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Laser Scanning on the Go

How Wearable Reality Capture is Shaping the Industry

INDOOR WAYFINDING AT AMSTERDAM AIRPORT

MULTI-SENSOR CAVE DETECTION

USING BEIDOU FOR TALL BUILDING CONSTRUCTION

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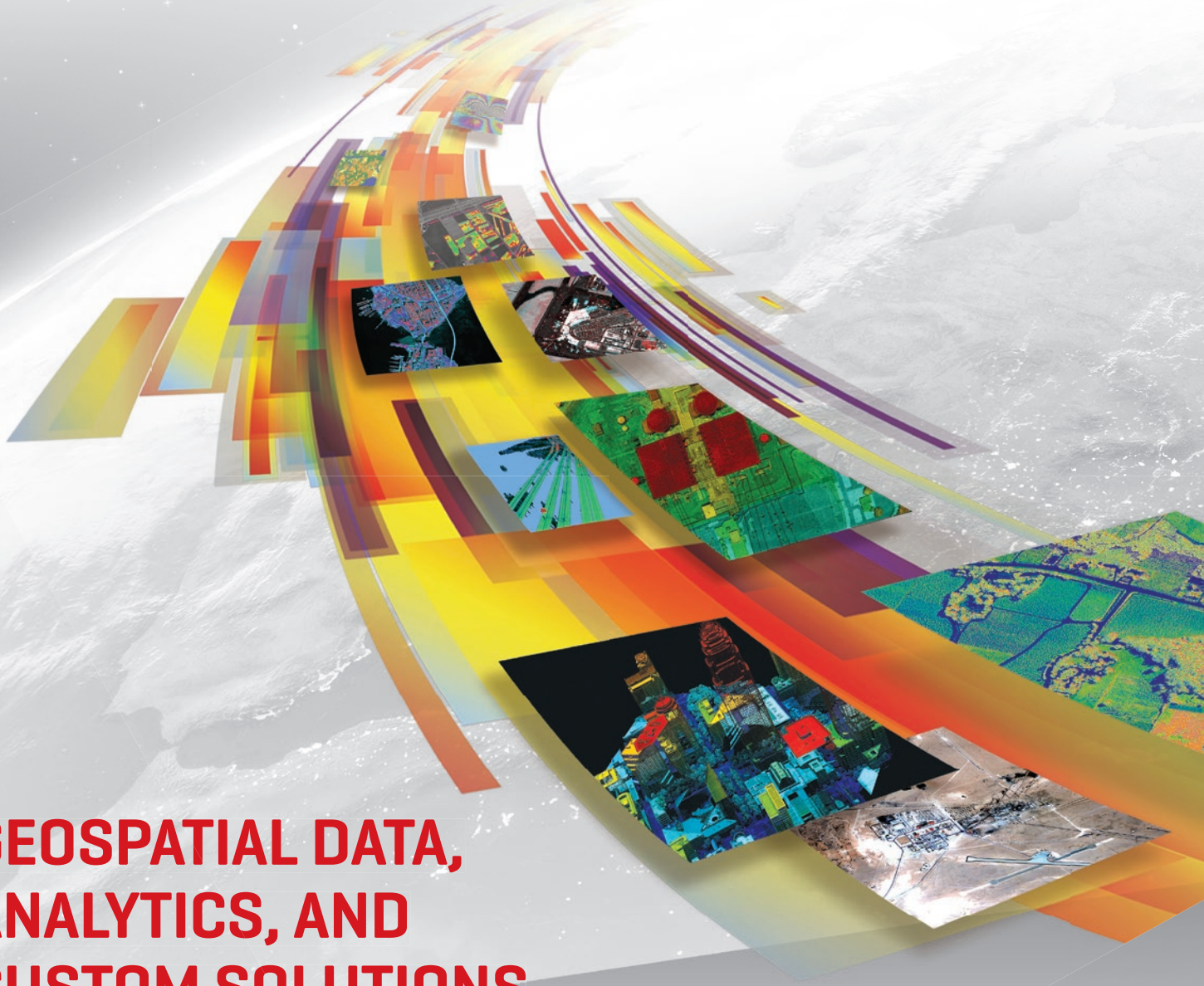

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Two of the themes in this issue are indoor mapping and GNSS. This month's front cover shows the NavVis indoor mapping trolley. NavVis develops innovative technology for the mapping and navigation of indoor spaces. Read more about this German high-tech start-up in the news section.

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Indoors, Outdoors, in Caves and up in the Air

We're going indoors in this issue of *GIM International*. While surveying and mapping are usually linked to outdoors, on the ground and in the sky, the sector is increasingly pushing back boundaries – and one such boundary is indoor mapping. We found an inspiring example right on our doorstep: Amsterdam Airport Schiphol. It is my airport of choice because it is close by – just an hour's drive from our offices – and very convenient with direct flights to many international destinations. I've driven to the airport so many times that I know the route by heart. However, it's a different matter once I enter the airport building – I become disorientated and can easily get lost. I'm sure I'm not the only one who loses my sense of direction and ability to judge distances when I'm indoors, whether at a shopping mall, a convention centre or an airport. In their article on 'Indoor wayfinding at Amsterdam Airport' on page 16, authors Mike Smolders and Harald Görtz describe how wayfinding features were added to the existing app to offer travellers a stress-free journey through the airport. To avoid the use of GNSS, which is often too weak indoors or even completely blocked, 2,000 beacons based on Bluetooth 4.0 LE technology were installed throughout the airport. The map was built on Esri's ArcGIS platform which enabled the addition of spatial tools and the creation of passenger routes. The flow of travellers through the airport will be analysed in the future and the outcomes will be used to develop even more efficient routing.

▲ *Durk Haarsma, publishing director*

This edition includes another interesting article with a tenuous link to indoor mapping: cave exploration! Many of the world's caves have not yet been discovered and it is very important to find and map them for mining, construction or archaeology purposes, for instance. On page 24, authors Tanya Slavova and Atanas Rusev describe a complete survey, showing that combinations of techniques like ground-penetrating radar (GPR), gravimetry, magnetometry, electrical resistance surveys and seismic reflectivity together with GNSS measurements and spatial analysis in GIS can improve the efficiency with which caves are detected. The key factor is time, since this method means that exploration is no longer limited to existing surface openings.

Last but not least this issue, I would like to highlight an inspiring feature on the construction of the new headquarters of the National Bank of Kuwait, a 300-metre-high tower. In the article on 'Core wall control survey' on page 21, Joël van Cranenbroeck and his co-authors Robert Bou Chedid and Peter Bruce describe the core wall control survey (CWCS) method that was invented by Van Cranenbroeck and was used to vertically monitor the building of the Burj Khalifa in Dubai, 828 metres above ground level, with millimetre accuracy. The project in Kuwait marks the first time that the signals from the available BeiDou GNSS satellites have been used to assist in the construction of tall buildings.

I hope that these and all the other features from right around the globe in this issue of *GIM International* inspire our readers to push back the boundaries of our sector. Whether indoors, outdoors, in caves or up in the air, geospatial solutions are everywhere.

OpenCitySmart and Enhanced SDIs

'Smart Cities' are liveable, efficient and sustainable cities, where the vertical services are built on an existing, basic infrastructure. To achieve the goals of environmental sustainability, we need tools that provide an interdisciplinary approach for survey, evaluation and audit, studying best practices, concepts, strategies, actions and business plans, impact analysis, involvement of solution providers, coordination, communication, community participation, education, ICT-supported integration, interoperability, optimisation, monitoring, etc. All of these must be aligned with the needs/interests of the city and its citizens, the wider community and society in general. Open source and open data enable effective cross-impact geospatial analysis between e.g. environment, mobility, people, government, economic development and lifestyle. This was the message at a recent conference on Smart City/Smart Mobility held in Budapest, hosted by two experienced Hungarian SMEs, Pro Urbe and Terra Studio.

Given the current trends and related consequences from a global perspective, it is critical that we design and build Smart Cities. A population explosion is occurring simultaneously with a massive urban shift. The global population has trebled since 1950, when there was an even distribution between rural and urban areas, and today 80% of people in the developed world live in cities. Compounding this issue, we are consuming 1.5 times Earth's sustainable resources each year. This cannot continue. The world's cities must seriously address the issue of sustainable living. Sharing best practices and working collaboratively are key to solving these problems.

Collective problem-solving and sharing of solutions will also help us better appreciate our common needs and similar aspirations. In the CitySmart session of the NASA Europa Challenge, we will present open platforms and geospatial tools for building sustainable living solutions. These applications will contribute to an 'OpenCitySmart' suite of functionalities for managing urban living, i.e. infrastructure, mobility, power, water, sewers, city services, fire, safety, public health, construction, permits, transportation, agriculture, etc.

The organisers of the NASA Europa Challenge 2016 especially wish to target the computer science/software engineering departments at universities, as this is a high-visibility and career-enhancing opportunity for students and young graduates, as demonstrated by the award winners of the previous three years (http://eurochallenge.como.polimi.it). Geospatial web app developers are in high demand and the NASA open-source geobrowser World Wind (www.WebWorldWind.org) provides the ideal platform for Smart City solutions.

A session at the Open Source Geospatial Research and Education (OGRS) Conference to be held in Perugia, Italy, this October is dedicated to 'CitySmart, Open Source Apps for Urban Management'. Patrick Hogan of NASA and Prof Maria A. Brovelli of Polimi Como will announce the Europa Challenge winners at this event (http://2016.ogrs-community.org/). An Asian version of the Europa Challenge is also envisaged with the same topic for the Urban Transitions Global Summit being held in Shanghai, China, in September 2016 (http://urbantransitionsconference.com).

In the Smart City context, the enhanced spatial data infrastructures (SDIs) will incorporate novel technologies and services such as seamlessly interoperable indoor/outdoor spatial data infrastructures, big data cloud services, location-based services, mobile GIS apps, spatially enabled Internet of Things (IoT), and the highest-resolution remote sensing from satellites and UAVs. Data access is essential, but even more important is to share experiences and solutions through cooperation and collaboration using open source.

The data issue was explicitly addressed at the GEO XII Plenary and Ministerial Summit held in Mexico City last November by EO and ICSU/Codata WDS experts, and the Global Spatial Data Infrastructure Association (participating member of GEO) expressed its supporting position in a formal statement.

Dr Gábor Remetey-Fülöpp,
Past secretary-general, HUNAGI
Organising member, WWEC 2016
Liaison of GSDI to CEOS WGISS

Dynamic GIM International Summit Concludes… But is Just the Beginning

Panel session at the GIM International Summit.

The first edition of the GIM International Summit concluded successfully on 12 February 2016. The three-day high-end conference, chaired by Steven Ramage, was held in the Dutch capital of Amsterdam and comprised eight keynotes and eight workshop sessions focused on various challenges which geomatics could help to tackle. While the GIM International Summit conference may have ended, the follow-up will be substantial since everyone was in agreement that geomatics is a driving force behind solutions to global challenges.

▸ **http://bit.ly/1KXZz3U**

senseFly Adds Multispectral Sensor to eBee Ag UAV

Swiss professional UAV manufacturer senseFly has confirmed that Parrot's Sequoia multispectral sensor – announced in early February at World Ag Expo in Tulare, California, USA and due to launch in March 2016 – will be immediately available for its eBee Ag UAV. Sequoia is one of the smallest and lightest multispectral UAS sensors released to date. It captures images of crops across four highly defined, visible and non-visible spectral bands, plus RGB imagery. In just one flight, agronomists, crop consultants and farmers can capture all the aerial data required to monitor and respond to the health of crops throughout the growing season.

▸ **http://bit.ly/1KXZAF1**

eBee Ag.

Sentinel-3A Satellite

ESA Launches Third Sentinel Satellite to Track Global Warming

The third ESA-developed satellite carrying four Earth-observing instruments has been launched, ready to provide a 'bigger picture' for Europe's Copernicus environment programme. The 1,150kg Sentinel-3A satellite was carried into orbit on a Rockot launcher from Plesetsk, Russia, on 16 February. This is the third of the Sentinel satellites launched in the less than two years – and it is certainly a special moment. It also marks a new era for the Copernicus Services, with Sentinel-3 providing a whole range of new data with unprecedented coverage of the oceans, said Volker Liebig, director of ESA's Earth observation programmes.

▸ **http://bit.ly/20FUqiI**

Sense and Avoid Technology Added to UAS

Aerialtronics, a Dutch unmanned aerial system manufacturer, has developed a sense and avoid solution for the Altura Zenith unmanned aircraft which will fundamentally change how companies inspect telecommunication towers, energy pylons, bridges and buildings. This advanced sense and avoid solution is designed to help the Zenith UAS stay clear of objects during inspections as it relays images, video and data to the user or a third party. The solution is expected to save customers thousands in costs, particularly during lengthy engineering maintenance projects or regular inspections of bridges or wind turbines.

▸ **http://bit.ly/20FUy1S**

Helping the Zenith UAS to stay clear of objects.

Volunteers Needed: Mapping Land Values in Latin America

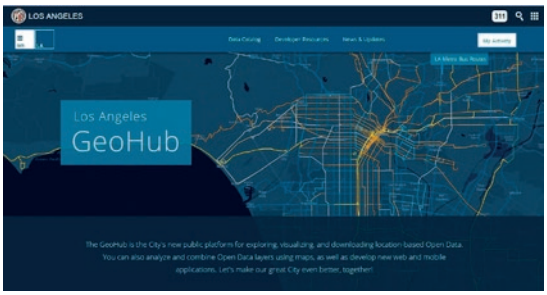
The Lincoln Institute of Land Policy is inviting volunteers from across Latin America and the Caribbean to participate in the creation of a map of urban land values in the region. The resulting open-access database of georeferenced, systematised land values from cities across Latin America will help urban planners develop sound urban policies. The 'Your City in 5 Facts' mapping project will run between 9 February and 31 March 2016.

▸ **http://bit.ly/20FTYBb**

Los Angeles and Esri Unveil Pioneering Urban Planning Hub

Mayor Eric Garcetti of Los Angeles and Esri president Jack Dangermond have unveiled the City of Los Angeles' new GeoHub, one of the USA's most complete collections of urban map data. The GeoHub builds on Mayor Garcetti's third Executive Directive, which created Los Angeles' first open data portal. By making more than 500 types of map data available to residents, city workers and private industry, the GeoHub helps residents better understand their communities and helps city departments better coordinate construction, road paving and public safety efforts.

▸ **http://bit.ly/20FUVti**

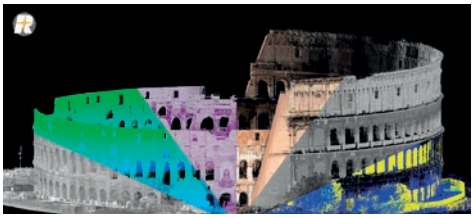


The Los Angeles GeoHub.

Most shared during the last month from www.gim-international.com

1. Leapfrogging Urban Problems with Smart Cities - http://bit.ly/1ZepHOr
2. Geomatics and Climate Change - http://bit.ly/1RVw3xT
3. Germany's Progress towards a Multi-dimensional Cadastre - http://bit.ly/1XUTtU4
4. Sweden Excels in Public Use of 3D in Smart City Applications - http://bit.ly/1XUTU0p
5. Using Geospatial Acoustics to Track Bat Movements - http://bit.ly/1XUTeIp

Major Update of RIEGL's Terrestrial Laser Scanning Software

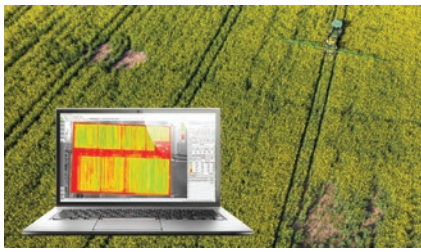


Point cloud of the Colosseum in Rome.

RIEGL has released a major update to its terrestrial laser scanning software suite of RiSCAN PRO, RiMINING and RiSOLVE. The latest terrestrial laser scanning software suite update includes a number of key upgrades featuring the new RIEGL Point Cloud Database (RDB 2.0), which provides new and advanced point cloud capabilities. With this upgrade, it is now possible to visualise and manage massive files, hundreds of scans and billions of points simultaneously with a new level of detail.

▸ **http://bit.ly/20FUMpG**

Pix4D Unveils New Precision Agriculture Solutions



Pix4DMapper Ag.

Pix4D has launched Pix4Dmapper Ag: photogrammetric software that converts multispectral images into agriculture-specific maps for better crop management and analysis. The software has been released in conjunction with Sequoia: a multispectral sensor from Parrot designed specifically for precision agriculture. The most important part about this joint release is the fact that the low price enables it to be deployed at the farming level, and not just the research level, said Pix4D founder and CEO Christoph Strecha. With a 16MP RGB camera, five Ag-dedicated sensors (Red, Green, NIR, Red Edge, Luminosity), 64GB built-in memory, GPS and IMU, Sequoia weighs 110 grams and can be mounted on any UAV.

▸ **http://bit.ly/20FV6of**

Your News and Views in *GIM International*?

Do you have an interesting idea for an article in *GIM International*? We are always looking for the best news and views from the geomatics industry. If you are working with the most innovative technology, have performed a challenging survey or simply want to share your perspectives on the future, please send an email to our editorial manager, Wim van Wegen: wim.van.wegen@geomares.nl. He will be more than happy to explore ways of sharing your ideas with your peers throughout the geomatics world.

Founders of NavVis around the 3D mapping trolley.

Indoor Mapping Startup NavVis Secures Millions in Funding

High-tech startup NavVis, specialised in the digitalisation of indoor spaces, has announced that it has successfully closed its latest funding round of EUR7.5 million. Target Partners and Don Dodge – investment veteran in digital indoor tech and developer evangelist at Google – are joining as new investors, and MIG Fonds and BayBG Bayerische Beteiligungsgesellschaft mbH are increasing their investments. These days GPS and maps are taken for granted – but not indoors. NavVis develops an innovative technology for the mapping and navigation of indoor spaces. The company provides a platform for end-to-end digitalisation of buildings – from 3D mapping (patent-pending M3 trolley), to visualisation (web-based IndoorViewer), to turn-by-turn navigation (NavVis app) – all in a fraction of the time previously needed and at a significantly lower cost. The NavVis technology also offers a platform for third-party providers to build innovative services on top of the digitised spaces, with applications spanning from logistics to repair and maintenance as well as facility management and seamless navigation.

▸ **http://bit.ly/1nMPv3a**

GEO Business 2016: Prominent Place on Industry Event Calendar

In the ever-changing geospatial industry, GEO Business is developing into one of the most important shows in the geospatial calendar, with 3,000 international visitors expected to attend this year's edition. Registration is now open for the event that will be held in the Business Design Centre in London, UK, from 24-25 May 2016. This year's high-level conference is expected to feature some of the most prestigious figureheads within the geospatial hemisphere, and the organisers are putting together a workshop programme that is set to be the most technically and commercially relevant yet. In addition, there is an impressive line-up of exhibitors, including for the first time Land Registry, Korec and Landmark, positioning GEO Business as the key place to network and do business.

▸ **http://bit.ly/20FVdjJ**

VGI in Land Administration: A Vision or a Necessity?

Is it possible for crowdsourcing techniques to be more widely introduced into official cadastral surveys and land administration systems (LASs)? Are citizens able to actively take part in decision-making policies? What are the effects of such a cadastral mapping project and what are its expected benefits?

The research community is becoming increasingly interested in the developing phenomenon of crowdsourcing. Not just the variety of definitions that have been developed within the last ten years but also the variety of projects worldwide that adopt crowdsourcing techniques reveal how this new practice has infiltrated governmental projects, voluntary actions and emergency circumstances. The new era in LAS and the need to embed crowdsourcing techniques in its design is very recent.


Sofia Basiouka

The benefits of this new trend can be summarised as follows: Simplification and transparency of official procedures, reduction of compilation time for cadastral surveys, in comparison to official procedures, reduction of costs, involvement of citizens as active cells of the society in an effort to reduce errors and increase accuracy.

The spatial collection of parcel boundaries may be done using various methodologies. The first approach is focused on the plain declaration of ownership by giving the point of its centroid. The second approach is focused on collecting parcel boundaries with the aid of a handheld GPS, tablet or smartphone. The third approach is online: citizens can declare their ownership by using online dynamic maps and/or online orthophotos as basemaps. It is clear that the virtual graphics interface (VGI) methodology is open and can offer various approaches depending on the different needs of each land administration project.

THE QUEST FOR SUITABLE DATASETS CAN LEAD TO THE INITIATION OF VGI PROJECTS

The technical factors behind VGI in LAS indicate that technical issues do not constitute a limiting factor in VGI approaches. The weakness of using a handheld GPS may be bypassed in cases where accurate basemaps exist (e.g. orthophotos). In developed countries, the use of high-accuracy basemaps for the identification of ownership further accelerates the accuracy of results. The required accuracy can be also reached with a combination of various technical solutions. The use of accurate and recent orthophotos in combination with the auxiliary use of GPS may improve the quality of the results. The use of OSM offers great potential for cadastral purposes in countries where no better basemaps exist.

The perception that VGI techniques may be adopted only in developing countries or in countries that suffer multiple financial problems has only recently been recognised as anachronistic. The outcomes of various studies have demonstrated that, in civilised societies that put citizens at the centre of decision-making policies and where there is a lack of governmental data, the quest for suitable datasets can lead to the initiation of VGI projects.

Experience has also indicated that the legal framework can be easily modified when required reforms are blocked due to legal restrictions. Also, concerns over privacy and personal data could be encountered at national or international level by the institutions involved in crowdsourcing.

It is a general fact that one of the greatest challenges that the research community will have to face within the next decades will be on land-related issues. The use of crowdsourcing techniques will be inevitable and the only way for this to work efficiently is for the requirements of such techniques to be proposed by experts right from the beginning. The VGI approach is not a need; it is a trend and should be defined within this specific framework. ◀

Sofia Basiouka is a PhD surveyor engineer and is working on the Greek Ministry of Culture's Archaeological Cadastre project. She is also a researcher at the National Technical University of Athens (NTUA), where she actively participates in teaching undergraduate modules. Her academic interests are focused on land administration systems, land management, GIS and crowdsourcing techniques. Sofia graduated from NTUA's School of Rural and Surveying Engineering. She holds an MSc in GIS from University College London and a PhD from NTUA. Her PhD studies were funded by the State of Scholarships Foundation.

GIM INTERNATIONAL INTERVIEWS CHUCK JOSEPH, HEMISPHERE GNSS

Opening up New Opportunities in High-precision GNSS

In a fiercely competitive landscape, there is considerable pressure on GNSS companies such as Hemisphere GNSS to be innovative and respond to the challenging market conditions. New developments, such as the expansion of the Chinese BeiDou and the European Galileo systems as well as the spectacular rise of UAVs, demand a long-term strategy combined with the agility to adapt. Chuck Joseph, president and CEO of Hemisphere GNSS (HGNSS), explains how his company strives to play a leadership role in the industry.

Mr Joseph, you have been president and CEO of Hemisphere GNSS since 2014. How do you look back on that period?

The past two years have been the most exciting times I have spent in my career. I often refer to what we are doing at Hemisphere GNSS as executing and performing like a 'start-up inside of a reinvention'. I've been involved in the GPS-centric world, or what is now known as the GNSS world, since 1992 and each and every iteration of growth and expansion brings with it new challenges and exciting opportunities. With our new business model, we are now participating in large-volume application areas where high-precision GNSS products are expanding exponentially, both in professional market segments, such as deep integration original equipment manufacturer (OEM) opportunities, and in consumer volume implementations such as autonomous driving. We are involved in high, very high technology and 'planes, trains and automobiles' – what could be more fun?!

LOWER-COST AND LOWER-POWER MULTI-FREQUENCY GNSS WILL ENABLE THE USE OF PRECISION GNSS IN APPLICATIONS WHERE IT HAS NOT BEEN SEEN IN THE PAST

In 2013 your company was acquired by Beijing UniStrong and was subsequently renamed Hemisphere GNSS. What impact has this change had so far?

Beijing UniStrong's support as our parent company has allowed us to thrive and grow rapidly in all our targeted market segments and new business opportunities. During a time when many of the market segments we serve are punishing our competitors by challenging financial success, we have been able to expand innovation by investing heavily and developing new technologies. We have recruited some of the best people in our industry to join the company and their contributions are already being seen in products and solutions we have been able to rapidly bring to market. In addition, the talent inside of UniStrong via our family relationship is shared across the world in our global markets.

What is Hemisphere GNSS's position in the geomatics sector?

HGNSS is a hardware, software and systems solution supplier in the overall geomatics business sector. We partner with application software suppliers in several market segments and, through these partnerships, provide total solutions to our customers. We provide our product capabilities in the form of board sets and firmware for our OEM and systems integrator customers as well as 'finished products', i.e. smart antennas and suchlike, through our dealer network. Additionally, we participate in industry-specific trade shows, technical councils and standards committees and often take a leadership role.

Your company's Atlas GNSS global correction service made its trade-show debut at Intergeo 2015 and you called it "a game-changer". Can you tell us more?

Before HGNSS released Atlas, the availability of high-precision augmented services was often far too expensive for end users to deploy, and the dealers and systems integrators who served them could not participate in selling or servicing the solutions. Atlas has a disruptive new pricing model and our business model for selling it through our dealer channel and to OEMs enables them to participate in the revenue model as well as supporting their customer bases. This has opened up the market tremendously. We have private-label OEM versions of the Atlas capability coming to market as well as a growing base of users who are purchasing the service through our dealer network. We believe the entire

augmented services industry will grow much more rapidly in multiple directions thanks to the market availability of Atlas.

What are your expectations of low-cost, chip-scale multi-frequency GNSS receivers, and what effect will they have on the professional OEM board business?

The technology is definitely moving in this direction. Lower-cost and lower-power multi-frequency GNSS will enable the use of precision GNSS in applications where it has not been seen in the past, especially due to power concerns such as in battery-powered devices. This will open up new and exciting market opportunities.

Just having a multi-frequency GNSS chip, though, is not enough. There is still the expectation, in the professional markets, to have very reliable and robust GNSS. The years of GNSS experience that many of the OEMs have accumulated in real-time kinematic (RTK), precise point positioning (PPP) and other high-precision technologies will allow them to continue to be involved, provided they adapt on the chip side of the business.

Unmanned aerial vehicles (UAVs) are a hot topic in the geomatics sector. How will they influence the regular GNSS receiver business, do you think?

GNSS is needed for a variety of UAV-associated applications such as monitoring, navigation, flight control, mapping, geofencing, autonomous operation, etc. For miniature UAVs, power and size are important, which provides the incentive for high-end GNSS systems to move further in this direction. In addition to position and velocity, vehicle attitude is needed which leads to tight integration of GNSS with inertial systems and into multi-antenna systems. For UAV applications requiring high accuracy, RTK can be used, but this is not always practical. HGNSS's Atlas system is an excellent fit for situations in which high accuracy is needed. Corrections are provided through the same antenna that is receiving the GNSS signals and consistent, reliable accuracy is delivered worldwide without the need for base stations or connections to RTK networks.

Indoor positioning has troubled the minds of numerous industry experts. How is Hemisphere GNSS dealing with this challenge?

Currently, we are not heavily focused on indoor positioning. We've looked into it, but it is complex from a technology standpoint, especially for high-accuracy situations where multipath and signal attenuation can wreak havoc. We are seeing a wide range of technologies being attempted to service this market and some seem to have potential where accuracy is not overly important. So far, nothing simple and ubiquitous has been found for higher-precision indoor positioning.

Galileo, Europe's GNSS system, is increasingly taking shape. How do you rate the opportunities Galileo offers?

With 12 Galileo satellites in orbit and more on the way, this is very exciting! We will soon have another highly useful GNSS system that further enhances the capabilities provided by GPS, GLONASS and BeiDou. Like GPS and BeiDou, Galileo is CDMA rather than FDMA and that is preferred for high-accuracy applications such as PPP. Galileo E5A and E1 signals align with GPS frequency bands which makes receiver design simpler. A GPS plus Galileo multi-frequency GNSS receiver, for example, could be made with a fairly simple radio-frequency footprint.

And what are your thoughts on BeiDou, the Chinese satellite navigation system?

BeiDou is great. The eastern hemisphere is enjoying the benefits of having three fully functional GNSS systems where you can often track more than 35 satellites. BeiDou, being a CDMA signal, acts much like GPS for precision needs. There are only a few satellites in the western hemisphere today, but that will change as BeiDou Phase III is rolled out. The Phase III system will be compatible with GPS and Galileo in many ways, adding simplicity and consistency to receiver architecture.

With China, Europe, India, and Russia actively developing GNSS systems, there are more positioning satellites available than ever before. How do you see navigation benefiting from this increased availability?

The more satellites and signals, the better! Accuracy improves, of course, but the real benefits are seen in robustness and in the ability to operate in environments with more obstructions and blockages. With so many satellites, even single-frequency RTK can become viable for many applications.

Jamming and spoofing become more difficult, because there are more cross-checks and receiver autonomous integrity monitoring (RAIM) becomes more solid. Carrier-phase-based techniques for position extrapolation will be particularly robust with the addition of so many signals.

Your company is involved in several industries including agriculture, construction, machine control & mining, GIS & survey and marine. Which trends and developments do you foresee for these industries?

There is definitely a great deal of ground to cover when you look at all these market segments. I believe we are leaders in high-precision GNSS as well as delivering great technology and products to our volume-OEM and dealer-network customers. From that point of view, it is possible to categorise common ground for all high-precision GNSS market segments. We are committed to developing lower-power, less-expensive and smaller-footprint solutions while not trading off high-precision accuracy and performance.

There remain only a handful of major GNSS players in the industry with complete vertical integration in developing their GNSS-centric solutions, and HGNSS is one of them. By controlling our technology from application-specific integrated circuit (ASIC) through to finished product including all the iterations along the way, we are able to drive technology and performance while reducing cost.

High-precision GNSS application solutions will be entering the consumer electronics world via several platforms in the months and years to come. Combining the strengths of HGNSS' proprietary technology with UniStrong's technology, product platforms and manufacturing capabilities uniquely positions us in every world market and market segment for GNSS solutions.

And which exciting projects is Hemisphere GNSS working on right now? Can you give us a sneak preview?

We will be announcing several key OEM business relationships as well as a number of new product offerings in the months to come. We will be happy to provide more details when the time is right. ◀

Chuck Joseph

Chuck Joseph has over 30 years of executive leadership experience across multiple industries, having served in corporate officer and board-level capacities. He also has extensive experience in GNSS OEM and direct sales market segments including survey, GIS, machine control, marine, agriculture, avionics, personal (mobile) navigation and tracking systems. Prior to joining Hemisphere GNSS, Mr Joseph most recently served as president and COO of Nusola Inc., an energy technology company he co-founded. Previously, Mr Joseph was senior VP and general manager of Immersion Corporation, corporate VP of marketing and sales for Magellan Corporation, and executive VP and general manager of Trimble Navigation.

A STRESS-FREE JOURNEY BASED ON 2,000 BEACONS AND A SIMPLE MAP

Indoor Wayfinding at Amsterdam Airport

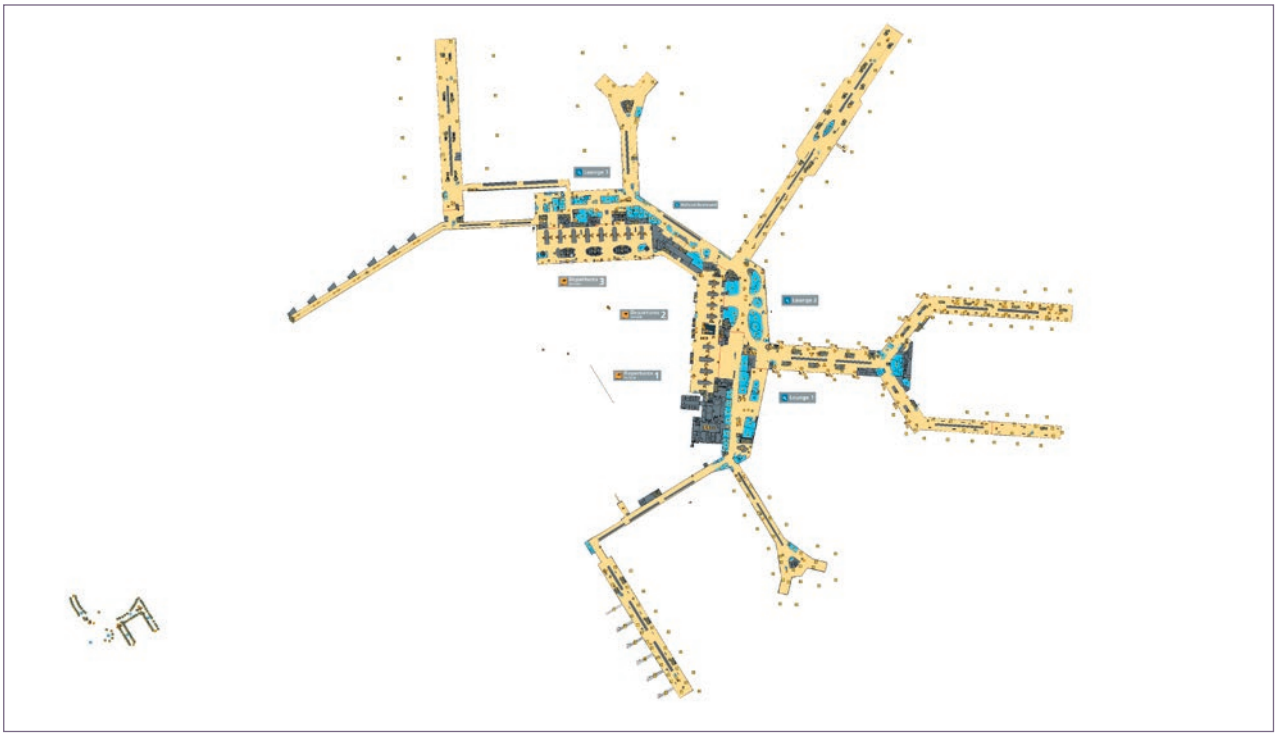
Thousands of people pass through Amsterdam Airport Schiphol in The Netherlands every day. Despite being one of the largest and busiest airports in the world, Schiphol strives to offer passengers a stress-free experience. Being unable to find your way around an airport is a common frustration for travellers the world over. In an endeavour to solve this problem, Schiphol has launched an update to its existing Schiphol Airport app to include indoor wayfinding. However, both the dynamic environment of Schiphol and the complexity of the source data and business processes turned out to be a real challenge in keeping the wayfinding application simple for passengers to use. In this article, the authors share their experiences from the project.

Indoor wayfinding applications help people to orientate themselves and to navigate from A to B as quickly as possible. The real-time feedback about the user's location significantly improves the user experience compared with physical maps and signs. Interactive wayfinding applications have been around for many years. However, most of the current applications are based on GNSS, which makes them unsuitable for metre-level navigation in complex indoor environments where GNSS signals are of poorer quality or even completely blocked. In addition, indoor environments usually require very different maps from outdoor environments, as users need different 'landmarks' and specific local information. Such maps or the data to produce those maps may not be readily available. For these reasons, even with today's modern technology, indoor wayfinding applications can still pose a sizeable challenge, in particular in an environment like an airport.

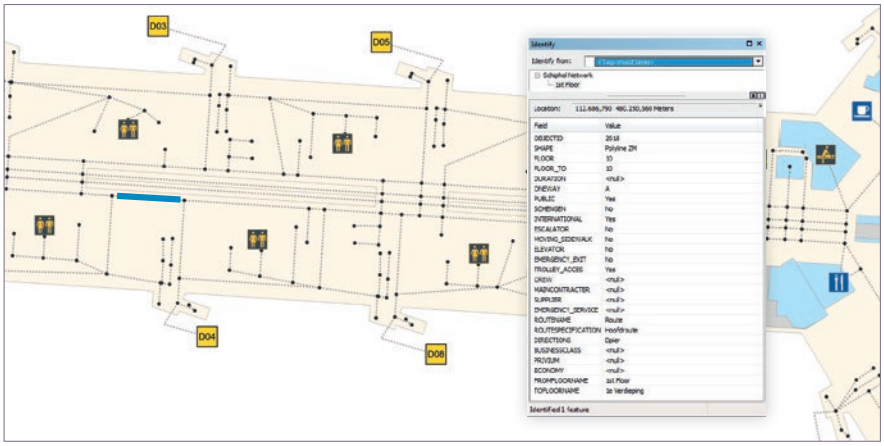
▲ *Figure 1, Indoor wayfinding helps passengers to navigate from A to B as quickly as possible at Amsterdam Airport Schiphol.*

BEACON TECHNOLOGY

For satisfactory indoor wayfinding, an accuracy of around five metres is required. If the error range is any bigger it becomes difficult to interpret direction and the user might take a wrong turn. As this accuracy is difficult to achieve with GNSS positioning, indoor wayfinding requires additional positioning techniques that overcome the indoor limitations of GNSS. There are various technologies available, each with their own advantages and disadvantages. To facilitate indoor wayfinding, the redesigned Schiphol Airport app uses beacon technology based on Bluetooth 4.0 LE (low energy) for both technical and practical reasons. Firstly, Bluetooth 4.0 LE uses little power and is compatible with most modern smartphones and other smart 4.0 devices. In addition, initial trials at Schiphol showed that a position accuracy of five to seven metres was possible in most areas; a similar trial at Schiphol based on Wi-Fi positioning had not managed to achieve that. In addition to these



▲ *Figure 2, Initial map of Schiphol based on the asset management source data. The decomposition of asset management objects and lack of recognisable labels and symbology made this map unsuitable for indoor wayfinding purposes.*



▶ *Figure 3, Part of the network used for route calculation. Each dot (a junction) is connected to a line (an edge). Here, the selected edge (visible as a blue line on the left) is a one-way route in a public area.*

technical aspects, one practical consideration was that beacon technology from Polestar was already in use for other applications at Schiphol. Polestar beacons are known for their good performance in complex buildings, like Schiphol, and using the same beacon technology would improve future interoperability and facilitate maintenance. Ultimately, to achieve the desired accuracy, more than 2,000 beacons have been placed throughout the airport.

ONE SOURCE

To create the map for the indoor wayfinding app, Schiphol's asset management database was used. Schiphol was already using that data source for maintenance of its buildings and other assets and it made sense to manage the app's map data from the same source. This ensures that the app will always utilise the most up-to-date map of the terminals. The map source data, which is managed in an Esri environment, had to go through multiple processing steps and required some smart workarounds in order to create simple maps with objects and annotations that passengers would be able to understand.

MEANINGFUL GENERALISATION

The design criteria for creating a meaningful map for use in the Schiphol Airport app were based on complete and recognisable objects. The source objects were decomposed and stored in high detail in Schiphol's asset management system which delivers the real-time source data for the app. A shop, for example, consists of many components, such as the sales area, storeroom, internal walls and support columns, but none of these individual asset components provide a meaningful map item for the end user. Therefore, the first challenge was to transform the data from detailed asset objects into generalised cartographic objects. Asset elements needed to be merged, gaps needed to be filled and boundaries needed to be generalised in order to achieve the design criteria.

SMART ICONS

The second challenge was the transformation of particular areas into cartographic symbols on the map. For example, a toilet zone consists of all the elements of that asset (such as men's and women's toilet areas, baby care facilities and disabled toilets). Using spatial

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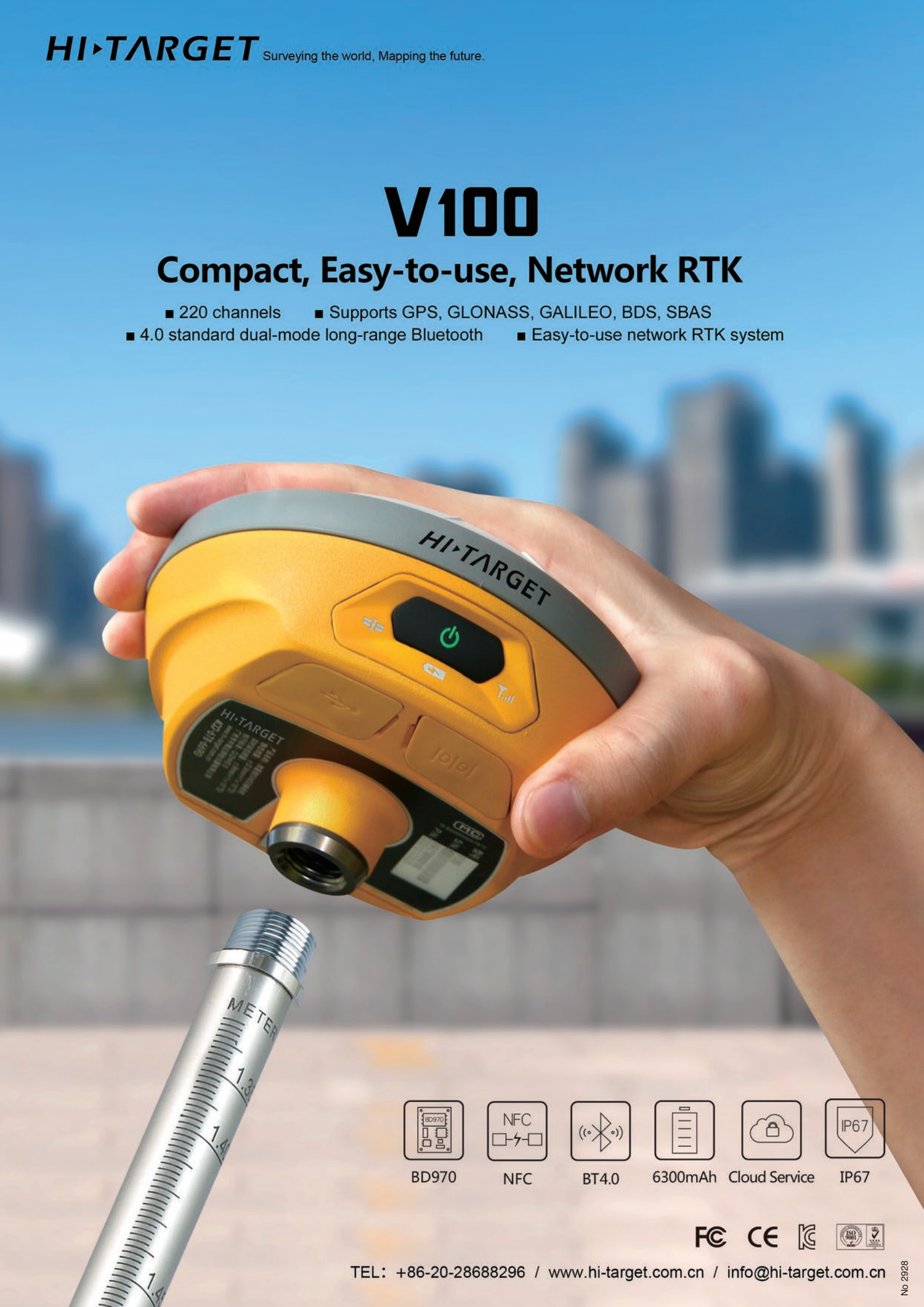

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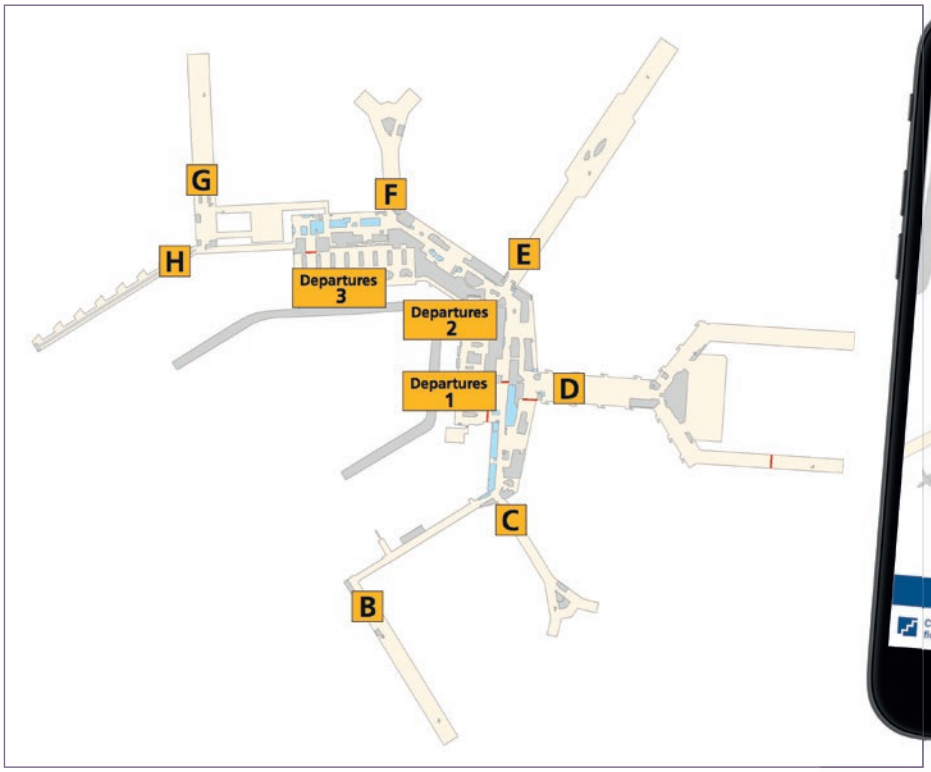

▲ *Figure 4, Final map with simplified objects and symbology suitable for use in the Schiphol Airport app. Any changes in the source data are automatically updated in the map.*

▲ *Figure 5, Schiphol Airport app showing the indoor wayfinding.*

tools in the ArcGIS platform, these areas were 'translated' into appropriate symbols. First, the minimum bounding geometry of each toilet group was calculated based on its unique identifier. Per toilet group, this provided a centre point for placing the symbol. The frequency of the elements within the toilet group was calculated using geostatistical tooling. If an element was counted once or more within one group, its value was set to 1. This method provided codes for each different toilet group, e.g. if all the elements were present the code was 1111. This code was then added as attribute data to the centre point of the toilet group so it could be displayed as a symbol on the map. These and various other similarly smart approaches were necessary to create the final map for the Schiphol Airport app.

CREATING ROUTES

To provide passengers with a simple navigation experience, much attention was paid to creating accurate routs and presenting them clearly. The routes are calculated using Esri's Network Analyst, a platform extension providing network-based spatial analysis tools for solving complex routing problems. The first phase was designing a geometric network consisting of two feature classes, which are collections of geographic features with the same geometry type (such as point, line, or polygon), the same attributes and the same spatial reference. In Network Analyst terminology, these two feature classes in the network are a 'junction' feature class and an 'edge' feature class. The junctions are all the points of interest (e.g. check-in desks, passport control and security, toilets, shops, departure gates), and the edges connect the junctions and represent the walking routes. The second phase was to design and implement operational rules within the network, such as in the case of one-way routes at security or, for example, designating preferred routes by giving the moving walkways preference over regular walking when devising the route. In other challenging route examples, routes for wheelchair-bound passengers cannot use stairs but rather are restricted to lifts, and VIP areas are not accessible to all passengers.

LOOKING AHEAD

Schiphol is one of the first major airports to have integrated indoor wayfinding into its own mobile application and such technology has rarely been used before in such a large and complex environment. Since the release of the new version of the Schiphol Airport app in September 2015, more than 20% of the app's users have also used the indoor wayfinding map. Looking to the future, Schiphol will be able to analyse visitor flows inside the building by using the spatial intelligence capabilities of the ArcGIS platform. Based on those results, operational rules can be enhanced to achieve optimised routing efficiency. In addition, real-time information can be integrated from other systems at Schiphol in the future, such as to avoid overcrowding at security control or to quickly identify and repair a broken moving walkway. ◀

MIKE SMOLDERS

Mike Smolders is a project manager at M2mobi, a mobile development agency based in Amsterdam, The Netherlands. Mike graduated with a master's degree in international business administration from the Vrije Universiteit Amsterdam (VU). At M2mobi, Mike has worked for several large brands and companies like Heineken, Schiphol and Dubai Airports.

HARALD GÖRTZ

Harald Görtz is a business consultant at Esri Nederland. He graduated from Van Hall Institute of Applied Sciences in nature management and GIS in 1998. Harald is specialised in cross-departmental information management. Before joining Esri Nederland he was team lead GIS & technical application management for the Province of Groningen.

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USING BEIDOU FOR TALL BUILDING CONSTRUCTION IN KUWAIT

Core Wall Control Survey

Tall towers can bend and sway due to wind, cranes and other loads. Ideally, such movements should be around the main axis as designed so that, in the absence of loads, the tower stands exactly vertical. However, raft settlement, concrete shortening and construction tolerances cause deviations. The authors adopted the core wall control survey method to drive the new headquarters of the National Bank of Kuwait – a 300m-tall building – in the vertical direction with millimetre accuracy. The method uses GNSS CORS technology. This is for the first time that signals from the available BeiDou GNSS satellites have been used to assist construction of tall buildings.

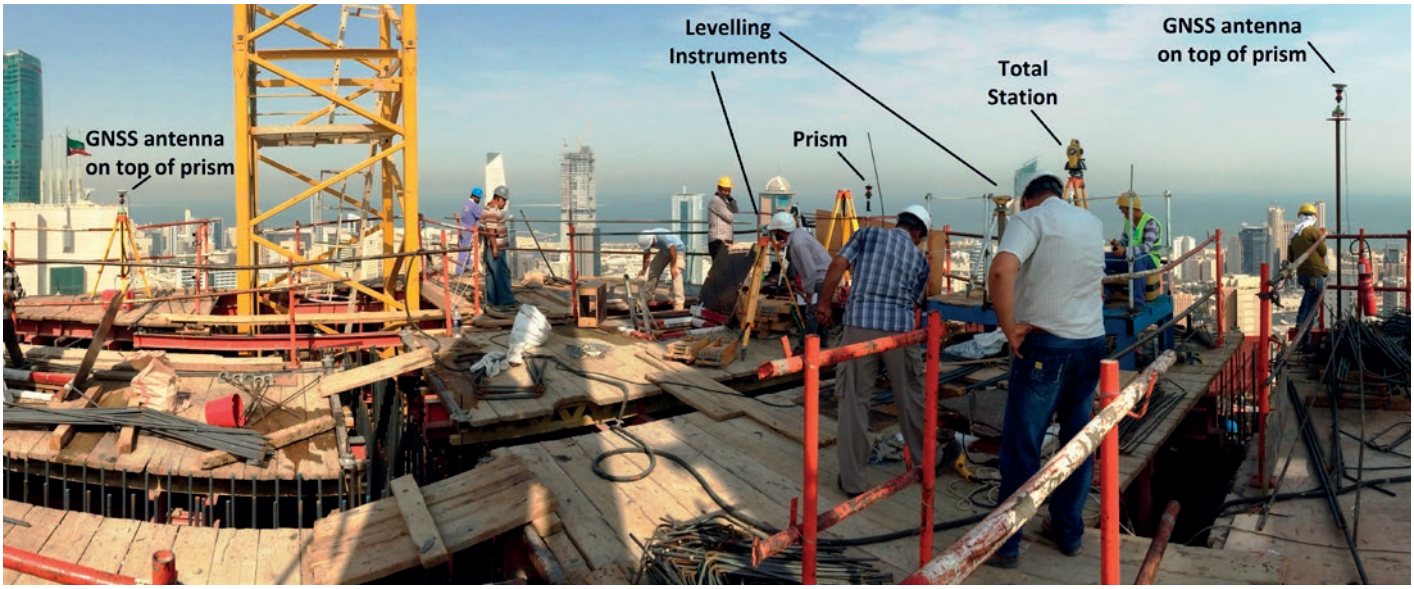
Figure 1, New headquarters of the National Bank of Kuwait under construction.

Designed by Foster+Partners the new building, which will be the headquarters for the National Bank of Kuwait, combines concrete, steel, glazing and glass-reinforced concrete (GRC) in a shellfish shape (Figure 1). To drive the tower exactly in the vertical direction the core wall control survey (CWCS) method has been adopted [1]. Joël Van Cranenbroeck invented this method for driving the Burj Khalifa in Dubai 828 metres above ground level and for the construction of the Al Hamra tower in Kuwait – the world's first-ever sculptural tower and surpassing the Burj Khalifa tower in terms of engineering complexity.

CWCS METHOD

Core walls are constructed bit by bit, one on top of the other. Each core wall element consists of several concrete pours. The placement of the formwork structure on top of existing core walls must be done very precisely using control points, marked

GNSS ground control point.



▲ *Figure 2, A variety of surveying instruments are arranged on top of the construction site.*

by nails for example, set in the top of the concrete. The coordinates of these control points must be precisely determined with respect to the main axis of the design reference frame, which is defined as the vertical in the centre of the tower. The main measurement devices are total stations, which need GNSS control points for georeferencing purposes. Dual-axis inclinometers, precise levelling and vertical laser plummets complete the sensor fusion approach (Figure 2). To guarantee the precise upward thrust of a tower along the vertical during construction, control must be maintained of the position of each new element erected on top. Therefore, the position of the formwork structures at the top must be continuously measured.

ACTIVE GNSS

The higher the tower is being built, the harder it is for total stations mounted on top of the building to have sight of the ground-based control points. Therefore, a network of three to four GNSS receivers has to be installed on top of the formwork as control points. After post-processing, the coordinates of the active GNSS network are transformed into the local datum and are available for any total station operating on top of the building. Comparison of the total station coordinates derived from this on-top-of-formwork network with ground control points showed differences of less than a few millimetres. As GNSS can only deliver high accuracies in differential mode, it is necessary to set up a local GNSS base station. For this the GNSS M300 Pro, a multi-purpose GNSS receiver designed by ComNav Technology, Shanghai Ltd., China, was selected (Figure 3). The device can track 256 channels simultaneously from GPS, Glonass, Galileo and BeiDou. With a large internal memory and expendable memory card for long-term big data storage, the integrated battery serves as either the primary power source or the stand-by uninterrupted power supply (UPS) backup. The built-in web user interface gives access to information on receiver status, configuration and firmware update and RINEX data download. The GNSS receiver and the AT300 geodetic-grade GNSS antenna were placed nearby the construction site and connected to a router to enable easy downloading of data for post-processing the measurements of the GNSS receivers placed on top of the building.

THIS IS THE VERY FIRST GNSS CORS STATION TRACKING BEIDOU SATELLITES SIGNALS DEPLOYED IN THE MIDDLE EAST

▲ *Figure 3, ComNav Technology's M300 Pro GNSS CORS station.*

BEIDOU

This is the very first GNSS CORS station tracking BeiDou satellites signals deployed in the Middle East region. The Chinese

BeiDou navigation satellite system consists of two satellite constellations. The three satellites of BeiDou-1 have limited coverage and applications and have been focused on customers in China and neighbouring regions since 2000. The second generation – known as BDS, Compass or BeiDou-2 – is still under construction and will ultimately have global coverage consisting of 35 satellites. The system became operational in China in December 2011, with 17 satellites in view, and began offering services to customers in the Asia Pacific region in December 2012. The intention is to begin serving global customers upon completion in 2020. Up to 11 BeiDou satellites are visible in the sky above Kuwait. The M300 Pro capability to track BeiDou signals over three frequencies (B1, B2 and B3) increases the number of GNSS signals that can be tracked which is beneficial on a site where obstructions frequently block GNSS signals.

PERFORMANCE

To compare performance of GNSS M300 Pro with the four Leica GRX1200 receivers used previously for the Al Hamra tower, a zero baseline test was conducted by connecting both receivers to the same ComNav Technology AT300 GNSS antenna. A temporary GNSS base station was set up using another Leica GRX1200 GNSS receiver. All the RINEX data collected during an hour was processed using the open-source software RTK-LIB developed by T. Takasu and Leica LGO software version 8. The differences between the two types of receivers were less than a millimetre. The baseline components between the temporary base station and both receivers showed respectively 1mm in X and Y (WGS-84) and 2mm in Z difference, which is acceptable and proved matching quality. ◀

FURTHER READING

[1] Cranenbroeck, J. Van (2010) Driving Vertical Towers – Surveying for High-rise Structures, gim-international.com/content/article/driving-vertical-towers

JOËL VAN CRANENBROECK

Joël Van Cranenbroeck has over 30 years of experience in precision surveying. Formerly working as business development manager for Leica Geosystems AG, Heerbrugg, he established CGEOS – Creative Geosensing Belgium in January 2014. This consultancy company is specialised in high-definition positioning, in positioning infrastructures (CORS network) and in monitoring.
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Robert Bou Chedid graduated as a civil engineer and is construction manager with Ahmadiah Contracting & Trading Co. Kuwait. The company was established by Abdulatif F. Al Thuwainy and Nagib Ibrahim Najjar in 1954 and is presently leading in Kuwait's civil engineering and building construction industry.
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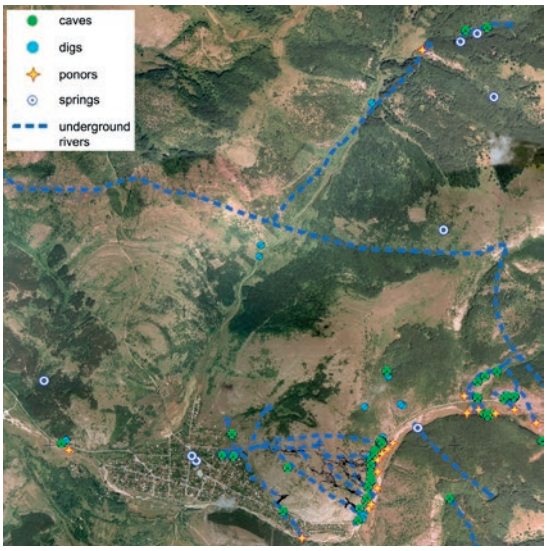
Multi-sensor Cave Detection

Caves are important in a wide variety of fields, ranging from construction engineering to mineral exploration and archaeology. Despite the scientific importance of caves, geologists believe that only a relatively small number of them have been discovered so far. Exploration is currently mainly conducted by speleologists but this is a time-consuming activity and is limited to exploration based on existing surface openings. The authors of this article show that the combination of multiple geophysical techniques provides an easier and effective on-surface exploration method that meets the challenges of complex karst environments.

Several geophysical techniques are recommended for cavity exploration, such as ground-penetrating radar (GPR), gravimetry, magnetometry, electrical resistance surveys and seismic reflectivity. However, their indirect on-surface application is related to some uncertainties due to the complex and dynamic nature of karst environments. For instance, one can never be sure in advance whether it is a dry or a water-filled cave or whether it has sediment cover (which makes it unsuitable for specific instruments). Another challenge is that a small cave at a certain depth may produce similar sensor observations to a larger cave at a greater depth, thus causing mapping ambiguities. Therefore, multi-sensor exploration, which relies on different physical properties of the environment, gives better results than an increased accuracy of a single technology. The combination of different technologies with additional information (such as details of local geology, subsurface features and topography) can further improve the results. In the research presented in this article, a surveying campaign has been conducted both on the surface above a known cave and inside it to investigate the effectiveness of multi-sensor cave detection.



▲ *Figure 1, Map of the Bosnek karst region showing various information, such as cave entrances, springs and underground rivers.*

▲ *Figure 2, The Zhivata Voda pulsating spring.*

KARST LABYRINTHS

The Bosnek karst region, the test location, is famous for the Duhlata cave which is the longest cave system in Bulgaria (Figure 1). With the connected underground spaces stretching for 18 kilometres, Duhlata is an impressive and sophisticated labyrinth. However, it is predicted that the known area comprises less than 10% of the total cave system, which leaves a large part still to be explored. Of much smaller size but similarly interesting is a pulsating spring near Duhlata called Zhivata Voda ('The Living Water').The irregular intervals of its water flow are the subject of various legends and superstitions, but scientific interest is focused on the subsurface features that actually cause the irregular water flows (Figure 2). A cave of the same name is situated about 100 metres away from the spring, and two other caves are also in close proximity. The entire area is a complex karst environment, making it a suitable test location for the multi-sensor exploration method.

GEOPHYSICAL TECHNIQUES

For the study, a combination of gravimetry, GPR and magnetometry was used. Gravimeters are sensitive to density changes (and work best if caves are dry), GPR is an active radar system that maps the reflections of radar pulses and magnetometers are able to discover anomalies due to different underground environments by measuring the magnetic field precisely. The common advantages of all three geophysical techniques for this research were their portable instrumentation, one-man operation and silent and non-intrusive performance. Nevertheless, the mountainous nature of the investigated area still remained a challenge for normal operation. In addition, accurate station positioning information (especially heights) is required for gravimetry, which is difficult to achieve in areas with poor GNSS coverage (such as deep in the forest).

Figure 3, Performing the in-cave measurements.

Figure 4, GPR measurements just above the cave entrance.

The three on-surface techniques were complemented by 3D mapping of a known cave within the investigated area, the Zhivata Voda cave. This model served for field calibration in order to study the multi-sensor effectiveness, as well as to improve data analysis and interpretation. Bringing all of the datasets together was a challenging but essential task for interpreting the final results.

SENSOR SETUP

The equipment consisted of both modern and classical surveying devices. Some results were available in real time, but others first required post-processing. The gravimeter used was a LaCoste & Romberg G with a sensitivity of 0.04mGal. The GPR was the MALÅ X3M, equipped with a 250MHz antenna. For magnetometry the GSM-19 magnetometer from GEM Systems was chosen with a resolution of 0.01nT. According to the gravimeter sensitivity, the accuracy threshold was 13cm for the height of the stations at the measurement locations. To achieve this, an integrated GNSS handheld Trimble Geo 7X (that supports GPS, GLONASS, BeiDou/Compass and Galileo) was used together with the external Zephyr II antenna on a 2m-high pole to make it easier to reach the required accuracy (up to 1cm was reached). The handheld also had an integrated laser rangefinder module including a digital compass and clinometer, which was useful in enabling offset measurements.

A Leica TCR303 total station was used for all tasks that required high accuracy but where a poor or no satellite signal was available.

SURVEYING CAMPAIGN

The fieldwork consisted of two parts: a cave survey and subsequently on-surface measurements. Because of the relatively large galleries and mostly flat base of the Zhivata Voda cave, mapping it was a relatively easy task (Figure 3). The traverse of the cave consisted of several measurement locations; their positions were chosen based on line of sight and specific formations to be surveyed. The absolute position of the cave was determined through GNSS measurements at the entrance. The on-surface measurements were carefully planned in advance using the available topographic data of the region as well as existing information on the Zhivata Voda cave. The measurement grid consisted of about 180 points, each spaced two metres apart and spread over eight rows positioned approximately along the terrain contours.

First, the grid points were laid out roughly by performing offset measurements with the handheld's rangefinder through the vegetation and rocks in order to choose the most suitable locations for the measurement stations. Next, due to the significant tree canopy, a combination of GNSS and total station measurements was applied. The use of the magnetometer was the easiest part of the fieldwork with several seconds spent on each station. Pulling the GPR across the hillside was physically harder (Figure 4) but the gravimetric measurements were the toughest part, taking on average 10 minutes per point and sometimes even longer.

ALL MEASUREMENTS WERE POST-PROCESSED TO IMPROVE THE GNSS ACCURACY AND TO COMBINE THEM WITH THE TOTAL STATION MEASUREMENTS

CAVE MODEL

All measurements were post-processed to improve the GNSS accuracy and to combine them with the total station measurements. The in-cave measurements, which consisted of about 350 points from four stations, were used to approximate the 3D layout of the cave. The measurement approach applied

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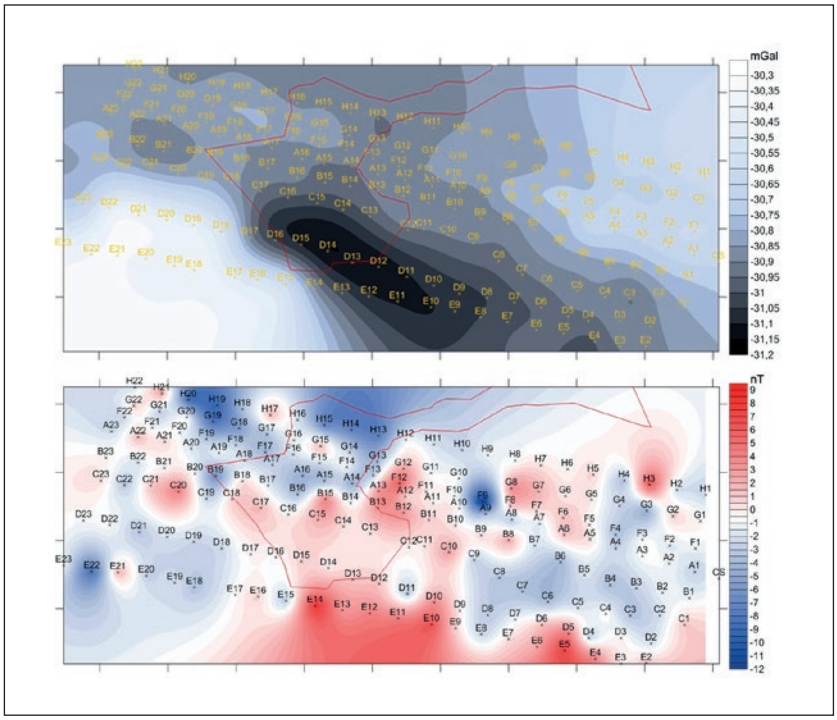
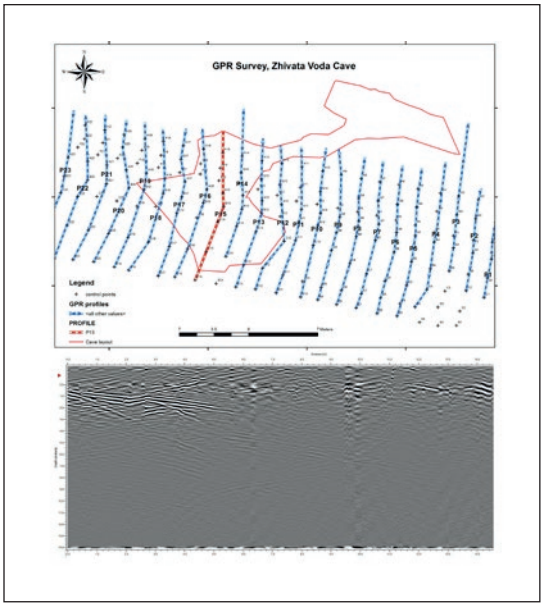


▲ *Figure 5, Filtered gravimetric (up) and magnetometer (down) results of the area with the cave layout shown in red; the numbers indicate the grid measurement locations.*



▲ *Figure 6, GPR results shown along profile 15 that starts above the cave entrance and goes up the hill.*

differs from a typical cave survey, which uses more stations but measures only four points per station (ceiling, floor and the two sides). Therefore, codes were used to mark the measurements in order to be able to distinguish between the floor and the other points. The model generated in AutoCAD Civil was used to obtain information on the shape, size and depth of the cave.

DATA IMPROVEMENTS

Although the GPR data was available in the field, it was post-processed with MALÅ Object Mapper and GroundVision, applying different filters to improve data analysis. The results were presented along the surveyed profiles. The magnetometer data was presented with Surfer on a map. Gravimetric data usually requires topographic corrections to obtain accurate results (especially in a mountainous region like the test region). For the research area of this investigation, topographic corrections for an area of more than 10 x 10km were calculated based on a combination of SRTM data, digitised topographic maps and the GNSS measurements acquired in the investigation itself. The resulting gravimetric data was filtered to improve data consistency.

NEW CAVITIES

Both the gravimetric and magnetometer results were presented as a 2D map which could be compared to the cave layout based on the in-cave measurements, but direct interpretation remained challenging. The filtered gravity data suggested the presence of two more cavities within the explored area (Figure 5). One of them was situated in the south-eastern periphery of the grid and this matched with a spring at the foot of the rocks there (measurement points E4-D4). The other one was located west of the cave near measurement points B21-22 and A21-22. Due to the lack of a sediment layer to block the electromagnetic signal, the GPR technology was successfully applied and showed similar results to the results of the gravimetry and magnetometry data (Figure 6).

FURTHER DEVELOPMENTS

The geophysical methods used in this investigation each have their advantages and limitations in terms of exploration of subsurface features. When used together, they are a powerful tool for cave detection. However, their combined interpretation is not straightforward and will likely benefit from further spatial analysis in GIS. The available GIS data for the Bosnek karst region consists of information about the known and possible cave entrances, their subsurface development and possible underground river flows. In the current investigation it was used in the planning process only, but the gravimetric, GPR and magnetometric results could be integrated with these datasets for enhanced interpretation. The current investigation can also serve as a starting point for a more complex dataset of the entire region to, eventually, reveal the secrets of Zhivata Voda.

ACKNOWLEDGMENTS

The authors express their gratitude to New Bulgarian University (NBU), University of Architecture, Civil Engineering and Geodesy (UACEG), Bulgarian Geoinformation Company (BGC), Karoll Financial Group and the people who reviewed this work. ◀

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- when it has to be **right**

Leica Geosystems

No 2957

HOW WEARABLE REALITY CAPTURE IS SHAPING THE INDUSTRY

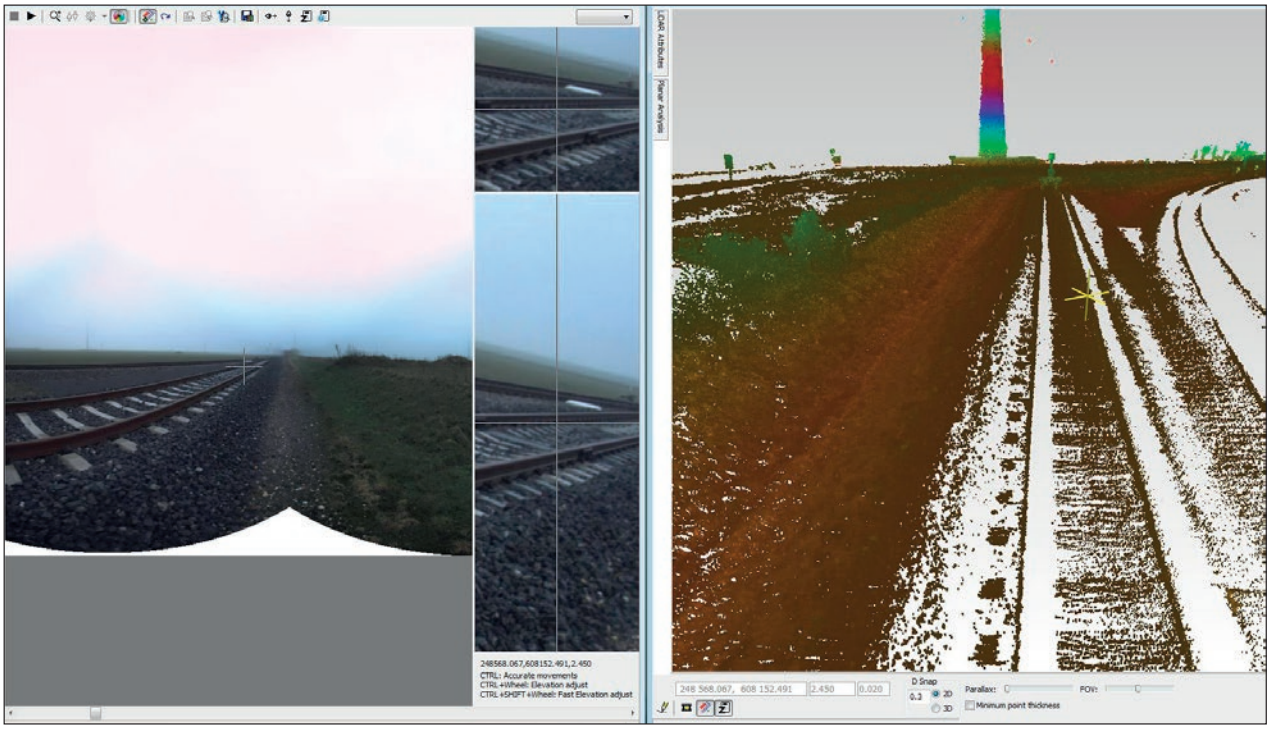
Laser Scanning **on the Go**

As the world population keeps growing and changes in buildings and infrastructures become more rapid, we have an increasing need to document this growth and these changes. To meet this need, we must consider a revolutionary approach to geospatial documentation on a local, individual scale. New systems enable users to walk around unhindered while logging reliable data about time, position and the world in 3D. Referred to as 'wearable reality capture systems', this new concept is shaping how measurement professionals come to understand the world around them. This article explains the impact of wearable reality capture on the industry and its benefits for new applications.

Wearable reality capture systems are relatively new to the market and their applications are still being explored. Pioneers in the field are primarily working in four main areas: building information modelling (BIM) documentation; reality-based industrial training; safety and security; and disaster response documentation. Outside of these four main areas, wearable reality capture is also gaining popularity in traditional survey applications such as cadastral and as-built documentation, in particular for areas with obstructed GNSS access or challenging terrain. All applications require a fast and efficient connection to the changing environment, but also a reliable understanding in terms of both time and position.

MULTI-LEVEL BIM

BIM is divided into multiple levels from 1D to 6D. Two levels can directly benefit from wearable reality capture systems. 4D is focused on adding a time or milestone scheduling to the typical 3D BIM design activities. 4D's scheduling aspect can be helped by providing a regular, fast and efficient connection to the chaotic construction site, enabling milestones and building changes to be easily documented and monitored. 6D, the phase after building construction is completed and operations are ongoing, is focused on the facilities management of a completed building. Here, reality capture offers the opportunity to pass on a complete as-built 3D and image-based dataset to the building's new owner. With a construction site changing almost hourly and considering that, typically, the only way



▲ *Figure 1, The Dutch survey firm Van Steenis Geodesie used 3D imagery provided by wearable reality capture systems in a traditional terrestrial survey of a Rotterdam rail yard for pre-design measurements (image courtesy: Van Steenis Geodesie).*

▲ *Figure 2, An employee from Van Steenis Geodesie logs data captured with the Leica Pegasus:Backpack. The firm found an absolute positioning improvement of about 3cm compared to traditional survey methods (image courtesy: Van Steenis Geodesie).*

to navigate a site is by foot, this makes BIM documentation an ideal situation for wearable reality capture systems.

INDUSTRIAL TRAINING

Reality-based industrial training is a requirement of the future. Today's buildings are more complex than ever before and many fire departments are now training in a gaming-based environment on a building before they are called out to an actual fire. Knowing which floor and/or around which corner the fire hose can reach will save lives in emergency situations. Oil refineries and chemical plants must be able to document any site changes in 3D and images for fast and efficient responses to emergencies. Gaming engines can now import reality capture data so the gap between as-built and gaming is shrinking.

SAFETY AND SECURITY

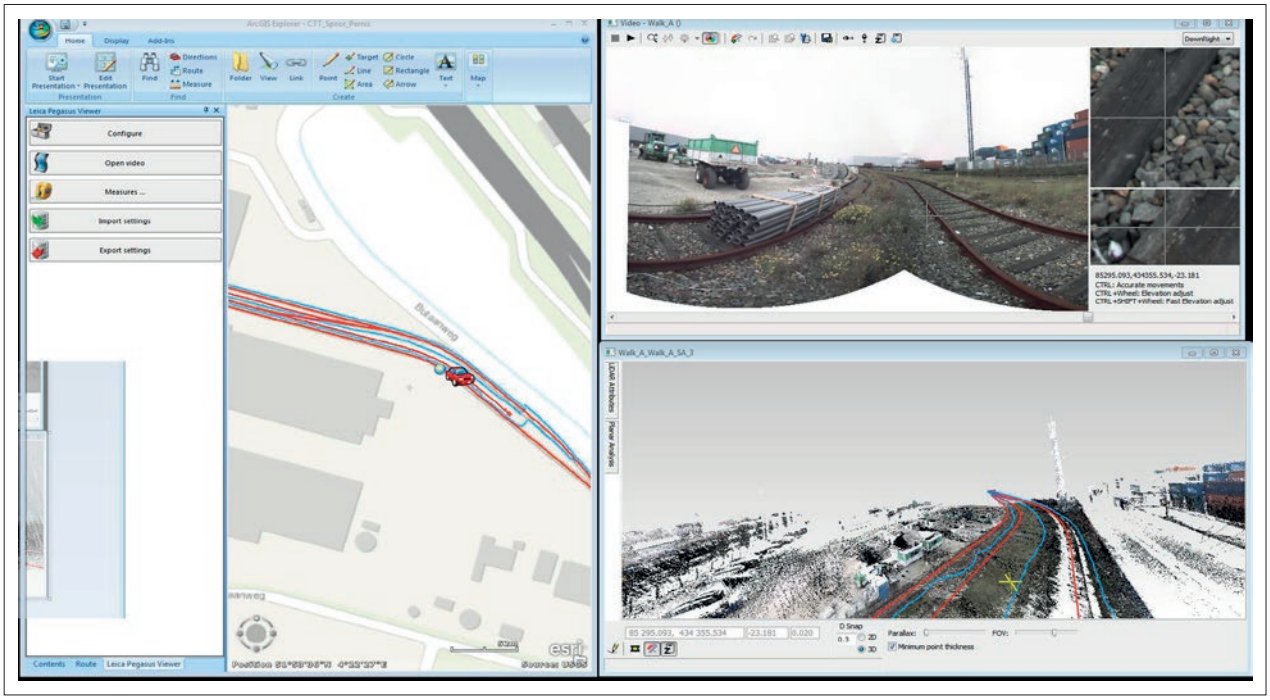
Safety and security is focused on the documentation of situations involving large crowds for emergency response or control, documenting large over-crowded housing camps, mapping of VIP routes for emergency or control, or border control. These are all situations where fast data capture is critical and primarily involve environments which are better approached from a pedestrian point of view.

NATURAL DISASTER RESPONSE

When a natural disaster strikes, it is important to be able to manage any type of terrain and gain the information quickly. Typically, the only way to access disaster areas is by walking. Documentation for disaster aid response can be captured quickly on foot, but there has been no option to do this in 3D until now. With reality capture sensor systems, faster response times translate into lives saved and damage minimised.

COMBINING TECHNOLOGIES

Lidar technology is fundamentally limited by certain physical properties, such as wet surfaces showing no returns or the inability to detect small changes in texture. In an urban environment, however, the visual aspects of objects are as important as their dimensions. In these complex areas, being able to calculate distances based on a difficult surface, such as a painted facade, can only occur through a combination with photogrammetry. In addition, using photogrammetry or image capture during post-processing helps in improving the position information. When no GNSS signals are available, as can happen in cities, wearable reality capture systems render the world in 3D from the Lidar profilers, cut up the 3D walking path into segments, compare the segments and then look for overlaps in those segments to estimate the movement from the last position. The Lidar system might not always be able to understand a change in elevation, but an anchor point can be included from the image data to help the system better understand its position and improve its accuracy. The best quality checks of a mass data collection can only come from a visual inspection of the images and dimensional checks through photogrammetry.



▲ *Figure 3, The Leica Pegasus:Backpack is used to capture GIS data around a rail yard where the safety and security of the employees and the site are critical. Esri's free view with MapFactory for ArcGIS is used to share the data with the client (image courtesy: Van Steenis Geodesie).*

A WORKING EXAMPLE

As part of this new generation of wearable reality capture systems, Leica Geosystems has created the Leica Pegasus:Backpack. Combining five cameras and a Lidar profiler within an ultra-light and ergonomic carbon fibre chassis, this mobile mapping solution creates a 3D view of virtually any location. The Dutch 3D survey firm Van Steenis Geodesie recently used the Leica Pegasus:Backpack in a terrestrial survey of a Rotterdam rail yard for pre-design measurements. The captured 3D imagery and point clouds will be used to design new rail tracks through reverse engineering, lay plans, ballast volumes and profiles, and quantity determination. Railways can present a particularly difficult environment for classical surveying methods due to low-hanging electrical lines and constricted spaces around train cars. With wearable reality capture systems, however, these environments can be thoroughly explored and documented. Van Steenis Geodesie director Klaas de Weerd, who led the survey, compared the use of the wearable reality capture system to traditional survey methods, finding an absolute positioning improvement of about 3 centimetres. The newer technology also allowed the entire survey to be completed in three hours with 360-degree visuals versus the traditional several days of capturing flat images. "Using wearable reality capture enabled us to realise many benefits over traditional surveying techniques," said De Weerd. "Every spot in the rail yard was reachable. We didn't have to implement extra safety measures either, since there was no need for us to enter high-risk areas; we could simply capture the data from a safe distance. Finally, we saw great time savings due to error-free data acquisition in a baseline survey that will allow us to accurately monitor any changes to the design in the future."

ENABLING REAL-TIME DECISIONS

Capturing the world in 3D is important, but without knowing the position or the time of capture it is difficult to compare different locations or different datasets captured during a specific time period. To accurately measure the changes around us, it is vital to understand how measurements relate to time and position. However, it is no longer merely a question of accuracy. Now, the future is about capturing reality at the same speed as our world is changing and enabling the level of documentation needed to make real-time decisions.

STUART WOODS

Stuart Woods is the vice-president of Leica Geosystems' Geospatial Solutions division. He leads Leica Geosystems' mobile mapping business with a passion for value creation. Woods is responsible for the research, development and implementation of hardware and software content collection for multiple verticals.

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CREATING A PRINTED 3D MODEL OF TINTAGEL ISLAND FROM UAS PHOTOGRAMMETRY

Reconstructing a Mythical Past

UAS photogrammetry has been used to create a printed 3D model of the area around Tintagel Castle in Cornwall, UK. The model is on display in the new visitor centre at the castle. Vertical images were taken with a fixed wing and oblique images with a multirotor. Data capture faced two major challenges: the weather and steeply rising cliffs. Working in the winter, in windy and gloomy conditions, proved tricky for obtaining sharp and vivid images so the use of high-quality cameras was a must. In contrast, the legal limitations were modest.

The ruin located on Tintagel Island, Cornwall, UK, was once a castle. It was built by Richard, Earl of Cornwall in the 13th century, after Cornwall had been subsumed into the Kingdom of England (Figure 1). The castle has long been associated with the legend of King Arthur; in the 19th century the ruin became a tourist attraction and archaeological investigations started. A new exhibition at Tintagel Castle brings King Arthur and Tintagel's mysterious past to life for tourists and shows the island changing over 1,500 years of history – from a thriving Dark Age settlement, to medieval fortress, through to romantic ruin. The centrepiece of the new visitor centre is an accurate and detailed 3D model of the island and nearby mainland (Figure 2). The 3D model has been created using UAS photogrammetry.

CHALLENGES

Data capture by UAS faced two major challenges. Firstly, Tintagel faces the Atlantic Ocean and is thus windy and gloomy in the winter months, which is when the data had to be captured due to project deadlines. The multirotor used was the Falcon 8 from Ascending Technologies. This UAS can handle much more wind than the available fixed wing, the eBee from senseFly, but the air dynamics require a high camera shutter speed. Table 1 compares the characteristics of both UASs. To avoid blurred imagery due to poor light conditions the standard camera on the fixed wing, a Sony A7r, was swapped for an upgraded Canon with shutter priority mode.

To obtain sharp images with as little noise as possible it is essential to shoot in RAW. RAW image formats help to preserve the radiometric characteristics of the scene by capturing a wider dynamic range or colour gamut than the ultimate image. The final image is created through white balancing and colour grading. A short exposure time decreases blur but also decreases grain as a high ISO setting is required. The ISO setting defines the sensitivity of the sensor to light: the lower the number, the less sensitive the sensor and the finer the grain. The high ISO setting produced insufficient crispness of the building edges (Figure 3). To resolve this issue, the buildings were captured again with the Sony A7r on board the multirotor. A second challenge was that vertical images alone were not sufficient to create a full, uniformly detailed 3D model of the island and adjoining mainland. Terrestrial laser scanning (TLS) could have been an option to capture the steeply rising cliffs of the island and the ruins but this is a time-consuming surveying method. Furthermore, only a small area was accessible on foot due to the steep and dangerous terrain. Therefore, the cliffs and the ruins were captured with a camera on board a multirotor taking oblique images. Since capturing the entire island by multirotor alone would have taken too long, a fixed wing was used to capture vertical images of the relatively flat parts of the area.

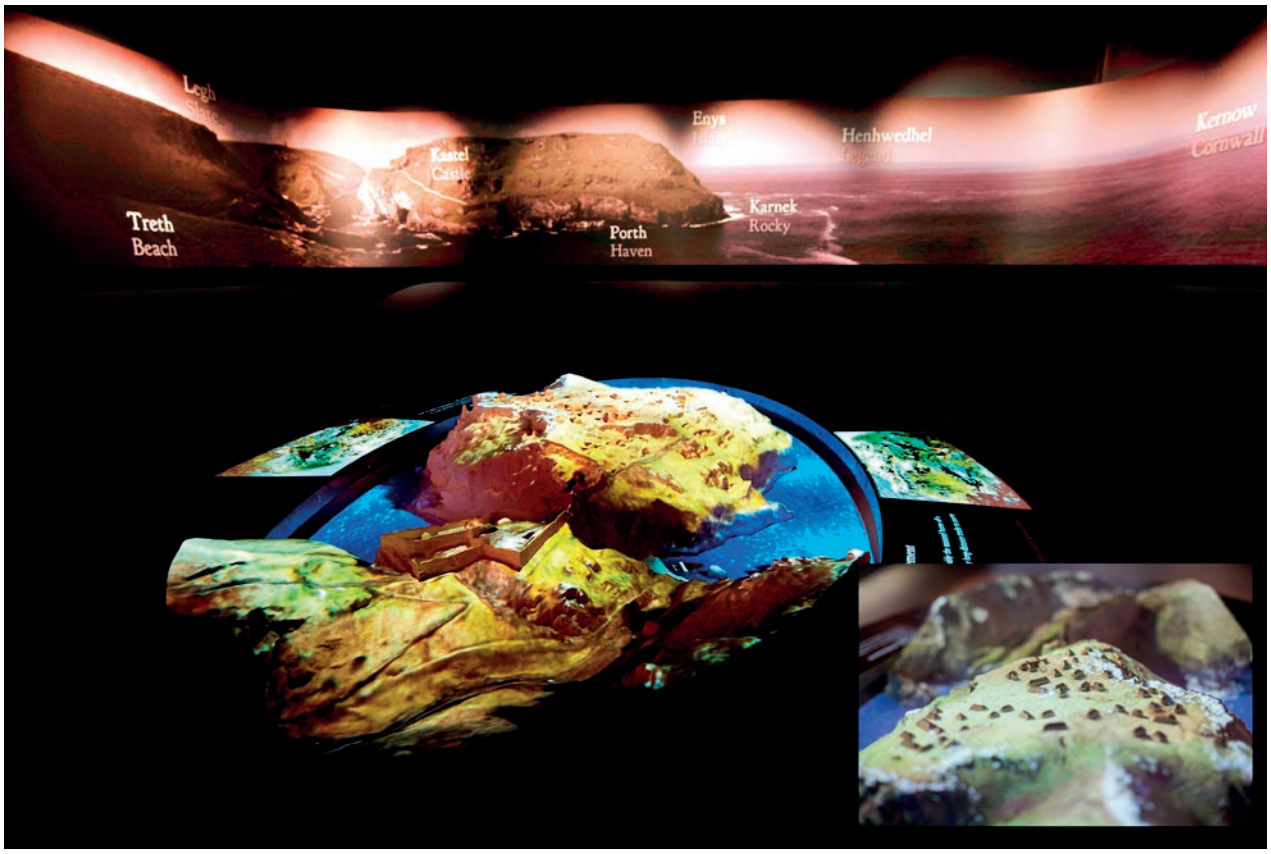
LEGAL ISSUES

The UK's Civil Aviation Authority (CAA) allows the commercial use of UASs for flights of up to 500m in the line of sight and not above 400 feet (122m). These conditions were easily met. Furthermore, there was no risk of

▲ *Figure 1, Location of Tintagel Castle in Cornwall, UK.*

Type	Fixed Wing	Multirotor
Brand	eBee	Falcon 8
Camera	Sony WX220	Sony A7r
Weight [kg]	0.4	2.3
Max. payload [kg]	0.15	0.8
Max. stay in the air [min]	45	22
Max. speed [km/h]	57	54
ø / wingspan [cm]	96	82

▲ *Table 1, Basic features of the fixed wing and the multirotor used to capture the area around Tintagel Castle.*

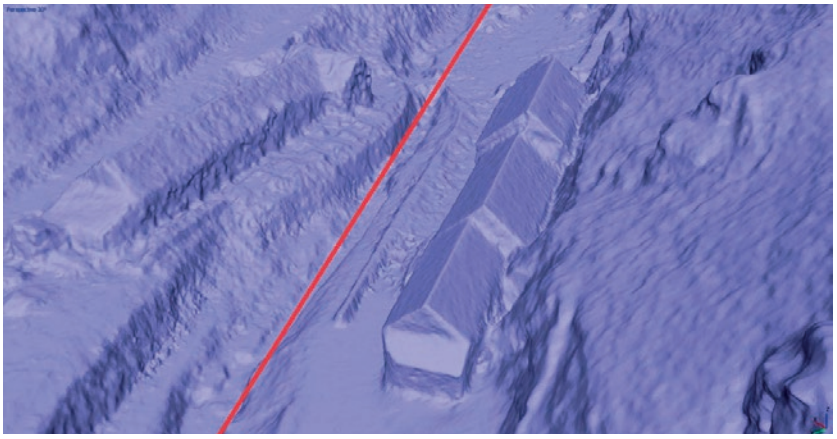


▲ *Figure 2, Exhibited 3D model and detail (inset). (Image Courtesy: Emily Whitfield-Wicks)*

harming people as the flights were conducted during times when the castle was closed to the public.

ON-SITE WORK

Work got underway with the multirotor until the weather allowed the fixed wing to be used. The multirotor can fly autonomously but, to give the camera operator time to frame photos correctly, the UAS was flown manually. This required extra care to ensure proper overlaps. The flight plan set the multirotor 100m out to sea at a height level with the top of the island and looking back towards it, always focusing on a central point (Figure 4). A distance of 100 metres ensured the island was fully framed in one shot whilst maintaining the best possible ground sampling distance (GSD) of less than 4cm. To keep the UAS in sight and within 500m, both the camera operator and the pilot followed it on foot. The challenging weather conditions necessitated considerable testing to determine the correct height, shutter speeds and distances. The capturing of the oblique images required 15 flights. When weather conditions became more favourable a follow-up visit was arranged to capture vertical imagery with the senseFly eBee. To



▲ *Figure 3, Crisp, defined building model (right) taken with a Sony A7r camera compared to the Canon on the eBee.*

▲ *Figure 4, Diagram showing the oblique images captured.*

ensure maximum coverage and overlap, the flights were conducted in two perpendicular directions; the waypoint abilities made flying much simpler compared to the multirotor. Due to the steep cliffs and rugged ground, it took a full day to lay out the ground control points (GCPs). Removable markers were used to leave no trace of the survey afterwards.

cloud is challenging; earlier experiments with 3D printing showed that photogrammetrically created meshes need to be cleaned as they are full of small spikes, tunnels, holes and non-manifold faces and intersecting polygons. Tests were carried out with three meshes of varying densities with high and low resolution textures. The full resolution version with around 42 million faces proved too difficult to work with. The best mesh was the medium one with around 15 million faces.

PHOTOGRAMMETRICALLY CREATED MESHES NEED TO BE CLEANED AS THEY ARE FULL OF SMALL SPIKES, TUNNELS, HOLES AND INTERSECTING POLYGONS

Figure 5 shows the 25 GCPs distributed over the area. They were measured with an accuracy of 1cm in all three dimensions.

PROCESSING

The data was processed using Agisoft Photoscan and resulted in a root mean square error (RMSE) of less than 5cm for the x, y and z coordinates. The point cloud contained 42 million points. Creating a printed 3D model from such a large point

ACKNOWLEDGEMENTS

Thanks go to English Heritage for commissioning the work, Paul Bryan of the Historic England Remote Sensing Team and Jon Bedford of the Heritage Protection Department.

▲ *Figure 5, Flight paths of the multirotor for capturing oblique imagery and ground control points.*

ANDREW BLOGG

Following an MSc in GIS, Andrew Blogg started his career as a GIS professional and subsequently explored the opportunities of UAS technology for GIS use. He started one of the world's first UAS mapping companies and is now director of Future Aerial Innovations.

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GEOSLAM

A Revolution in Handheld Mobile Mapping

GeoSLAM is a UK-based company with a global reputation for developing game-changing survey solutions. From its Nottingham headquarters, GeoSLAM has pioneered the development and manufacture of handheld indoor 3D mobile mapping systems such as the award-winning ZEB1 and newly released ZEB-REVO. Utilising revolutionary simultaneous localisation and mapping (SLAM) technology, GeoSLAM's solutions offer a cost-effective alternative for rapid mapping of enclosed environments without the need for GPS. GeoSLAM strives to create solutions which are fast, accurate, proven and efficient, for a diverse range of applications including measured building surveys and real estate valuations, mine and cave mapping, forestry scanning and crime scene reconstruction.

▲ *Mobile mapping made easy with the handheld ZEB-REVO.*

Every month ***GIM International*** invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.

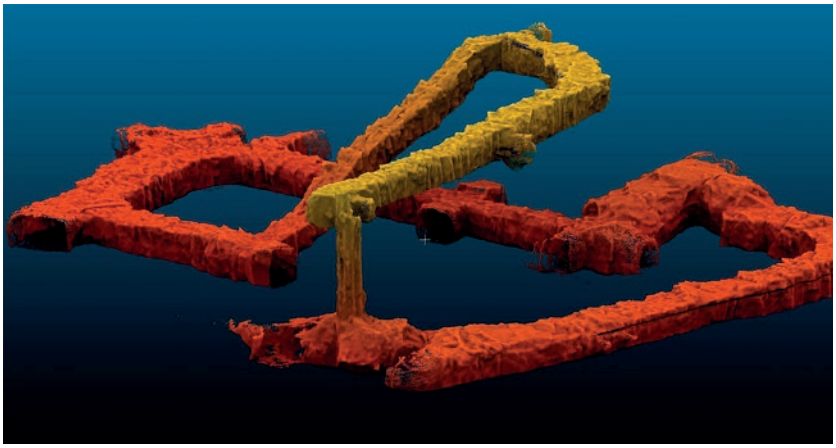
GeoSLAM was founded in 2012 as a joint venture between Australia's national science agency and the inventor of Wi-Fi (CSIRO) and 3D Laser Mapping (a leading global provider of 3D Lidar solutions). Initially starting out as a manufacturer and developer of the ZEB1 handheld laser scanner, the company has grown rapidly in both range and scope, now incorporating a global network of distributors serving 28 countries across six continents. It has a firm commitment to continuous innovation and making disruptive technology accessible to all. GeoSLAM has recently launched its latest generation of handheld indoor mapper (the ZEB-REVO) plus a desktop version of its hugely successful cloud-based automatic SLAM registration software.

Founder and board member Graham Hunter describes the company's beginnings: "GeoSLAM was born out of the partnership between CSIRO and 3DLM – a relationship that continues to this day. We identified a gap in the market for a rapid, handheld scanner that would complement, not replace, existing surveying tools. We are proud of our unique products and our customer-focused approach to applying the latest technology to solve real world problems."

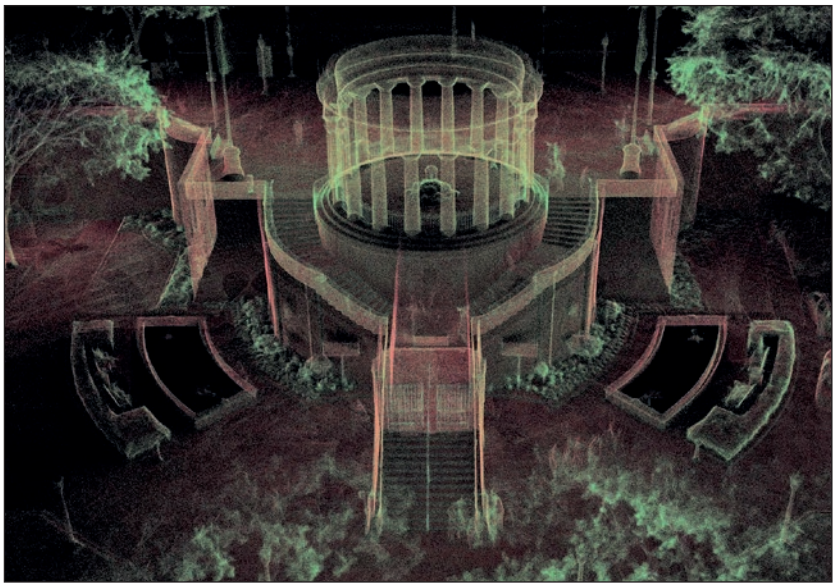
DISRUPTING THE MARKET

GeoSLAM prides itself on being unique in the surveying solutions industry. A fusion of cutting-edge SLAM technology, a small and dedicated workforce and a strong brand image set the company apart from the crowd. This filters through to the products themselves – whether it be the nodding ZEB1 or the rotating ZEB-REVO, GeoSLAM's products are simple, user-friendly and effective. The product range was developed by a desire to meet a need in the market – namely, for a fast, highly mobile, multi-level laser scanner that could be used by anybody.

The beauty is in the simplicity; both scanner units are designed with simple 'on/off' functionality, after which they are simply picked up to begin a scan. With the battery and data logger safely stowed in the backpack, the user is free to capture data



▲ *Underground mine mapping at the Camborne School of Mines, UK.*



▲ *3D point cloud of the ANZAC Square memorial, Brisbane, Australia, captured with the ZEB1.*

across a range of environments and a multitude of levels. With an indoor range of 30m and a requirement to conduct just one closed loop, data is captured in a fraction of the time of traditional survey methods. COWI, an international multidiscipline consultancy firm, is one of GeoSLAM's largest clients and has been a ZEB1 user for over two years. Morten Thoft, chief specialist mapping & surveyor officer at the firm, is delighted with the results: "GeoSLAM's solutions are changing the way we survey buildings – we can now measure building plans 10 times faster than we used to with total stations or traditional survey equipment."

In an extension to that simplicity, the company has developed two solutions for data registration to suit the varied needs of its clients: cloud processing and desktop processing software. Cloud processing uses a simple uploader and a 'drag and drop' functionality to enable users to load their data to GeoSLAM's cloud. Once uploaded and automatically registered, clients purchase their data using 'GeoSLAM credit cubes', a simple payment method which ensures they only pay for the area they move through. Further options allow users to 'flag' datasets with errors or to share data with colleagues. This approach allows users to reduce initial capital expenditures and spread the cost on a project-by-project basis. Desktop processing software is the alternative to the cloud. For a one-off upfront fee, users process their data locally, removing the need for an internet connection and providing an on-site visual of the data collected. This option allows data to be processed 'in the field', making it ideal for caving, mining and forestry applications.

GLOBAL REACH

The versatility of the ZEB1 scanner has attracted a wide variety of end users – currently numbering several hundred across the globe and ranging from property management companies, mining corporations, surveyors and higher-education establishments. As a customer-focused business, GeoSLAM strives to develop and maintain these relationships, offering truly global support through a dedicated distribution network. The company continues to strengthen its distribution base globally with recent appointments in North America, the Middle East, Asia and Europe.

THE FUTURE

As any technology company knows, standing still is simply not an option. In such a rapidly growing, rapidly changing industry, companies need to demonstrate flexibility and to respond to new technological developments, changing client demands and new areas of application. 2016 is set to be a busy year for GeoSLAM. Following the launch of the ZEB-REVO in the first quarter, GeoSLAM will be hosting a Distributors' Forum in May as an opportunity for its network of resellers to come together and compare experiences of selling in widely divergent markets. Furthermore, the company expects to see continued significant growth and adoption of the technology in the measured building and BIM sectors, markets which are set to grow exponentially over the next few decades.

Further down the line, the company will continue to work closely with CSIRO in developing the next stage of indoor mapping utilising real-time data capture and processing. With the increasing threat of terrorism and shifting geopolitics, security concerns and contingency planning are increasingly likely to come to the fore. ◀

▲ *Scan to BIM – creating accurate 2D floor plans from collected ZEB data.*

More information
www.geoslam.com

The GLTN Professional Cluster

More than 70 partners cooperate within the Global Land Tool Network (GLTN), and these partners are organised in clusters. There is 'Bilateral Organisations' cluster which integrates many ministries and organisations for development cooperation, and also includes the Bill & Melinda Gates Foundation. The 'International Training/Research Institutions' cluster facilitates cooperation between close to 30 universities and networks/groups of universities. Furthermore there are clusters for 'Multilateral Organisations' (like UN bodies) and 'Rural/ Urban International Civil Societies'. FIG is a member of the 'International Professional Bodies' cluster together with the Arab Union of Surveyors, the Commonwealth Association of Surveying and Land Economy, the Federation des Geometres Francophones, the International Union for Land Value Taxation and Free Trade, the International Union of Notaries, the Open Source Geospatial Foundation and the Royal Institution of Chartered Surveyors. National mapping and cadastral organisations are also members of this cluster, including Kadaster International (Netherlands), the Korea Land and Geospatial InformatiX Corporation, Lantmateriet (the National Land Survey of Sweden), Statens Kartverk (the Norwegian Mapping Authority, Cadastre and Land Registry) and the Regional Centre for Mapping of Resources for Development in East Africa.

FIG President Prof Chryssy Potsiou was elected as cluster representative to GLTN's International Advisory Board. In close cooperation with the cluster members, a work plan has been prepared for the next two years. This includes an overview of activities, results and planning with a focus on innovative approaches in land administration such as fit-for-purpose (FFP) land administration and the Social Tenure Domain Model (STDM).
Many people around the world do not have formally recognised, identified and documented land rights. The fit-for-purpose land administration approach provides a new, innovative and pragmatic solution to land administration. The work plan includes the organisation of an event on building developing infrastructure and services for imagery-based land administration, with particular attention paid to the requirements and the options for business models.
This will provide an insight into the topic for industry.

Further areas of attention within the work plan are:

- Dissemination of GLTN tools with stakeholders involved in challenges related to land rights of immigrants, refugees and displaced persons
- Awareness and mindset change – experience and capacity development through the STDM in order to increase understanding of this approach amongst GLTN partners
- Dissemination of knowledge on the fit-for-purpose approach for land administration, investigation of potential feedback on recommendations, development of an outreach strategy and a roadmap to implementation
- Design and development of an online version of the STDM. ◂

More information
www.fig.net

GSDI Members Receive Free Training in Asia and GSDI 15 World Conference Preparation Underway

The GSDI Association's Capacity Building Project is providing a free training opportunity for candidates from Africa, Latin America and the Asia Pacific region to attend the International Center for Land Policy Studies and Training (ICLPST) seminar on geographical information systems and land management in Taipei, Taiwan (Republic of China). The training seminar is being held from 2-15 March 2016.

The 2016 seminar is the fifth annual session to be offered by ICLPST since 2012, during which time 17 GSDI members have benefited from this important training. Each candidate had to satisfy specific requirements and the applications were vetted by a committee made up of GSDI officers and members. The training opportunity is overseen by the GSDI Association's Mr Jeremy Shen, deputy director, individual members.

After reviewing 33 applications from the members of GSDI, the five selected participants for the 2016 ICLPST seminar on geographical information systems and land management were:

- Ms Meron Kinfemichael Teklie of Ethiopia
- Mr Ram Kumar Sapkota of Nepal
- Mr Laxmi Prasad Sharma of India
- Mr Lekha Nath Daha of Nepal
- Ms Leidy Johana Rico Trujilloof of Colombia

All expenses are being paid for by the government of Taiwan. For more information on past training sessions, please visit http://gsdiassociation.org/index.php/publications/workshops.html. ◂

▲ *The Taiwan national seminar on 'Smart National Territory and the TGOS' was held in November 2015.*

Also in Taiwan, GSDI President David Coleman and Secretary-General Mr Roger Longhorn were guest keynote speakers at the Taiwan national seminar on 'Smart National Territory and the Taiwan Geospatial One-stop Shop (TGOS)' in November 2015. Dr Coleman's presentation was on 'Ethical Concerns over Personal Spatial Data Infrastructures in a Smart National Territory' and Mr Longhorn's presentation was on 'Crowdsourcing in the Smart Environment'. These are also some of the themes for the GSDI 15 World Conference, to be held from 29 November to 2 December 2016 in Taipei at the Taipei Nangang Exhibition Center, based on the overall theme of 'Spatial Enablement in the Smart Homeland'. Check out the conference website at http://gsdi15.org.tw/ for more information and to register. Abstracts are due on 1 April 2016.

Learn more about the GSDI Association and how to participate at gsdiassociation.org

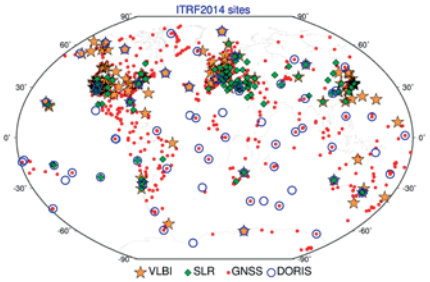
More information
www.gsdi.org

New Version of ITRF Released

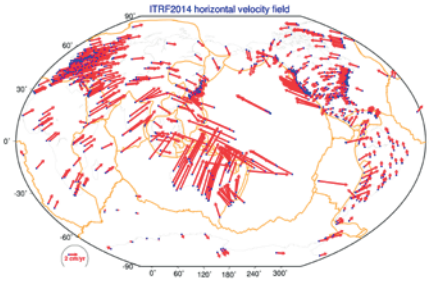
The new version of the International Terrestrial Reference Frame (ITRF) is one of the most significant of the IAG's products, utilising over 20 years of archived measurements from four space geodetic techniques. As recognised by the United Nations General Assembly resolution on the Global Geodetic Reference Frame for Sustainable Development (www.unggrf.org), the ITRF is the fundamental datum for surveying, positioning, mapping, satellite orbit determination and many Earth science applications. ITRF2014 was released on 21 January 2016 and is an update to the ITRF2008 reference frame used hitherto. The ITRF is used by the international geodetic community, at the global and regional levels, as the most accurate terrestrial reference frame available today. Many countries adopt ITRF as the foundation for their national datum.

Developed and maintained by the International Earth Rotation and Reference Systems Service (IERS), the ITRF is an IAG service dating back over 30 years. Its construction is based on a rigorous combination of geodetic products (temporal station coordinates and Earth orientation parameters or EOPs) provided by the main four space geodetic techniques through their co-located measuring instruments at a certain number of core sites. The space geodetic techniques that provide measurements for the computation of the ITRF include the global navigation satellite systems (GNSS), satellite laser ranging (SLR), very long baseline interferometry (VLBI), and Doppler orbitography radio positioning integrated by satellite (DORIS). These space geodetic techniques are organised as scientific services under the umbrella of the IAG: the International GNSS Service (IGS), the International VLBI Service (IVS), the International Laser Ranging Service (ILRS) and the International DORIS Service (IDS).

The ITRF2014 solution includes 1,499 stations located at 975 sites, about 10% of which stations are co-located with two, three or four distinct space geodetic instruments as illustrated in the figure below. The ITRF2014 input data comprises: (1) the IAG technique service solutions provided in the form of daily or weekly time series of station positions and daily EOPs (Polar Motion from satellite techniques and VLBI, and Universal Time and Length of Day from VLBI only), as detailed in the table below, and (2) 239 local tie vectors provided by the owners of the co-located instruments, in 139 SINEX files with full variance-covariance information.



▲ *ITRF2014 sites.*



▲ *ITRF2014 horizontal velocity field.*

Service/Technique	Number of Solutions	Time span
IGS/GNSS/GPS	7,714 daily	1994.0–2015.1
IVS/VLBI	5,328 daily	1980.0–2015.0
ILRS/SLR	244 fortnightly	
1,147 weekly	1980.0–1993.0	
1993.0–2015.0		
IDS/DORIS	1,140 weekly	1993.0–2015.0

Summary of ITRF2014 space geodesy input data.

The Earth is deforming due to a number geophysical phenomena, such as tectonic plate motion, earthquakes and loading effects generated by the atmosphere, ocean circulation and terrestrial hydrology. While tectonic plate motion will be an additional product of ITRF2014 that is to be released soon, post-seismic deformation and loading effects have to be considered during the ITRF2014 processing in order to improve the accuracy and precision of the frame. Two innovations were introduced in the ITRF2014 processing, namely:

- To account for the loading seasonal effects, annual and semi-annual terms were estimated using a sinusoidal function, for stations with sufficient time spans of the four techniques during the stacking processes of the corresponding time series.
- Post-seismic deformation (PSD) models, using logarithmic and/or exponential functions, were determined by fitting GNSS/GPS data at major GNSS/GPS earthquake sites. The PSD models were then applied to the three other techniques at earthquake co-location sites.

The main benefit of estimating seasonal signals and post-seismic deformations is to be able to infer a robust and accurate velocity field of the ITRF2014 sites, as illustrated by the figure below.

The production of ITRF2014 has been a massive computational effort by all four space geodetic services, coordinated by IERS. ITRF2014 is now ready for adoption by the wider geodetic and geospatial communities.

Zuheir Altamimi, IGN France,
IAG vice-president

More information
www.iag-aig.org

Indian Tonic

ICA's engagement with cartography on the Indian subcontinent started many years ago: the 4th International Cartographic Conference and 3rd General Assembly of ICA were held in Delhi in 1968. India has been connected with ICA for decades, particularly through its highly regarded governmental mapping agencies: the Survey of India, the National Hydrographic Office and the National Atlas & Thematic Mapping Organisation.

India's national organisation for cartography, the Indian National Cartographic Association (INCA), was founded on 7 August 1979 in Hyderabad and has evolved into one of the biggest organisations of its kind in the world, with nearly 3,000 life members and many other ordinary members. Membership also includes commercial and governmental agencies which maintain the long tradition of cartographic expertise on the subcontinent. The Association organises a national annual conference in India and operates regional branches in Ahmedabad (Gujarat), Bangalore (Karnataka), Bhubaneswar (Odisha), Chandigarh (Punjab and Haryana), Chennai (Tamil Nadu), Dehradun (Uttarakhand), Delhi, Hyderabad (Andhra Pradesh), Indore (Madhya Pradesh), Jodhpur (Rajasthan), Kolkata (West Bengal), Mumbai (Maharashtra), Patna (Bihar), Shillong (North East) and Thiruvananthapuram (Kerala). It also promotes its useful website (http://www.incaindia.org/), conducts an annual map quiz programme for schoolchildren and publishes the journal Indian Cartographer, a compilation of technical papers presented at the annual conferences.

The 35th Annual Congress of INCA took place in New Delhi from 15-17 December 2015. Under the main theme of 'Spatial Governance for Development, Planning Smart Cities and Disaster Management', this busy three-day event offered many parallel sessions, with all presentations being given in English. Plenary lectures were also held, including the Todar Mal Memorial Lecture (by Laszlo Zentai, ICA secretary-general) and the S.P. Chatterjee Memorial Lecture (by Prithvish Nag, former surveyor general of India, former INCA president and currently vice-chancellor of Mahatma Gandhi Kashi Academy, Varanasi). A total of 188 papers were selected for oral and poster presentation.

Further notable activity in India is the ICA-supported Geo4All initiative managed through OSGeo. The local OSGeo chapter in India (http://wiki.osgeo.org/wiki/India) has encouraged establishment of ICA-OSGeo-ISPRS labs in Ahmedabad and Hyderabad for promotion of research and teaching in open-source mapping.

The ICA secretary-general (right) meets with (left to right) Shri A. K. Singh (INCA secretary-general), Anuradha Banerjee (outgoing INCA president), Shri Rajendra Mani Tripathi (surveyor general of India) and Amod Srivastava (Indian delegate to ICA, 2015).

More information
ITRF2014 http://itrf.ign.fr/ITRF_solutions/2014/
IERS http://www.iers.org
IGS http://igs.org/
IVS http://ivscc.gsfc.nasa.gov
ILRS http://ilrs.gsfc.nasa.gov
IDS http://ids.cls.fr
www.icaci.org

Geospatial Data and Information to Support the Sustainable Development Goals

Last September, the UN adopted the 2030 Agenda for Sustainable Development. It comprises 17 new Sustainable Development Goals (SDGs), which will guide policy and funding for the next 15 years.

The UN Statistical Commission is developing indicators for the SDGs and the final recommendations are expected by March 2016. Such indicators will serve as a management tool for countries to develop implementation strategies. They will also serve to measure progress towards sustainable development.

DATA TO DERIVE INDICATORS FOR THE SDGS

The main challenge is to collect all the necessary data and to harmonise it in order to combine it and use it to derive the different indicators. These different data challenges open up a wide range of opportunities for remote sensing and photogrammetry: how can all sources of data (e.g. Earth observation (EO) data with socio-economic data) be combined and how can useful information that matches the indicators be derived?

The UN also identified a critical need to protect our ecosystems for all societies and our children. This includes the need to "address climate change, halt loss of biodiversity, address desertification and unsustainable land use, protect wildlife, safeguard forests and mountains, reduce disaster risk and build resiliencies, protect our oceans, seas, rivers and atmosphere, promote sustainable agriculture, fisheries and food systems; foster sustainable management of water resources and of waste and chemicals; foster renewable and more efficient energy; advance resilient infrastructure; and achieve sustainable management of marine and terrestrial ecosystems and land use." Consequently comprehensive, coordinated and sustained observations of the Earth, acquired by satellites, ground and/or marine-based systems and airborne platforms, are essential for monitoring the state of the planet, increasing understanding of Earth processes and enhancing predictability of Earth system behaviour. Earth observations contribute to reinforcing coherence among these international instruments and provide the "credible data and evidence" to enable nations to make decisions in all societal areas and to monitor performance towards achieving the goals and targets of the Development Agenda.

GLOBLAND30

For example, the National Administration of Surveying, Mapping and Geoinformation of China (NASG) recently provided the public with free access to GlobLand30, the world's first global land cover dataset at 30m resolution. This dataset provides information about changes for the years 2000 and 2010. Such data is useful for governments to better understand their land use changes and, based on these changes, to derive their policies for sustainability. To elaborate on datasets like GlobLand30 it is necessary to semi-automatically process large amounts of satellite data. There is therefore a need to develop methods to process large amounts of EO data, to define worldwide standards for data and associated harmonisation. This represents a wide future for ISPRS.

Mario Hernandez – Future Earth Scientific Engagement Committee

More information
www.isprs.org

Sustainable Development Goals.

MARCH

AUVSI'S UNMANNED SYSTEMS EUROPE
Brussels, Belgium
from 22-23 March
For more information:
www.auvsi.org/unmannedsystemseurope

AAG ANNUAL MEETING
San Francisco, CA, USA
from 29 March-02 April
For more information:
W: www.aag.org/cs/annualmeeting

APRIL

RSCY2016
Paphos, Cyprus
from 4-8 April
For more information:
www.cyprusremotesensing.com/rscy2016/

SPAR INTERNATIONAL 2016
Houston, TX, USA
from 11-16 April
For more information:
www.sparpointgroup.com/international

INTEREXPO GEO-SIBERIA
Novosibirsk, Russia
from 20-22 April
For more information:
W: www.expo-geo.ru

GISTAM 2016
Rome, Italy
from 26-27 April
For more information:
E: gistam.secretariat@insticc.org
W: www.gistam.org

MAY

FIG WORKING WEEK 2016
Christchurch, New Zealand
from 02-06 May
For more information:
E: nzis@surveyors.org.nz
W: www.fig.net/fig2016

GEO BUSINESS 2016
London, UK
from 24-25 May
For more information:
E: info@geobusinessshow.com
W: www.geobusinessshow.com

ESRI USER CONFERENCE
San Diego, CA, USA
from 27 June - 1 July
For more information:
www.esri.com

JUNE

NORDIC UAS EVENT
Odense, Denmark
from 1-3 June
For more information:
www.nordicuasevent.com

HXGN LIVE
Anaheim, CA, USA
from 13-16 June
For more information:
hxgnlive.com

JULY

XXIII ISPRS CONGRESS
Prague, Czech Republic
from 12-19 July
For more information:
E: info@isprs2016-prague.com
W: www.isprs2016-prague.com

SEPTEMBER

GEOBIA
Enschede, The Netherlands
from 14-16 Serptember
For more information:
W: www.geobia2016.com

OCTOBER

INTERGEO
Hamburg, Germany
from 11-13 October
Fore more information:
W: www.intergeo.de

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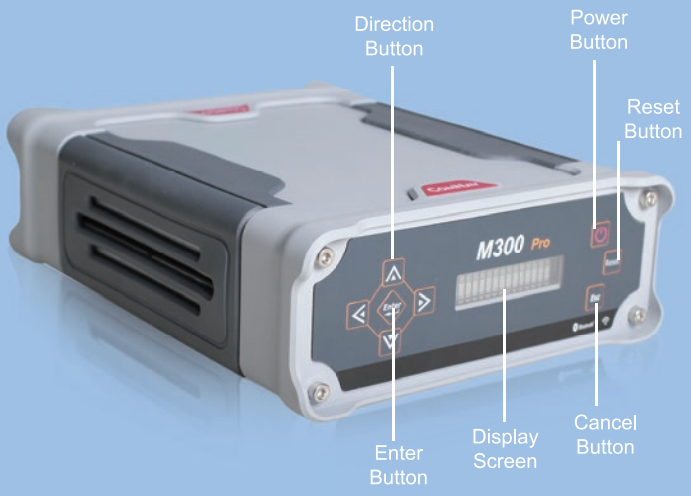

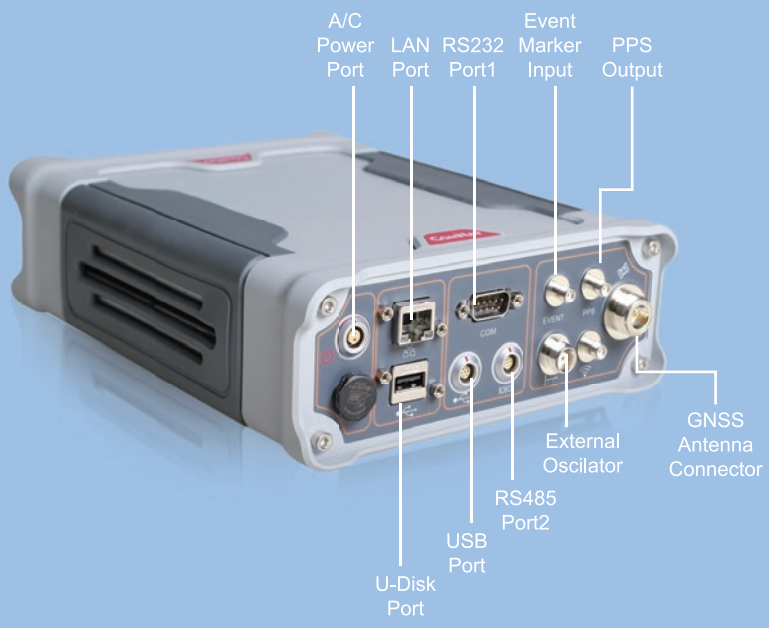

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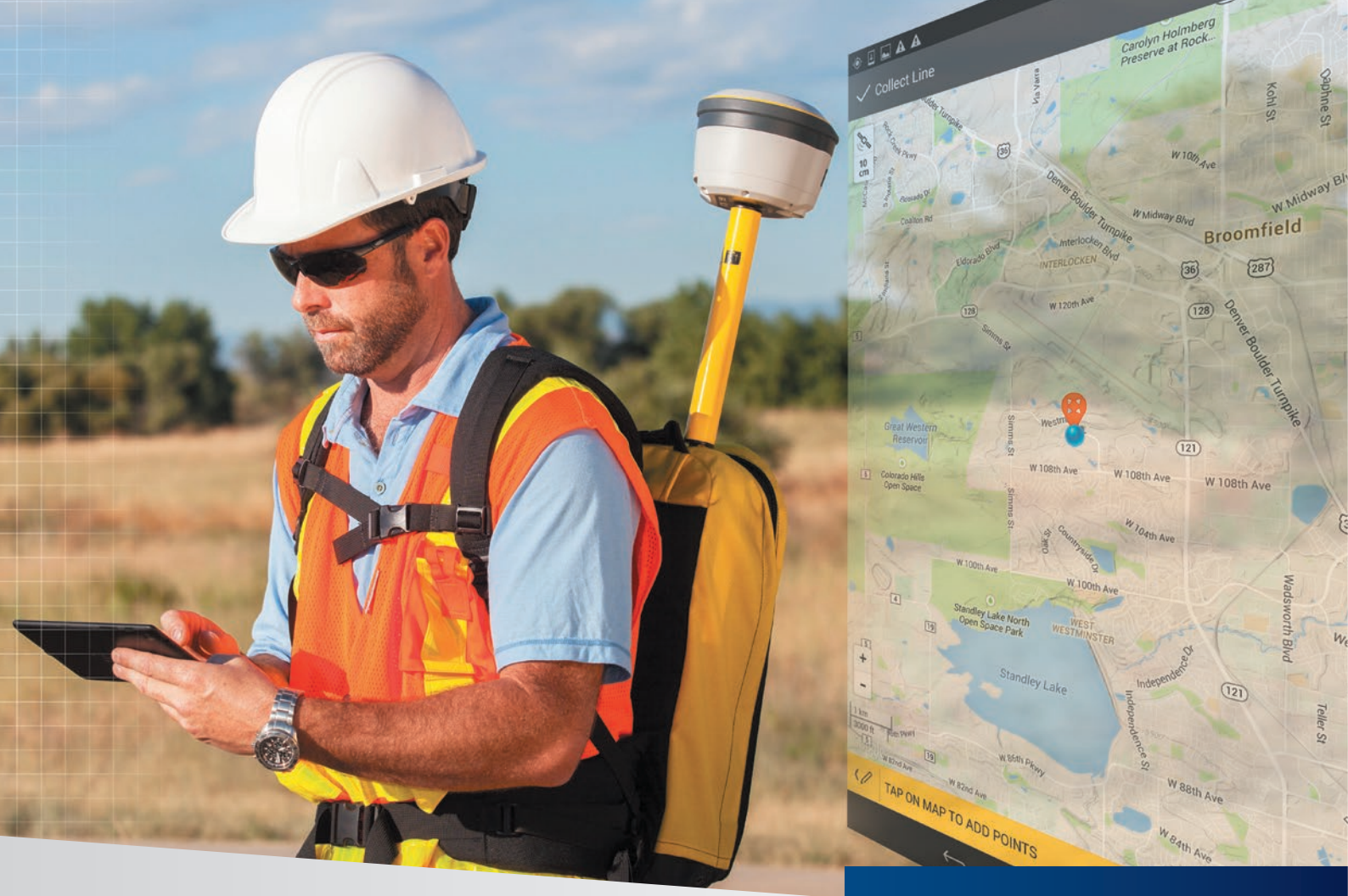

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