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YOUR GEOSPATIAL INDUSTRY MAGAZINE

GEOSPATIAL WORLD™

OCTOBER 2014 » VOLUME 05 » ISSUE 03 | ISSN 2277–3134

www.geospatialworld.net

Germany has been the engine of growth in the EU, almost single-handedly pulling Europe out of the economic recession. Innovative instincts, coupled with consistent government policies and investments are keeping the local geospatial community at the forefront of a technology revolution. P | 30

ACHTUNG! BITTE!

R.N.I No - UPENG/2010/34153; Registration no: UP/GBD-136/2014-16

Publication: 10th of every month | Posting: 15th / 20th of every month

Is Your Water Infrastructure Efficient, Economic, Sustainable ...

Water management systems are crucial to maintaining our way of life and heavily depend upon reliable and safe infrastructure. When a dam crumbles, a reservoir floods or a levee is breached, the results can be devastating and include massive property damage, long-term environmental consequences and even loss of life.

Smart H^2O from Hexagon Solutions provides valuable insight into the health of critical water infrastructure and helps solve potential problems before they can occur.

... and Smart?

Powered by technologies from Hexagon brands including Leica Geosystems, Hexagon Geospatial and Intergraph, Smart H^2O uses total station, sensors and monitoring and dispatch solutions to provide a complete picture of critical water infrastructure.

The Leica Nova MS50 MultiStation combines the functionality of an imaging total station and 3D laser scanner so you can manage and monitor your water infrastructure assets with precision, accuracy and quality. And GeoMedia Smart Client provides streamlined, customer-specific workflows that enable web- and field-based asset management. With the open architecture of GeoMedia, you can easily generate smarter maps and reports.

The Smart H^2O Dashboard provides real-time sensor status and critical and timely notifications to the right people at the right time so they can make important life-saving decisions.

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HX2100-AD-0417


Trimble
2014
DIMENSIONS
NOVEMBER 3–5
MIRAGE HOTEL, LAS VEGAS
2014
www.trimbledimensions.com
trimble_dimensions@trimble.com

THEME: Germany

Cover Story

Interviews

First Person

Special Focus: GNSS

Interviews

Corrigendum

With reference to our article '...So Shall We Reap' published in August 2014 edition, the comments of ***Clint Graumann****, Sales Director, North America, BlackBridge were inadvertently attributed to John Ahlrichs, Vice President, International Sales, BlackBridge. We regret the error.*

Owner, Publisher & Printer Sanjay Kumar
Printed at M. P. Printers B - 220, Phase-II, Noida - 201 301, Gautam Budh Nagar (UP) India
Publication Address A - 92, Sector - 52, Gautam Budh Nagar, Noida, India
The edition contains 68 pages including cover

Geospatial World
Geospatial Media and Communications Pvt. Ltd.
(formerly GIS Development Pvt. Ltd.)
A - 145, Sector - 63, Noida, India
Tel + 91-120-4612500 Fax +91-120-4612555 / 666
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A Success Story, Made in Germany

Prof Arup Dasgupta
Managing Editor
arup@geospatialmedia.net

Intergeo 2014 opens in Berlin on October 7. Billed as "the world's leading conference trade fair for geodesy, geoinformation and land management", it attracts a huge number of participants and exhibitors; 92 countries participated in the last count. Intergeo is hosted by Germany, a country known for its attention to quality, precision, endurance and innovation; all qualities summed up by the phrase 'Made in Germany'.

Germany has been the European powerhouse for many decades. Think of any breakthrough technology and you will find Germany or Germans behind them — be it instruments, cars, jet engines, satellites or rockets. After a debilitating war that would have finished off any other country, Germany sprung back to become the fourth largest economy in the world and the kingpin of the European Union, pulling it out of a mega recession almost single-handedly.

Germany's attention to geospatial systems is well illustrated by the statement of Professor Karl-Friedrich Thone, President of the German Society of Geodesy, when he says in his welcome statement that the conference will "demonstrate how geoinformation has moved to the heart of society and provides the key to solving the challenges of our 21st century world. Modernising transport routes, mobility and expanding broadband all require the increasing digitisation of our infrastructures — in the form of good governance via e-government. Climate change, the energy revolution and flood prevention are never far from the headlines and thus well-deserving of their prominent place on the conference agenda".

Indeed, the German Space Agency DLR has pioneered many innovative technologies like stereo imaging from space (MOMS-02) and synthetic aperture radar (TERRASAR-X). German technology has led the field in photogrammetry and surveying. Companies like Carl Zeiss (now part of Trimble) have been innovators of cameras and precision instruments for photogrammetry and surveying. Research emanating from its universities in Berlin, Hannover, Heidelberg and Stuttgart, to name a few, are essential reading for others in the field.

Germany's High Tech Strategy for 2020 significantly includes 'mobility' and the use of the European Galileo GNSS for diverse applications from freight and logistics to urban mobility and maritime technologies.

GNSS and its applications have gone from strength to strength. Today we have, apart from Galileo, the US GPS, Russia's GLONASS and China's Beidou, not to mention regional systems like India's IRNSS and efforts by France and Japan. While Location Based Services is the most visible application the real money lies in navigation, maritime applications, precision timing and precision surveying.

As I write this, a seminar on 'Make in India' is underway in Delhi and speaker after speaker are echoing 'quality, precision, cost' as desirable goals. Indian industry could learn these from German industry. With the success of the Mars Orbiter Mission, MOM India can justifiably be proud of having achieved these goals albeit in a small way. Incidentally, India shares with Germany the acronym MOM in MOMS 02, which flew onboard the German D2 was the world's first space borne in-line stereo scanner.

Business

Intermap nets airborne radar mapping contract

Intermap has recently bagged a $1.8-million contract to provide an airborne radar mapping services solution. It will use its proprietary Interferometric Synthetic Aperture Radar (IFSAR) technology to collect orthorectified radar imagery and high resolution elevation data to boost the customer's existing geospatial map database. This new dataset will be used for improved disaster planning, resource management, security interests, and infrastructure planning.

$1.8 mn
contract value

Topcon, GAP announce partnership

Topcon and GAP Group have recently announced a new partnership to promote innovative surveying equipment to a larger client base. As part of the deal, Topcon will assist GAP in the expansion of its newly set up specialist divisions, offering continued technical support for its products and support for GAP employees. Topcon lasers, levels, robotic total stations and GNSS systems will now be available for hire through GAP. Topcon experts will lead technical demonstrations and training for all its products at GAP's Survey and Safety depots across the UK.

Jim Burke, head of Survey & Safety division at GAP with Nick Voller, Construction Products manager at Topcon

Apple hires ex-HERE employee Krenz to fix maps

Apple, in a bid to revamp its mapping division, has hired former Nokia HERE and NAVTEQ executive Torsten Krenz to fix its mapping division. Krenz was earlier Vice President of Global Expansion in NAVTEQ's Digital Mapping Operations before it was acquired by Nokia and merged with HERE. The hiring of Nokia HERE executive is viewed by many as Apple's move to step up its own data-collection to improve its in-house Maps service. Further, Apple also recently hired Benoit Dupin from Amazon's A9 search technology group to advance its mapping efforts.

HERE in research tie-up on connected cars

HERE has announced two new research collaborations with the SWARCO Group and the Oakland County Connected Vehicle Task Force (OCCV). It will work with the SWARCO Group to combine probe data from HERE, and SWARCO's sensor data and traffic management information to create new navigation services that will give the drivers of connected cars intelligent speed guidance. With support from the Oakland County Connected Vehicle Task Force (OCCV) and Paxgrid, HERE has also planned an alternate and potentially safer means of maintaining accurate positioning in parts of a city where there isn't adequate GPS coverage.

Geomarketing startup xAd rides high on location wave

New York-based mobile ad startup xAd has raised $50 million in equity and debt funding in a bid to deliver hyperlocal mobile marketing in a big way. The funding is backed mainly by Institutional Venture Partners followed by Emergence Capital, Softbank Capital, and Silicon Valley Bank. Using geomarketing, xAd provides a contextual local targeting opportunity to get closer than even a ZIP code. The USP of xAd is that it gathers data about buyers' locations and where they are headed to understand where they might go next and what they mean to buy. The resultant 'intent data' can be leveraged by the advertisers to help drive future sales in a significant way.

$50 mn
Equity & Debt funding

PCI Geomatics wins CSA contract

PCI Geomatics has won a contract from the Canadian Space Agency to develop a commercial end-to-end interferometric processing capability for environmental monitoring. This deal will allow PCI to develop an end-to-end, commercial interferometric processing and visualisation capability designed to considerably decrease the processing requirements and operational constraints faced when using Syn-

thetic Aperture Radar (SAR) data by non-SAR experts. The extracted land motion estimates will be more easily integrated as the software will be reformatted to virtually any map projection and combine results with vector, optical, cadastral or map data to augment the spatial context. The targeted application areas for new software include urban subsidence, mineral extraction, oil and gas extraction, pipeline monitoring, volcano monitoring, transportation networks, and landslide prediction. The software is expected to be released in 2016.

Richard Branson invests in 3D Robotics

Founder of Virgin Atlantic Richard Branson has chosen to invest in 3D Robotics — a company that develops UAV technology and drones for business applications and exploration. Founded in 2009 by Chris Anderson, founder of DIYDrones.com, and Jordi Munoz, 3D Robotics is a VC-backed startup with over 180 employees in North America and more than 28,000 customers worldwide. The details of the investment are yet to emerge.

Miscellaneous

Senator Baldwin introduces Digital Coast Act

US Senator Tammy Baldwin on September 18 introduced the Digital Coast Act to help Wisconsin communities along the Great Lakes better prepare for storms, cope with varying lake levels, and strengthen economic development planning efforts along the shore. The Digital Coast is a geospatially enabled programme to perk up coordination and support work with stakeholders to spot geospatial priorities; better coordination of coastal mapping and management activities; deploy standardised methods for data acquisition, processing, and distribution; promote best practices when applying geospatial data for coastal decision making; and contract for the collection and creation of quality non-navigation feature data sets to include: shoreline change, satellite and aerial imagery, benthic habitat mapping, land use and land cover maps, terrestrial topography, submerged aquatic vegetation and shallow water bathymetry.

NASA to add EO instruments to ISS

NASA is all set to add six earth observation instruments to its International Space Station (ISS) before the end of 2020 in a bid to monitor the planet better. The first NASA earth observing instrument, RapidScat will monitor ocean winds for climate research, weather predictions and hurricane monitoring from the space station. The second

Trimble on acquisition & partnership spree

Buys Gehry Technologies: Trimble has acquired Gehry Technologies, the software and consulting services business of Frank Gehry, to develop on-site construction technologies. Los Angeles-based, Gehry Technologies provides design and project management solutions, consulting services and project collaboration software tools. Gehry Technologies solutions include GTeam software, a Web-based 3D file management and project collaboration platform, building information modelling (BIM) technology for architects, engineers, builders, fabricators and industry professionals worldwide. Gehry will be part of Trimble's Engineering and Construction segment. Trimble has also acquired London-based **Manhattan Software**, real estate and facility management software developer. The acquisition extends its Trimble Buildings' portfolio of design-build-operate (DBO) solutions by providing integrated, end-to-end property, asset and facilities management systems.

In another development, **Trimble and Ryde**r have signed a four-year partnership agreement to equip UK Ministry of Defence's (MoD) administrative vehicles with Trimble's GeoManager Fleet Management, Driver Safety and vehicle diagnostics solutions. The implementation of Trimble Driver Safety will enable the MoD to review driving behaviour across its fleet. Ryder is a German player in commercial vehicle rental, contract hire and maintenance, providing and managing the fleet of administrative vehicles for the UK Ministry of Defence.

instrument is the Cloud-Aerosol Transport System (CATS), a laser instrument that will measure clouds and the location and distribution of airborne particles such as pollution, mineral dust, smoke, and other particulates in the atmosphere. Two additional NASA Earth science instrument, SAGE III and LIS, are scheduled for launch in 2016.

OGC announces new Urban Planning Domain WG

Open Geospatial Consortium (OGC) has announced a new Urban Planning Domain Working Group to define the role for OGC standards and related activities within the Urban Planning discipline and to offer an open forum for the discussion and presentation of interoperability requirements, pilots, use cases and implementations of OGC standards in this domain. The Group seeks to discover requirements for open spatial standards in information systems involved in the planning, design, use, maintenance and governance of publicly accessible spaces. Earlier, OGC had also announced the formation of Big Data Domain Working Group.

SAP spruces up prediction with geospatial data

SAP has announced support for geospatial data and Hadoop into its predictive software offering 'InfiniteInsights'. InfiniteInsights 7.0 would allow users to use geo-referenced data as input in the predictive models. The introduction of geospatial support will make predictive work easier, particularly in scenarios like churn analyses done by telecom companies and fraud analyses done by banks. The software can merge multiple variables containing latitude and longitude to produce variables, which can be used in predictive models.

WorldView-3 first images released

Digital Globe has released first WorldView-3 images from their collection of Madrid. It has also highlighted some use cases for their current and new customers. With the availability of 30-cm super-spectral imagery, quantitative assessments of the state of highway networks (including surface wear) can offer precious maintenance planning information to national, state, and local governments. However, owing to regulatory restrictions, the company is unable to display the 30-cm native resolution data, so the shared imagery has been re-sampled to 40 cm. Jeff Tarr, Chief Executive Officer, said "We are delighted that even in the early stages of calibration and commissioning WorldView-3 is revealing new insights that will enable customers to address some of the most pressing global challenges." With WorldView-3 imagery, it is possible to distinguish dissimilar colours, textures and measure change over time which is important for the energy sector, conservationists, and the governments.

UCSF to map and predict malaria using Google Earth

UC San Francisco (UCSF) is working to create an online platform that health workers around the world can use to predict where malaria is likely to be transmitted using data on Google Earth Engine. With the malaria prediction platform, local health workers will be able to upload their own data on where and when malaria cases have been occurring and combine it with real-time satellite data on weather and other environmental conditions within Earth Engine to pinpoint where new cases are most likely to occur. The new tool will be piloted in Swaziland, a country in southern Africa. Google Earth Outreach is giving UCSF $100,000 to develop the new platform.

NASA's LiDAR to study earth's forests in 3D

NASA will seek to map earth's forests in 3D through its new Global Ecosystem Dynamics Investigation (GEDI) LiDAR. The GEDI will be the first laser-based instrument to systematically probe the depths of forest from the space and the project is scheduled for completion in 2018.

Finland

Nokia HERE's CEO resigns

Michael Halbherr

Nokia has announced that Michael Halbherr, CEO of mapping unit has resigned from his services. Cliff Fox, currently Senior Vice President, Core Map Group, at HERE, has taken over the role of acting head of HERE. Halbherr cited his wish to focus once again on entrepreneurial activities as reason behind his decision.

France

Sentinel-2A satellite enters testing phase

Airbus Defence and Space has delivered Sentinel-2A satellite for a series of environmental tests at IABG, near Munich, Germany for six months. Sentinel-2A is scheduled to launch in 2015; Sentinel-2B, which is identical in design, is set to follow in 2016. The two satellites together will be able to capture images of earth's total land surface in just five days in a systematic manner. The Sentinel-2 satellites will render optical images from the visible-near infrared to short-wave infrared range of the electromagnetic spectrum using a total of 13 spectral bands with a resolution of 10, 20 or 60 metres and a swath of 290 km. They will be used for soil sealing, land use, forest monitoring, land management, natural disasters (forest fires, floods, erosion, landslides) and humanitarian aid.

Artistic rendition of Sentinel 2 satellite

HySpecIQ eyes hyperspectral data market

HySpecIQ has placed an order for two Boeing 502 Phoenix small satellites. Boeing claims that these satellites will carry the commercial remote sensing industry's first high-resolution hyperspectral payload, capable of providing spectral imaging fidelity that far exceeds what is currently available. According to the partly vendor funded contract, Boeing will manage sales, processing and distribution of the hyperspectral imagery products to the US Government intelligence community, Department of Defense and international partner customers. HySpecIQ will manage sales, processing and distribution of the hyperspectral imagery products to the global civil and commercial market. The capability would enable HySpecIQ to deliver a range of information products to large commercial markets such as the global oil and gas industry, as well as mining, agriculture and environmental monitoring.

Pix4D and Delair-Tech announce partnership

Airbus France-based Delair-Tech has partnered with Pix4D to include Pix4Dmapper image processing software in its UAV packages as the standard method of post-processing UAV-collected imagery to convert the DT-18 or DT-26 imagery into geo-referenced orthomosaics, 3D surface models, and point clouds.

3D maps of rail networks created using LiDAR

France's national railway company SNCF has used mobile laser scanning system StreetMapper to produce detailed 3D maps of the nation's rail network for improved overall safety and faster track upgrade works. The data acquired from millions of individual laser-scanned measurements is used to produce engineering-grade survey data and a 3D topographical map of the track, trackside area and catenary.

Czech Republic

Grant announced to promote EGNOS adoption

The European GNSS agency (GSA) has announced a grant to further promote European Geostationary Navigation Overlay Service (EGNOS) adoption in Europe's civil aviation domain. The total value of the grant is €6 million and maximum EU financing of eligible direct costs is 60%. Moreover, a flat-

€ 6 mn

Value of Grant

rate amount of 7% of the total eligible direct costs of the action is eligible under indirect costs. GSA will co-fund projects capable of fostering EGNOS operational implementation for regional, business and general aviation and rotorcraft. The award of grant will commence in December 2014.

Germany

GAF and partners working on intelligent transport app

The Deutsche Bahn subsidiary DB Schenker is developing a new, advanced transport and logistics solution together with T-Systems and GAF AG. The system delivers real-time data based on satellite navigation, EO and satellite communication technologies. To boost the accuracy of the results, GAF is implementing high-quality Digital Elevation Models based on satellite earth observation images to achieve an even more precise calculation of CO2 emissions and fuel consumption. The project is funded jointly by the European Space Agency's Integrated Application Promotion (IAP) programme.

Denmark

Boeing, Sky-Watch partner on Danish UAV project

Boeing and Danish company Sky-Watch have partnered to allow Boeing to explore helping the company in developing a new type of unmanned aerial vehicle (UAV). Called the 'Smart UAV' project, it aims to develop a new generation of vertical take-off and landing (VTOL) UAVs, which will blend the benefits of current rotorcraft UAVs with those of fixed-wing aircraft for longer range and endurance. The new type of UAV will be used for a wide variety of missions, including geo-data research and environmental monitoring in addition to maritime surveillance in Arctic regions.

Ireland

Envitia bags LPS Contract

Land & Property Services (LPS), Northern Ireland, have chosen Envitia and its MapRite product to enable the automatic alignment of Department of Agriculture and Rural Development (DARD) field boundary and ineligible area polygons to positionally improved OSNI largescale vector mapping. The work will ultimately allow DARD to continue to offer landowners and farmers with a reliable and current map from which they can make accurate declarations for EU area-based aid schemes.

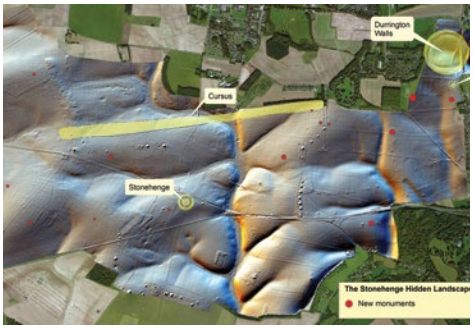
UK

GPS-aligned coordinate system likely soon

The Ordnance Survey (OS), Britain's national mapping agency, is contemplating to discard its system of coordinates on maps devised more than 180 years ago. The national agency is gathering views on changing its latitude and longitude markers to a system used by most GPS devices. It, however, clarified that national grid references are not going to be changed but it may change the lat and long datum to the WGS84 model, in recognition that most users now refer to that, rather than its present Airy 1830, first devised by Sir George Biddell Airy, the Northumbrian-born mathematician and astronomer. To support the increasing usage of GPS devices, OS is considering options that could help bring digital navigation devices and paper maps closer together.

Detailed map of Stonehenge released

The archaeologists of the Stonehenge Hidden Landscapes Project, led by the University of Birmingham and the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology have unveiled a detailed map of the earth beneath Stonehenge and its surrounding area. Using remote sensing techniques and geophysical surveys, researchers have discovered hundreds of new features which now form part of the most detailed archaeological digital map of the Stonehenge landscape ever produced. The startling results of the survey include 17 previously unknown ritual monuments dating to the period when Stonehenge achieved its iconic shape.



Distribution map of new monuments discovered around Stonehenge.

New Zealand

NZAM fails to find a buyer, heads to liquidation

Digital NZ Aerial Mapping (NZAM), a company that has handled several aerial mapping projects on New Zealand for around eight decades recently went in to liquidation after receivers could not find a buyer. The decision to put NZAM in receivership was taken after the company ran out of cash, with $1.5 million in payments outstanding from contracts in Saudi Arabia. Fifteen of the Hastings-based company's 22 staff have been made redundant. The remaining seven have been kept on to complete work and assist with the sale. In 2010, it was contracted by the governments of Saudi Arabia and Kuwait to accurately mark out and map their shared border. However, a failure in collecting the payment further worsened the already deteriorating financial health of the company.

Australia

NSW releases public transport data

The Transport Department of New South Wales (NSW) has released real-time public transport network data to inspire innovative transport solutions. The data was released at the Codeworks 2014 New South Wales Hackathon, managed by Deloitte, in Sydney on September 20 and 21. Data on traffic lights, incident data base, traffic volumes and transport networks is available to software developers and entrepreneurs in the hope that they can create innovative ways to help the state's road users. Open data is a well-established policy of the NSW government with various agencies ever exploring ways to realise some early benefits of that policy.

McMurdo grabs AMSA's MEOSAR contract

Techno-Sciences (TSi), a recently acquired company of McMurdo Group, has been chosen by the Australia Maritime Safety Authority (AMSA) and Maritime New Zealand (MNZ) to deploy their next-generation satellite-aided search and rescue systems. The MEOSAR (Medium-altitude Earth Orbit Search and Rescue) installations will be the first such system in Asia Pacific and will significantly reduce the time between a distress beacon activation and the resulting emergency alert notification from hours to minutes, accelerating the rescue coordination effort by SAR personnel. The deal, which exceeds €13 million approximately ($17 million), includes a six-antenna MEOSAR satellite ground station system (MEOLUT) in each country, a common Mission Control Centre (MCC) in Canberra and associated support and maintenance. Installation is scheduled to start in September 2014 and is expected to take 15 months.

$17 mn
Contract Value

South Korea

Daum offers better maps of North Korea than Google

Daum, South Korea's search giant has offered new and better maps of North Korea as compared to Google Maps. The free, new maps are based on data from National Geographic Information Institute (NGII) of South Korea and provide better coverage of its hostile neighbour North Korea than Google Maps. The NGII data on Daum captures far more information than Google which becomes evident on comparing the two maps on any region. Daum maintains that in addition to covering greater detail on railways and roads, the new maps even cover rural areas whereas Google only covers major cities. However, Daum's satellite imagery seems less crisp due to a lower spatial resolution compared to Google's.

S Korea, Uzbekistan tie up on spatial information

A memorandum on mutual understanding was recently signed between Goskomzemgeodezkadastr (State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadastre) and Ministry of Land, Infrastructure and Transport of Korea on cooperation in the field of spatial information and land management. The two countries will exchange experiences, and South Korea will familiarise Uzbekistan with the best practices in the field of geographic information systems and the latest technology in the field.

India

India to offer GAGAN services to partners

India is considering to provide GAGAN (GPS-aided geo augmented navigation) system to countries of South-East Asia in a bid to generate financial returns and demonstrate its next-gen navigation and surveillance technologies. There are also plans to provide global navigation services by clubbing GAGAN's capabilities with that of the US Global Positioning System (GPS), Russian GLONASS, European Galileo, Chinese Compass, Japanese Quasi Zenith Satellite System.

Artistic rendition of GAGAN system

China

Baidu invest in IndoorAtlas

IndoorAtlas, developer of magnetic positioning technology for indoor location, has received a $10-million investment from Baidu, a leading Chinese search engine. Baidu has also signed an exclusive agreement with the indoor positioning technology company to strengthen its indoor mapping offering in China. IndoorAtlas uses earth's geomagnetic field to pinpoint the exact location inside a building with an accuracy of two meters. Baidu highlighted the first IndoorAtlas solution customised for the Baidu Maps app at its annual Baidu World conference, held in Beijing on September 3, 2014. The company will use the funds towards ramping up R&D, engineering and business development in the US, Asia, and Europe.

$10 mn

Investment from Baidu

Indonesia

Indonesia launches open data portal

The Indonesian government has formally launched its open data portal beginning with 700 datasets from 24 agencies. The portal features a 'Community' section where visitors can suggest open datasets that they would like to see on the portal or subscribe to a mailing list to stay connected with the open data community. To benefit users without data skills, the portal also offers visualisations made using open data sets. The portal is part of government's larger open government movement and aims to integrate all government maps and public service competitions.

Azerbaijan

Azerbaijan, Airbus deal for SPOT 7 data in final phase

Negotiations between Azerbaijan's Space Agency Azercosmos and the French Airbus Defense and Space on the transfer of control of LEO satellite SPOT-7 are in a final stage, Communications and High Technologies Minister Ali Abbasov informed media recently. Azercosmos and Airbus Defense and Space signed an agreement to jointly launch the SPOT 7 satellite in May this year. The satellite launch was an important step in the implementation of the agreement on strategic cooperation with Azercosmos, which involved the joint use of satellites and empowerment in the area of geoinformation. The project is expected to kickoff by the end of the year 2014.

Philippines

Remote sensing-based crop monitoring system unveiled

The Philippine Statistics Authority (PSA), along with the Asian Development Bank, Japan Fund for Poverty Reduction, and Japan Global Development Assistance, has launched the RCDTA 8369, a remote-sensing based data collection system on rice. The RCDTA 8369 project stands for Regional Capacity Development Technical Assistance 8369: Innovative Data Collection Methods for Agricultural and Rural Statistics. With funding from the Japan Fund for Poverty Reduction and technical advice from the Japan Aerospace Exploration Agency (JAXA), PSA will implement activities under RCDTA 8369 in the Philippines such as the introduction of the JAXA software called the International Asian Harvest Monitoring System for Rice (INAHOR) to implementing agencies' staff.

Africa News

Sudan

Regency releases ASTER study results

Regency Mines, natural resources exploration and investment company, has announced the preliminary results of a phosphate-oriented ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) targeting study across the Jebel Abyad concession in Sudan. As a result of the study, eight high priority targets areas of anomalous phosphorous potential have been identified. The company carried out an ASTER study across its 26,064 sq km Jebel Abyad concession to define target areas of potential phosphate anomalies for follow up ground work. Researchers carried out detailed in-house GIS analysis of all images, layered with geological and geochemical data gathered during field trips. The next stages of exploration planning will focus on ground verification of the targets identified as high-priority.

Nigeria

NASRDA releases data for resource monitoring

Space Research and Development Agency (NASRDA) has released relevant satellite datasets for socioeconomic and intelligent mapping and resource monitoring across Nigeria and other parts of the globe. NASRDA plans to leverage on the progress made through the development, launch and utilisation of Nigeria Sat-2 and Nigeria Sat-X products in the sustainable development of Nigeria. The spokesperson of NASRDA told media that the organisation was intensifying effort towards achieving the Millennium Development Goals (MDGs) in the country and Africa at large. He also informed that the imagery from NASRDA satellites are being used by 18 universities, six MDAs and more than 100 academic researchers across Nigeria, Africa, Europe, Asia and other parts of the world.

Spectra Precision LL300N Laser Level:

a ruggedised, fully automatic machine

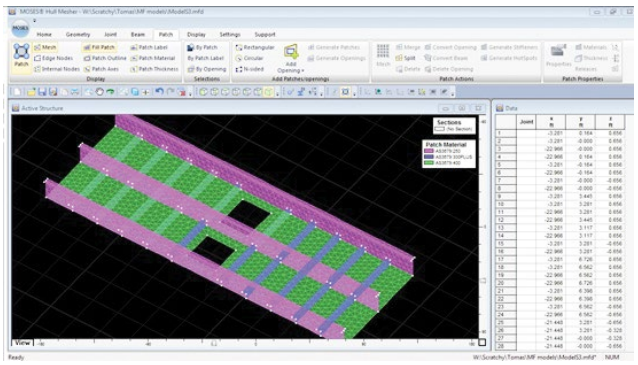
Trimble has launched Spectra Precision LL300N Laser Level which is a ruggedised, self-levelling, fully automatic laser level designed to handle a wide range of general construction, concrete and site preparation applications including general elevation control, levelling forms and footers, concrete pours, excavations and basic slopes.

It features a glass lighthouse, and offers an IP66 environmental protection rating that allows operation in adverse environmental conditions. With a metal sunshade and tough composite material housing, the laser can withstand drops of up to 3 feet (1 metre) onto concrete and tripod tip-overs up to 5 feet (1.5 metres). Its single cross-axis manual slope mode with cross-axis self-levelling allows grade matching for basic slope work, while maintaining accuracy in the cross-slope. The LL300N Laser Level also features easy, one-button operation for basic levelling. For a wider range of applications, the optional RC601 Remote Control enables additional performance features including single-axis slope mode and manual slope matching capabilities.

MOSES V7.1

for Floating Offshore Structures

Bentley Systems has released an update to its MOSES V7 software for the hydrostatic and hydrodynamic analysis of offshore platforms and vessels. MOSES is the leading software for analysis and simulation of complex offshore structure transport and installation projects. The update includes a modern graphical user interface that ensures model accuracy and consistency; faster, intuitive 3D modelling to help explore design alternatives (optioneering); reduced delays and rework from the tighter integration of MOSES and Bentley's SACS software for the analysis and design of fixed platforms and topsides; and enhanced information mobility through Integrated Structural Modeling.



In addition to these, through MOSES V7.1's support of Integrated Structural Modeling, users are able to work within integrated and flexible structural modelling, analysis, design, documentation, and detailing workflows. This gives them the advantages of intelligent structural design practices.

LN-100 and GLS-2000:

Topcon driving dynamics of BIM

Topcon has introduced two new products in the market to the construction industry. The Topcon LN-100, the Layout Navigator is the a 3D Layout tool designed specifically for construction stake-out and as-built, with easy-to-use software. LN 100 offers users with extremely simple operation for layout and topo measurement, and is equipped with features such as automatic levelling, TSshield and one-person layout by automatic target tracking.

The Topcon GLS-2000 is a compact and lightweight full-dome laser scanner which allows users to quickly and accurately capture 3D data. With its 350m (1,150ft) eye-safe long-range scanning technology, the GLS-2000 features survey-grade accuracy that reduces the amount of scan setups required on site. The integrated twin cameras help ensure that the images recorded provide the best possible definition photography for all levels of scan detail. Its dual-axis compensators provide tighter registration, overall increased accuracy, and increased field flexibility to help meet the needs of unique site logistics and project situations.

Leica ALS80 LiDAR

mapping solution with expanded pulse rate capability

Leica Geosystems has launched its next generation of airborne LiDAR solutions, the Leica ALS80. The product offers expanded Multiple Pulse in Air (MPiA) capabilities and a new scanning geometry that offers pulse rates up to 1.0 MHz. This technology greatly expands pulse rate capability throughout the entire range of flying heights, allowing faster collection rates and shorter flight times.

The Leica ALS80 comes equipped with the NovAtel OEM638 GNSS/IMU subassembly, which provides users with a future-proof precision receiver solution that tracks signals of all available constellations, GPS, GLONASS, Galileo and BeiDou as well as L-band, SBAS and QZSS. The OEM638 also continues to support the popular CUS-6 IMU.

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UNDP, GEF launch project on sustainable land management in Uzbekistan

The United Nations Development Program (UNDP) and the Global Environment Facility (GEF) have launched a project 'reducing the burden on natural resources as a result of competing of exploitation of rain-fed dry lands in mountainous, semi-desert and desert landscapes' in Uzbekistan. Within the framework of the project, studies on introduction of better practices on sustainable pasture and forestry land management in the country, integrated planning of land use in the target areas of Uzbekistan are scheduled for to be complete by August 2018. The project worth more than $2.5 million worth is funded by the GEF ($2.314 million) and UNDP ($200,000). The main partners in the project are the Ministry of Agriculture, the State Committee for the Academy of Sciences, and the local administration of a number of districts of the republic. The State Committee on Land Resources, Geodesy, Cartography and State Cadastre of the Republic of Uzbekistan have been appointed as the executing agency.

$ 2.5 mn
Cost of project

Macedonian gives investors easy access to real estate data

Potential real-estate investors will be able to access information on available building lots in Macedonia online, from anywhere in the world. The Macedonian Agency for Real Estate Cadastre will prepare a register that would show prices and the exact location of the available locations. Macedonian Government spokesman and the Cadastre Director Slave Trpeski said the goal of the project was to offer quick and free access for all citizens, institutions, and especially to investors. The register would include all available spatial plans. Trpeski added that the preparation of this register is part of the policy to attract more foreign investment into Macedonia. The plan is to have the register operational by the second quarter of 2015. The project is estimated to cost €50,000, which will be provided by the state budget. The Cadastre Agency also announced that it will publish quarterly, semi-annual and annual reports about real estate trends.

€ 50,000
Cost of project

Ethiopia inches towards its Urban Land Information System

The Ministry of Urban Development, Housing and Construction (MUDHCo) is about to launch the implementation of Urban Land Information System project. One of the objectives of the Ministry of Urban Development, Housing and Construction (MUDHCo) is to curb the problems of mismanagement and increase the real pension in urban areas through the establishment of the Cadastre and Real Property Registration System. The main objective of the project is to assist and support the MUDHCo in accomplishing the design, development and deployment of the Cadastral and Real Property Information System through this supervision project. In July 2014, the international Consortium led by IGN France International was awarded a 2 year contract for monitoring the implementation of the Cadastral and Real Property Information System. The activities taken in charge by the consortium include elaboration of the standards, gathering and formalisation of user requirements, elaboration of general system architecture, supervision of system development and deployment, and training and capacity building activities implementation. The system will be deployed in six pilot regions (Addis Ababa, Harar, Oromia, SNNP, Amhara, and Tigray).

Indian state govt finds location key to new tax structure

The eastern state of Orissa in India recently proposed to amend the Orissa Municipal Act and Orissa Municipal Corporation Act to augment its tax base by replacing holding tax with property tax. While the current holding tax collection is based on the annual rental value of a household, the property tax, after the ammended it will use the unit area method for assessing properties. This means net value of a building will be decided on the basis of its location. Experts are of the opinion that once the property tax is in force and the civic body manages the tax net through a remote sensing and GIS system, tracking the un-assessed holdings will be easy.

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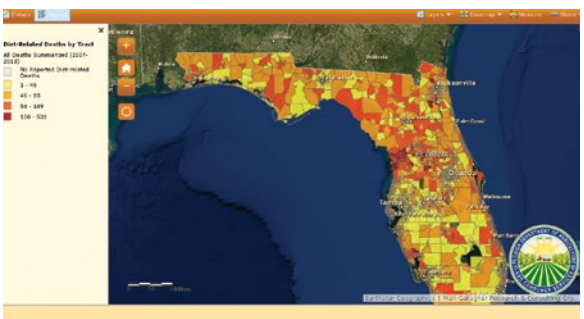
Remote sensing-based rice crop monitoring system launched

The Philippine Statistics Authority (PSA), along with the Asian Development Bank, Japan Fund for Poverty Reduction, and Japan Global Development Assistance, has launched the RCDTA 8369, a remote-sensing based data collection system on rice. The RCDTA 8369 project stands for Regional Capacity Development Technical Assistance 8369: Innovative Data Collection Methods for Agricultural and Rural Statistics. Experts are of the opinion that the Philippines along with other recipients of RCDTA 8369 such as Lao PDR, Vietnam and Thailand can streamline the data collection methods in agriculture, particularly in rice production, through the use of satellite imagery. With funding from the Japan Fund for Poverty Reduction and technical advice from the Japan Aerospace Exploration Agency (JAXA), PSA will implement activities under RCDTA 8369 in the Philippines such as the introduction of the JAXA software called the International Asian Harvest Monitoring System for Rice (INAHOR) to implementing agencies' staff. The project will be piloted in Nueva Ecija, since it is a leading rice-producing province. PSA aims to soon start the initial training program on Linux, basic remote sensing, and software installation, configuration and use of International Asian Harvest Monitoring System for Rice (INAHOR) software.

Florida's new food map

The Division of Food, Nutrition, and Wellness has provided an interactive map to illustrate options and areas of need for fresh foods in the State of Florida. The map, developed using ArcGIS tool, overlays data available on health and wellness by census tract, including food deserts, food stamp households and death rates attributable to nutrition-related diseases. Next, the map overlays assets that are available to assist communities, including food banks, food pantries, farmers markets, child nutrition programmes, federally qualified health centres and school performance, among others. The data can be used to help organisation determine how to use limited resources to have the greatest impact on the communities most in need. It will establish benchmarks so future progress can be measured and the most effective strategies can be determined. The tool is customisable so organisations can overlay their own data on top to help make strategic decisions.



Screenshot of the interactive map

Pix4D, Tetracam partner for farming using remote sensing

Pix4D and Tetracam have announced a worldwide strategic partnership to enhance farming through airborne remote sensing. The new alliance facilitates software integration of two companies, whereby simple importing of images and seamless production of 2D and 3D ortho-mosaics is possible. Through the new partnership, Tetracam would act as a reseller of Pix4D providing reduced prices on Tetracam cameras as a bundled offering with Pix4Dmapper. It has also set up a dedicated tech support engineer to handle the questions from the perspective of a Tetracam system user.

CNH Acquires Miller-St. Nazianz

NH Industrial has entered into a definitive agreement to acquire substantially all of the assets of precision spraying equipment manufacturer Miller-St. Nazianz. The assets of Miller acquired will become part of New Holland Agriculture, a CNH Industrial brand, building on a four-year manufacturing and distribution partnership between New Holland and Miller in North America. Under the terms of the agreement, CNH Industrial, through its wholly owned subsidiary CNH Industrial America, will acquire Miller's business in its entirety. Headquartered in St. Nazianz, Wis., Miller was founded as a hardware retailer in 1899. Miller has expanded through five generations of family management to become a leading innovator of front boom sprayers. One of the most used pieces of equipment on a farm today; sprayers operate through crop fields to distribute fertilisers and pesticides in the form of droplets. Miller's manufacturing facilities and 260 employees are supported by a worldwide distribution network.

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Coming up with new branch in Mexico City....

Eurasia to invest in smart grids heavily

Eurasian countries will invest $18.3 billion in electric smart grids over the next decade, forecasts a report published by Northeast Group. The report, Eurasia Smart Grid: Market Forecast (2014-2024) claims that the region has strong drivers for smart grid investment, a number of experienced vendors and significant funding available from multilateral lending organisations. Near-term growth will be focused in Central Asian countries currently battling high electricity losses. Larger countries such as Russia are expected to develop in the medium term. Since 2011, the World Bank and Asian Development Bank have committed $380 million for smart grid investments in Uzbekistan. Several other Eurasian countries have similar electricity sector characteristics and could see financing become available if deployments are successful in Uzbekistan. For example, Kyrgyzstan has the second highest electricity losses in the world (at 29%) due to electricity theft and unmetered premises.

$ 18.3 bn

Investment in smart grid

LiDAR helps improve wind turbine performance, finds research

A collaborative research project at the Department of Energy (DOE) National Renewable Energy Laboratory (NREL) has shown that the Wind Iris nacelle-mounted LiDAR is an effective diagnostic tool for identifying wind turbine yaw misalignment. This is the first independent scientific field study which has validated the benefits of using turbine mounted LiDAR to correct rotor-induced yaw misalignment. The research project, supported by DOE, was studying how wind LiDAR measurement improves turbine performance and power output by correcting yaw misalignment and a reduction in turbine O&M costs through improved load mitigation. The research was conducted in collaboration with Avent Lidar Technology and Renewable NRG Systems.

Wind Iris nacelle-mounted LiDAR from Avent Lidar Technology and Renewable NRG Systems

CartoPac, EDM partner to develop mobility solutions for electric utilities

CartoPac International and EDM International have formed a strategic partnership to provide mobile and enterprise workflow solutions for the electric transmission and distribution, and telecommunication utility markets. The companies also presented a joint webinar demonstrating how the CartoPac mobile platform can be used by electric utilities for inventories, inspections and lifecycle management of critical infrastructure on September 30, 2014. In the webinar, EDM International shared its previous mobile strategy, drivers for changing the mobile strategy and solutions configured using the CartoPac platform. EDM discussed how it has integrated CartoPac with its own DCALC product and developed improvements for managing high-resolution photographs necessary for utility inspections. The CartoPac Platform is a configurable suite of field and office tools designed to maximise the productivity of crews as they digitally map, inventory and inspect critical assets using GPS-enabled mobile devices.

Geospatial Corporation acquires ShaleNavigator

Geospatial Corporation, US based infrastructure asset mapping and data management services provider, has entered into a definitive agreement to acquire ShaleNavigator. ShaleNavigator is the shale oil and gas informational SaaS platform covering the rapidly growing Marcellus and Utica unconventional shale plays. ShaleNavigator is a cloud-based, interactive mapping software product containing over 20 map layers including current permits, well results, lease offers, available property, and pipelines in US Shale oil & gas plays. ShaleNavigator offers map query, drawing, and saving tools, and a newsboard that allows subscribers to zoom to breaking news. ShaleNavigator currently serves a diversified mass audience comprised of oil and gas pipeline companies, property owners, municipalities, service providers to oil and gas, including engineering, construction, and housing; financial service providers, such as regional banks, wealth managers, investors, and appraisers; local, state and Federal government entities, colleges and universities. The transaction is scheduled to close on October 17. Financial terms were not disclosed.

India releases concept note on smart cities

The Ministry of Urban Development, Government of India has released a concept note on 100 smart cities to be developed across the country. The 35-page blue print includes various suggestions on operational procedures, approval process for proposals, nature and extent of Central government support on financing, capacity building, which would be useful for further discussions. It outlines in detail about the several facilities that would be developed in smart cities, including reliable utility services, efficient social infrastructure and a smart transport system, which would restrict the travel time within the city to 30 to 45 minutes, 100% coverage of road network with storm water drainage network and 100% access to toilets. All smart cities will need to have a masterplan valid for the next 10 years, in addition to having digitised spatial maps, regularly updated open data platforms, amongst other benchmarks specified in the concept note.

VANZI inches closer to its 3D modelled country vision

Virtual Australia & New Zealand Infrastructure (VANZI) is a step closer to modelling Australian cities and towns — including buildings, roads, railway lines, power lines and water pipes — in 3D with volunteer group Code for Australia agreeing to develop a prototype for the project. In 2010, VANZI CEO Michael Haines had a vision to go beyond spatial modelling and use realistic 3D simulations to help construction companies better plan, design and build offsite, and allow transport logistic companies to move in and out of locations quickly. This requires the integration of geographic information systems (GIS) and building information models (BIM). There are three initiatives under the project, which Code for Australia will help with. The first will link 3D models of buildings and infrastructure to a cadastre, which is data on property boundaries. The organisation will also use Geoscience's spatial data and Geocoded National Address File (G-NAF) information. The second will enable information on legal rights of a property or asset to be visually displayed in a 3D model. The third will create a 'data bank' where Property Exchange Australia (PEXA), lessees, construction companies, councils, insurers, emergency services and utilities can securely share information. Information on legislation and legal rights of each property and asset will be attached to the 3D model.

Facility management solutions market to almost double by 2019

Global facility management market is estimated to grow from $24.65 billion in 2014 to $43.69 billion by 2019, claims a market research report published MarketsandMarkets. Over the forecast period, this market is expected to experience high adoption in Asia-Pacific, and MEA regions. IT-based facility management solutions help facility managers to track and manage usage and storage of resources such as inventory, people, or property (owned or leased). On the basis of these, facility managers can identify patterns and make decisions, keeping future perspective in mind. These future perspectives include several aspects such as resource utilisation, space utilisation, and environment sustainability among others. Strategic decisions taken based on this information help organizations to take better decisions. CAFM tools use several IT tools such as database, visual data display tools and GIS and services and then information is conveyed in graphical and pictorial form to the facility managers.

$ 43.69 bn

Estimated market value

Nigeria launches Integrated Infrastructure Master Plan

Nigeria's Minister of National Planning and Deputy Chairman of the National Planning Commission, announced that National Integrated Infrastructure Master Plan (NIIMP) is ready to be implemented following approval by the country's Federal Executive Council. By implementing the 30-year master plan, Nigeria aims to invest $3.05 trillion across all infrastructure sectors. In expressed concern that the plan would be sustained and implemented effectively if the utility of geospatial data were taken into cognisance by major actors involved in its implementation. Last year, Ademola Adeyemi, Head, Geographic Information System in the National Planning Commission, called on ministries, departments and agencies (MDAs) to devote 10% of their annual budgetary allocation to geospatial data development. He defined geospatial data as the data or information that identifies the geographic location of boundaries on earth such as natural or artificial features, oceans, among others.

‘Geospatial, a chance encounter’

A strong believer of open communication and people-centric approach, **Steven W. Berglund, President & CEO, Trimble** has transformed the way the company works. In a rare, candid first person narrative, Berglund tells *Geospatial World* about his ‘chance encounter’ with geospatial, his working style, and his vision for the geospatial industry.

I was brought up from a very early age as a Swedish American. I attribute the inherent self-reflective elements of my character to my Swedish lineage. Swedes believe in '*lagom*' [a Swedish word with no direct English equivalent, meaning "just the right amount" with an undertone of appropriateness. Living in Stockholm for four years, the *'lagom'* concept was reinforced in me, and it is a belief I have applied both professionally and personally.

Growing up, I was always interested in science and knew that was the field I was going to choose as my profession. The challenge I faced was deciding exactly which science I would pursue — chemical, mechanical or electrical engineering. I ended up choosing chemical engineering and completed my MBA. While working as an engineer, I joined Spectra Precision in 1985 and rose to become the CEO. The company was bought and sold a couple of times, before being acquired by Trimble.

One could say my involvement with geospatial technology was purely coincidental. Going back to the concept of *'lagom'*, I never tried to master every aspect of geospatial. But my perspective has always been to understand how the technology is being applied to the use case. I approach a problem not from technological perspective but from the problem-solving perspective.

In some way, my expression has more elements of European style of management than the US-style. Some of that is inherent and some of that is learnt. But again, if you look at the make-up of Trimble's management, there are several other nationalities within the management group. You don't simply see European or American characters. Instead, we are striving to find a unique style and culture, and for me this makes Trimble special. If I display self-reflective or introspective characteristics, I think it is really the engineer in me trying to find objectives. My introspective attitude has a lot to do with the management culture of Trimble.

I think it is the fear of failure, fear of mediocrity and the pursuit of perfection that motivates me. And one has to be mature enough to realise this. Just like anyone else, there are phases of uneasiness and self-criticism in my life. I think I can be a great philosopher.

Defining the market

Before Spectra Precision's acquisition, Charlie Trimble and I had a number of discussions looking for some mechanisms to bring the two companies together from technological and distribution point of view. I guess I solved the problem by going to Trimble and not the other way around.

Spectra Precision was purely a laser company and Trimble a GPS company. From my perspective, it is dangerous defining a market in terms of trends and technology. I was fundamentally sceptical about defining Trimble as a GPS company. Therefore, over a period of time, we evolved the definition to say that we are a solution provider company to construction, agriculture industry etc. This gave us more strategic space. We started defining ourselves in terms of vertical markets and provided components for the end user customer supplies. This enabled us to address a larger market and fill the void.

We have been lucky because the financial model of the company was strong. We generated sufficiently strong financial returns and we spend meaningful percentage of our turnover on R&D every year. This is our commitment to the future. This model did not exist 15 years ago; it was created and is rich enough now that we are able to invest, acquire companies and pursue our goals in each of these markets. We do have quarterly pressures but we never sacrifice our long-term goals. We do not believe in annual budgets. At Trimble, there are two time periods that matter. We just believe in asking two questions — where will we be in the next three years and what will we do this afternoon to make that three-year goal a reality? I have never felt the pressures that the US public companies and CEOs are expected to feel. I have been lucky in this respect.

Another phenomenon of Trimble is that in the last 14–15 years there has been a significant progression but it is more like taking a thousand small steps. There have been very few big steps, with the exception of the Spectra transaction in 2000.

The invisible force

My definition of organisational elegance is to have a profound effect while remaining invisible. I am an important part of Trimble but I have

I have never felt the pressures that public companies in US and CEOs are expected to feel. I have been lucky that way

always resisted the photo of the CEO on the cover of *Fortune* magazine.

Trimble, as a company, also projects this characteristic. A company has to be humble, in terms of going to the marketplace, to learn as opposed to teach. Teaching is definitely part of it but I think the fundamental perception should be that we have come to the market place to learn first. I think we take a certain amount of pride in being a private company which emphasises more on action and results.

Also, it is important to not assume that your past success is part of your future success. Human psychology is to return to the comfort zone, and my role is to push people out of their comfort zones and make them uncomfortable one way or the other. It is wonderful to be successful, but one should ask the question how we can do better the next time. This is part of the typical Trimble vocabulary. One has to achieve this daily balance. It is important for the company to project itself with some confidence in the marketplace, but it should also balance this confidence with a dose of humility. One has to be humble and powerful

I am an important part of Trimble but I have always resisted the photo of the CEO on the cover of *Fortune* magazine

simultaneously. Companies need to evolve continuously. A long lasting culture of values, aggressiveness, discipline, risk taking etc. should be built around it.

In my experience, Trimble is one of the most humble organisations which is continuously asking the question "are we doing the right thing?" I don't think there is magic in the company — it is employee-centric, communication-intensive; and that has always been the case.

In terms of establishing a new market culture, there is a need to be radically dramatic workwise. On one hand, one should be aggressive but on the other, one should also take care of their success, as it is a dangerous thing. To achieve future success one has to do what it takes to achieve that success now; and the challenges in the next 10 years would be different from the challenges now.

Innovation leap

Technical innovation is an organisational model in which we are trying to perfect ourselves. A few years ago, we created a position at the corporate level for innovation, and we hired an outsider who had worked for other high-tech companies. His role was to create a collaborative technical community within Trimble while minimising the levels of structure. This involved building a community so that if somebody has an idea or has a problem, he should be able to call somebody on the other side of the world who has some expertise in that area. Keeping the communication channels open is one element of our innovation model.

I think a company should adopt a goal-driven and process-enabled approach. Historically, Trimble has not put the process at the centre; we have used it as a tool. We do have six-sigma master blackbelts walking around the company but I think the way to process-enabled procedure is through consultation and communication. Messy and complex processes can be resolved through communication. The way to compensate for the ambiguity and complexity of the process is through constant and effective communication.

As a company, we put a great

We just believe in asking two questions — where we will be in the next three years and what will we do this afternoon to make that goal a reality

deal of emphasis on collaboration which revolves around dialogue. And we do not intend to be a company that relies heavily on emails. I wish I could eliminate email. The entire management team of Trimble relies on dialogues, whereby one can talk about their problem until it is resolved.

We are taking steps to intensify our innovation culture and technical conferences. We always had technical fellows, and now we have distinguished 'A' category engineers who are innovating in the company. In terms of quarterly dialogues, we have an intense cabinet system built around quarterly reviews. It is less a matter of process than a matter of creating a public culture and enforcing that culture; and finally attempting to involve large number of individuals within the company into the innovation process. So I would say most of the innovation in Trimble is coming out from our association with the market place as opposed to great minds sitting in a room churning out great thoughts and distributing those thoughts within the organisation. Mostly it is a democratised approach.

Vision for the geospatial industry

I don't know if Trimble has ever committed that there is a geospatial industry *per se*. But there is certainly a geospatial connection. If you start looking at construction, agriculture, mining or any other market sector, they are looking for answers. Construction will demand an answer, so will agriculture, and there maybe some common elements. But I am not sure if there is a geospatial entity that could define the answers for each of these segments.

We do not intend to be a company that relies heavily on emails. I wish I could eliminate email. Trimble relies on dialogues

Technology is evolving around sources of geospatial data, as in location and position and information coming from various sources. But I think the market forces are such that they are well defined, easily developed boundaries around geospatial community. When it comes to mapping or architecture, there is some amount of discipline but when it comes to used case in construction, agriculture etc, I make sure that there is some kind of centrality there. I think our role is to pursue the user and act as a counterback to the geospatial community and play some kind of translator or interpreter between the two.

Deutschland

GERMANY IN NUMBERS

4 largest by nominal GDP in the world

5 by GDP (PPP)

3 largest exporter in the world in 2012

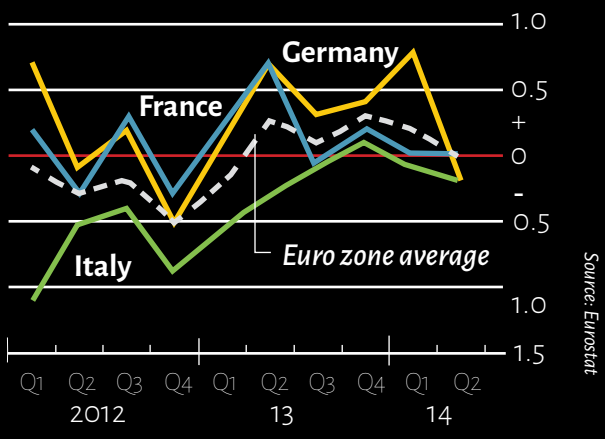
6 in rank of all countries by Human Development Index

260 value of construction market in 2012 (bn €)

86% Natural gas demand met with imports

SOUTHBOUND NOW

GDP, % change on previous quarter



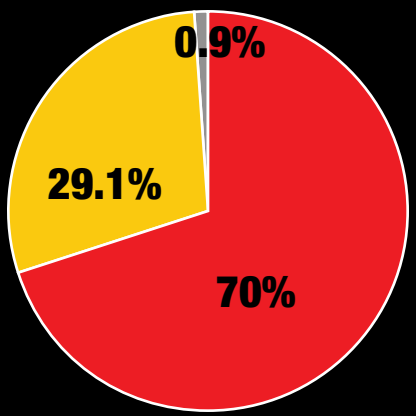
Source: Eurostat

BUT FUTURE'S BRIGHT

1.9% IMF growth forecast for Germany this year

GROWTH ENGINE

- Service Sector
- Industry
- Agriculture



Graphics: Debjyoti Mukherjee

Leads the Way

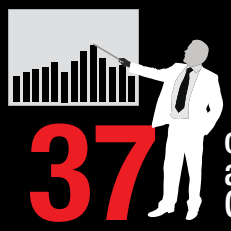
Germany has been the engine of growth in the EU, almost single-handedly pulling Europe out of the economic recession. Innovative instincts, coupled with consistent government policies and investments are keeping the local geospatial community at the forefront of a technology revolution.

By Sarah Hisham

Germany is the largest national economy in Europe, the fourth-largest by nominal GDP in the world, and fifth by purchasing power parity (PPP). Since industrialisation and beyond, the country has been a driver, innovator, and beneficiary of an ever more globalised economy. It is the largest contributor to the EU budget and among the top five contributors in the UN. And it was the Deutschland's sustained economic performance which helped haul the euro zone out of recession last year after a long 18-month contraction. Even now, as the single-currency euro zone is yet to recover fully, it is the stern, business-like German Chancellor Angela Merkel who is expected to yet again lead the show to pull Europe out of its misery.

It is the strong fundamentals and a highly innovative, knowledge-driven approach that

DID YOU KNOW?



37 of Fortune 500 firms are headquartered in Germany

FLYING HIGH ON SPACE TECH

€1.25 bn allocated to space sector in 2014 budget

€272 mn allocated to the national space programme in current budget

€634 mn for international cooperation within the ESA

"Above all, it is important to point out that we can only maintain our prosperity in Europe if we belong to the most innovative regions in the world.

Angela Merkel, Chancellor, Federal Republic of Germany

Geospatial Infrastructure

Cadastre and Mapping

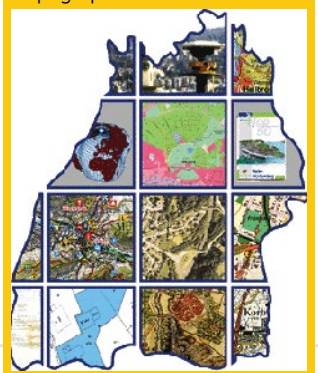
Germany has 16 mapping and cadastre agencies organised in different ways. Survey and mapping activities are coordinated by the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV).

Earth Observation

The Earth Observation Center at the German Aerospace Center (DLR) consists of the German Remote Sensing Data Center and the Remote Sensing Technology Institute and is the center of competence for EO in Germany.

SDI

The development of Geospatial Data Infrastructure for Germany (GDI-DE) as a public infrastructure began in 1998 within the Federal Government. Federal Agency for Cartography and Geodesy (BKG) acts as the main coordinator of GDI-DE, providing nationwide uniform geodetic reference frames and topographic reference data.



kept Germany on its tracks even when the entire world nosedived during the global economic crisis. Its highly skilled service sector has made the country one of the world's most influential economies, alongside its world class engineering, IT and manufacturing industries; Germany has secured the status of global leader in innovation and precision technology.

Geo-driven growth

The geospatial sector has been growing continuously over the years in Germany and showing no signs of slowing down, especially with a variety of investments allocated for R&D. The overall market trends in Germany are moving towards modern GNSS, UAV, 3D visualisation and point clouds. "Geospatial technology is continuing to serve horizontal applications while being more integrated in verticals, and this is supported by a variety of institutions. Government organisations and other associations understand and support this trend," says Juergen Kliem, Vice President, Trimble, responsible for the German market.

Germany's tryst with geospatial technology goes back many years. In 2003, the Federal Ministry of Economics had forecasted that geospatial technology had the potential to add value worth several billion euros to the economy. Following this, the government set out the Commission on the Economics of Geoinformation (now under the Federal Ministry for Economic Affairs and Energy) to harness this value and be the mediator between geospatial industry and government.

Various PPP projects with applications ranging from agriculture, real estate, risk assessment and others led by the GIW Commission have been undertaken. Today, geospatial technology provides the tools for addressing a wide variety of growth development issues in Germany, including utility management, spatial planning and implementing adaptation measures to address climate change, energy transition, demographic change, environment monitoring, urban sprawl and evaluation of census results. As a mediator, the commission also provides views, analysis and strategies to create an effective business model and framework for the utilisation of the Germany Geospatial Data Infrastructure (GDI-DE).

As noted by Marcus Wandinger, Secretary General of Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV), "More and more complex decisions need to be taken in short periods of time. Geospatial technology and appropriate reliable official geo-datasets enable these decision making processes."

As spatial information becomes crucial in many value-added processes in the industry and an important factor in all kinds of planning processes, Martin Seiler of the Coordination Office SDI Germany, the federal agency for cartography and geodesy, says "Geospatial technology is making available data that is otherwise locked in silos." This, in conjunction with capabilities to analyse data, is enabling the government authorities, the industry, research/education and the general public.

"From a technology perspective, we see a diverse environment in Germany, with still software companies developing software 'Made in Germany'. A decade or two ago, there has been much more diversity, but following global trends, consolidation has also taken place with global companies playing an important role," says Athina Trakas, Director, European Services, OGC. "For the past 15 years, a huge trend can also be 'seen' in public administrations and government of using solutions based on free and open source geospatial software. Strong communities have developed around FOSSGIS in Germany supporting a growing market and users, especially for spatial data infrastructures which are already largely based on Open Source software," she adds.

Complex decisions need to be taken in short periods of time. Geospatial technology and reliable official geo datasets enable these decision making processes

Marcus Wandinger, Secretary General, Working Committee of Surveying Authorities of the States

Survey and mapping activities

The Federal Republic of Germany has no single land and cadastre authority. As it is the responsibility of the constituent states, the country has 16 mapping and cadastre agencies organised in different ways. The

activities are coordinated by the Working Committee of the Surveying Authorities of the States (AdV). AdV ensures a uniform, standard-based data model for all reference data such as topographic and cadastre information. A common geodetic reference frame has also been established. Data dissemination is facilitated by a standardised data exchange format as well as uniform licensing agreements for geodata.

Such standardisation is by no means an easy task. "Establishing common standards is always challenging. This is further owing to the fact that the responsibility for official surveying and mapping lies with 16 states. This includes the elaboration of a common licensing and pricing policy," reveals Wandinger.

While, on one hand this was good in terms of employment opportunities for the surveying engineering graduates educated at nine German universities, in the long run, this moved the graduates away from administrative services due to shrinking public budgets and better technology replacing human workforce, says Gottfried Konecny, Emeritus Professor at Institute for Photogrammetry and Geoinformation, Leibniz University of Hannover. "However, this ultimately led to the growth of a niche market created by small GIS and IT companies, where survey graduates found an entry."

Space programmes

Germany's space programme covers the entire spectrum of EO capabilities. Its twin satellite constellation, TerraSAR-X and TanDEM-X, are among the world's best in the X-band radar technology. It is also a leader in ground-segment technology, in terms of managing the operations of satellites and the reception, administration, and distribution to end users of the vast amount of data.

The Germany Earth Observation Center (EOC) comprises of Remote Sensing Data Center (DFD) and Remote Sensing Technology Institute (IMF). While IMF focuses on basic development work related to the EO sensors, DFD concentrates on generating geoinformation products and services based on sensor data and its applications.

EOC is also working on developing German hyperspectral satellite mission called EnMAP (Environmental Mapping and Analysis Program), which aims at monitoring and characterising the earth's environment at global scale. The EnMAP mission is in development and production phase and expected to be launched in 2017.

Geospatial technology is making data that is otherwise locked in silos available. This is enabling government authorities, industry, research/education and the general public

Martin Seiler, Coordination Office SDI Germany

Germany is also strongly engaged in Europe's Copernicus programme, contributing its expertise and systems at national and European levels relating to ground segments, IT and geoinformation applications. DLR is currently developing massive computing of large datasets (e.g. 1.5 petabyte on Sentinel-2 information per year) using its 'GeoFarm' cloud processing facility. While the country is also an active member of Group on Earth Observation (GEO) and its Global Earth Observation System of Systems (GEOSS) initiative, the GDI-DE is fully integrated in the GEOSS Information System. Starting early 2014, digital elevation data of the TanDEM-X mission has been made available for the scientific use of GEO members.

Spatial data infrastructure

The development of GDI-DE as a public infrastructure began in 1998 within the federal government. Since 2005, the GDI-DE Coordination Centre has been financed jointly by the federal government and the states as a cooperative project of the public administrations at federal, state and municipal levels. The Federal Agency for Cartography and Geodesy (BKG) acts as the main coordinator of GDI-DE, providing nationwide uniform geodetic reference frames and topographic reference data.

Together with the State Surveying Offices, BKG produces the uniform Digital Terrain Model for Germany at the grid widths of 10 m, 25 m, 200 m, and 1,000 m. This model is available for the whole of Germany on a full-coverage basis, and continuously updated.

Another milestone in German SDI is the establishment of SAPOS (Satellite Positioning Service of the German Surveying Authorities), the complete transformation of all data from analogue to standardised digital data and the creation of the German-wide WebAtlasDE (Web-based Map Viewing Service of

QUICK FACTS

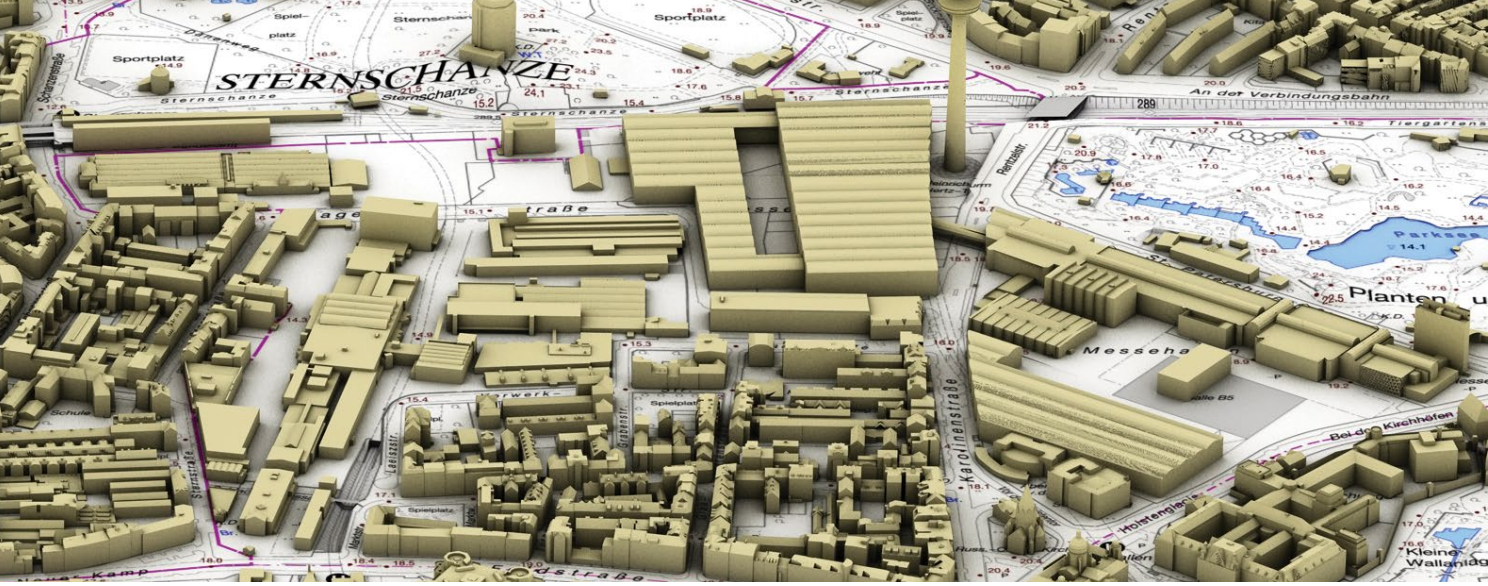
Germany is located in western Europe, bordering the North Sea between France and Poland.

357,021 sq km
Total area

80 mn
Total population (July 2014)

99%
Literacy rate

$45,085
GDP per Capita (2013)



The State Geological Information and Surveying office, Hamburg's primary source for official cartography, geo data and surveying, has prepared a unique model of the port city — a digital 3D model. The 3D model, which was created based on a digitised city map, is available in two levels of detail

For the past 15 years, a huge trend can also be 'seen' in public administrations and government of using solutions based on free and open source geospatial software

Athina Trakas, Director, European Services, OGC

the German Surveying Authorities). "New features such as 3D-applications allow more ways to use geospatial data for illustration and analysis purposes," adds Marcus Wandinger.

The GDI-DE also consists of real estate cadastre information, which is the official register of all parcels and buildings in Germany. The access, however, is restricted to authorised persons or institutions (e.g. licensed surveyors, notaries, local authorities). Today, geoportal.de portal contains over 120,000 entries of maps, aerial photos and thematic maps from 1,800 data providers, and accessible for free to the public. All spatial data stored in GDI-DE are accessible to the European community in standard format following the enforcement of INSPIRE Directive in 2007.

Seiler thinks the INSPIRE directive is the big driver for interoperability in the domain, as it brings the legal obligation to provide the main building blocks for SDIs — metadata, view services, download services and harmonised data models. "The legal and organisational structure is in place; the technical implementation is well advanced. The next big challenge is the transformation of datasets into harmonised data models," he adds.

National Geospatial Data Policy

The National Data Security Policy for Space-Based Earth Remote Sensing Systems (SatDSiG) became effective on December 1, 2007 following the launch of TerraSAR-X satellite earlier in June. The law established a control procedure for distributing satellite data/images from high-grade earth remote sensing systems to prevent harm to the security interests of the country. Details on the definition of high-grade earth remote sensing satellites as well as the procedures and the licensing aspects for the sensitivity check are defined in the Statutory Ordinance for Satellite Data Security Act (SatDSiV) published on April 5, 2008.

The Federal Spatial Information Access Act (GeoZG) came into force on November 16, 2012. The amended legislative of the earlier Spatial Data Access Act 2009 declared that the federal government spatial datasets and services, including the accompanying metadata, are available free of charge for commercial and non-commercial use and reuse.

According to Gunter Schreier, Deputy Director, German Aerospace Center, who is also in-charge of business development and Copernicus at DLR, "Such regulation is also considered to be adapted at European level to have a fair competition amongst European players for Copernicus Sentinel data. The data will be freely available for industry, government and scientists."

An Ordinance to determine the conditions for use for the provision of spatial data (GeoNutzV) followed into force on March 23, 2013. The Ordinance serves to reduce bureaucracy, ensures equal treatment for commercial and non-commercial use of the spatial data and creates legal certainty on the same.

"While harmonisation on a technical level made good progress, harmonisation of licenses and access condition remains difficult," says Seiler. However, while there are numerous different license models out there, the open data policy has increasing impact in the domain.

The E-Government Act enforced on July 25, 2013, among others, mentioned that all electronic registers which contain information relating to real estate within Germany, whether newly

created or revised, must be geo-referenced based on nationwide standard coordinates. The Act facilitates electronic communication between the federal government, states and municipalities.

Dr Peter Hecker, Network Manager, GEOkomm Networks, an association of geospatial experts in Germany, thinks that the German geospatial data policy is moving in the right direction, but there is much work to do and many obstacles to remove for companies — especially those not originating in the geospatial industry — to fully leverage the potential of the existing data.

Digital Germany 2015

The government has developed an ICT strategy to harness the potential of ICT for growth and employment. Apart from enhancing transparency and facilitating access to geoinformation and services, the government has pledged to further develop the GIW Commission by extending the network of enterprises, authorities and scientific institutes. This is in order to support ICT-based business start-ups and SMEs in the country.

"With the amount of open data that is available (and there will be more), there are many opportunities for SMEs for new businesses," says Trakas, who feels big players (like the energy providers) too need to become more flexible and reach out to others to work in a strong network.

High-Tech Strategy 2020

In its effort to remain competitive in the global market, Germany has set priority areas for its research and innovations for a period of 10 to 15 years through the country's first broad national concept called High-Tech Strategy. The updated version, presented in 2010 and known as High-Tech Strategy 2020, identifies the key technologies and measures to address the 21st century global challenges, and at the same time tapping into emerging industries.

For instance, space-based EO has been described as a key technology to provide insights and prognoses in the area of 'climate and energy research'. The government has pledged to support the development of new commercial markets and long-term provision of remote sensing data.

In the field of 'mobility', the strategy highlighted that the future of transport system will benefit from Galileo, the European satellite navigation system, especially in freight and logistics, urban mobility and maritime. "Work is underway in the processing and evaluation of long time series of existing EO data for climate research (e.g. global AVHRR from the beginning) and better near real-time performance to react in maritime security (less than 15 minutes from sensing) and natural disasters (less than few hours from sensing)," reveals Schreier.

'Communication' is also identified as a priority field to create value for the mobility and information requirements of citizens. Among the lines of action include joint initiatives with the scientific community to promote R&D for cloud computing, smart grids and embedded systems.

Shrinking public budgets and technology replacing workforce in the survey administrations moved the graduates away

Prof Gottfried Konecny, IPI, Leibniz University of Hannover

Geospatial data policy is moving in the right direction, but there is much work to do — especially those not originating in the geospatial industry — to leverage the potential of the existing data

Dr Peter Hecker, Network Manager, GEOkomm Networks

True to its reputation, Germany was among the first innovators and adopters of earth observation system. It was the first to adopt aerial camera during the World War I to record enemy movements, and has since been the leading manufacturer of state-of-the-art airborne digital photogrammetric camera through globally known brands like Carl Zeiss and Leica.

Pillars of economy

►**Agriculture:** Germany is the third largest producer of agricultural goods in the EU. Although known for its engineering innovation, the country has successfully maintained its agricultural sector with 53% of the surface area being used for agriculture. In the last 50 years, agricultural yields in Germany have increased steadily and more than tripled since 1950, mainly owing to technological innovations, including development of new seeds, improvements in plant protection, new and improved sowing, cultivation and harvest techniques and enhanced fertilisation. Application of ICT and geospatial technologies for research and development in the field of agriculture is a booming sector.

In the next seven years, EU will invest around €44.1 billion in Germany's farming sector and rural areas through the Common Agricultural Policy (CAP), which includes €35.8 billion of direct payments. The key priority areas include sustainability, modernisation, innovation and quality. The CAP supports German farmers to practice sustainable farming and combat climate change. As much as 30% of the direct payments will be linked to three environment friendly farming practices — crop diversification, maintaining permanent grassland and conserving 5% of areas of ecological interest.

In early 2014, European Commission awarded a multi-year framework supply contract to Germany-based European Space Imaging for providing very high-resolution satellite data and associated services in support of CAP. The framework agreement has an estimated value of €22.3 million over up to four years. The contract will be carried out by European Space Imaging and its technology partner GAF AG with the support of DLR. The satellite imagery will be provided directly to EU Member States for quality assessment of the CAP with remote sensing and land parcel identification system.

Germany is a federal state made up of 16 constituent States. One of the peculiarities in Germany is that since 1945 by decision of the Allied Forces following World War II, surveying and mapping was not allowed to be federally managed, and it became the responsibility of the 16 States. As a result, Germany has 16 Mapping and Cadastre Agencies organised in different ways.

►**Construction:** The German construction market is the largest in Europe with the total volume of building investments in 2012 amounting to €260 billion. Every year, about 10% of annual GDP is spent on construction projects. Many local construction companies are also successful internationally, contributing more than €20 billion annually from building output. Today, the German construction industry is increasingly focusing on environmental research, especially on optimising energy efficiency of buildings and sustainable construction through integrating IT applications in construction and the use of state-of-the-art innovations in the areas of digital planning and construction.

Technology companies need to help the industry and its customers to stay connected with the fast changing environment

Juergen Kliem, Vice President, Trimble

As in all developed nations, in projects focusing on building highways and other critical infrastructure, geospatial technology has revolutionised workflows. "The traditional workflow has been modified to incorporate data integration with 3D models, and has resulted in transitioning construction machinery into intelligent-measuring sensors, which are connected to each other," emphasises Kliem. This technology is being used now on major projects, especially in building and maintaining roads, bridges and tunnels as well as sizeable infrastructure projects.

Technologies like BIM are yet to catch on however. A research programme by the Federal Ministry for Transport, Building and Urban Affairs (BMVBS) in December 2012 found that BIM in Germany was predominately used in construction projects driven by the private industry. Institutional clients and the public authorities did not have sufficient experiences and do not state their requirements for utilising BIM yet. Following this, 'BIM-Guide for Germany' was produced by 2013 end, outlining a guideline for BIM implementation as well as recommendations on how to develop the guide further.

►**Water:** Water supply utilities in the country have by far the lowest water losses rate in Europe due to its high technical standards and well-maintained plants and networks. Constant modernisation process ensures wastewater treatment plants are well utilised and sufficient reserves are available. With an investment of €2.4 billion in public drinking water supply in 2013, the German water sector is one of the biggest

Scientists rule, but capacity development a challenge

The wide range of EU-funded projects coordinated by German companies, universities and research institutes, not only highlight the diversity of German science and technology innovation, but serve as a proof that German scientists are still at the top of their league and continuing their contributions to expanding knowledge and improving technology.

"University professors in Germany are individually elected as members of the German Geodetic Commission at the Bavarian Academy of Sciences. This group of 45 active professors is the stronghold of academic quality for the geospatial disciplines," points out Gottfried Konecny, Emeritus Professor at Institute for Photogrammetry and Geoinformation, Leibniz University of Hannover.

This is also supported by the statistic of German representatives in the OGC working group as provided by Athina Trakas, "With 42 members, Germany has the biggest number of OGC members from Europe. About 20 of them are universities and research institutes."

Internationally well-known universities and polytechnic institutes can be found across Germany that guarantees the formation and training of highly-qualified engineers. There are also numerous apprenticeship opportunities both in the government and private sectors that open up many job opportunities for fresh graduates in the field of surveying, mapping and geospatial information business.

customers for private industry, mostly for the planning, construction and operation of water plants.

Among the most advanced adopters of smart water metering in Europe, the country is host to numerous smart meter manufacturers making it a healthy investment environment. With regulatory push by EU towards smart metering by 2020, the water supply market offers good opportunity for data management and location-based services companies to integrate their products on top of the smart system.

►**Energy:** Germany is the biggest electricity consumer in Europe and is also the largest exporter of power in the region. It has one of the most reliable networks in Europe in more than a decade, with average expected annual interruption per consumer at 16 minutes. Contrary to its abundant amount of water and electricity, Germany is facing decline in natural gas production. Approximately 86% of Germany's natural gas demand is met with imports, mainly from Russia, Norway and the Netherlands, which are supplied via a number of cross-border pipelines.

The energy-related policies and guidelines in Germany are aligned towards three prime areas of focus — energy security, economic efficiency and environment protection. It is aiming at reducing greenhouse gas emissions, phasing out nuclear power and optimum utilisation of indigenous fuels for generation.

It is also planning to reduce its reliance on fossil-based fuels; the target is to generate 80% of total power from renewable sources by 2050. At present, power generation is dominated by conventional thermal sources (coal, lignite and gas) which had a cumulative share of nearly 56% in the total output for the year 2013. Renewables, nuclear and hydroelectricity constituted 24%, 16% and 4% respectively in the same year.

The transition to renewable sources is opening up new opportunities for geospatial technologies. "The energy and high-voltage transmission line development is a very sizable market segment. Spending on a variety of energy generation alternatives offers a growth potential to our customers as well as requires the usage of geospatial technologies," says Kliem.

Germany is already one of the leading investors in grid modernisation. It has carried out six state-sponsored pilot projects in smart grid. With the expected drastic change in the generation mix (addition in renewable and distributed

Screenshot from the Google StreetView of Brandenburg Gate in Berlin

capacities), its grid operations is likely to see a large-scale transformation. It would require a much higher degree of real-time network data and IT interventions at different stages.

The Parliamentary State Secretary in the Federal Ministry of Economics and Technology (BMWi) initiated the 'E-Energy: IKT-based energy system of the future' competition providing national funding for smart grid projects. The programme is aimed at funding projects that demonstrate how ICT can be exploited to achieve greater cost-effectiveness, security of supply, and climate and environmental compatibility in electricity distribution. It has an overall budget of €120 million, almost half of which came from the E-Energy funding programme. The projects have been implemented in six different 'model regions' on pilot basis.

The main goal was to assess feasibility and day-to-day challenges for demand response schemes in real conditions with a platform which brings together generators, consumers, and transmission and distribution system operators. A go-ahead

There is a challenge to adopt the new, large volume and free Sentinel data within Copernicus as new computing and data access/ distribution mechanism are still under development both in Germany and Europe

Gunter Schreier, Dy Director, German Aerospace Center

However, the number of geospatial workforce has to increase in order to maintain and meet the growing demand of the technologies in the upcoming years, says a representative from Zoller & Frohlich.

A few geospatial stakeholders are already finding it a challenge to hire adequate skilled labour. "While our brand recognition still helps in attracting the high-level talent needed, we see a shortage in certain areas like surveying and geospatial professionals, IT specialists and software developers," says Juergen Kliem.

Explains Martin Seiler: "The work with geospatial technology requires a broad skillset, including up-to-date general IT-knowledge, specialised geo-IT know-how as well as organisational and communicational talent. For public administrations specifically it becomes increasingly difficult to recruit and keep qualified staff in a tight labour market."

Geographical region could play a role in the skill shortage and Dr Peter Hecker feels there is quite a difference between the larger cities and the countryside. "Companies in rural areas often face difficulties when recruiting as many young professionals prefer the liveliness of urban surroundings."

However, Dr Thomas Heege believes that the right skills and long-term engagement of employees are the most relevant issues. "We try to support this with most attractive working conditions and environments," he adds.

to smart grid application on a wider scale would increase the necessity for location awareness of network components and consumers at all times. Geospatial technology would play a critical role for the utilities in enabling them with better network visualisation and real-time awareness. Apart from the absolutely foundational role in smart grid applications, GIS would also become an innate part of the system as network complexities and distributed generation would require better integration and information-based business analytics.

Some hurdles on the way

Being an innovation leader could pose a challenge when the adoption speed on the consumer side is not synchronised. "Technology companies need to help the industry and its customers to stay current with the fast changing environment. This coupled with the data integration needs and to deploy more data intelligent solutions are reflecting the main points," says Kliem.

According to a representative from Zoller & Frohlich, a local laser scanning system manufacturing firm, geospatial market in Germany still has not reached its true potential. "There is still lot of potential in the field of geospatial technology, as it is ought to make an even bigger impact than it does at the moment," he adds.

The major challenge for a private company and the industry is to make the technology and/or technological developments available to users and public, he says, adding since technologies like laser scanning are still fairly new, the level of awareness has to be raised. There has been significant progress over the past five years, but there is still a lot to be done in order to establish laser scanning in all possible fields of application.

The EO sector seems to be facing a similar challenge. "There is a challenge to adopt the new, large volume and free (open and free) Sentinel data within Copernicus as new computing and data access/distribution mechanism are still under development both in Germany and Europe," says Schreier, who feels it is also a challenge to get these data closer to OGC/ GIS community.

Dr Thomas Heege, CEO, EOMAP, a local company focusing on aquatic EO and mapping services, however, is of the opinion that public initiatives such as EU Copernicus services and ESA-funded projects have an impact on the commercial development of the EO market. "Clients get used to free services. This hinders a demand-driven approach to exploit the market."

The federal Cabinet introduced High-Tech Strategy 2020 to stimulate the country's enormous scientific and economic potential post financial crisis in Europe. The Strategy focuses on selected forward-looking projects based on global challenges in the fields of climate/energy, health/ nutrition, mobility, security, and communication over a period of 10 to 15 years.

Public initiatives such as EU Copernicus services and ESA-funded projects have an impact on the commercial development of EO market

Thomas Heege, CEO, EOMAP

The federal structure too has posed some challenges in terms of standards and interoperability. "Germany faces the challenge of creating Geo-IT interoperability and usability while respecting the autonomy of the administrative units. Considering the tight resources available, the participation of the municipal level remains difficult," maintains Seiler.

What lies ahead

With the fast-changing technology landscape, a much broader offering in data collection and data intelligence is expected. These trends will change some traditional markets, while at the same time open up fresh opportunities.

"Surveying professionals will become data managers and specialists with domain knowledge not only in the geospatial field, but with adjacent knowledge in important applications. Close cooperation with universities, winning young people for this industry and providing them education for the changing needs will present a very interesting task," predicts Kliem. Importance will be given not only in the hardware-enhanced technology tools, but also the communication and software platforms with multiple functionalities that will be a very important driver to the growth of geospatial industry in the country.

Seiler thinks more work needs to be done to further integrate spatial data into government operational workflows. "The existing spatial data infrastructure provides access to spatial data that should be used by others. There is still a huge unused potential for spatial information to be integrated in e-government, business processes and applications. The main challenge is to unleash this potential through stakeholder involvement from all levels."

Here, the government agencies are expected to play an important role in promoting the use of geospatial technology in the future. The use of GIS has increased over the past couple of years and is expected to increase even more. Government agencies can also help raise public awareness for these technologies.

Sarah Hisham, Regional Product Manager,
Europe, Geospatial Media & Communications
sarah@geospatialmedia.net

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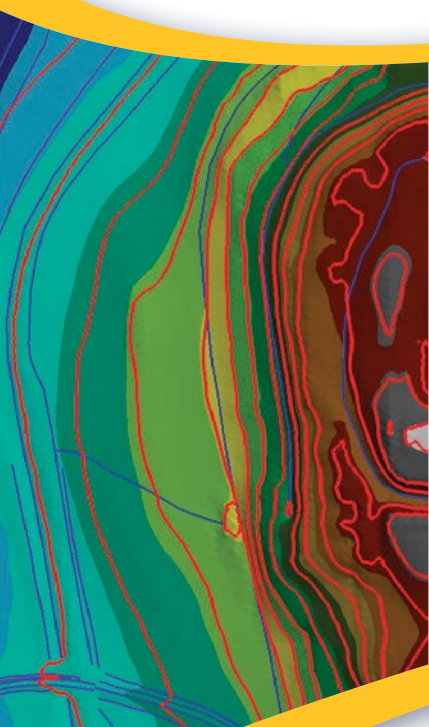

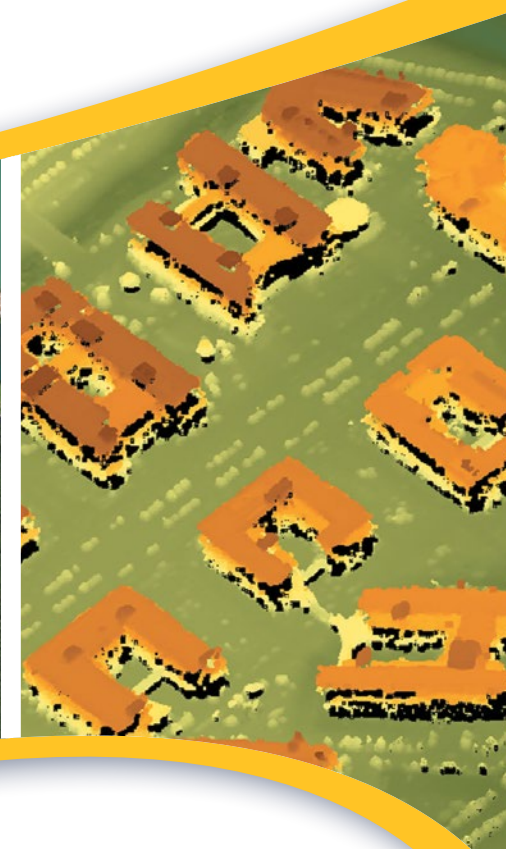

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Exciting Times for space tech in Germany

The German Remote Sensing Data Center aims to ensure global earth observation at high temporal and spatial resolution, and to contribute to an understanding of global change processes. **Prof. Dr. Stefan Dech, Director, DLR, German Remote Sensing Data Center (DFD)**, explains how DFD will contribute to national and European earth observation missions

How has the German Remote Sensing Data Center (DFD) evolved over the years?

The mission of the German Remote Sensing Data Center (DFD) is to support science, industry, and the general public, enabling informed decision making in the context of global change on the basis of satellite-based earth observation techniques. DFD and its sister-institute, the Remote Sensing Technology Institute (IMF) together comprise the Earth Observation Center (EOC), which has become a centre of competence for earth observation in Germany. It belongs to the German Aerospace Center (DLR), which is the country's national institution for aerospace, energy and transportation research. At DFD, we have set ourselves the task of making remote sensing an indispensable tool for earth stewardship. We operate national and international satellite data receiving stations which enable direct access to data from many earth observation missions, derive value-added information products from raw data, and archive and disseminate such products and information to the end users.

We also host the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT) — a user service that processes, archives, and distributes atmospheric information. Today, DFD is Germany's most important EO institution.

There is no other institution in Europe with a comparable architecture comprised of geoscience research, engineering advances, round-the-clock uninterrupted operation of receiving stations, and a national data archive.

Which are the sectors in Germany that are important users of remote sensing technology?

End users of DFD products and services are the Federal national government, states, and communities; international government bodies and line agencies, large international and non-governmental organisations; and of course the industry and the media. For example, during the disastrous tsunami in Indian Ocean, in December 2004, DFD delivered maps within 48 hours to relief organisations such as Germany's Federal Agency for Technical Relief (THW), the German Red Cross, or 'Médecins sans Frontières'. Our map products, which depicted damage extent and accessibility challenges, were requested by television, print, and online media to inform the public. At that time, we founded the Center for Satellite based Crisis Information (ZKI), which has been actively contributing to disaster related mapping activities globally for 10 years now.

What are the current trends in the earth observation industry in Germany?

Earth observation in Germany is driven by large research organisations — German as well as Germany-based international companies — as well as small and medium scale enterprises (SMEs), and to a certain degree by R&D initiated at universities. For example, the German satellite TerraSAR-X, which was realised via a public-private partnership between DLR and EADS Astrium, has been effective in boosting synthetic aperture radar (SAR) based earth observation applications. The mapping and analysis of urban area floods, surface motion, and many other application fields have profited greatly from this sensor. The success of TerraSAR-X led to the launch of the TanDEM-X satellite, enabling exact and consistent topographic mapping of our planet at unprecedented precision. EADS Astrium, a company that has been fused with Cassidian and Airbus Military to form the new Airbus branch Airbus Defence and Space, with headquarters in Munich, will be responsible for commercially distributing the resulting so-called WorldDEM dataset.

A trend which we observe at the global scale is the opening up of data archives, making earth observation data freely available. Here, the USA has set the pace with the free provision of a large number of medium resolution datasets, as well as products provided by the MODIS and Landsat science teams. Landsat data is also freely available to the global community, and the EU and the European Space Agency are already following this path by providing easy access to historic ENVISAT satellite data and making the upcoming Sentinel sensor fleet data freely available. The large amount of free data of course poses challenges for many analysts and scientists with respect to storage space and data processing.

The latest trend of launching CubeSats — miniature satellites — might change EO. CubeSats form the backbone of commercial ventures such as PlanetLabs. DLR has helped Berlin University of Technology (TU Berlin) to launch its CubeSats BEESAT-1 to BEESAT-3, a small mission meant for educational purposes.

Another trend which will make a difference in the EO industry in the future is development of so-called citizen science applications. We are living at a time when nearly every citizen owns a smartphone. The devices are increasingly capable of not only collecting GPS coordinates and photographs, but evolve more and more towards being mini-laboratories that can be equipped to measure atmospheric parameters such as air temperature, moisture, and particle density, or can even be used to steer tiny mini-drones. At the same time, the challenge of Big Data will remain: the tricky task will be to extract 5% of useful information and data from the huge amount of not-so-useful data.

How would you rank the German remote sensing industry in terms of the technology innovations?

Germany's major strength is in airborne and spaceborne SAR sensor and platform development. At the global level, we are in the same league as the USA, France, Italy, or Japan. In the field of optical sensor development, France is a strong player within Europe, and historically there has always been a bit of competition between the two countries, with France setting the pace. However, German companies such as Jenoptik, OHB System (including the former Kayser-Threde), and Astro- und Feinwerktechnik Adlershof are often high in demand when it comes to sensor technology. The Korean Aerospace Research Institute (KARI), for example, has cooperated with German private-public partnerships for many years, and relies on DLR technology to boost its national KOMPSAT satellite programme.

"There is no other institution in Europe with an architecture comprised of geoscience research, engineering advances and a national data archive

Furthermore, international players like Airbus Defence and Space have branch offices in Germany.

Additionally, several dozen SMEs focussing on data processing and remote sensing applications have been established in recent years. Most of them are partners of DFD in numerous projects, such as the companies GAF and the former Euromap, European Space Imaging, BlackBridge, EOMAP, Brockman Consult, Remote Sensing Solutions GmbH, EFTAS, and CloudEO, to name a few. The German remote sensing industry is well-respected on the global scene, valued for high precision technology and high quality information products.

What is the strategy to support local SMEs and to raise the profile of the geospatial industry in Germany?

DFD has already been an incubator for SMEs in Germany for more than three decades. Several small companies have been successfully founded either by former DFD experts or with the strong support of the DFD directorate. The EOMAP, specialising in information products for oceans and inland waters, was founded in 2006 by one of our former post-doctoral scientists. Another SME Green Spin, focussing on satellite-based solutions for efficient agricultural management, has evolved from the remote sensing department at the University of Würzburg, and has a solid backup via the knowledge and competence available at DFD. DLR furthermore offers technology marketing support for colleagues who would like to found a company and continue their career on the open market. The fact that space science in Germany is funded and supported by the BMWi ensures bridging of the gap between science and industry. In this way utmost transparency between both sectors is ensured, and cooperation can easily be backed up and strengthened.

Is DFD involved in skill development or training?

While training and capacity building is not the main mandate of DFD, many of our scientists are actively involved in such activities around the globe. Some of our experts — especially from the geoscience research departments — assist the next generation of scientists and frequently teach at German universities. We have close links with the Munich University of Technology, and the University of Augsburg. Furthermore, some of our group leaders teach during summer schools or short workshops of the European Space Agency (ESA) and other space agencies. In many of our bilateral and international applied research projects we support local partners in the focus countries with training in remote sensing data analysis. Such training has — for example — been well received by institutes of the Chinese Academy of Sciences (CAS), the Vietnam Academy of Science and Technology (VAST) and by surveying and mapping agencies in Indonesia and Kazakhstan. At the moment, we are actively involved in IT training in the Chinese Yellow River Delta, where DFD, jointly with its Chinese partners, is implementing an environmental information system to support local stakeholders' planning tasks.

Furthermore, DFD actively contributes to the DLR School Lab. DLR operates 12 school labs at 12 different locations in Germany. One of them is located on our premises in Oberpfaffenhofen near Munich.

How do you see remote sensing technology and related industry evolving in the coming years in Germany?

I am confident that exciting times lie ahead of us. More and more earth observing sensors are being launched into orbit — especially emerging economies such as China, India, Brazil or Vietnam have started building up monitoring fleets. In February 2013, Landsat 8 was launched by the USA, granting mission continuity to this important sensor line. And this spring, the ESA has launched Sentinel-1 — the first of a fleet of so-called Sentinel satellites. The Sentinels are a milestone in European earth observation. The very next launch will be Sentinel-2, which is scheduled for April 2015. DFD plans to acquire, process, and use Sentinel-2 data as part of the national collaborative Copernicus ground segment and initiatives such as the Bavarian Copernicus Center.

Cloud computing will revolutionise the way we store and process earth observation information. An ever increasing IT affinity in our society will influence how we transport and validate our results. Environmental information systems and decision support systems will become standard tools for visualising and sharing our data products and findings. While there definitely is a trend towards privatisation of the space sector, there also is a trend towards more input from the global public — be it via CubeSats, funding projects, or mobile data uploading. Our society is greatly fascinated by space, remote sensing and earth observation, and I observe an increase in participation; maybe one could even call it democratisation. These are truly exciting times!

"The German remote sensing industry is well-respected on the global scene and valued for high precision technology

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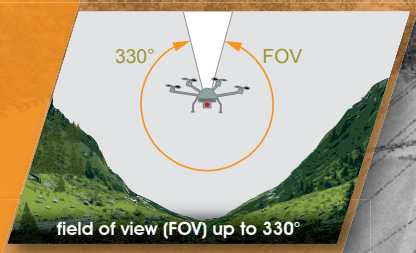

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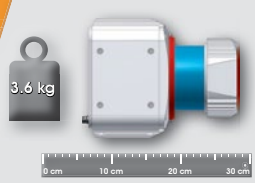

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‘G-tech is an economic growth driver in Germany’

Geospatial technology is widely used across the length and breadth of various sectors in Germany. **Dr Peter Volk, CEO, GAF**, a European provider for earth observation and geoinformation solutions, talks about the company’s projects and future directions

How is geospatial technology helping in growth and development projects in Germany?

Geospatial technology is widely accepted as an economic driver throughout public and private sectors, and its is increasingly contributing to the domestic growth and export markets. The EU and specifically EU programmes namely INSPIRE, Copernicus and Galileo are already delivering growth repercussions to an even wider community within Europe, and of course in Germany. The use of geospatial data, software and services has become a real commodity here in the past few years. A good measure is the growth of geospatial service companies in Germany that work in this sector and GAF is one of them.

Which are the major projects you are involved in?

GAF has experienced across-the-board expansion along the geoinformation value chain. Through our former subsidiary Euromap — now an integral part of the company — we have delivered pan-European datasets of Indian origin to the European data users within the Copernicus programme. A good example for a fruitful Indian-EU-German cooperation! We are also involved in Copernicus value-added projects and services in the area of land, emergency response and atmosphere. On the spatial software side, we work with customised Esri, ERDAS and PCI Geomatics as our workhorses

but also with own software products (like GAFmap) or OS-based technologies.

GAF also deals with complex consulting services where geospatial components make up between 5 and 50% of the project. Here, we are active in various sectors such as mining, agriculture, environment, REDD and, regional planning to name a few, across many countries around the globe. Important to us are a significant number of projects for military and security customers, ranging from data and processing to analysis and software services. It is this mix that makes us special and enables us to transfer a development from one sector for the benefit of another.

What has been the progress on the ground?

There have been some remarkable developments like the wide recognition of VHR and SVHR (very-high-resolution and super-very-high-resolution) data from Earth observation satellites, capable of intruding in some airborne data domains. Spaceborne SAR and optical sensors are capable of providing uniform and detailed DEMs. Good examples include the DLR/Airbus developed World-DEM Programme and GAF's Euromaps-3D product, which use the excellent data provided by ISRO's P5 Cartosat system. LiDAR and UAV technology associated software solutions have just boosted a plethora of daily real-time planning and monitoring applications, which are now, for example, under consideration for operational use in time-critical emergency management projects. Advances have been made on the software side too. GIS and image processing COTS packages have converged and have reported growth, besides the wish to have focused, easy-to-use solutions which are often based on open source technology. Most interesting has been the development of service level agreements requiring rapid reaction in data procurement and analysis, sometimes up to an 365/7/24 scheme, such offerings can only be done when one has a critical number of excellent trained and motivated employees.

What are the challenges that a private company/ industry faces in Germany?

Of course cost and budgets, though Germany does not have the highest labour cost in the EU, but the level is definitely higher than in other advancing and advanced economies. As private industry we have to offer something special, we have to be even more innovative, a step ahead technically, and put emphasis on the highest quality standards or fast turnaround through outstanding project management. The geospatial industry in Germany, like the other industrial service sectors, is facing competition from public and semi-public institutions. With increasing budget constraints, universities and research establishments are forced to tap into the grey areas of pilot and operational projects, or even service level contracts. Here, it needs the good will and constant communication to find solutions.

What is your opinion about the availability of manpower resources and skill development in Germany?

Education level of geospatial experts here is good. In the powerhouse regions like Munich, Frankfurt, Hamburg etc. we have basically full employment and to find excellent people there is difficult. Here we have the possibility of looking in regions that are not so endowed with economic progress, or to activate recruiting assistance in other EU countries through our human resources department within the Telespazio Group. When it comes to spatial software architects we require highly specialised staff and there is a shortage of them. It is also unfortunate that the geospatial industry does not yet offer attractive salaries, in comparison to the financial or automotive sector. We have to instead offer a supportive and family-like environment where staff is happy to go every day. This is the recipe which many successful firms in Germany follow.

> **"Private industry has to be more innovative and put emphasis on quality standards or fast turnaround through outstanding project management.**

What is your opinion about the German geospatial data policy? Do you think government policies have been encouraging?

Yes, definitely. In Germany, the federal and local policies are supporting the use of geospatial technology not only within the framework of EU triggered programmes, but also by national initiatives like application driven research and geospatial infrastructures by DLR, the German Aerospace Establishment. Currently, there are five or more federal ministries involved in EO activities. This fragmentation is causing problems. Also, there is no uniform pricing and licensing policy for very high-resolution data. Though geospatial adoption in Germany is considered as advanced, there is still a lot of work to do.

'The Value of GNSS is in

Galileo, the European Global Navigation Satellite System, is currently a work in progress. **Carlo des Dorides, Executive Director of the European GNSS Agency (GSA),** gives sneak peek into its programmes.

What is the mission of the European GNSS Agency?

We are a regulatory agency whose stakeholders include the 28 Member States of the European Union and the European Commission. The European Commission is in charge of the overall mission, including setting the road map and budget for European space programmes such as EGNOS, Galileo and Copernicus. The European Space Agency (ESA) serves as the core engineer of these programmes, having been delegated the responsibilities of system design and development. As these programmes become operational, the GSA is charged with managing their operations and developing their service provision.

What does this mean in practice?

With EGNOS now fully operational, the GSA is focused on what we call the service provision side of the equation, or the development of new system capacities and services. For example, in aviation we are developing a service capacity for more EGNOS-based landings. Services are also being developed across other sectors too — road, maritime, rail, mapping, location-based services and agriculture.

Within this organisational structure, the GSA's focus, or mission, is the successful exploitation of Europe's GNSS programmes. This is where the most important paradigm shift from a technology-focused push to a service-orientated pull must occur. With Galileo, as the programme moves from design and development to initial services, the GSA will take up the exploitation role — as we currently have with EGNOS.

> **EGNOS is the world's second system augmenting the performance of GPS on a regional basis, mainly in Europe**

In fact, we are already getting ready for a transition to Galileo in 2017. For example, with Galileo we aim to provide a tangible service to European citizen. To do this, GSA is currently engaged in dialogue with users across all sectors, discussing the many benefits of Galileo and listening to their needs.

As GNSS has evolved in the last few years, where do you see the opportunities for providing services?

It is true that over the past five years we have witnessed a tremendous evolution in GNSS applications — to the point that they have become an essential and integrated part of our everyday lives. For example, most of our mobile phones are equipped with GNSS receivers, and in Europe nearly one-third of all new cars come with in-car navigation devices. This alone gives you an idea of the reach and penetration of this technology.

Although GNSS is widely used in road transport and location-based services (LBS) — together these sectors account for more than 90% of the overall value — there are many other sectors benefitting from satellite technology. Maritime, rail, civil aviation, surveying, precision agriculture are to name only a few. Clearly, there are many industries where GNSS can be effectively utilised, and in fact many are already benefiting from GPS and GLONASS. We believe that with the addition of Galileo, these users will benefit from greater efficiency and improved performance — further enhancing the user experience.

In addition to these many public services, is it correct that Galileo will also offer a commercial service?

That is correct. Galileo's Commercial Service (CS) has the potential to improve the performance of existing location services for all user communities and will be a key element of Galileo's service provision. More so, it will also help further enhance Galileo's economic added-value in downstream markets.

Specifically, the Galileo Commercial Service will deliver a range of value-added features, including positioning accurate to decimetre level and an authentication feature, both of which allow for the development of innovative applications for professional or commercial use. The Galileo CS demonstrator began its proof of concept earlier this year, and initial service is expected to start in 2016.

the Downstream Market'

Once operational, CS will provide access to two additional encrypted signals on the E6 band, delivering a higher data throughput rate and increased accuracy. CS addresses the authentication and high-precision market segments and will deliver innovative services with improved performance and greater added value than those obtained through the open service.

With GPS modernising and other regions coming up with their own navigation systems, what opportunities do you see for Galileo?

It is true that Galileo is entering an increasingly mature environment. However, we believe Galileo will create a multi-constellation system that will provide better performance, availability and accuracy for the end user. More so, Galileo is designed to be 100% compatible and interoperable with these other systems.

To illustrate the importance of this, we conducted tests to measure the performance of Galileo when used in various combinations with GPS and GLONASS. The results showed that adding Galileo on top of GPS and GLONASS improves the accuracy of location fixes when indoor and in urban canyons.

Another point that I believe distinguishes Galileo from other GNSS programmes is its civil nature whereas programmes like GPS and GLONASS are essentially military projects. This distinction is important as it will allow, for example, the provision of the commercial service and will lead to the opening up of many new market opportunities.

What is the current status of EGNOS and Galileo?

As the precursor to Galileo, EGNOS has been fully operational for over three years and is being heavily utilised, for example, in the civil aviation sector. EGNOS is the world's second system augmenting the performance of GPS on a regional basis, mainly Europe. It has shown excellent performance, including guaranteeing one metre accuracy — and is capable of establishing integrity communication information within six seconds. Galileo will build from this foundation and take Europe to the next level in space technology. Although it is a complex project, the programme continues to move forward. It is now a matter of deploying the satellites and achieving the final nominal performance with the operation of 30 satellites, which is expected by 2018.

What happens to EGNOS when Galileo becomes operational?

Not only is Galileo designed to coexist with other international GNSS programmes, it is also designed to coexist with EGNOS. Although the two systems' target markets are different, with EGNOS being a regional system and Galileo a global one, in certain scenarios they will complement and enhance each other.

Do you feel there is enough collaboration between the world's various air navigation systems?

First, let me point out that although it is true that EGNOS is specifically targeting the civil aviation industry, it is not restricted to it. EGNOS can and will provide an accuracy that traditional navigation systems, regardless as to which sector, simply cannot achieve.

As to cooperation between the different air navigation systems, I can say that we have a very good level of cooperation with GPS. Every six months there are meetings between representatives of the EU and US where specifics are discussed. Because of this intense level of cooperation, we have ensured that EGNOS operates on the same equipment standards used for other GNSS systems, meaning the same aircraft equipped for the US can land in Europe using the EGNOS signal.

According to the GSA's last annual report, the "rapidly developing and complex GNSS market" already boasts a global installed base of over 2 billion GNSS devices. How do you define this market?

We have experts across Europe analysing numerous variables and predicting the evolution of these markets to reach the figures you quote. As I previously mentioned, the bulk of these devices are found in the LBS and road navigation segments and that is why the GSA continues to focus in these areas. To illustrate, we work closely with receiver manufacturers to help ensure that future chips are indeed Galileo-enabled.

It is important to note that this success in the road transport sector extends beyond vehicle navigation. We are seeing significant interest in road tolling, where GNSS can provide the high level of reliability and flexibility needed to monitor toll roads. This means that in a large city like London, if there is a need to focus on a certain area of the town, it can be done quickly and without a need for a major investment.

Looking into the future, it is foreseen that this market segment will only continue to grow. Powered by a quickly developing intelligent transport system — including the launch of a driverless car — the act of driving will become increasingly dependent on automated GNSS capabilities.

Have you seen a proliferation of companies manufacturing and designing GNSS chipsets?

Our research and experience tells us that the real value of GNSS technology is in the downstream market. The future of the market is not in developing, launching and operating satellites but in what can be done with those satellites here on the ground — the applications and services.

Realising this, I see increasing competition happening at the lower end of the value chain, including the manufacturing of chipsets and receivers. This is an area where Europe is losing to the competition coming from the US and Asia. Another area where I see potential, particularly for SMEs, is in the development of applications and services. With EU funding programmes like the current Horizon 2020 Framework Programme, we expect to see Europe evolve into a major player.

As a GNSS expert, what are the challenges to market development that you see?

Although Europe may not have a high market capacity in some areas for manufacturing, I believe it can provide a number of opportunities in terms of applications and services. For this reason, Europe should concentrate its efforts in this direction.

One challenge I see is the need to provide a reliable — or trustable — GNSS signal. As this becomes more and more of a concern, it may present a challenge to GNSS which, by definition, provides a low power signal that is easily jammed. In this sense, GNSS will have to provide new solutions — this is the main challenge facing the sector.

Is there enough push coming from the public sector in support of GNSS projects?

As mentioned, the EU supports GNSS projects through its Framework Programmes for research and development. Under the Horizon 2020 Framework Programme's first call for applications in satellite navigation, €38 million will be going to support GNSS projects. Over the course of the next seven years the total budget for this type of funding will be EUR 140 million — double the amount available during the prior funding programme.

Would it be right to call GNSS the poor cousin of earth observation?

Not at all. Today, Europe has two flagship programmes — Galileo for GNSS and Copernicus for earth observation. The €7 billion budget assigned to Galileo is roughly double of what has been assigned to Copernicus.

But comparing the two is like comparing apples and oranges as the two systems target different needs, although in the future I see these two worlds coming closer together. For example, precision farming can benefit from the synergies between the two systems — a good understanding of the ground provided by Copernicus coupled with Galileo-enabled accurate positioning can only benefit the farmer.

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GNSS was conceived alongside with Sputnik, Explorer and the International Geophysical Year of 1957. Shortly after the launch of the first Earth-orbiting satellites, concepts began to take shape for a satellite-based system for positioning and timing. The core technologies—satellites, tracking and control, user receivers and processing software—have advanced to provide what is today a remarkably capable and reliable system. But while the visionaries of 40 years ago might have anticipated the technical advances, no one could have foreseen the breadth and depth to which GNSS today affects our world.

GNSS has matured from its military origins to serve the global community. Generations and constellations of GNSS satellites have emerged to deliver new signals and improved performance. Today it's possible to utilize GNSS positioning just about anywhere on Earth. On the ground, receiver hardware has become smaller and more powerful, increasing its portability and flexibility. And new techniques in software, communications and information management enable innovators to incorporate GNSS positioning into day-to-day work processes in a broad array of uses.

While the early adopters of civilian GNSS were concentrated in geodetic, scientific and energy exploration, modern GNSS offers nearly boundless opportunities. It's not a "one approach fits all" solution. Because it can support a variety of precision, form factors and operator interaction, GNSS has found its way into new industries, places and applications.

There are several drivers to the growth of GNSS:

- GNSS can be integrated with other sensors to create new geospatial solutions that can produce entirely new types of information.
- Developers can use software and communications tools to create customized workflows and equipment tailored to the tasks at hand.
- GNSS equipment continues to get smaller and lighter.
- It's increasingly possible to achieve precise positions in real time.

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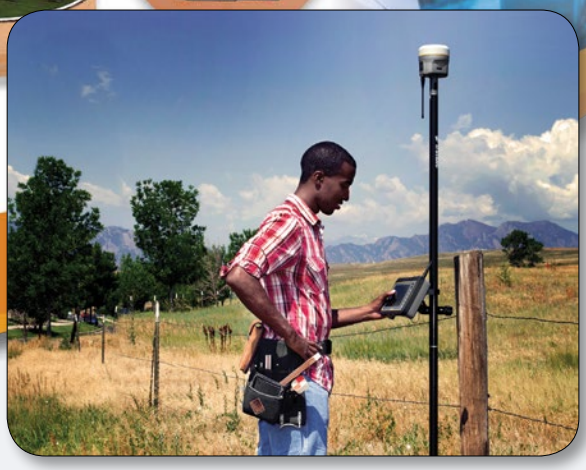
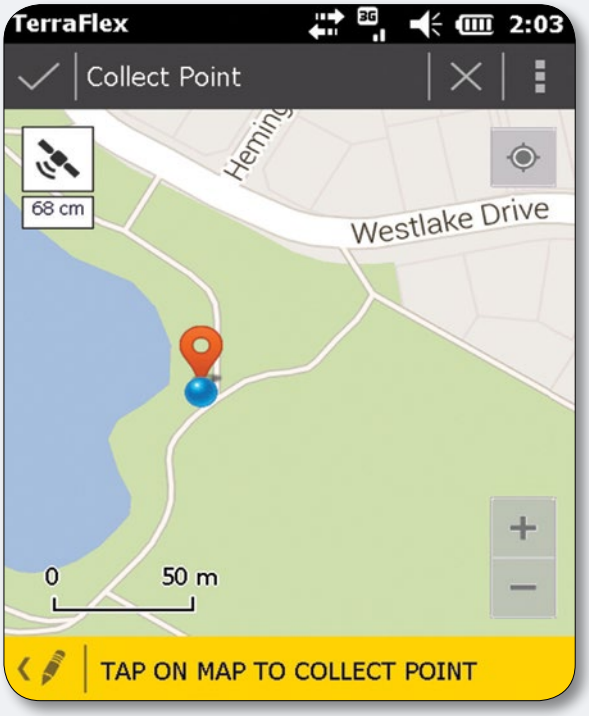
Precision and Productivity in Geospatial Applications

Surveyors and geodesists quickly recognized the value of GNSS. For decades, GNSS has been an essential tool for these users. By capturing precise data on land, boundaries and improvements, GNSS reduces time and error in





developing and utilizing information in cadastral and land administration applications. Even though GNSS is considered a "mature" technology for surveying and related disciplines, rapid technological enhancement continues to increase its value. For example, the Trimble R10 GNSS receiver utilizes Trimble 360 technology to support signals from existing and announced GNSS constellations including GPS, Glonass, Galileo, Beidou and QZSS. In addition to its advanced tracking capabilities, the Trimble R10 utilizes Trimble SurePoint™ and HD-GNSS technologies to reduce measurement time while producing accurate, reliable positions.

The Trimble R10 can be combined with the Trimble V10 Imaging Rover to produce georeferenced panoramic images. With this approach, surveyors can create deliverables that include traditional points and plans as well as orthophotos and 3D models. When the design work is completed, teams can return to the field and use RTK to set points with high confidence, receiving correction data from single base stations or real-time networks utilizing Trimble VRS technology. The work can continue even when RTK communications are interrupted. The Trimble R10 uses Trimble xFill™ technology to fill in RTK or VRS corrections during temporary outages such as radio black spots. And by connecting to the Trimble CenterPoint™ RTX™ Correction Service, the Trimble R10 can produce RTK positions without a base station or active GNSS network.

Managing Public Assets Using GNSS

Local governments and utilities must manage and maintain an immense variety of assets and infrastructure. From underground water pipes to overhead electric lines, from expressway interchanges to simple neighborhood footpaths, GNSS helps achieve high levels of efficiency in inspection, operations and lifecycle management.

For example, consider the work needed to maintain a city's streetlights. In addition to knowing the location of each fixture, asset managers need information on the streetlight's condition, functionality and maintenance history. By using mobile mapping systems such as the Trimble MX2, GNSS positioning can be combined with data from lidar, video imaging and inertial sensors. The result is a rich set of geospatial information that can be merged with records for each fixture's maintenance and performance. When managed in a GIS-enabled enterprise management system, stakeholders can easily access and visualize the information. When maintenance is required, field crews can use GNSS navigation to help ensure they are working on the correct fixture.

The accuracy and precision of GNSS is invaluable in managing underground assets. Crews for water and wastewater utilities can use Trimble GNSS to capture data on valves, manholes, pipe locations and other assets. Information about the assets can be collected using Trimble TerraFlex™ software, a highly customizable solution that utilizes Cloud-based information sharing to collect and share specialized information. Asset information can be added to a GIS to provide field workers

information that is correct and up-to-date. The information can be delivered in real-time to field crews, who can use GNSS to quickly locate valves or other assets covered by earth, pavement or water.

Cutting Costs and Increasing Productivity on the Construction Site

When working on civil infrastructure and other heavy construction jobs, contractors must keep careful control over project schedules and budgets. By integrating GNSS positioning into a variety of construction workflows, Trimble solutions make important contributions to efficiency and productivity.

Heavy civil construction requires significant earthwork including removal, placement, compaction and grading. These processes benefit through the use of automated grade control systems in bulldozers, excavators, graders and other equipment. For example, the Trimble GCS900 Grade Control System for bulldozers delivers real-time data to the on-board display panel. The operator receives information such as cut/fill data and avoidance zones to keep tight control over dirt movement and safety issues. The system captures as-built data and enables project managers to see precisely where dirt is moved on the site.

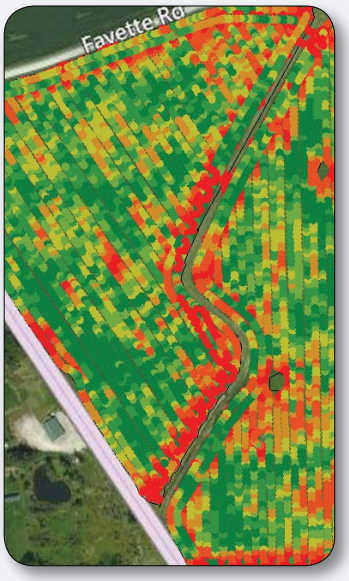
Construction surveyors utilize GNSS in setting project control, layout, grade checking and quality control. Surveyors can use a Trimble SPS985 GNSS Smart Antenna to operate with real-time centimeter precision. By loading design information such as digital terrain models, roadway alignments, cross sections and 3D points into rugged handheld controllers, field crews can quickly compare existing grades and conditions to design data. Office and field software use as-built data captured using GNSS for computations and analysis including quality control, volume computations and construction inspection.

Modern construction techniques include real-time communications between the job site and stakeholder offices. Operating as a component of the Trimble Connected Site®, the Trimble SPS985 works with the Trimble Site Tablet, the Trimble TSC3 controller or the Trimble Site Mobile to capture detailed site data and communicate changes or problems between field and office.

Reaching New Heights in Agriculture

GNSS is delivering significant positive impacts in the agriculture industry. Tractors, sprayers, harvesters and other equipment can be steered and controlled using onboard Trimble GNSS receivers and guidance solutions. For example, planting systems control application rates and prevent overlap to reduce seed costs and increase yield. Applications of fertilizers and other inputs can be managed as well. In addition, automated steering systems help to extend operating hours and reduce driver fatigue across all farming operations.

Precision farming extends beyond GNSS-based control of farm machinery. Trimble agricultural solutions provide systems for collection and analysis of data such as yield, moisture and equipment status. The information forms the basis for timely, data-based decisions on farm operations and resource utilization.



By implementing the Trimble Connected Farm™ solution, farmers can collect and share information through wireless data transfer. The solution provides communications between field and office and between individual vehicles operating in the same field. The farmer can transfer guidance lines, drainage designs, variety maps, yield data and variable rate prescription maps. The rapid communications and GNSS positioning enable farm managers to quickly access data in the office using Trimble Farm Works™ software to assist in decision making and improve field record keeping. For example, by receiving positions and yield data directly from on-machine sensors, Farm Works can develop yield maps for each field and crop. The information enables farm managers to adjust fertilizer prescriptions on the same day the yield data arrives in the office. With the yield maps in hand, farm managers can plan to apply the right amount of fertilizer the next day.

GNSS and the Mobile Work Force

The use of GNSS has produced new levels of productivity infield service operations and mobile workers. Fleet managers can use Trimble GNSS and mobile resource management solutions to track the location and status of mobile assets.Geospatially-enabled fleet management extends to local activities such as waste collection, construction fleets, telecommunications and utilities.

GNSS-based fleet management goes beyond providing location and navigation. The in-vehicle components support real-time communications between driver and office. Trimble's cloud-based systems for response and dispatch coordinate with onboard displays to guide to field technicians to customer sites for pickups or service calls. In addition to improving response times, the systems help reduce fuel consumption and emissions while trucks are in the field.

For example, a fleet of trucks to collect trash and recyclables can be managed using Trimble GeoManager, a web-based mobile software application that integrates GNSS, wireless communications, satellite and Internet technologies to deliver on-demand visibility into the firm's mobile workforce and vehicles. The system helps dispatchers to instantly map the locations of vehicles, find vehicles close to a customer, log work hours and exchange text messages and forms with the drivers. Each time the truck lifts a container, the system captures the time and GNSS location to provide data for proof of service, billing and worker performance.

Riding the Growth Curve

It all comes down to understanding the work and the people involved: What information is needed? Who will use it, and for what purpose? Where is it used? In what forms is the information most useful? Trimble uses that knowledge to creates solutions to collect, process, model and analyze information,

Trimble leverages GNSS to create start-to-finish solutions that focus on deliverables and help users become more efficient throughout their work processes. The results are transforming the way work is done across a growing variety of applications and industries.

Tracing a Growth Trajectory

As the utility of GNSS grows beyond surveying, LBS and navigation with new satellites and constellations, the market size of the GNSS industry is all set to leapfrog in the coming years. *By Anusuya Datta*

"The global installed base of GNSS devices has surpassed 2 billion units, despite the economic slowdown. Mindful of recent milestones and the fact that multi-constellation GNSS is becoming a reality, the prospects for the future are highly promising".

– GNSS Market Report 2013, the European GNSS Agency (GSA)

The only thing more difficult than describing the GNSS market is predicting its future growth. In an ever more connected world, people's use of high-integrity positional, navigational and timing data is growing like never before. The easy and cost-effective availability of location data is enabling its access in an increasing number of products and services.

The demand for satellite navigation and communications was initially driven by the militaries. However, the largest growth by far today comes from civil applications of GNSS, driven by the 'traditional' applications including surveying, geodesy, engineering and GIS, says Elmar Lenz, General Manager, Geospatial GNSS, Trimble.

Not without reason then that the GSA predicts that there will be 7 billion GNSS devices by 2022, almost one for every person on the planet. Over the coming decade, the installed base of GNSS devices will increase almost four-fold, largely driven by increased penetration in regions outside Europe and North America. "The major part of the value is in the downstream market," says Carlo des Dorides, Executive Director, GSA. He is categorical that the value is on the receiver, application and services side. "I see an increased potential and growth in the number of companies, especially SMEs, in the application and service provision. It is a continuous and fertile growth," he adds. GSA has recently been holding talks with chips manufacturer for embedding Galileo signals.

The *GNSS Market Report 2013* from the GSA foresees a compound annual growth rates (CAGRs) for "GNSS core" and "GNSS-enabled" revenues increasing by 9% through 2016 and 5% through 2020, respectively, to attain €350 billion ($478 billion) per year. By 2022, GNSS core revenues will comprise about €100 billion ($137 billion). These market results remain the current benchmark for the evaluation of market opportunities for the upstream and downstream industry.

The projected long-term growth revenues indicate significant business opportunities; however, the changing technology ecosystem (use of communications and other positioning technologies alongside GNSS, and the emergence of new constellations) requires constant innovation on the supply side. Although various location technologies are integrated in one device, GNSS will remain one of the main sources of outdoor positioning information.

Worldwide, regulatory measures are being put in place to promote the use of GNSS. For example, regulatory requirements for emergency location sharing, such as the European eCall, the mobile 911 (North America) and 112 (Europe), or Search and Rescue (SAR) services, promise to provide further impetus for growth in Europe and North America over the next five to ten years.

Multi-constellation devices that use all navigation signals in view are becoming more common in the market, offering increased availability (appreciated especially in urban environments) and more robust performance in professional applications (e.g. in Surveying). More than 70% of models available on the market are GPS-SBAS (satellite-based augmentation system) capable (SBAS like WAAS, EGNOS, and MSAS) and the penetration will grow further with the expansion of SBAS coverage around the globe.

The biggest step forward is the availability of satellites, says Alois Geierlehner, Director, Business Development at GeoMax, a Hexagon Group company. "Simply said, the more satellites you have up there, the higher are the chances that you can fix your position even in bad conditions such as under a canopy or in urban canyons. In this way, the areas without sufficient satellite coverage shrink dramatically and you can use GNSS in locations not possible only a few years back."

As of now, only the United States NAVSTAR Global Positioning System (GPS) and the Russian GLONASS are global operational GNSSs. China is in the process of expanding its regional BeiDou navigation system into the global Compass navigation system by 2020. The European Union's Galileo positioning system is a GNSS in initial deployment phase, scheduled to be fully operational by 2020. France, India and Japan are in the process of developing regional navigation systems.

Applications galore

Scientific applications of GNSS are widespread and include surveying, environmental and atmospheric monitoring, meteorology and climate research. But it is the free availability and accuracy of GNSS signals, combined with falling costs of hardware, that have made GNSS the chosen solution for several industrial applications too. While Trimble's Lenz says the past 15 years have seen strong demand coming from the construction and agriculture markets, Charles Rihner, Vice President of the Topcon GeoPositioning Solutions Group, sees the uses for GNSS technology continually broadening. "We provide precise positioning solutions for the global surveying, construction, agriculture, civil engineering, BIM, mapping and GIS, asset management and mobile control markets that result in tremendous productivity growth. Highways, infrastructure, buildings, pipelines, mining, and more… the application opportunities are there and we are continually introducing new solutions for emerging markets."

LBS, the obvious gainer

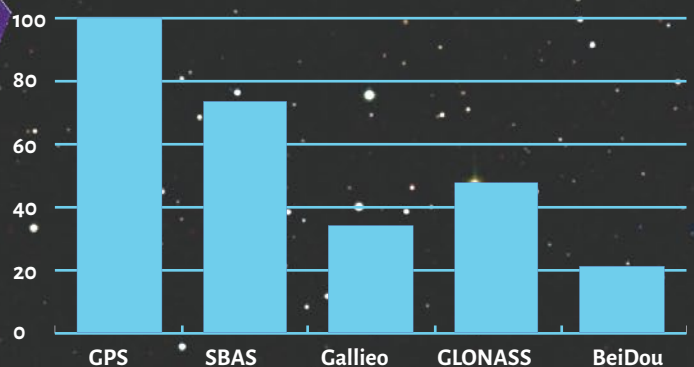
"If your smartphone recommends the nearest restaurant suited to your tastes or tracks your fitness level with a special app, this is far beyond what GNSS was originally designed for. To have a position and knowing where you are is key to a lot of applications and we still see this expanding," says Geierlehner. The increased affordability of smartphones and other GNSS-enabled platforms will drive the growth of the LBS market; expected to be 10% CAGR over the next decade. Smartphones comprise 90% of LBS devices sold. However, with the growing penetration of tablets and increased GNSS usage in digital cameras, the smartphone share will decrease over the next decade.

With LBS devices increasingly supporting navigation and services in other applications, new smartphone capabilities alongside integrated technologies are blurring the market segment breakdowns. LBS is forecasted to be the largest market segment by revenue, overtaking road, where the PND market continues to decline, being cannibalised by the use of smartphones in cars. LBS devices are also being used in general aviation and leisure maritime.

Navigation leads the way

At present, road transport applications are the majority users of GNSS signals, for in-car navigation, commercial fleet management, taxi services, public transport

GNSS CAPABILITY IN RECEIVERS



** Source: GSA analysis based on GPS World Survey 2013. Percentages based on number of models available, not sales*

monitoring and passenger information, and emergency vehicle location, dispatch and navigation. In road transport, emergency vehicle location, dispatch and tracking require medium availability and accuracy. Future applications such as automated highways and lane control will need very high availability, integrity and accuracy.

7bn

GNSS devices by 2022 – almost one for every person on the planet

The number of embedded devices and On-Board Units is growing, replacing traditional nomadic devices (e.g. PNDs). As smartphones are increasingly used for road navigation purposes, new Intelligent Transport System (ITS) services are expected to be deployed in the coming years, taking the use of GNSS far beyond in-vehicle navigation. For instance, every third new car on the road is equipped with in-car navigational devices in Europe. "This alone can give you an idea about the reach and penetration of this technology," points out des Dorides. "The big numbers are there, and that is why we are focusing on them. We have been quite successful in having a good number of them in the transport sector".

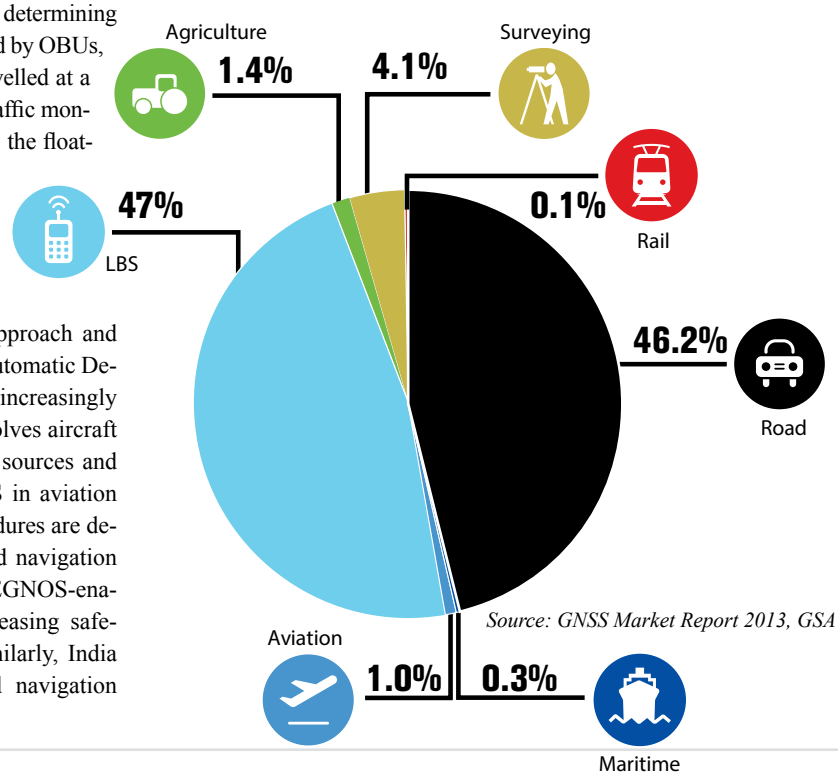
Further, there are applications beyond traditional navigation, such as pay-per-use insurance (enabling pricing policies based on timing, location and driving behaviour); driver assistance systems and connected vehicles where GNSS, complemented by sensors (e.g. camera, radar) and communications systems (e.g. Wi-Fi, 3G), is used to enhance intelligent vehicle safety systems (e.g. intelligent speed adaptation, lane change assistance, curve speed warning, collision avoidance, automated driving; road user charging solutions), determining the position of vehicles using GNSS data received by OBUs, which calculate road tolls based on distance travelled at a particular location and time; and Satellite road traffic monitoring using real-time traffic information where the floating car location data, collected in real-time from vehicles, are sent to a central processing centre and shared with interested parties.

In aviation, most commercial aircraft now use GNSS for en-route navigation and several countries have licensed GNSS for initial approach and non-precision approach to specified airfields. Automatic Dependent Surveillance - Broadcast (ADS-B) is increasingly used where there is no radar coverage; this involves aircraft calculating its position using GNSS and other sources and broadcasting it to other aircraft. Use of GNSS in aviation sector is expected to go up as more flight procedures are designed to take advantage of performance-based navigation (PBN). For example, Europe is rolling out EGNOS-enabled instrument approach procedures for increasing safety and business continuity at aerodromes. Similarly, India has launched the GPS aided geo-augmented navigation (GAGAN), a regional SBAS, to improve the accuracy of a GNSS receiver with reference signals for the aviation industry. PBN is expected to be a key enabler for Ground Based Augmentation Systems, resulting in lower minima to CAT II or CAT III standards, demanded by some commercial operators. Commercial aviation GNSS manufacturers are expected to capture about 30% of the aviation market revenue by 2022.

Maritime applications include ocean and inshore navigation, dredging, port approaches, harbour entrance and docking, vessel traffic services (VTS), automatic identification system (AIS) hydrography, and cargo handling.

Railway applications include the management of rolling stock, passenger information, preventing doors opening unless they are alongside the platform, cargo tracking, train integrity and level crossing approach. As a combination of technologies such as balises, RFID and GNSS enables a train to detect its own position, the railway signalling system is expected to gradually become more intelligent. GNSS will support this programme by providing an additional source of positioning information, especially in the evolution of signalling system. The GSA report sees 30% of trains across the world to be equipped with GNSS by 2022. As market needs for cheaper and more sustainable transpor-

CORE REVENUE SHARE 2012-22



Source: GNSS Market Report 2013, GSA

tation systems favour GNSS-based RUC schemes and PPUI applications, the combined shipments of devices in these two applications is likely to grow to around 20% in 2022, says the report.

Sowing seeds in agriculture

Agriculture is one area that has jumped to take advantage of acute positioning. The use of GNSS together with EO data enables a new range of applications in agriculture (e.g. assessment of land use and the impact on biodiversity and landscapes, crop conditions and yield forecasts or management of irrigation), and has been put to use by governments across the world. However, what is interesting is the uptake in precision agriculture, mostly in developed countries, which have larger farms and fewer farm hands.

Precision farming is perhaps the clearest example of the commercial application of GNSS. Machine guidance, precise planting and harvesting, fertilisation advice, yield monitoring, and water management advice at farm level all contribute to increased production and cost savings. Often the first GNSS application a farmer adopts is Tractor Guidance (making use of a digital display which assists drivers to follow a predetermined path, minimising risks of overlap/gaps). Automatic Steering, the most advanced form of tractor guidance, is used mainly on large farms and allows tractors, harvesters and other farm vehicles to be automatically steered along a predetermined path. The operator can concentrate solely on monitoring the overall process. Variable Rate Technology (VRT) leverages local conditions on the field for precise control over farming inputs (e.g. fertilisers, nutrients). Farmers are also using GNSS for asset management, involving the use of real-time information for monitoring the location and status of farm equipment.

The uptake of GNSS-based precision agriculture in less industrialised regions is set to accelerate, supported by consolidation of farms. Precision agriculture responds to the need to improve yields and efficiency, while controlling costs. GNSS is used together with augmentation systems like RTK, and SBAS to increase the accuracy. Solutions based on SBAS initiated the diffusion of precision agriculture into smaller farms thanks to more affordable equipment and a medium level of accuracy.

No wonder then that between 2006 and 2012, global shipments and the installed base of GNSS devices is said to have more than tripled. North America and Europe naturally are the most technologically advanced region with respect to precision agriculture. The rest of the world comprises countries with markedly different levels of technological development, varying from Japan and Australia, with extensive adoption of precision agriculture, to nascent markets such as China and India.

Dealing with multiple signals

GPS is modernising. GLONASS is here. BeiDou is functioning well at regional level. Galileo is in the advanced stages. India and Japan are in the process of launching their own constellations. So how do the multiple GNSS signals enable the industry?

"Improvements to GNSS provide important benefits to end users in all disciplines," says Lenz. Beginning with the introduction of the L2C GPS signals, Trimble has provided support for new signals as they come available. We can use these advances to achieve positions in difficult situations such as urban canyons, buildings and dense vegetation canopy. The enhanced satellite segment enables us to increase the availability of accurate, reliable positions in these harsh environments.

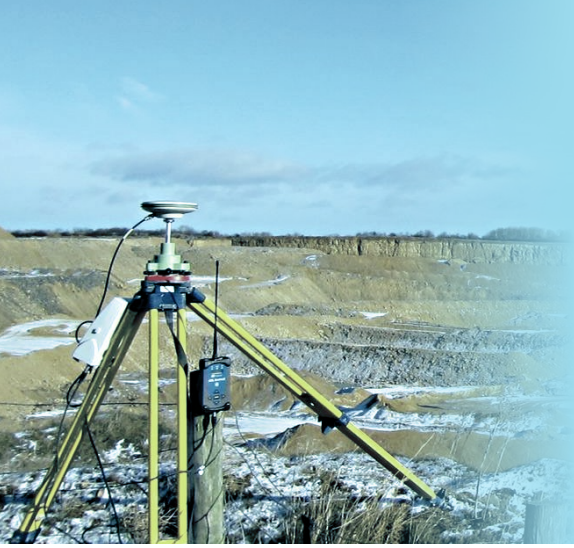
Similarly, with companies like NovAtel, the world's leading supplier of GNSS boards, Leica Geosystems and GeoMax, Hexagon has direct access to the latest developments in the market and its products are ready for new signals as soon as they are launched, says Geierlehner. "Our strength in working with multiple GNSS signals from different systems is that we are able to treat them not as separate, but as a combination. This means we don't just get one position from GPS and one from GLONASS and average them, we use all the information we receive to provide the best and most accurate single result. This is not as easy — due to the fact that the independent systems were not designed to be used together — but the results we get show that we can increase availability as well as accuracy and reliability dramatically by using this approach."

Galileo was designed to have a frequency band and modulation which is very beneficial for having a complete interoperability with GPS and Galileo. Therefore, there already exists good cooperation and interoperability between the two systems. Further, there are regular EU-US meetings which discuss specifics in details. "Cooperation with GLONASS and BeiDou is certainly not at the same level as we have with GPS," says des Dorides.

The key consideration is the Interface Control Document (ICD) that is published by the various organisations and governments that operate the GNSS constellations, says Lenz. The ICD defines the signals and provides the information needed to design a GNSS receiver. GPS, GLONASS, Galileo, QZSS and BeiDou all have public ICDs, but IRNSS does not. A second important document is a performance standard, which defines the guaranteed performance level. This is important because many of the differential systems (such as RTX) need the best possible estimates for clocks and orbital parameters.

"The only problem is when satellite signal providers do not provide accurate Interface Document publicly and on a timely manner," says Javad Ashjaee, CEO and President of California-based Javad Group, which specialises in GNSS hardware.

Once the key documents are available, most of the system interoperability issues can be solved as part of the detailed receiver design. The UN-based International Committee on Global Navigation Satellite Systems (ICG) was established to promote cooperation between the governments providing GNSS services on civil satellite based positions.



The Pricing Factor

Low-cost, high-precision GNSS chipsets are still a couple of years away even though prices of high-precision GNSS receivers have been declining in parts of Asia, Africa, Europe and South America even though it is still very high in US and Canada. The price erosion in the last few years has largely been supported by increased competition and demand, and lower production costs. Leading manufacturers have introduced low-cost devices sometimes under other brand names to satisfy the increasing demand in emerging economies, which are more eager to buy less expensive devices. These systems are usually less technically advanced so as not to undermine sales in more developed markets.

"Users in developing countries no longer accept working with out-of-date technology just because they cannot afford high-end brands. We are seeing increasing demand from customers outside of the traditional surveying market, for example, a foreman on a construction

Surveying new territories

Surveying is an early adopter of new location technologies including GNSS. Currently, professional surveying receivers are using all available GNSS signals (multi-constellation and multi-frequency) and differential correction techniques (e.g. SBAS, RTK, DGPS). The role of GNSS receivers in the surveying equipment market has demonstrated the added value of satellite positioning to optimise survey operations and fruitful co-existence with other land measurement technologies, such as laser scanners and photogrammetric/LIDAR cameras. The trend in surveying is to adopt all new signals in one device, maximising accuracy of measurements and improving availability in places with poor aerial exposure (e.g. urban canyons and forests).

All total stations now come GNSS-equipped, a trend observed over the last few years. "But I still believe we are at the start of this development, as it is concentrating mostly on the high-end segment," says Geierlehner. He, however, adds that more and more users are no longer exclusively using total stations or GNSS, but both. "By bringing these two technologies together, you get the best of the two worlds. Above all, GNSS made a major step over the last years in terms of usability and being affordable to a much wider base of users. And a wider user base results in a bigger market."

Major growth in surveying depends heavily on economic conditions in high-growth economies. Cadastral and construction segments are the largest applications of GNSS in surveying. New professional users in environmental and engineering disciplines together with mapping communities are fostering the use of geoinformation and the development of new applications. "Professionals in the surveying, engineering and construction segment face increasing competition. No geographic region or segment is immune to this," emphasises Geierlehner.

In the coming years, the surveying market in the developing world is expected to experience major growth since land boundaries and their measurement are likely to become an important issue. Add to that the high level of construction and infrastructure activities in these regions. GNSS is expanding faster in the emerging markets because often there are no alternative legacy systems, and dense geodetic ground networks to support surveys frequently do not exist.

Mapping applications will also support further market growth by enabling new applications, requiring lower levels of accuracy. Volunteered Geographical Information (VGI) initiatives are fostering the use of GNSS devices to share instant updates of geoinformation within mapping communities.

The surveying market in rest of the world is expected to develop much faster than in Europe or North America owing to the high level of construction activity in these regions.

Other positioning technologies are used to complement GNSS. In mobile mapping systems, inertial measurement units and wheel sensors help refine GNSS-measured positions. The results are georeferenced datasets from LiDAR and imaging sensors that can produce detailed 3D models over large areas and corridors. For instance, Trimble's newest GNSS rover, the Trimble R10, can be integrated with the Trimble V10 imaging rover to provide survey-grade georeferencing for panoramic images captured on site.

Construction is a whole new world

Site surveying apart, GNSS technology is being integrated into construction equipment such as bulldozers, excavators, graders and pavers to enhance productivity in the real-time operation of this equipment, and to provide situational awareness information to the equipment operator.

100

Number of GNSS satellites to be available to the users by 2020, as many as 30 or 40 simultaneously

Increasingly, large-scale infrastructure projects are incorporating augmented GNSS positioning across the design phase to construction lifecycle and on into asset management post construction. Most of these applications require accuracy of around 2 cm although

site conducts many tasks traditionally done by surveyors," says Alois Geierlehner of GeoMax. He adds that GeoMax was developed from scratch to fill a gap the Hexagon group was facing – high-quality yet cost-effective products and solutions.

Another factor that has skewed the market is the tough competition from Chinese manufacturers. A typical Chinese receiver is made using the guts (GNSS receiver boards) from mainstream GNSS receiver designers like Trimble, Topcon, NovAtel, or Hemisphere, and are available at a fraction of the price.

However, big players do not see that as a threat. "When you buy a product as a customer, you don't only buy the hardware but also the service, support, accuracy, compatibility, durability and a lot of other factors. To be the least expensive in price does not mean that the cost of ownership is also the lowest," says Geierlehner.

Lenz also feels that providing position using GNSS is just the beginning. "Regardless of the application, a user has a reason for collecting GNSS data. By understanding why the data is needed, where it will go and how it will be used, we can help our customers increase the value of the service and deliverables that they give to their clients," he adds. The entire flow of data — collecting, processing, modeling and analysing — can be managed to improve productivity and value. This includes software in the field and office, specialised hardware, communications and interfacing to downstream systems.

However, some Chinese manufacturers like CHCNav are addressing the servicing issue by setting up regional centres around the globe for support and repair. But it's yet to be seen if they can disrupt the high-quality GNSS market with products that will meet the expectations of US and Canadian buyers.

some can operate with accuracies at 5 cm. Productivity benefits are significant, in addition to increased safety for construction workers through the use of machine guidance and automated systems that remove operators from dangerous situations and from exposure to dust and contaminants.

GNSS information can be used to position the cutting edge of a blade (on a bulldozer or grader) or a bucket (excavator), and to compare this position against a 3D digital design to compute cut/fill amounts. Productivity studies have repeatedly shown that the use of 3D machine control results in work being completed faster, more accurately and with less rework than conventional construction methods.

For instance, a report prepared by the Australian government's Department of Industry found that machine guidance enabled with augmented GNSS in construction projects has the potential to deliver a 20–40% reduction in labour requirements, and a 10% reduction in total project costs and subsequent asset management.

Tracking the future signals

In the evolving markets, GNSS is now found in many industries where positioning can be combined with other information to simplify and accelerate work processes. For example, integrating GNSS with gas detection sensors helps workers detect emission levels at landfills and industrial plants, says Lenz.

GNSS timing is important for telecommunications applications. Synchronous technologies are much more efficient than asynchronous technologies but require a time source with appropriate accuracy, stability and reliability to operate effectively or at all, and GNSS can provide this. Similarly, financial systems increasingly need precise time stamping to prioritise trades and to provide an audit trail.

GNSS will remain an exciting field over the next years and decades to come, and what for sure is that it will merge into a lot of other industries, feels Geierlehner. For several people, GNSS is already a commodity — a smartphone user does not care who owns or which technology runs on the satellites to navigate to their favourite shop.

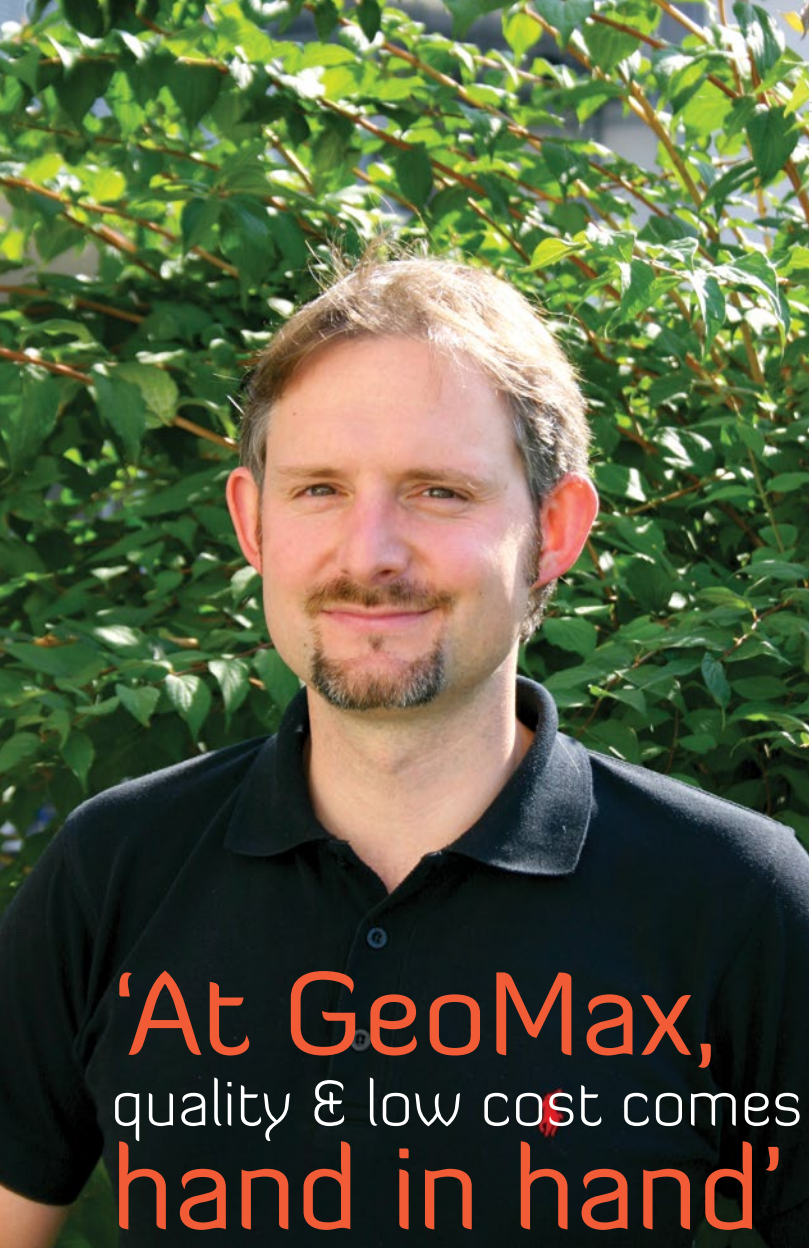
Players like Trimble, GeoMax (Hexagon) or Topcon keep a close eye on any new developments and opportunities. "We are positioned to extend our core technologies to new markets. In some cases, this involves developing new solutions to present to existing customers and applications. In others, we can adapt an existing solution to enter new markets. We learn from what we are good at and leverage our knowledge into new arenas," adds Lenz.

There are newer challenges like a number of applications want to use GNSS to operate at the centimetre level now. But for many more applications, it is easily sufficient to work at precisions of 10 cm up to a few meters. "By understanding that — together with domain knowledge of the users' workflows and deliverables — we can develop solutions that provide exceptional value," says Lenz. As with any technology business, geopositioning is certainly cutting edge and fast moving. "Sometimes new applications are presented to us from our customers that we had not even dreamed of. In those instances, we work together to come up with technology solutions to suit the applications at hand," says Rihner.

Often GNSS technology itself drives market expansion and new applications, allowing people to do what they hadn't been able to do before. For instance, the partnership between Topcon and MAVinci brought about the world's first UAS to incorporate RTK GNSS positioning, allowing for 2-5cm accuracy without the need for ground control points. Imagine the power to be able to quickly collect high-accuracy images by air of ground sites that cannot be reached on foot! "Through the creation of this new technology, we bring GNSS aerial mapping to construction, disaster management, mines and quarries and other diverse environments," adds Rihner.

The accuracy, pervasiveness and convenience of GNSS mean that its application has moved far beyond navigation and the list of the same continues to grow.

Anusuya Datta, Deputy Executive Editor
anusuya@geospatialmedia.net



‘At GeoMax, quality & low cost comes hand in hand’

GeoMax was developed from scratch to fill a gap Hexagon was facing — high-quality yet cost-effective products and solutions, says **Alois Geierlehner, Director, Business Development**

GeoMax provides a comprehensive portfolio of integrated instruments for surveying, mapping and construction industries. What are the current market trends and how are they shaping your business strategies?

Professionals in the surveying, engineering and construction segment face increasing competition. No geographic region or segment is immune to this; that is the reason why GeoMax is present in most markets. Users in developing countries no longer accept working with out-of-date technology just because they cannot afford high-end brands. With GeoMax, we bring the technology these customers need and provide them with the support needed to take them to the next level of quality and productivity. In developing markets, we are seeing an increasing demand from customers outside of the traditional surveying market, for example, a foreman on a construction site conducts many tasks traditionally done by surveyors. What GeoMax offers them is a product that speaks their language and does not try to force them to become surveyors. We believe that the system needs to adapt to the user and not vice versa.

Geomax is also known for its state-of-the-art technologies in total stations, GNSS receivers, controllers and onboard software. Which are your best selling products and why?

Only a few players in our market are able to cover the complete range of technology from motorised and manual total stations to GNSS, and digital levels, software and a complete construction portfolio like we can. We see that customers do not just exclusively work with one technology and want their products to have only one source in order to optimise their workflows. We are currently growing along with our products. The strong market trend we experienced over the recent years was towards GNSS and robotic total stations. This certainly had to do with the trend that more typical total station users start with GNSS, but it was also strongly supported by the fact that the simplified software we offer opens up these products to a whole new group of users.

All total stations now come equipped with GNSS. How has this development helped the industries you operate in?

We have experienced this trend over the last few years, but I still believe we are at the start of this development, as it is concentrating mostly on the high-end segment. What we have seen is that more and more users are no longer exclusively using total stations or GNSS, but both. By bringing these two technologies together, you get the best of the two worlds. Above all, GNSS made a major step over the last years in terms of usability and

being affordable to a much wider base of users. And a wider user base results in a bigger market.

Geomax also takes pride in its array of GNSS products that has a reliable and robust GNSS system that "works when you do" — even in extreme environments. What sets these products apart from your competition?

"Works when you do" means that the product does exactly what you need it to do for the task at hand and is able to withstand the extreme conditions you face every day. Right from the beginning when designing a new product, we eliminate those hypothetical cases that are irrelevant for most applications but would increase the price dramatically. If you pay for what you don't need, you automatically increase the price you paid. Concentrating on providing products that work when, how and where you need them to, let us cut back on the thrills not needed and save in terms of material, production and complexity. With GeoMax, we understand that quality and low cost have to come hand in hand and should not contradict each other.

GNSS made a major step in terms of usability and affordability to a much wider base of users. And a wider user base results in a bigger market

How does GeoMax fit into the Hexagon Group? What sets you apart from group companies like Leica?

GeoMax was developed from scratch to fill a gap Hexagon was facing. Compare it with the car industry. For example, the Volkswagen group not only holds Volkswagen but also Audi in the premium segment, as well as SEAT and Skoda in the value range and Bugatti in high-end. If budget is not an issue, we all know which car to buy. But there are clearly different segments of the market with different needs asking for different solutions. The aim of GeoMax is to provide these customers with instruments that enable them to fulfill their tasks and maintain their productivity while optimising cost.

Hexagon also focuses a great deal on integration and collaboration among group companies to address the total solutions market. How does Geomax fit in to this?

The oldest companies in Hexagon have a history of more than 100 years. You cannot build the knowhow and experience overnight. One of the biggest strengths of Hexagon is that we are able to share and utilise this knowhow among the different companies within the group. But this is not a one-way street — you will find inventions in other Hexagon products that made their first appearance in GeoMax.

We need to understand that the technology, regardless of what it is, serves the need to collect, process and analyse data, in order to deliver results and answer questions. And with questions becoming increasingly complex, it is no longer possible to consider the various technologies as independent. The process does not end with collecting points in the field. The companies united under Hexagon cover the entire range of data acquisition: from processing to visualising, and from analysing to maintaining them. Hexagon is able to cover this workflow — and this is where the strength of Hexagon can be found.

What does Geomax contribute, in terms of revenue, to the Hexagon Group?

Despite the worldwide economic crises and often saturated and mature markets, GeoMax achieved high two-digit growth — and this has been the case consistently from the very beginning. The initial strategy, to cover GeoMax segments not touched by other Hexagon companies, is working out extremely well and generates maximum benefit.

EGNOS Sows New Seeds

From being a technological opportunity in agriculture, EGNOS today has become a necessary infrastructure to drive increased productivity with optimal inputs in Europe

When GPS first appeared, it seemed to be a useful solution for agriculture. However, GPS by itself is not accurate enough for agriculture as its signals need to be corrected to provide the required higher accuracy. On an average, European farm fields are 10 times smaller than in the US, requiring the guidance technology to be more accurate. New needs, such as steering guidance and variable rate application techniques, also require precise measurements.

To overcome these limitations, precision agriculture system manufacturers began integrating their products with EGNOS, the European satellite-based augmentation systems (SBAS). Today, EGNOS has evolved from being a technological opportunity to a necessary infrastructure for precision agriculture. It is enabling farmers to automate many production cycle tasks, including yield mapping, fertilising, spraying and harvesting.

European GNSS in the field

As farmers prepare the soil, EGNOS-based steering guidance systems allow them to choose consistent driving strategies and avoid row overlaps. Yield monitoring, yield mapping and variable rate applications are often the first activities as farmers begin to embrace precision agriculture solutions. These applications provide farmers with the information to better estimates, allowing them to record a history of field performance and, make better management choices.

The necessary data for the creation of yield maps is generated by yield monitoring systems in combine harvesters. These systems include such key elements as a mass flow sensor that monitors the volume of grain moving through the grain elevator; a grain moisture sensor to measure the moisture of the harvested grain; and a GNSS receiver that provides spatial positioning required to geo-reference the measurements within the crop.

Once the harvest is complete, information about grain mass and moisture is combined with the position and processed through GIS — resulting in creation of yield maps. Yield maps enable farmers to visualise the performance of the crop. The colours of the map represent different performance ranges, allowing farmers to easily distinguish between areas with richer yields and zones performing below average.

Details of crop characteristics and performance from yield maps is used to create application maps, which represent the inputs for variable rate application, such as seeding or fertilising. GNSS systems take advantage of EGNOS accuracy to continuously update the nutrients application rate according to the machinery's position on the crop. Indications about crop performance help farmers identify the key sources of yield variability. Some may be due to management practices, such as sub-optimal soil compaction, water management or mechanical errors. Others may be natural, due to parameters such as soil fertility, pest concentration, weather and crop configuration. The increased accuracy provided by EGNOS enhances the accuracy of the data. With time, yield mapping helps farmers learn more about the characteristics of their fields.

Benefits on the field and beyond

According to CLAAS Agrosystems, which equips 90% of its high-end combine harvesters with EGNOS-enabled receivers, EGNOS allows European farmers to save up to 7% on operating costs. The main benefit comes when a farmer turns his machine to work in the following 'pass', he does not overlap more than 10-20 cm in the areas he already worked. A tractor equipped with a simple guidance unit, can approximately save 10% of the products used for spraying nitrogen, herbicide and fertilisers. When the guidance is connected to the steering wheel in field jobs like ploughing, hoeing, cross-killing or even seeding, cost savings can reach up to 12%.

At the same time, farmers can reap the benefits of EGNOS beyond the fields. GNSS positioning can be used to remotely monitor, track and analyse the work flow and provide routing tools for product transport operations. The combination of these advances have revitalised farming — taking it from a profession of tradition to one driven by technology.

Courtesy: The European GNSS Agency (GSA)

At GeoMax we provide a comprehensive portfolio of integrated solutions by developing, manufacturing and distributing quality construction and surveying instruments and software. We address professional as well as occasional users with our easy-to-use, yet highly productive total stations, GPS/ GNSS instruments, software, lasers, optical and digital levels and accessories.

Being part of Hexagon, a global technology group with strong market positions within measurement technologies, grants GeoMax access to state-of-the-art development and production facilities in Europe, America and Asia.

For more information, visit our website at **www.geomax-positioning.com**
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GEOMAX

'We are Positioned to Stay at the Forefront of Technology and Product Development'

As a GNSS hardware player, Javad has a unique vantage point with solid operations in the US and Europe and an R&D centre in Russia. **Javad Ashjaee, President & CEO,** sees an exciting future ahead for the market as he says the focus is to be flexible enough to be able to respond to change

Javad group comprises three divisions – Javad GNSS, Javad ArWest and Javad EMS – how much of these are geospatial in nature?

Our focus is on 'precision positioning and timing using GNSS satellites'. Javad GNSS focuses on the GNSS technology, ArWest's focus is on communication and modems that are essential in RTK and real-time applications. To have a direct control on our manufacturing, we established Javad EMS to bring manufacturing back to US and to the heart of Silicon Valley. In Javad EMS, we manufacture our products and also provide manufacturing to other companies. Some of the largest international companies are clients of Javad EMS.

TRIUMPH-4X is equivalent of four independent TRIUMPH-1 receivers packaged in the same small box

TRIUMPH-F1 is equipped with four-angled documentation cameras and a downward high-precision camera for photogrammetry

Which are the businesses and geographies you are focussing on?

We are not focusing on low-end and low-precision applications and none of our products are aligned for those markets. We are not even going to touch markets like smartphones which comprise most of the GNSS market. That market is not complex from technology point of view but extremely complex from low-cost manufacturing and distribution. Taking advantage of new developments in integrated circuits, we were able to reduce the cost to lower than half while doubling the performance. This is the challenge of our market.

We are not excluding any geographic areas, but most of our success has been in America, Europe, Australia, and Asia. We plan to sell mostly direct in the USA and strengthen our dealership network outside of the USA. We had solid growth and huge success in bringing new technology to the world. Our focus in on technology and revenue and profit margin follows.

GNSS is an area which is continuously evolving. What overall opportunity are you addressing?

First, we introduced 12 channel receivers when only GPS satellites existed. Then we were the first to offer GLONASS with 86 channel receivers. Then we followed with 216 channels and this year with 864 channels to be ready for all new satellites and also be able to monitor interferences. We allocate more than 100 channels to monitor interferences that are becoming a major issue in congested spectrums, especially now when wireless technology is expanding and threatening GNSS bands.

We have GPS and GLONASS and we currently track Beidou too. We are the only company that offers tracking and decoding Japan's LEX QZSS signals. We are well positioned to stay in the forefront of technology and product development with all types of satellites and signals. There is no technical difficulty in using multiple GNSS signals. The only problem is when satellite signal providers do not provide accurate Interface Document publicly and on a timely manner.

We plan to sell directly in the USA and strengthen our dealership network outside of the USA. We had solid growth and huge success in bringing new technology to the world

Do you think there is enough collaboration, cooperation and coordination between various countries offering GNSS signals?

Cooperation between GNSS signal providers has been good. I have witnessed a lot of cooperation to make the systems interoperable. More satellites and more signals make GNSS receivers accurate and reliable. Everyone is going to benefit from this.

How proactive are governments or multilateral organisations like World Bank/FAO in promoting the use of GNSS in areas like agriculture, construction etc?

There is not much that such organisations can do. It is the demand of the customers that drives the markets and the response of manufacturers to such demands.

Where do you see Javad, say, five years from now?

Your question reminds me of an article I read 20 years ago "Future is not what it used to be". It is so hard to predict what will happen in the next five years. Our focus is to be flexible enough to be able to respond to changes. Imagine a tennis player who does not know from which side the next ball may come, but the player positions himself/herself to be able to respond to most possibilities.

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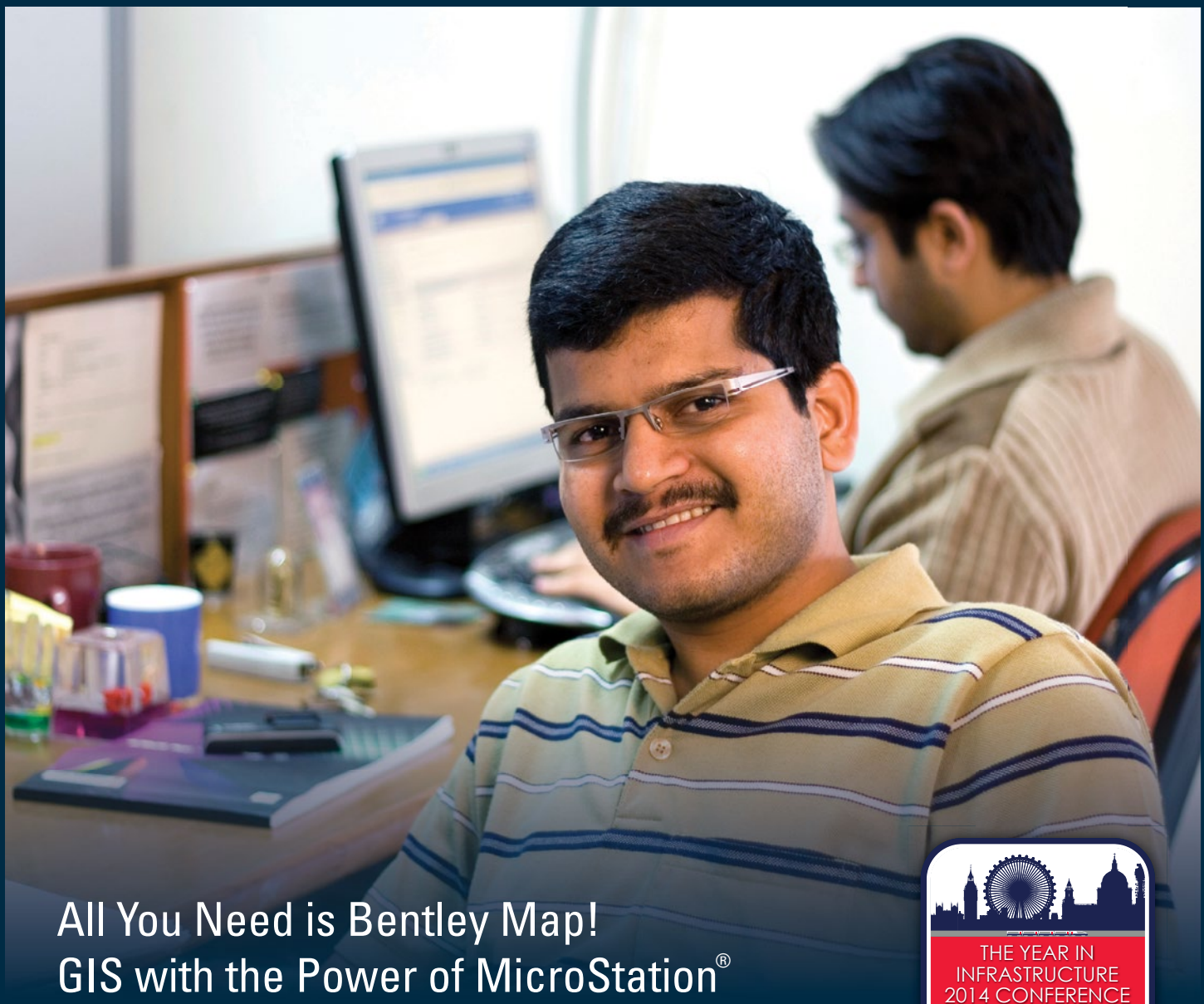

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