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GiS PROFESSIONAL

GiS Professional is published bi-monthly by Geomares Publishing UK Ltd and endorsed by the UK's Association for Geographical Information. Our mission is to help grow the business for the whole GIS community by providing an effective, reliable and timely medium for news, information and comment.

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COVER STORY

Various symbols representing the different fields in GIS. Image credits to Niall Conway.

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BY NIALL CONWAY

GIS - A New Direction?

Valued reader,

It is with some sadness that I must inform you that this edition will be the final printed edition of GIS Professional. The difficult decision follows careful consideration by the publication's owners who feel that the geospatial industry requires a new fresh approach to content and marketing.

As maps have become more mainstream and accessible, GIS has become a less easy to define field to explain to other non-GIS folk and to, therefore, promote as the discipline which it once was. At the same time however, locational intelligence has become of new frontier of opportunity for many industries and the geospatial knowledge and skills which our industry possesses has almost limitless potential. I therefore believe that GIS Professional is stepping aside in order to allow great new things to happen for the industry.

In terms of this final edition, we have, as always, some excellent content. This includes regular news and updates from across the increasingly satellite and data dominated geospatial world. Neil Brammall of Utility Survey Exchange shares his experience of participating in the recent NWG Innovation Festival, David Green of University of Aberdeen provides an interesting GIS-focused look on the Toll Road network in Scotland, while San Francisco's Mike Foster explains how the world has entered a 'Golden Age of Mapping' wherein new digital skills have become an essential prerequisite. In addition, we also have insights from our regular contributors Abigail Page and Adena Schutzberg.

To conclude, I would like to say that I have thoroughly enjoyed my time as editor of this well-respected publication and have endeavoured to bring new writers, new ideas and a new feel to the magazine. I would also like to thank our many readers, contributors, advertisers, and supporters, such as the AGI. Finally, a special thanks to GIS Professional's parent company, Geomares, for giving me the opportunity to work in this position. I strongly encourage you to follow their other excellent publications such as GIM International, Hydro International, Products4Engineers, and Geomatics World and/or to explore their unique marketing services.

We live in a very different world from when GIS Professional first began, one where change has become norm. However, GIS is more than just software, just as it is much more than any one publication. Rather, the discipline and its community represent a unique holistic way of thinking about the world and its challenges. In today's age especially, this way of thinking must be both protected and nurtured. If you would like to keep in touch then please connect with me via LinkedIn.

Sincerely, Niall Conway, Editor

Niall Conway,
Editor of GIS Professional.

A NOTE FROM THE PUBLISHER

Dear reader,

It is with sadness that we have to announce that this is the last printed issue of GIS Professional – the online platform will continue as normal. The printed version has been around for exactly 14 years, starting with the November/December 2004 issue, and now the last being October 2018 – a great achievement in this growing digital age! GIS Professional established itself as a leading magazine in the field of GIS and all its applications. But times are changing and it's getting more and more difficult to keep printed magazines afloat.

I want to thank all who worked on and supported this great magazine over the years. Of that long list, I want to name a few. First, our current editor Niall Conway, who always had insightful views and opinions on the field of GIS. I wish him all the best for the future and have no doubt he'll put his skills to good use in another place to further strengthen the role of GIS. Secondly, Jason Poole, our content manager, who carefully put together and sub-edited the magazines for the last few years; and lastly, advertising manager Sharon Robson, who has been instrumental in making the connection between the GIS manufacturers and its users. I definitely should not forget AGI who has been an avid supporter of the magazine and a pillar underneath it throughout the years.

I would like to invite you all to keep track of our website www.gis-professional.com to keep up to date on all news and read up on developments in GIS and adjacent technologies. See you there!

Durk Haarsma, publisher, GIS Professional.

UK Geography Student Numbers Get Boost

The geospatial industry is likely to benefit from the fresh wave of interest in the subject of geography. According to reports, A-level and GCSE geography entries in England are on the rise - growing by 36% and 21% respectively between 2012-2017. The increased take-up in the subject is quite possibly driven by the introduction of the English baccalaureate, a government measure that recognises teenagers who undertake subjects such as geography, maths, science, English, or history and a language at GCSE level.

UK-led EO Consortium Focuses on HD Imagery and Video Capture

Earth-i has announced that a consortium it is leading has received a grant from the Centre for Earth Observation Instrumentation (CEOI), funded by the UK Space Agency. The project will be used to develop a number of new Earth Observation technologies that will enable processes such as the enhancement of image resolution, cloud-detection, change detection and video compression, to take place onboard a small satellite rather than on the ground. This is likely to accelerate the delivery of high-quality images, video and information rich analytics to end-users.

Onboard cloud detection will make the tasking of satellites more efficient and increase the probability of capturing a usable and useful image or video. To achieve these goals, 'Project OVERPaSS' will implement, test and demonstrate very high-resolution optical image analysis techniques, involving both new software. It will also make use of dedicated hardware installed onboard small satellites to radically increase their ability to process data in space. Project OVERPaSS is likely to determine the extent to which these capabilities could be routinely deployed onboard British optical imaging satellites in the future.

Bing Maps Routing API Optimises Deliveries

Microsoft has announced an improved Bing Maps routing API that uses algorithmic path modelling to save on route time and distance. The system automatically reorders stops (up to a total of 25) and uses actual road distance for optimisation.

The algorithm assesses how geographic constraints like rivers, lakes and divided highways can make a difference to the actual distance travelled - as well as delays due to road restrictions and traffic congestion. The Bing Maps update is free of charge and API calls are one billable transaction. It is available in the Bing Maps REST API, while JavaScript controls are due for release later this year.

Chinese Hongyan Constellation: A Rival to GPS Dominance?

China has announced its plans to launch a 300 satellite array known as the Hongyan constellation, to both rival and become independent of America's GPS. The first of the satellites is due for launch later this year.

China Aerospace Science and Technology Corporation (CASC) intends to provide worldwide communication services at a much-reduced cost reduction. The plan is to replace current ground-based networks, meaning that a mobile phone could be connected everywhere on the planet - either in a remote desert or at sea.

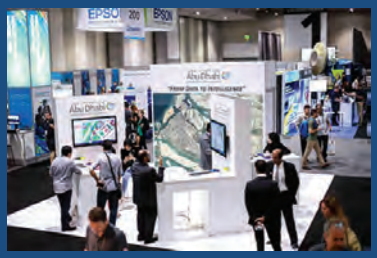
China is already developing the low-orbit BeiDou Navigation Satellite System (BDS) which will be used for military and emergency management purposes. The advantage of these satellites compared to 'synchronous orbit satellites' (which are 36,000km above the equator), is that they will have stronger signals and a shorter signal delay. Low earth orbit is between 160 and 800km in altitude - meaning that objects take about 90mins to orbit the earth. However,

coverage of a single low-orbit satellite is limited, requiring more satellites to cover wider areas.

Google and United Nations use EO Imagery and AI

Google and the U.N. Environment Program (UNEP) is combining three decades worth of raw satellite imagery and data with powerful geospatial and AI tools in order to produce maps which show where water has disappeared due to climate change and urbanisation. This fresh-water ecosystem mapping effort is intended to help countries manage this change and to mitigate further losses. The online mapping platform allows users to compare past and present data in order to help distinguish between changes which are seasonal and those that may be caused by climate change and man-made activity. This will be especially relevant to authorities who need to monitor the inland lakes and rivers which are sensitive to evaporation, as well as to cross-border authorities which have a shared interest in strategies which help to protect valuable water sources.

Abu Dhabi to Set-up Smart Geospatial Centre



The Abu Dhabi Smart Solutions and Services Authority (ADSSSA) has announced the Smart Geospatial Contact Centre, a first-of-its-kind government level project being implemented in cooperation with Esri, a global leader in GIS software.

The Smart Geospatial Contact Centre is based on the use of machine learning technology, Big Data and AI, which employs state-of-the-art GIS technologies and mechanisms aimed at modernising the operations of the Abu Dhabi Government Contact Centre.

Under the partnership, the Abu Dhabi Government will be the first in the world to provide a comprehensive platform that serves the geospatial infrastructure that is able to integrate data from all government entities in Abu Dhabi, and handle a large amount of data accurately, thus contributing to provide services and projects efficiently.

Ursa Receives Major Investment

Geospatial analytics start-up Ursa, which builds business intelligence products based on satellite radar imagery, has announced that it has raised US$5.7 million in funding. The investment, by RRE Ventures. Paladin Capital, and S&P Global, comes on top of a US$7 million investment which was raised recently.

Ursa builds data analytics products based on satellite images using synthetic aperture radar (SAR), a technology which captures information that traditional satellite imagery are unable to. Ursa's most popular SAR-based output product is its weekly report on global crude oil supplying over 300 different oil terminals. However, the company has expressed its vision to use this rich data for the purpose of "building infrastructure to monitor all supply chains."

PSMA and DigitalGlobe Digitise Australia

Authorities have for the first time captured, using a combination of high-resolution satellite imagery, AI and crowd-sourcing data, the location of almost every tree and building in Australia. Geoscape, an analytics-ready data set, along with earth imagery company DigitalGlobe used 200 terabytes of satellite imagery covering the 7.6 million square kilometres continent in order to do so.

It is intended that the dataset will help users of the information to place citizens and activities in a locational context which could offer businesses a competitive advantage, as well as to increase efficiency, productivity and innovation. The digital representation of Australia's built environment, which will include 15 million buildings later this year, will, for example, allow authorities to identify solar panels and swimming pools in satellite imagery.

One innovative use of Geoscape is for the modelling and rollout of Wi-Fi and 5G telecommunications services, and for identifying building heights and surface feature trees that could impact the network. In addition, the rich data source can be used by companies for the purpose of producing 2D and 3D models of cities, including simulation and scenario-testing capabilities.

Scotland Hosts First Spaceport on British Soil

A'Mhoine Peninsula in Sutherland on the north coast of Scotland has been chosen by the UK Space Agency to become the UK's first spaceport. The area is deemed the most suitable place from which to launch rockets vertically (by as early as 2020s). The area was selected because of its remoteness and low population density - meaning that any launch failure will present a low risk to humans. The Highlands and Islands Enterprise has received £2.5m grant towards the development of the facility and will work closely with a consortium that includes the American aerospace giant Lockheed Martin.

Both plans represent a wider aim by the UK government to consolidate and develop the satellite research, development, manufacturing and application industry in the UK. The moves are also intended to support leading British companies such as Surrey Satellite Technology Limited (which works with companies such as Earth-i) and AAC Clyde Space, with the ability to launch satellites. Post-Brexit, this is considered to be a critical factor in helping Britain to develop its own self-sufficient space industry.

Galileo's Global Reach Expanded by Satellite Launch

In July, four more Galileo satellites were launched by Ariane 5. Their arrival in orbit brings the Galileo constellation to 26 satellites, extending the global coverage of the constellation. Ariane 5 flight VA244, operated by Arianespace under contract to ESA, carried Galileo satellites 23–26.

Paul Verhoef, ESA's Director of Navigation, said "Galileo has been providing initial services on a worldwide basis since 15 December 2016, and has more than 100 million users." More batches are expected for launch over the coming months.

African Scientists Access European Satellite Data for Free

African scientists will soon have access to a wealth of free earth observation data. As part of a new agreement between African Union's science and technology department and European Commission's Copernicus program, it is intended that the satellite imagery will be used to support sustainable policy-making and development. The Copernicus program currently generates up to 12 terabytes of earth observation data on a daily basis. The Copernicus portal provides access to three sets of satellite data, as well as a range of digital aerial photographs of land temperature, vegetation changes, sea topography, and weather patterns.

The deal represents a major step in European and African efforts to increase EO-focused collaboration in order to help improve agriculture, guard tropical forests from deforestation, forestall climate change, and improve disaster planning. Meanwhile, nations including Egypt, South Africa, Ethiopia, and Nigeria have all invested in their own space programs, while Kenya has partnered with Japan to deploy its own home-designed nano-satellite into space.

Accenture and Pitney Bowes Collaborate on Underwriting Tool

Accenture, the global management consulting and professional services firm, is collaborating with Pitney Bowes to rollout an intelligent cloud-based insurance underwriting tool called 'Property Evaluator'. The solution is intended to reduce the time an underwriter needs to triage a property risk and help the underwriter to identify key exposures which need to be addressed and priced. The tool brings together a range of spatial and non-spatial data on unique property hazards such as wildfires, floods, and earthquakes etc.

NASA Microsatellites Capable of Flood Detection

Credits: NASA/JPL/NIMA.

Analysis of data collected by the Cyclone Global Navigation Satellite System (CYGNSS), which were launched by NASA in 2016, presents a new opportunity for scientific analysis. It has been revealed that the onboard sensors are capable of seeing through clouds, rain and vegetation to see flooded landscapes which may be otherwise obscured. The satellites can help determine the wind speed of tropical cyclones and have the potential to increase data coverage of hurricanes and aid forecasts.

The satellites measure wind speed by determining how choppy or smooth the water is from a microwave signal bounced off the ocean surface. The CYGNSS data has so far been used to develop flood inundation maps of the Amazon River in Brazil, which overflows its banks seasonally, as well as of the post-Hurricane Harvey Texan coastline and the post-Hurricane Irma Cuban coastline.

UN and World Bank Launch Geospatial Guide

At the recent Eighth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) held in New York, the UN Statistics Division of the United Nations and World Bank launched a guide which is aimed at helping nations worldwide better manage geographical information data.

Entitled 'Integrated Geospatial Information Framework – A Strategic Guide to Develop and Strengthen National Geospatial Information Management', the document includes advice for countries on how to collect, access and use geospatial information. In particular, it is intended to help governments, especially in low- and middle-income countries, to develop tailored and effective national policies. These will include policies which support decision-makers in directing aid and development resources.

Scale Raises US$18M for Lidar Training

Scale has recently raised US$18m in Series B funding - bringing its total inward investment to date to US$22.7m. The company uses a combination of statistical and machine e-learning tools and technologies which enable businesses to turn raw information into human-labelled training data that powers their AI applications. This includes high-quality human task work, smart tools, statistical confidence checks and machine learning. The Scale API offers Semantic Segmentation, Image Annotation, and Sensor Fusion which are being used by autonomous vehicle companies. The company has now annotated more than 200,000 miles of data collected by self-driving cars.

WGIC Launched at UN-GGIM

Geospatial industry leaders from across the world recently came together to announce the formation of the World Geospatial Industry Council (WGIC). The announcement was made on 1 August 2018 at the 8th session of the UN-GGIM held in New York, by Jack Dangermond, Chairman of WGIC and Founder and President, Esri.

WGIC is co-founded by a group of 21 companies including AAM Group, AGI India, Autodesk, Bentley Systems, Cyient, Data World, DigitalGlobe, e-GEOS, Esri, FARO, Geospatial Media, GeoTech Vision, Ground Truth, Hexagon, IIC Technologies, Oracle, Riegl, Rolta Group, Trimble, TomTom, and Topcon.

WGIC aspires to be a collaborative platform for advancing the role of the geospatial industry and strengthening its contribution in the world economy and society. WGIC endeavours to facilitate the exchange of knowledge within the geospatial industry and co-create larger business opportunities for the geospatial industry. Further, with policy restraints limiting private sector participation and commercialisation, WGIC also seeks to raise awareness among policymakers and advocate for better environment and investments in the geospatial sector.

WGIC Chairman, Jack Dangermond, said "The WGIC will allow new kinds of partnerships to emerge, enabling companies to help each other, and also allow the geospatial industry to collectively work with big global initiatives such as World Bank and the UN. This will also enable our industry as a whole to have a collective opinion on emerging policies such as those on privacy or geospatial data restriction."

Australia - Transitioning to GDA2020

A recent event held by the Surveying and Spatial Sciences Institute in Brisbane, Australia, focused on some of the key challenges facing the country in terms of transitioning to the Geocentric Datum of Australia 2020 (GDA2020). This urgency is due to the fact that Australia is moving faster than any other continental tectonic plate on Earth. The cumulative effect of this continental drift means that there is now a difference of up to 1.7m when comparing certain GIS data with survey data collected in the field.

The SSSI session focused on helping the community to settle on a practical and manageable approach to transition the business systems that rely on geographic information from GDA94 to GDA2020.

Google User Locations Tracked Without Permission?

It has been suggested that Google is recording user locations even when they have asked them not to. It is expected that the issue could affect an estimated two billion Android and Apple devices. According to the report, which has been verified by researchers at Princeton University, user locations are recorded even when location history has been disabled. Data recorded includes snapshots of a users' location when they open the Maps app, link with automatic weather updates, as well as when they perform non-location type searches on the Google search engine.

The OSGeo Signs MoU with YouthMappers

The Open Source Geospatial Foundation (OSGeo) and YouthMappers have signed a Memorandum of Understanding to help advance the vision of linking research and educational activities on open geospatial technologies in universities around the world. The partnership encourages universities with open labs to establish YouthMappers chapters. It is intended that these chapters will expand student links with the Open Source geospatial community.

Esri Announces ArcGIS Indoors Mapping System

Esri has announced ArcGIS Indoors, a complete indoor mapping system. Scheduled for release in Q4 of 2018, the system will offer a floor-aware location platform providing maps, data and location information for indoor spaces. It is targeted for use in facilities, retail and commercial locations, airports, hospitals, event venues and universities, to analyse, optimise, locate, navigate, collaborate and share indoor information.
To be able to offer real-time indoor positioning and routing directions, the building in question needs to be equipped with location technology that connects to the phone where the app is running. Although this is not part of the ArcGIS Indoors system, it is a prerequisite for the system to work. Esri stated that it has used Apple's location technology for prototype versions of the system.

BY GEOFF ZEISS

Technical Advances Bring **Digital Twin** of Underground Infrastructure Closer

Mapping the underground is one of the major challenges in creating an infrastructure map at the municipal, regional, and national level, which is a key foundation for a national digital twin. Recent technical developments include: the ability to collect data at highway speeds that can be used to create a 3D model of underground infrastructure, software that can extract relevant 3D underground information from consumer digital photography, and video capture. Meanwhile, novel ways to share information about underground infrastructure, and progress on standards for sharing information about the subsurface are making mapping the underground increasingly feasible.

The uncertainty in the location of underground utilities costs the U.S. economy at least US$50 billion annually, plus 1,906 injuries and 421 deaths over the past 20 years. A leading cause of highway construction delays is missing or inaccurate information about the location of underground utilities. To address the risk of liabilities associated with unknown or inaccurately located underground utilities, contractors regularly increase bid costs by a minimum of 10-30%. Knowing where things are underground has become important enough that in several countries around the world (France, The Netherlands, Singapore, UK and USA), initiatives to create national digital twins of above and below-ground infrastructure are already underway.

A typical example of the impact of poor information about the location of underground utilities can be seen in the Sydney Light Rail Project which is a US$2.1 billion PPP project for a 12km light rail extension in Sydney, Australia to be completed by 2019. In preparation for construction, a year was allocated for identifying potentially conflicting utilities in the proposed right of way. About 500 subsurface utilities were identified and scheduled for relocation. During construction, a further 400 unmapped utility services were encountered. An economic impact study by an independent consulting firm estimated that the project could have been completed at least one and a half years sooner if a complete and reliable 3D map of underground infrastructure had been available at the project planning stage.

In the UK, about 4 million excavations are carried out every year on the country's road network to install or repair buried utility pipes and cables. Not knowing the location of buried assets causes practical problems that increase costs and delay projects - but more importantly, it increases the risk of injury for utility owners, contractors and road users. Research at the University of Birmingham has determined the direct costs of utility strikes in the UK range from

£300 to £2,800. Furthermore, the researchers found that the true costs, including indirect and social costs, associated with utility strikes is 29 times the direct cost. In the U.S. the Common Ground Alliance (CGA) reports that there were 390,366 documented underground utility hits in 2016. The average direct damage cost was found to be US$4,021. The CGA estimates conservatively that the direct cost to the U.S. Economy was US$1.5 billion. If the UK ratio is applicable to the US, it would indicate that the total estimated impact of unknown or poorly located underground infrastructure on the U.S. economy is at least US$50 billion.

University research has put a dollar figure on the benefits of accurate location data for underground utilities. In 2007, the Pennsylvania Department of Transport commissioned Pennsylvania State University to study the savings on ten randomly selected PennDOT projects. The study found a return on investment of US$21.00 saved for every US$1.00 spent on improving the quality level of subsurface utility information. In Europe, an economic analysis of a Milan pilot project to map all underground infrastructure using ground penetrating radar for the Expo Milan 2015 site found a return on investment of €16 for every euro invested in improving the reliability information of underground infrastructure.

... the project could have been completed one and a half years sooner if a 3D map of underground infrastructure had been available...

INVESTMENT IS KEY

The need for investment in infrastructure is steadily growing - with an estimated US$53 trillion investment required over the next 15 years (double this figure if the infrastructure is to be truly sustainable). Increasingly, infrastructure projects require private investment because governments simply have less and less money for capital projects. Private investment in infrastructure, which reached nearly US$80 billion in 2016, is unlike government investment, which is primarily focused at social benefits. Its requirement for financial returns drives productivity of construction, operations and maintenance which, in turn, subsequently drives more investment in technology.

Until recently, construction has been among the lowest industries with respect to investment in research and development, but there are signs that this is changing. In the last few years, the number of start-ups focussed on technological innovation in construction has risen dramatically. As evidence of increasing investment in the underground detection sector Hexagon, which has revenue of US$4 billion annually, acquired IDS (Ingegneria dei Sistemi) GeoRadar, an Italian company that has developed a towed multi-channel ground penetrating radar (GPR) array that can collect data on underground infrastructure at faster speeds than previously possible. Since then, Leica has released important enhancements to the software used to create 3D models of underground from the GPR scans and other information.

Bentley Geosystems, which earns about US$1 billion in annual revenue, has developed software specifically for managing underground infrastructure location information. Bentley Subsurface Utility Engineering (SUE) enables users to develop 3D subsurface utility models from 2D models, resolve subsurface utility clashes, and model, analyse, and design subsurface infrastructure networks.

In 2018, two technical advancements in detection were reported that bring the cost-effective mapping of underground infrastructure at the municipal, regional, and national level closer to reality. T2 Utility Engineers, based in Whitby, Ontario commercially use a IDS GeoRadar Stream EM multi-channel GPR array towed routinely at 10-12km/hr to capture subsurface data. In a separate initiative, a successful proof of concept has been reported by DGT Associates in Mississauga, Ontario in which data collected by a Siteco rig (combining a FARO mobile laser scanner, sensors and software GPR arrays) collected data simultaneously above and below ground at roadway speeds of 80-90km/hr.

To complement the advances in detection there are several initiatives to develop ways to share information about underground infrastructure that is captured during construction. The City of Chicago has launched a pilot to deploy a platform for collecting data and creating and sharing a 3D map of underground. In a similar vein, Bentley Systems has experimented with a system that equips excavation equipment with four inexpensive digital cameras that are used to collect images of underground infrastructure encountered during excavation. In the UK, Project Iceberg, a collaborative project between

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Ordnance Survey (OS), British Geological Survey, and Future Cities Catapult, has been created to better capture, collect and share data about underground assets and geological conditions, as well as to establish a way of sharing all this information among utility and energy companies, the transport sector, street works planners, building developers, and the construction industry.

Recent developments in standards reflect improvements in underground remote sensing technology. In France, the 2012 presidential decree defines three explicit levels of cartographic accuracy for underground structures: A = less than 40cm; B = 40cm to 1.5m, and C = greater than 1.5m. In the UK, the 2014 Publicly Available Specification (PAS) 128, developed under the auspices of the British Standards Institution (BSI) and sponsored by the Institution of Civil Engineers (ICE) and others, not only includes the A, B, C, D quality levels of the U.S. standard, but extends it with explicit precision levels B1 to B3. A process to revise PAS 128 to reflect newer technical developments has just been initiated. The Open Geospatial Consortium (OGC) has initiated a three-phase project to develop interoperability standards for underground infrastructure. The project is supported by the Fund for the City of New York, the National Center for Civic Innovation, the UK Ordnance Survey and other organisations.

Reflecting the growing public awareness about the importance of accurate location information about underground infrastructure, France embarked on a nationwide multi-billion euro project to improve the quality of the location information about national underground utility infrastructure. The presidential decree mandates that, by 2019, the location of 'critical underground infrastructure' (which does not include telecoms, sewers or water infrastructure) in urban areas will be mapped to 40cm or better. Furthermore by 2026, the location of the nation's infrastructure will be mapped to 40cm. The decree also specifies the liability for hitting underground infrastructure that shares the responsibility between the utility owner and the contractor depends on the precision of the information available about the utility.

The decree also specifies the liability for hitting underground infrastructure...

In the Netherlands, in 2015, the States General passed legislation mandating a "Key Registry for the Subsurface" or Basisregistratie Ondergrond (BRO). It requires that, beginning in 2018, whenever excavation is performed, information about subsurface must be reported to the Key Registry. This includes information about subsurface utilities and geology. The objective is to begin sharing the information that is routinely discovered during construction projects.

In Singapore, the Urban Redevelopment Authority is planning to have a master plan of Singapore's underground spaces ready by 2019. It will be released as part of the next Master Plan guiding Singapore's development in the medium term.

THE DIGITAL TWIN

As a result of the conjunction of the release of three UK government reports, Industrial Strategy Building A Britain For for the Future, Transforming Infrastructure Performance, and Data for the Public Good, the transformation in how infrastructure is built, managed and operated in the UK has made a national digital twin a key concept for the UK government. A national digital twin includes above and below ground assets. It is based on the foundation concept that a digital model is equally important as the physical assets.

In the U.S., an initiative has just been started to create a national infrastructure map which would include subsurface infrastructure. At a special summit in Arizona, leaders in public administration, infrastructure development, geography, GIS, and data integration/open data reviewed the current state of location-based information on national infrastructure (including underground). The aim was to examine efforts to integrate location based data systems across jurisdictions, to understand stakeholder communities perspectives, to identify strategies for more systematic access to data at the national scale, and to discuss the role of government to implement such strategies.

Taken together - the public awareness of the problem, the recent technical advancements in underground detection are making cost-efficient 3D mapping of the underground increasingly feasible, and the benefits of accurate 3D maps of underground infrastructure – have led to growing momentum to create a digital twin of the subsurface at the municipal, regional and national levels.

ABOUT THE AUTHOR
Geoff Zeiss is currently Principal at Between the Poles, a thought leadership consulting firm.

Is it Time for Slow Learning in GIS?

Everything is speeding up but I'm going to suggest slowing down. My guess it that the phrase 'slow learning' is new to many readers. Slow learning is a vision for less formulaic, less time-driven learning. It's self-directed (students select the topics to learn), long-lasting (more like lifelong learning than finishing a course, grade or degree), authentic (based on real world activities), and supports, and is supported by, a learning community. Slow learning joins other slow movements such as slow food, which aims "to prevent the disappearance of local food cultures and traditions, to counteract the rise of fast life…" and slow weights which suggests, instead of going to the gym and pumping iron for an hour, that individuals do a few exercises in a few sessions during their day.

I've seen what I'd describe as 'fast learning' taking hold in our industry. I see queries like "How can I learn python tomorrow?" on forums and e-mail lists. There's a proliferation of online on demand offerings to address such questions. I found a course 'Python for Geospatial' with just two hours of video, available any time you'd like to begin. I learned from a colleague that a student recently completed Esri's four week Do-It-Yourself Geo Apps course in two days. Institutions that offer GIS certificates are trying to out-market one another by offering the quickest time to completion - current offerings boast completion times in anywhere from two years to just a matter of months.

Fast learning's promised quick return on investment is perhaps its greatest potential benefit. But, it has a number of downsides. Fast learning, I'll posit, happens when there's a proverbial "gun to one's head." For example, you may have to learn to make a bivariate 3D map today because the boss wants one tomorrow. Learning under pressure, as every college student who had "crammed" can tell you, is stressful and boast little long term mastery. The pressure almost ensures that the student is not in a good headspace to learn. Elementary teachers know that calm, well rested, well-fed students can absorb new skills like a sponge, while the agitated, drowsy and hungry cannot. Fast learning forces an experience of the content that's high level and light at best. Fast learning is the highlight reel, rather than the full story arc, of a topic.

Adena Schutzberg has worked in geospatial technologies for more than 25 years. She is a member of the Esri Education Team.

Old slow sign in Australia (1940s-1964).

In contrast, slow learning is guided by the learner and thus is more likely to be selected when there's a smile on the student's face and twinkle in the eyes that says, "I want to learn to do that!" Further, there's a sense of "I'll learn a little today, a bit more next week, and then go to the session on it at the conference next month." Slow learning encourages participation in a learning community. That may mean colleagues who chat about image formats over lunch now and again, or a regular crowd that convenes for Geo-beers once a month, or an online community that tackles cartographic issues as they are raised.

Where does a publication about GIS fit in? Is it fast learning or slow learning? I'd suggest it has the best of both worlds. When you pick up a GIS magazine, or any magazine really, the first thing you do is flip through it or review the table of contents. While the activity may be fast, it sets up slow learning's self-direction. The skimming helps you find areas of interest as you are drawn to some articles and uninterested in others. Finally, with a few articles selected, I like to imagine, you slowly and deliberately begin reading.

I'm hopeful that in the coming months you'll find and commit yourself to some slow geospatial learning activities. If you select them well, they will keep you interested, interesting, marketable and successful.

BY SERB OCAL

The Importance of **REST APIs for 5G Network Technology**

The use of technology to communicate fulfils an innate human need to connect with loved ones across geographies. Since the first telephone was invented in 1877, the demand for communication has been ever-growing.

141 years on from this achievement, Information and Communications Technology (ICT) is a very dynamic and fast moving field and one which is becoming more and more intertwined with the geospatial industry, with geospatial, telecommunications, and Big Data industries beginning to converge in a significant way.

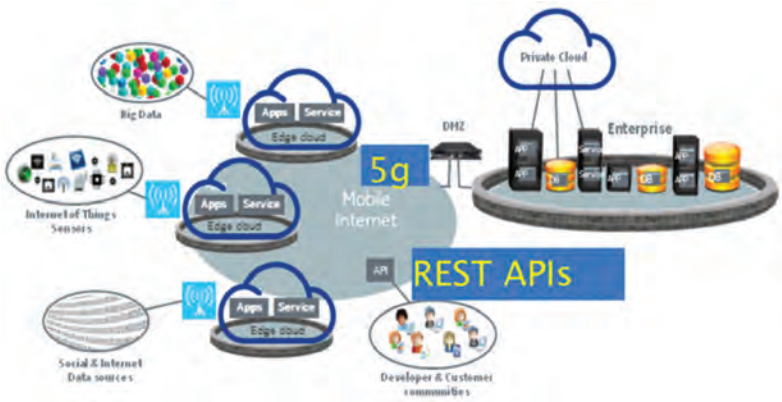
End users and businesses are constantly seeking more from the telecommunications industry and, interestingly enough, vice-versa. On the one hand, end users request personalised services, better performance and user experience; on the other hand, businesses need to get more information about their consumers in easier and secure ways.

According to International Telecommunication Union (ITU), 2018; the emerging trends within the ICT sector, which the geospatial industry has already established a presence, are; 5G, Artificial Intelligence (AI), Cloud, Internet of Things (IoT), Big Data, Smart Cities, VR/AR and Open Source. These services bring together people along with components such as data, applications, transport systems and cities in a smart networked communications environment.

This article focuses specifically on 5G, which refers to the fifth-generation mobile network. 5G is an IP based model designed for wireless and mobile networks which offers more reliable, ultrafast and low latency mobile connections. Facilitated by the use of mapping technology, 5G expected to be rolled out across many developed countries in 2020's.

In the United States, for example, organisations such as AT&T and Verizon have tested 5G delivery methods for the primary purpose of improving speed and capacity for mobile broadband. Meanwhile, in the UK, Ofcom, the UK's communications regulator, predicts that 5G will help innovation and improve productivity for a variety of sectors such as manufacturing, healthcare and transport.

With 5G offering greater possibilities for more accurate and timely data, more devices to collect the data across a broad range of sectors (energy, health, agriculture etc.), and faster response to meet the needs of the people, society appears to be entering a new paradigm. Aryaputra (2011) calls this 5G world the Wireless World Wide Web Applications (WWWW), wherein uninterrupted access to the internet means that space and time are no longer the constraints they once were. According to Fuetsch, A. President and CTO of AT&T Labs "the world is eager to see what 5G can do. And, all we can do is make sure we have networks that are ready for whatever developers, businesses and consumers want to throw at us."



IT and Telecom networking convergence model (ITU, 2018).

WHAT ARE APPLICATION PROGRAMMING INTERFACES?

The rollout of 5G networks will, however, not be an easy process - not just from a physical, infrastructural point of view, but from an interoperable angle also. The ITU Focus Group, for example, emphasises the importance of Application Programming Interfaces (APIs) to the 5G ecosystem - something which will allow applications and services to program network functions.

In layperson's terms, APIs (Open or Private) are technologies that allow applications to talk to one another, and they are critical to powering complex apps as they give organisations the ability to connect systems and share data. Meanwhile, Oracle, the developer behind an integrated stack of cloud applications and platform services, stresses that APIs make it possible for organisations to open their backend data and functionality for providing interoperability, fostering software reuse and reducing programming effort.

APIS IN GIS WORLD

So, what does all of this have to do with the GIS world? Well, as an emerging trend in GIS, APIs have become very important, particularly across governments which require integration of vast amounts of information. Government centric organisations, such as Scotland's Environment, Spatial Northern Ireland's Land and Property Services and Britain's Ordnance Survey have, as examples, implemented APIs (Restful style) for their maps and data services which can be used (consumed) by the public sector and the citizens.

The maps and data services which have been developed by these bodies at the local, regional and national levels form the basis of each countries National Spatial Data Infrastructure (NSDI). The APIs, which have been integrated with web services/microservices, cloud computing, geo-browsers, mash-ups and other web technologies, meanwhile, increase the required flexibility of sharing information.

In case you think that APIs and NSDIs can exist independently of one another, then it is perhaps worth quoting Jack Dangermond, founder and President of Esri, who in 2009, stressed the technical philosophy of NSDI. "The architectural answer for an integrated geospatial framework is creating a network of distributed geospatial services that can be dynamically integrated using open standards and free APIs that can visualise, query, and support advanced applications on the web."

RESTFUL STYLE APIS

Even the API innovation itself has changed. The term REST API finds its origins in American computer scientist Roy Fielding's PhD dissertation, which was published in 2000. REST, which stands for Representational State Transfer is, contrary to common belief, not an architecture, but rather a set of constraints that, when applied to the design of a system, creates a software architectural style. A RESTful system has main constraints of being a client-server system and stateless. In addition to these constraints; a RESTful system has to support a caching system and be uniformly accessible and layered. It uses a standard URI (Uniform Resource Identifier) that makes a call (Request URL) to a web server like http:// or a specific API domain.

Bringing this back to the above-mentioned geospatial systems, Spatial NI is a web based portal (client-server system) that facilitates sharing, using and developing geographic information. Its purpose is to allow ease of access to Land & Property Services' (LPS) mapping and geographic information and this is achieved by implementing Restful APIs, wherein their specific URIs are accessible by public services and citizens who demand base maps, land and property information.

WHY REST APIS ARE IMPORTANT IN TELECOM (ESPECIALLY 5G)

The importance of REST APIs to programmers and developers has grown significantly as the geographic web of customers (the public), businesses and government has grown. From a telecoms perspective, 5G is not only about the development of a new radio interface, but also of an end-to-end system, one which includes the "integration and convergence of all network segments with heterogeneous wireless and optical technologies, together with massive cloud computing and storage infrastructures" (Alliance, 2015).

... as an emerging trend in GIS, APIs have become very important, particularly across governments...

While most traditional distributed, networks and web services which are used for building web applications are unable to cope with and meet current networking requirements of 5G; REST, can cope with 5G's future networking requirements like WWWW. Firstly, for cooperation and sharing information; RESTful Web services not only use the web as a transport medium, but also integrate into it. Secondly, they are lighter and more simple than traditional methods in terms of computation requirements, bandwidth and memory. Thirdly, since HTTP is on charge, they can go through firewalls or proxy web servers (Mayoral et al., 2016 & Mayer, 2018).

>

Since 5G is about society interconnection; REST is the right software architecture style for ease of programming, ease of collaboration between many parties, and for flexibility supporting multiple vendors and adopting multiple operators.

EE's Coverage Checker REST API's features (Ocal, 2018).

USAGE OF REST APIS IN TELECOM (MOBILE INDUSTRY)

In terms of the usage of REST APIs by the Telecom (Mobile Industry), they will be critical to the implementation and deployment of new 5G services. According to Ofcom, mobile network operators are going to be the first to implement and deploy 5G and services on their existing websites in order to meet growing demand for data.

For example, EE Mobile Network Operator's Coverage Checker Application (used for identifying areas with the best 4G Network in the UK) uses REST APIs that let consumers use locator web services (geo-coding) to integrate their current location or point of interest with coverage checker services.

Coverage Checker Application is a customer faced application which is based on REST APIs such as Geo-coding and Coverage Checker Spatial REST APIs. Geo-coding REST API is an Analytical Service in which physical addresses are converted into geographical coordinates and obtained response type as GeoJSON format. However, the integration between REST APIs and geospatial services goes much deeper. The Coverage Checker REST API, for example, serves as a Data Visualisation Service used to request images/ tiles via OGC's Web Map Service (WMS) Standards. In this spatial web service; maps produced by WMS are rendered in a pictorial format (png) in different coverage layers (2G, 3G, 4G, 4G double speed and 4G+) for different geographic extents. The coverage tiles are delivered by Geoserver & Geowebcache by adding up SLDs & Projections and supported by Java EE (Backend) and invoked by Javascript files (Frontend).

EE's Spatial Rest APIs interaction via APIGW.

These Spatial REST APIs are exposed to 3rd party applications and partners (e.g. BT Mobile) via API Gateway which is the single entry point and responsible for request routing, composition, and protocol translation. By using API Gateway, EE allows her partners to build and maintain their own tools e.g. User interfaces (UI) by just consuming these APIs.

CONCLUSION

It is predicted that 5G technology will allow flexible, reliable and secure wireless networks to connect people with all applications, services, and "things". With the advent of 5G, new technologies continue to emerge to which we will need to adapt. While adapting these new technologies, there is a need of cooperation and sharing information.

REST APIs are central to this process. They can maximise technology innovation and optimise the efficiency of sharing information to deliver value-added services. In this context; for sharing location and addressing data; Geospatial Rest APIs play an important role for the organisations and industries who manage Geographical Information Systems via web based portals that allow sharing, using and developing geographic information.

In the Telecom industry, for instance, mobile network operators have developed GIS management strategies to prepare for 5G. For achieving this; they have improved their infrastructures by providing Geospatial REST APIs and they let consumers use these location based web services.

The availability of these REST APIs has allowed the geospatial, telecommunications, and Big Data industries to implement software and services. By embracing REST APIs, these industries will provide smart networked communications environments such as 5G roll out.

With the rollout of 5G, the future is going to be even greater for the GIS industries who want to use GIS and maps by building their own creative maps and sharing them on the web or on mobile devices.

GIS for Visualising Scotland's Toll Roads

There are still a handful of bridges, tunnels, and roads in the UK where tolls are collected, along with a couple of more recent road-pricing schemes. In Scotland, all tolls on roads or bridges have been removed. In the past, there were frequent references to turnpikes or toll roads in Scotland's guide books - although none were ever mapped. Today, we still use the same roads and there are some 400 surviving toll houses scattered across Scotland's landscape as evidence.

Most of us are blissfully unaware of the major impact that these had on the development of our current road transport network. The legacy of Scotland's turnpikes is hard to escape owing to the sheer size of the network that once existed, and the fact they were Scotland's most important routes of transport for well over half a century. Between 1750-1870, there were some 370 road and bridge acts passed in Scotland to establish turnpike trusts leading to a road network that ran for thousands of miles with construction costs running well into millions of pounds.

REVOLUTIONISING SCOTLAND'S TRANSPORT

In 1750, Scotland was on the brink of a period of major industrial and agrarian change that would ultimately transform the lives of the Scottish people. Key to this change was the simultaneous arrival of the turnpike era that would revolutionise Scotland's road network and play a pivotal role in the coming century.

A recent study by McEwan (2018) used a combination of historical sources and GIS mapping of the toll road network to begin to visualise the scale and extent of Scotland's first industrial revolution, and also to examine the importance of communications and connectivity in the formation of modern day Scotland.

The historical evidence was gathered from the Old Statistical Accounts, the New Statistical Accounts, various volumes and editions of the Statutes at Large/ Public General Statutes, the Journals of the House of Commons, minutes of road authorities, and a variety of other information notably the 'improving' literature of the late 18th century. This information was also used in conjunction with the English turnpike literature for comparison, and with early modern Scottish histories for placing these roads in their wider context.

MAPPING THE TOLL ROADS

ESRI's ArcGIS 10.5 GIS software was used to map Toll Roads for three time periods: 1750-1770, 1770- 1790, and 1790-1800. Toll Roads were identified with the aid of historical literature, a Road Atlas, Google Maps, and two freely available digital datasets of the road network of Scotland: OpenStreetMap and OS OpenData. GIS tools were used to search for the road of interest identified, to sub-set the map dataset to create a new road map layer, and then add two new fields into the road attribute tables of the sub-setted data to allow the toll road network to be mapped. Using the ArcGIS View function and the Year field to represent the three years, the layers were mapped.

THE TURNPIKE MAP

Chronological mapping of the toll roads in Scotland has provided a visual way to help improve our understanding of an innovation that was to play a critical role in a critical period of Scottish history. The maps produced have helped to visualise the evolution of the toll road network opening a door to further study. The result is a simple GIS map, but one that provides significant insight into the major periods of growth and decline in the Scottish toll road network and one that can clearly be linked to major economic, operational, and social transformations.

AUTHORS

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Driving Address Management

Efficiency Using a Corporate Gazetteer

Whatever your business, using poor quality, inaccurate address data is going to impact on more than just your reputation. In fact, the lack of an effective address management system is likely to cost your organisation thousands of pounds in wasted staff hours, both in the office and out in the field, ineffective billing and for the emergency services, it could even risk lives.

Mail Online headline. Read the article at https://dailym.ai/2OhuL4L

In large organisations, there are likely to be multiple departments and systems creating and managing records for the same address. For example, in a Local Authority the same address could be used by a council tax system, voting register or revenues and benefits department. With a range of people entering or updating address data at different times on isolated systems that are not linked, the incidence of error is inevitable.

According to GeoPlace, there are more than 2.5 million address changes in Great Britain every six weeks, so unless organisations manage this effectively, they run the risk of substantial financial loss.

CORPORATE GAZETTEER

Address Management experts Aligned Assets work with more than 150 large public and private sector organisations helping them reduce waste and increase efficiency by providing the most up-to-date address data through a corporate gazetteer. The key principle behind this tool is that it provides one version of truthful addresses that can be communicated across a whole organisation via any operational system. This not only eliminates the duplication of creating and managing address data, it removes the risk of error as a result.

Shaving seconds off response times saves lives.

At the heart of the corporate gazetteer is a repository of British Standard BS7666 addresses engineered to supply operational staff and systems, ensuring consistency, accuracy and concurrency. This British Standard defines how land, property, streets and their associated addresses should be recorded. This includes the use of a Unique Property Reference Number (UPRN), Unique Street Reference Number (USRN) and grid coordinates. By adopting this standard, any conflict of address data is minimised. It also means that due to the grid co-ordinates, all address data is mappable.

In addition to the gazetteer being kept up-to-date with address changes across Great Britain, organisations can add operational locations and assets that are relevant to their business, but are not captured by the national dataset. For example, there may be sub-units within a building, like a house converted into flats, each of which is likely to have a separate address; or there may be a separate building within a site, which is of interest to an organisation but has no postal address.

REAL-TIME REQUESTS

This consistent and up-to-date register of addresses, enhanced by your own local information, can

then be accessed by individuals or systems that use addresses. This real-time access returns the most up-to-date address data from the corporate gazetteer.

MANAGING CHANGES ON SILO SYSTEMS

In cases where organisations are not working from a centralised system, and each department is working with their own defined systems, a corporate gazetteer will push out any updates to all the different systems on an automated schedule that best suits the business (daily, weekly, monthly etc). These updates can also be filtered based on data content ensuring only the relevant information is being pushed out. For example, one system may require updates for all addresses, and another may only need residential addresses.

The result is that whichever system is using the data, it will always get the most up-to-date address, and then have any address already stored kept up-to-date with changes that happen at a national level. This model is a proven and tested one and exists in multiple public and private sector organisations.

A corporate gazetteer provides the building blocks for increasing efficiency both in terms of reducing costs, maximising income and safeguarding staff and the public.

A few years ago, West Yorkshire Police found themselves at an address management crossroads when new divisional boundaries were introduced, and Ordnance Survey's legacy address products were being withdrawn. Their requirement was to be able to access and share the most up-to-date address data for the UK, that would not only integrate seamlessly with their Incident Records Management System and their Command and Control System, but would also allow them to upload and share local intelligence data. West Yorkshire Police have been able to achieve this by utilising an Aligned Assets corporate gazetteer tailored for their needs.

Ben O'Hara, Information Specialist for West Yorkshire Police, said "As criminals and victims are not constrained by political and policing boundaries, the availability of a national address gazetteer has meant West Yorkshire Police know the addresses we're verifying across the nation are the very most up-to-date. While this has a very clear impact on improved response times, it has also been responsible for vast efficiency savings through eradicating the manual updating of address records and the elimination of errors as a result."

ATTACHING LOCATION INTELLIGENCE

A further dimension to the corporate gazetteer that is proving to be of enormous benefit to emergency services and Local Authorities alike, is the ability to attach local intelligence information that correlates to a specific address and sharing this across the organisation. This local intelligence could cover anything from access points for repairs to risk information. Once again, time saving and consistency of information are the key benefits of attaching your local intelligence to the address management system.

If your organisation is using address information, by enabling consistent access to the most up-to-date address data available through a corporate gazetteer, you will be driving efficiency, maximising the potential for revenue remittance, and in the case of the emergency services, better safeguarding staff and the public.

BY MIKE FOSTER

The Land of Coding - Cartography and the Embrace of Technology

Mike Foster is a cartographer, GIS professional and visualisation expert from Boston who currently works in the San Francisco tech industry. He has previously worked at MIT Department of Urban Studies and Planning and is active in the US GIS community. The following is a republished version of Mike's blog about the complex but changing landscape of cartography. It's a must-read for traditional cartographers, GIS specialists, coders and visualisation professionals.

Somewhere in the past few decades, cartographers have lost control of cartography. How could this happen? Can we get it back?

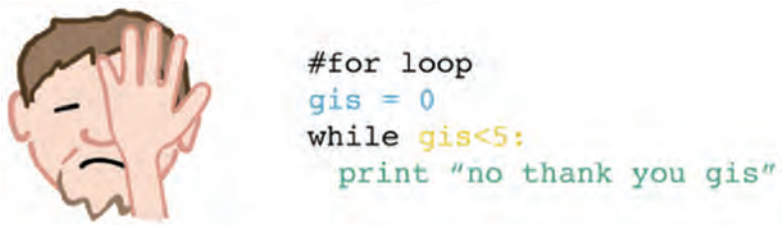
LEARNING TO CODE

This past fall, I co-taught an introductory GIS and Cartography class in a department of future urban planners. Many great questions were brought up and discussed through the duration of the course, some I would hear more than others. Two of the biggest questions were often in tandem. "Should I learn to code?" and more specifically, "what language should I learn to code in?" My answers were always, "Yes, you should!" and "Anything!" – The reasons for these answers are obvious, I suppose. Learning to program involves a paradigm shift, and you have to be taught what this shift is and should look like. Learning one language will allow you the paradigm that you need to pick up other languages more efficiently. Once you can change and establish your basic assumptions, it becomes a classic example of the law of increasing returns. A coder learning new functions is much like a linguist learning new verbs.

... the most important professional attribute one can have in our modern society is the ability to learn and pick up new technologies quickly.

Perhaps the most important professional attribute one can have in our modern society is the ability to learn and pick up new technologies quickly. When doing so, the trick is not to focus on the tool itself. Rather, it's more important to focus on the concepts and fundamentals that manifest themselves through the tool. The same goes for coding. Many of the basics from one language to the next, or from one library to the next, will transfer. This is, of course, not to say that you won't have to bury yourself in syntax references for a while.

To an extremely visual person, such as a cartographer, learning to code can be a tough task. Taking yourself from the world of visually choosing colours from a palette to being more concerned about what specific hex codes are, is not a very



scintillating prospect, and going to a place where you generalise a map by creating an algorithm consisting of "if and for" loops quite frankly sounds super boring. One must, however, get to the point where it becomes a puzzle and you are using the pieces to help solve a task. Do this, and you will no longer see just a string of strange characters.

EMBRACING CODING

Much to my dismay, and unfortunately to the huge detriment of the field, geographers, and specifically cartographers, have been slow to embrace coding. I would largely attribute this to the fact that the history of cartography is very visual. The craft and science has revolved around the illustrative, visual representation of location and earth for hundreds, if not thousands of years. Although being fundamentally scientific, in practice cartography is an ultimate exercise in communication and design. In the 1980's when GIS was beginning to take hold and technology started to explode, software made really (like, really) ugly maps. Unfortunately, this lead many cartographers to write it off, think of it only as a data utility, then quickly return to familiar and well-known visual mediums for geographic representation. In doing so, we have lost our hold as the creators and keepers of maps. Cartographers, as such, did not embrace coding as a new tool for creating maps. This in hindsight was a monumental mistake.

Because maps and location are so prevalent in society, the field of cartography did not die. Instead, it is shared with computer scientists, data programmers, and a range of other professions - ones that often have little knowledge of the intricacies of geographic data, longstanding cartographic conventions, and proper spatial science techniques. Is this a bad thing? I don't know, probably not. Cartography, even if it goes under the guise of "infographic" or "data visualisation" has seen a renaissance in the last ten years as location-based services, spatial data management and visualisation software has exploded. Some have even argued that we live in a golden age of cartography. Can we take back control? Probably not in full. Can we embrace what it has become? Absolutely.

The professional world and nature of mapping have changed. To survive, you must have a useful, relevant, and utility-driven work belt.

CODING IS IMPORTANT

In many professions, coding is a buzzword. However, to those in the spatial industry, be it geography, visualisation, planning, or whatever, it is important to get yourself in the proper paradigm so that you can carry the field into the future. The professional world and nature of mapping have changed. To survive, you must have a useful, relevant, and utility-driven work belt. Just make sure that being able to create and design through the use of code is one of the tools you have in it!

BY JOCHEN WENDEL, JOSÉ MIGUEL SANTANA AND ALEXANDER SIMONS

Urban Energy Modelling - Semantic 3D City Data as Virtual and Augmented Reality

The visualisation of results from urban energy modelling and simulation is a crucial part of energy research as it is the main communication tool among scientists, engineers and decision-makers. Energy modelling and simulation results are directly linked to spatial objects, and 3D therefore becomes a necessity. The multiple interactive 3D visualisation environments that exist are mainly targeted as 3D viewers for use on desktop machines and lack immersive components that enable users to truly immerse themselves, explore and interact with the real environment onsite.

In this study, the team focused on a holistic approach that implements a seamless transition from a traditional virtual map view to virtual reality (VR) and augmented reality (AR) modes in a single mobile application. This is particularly of interest to experts and decision-makers as it provides them with means to explore results onsite through AR or VR. These two visualisation techniques have been combined with traditional maps for a better overview and strategic planning capabilities.

MULTIMODAL VISUALISATION

The multimodal application that has been implemented utilises the Glob3 Mobile framework (Santana et al., 2017). This software development kit (SDK), presented in Suárez et al. (2015), is a mobile-oriented framework for the development of map and 3D globe applications, being highly configurable on the user-navigation and level-of-detail strategies. Thus, the framework is suitable for the present research, having recently demonstrated the possibilities that mobile devices offer for the planning of complex infrastructures and large datasets.

DATA INFRASTRUCTURE REQUIREMENTS

Given the complex nature of multidisciplinary energy-related modelling, datasets commonly differ in spatial and temporal resolution, data structure or storage format that requires an intensive data integration workload. Therefore, in order to maintain flexibility, all datasets are stored in an open-source data infrastructure that is based on a PostgreSQL database and PostGIS, for spatial capabilities. A major requirement of the mobile prototype is its connectivity to a PostgreSQL database and the CityGML data structure in which building information and energy models are stored. A benefit of using the CityGML standard instead of other geospatial data formats is that semantic information about each surface or element of a building can be stored. In addition, object-modelling specifications include different levels of detail (LoDs) (Döllner et al., 2006). Furthermore, the concept of LoDs can be used not only for semantic object abstraction but also for cartographic visualisation purposes. For efficient central data storage of information from diverse energy models and spatial analysis tools, the 3DCityDB – a simplified CityGML database – is used (see Figure 1).

GLOB3 MOBILE API

The Glob3 Mobile (G3M) API allows the generation of map applications in 2D, 2.5D and 3D following a zero

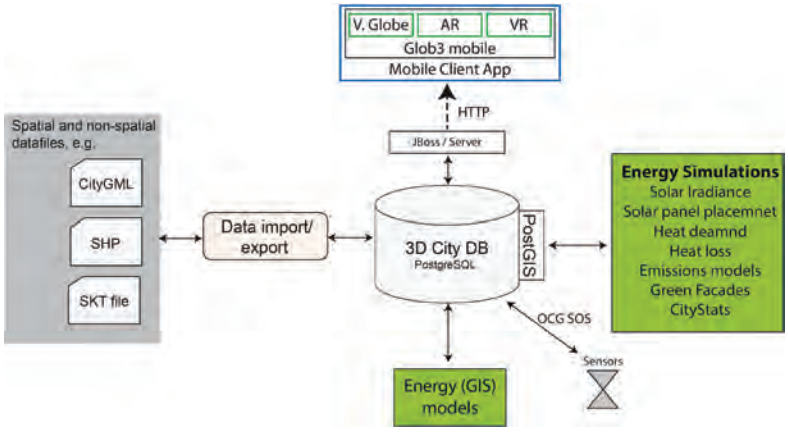


Figure 1: Open-source data infrastructure for urban energy analysis.

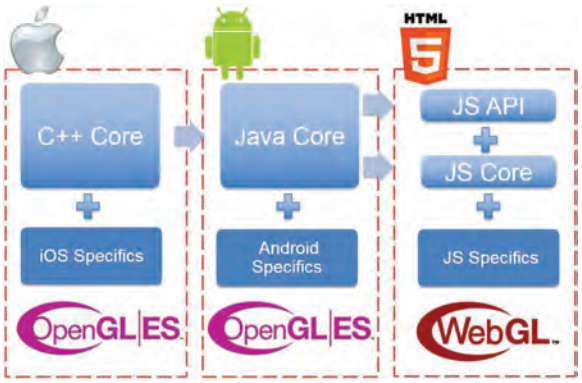


Figure 2: Automated multiplatform development pipeline of the G3M project.

third-party dependencies approach, and provides native performance on its three target platforms (iOS, Android and HTML5). 3D graphics are supported by the Khronos Group APIs, OpenGL ES 2.0 on portable devices and WebGL (web counterpart of OpenGL) on the HTML5 version. Features of this framework include multi-LoD 3D rendering and automatic shading of objects. Due to the multiplatform nature of the G3M API, portability to Android or HTML5 is possible (Figure 2).

Figure 3: Screenshots showing the app layout and the different visualisation modes.

A major part of this work was dedicated to the development and integration of new features for supporting seamless VR and AR modes to the G3M application core. From the perspective of the hardware, the location of the device is determined via the GPS system, whereas the orientation of the camera is obtained by processing the readings of the embedded accelerometers.

The different platforms on which G3M runs represent the camera attitude in different ways. These new features, now added to the G3M repository, are aimed at achieving a common description of the device positioning so that VR and AR functionalities and applications could be developed in a multiplatform fashion.

For the AR implementation, a careful mathematic modelling of the camera projection was carried out. In this case, the OpenCV library was used to determine how this projection was applied to an object of reference, determining the internal parameters of the device's camera.

APPLICATION DESIGN

As a proof of concept, a first implementation of the application has been developed and tested on iOS, making it compatible with any iPhone or iPad running versions of iOS 9.0 or newer (Figure 3).

The app is divided into the following viewing modes:

- Classic Map mode, which offers an aerial view of the whole dataset. The user can navigate by using touch commands, exploring the city model in different visualisations and selecting the city structures to manually inspect the assets.
- Mono VR mode, which allows VR visualisation of the urban model in situ by holding the mobile device without the use of a VR headset.
- Stereo VR mode, which implements stereographic rendering. The app must be used inside a VR headset to experience a depth-enriched visualisation.
- AR mode, in which the images captured by the device's camera are merged with the 3D-rendered scenario. This enhances the elements present in the scene with contextual information.

THE URBAN DOMAIN

Three different case studies have been applied as proof of concepts for the developed app. In the first use case, the researchers demonstrated the visualisation of energy efficiency values generated by energy models developed in EIFER on LoD1 and LoD2 CityGML building models in Karlsruhe, Germany. The user is able to interactively explore values such as heat demand and CO2 emissions or energetic properties such as wall-to-surface ratios directly onsite as AR through the lens of the smartphone (Figure 4, left). As a second use case, the visualisation of underground infrastructure such as pipes, electrical wires or telecommunication lines was demonstrated. The underground structures (Figure 4, right), are directly visualised from CityGML. The CityGML Utility Network ADE was used to store and visualise semantic properties such as diameter or flow rate of the pipe directly in CityGML.

The third use case shows the capability of dynamic multimodal data visualisation. Outputs from a vertical solar radiation energy model have been implemented. The solar radiation data model consists of massive sets of points associated to a time series that describe the intensity of the received sunlight at a 1m resolution >

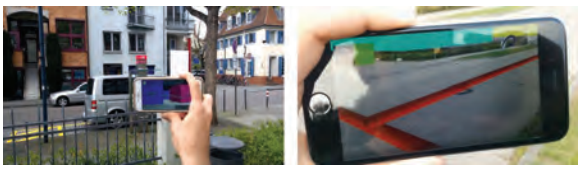


Figure 4: Exploring energy efficiency of buildings onsite (left); Underground infrastructure stored as CityGML visualised as AR onsite (right).

Figure 5: Dynamic solar radiation point cloud visualisation process (Santana et al., 2017).

(Wieland et al., 2015). This form of visualisation is particularly useful in AR mode, as the user can explore solar gains and façade shadowing of potential solar installations as animations onsite. In order to visualise and animate the time series data, the user selects the building of interest. Once the selection has been made, the user is prompted with a command that triggers the visualisation of the point cloud associated with the selected building (Figure 5).

To display this solar radiation model, the geometry model of the building becomes invisible and is replaced by a point cloud. The vertices of such point clouds are stored server-side and retrieved by the client on demand. With the geometry in place, a periodical task scans the data series converting the radiation values into colours using a linear interpolation.

CONCLUSION AND OUTLOOK

The usage of VR and AR for the exploration of urban models and multiple energy simulation outputs has been successfully demonstrated. Likewise, the VR modes have been tested for energy planning purposes where users could explore the heat energy loss and gains model in an immersive environment. However, as only an LoD2 CityGML model was used in this proof of concept, a higher and more detailed abstraction level is necessary in future versions for a more realistic display.

The AR mode was successfully tested for the dynamic visualisation of point clouds generated by a vertical solar radiation model (SolarB). The user was able to select a building and visualise solar gains and the shadowing effect of neighbouring buildings as animations that blend with the environment. This use case sparked great interest, as it is a visual way to communicate the benefits and drawbacks of potential future solar panel installations. Furthermore, the seamless switch from map mode to VR or AR mode was beneficial for users when exploring the study site in the real environment. Without changing from one device or application to another, the user could rapidly change the data visualisation perspective and in consequence could more efficiently analyse the data.

Currently, only GPS and inertial measurements of the smartphone are used for positioning. However, as higher precision is sometimes required (e.g. for underground structures), differential positioning technologies such as the inclusion of Wi-Fi fingerprinting or Bluetooth localisation or the use of visual landmarks are being evaluated.

ABOUT THE AUTHORS

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Innovation Festival and Underground Utilities

When the Northumbrian Water Group (NWG) held their second Innovation Festival in July 2018, it was an event like no other. The festival's aim was to turn the concept of a typical business conference on its head. By staging the festival in an open field, complete with marquees, NWG were going back to the roots of why people generally attend a festival: to release themselves from the predictability and routine of everyday business life. In doing so, the festival aimed to encourage a diverse group of people to think differently about innovation, and to share views and ideas from various different viewpoints - both commercial and non-commercial.

Despite the many distractions such as free yoga classes, the festival had a clear structure and focus. The event was geared around 12 distinct themes, with design-focused innovation 'sprints' aimed at addressing selected problem areas. During these sprints, design thinking was used to turn concepts and ideas into real projects, with a Problem-Solution-Execution approach applied to each of the problem areas.

THE IMPORTANCE OF GEOSPATIAL

As would be expected of any event which is focused on reinventing and redesigning the utilities world, the geospatial industry had a strong presence at the festival. Neil Brammall, the CEO of Utility Survey Exchange, was one independent expert in attendance thanks to his domain expertise in the utilities geospatial sector. Neil, who has worked in the industry for over 17 years, is helping to take one of the projects from the Innovation Festival forward. Introducing why utilities are now an innovative space, he explained to me the current cutting-edge project, which is focused on developing a combined underground infrastructure map for the Northeast of England.

The 'Mapathon' sprint was sponsored by Ordnance Survey and jointly led with NWG. Entitled 'Going deeper underground – can we build an underground map of the UK?', and consisting of a team from utilities, local government, engineering and GIS expertise, the goal of the sprint was to: "Build a Common Infrastructure Map pilot for Newcastle and the surrounding area including water, wastewater, gas, electricity, telecoms and other underground services". The essential aim of the sprint was to create a working system that allowed the demonstration of various use cases around obtaining information about the location of underground assets. These use cases ranged from support for safe working during excavations, through planned construction works to resilience planning.

These use cases actually arise from the supposed lack of a simple and consistent means to access all underground asset records in England and Wales. Considering this, topics such as interoperability and data sharing were high on the sprint's agenda, along with the matter of data quality, accuracy, and how this could be improved.

NOT JUST A TECHNOLOGY PROBLEM

Three broad streams were defined to progress different aspects of the sprint: Technical, Benefits and Business Case, and Data Sharing Agreement. Each of these streams helped to define the requirements, use cases and constraints for solutions to these different aspects of the central problem - based on insights shared by the participants. Structuring the sprint in this way was an important acknowledgement that the problem under consideration was not simply technological in nature, and that commercial, organisational and behavioural aspects are equally important. The business case development and benefits analysis were given particular focus, with PESTLE analysis (Political, Economic, Social, Technological, Legal, Environmental) being particularly impactful. Of equal importance was the draft data sharing agreement, which will form the basis for ongoing discussions and refinement to find a formulation

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that will allow organisations to share data - freely and securely.

On the technical side, a working architecture was provisionally agreed based on a 'Hub' model, whereby contributing organisations would upload copies of agreed data on a periodic basis to be served out to authorised recipients. A demonstrator system was developed based on this architecture, with services exposed that allowed the participants to develop proof of concept demonstrators to illustrate potential solutions for some of the use cases.

A WIDER AGENDA

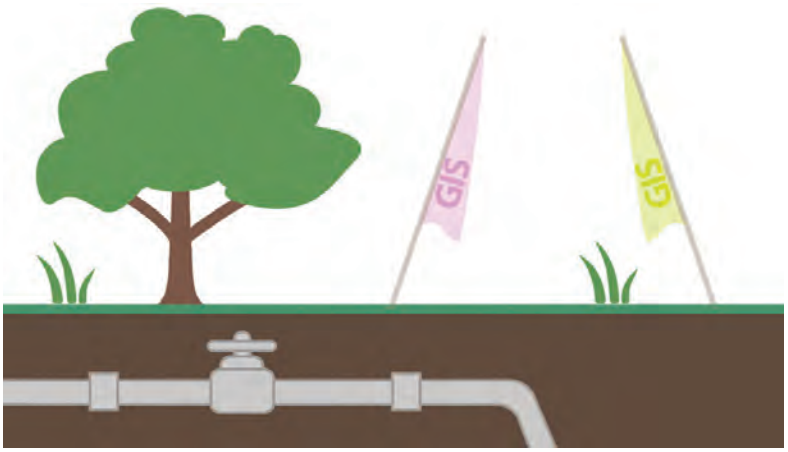
The Mapathon sprint, like the NWG Festival more broadly, was about much more than having a nice collaborative festival experience. The event was a coordinated effort to build a community around the important topic of underground utility mapping for the purpose of safety and sustainability. It also represents a much wider movement in the UK to improve how things are done in this area.

Two of these major developments are recently established initiatives which are geared towards the utilities sector. The first, Project Hades, funded by Transport for London (TfL) and sponsored by Thames Water, is focused on setting up a data sharing exchange between utilities and developing a combined underground infrastructure map for the London area.

The second, Project Iceberg, is a collaborative project between Ordnance Survey (OS), British Geological Survey (BGS) and Future Cities Catapult (FCC) exploring how to better capture, collect and share data about the subsurface in general, including underground assets and geological conditions. This initiative aims to demonstrate the value of interoperable data about the subsurface (including buried assets) and to find effective ways of sharing all this information among a wide range of relevant organisations, going beyond operational use cases of network operators. Phase 1 is now complete and has produced a comprehensive market research report and literature review, and started the work on defining a framework and standards to underpin data exchange (https://bit.ly/2zsbVQe). Phase 2 will consist of a series of research activities based on the use cases defined in Phase 1 and will get underway later this year.

INTERNATIONAL EXAMPLES

Despite the growing interest in the issue of accessing underground utility data, a number of issues remain which are holding back data sharing and interoperability developments in this sector. These include concerns around data security, and uncertainty around the location of buried assets. After all, utilities can be high risk and anyone sharing information needs to have a high degree of certainty about their location.



There is a growing recognition in the UK that the problems arising from a lack of accessibility and interoperability are not going away, and examples of how the situation can be improved can be found internationally. Examples of effective sharing of underground asset data can be found in the Flemish region of Belgium with the KLIP system and closer to home in Scotland with the Vault system. Both of these initiatives were driven by legislation. An overview of the initiatives and can be found at http://docs.opengeospatial.org/per/17-048.html.

A SPRINT TO THE FINISH LINE

Unlike most UK summer festivals, wherein the attendees are more often than not in need of recovery after the event, the overall feeling from the NWG festival was that the attendees, and in particular the sprint participants, left in an energised and enthusiastic mood. Amongst the delegates of the Mapathon sprint, the feeling is that excellent progress was made during the week.

The spirit of cooperation between all participants, and in particular between the organisations who shared data for the event was incredible and, in Neil's experience, unprecedented.

A number of demonstrations in response to use cases were developed "in the tent" during the week, including incorporation of Combined Infrastructure Map data in a third party web viewer and a demonstration of the availability of offline data. As an example, Neil Brammall was able to implement a link between the Utility Survey

Exchange platform and the Combined Infrastructure Map, allowing feedback from the field to be uploaded and displayed in real-time.

This concept of the feedback loop is of particular interest to utility data managers, and the ability to easily and quickly report unknown and incorrectly recorded assets from the field is seen as key to long term data quality improvements. The same applies to high quality survey data captured according to the standards outlined in the PAS128 standard.

In short, there is a great deal of useful information which is not finding its way back to the asset owners, and an opportunity is being missed to improve the quality and accuracy of the authoritative record of underground assets. It is expected that completing that circle by providing utilities with validated data from a wider variety of sources - giving a fuller understanding of data quality in different locations - will yield tangible operational benefits. Bringing these additional data sources into play is what the Utility Survey Exchange system is all about.

THE HARD WORK STARTS NOW

Now that the festival is over, the real work begins in overcoming the technical, commercial and cultural challenges of designing and implementing an operational data sharing hub. The priority will be to define a mechanism that will allow asset owners to share their data in a manner that is simple yet comprehensive and secure, and will then allow stakeholders with a legitimate requirement to access that data in a straightforward and usable manner.

There is no “one size fits all” solution to these requirements, so building in flexibility to suit a wide variety of existing business processes and systems will be key. Different organisations are at different points of their geospatial journey - some are raring to go with this proposition, while others will need a little help along the way.

Neil therefore advocates for a “hybrid” architecture with a low barrier to entry that will allow organisations at different stages of technological evolution to gain benefits from the system which will be crucial for widespread adoption.

Going forward, architectures other than the ‘Hub’ model will be evaluated, with particular consideration being given to the benefits of real-time access to ‘live’ versions of data rather than periodic snapshots. This approach would represent a significant step forward from previous initiatives.

Also of critical importance will be the need to find practical ways to improve data quality and accuracy. If utilities and other organisations are communicating and sharing with each other more effectively, the more opportunities there are to improve the authoritative record of the underground by sharing observations in online platforms.

Technological advances in machine learning, augmented reality, advanced survey techniques and AI may all help to improve our understanding of what lies beneath our feet, but that information still needs to find its way to the people who are responsible for maintaining the authoritative record. Otherwise, it gets isolated in a silo and provides no long-term benefit.

Having already demonstrated the feasibility of the real-time view of feedback from the field during the week of the Innovation Festival, Neil is confident that this can be a crucial element of any longer term development.

ON THE CUSP OF CHANGE

Neil Brammall is optimistic about where the “Mapathon Sprint” will lead. The week “in the tent” laid the groundwork for genuine progress, and now the challenge is to maintain the momentum needed to overcome the technical and business challenges. This momentum appears to be plentiful. Ordnance Survey have been appointed to provide technical leadership for the ongoing project, with members of a steering group consisting of regional utilities, local authorities and technical experts already being identified and formed into a steering group. The spirit of cooperation so evident during the Festival has continued, with follow-up meetings being held, and a collaborative and achievable implementation plan already under development.

Clive Surman-Wells said “We had a winning formula which laid bare the problems in existing methods and that allowed us to focus on solutions, but the real secret to the success of the Mapathon was in getting all the key organisations, and the right people, into the tent face-to-face for five days working together on one solution”.

It feels like the UK may be on the cusp of a significant step forward in making information about the subsurface more easily available to those who need it. Support from the bottom-up from utilities and other stakeholders becoming more open to data sharing is amplified by support from the top-down in the form of the National Infrastructure Commission and the newly-formed Geospatial Commission. Initiatives like those arising from the NWG Innovation Festival, along with Projects Hades and Iceberg, embody this desire for improvement and will lay the groundwork for solving the technical, commercial and cultural challenges ahead.

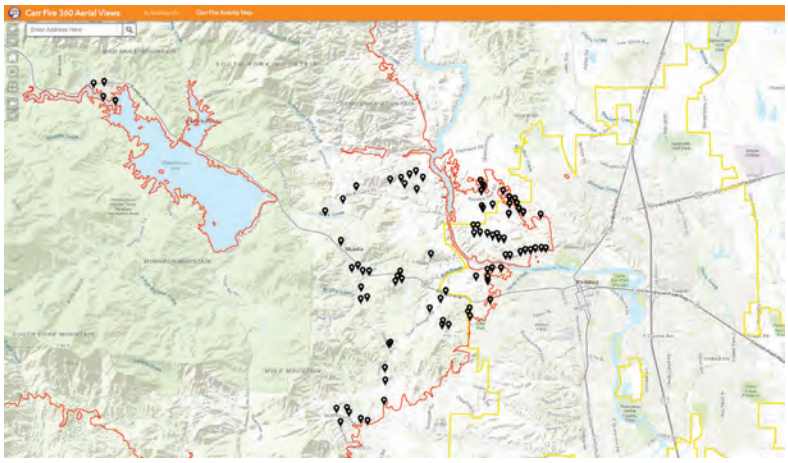
BY KATIE DECKER

Turning Drones into Autonomous, Reliable Data Collectors

Drone technology is exciting and new and has captured the minds of the public. But it is still very much burdened by a critical barrier to entry. Drone operation is difficult to learn, and even once company personnel have been trained, the error margin for piloting is narrow. Precision and accuracy count when collecting spatial data, and drones are growing as a key tool in many organisations' GIS departments. This is because imagery provides context that can't be created or inferred by satellites or computers. 3D imagery is still the best context for understanding a physical space. But this imagery itself needs context. That's where the Austin, Texas-based Hangar Technology comes in.

By automating the process of piloting drones, Hangar has created an exact method for collecting imagery. Freeing drones from human error eliminates uncertainty and unpredictability and produces precision data. When an autonomous drone can repeatedly fly the same path with high accuracy, it is no longer simply providing unstructured aerial photography; it is offering a new layer of spatial data. And this data has four dimensions: the x,y,z physical space in addition to the added dimension of time. The term 4D data doesn't just represent a new context of the physical environment; it also opens the door to deeper analysis to reveal patterns, relationships, and insights.

This technology can be applied to almost any industry or organisation that needs to have an in-depth, detailed spatial understanding of people, places, or things with an up-to-date visual context. Most notably, developers, utility companies, and governments can monitor what is happening on jobsites with visual, spatial, and temporal situational awareness. The Hangar platform uses this data to assess and prioritise what needs to be done and when, then automates task routing to the appropriate department or person. And because Hangar automates drone operation, imagery can be refreshed without wasting valuable employee time piloting, inputting, and analysing the data.



A GIS Map showing fire activity as points on a map.

Most recently, Hangar has offered its unique capabilities to another area where humans have had limited ability to perform data collection. After the Carr Fire in Northern California this past July, homes, infrastructure, and utilities were severely damaged in an area spanning over 200,000 acres. And these areas were still dangerous to access long after the flames were extinguished. Hangar's 360 app was used to capture interactive imagery of the area. The city of Redding, California, made this data public so it could be used to provide better location intelligence for recovery efforts. Power companies could access this information to know where damage to lines had occurred; the US Postal Service was able to see which delivery routes had been affected; the fire department was able to see which homes were damaged and to what extent and whether or not a house was still standing; and insurance companies were able to see detailed imagery of covered assets ranging from private residences to infrastructure.

Hangar has automated the collection and analysis of imagery-related location intelligence. By doing so, it has made the GIS workflow in areas such as jobsite management, infrastructure maintenance, and disaster recovery cheaper, quicker, and safer. The company is adding visual context to spatial data and, in turn, making drones an indispensable element for any modern GIS department.

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Maximising Geospatial Information After UN-GGIM

What does a modern national spatial data infrastructure look like? As I covered in my last column, to see geographic information supporting a growth in UK productivity, we need both the underlying foundations (tools) and investment in innovation. An infrastructure is often thought of as being just the technical elements of that foundation, a set of servers and a geoportal (!) for example. But we know that it's more than this. It's about the broader environment to enable maximum productivity gains from the use of geospatial.

Our UK delegation to the United Nations Committee of Experts on Global Geospatial Information Management' (UN-GGIM) has recently returned from the annual meeting in New York in August. Amongst other activities, the UK has supported and been involved in the Integrated Geospatial Information Framework, which was adopted at that meeting. The framework is an excellent example of a rounded view of the elements that should be considered to maximise the benefits of geospatial information for a nation.

Under the vision statement: "The efficient use of geospatial information by all countries to effectively measure, monitor and achieve sustainable social, economic and environmental development – leaving no one behind" sit nine strategic pathways. These cover elements from data, standards, innovation to legal and policy, finance and engagement. Developed in collaboration between the UN and the World Bank, the framework was originally intended to guide developing nations but it certainly seems to be a framework that would be beneficial worldwide in considering national arrangements for geospatial.

In the UK we're already viewed as a world leader in geographic information – but this is a position which we need to continue to both maintain and develop. The world around us is moving quickly. We need to take a cohesive view on our ambitions for geographic information in the UK and how we will move forward together.

A series of AGI workshops and events around the recent Geospatial Commission Call for Evidence are well underway. It has been an opportunity to hear from our members on what they believe are the key considerations as we move towards the development of a UK Geospatial Strategy in 2019. AGI Council members have ensured that we meet with members across the UK as we compile our response. It's clear there is a recognition that we must look beyond just the availability of data and government agencies to develop an effective route to maximising the benefits of geospatial information for and in the UK.

Abigail Page is Chair of the AGI's Council, which is formed from elected members of the AGI. Its main role is to set the strategic direction for the organisation. www.agi.org.uk

We're now weeks away from our AGI Annual Conference, GeoCom. A dedicated team are bringing together a range of inspirational speakers to lead us in a day of exploring the theme of 'Solving the Productivity Puzzle'. Together, our community can consider our aspirations for important work in 2019 and beyond. It will be one of my last significant calendar appointments as AGI Chair, a role which has been a real privilege to serve in and see first-hand the step change in perceptions of geospatial information in the UK over the last two years. I have no doubt this is an incredibly exciting time for all of us as we come together in November.

This is also my last column for GIS Professional. AGI Council were sad to hear that this will be the last issue and greatly appreciate the support and dedication of the publication teams over the life of the magazine in supporting AGI and bringing readers the latest news and innovations. I'd like to thank them all and wish them the best for the future. You can be rest assured that you will continue to hear regularly from the AGI Chair, and AGI will ensure that our members continue to be well informed through alternative and new channels. Visit our website, join us as a member – and thank you as always for your support.

Got an event to list?

Go to www.gis-professional.com/events

BIG DATA FOR INTELLIGENCE SYMPOSIUM 2018
16-17 October 2018, Washington DC, USA
http://bigdatasymposium.dsigroup.org/

INTERGEO 2018
16-18 October 2018, Frankfurt, Germany
www.intergeo.de/intergeo-en/index.php

GEOMETOC 2018
17-19 October 2018, Prague, Czechia
https://bit.ly/2N6qpO9

GEO | DESIGN + BIM 2018
1-2 November 2018, Amsterdam, The Netherlands
https://geo-bim.org/europe/

INTERNET OF THINGS APPLICATIONS 2018
14-15 November 2018, Santa Clara, California, USA
www.idtechex.com/internet-of-things-usa/show/en

UN WORLD GEOSPATIAL INFORMATION CONGRESS
19-21 November 2018, Deqing, China
http://ggim.un.org/unwgic/

MARINE DATA MANAGEMENT AND GIS WORKSHOP
27 November 2018, Alton, UK
www.whereyourdatamatters.com

GEODATA 2018 LONDON SHOWCASE
29 November 2018, London, UK
https://vrsk.co/2N7B2Ly

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