sustainable mining practices.

For decades, AAM's Geo-Solutions have enabled our clients to measure, monitor and visualise the natural and built environment. Today, as the world changes at an ever increasing pace, AAM's Geosolutions are truly providing the framework to enable the digital revolution in which we are living.

ANTRIX CORPORATION LIMITED

START OF OPERATIONS

1992

HEADQUARTERS

Bengaluru, India

OPERATING REVENUE

$300 million

OFFICE LOCATION

Bengaluru, India

Contact

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URL: http://www.antrix.co.in
Email: mail@antrix.co.in

ABOUT US

Antrix Corporation Limited (ANTRIX), is a wholly owned Government of India Company, under the administrative control of Department of Space. It is the only PSU in Space Segment and in operations since 1992, profitably. It has the unique advantage of being the commercial arm of ISRO. ANTRIX is responsible for promotion and commercial exploitation of the products and services emanating from the Indian Space Programme.

PRODUCT PORTFOLIO

Satcom Services

- Television broadcasting
- Direct-to-Home (DTH)
- Very Small Aperture Terminal (VSAT)
- Digital Satellite News Gathering (DSNG)

Launch Services

- Launch of customer satellites to various orbits (LEO, SSPO, GTO, Sub-GTO Orbit)
- Dedicated Mission and Ride share Options
- Sounding rockets, launch of upper atmospheric experimental payloads

Satellites and Sub-systems

- Satellites for communication & Earth Observation missions.
- Satellite sub-systems including payloads.

Mission Support Services (GEO and LEO)

- Telemetry, Tracking and Command (TTC)
- Transfer Orbit Support Service (TOSS)
- Launch and Early Orbit Phase (LEOP)
- Establishment of Ground Stations

Remote sensing Data and Services

- Establishing International Ground Stations for IRS Satellites
- Provisioning of IRS data to Global Users
- EO Ground Station Establishment for Users
- Geospatial Services

FOCUS INDUSTRIES

Aerospace & Defence, Satellite Communication, Navigation, Remote Sensing Data and Geospatial Services, Space Technology Education and Training

VALUE TO USER

- ANTRIX helps to create value from Space using the expertise of ISRO.
- 25 years of experience in Space Technology to meet requirements of global space industry.
- Access to the state-of-the-art ISRO facilities in all space related testing and AIT.

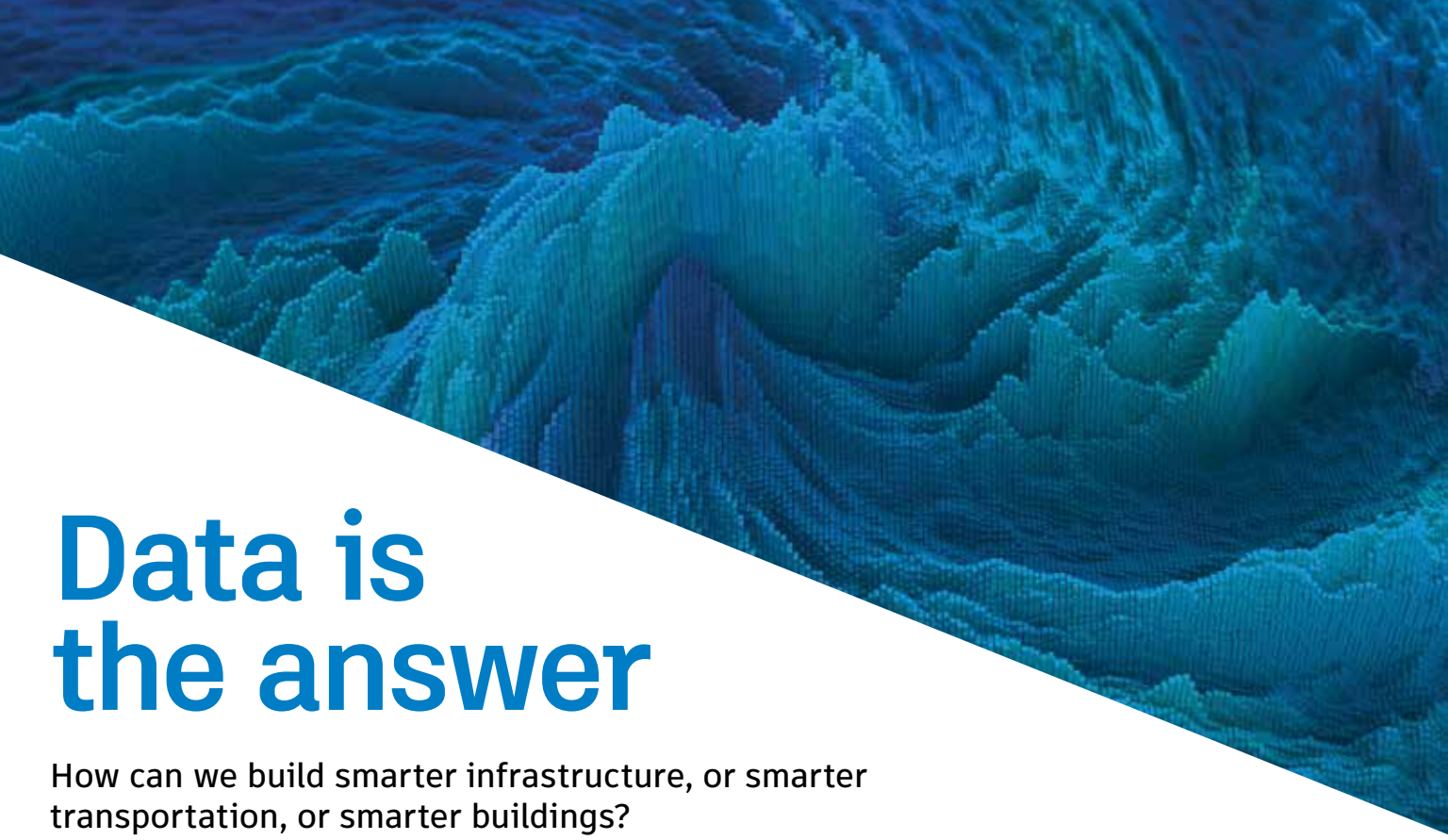
COLLABORATION AND PARTNERSHIPS

ANTRIX sustains its customer base by providing quality products and services in Launch services, Satcom and Remote sensing.

Antrix works with Indian Industries to create a space ecosystem in India under Make-in-India Initiative. We intend to tie with Startups to promote their creative ideas.

ACHIEVMENTS

- Antrix has been conferred the “MINIRATNA” – Category 1, PSU status by the Government of India during 2007-08.
- Record launch of 104 satellites on-board PSLV -C37 on February 15, 2017
- “Globe Sustainability Research Award 2010”, The Globe Forum, Stockholm, Sweden, for outstanding contribution to improve rural livelihoods and productivity of degraded lands using Space and Information technology.



Data is the answer

How can we build smarter infrastructure, or smarter transportation, or smarter buildings?

By making smarter decisions, which requires data. Data is the answer.

Planning smart cities, or designing infrastructure, or building buildings requires the ability to access and share data, from project concept through to operations. This need for information is (literally) at the center of Building Information Modeling (BIM). BIM's intelligent 3D model-based processes give you the insight and tools you need to more efficiently plan, design, construct, and manage buildings and infrastructure.

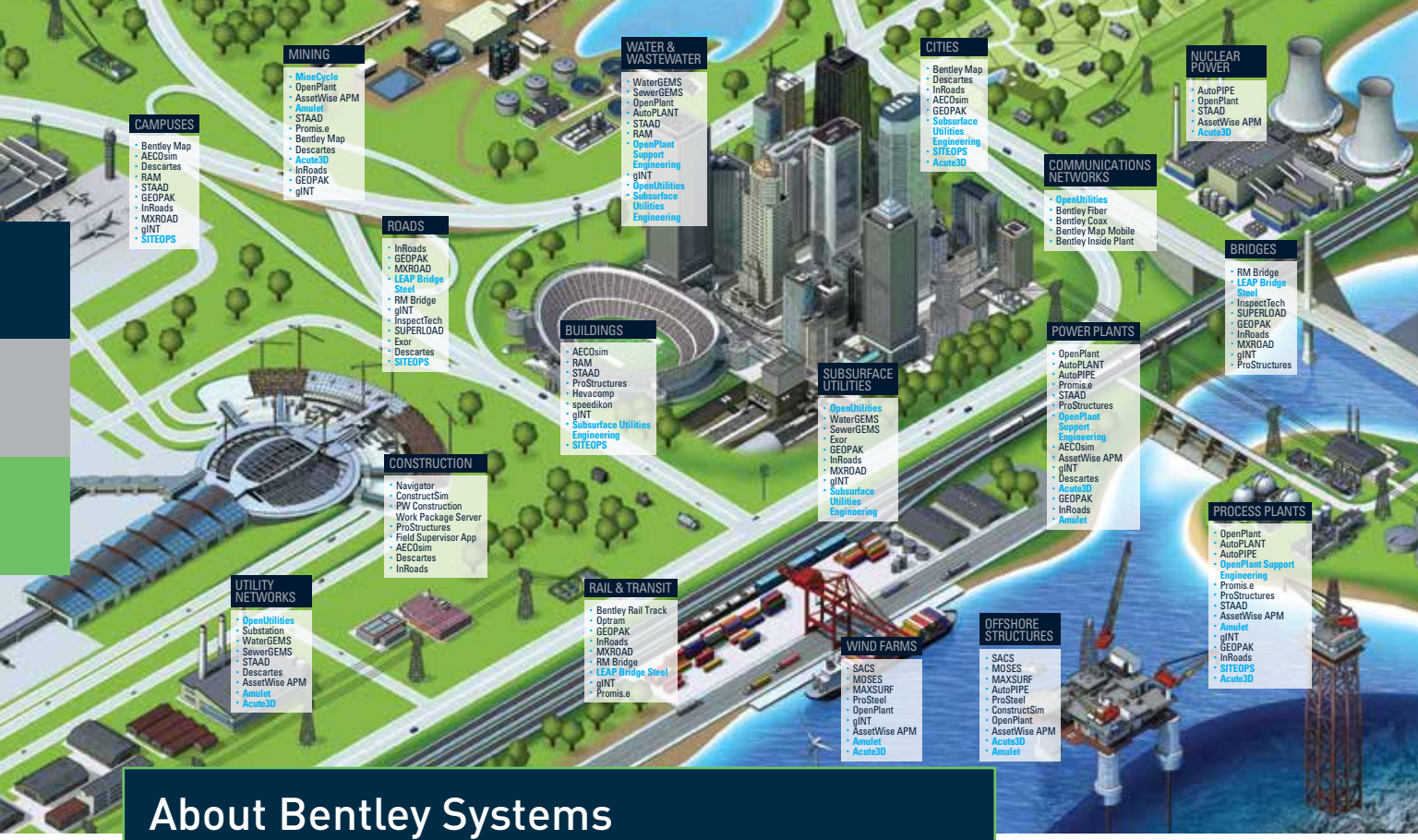
The geospatial data in that information flow helps you consider the interface between our built environment and natural environment, and the impact that design decisions have on this balance. Designing in the context of the natural environment helps you predict potential issues, streamline the project lifecycle, and reduce costly delays. More projects finish on time, within budget and with less negative impact on the community.

With the Autodesk AEC Collection, you can more seamlessly conceive, model, optimize, and coordinate designs—all in the context of the project surroundings and based on reliable geospatial data. The Autodesk AEC Collection offers integrated, multidiscipline BIM workflows for reality capture, design, visualization and analysis, construction, and multi-team collaboration. Capabilities include:

- Cloud connected conceptual design, analysis and planning
- 3D model-based building and civil design and documentation
- 3D modeling, animation, and rendering for design visualization and engaging virtual reality experiences
- Reality capture and 3D scanning for high-definition in-context design, visualization, and construction

For more information, please visit:
autodesk.com/collections/architecture-engineering-construction/infrastructure-design

AUTODESK.



About Bentley Systems

At its core, Bentley Systems is a software development company that supports the professional needs of those responsible for creating and managing the world's infrastructure, including roadways, bridges, airports, skyscrapers, industrial and power plants as well as utility networks.

Bentley's commitment to our user community extends beyond delivering the most complete and integrated software – it pairs our products with exceptional service and support. Access to technical support teams 24/7, a global professional services organization and continuous learning opportunities through product training, online seminars and academic programs define our commitment to current and future generations of infrastructure professionals.

PRODUCT PORTFOLIO

Bentley delivers solutions for the entire lifecycle of the infrastructure asset, tailored to the needs of the various professions – the engineers, architects, planners, contractors, fabricators, IT managers, operators and maintenance engineers – who will work on and work with that asset over its lifetime. Comprised of integrated applications and services built on an open platform, each solution is designed to ensure that information flows between workflow processes and project team members to enable interoperability and collaboration.

Products include equipment that ContextCapture, our reality modeling solution enables building highly precise 3D geometric models of existing terrain or infrastructure. It uses digital imagery captured from any source, including UAVs, aircraft, or handheld digital cameras. ContextCapture Cloud Processing Service can be used to upload photos and generate 3D engineering-ready reality meshes, orthophotos, digital surface models, and point clouds dramatically faster than possible before. This high-performance, cloud-based service automates the production of 3D models of virtually any size without the need for high-end hardware or specialized IT support.

FOCUS INDUSTRIES

Railways, Roadways, Airports, Buildings & Facilities, Industrial & Power Plants, Oil & Gas, Water & Wastewater

COLLABORATIONS AND PARTNERSHIPS

Bentley Channel Partners deliver, implement, train, support, and enhance our offerings to users through their industry expertise and proven sales and technical knowledge of our products and solutions. Channel partners are carefully chosen, selectively authorized companies that focus on small and medium-size organizations to improve Bentley users' long-term growth and satisfaction.

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Bentley®
Advancing Infrastructure

esri

THE SCIENCE OF WHERE™

JACK DANGERMOND
President / Founder

MORE THAN 100
Esri offices around the world

MORE THAN 350,000
organizations use Esri technology every day

- 75 percent of Fortune 500 businesses
- 20,000 cities
- Every US state
- More than 7,000 universities

30 percent of Esri revenue invested annually in **R&D**

More than **1 billion daily views** of maps, charts, and datasets hosted in ArcGIS

More than **142,000 daily views of story maps** that fuse geography and storytelling

More than **15,000 new maps** created by customers **every day** using Esri technology

CONTACT
Esri
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www.esri.com

ABOUT US

Esri, the global market leader in geographic information system (GIS) software, offers the most powerful mapping and spatial analytics technology available. Since 1969, Esri has helped customers unlock the full potential of data to improve operational and business results. Today, Esri software is deployed in more than 350,000 organizations including the world's largest cities, most national governments, and 75 percent of Fortune 500 companies. Esri engineers the most advanced solutions for digital transformation, the Internet of Things (IoT), and location analytics to inform the most authoritative maps in the world. **Visit us at esri.com**.

Our span of influence includes the **biggest names in industry**, **government**, and **NGOs** around the globe.

In business our **customers achieve superior results** by mitigating risk, optimizing operations, growing sales, and serving their customers better.

Our customers **address all significant challenges on the planet**, from climate change, to food production, to humanitarian relief, to making cities better places to live.

PRODUCT DESCRIPTION

ArcGIS: A Platform for GIS, Mapping, and Location Analytics

SUPPORT OF MORE THAN 60 INDUSTRY VERTICALS, INCLUDING

Banking | Education | Electric & Gas Utilities | Government | Health and Human Services
Insurance | Manufacturing | Natural Resources | Petroleum and Pipeline | Public Safety
Real Estate | Retail | Sustainable Development | Telecommunications | Transportation | Water

MULTIPLE LICENSE OPTIONS
- Enterprise agreements
- Industry bundles
- Products
- Data

FLEXIBLE DEPLOYMENT OPTIONS
- Desktop
- Client/Server (on-premises)
- Cloud/Software as a service (SaaS)
- Hybrid
- Mobile

COMPLETE PORTFOLIO OF SERVICES
- Managed services
- Consulting
- Training and learning resources

APPLICATION CAPABILITIES

Logistics Operations
Infrastructure
Network Management
Supply Chain
Marketing and Sales
Service Delivery
Underwriting and Risk
Finance
Public Safety
Public Works
Public Health
Policy
Planning and Administration

CORE CAPABILITIES

Mapping & Visualization
Data Management
Field Mobility
Monitoring
Analytics
Design & Planning
Decision Support
Constituent Engagement
Sharing & Collaboration

AWARDS

- 2016 Microsoft Azure **Certified ISV Solution Provider of the Year**
- Price Waterhouse Cooper 2016 **25 Fastest Growing Cloud Companies**
- Top Ranking in **Current Offering and Market Presence Category in Geospatial Analytics Tools and Platforms Report**—Forrester Wave™
- **The World's Top 10 Most Innovative Companies** in Data Science, 2017, *Fast Company* magazine

About FARO Software

FARO is the world's most trusted source for 3D measurement, imaging, and realization technology. The Company develops and markets computer-aided measurement and imaging devices and software. Technology from FARO permits high-precision 3D measurement, imaging and comparison of parts and complex structures within production and quality assurance processes. The devices are used for inspecting components and assemblies, rapid prototyping, documenting large volume spaces or structures in 3D, surveying and construction, as well as for investigation and reconstruction of accident sites or crime scenes.

FARO's business is mainly segmented into 6 vertically focused teams – namely, factory metrology, product design, construction BIM-CIM, public safety forensics, 3D Machine Vision, and 3D services. This purpose of this segmentation is to develop and deliver industry and application specific solutions to our customers.

PRODUCT PORTFOLIO

Focus^{S} Series

Focus^{M} 70

Freestyle^{3D}

A HISTORY OF INNOVATION

1994
Evolves from medical 3D component construction to manufacturing

1995
Introduces FaroArm®

1996
FARO Arm Platinum becomes world's best selling measurement arm

2004
Introduces Xtreme ADM Technology

2009
Introduces world's most accurate laser tracker - ION® Laser Tracker

2010
Introduces world's smallest and lightest 3D laser scanner Focus3D

2014
Introduces new blue laser technology for high definition

2015
Launches the Freestyle^{3D} Handheld Laser Scanner with a scan range from 1.6ft to 9.8ft.

2016
Launches the Focus^{S} Laser Scanner with IP54 Rating and in-field compensation

2017
Launches new Focus^{M} 70 Laser Scanner – setting a new entry price/ performance standard.

ACHIEVEMENTS & AWARDS

2015 – FREESTYLE^{3D}
- Red dot design award 2015
- "Hardware Product of 2015" Construction Computing Award

2016
FARO wins **"Hardware Product of 2016"** award

2017
FARO have been named **3D Scanner** company of the year at the **2017 3D Printing Industry Awards**

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FARO®

LUCIAD

START OF OPERATIONS

1999

HEADQUARTERS

Belgium

EMPLOYEES

100

OFFICE LOCATIONS

CONTACT

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Email: info@luciad.com

ABOUT US

Luciad delivers geospatial software solutions that power the world's mission critical operations. Our APIs provide developers with advanced visual analytics that allow them to unlock the potential of real time location intelligence and create the foundations for next generation geospatial systems. Luciad is now part of Hexagon.

"Connect, visualize, analyze, act" is both our method and our motto.

PERFORMANCE AS FLUID AS DATA

The human eye is a highly developed tool for picking up movement, but works best with seamless movement. Systems built with Luciad technology provide a performance at 60FPS even when managing complex and continuous moving data.

GEOSPATIAL ANALYTICS FOR THE FUTURE

The volume of data we produce is growing at an exponential rate. Luciad provides the building blocks which enable users to develop 2D, 3D and 4D visualization solutions which can scale to meet future challenges.

CRUCIAL INSIGHTS IN REAL TIME

Luciad provides the foundations for truly interactive solutions capable of analyzing and visualizing real-time data. Whether in the control room or the board room, our advanced geospatial analytics enable split-second decision making.

PRODUCT PORTFOLIO

Our software components empower users to unlock the power of advanced geospatial analytics, providing real-time situational awareness that the modern world demands.

LUCIADRIA
Key Features

Full browser-based platform
Seamless 2D & 3D views
HTML5, Java & WebGL powered
No plug-ins

LUCIADLIGHTSPEED
Key Features

High performance and precision
Easy-to-use API
Modular, open architecture
Flexible deployment

LUCIADFUSION
Key Features

Powerful server solution
Handle multi-layered & multi-dimensional data
Central management and quick access to data

FOCUS INDUSTRIES

Aviation, Defense, Homeland Security, Logistics, Maritime, Public Safety, Utilities

COLLABORATION AND PARTNERSHIPS

In addition to developing high performance geospatial software solutions, Luciad contributes to open geospatial standards development as a long-term member of the Open Geospatial Consortium (OGC). Luciad also works with many technology partners including AFCEA, Barco, Cloudalize, DigitalGlobe, exactEarth, Hortonworks, Open Design Alliance, Oracle and Nvidia.

VALUE TO USER

From safeguarding critical assets to creating the digital infrastructure for smart cities, we help users implement intuitive command and control systems for leading organizations such as Airbus Defence and Space, Lufthansa Systems, NATO, Lockheed Martin and Thales. Our customers depend on Luciad for high performance visualization that allows them to implement scalable solutions. We provide users:

- Accurate, high performance visualization of their datasets
- Advanced visual analytics to make sense of big data
- Powerful, flexible API to handle the most complex data

AWARDS & ACCOLADES

2015 Geospatial Excellence Award: "LuciadRIA – 3D Situational Awareness in the Browser" (Geospatial World Awards)
Best in Class Solution: "CAPS (Collaborative Airspace Provision Service)" (2014 SWIM Master Class, Single European Sky ATM Research (SESAR))
Best in Class Runner-Up Solution: "Remotely-Piloted Aircraft Systems Very Low Level Operation Coordination (RPAS VLLOC)" (2014 SWIM Master Class, Single European Sky ATM Research (SESAR))

About Oracle

ORACLE

Spatial Technologies and Services

Oracle is a leading global provider of spatial data management, analytics, business intelligence and spatially-aware applications, tools and cloud services. The Oracle Cloud offers complete SaaS application suites for ERP, HCM and CX, plus best-in-class database Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) from data centers throughout the Americas, Europe and Asia. For more information about Oracle (NYSE:ORCL), please visit us at oracle.com.

FOCUS INDUSTRIES

- Oracle spatial technologies are the platform for the world's largest and most demanding public sector; telecommunications; logistics; land management, cadastre, and mapping agencies; utilities; financial services and insurance; and public safety and intelligence systems.

COLLABORATIONS AND PARTNERSHIPS

- Through Oracle Partner Network, leading global and regional GIS providers, map data providers, application solutions, and consulting and professional services organizations work with Oracle spatial technologies to help our customers succeed. Visit oracle.com/partners

VALUE TO USERS

- Oracle simplifies the use, integration and deployment of spatial applications and analysis by delivering spatial capabilities in the context of your application and platform. Oracle offers built-in low code and no-code spatial analysis and visualization in applications, tools and platform services. Whether you are implementing an enterprise GIS platform, a location-enabled Business Intelligence system, performing massive spatial processing on petabytes of data or using spatially-aware business applications, Oracle provides powerful solutions.

PRODUCT PORTFOLIO

Oracle strategy has been to deliver spatial analysis as integrated capabilities in a broad range of products, development tools and SaaS and PaaS services.

- **Oracle Database Cloud Service:** An enterprise-proven database cloud service that supports any size workload from dev/test to large scale production deployment with multi-layered, in depth security with encryption by default. Oracle Spatial and Graph is included in High Performance, Extreme Performance, and Exadata Database Cloud Service.
- **Oracle Analytics Cloud:** The most comprehensive analytics in the cloud. Analytics Cloud is a single platform that empowers your organization to ask any question of any data in any environment on any device with native map visualization and spatial business analysis.
- **Oracle Big Data Cloud Service:** Delivering Hadoop, Spark and data science with Oracle security and cloud simplicity. A secure, automated, high-performance service, which can be fully integrated with existing enterprise data in Oracle Database and Oracle Applications. Includes Oracle Big Data Spatial and Graph capabilities.
- **Oracle Spatial and Graph:** An option to Oracle Database with spatial database features for IT and geospatial specialists. With hundreds of parallel spatial analysis operations; an international geocoder, router and map visualization component; planar topology; a network data model; raster management, mosaicking, and raster algebra; LiDAR management and point cloud analysis; ISO and OGC-compliant spatial features and web services. Oracle Spatial and Graph also includes a W3C-compliant RDF graph and a high performance property graph with integrated spatial analysis.
- **Oracle Business Intelligence:** A modern analytics platform to simplify your analytics strategy by standardizing on one integrated platform. Integrated Map Views and spatial analytics allow for Location Intelligence and map-based analysis.
- **Oracle Big Data Spatial and Graph:** Rich Spatial and Graph Analytics for Hadoop and Spark. Discover relationships and connections among customers, organizations, and assets, and enrich your big data with location.
- **Map-enabled and spatially aware applications:** Oracle has Cloud and on premise application solutions for every business need. These include HCM, ERP, SCM, PLM, Customer Experience, Analytics and Sustainability Solutions. Industry solutions include Automotive, Communications, Construction and Engineering, Financial Services, Health Sciences, Healthcare, Higher Education, Hospitality, Industrial Manufacturing, Public Sector, Retail, Transportation and Logistics, Utilities, and more.

Ordnance Survey

About Us

Ordnance Survey (OS) is the national mapping agency for Britain, and a world-leading geospatial data and technology organisation. As a trusted partner to government, business and citizens across Britain and the world, OS expertise and data helps customers in energy, utilities, property, retail and finance deliver efficient services.

Our accurate location data is used for smarter solutions to the world's most complex problems including resource management, urbanisation and population growth. By being at the forefront of geospatial capability for more than 225 years, we've built a reputation as the world's most inspiring and trusted geospatial partner.

Global Product Portfolio and recent projects

Geospatial capability: We help national mapping agencies and industry build efficient capability to meet growing demand for data. By providing advice, training, implementation, technology platforms & managed services, we're enabling cities and nations to benefit from geospatial data.

Smart Cities: Connected cities require geospatial data: We integrate complex data, from multiple sources into geospatial frameworks and enhance Smart capability. We've worked on projects enabling driverless cars, 5G and IoT demonstrators.

Defining a geospatial IT strategy for Kosovo Cadastral Agency

Helping Dubai become the world's smartest and happiest city

Monitoring natural and urban environments in Dubai - automatic change detection

See our case studies: www.os.uk/international

Focus Industries

National Mapping and Cadastre Agencies | Local Government | Municipalities | Infrastructure owners and operators | Telecommunications | Utilities

Collaborations and Partnerships

OGC® Making location count.

Strategic Member

Ordnance Survey became the first Strategic Member outside of the USA, reinforcing our vision to be at the forefront of open standards development.

100 RESILIENT CITIES

100 Resilient Cities

Ordnance Survey is the first national mapping agency to join the 100 Resilient Cities (100RC) platform.

Take our FREE geospatial maturity assessment: www.os.uk/gma

Value to Users

Nations who use geospatial data effectively can grow GDP by as much as 0.6%. Our customers have saved millions of dollars using our geospatial data and studies.

In Britain, Ordnance Survey's data underpins emergency services, insurance quotations, delivery services, energy distribution, land registration and valuation, policy decisions including rural planning/development. Every day Ordnance Survey makes over 20,000 changes to more than 500 million geographic features in its geospatial database.

Ordnance Survey provides surveying for HM Land Registry's land valuation and registration transactions in England and Wales, and detailed mapping for Registers of Scotland.

Our Innovations

1791	Building mapping capability
1936	Created UK National Grid
1950s	Consumer maps printed
1971	First digital maps for sale
1999	Ordnance Survey became a trading fund
2001	Established intelligent national mapping data
2007	Launched CORS Network
2009	Offered web-based mapping
2010	OS Opendata released
2011	UK Public Sector Mapping Agreement
2015	Opened Geovation Hub
Today	Leading geospatial innovation to meet customer demands and technological advancements

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Ordnance Survey

About Pitney Bowes Software

Pitney Bowes is a global technology company powering billions of transactions – physical and digital – in the borderless world of commerce. Leading organizations around the world rely on our software and data solutions to help them surface relevant business insights by understanding the relationships between people, places, and things.

For nearly a century, Pitney Bowes has processed 100s of billions of addresses, precision matched thousands of data points to each address, and ensured billions of pieces of mail get to its intended recipients every year at lowest cost, as quickly as possible.

In this time, we have developed massive knowledge and industry expertise in handling large volumes of data, correcting incomplete or malformed names and addresses, identifying and locating the people that matter to your business, and personalizing business communications.

Today, the world's top 25 financial services companies, 40 out of 50 telecom companies, and scores of other organizations in public sector, healthcare and retail rely on this knowledge to enhance and accelerate critical business processes. Pitney Bowes is helping insurance companies with accurate pricing of risk, financial institutions with managing data to meet regulatory conditions, telco providers with providing real time coverage maps, and retailers with establishing a single view of their customers.

Focus Industries

- Financial Services
- Insurance
- Healthcare
- Telco & Utilities
- Public Sector
- Retail

Software and Data Product Portfolio

Data
A comprehensive portfolio of business, geographic, and industry-specific data featuring global coverage across 250 countries and territories. Thousands of highly detailed and accurate datasets to help you understand customer segments, manage risk, and make decisions with confidence.

Location Intelligence
Geocoding, spatial analytics, and visualization software along with accurate address, location, and business data to help you enrich, analyze, and visualize locations of customers, properties, and assets for enhanced business insights.

Customer Information Management
Data quality, data management, and customer analytics software to help you identify high-value prospects and deepen customer relationships by ensuring high quality customer information and insights are available across the enterprise.

Customer Engagement
Digital and physical communications software to boost customer engagement and reduce customer service costs by crafting and delivering compelling and personalized interactions across all customer touchpoints.

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pitney bowes

RIEGL Innovation in 3D

ABOUT US

RIEGL is an international leading provider of cutting edge technology in laser scanning solutions for surveying applications. *RIEGL* has been producing LiDAR systems commercially since 1978 and focuses on pulsed time-of-flight laser radar technology in multiple wavelengths. *RIEGL's* core "smart waveform" technologies provide pure digital LiDAR signal processing, unique methodologies for resolving range ambiguities, multiple targets per laser shots, optimum distribution of measurements, calibrated amplitudes and reflectance estimates, as well as the seamless integration and calibration of systems. *RIEGL's* various 3D scanners offer a wide array of performance characteristics and serve as a platform for continuing "Innovation in 3D" for the laser scanning industry.

The *RIEGL* headquarters are located in Austria, with international main offices in the USA, China, and Japan. *RIEGL* comprises more than 200 highly skilled and motivated staff members in research, development, production, marketing, sales, training and administration worldwide, who deliver highest quality LiDAR products and outstanding customer service to the marketplace.

PRODUCT PORTFOLIO AND RECENT INNOVATIONS

The broad *RIEGL* portfolio comprises various laser scanners and laser scanning systems for terrestrial, industrial, mobile, bathymetric, airborne and UAS-based applications. The sophisticated hardware is complemented by innovative software resulting in powerful solutions for nearly all imaginable fields in surveying.

Some of our recently launched key products are:

RIEGL miniVUX-1 LiDAR Sensors

Extremely compact and lightweight LiDAR Sensors for UAS-based laser scanning, available in application-optimized versions for highest efficiency

RIEGL VQ-780i

Waveform Processing Airborne Laser Scanner for high density and wide area mapping

RIEGL VZ-2000i

Extremely fast Long Range Terrestrial 3D Laser Scanner System with innovative new processing architecture and latest waveform processing technology

VALUE TO USERS

According to the slogan "Innovation in 3D" *RIEGL* provides:

- sophisticated state-of-the-art Waveform-LiDAR processing technology
- highest performance, quality, reliability, and longevity of all products and services
- strict adherence to applicable international standards
- perfect fulfilment of measurement requirements and customers' expectations

FOCUS INDUSTRIES

Mining I Mapping I Monitoring I Civil Engineering I Archaeology & Cultural Heritage I City Modeling I Agriculture & Forestry I Hydrography I Investigation I Emergency Management

COLLABORATIONS AND PARTNERSHIPS

Worldwide sales, training, support, and services are delivered from *RIEGL's* Austrian headquarters and its offices in Vienna, and Salzburg, main offices in the USA, China, and in Japan, and by a worldwide network of representatives covering Europe, North and South America, Asia, Australia, and Africa. Current cooperation with numerous universities and technical institutions worldwide provides a sound basis for developing and testing new technologies and equipment.

ACHIEVEMENTS AND AWARDS

2017 Dr. Johannes Riegl was awarded with the Geospatial World Special Achievement Award for more than 3 decades of dedication to excellence, innovation and major geospatial industry contributions. Additionally, *RIEGL* was awarded with Sebastian Sizgoric Technical Achievement Award for efforts and developments in the field of LiDAR-Bathymetry and airborne coastal mapping.

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RIEGL®

Trimble

TRANSFORMING THE WAY THE WORLD WORKS

STEVE W. BERGLUND
CEO

START OF OPERATIONS
1978

HEADQUARTERS
America

EMPLOYEES
8600

OFFICE LOCATIONS

CONTACT

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Phone: 1-408-481-8000
Website: www.trimble.com
Email: geospatial@trimble.com

ABOUT US

Trimble is transforming the way the world works.

Trimble is transforming the way the world works by delivering products and services that connect the physical and digital worlds. Core technologies in positioning, modeling, connectivity and data analytics enable customers to improve productivity, quality, safety, and sustainability. from purpose built products to enterprise lifecycle solutions, Trimble software, hardware and services are transforming a broad range of industries such as agriculture, construction, geospatial and transportation and logistics.

OUR HISTORY

From Silicon Valley to a global presence. In a few short decades.

Every brand has history. Ours starts with Charlie Trimble and two others from Hewlett-Packard. They didn't know they were creating an entire industry when they founded Trimble in 1978. But that's just what they did.

OUR PURPOSE

Our place in the world. Our reason for being.

At Trimble, we keep our feet on the ground and our eyes on the horizon. Because we believe it isn't enough just to keep pace. We're intent on leading the way by creating breakthrough solutions that solve customers' problems so they can be more productive and more profitable.

OUR FOCUS

Our focus revolves around building lasting relationships with each and every customer. By providing positioning solutions, we are able to help our customers make intelligent decisions, solve complex problems, optimize productivity, improve operating results and safety.

PRODUCT PORTFOLIO

Positioning

Wide range of positioning technologies including GPS, laser, optical and inertial technologies with application software, wireless communications, and services to provide complete commercial solutions. Its integrated solutions allow customers to collect, manage and analyze complex information faster and easier, making them more productive, efficient and profitable.

Automation

Products include equipment that automates large industrial equipment, such as tractors and bulldozers; integrated systems that track fleets of vehicles and workers and provide information and analytics to the back-office; data collection systems that enable the management of geo-referenced information; software solutions that connect all aspects of a construction site or a farm, and building information modeling (BIM) software that is used throughout the design, build and operation of buildings.

FOCUS INDUSTRIES

Professionals worldwide across numerous diverse markets including Agriculture, Civil Construction, Buildings, Land Information, and Transportation and Logistics use our intuitive products, reliable data, advanced modeling, professional services and powerful visualization tools.

VALUE TO USER

For nearly 40 years, supported by a global employee base and distributor network, Trimble has delivered accurate information that our customers in over 150 countries can act upon with the confidence. Whether we are providing high accuracy technology, a unique answer to a business challenge or a product that is simple and easy to use, our solutions transform the way our customers work. Bringing together the right resources and technologies provide our customers with the experience they deserve.

ABOUT GEOSPATIAL MEDIA AND COMMUNICATIONS

Geospatial Media and Communications, with its vision of making a difference through geospatial knowledge in World Economy and Society, works to build the geospatial industry in all its facets. In over two decades, Geospatial Media and Communication has built an international repute and credibility as an evangelist of the geospatial industry - hosting meaningful engagements to represent the entire eco system of the geo-spatial industry; supporting and advancing the work of UNGGIM member nations, European Commission, Open Geospatial Consortium and several national governments; interplaying the role of synergizing thought leadership of geospatial industry and facilitating advancement of its unparalleled value in the world economy and society.

Geospatial Media achieves the stated objectives by publishing content on geospatial technologies, trends, policies and applications by the Media Division of the Company. The Market Intelligence and Policy Advocacy Division, undertakes research and business consulting work and produces industry reports on market behaviour, requirements, challenges and prospects of geospatial information and applications for society and economy. In addition, the Business Development and Outreach division of Geospatial Media organises many national, regional and international conferences which are considered as most sought-after platforms for fruitful engagements, networking opportunities and meaningful conversations.

ACKNOWLEDGEMENTS

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PRODUCED BY

GEOSPATIAL
media + communications