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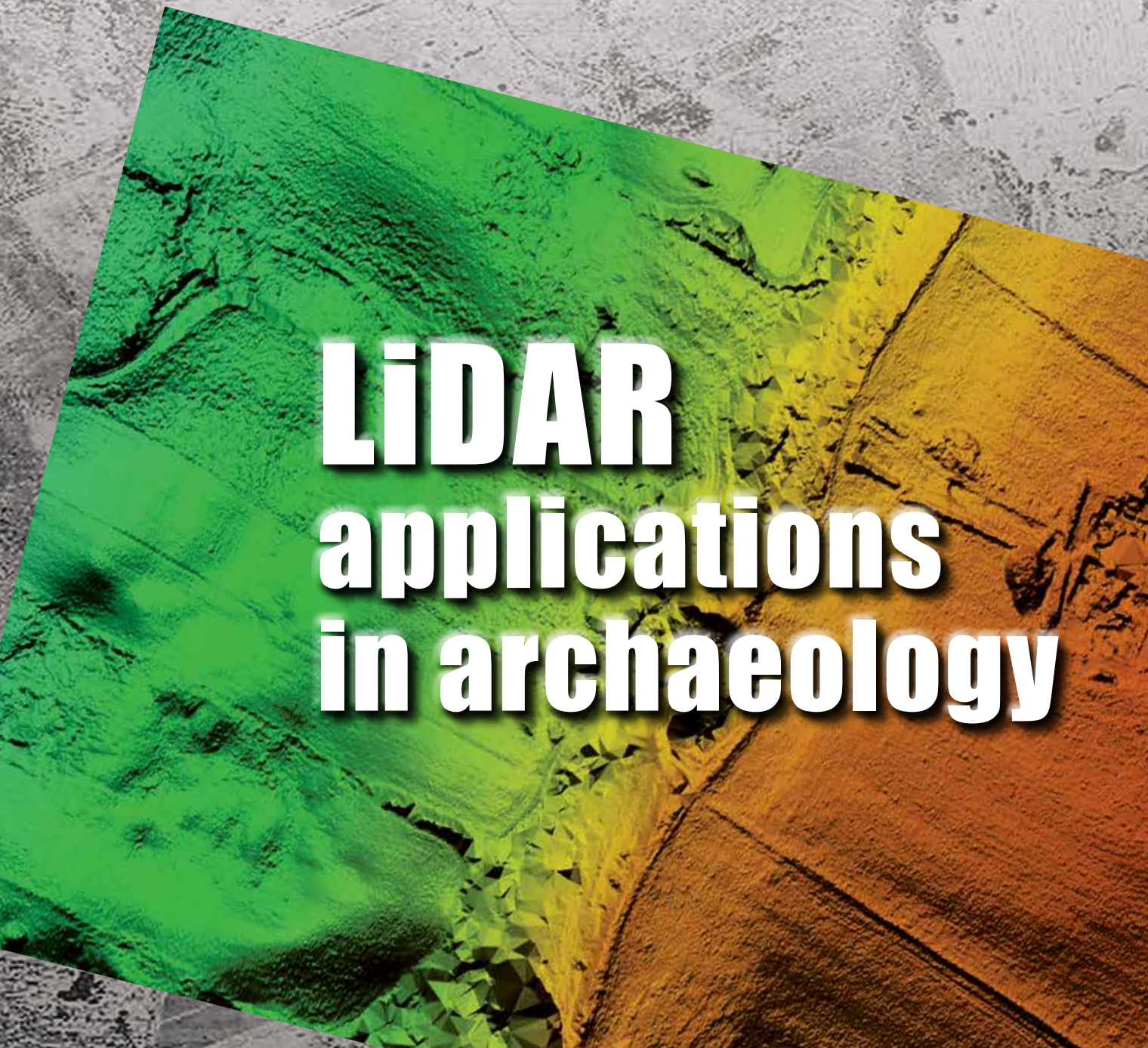

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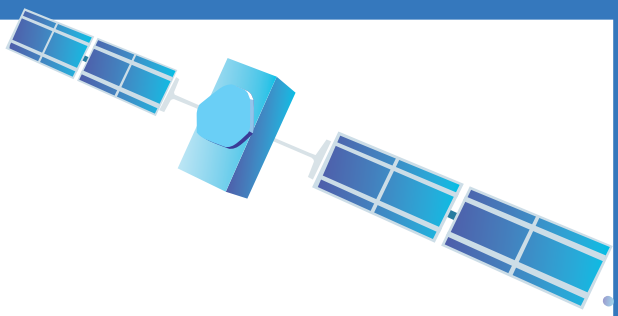

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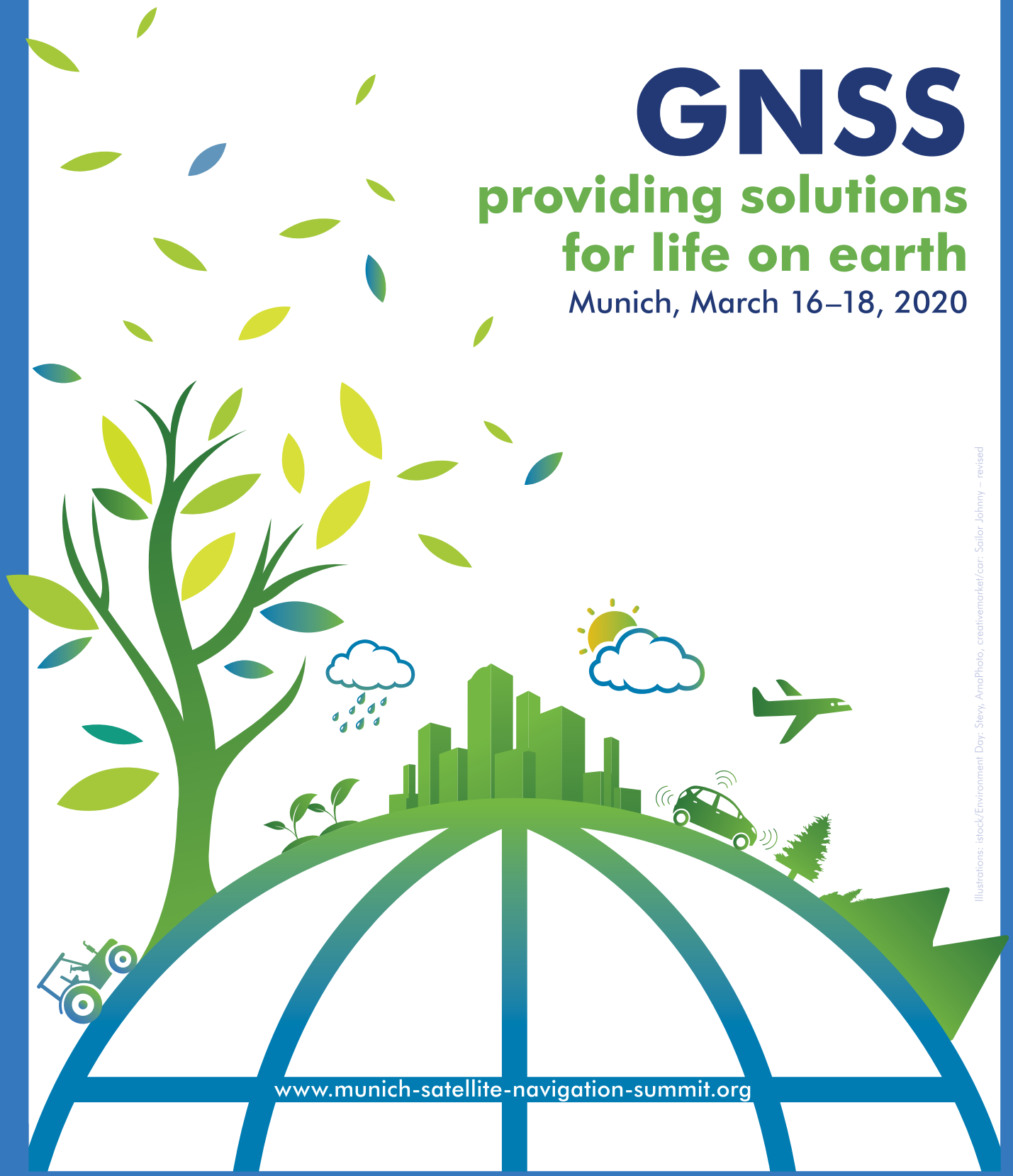

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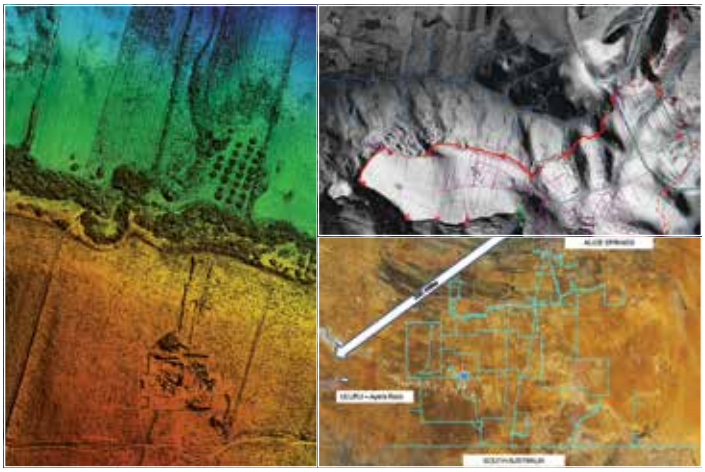

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Mailing Address
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.
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This issue of Coordinates is of 52 pages, including cover.

Hope and wish

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Coordinates wishes 2020, a year of hope and growth

To all our readers, authors and advertisers.

Bal Krishna, Editor
bal@mycoordinates.org

Territorial and topographic analysis for the protection and enhancement of fragile archaeological areas

The carried out activities were aimed at defining the best methodologies for the documentation, analysis, protection and enhancement of the archaeological remains in the territory of Tarquinia

A Garzulino
Dipartimento di Architettura e Studi Urbani (DAStU), Politecnico di Milano, Italy

M Marzullo
Dipartimento di Beni Culturali e Ambientali, Università degli Studi di Milano, Italy

Within the "Tarquinia Project" and the "Centro di Ricerca Coordinato", involving different groups of the Università degli Studi di Milano (Archaeology, Computer Science and Communication, Geoarchaeology, Palaeoanthropology) and the Politecnico di Milano (Architecture and Conservation of Cultural Heritage), the carried out activities were aimed at defining the best methodologies for the documentation, analysis, protection and enhancement of the archaeological remains in the territory of Tarquinia. Within this broad framework, from 2010 the two research groups focused their efforts in the identification of the entire route of the ancient Tarquinia wall circuit and the archaeological structures it contains in order to create thematic maps of the "Pianoro della Civita". The performed work examined the available historical documentation, proceeding in an extensive analysis of the marks that characterized the area. Given the complex morphology of the area, the ancient emergencies spread over fourteen centuries and the dense vegetation characterizing the slopes, a laser scanner survey using LiDAR technology (Light Detection and Ranging) of the entire area was performed in order to investigate the archaeological objects. These investigations, together with what emerges from the interpretation of the cartographies and about the history of the archaeological analysis and research (*Marzullo 2018*), made it possible to evaluate and verify the archaeological remains, contributing to the creation of the thematic maps of the ancient Tarquinian city walls.
The "Tarquinia Project" (*Bagnasco Gianni, 2012; Bonghi Jovino, 2006*) was extended to the whole plateau in order to deepen the knowledge of the Etruscan settlement, contextualizing not only the archaeological sites in which the Università degli Studi di Milano worked directly,

Within the "Tarquinia Project" and the "Centro di Ricerca Coordinato", involving different groups of the Università degli Studi di Milano (Archaeology, Computer Science and Communication, Geoarchaeology, Palaeoanthropology) and the Politecnico di Milano (Architecture and Conservation of Cultural Heritage), the carried out activities were aimed at defining the best methodologies for the documentation, analysis, protection and enhancement of the archaeological remains in the territory of Tarquinia

but also the previous excavations, in a wider topographical context embracing the surrounding territory.

In this regard, thanks to the funding of a "Progetto Ricerca Interesse Nazionale" (PRIN – "Mura di legno, mura di terra, mura di pietra: fortificazioni in Etruria")[1], the project "Mura Tarquiniesi" was started in collaboration with the Politecnico di Milano, in order to evaluate the extension of the ancient city, enclosed in the circuit of the walls, in relation to the morphological characteristics of the plateau, reviewing the structure, the palimpsest of the signs in historical key and the relationship with the settling phases[2]. The ancient use of the site extends over a chronological period of about fourteen centuries (X B.C. – IV A.D.), if not beyond. For this reason, the performed work examined graphic reproductions, cartographic thresholds and available aerial images, proceeding in an extensive study of the signs that characterized the area, examining not only the aspects more properly referring to archaeological findings, but also the geomorphological and infrastructural ones (Marzullo 2018, pp. 21-48). Given the particular territorial shape and the presence of dense vegetation on the slopes of the plateau and in the flat areas (figure 1), in order to identify and investigate the current archaeological remains, a laser scanner survey using LiDAR technology (Light Detection and Ranging) of the entire territory was performed. This technology, used here for the first time in an Etruscan archaeological area, allowed us to identify every morphological discontinuity of the plateau for the whole knowledge, analysis and preservation of this inestimable heritage.

The acquisition methodology

As is known, the LiDAR technology uses measurement system mounted on airplanes that scans the overflowed field, storing information useful for the knowledge and representation of the territory and of the objects it contains. The raw data, the first output of the aerial survey, is presented as a cloud of points that defines the terrain altimetry and the elements present in it as vegetation, buildings, roads, waterways, etc. The points that contribute to form the cloud were arranged according to the scanning pattern of the instrument, therefore requiring in-depth processing. Regarding these points are known the planimetric coordinates, the altimetry, the intensity of reflection, the classification based on the intercepted surfaces and other indications regarding the characteristics of the flight (*Kokalj et al., 2010; Cowley and Opitz, 2012*). Generally, the laser scanner is a system used for surveying objects and artefacts and consists of a device that automatically drives, directs and records the impulses of the attached laser range finder that determines the distance between the point of emission of the impulse and the point of reflection on the surface of the intercepted object (*Shan and Toth, 2009; Remondino and Campana, 2014*).

Since the position of the impulse origin is known, and the angle of direction and the distance are recorded, the set of intercepted points helps to form a cloud of points, a sort of digital cast of the scanned surfaces. In this specific case, to know the position of the point of emission of the pulse, the orientation of the laser and the direction of the emitted beams, it was necessary to integrate an inertial system and a GNSS system useful for the reconstruction of the flight paths. Since the instruments were synchronized one with each other, it was possible to insert in a geo-referenced space the intercepted point by the laser pulse at any time since spatial information was known (for laser scanning techniques used in LiDAR technology and for processing: *Shan and Toth, 2009; Cowley and Opitz, 2012; Remondino and Campana 2014*).

In addition to the laser scanner instrumentation, on the aircraft there was a digital photogrammetric camera that allowed to perform numerous aerial shoots of the entire archaeological area. These images were processed using image based photogrammetric systems and structure from motion techniques (SfM) in order to obtain a three-dimensional texturized model with high definition details. The model has been verified, from the point of view of dimensions, proportions and precision, thanks to the LiDAR cloud of points and the results obtained have therefore allowed to create a new cartographic support on which to ground all the analytical elaboration of the project.

Figure 1. The vegetation on the slopes and on the main area of the Civita Plateau of Tarquinia

The application for the archaeological context

In this specific case, although some areas of the "Pianoro della Civita" are characterized by a thick Mediterranean vegetation, it was possible to obtain a valid result in the acquisition and representation of the morphology of the underlying terrain. This result was obtained thanks to the application of appropriate algorithms and selection criteria (geometric parameters such as maximum permissible gradient and acceptable height differences – *Cowley and Opitz, 2012*) in order to extract from the point cloud only the information deriving from the surface of the ground. This method enabled the generation of a digital terrain model (DTM - figure 2) able to describe all its three-dimensional trends and in which it was possible to create contour lines with any type of interval, depending on the needs, up to 15-20 centimetres (figure 3).

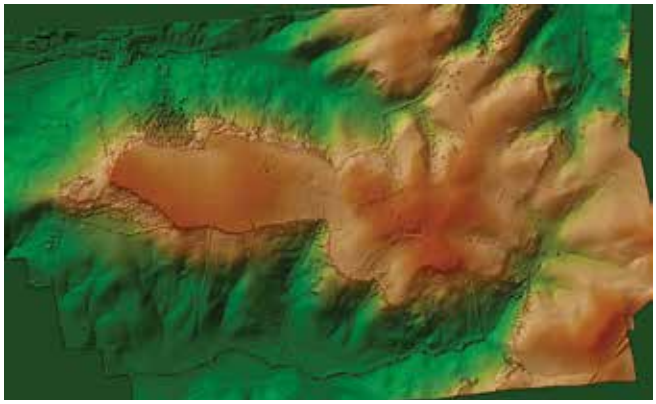

Figure 2. DTM without vegetation

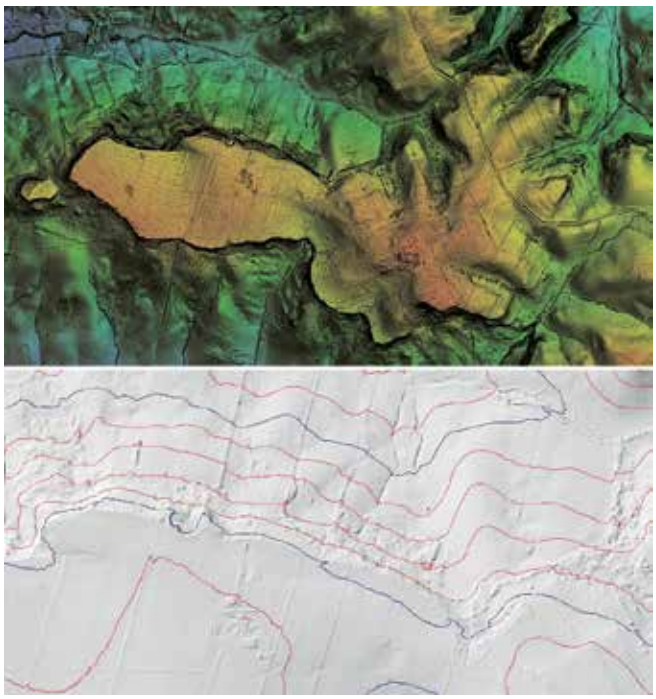

Figure 3. Contour lines every 0.25 meter on DTM without vegetation and contour lines every meter on the 3D model

In addition to the laser scanner instrumentation, on the aircraft there was a digital photogrammetric camera that allowed to perform numerous aerial shoots of the entire archaeological area

Therefore, the resulting model has clearly differentiated from any other three-dimensional product obtained starting from the cartography or available aerial image. The quantity and quality of the data collected by the laser scanner had therefore made it possible to realize a high precision DTM and DSM which proved to be extremely profitable in the census of archaeological emergencies on large areas, since any type of anthropization has clearly emerged from the level of the ground. A further advantage is the creation of an updated and metrically correct cartographic base on which the identifiable archaeological structures have been placed, thus being correctly positioned.

In this way all the problems connected to archaeological structure identification and positioning were overcome, criticisms that had invalidated the previous attempts to draft archaeological thematic maps.

In this regard it is important to underline how the only modern cartographies (regional and provincial technical maps and municipal cartographies) could not act as a unique support for such elaborations. This for two main reasons, the first because they represent primarily data already interpreted with a purpose and a level of definition completely different from the one of the project. The second, closely connected to the previous one, concerns all the criticism of metric reliability of these cartographies and the problems linked to the absolute positioning of the information therein contained.

In fact, the data relating to the archaeological remains are often represented in a very general way (given the large scale of these cartographies – 1:5000, 1:10000 and 1:25000) so as not to fully understand their geometric consistency. Moreover, the area has been characterized by archaeological investigations since the beginning of the XVIII century that revealed structures spread all over the plateau and now not easily recognizable except for limited portions that are anyway not represented in the traditional and current maps.

A separate question deserves aerial imagery, both historical and modern. These constitute a clear snapshot of the territory at different times (the first date back to 1938 with numerous attestations to nowadays) and for the territory in question they are a valid and important source of information especially about the evolution of the landmarks. Previous studies regarding the Etruscan territory (E. Wetter e J.P Bradford for Tarquinia: *Henken, 1968*; F. Castagnoli for Cerveteri: *Melis and Serra, 1968*) had undoubtedly drawn attention to the possibilities offered by aerial surveys and investigations. However, for the tangible verification of the signs

seen through photographic analysis, it was fully demonstrated that the aerial shots could not be enough to identify buried or almost buried remains (*Lerici, 1959*).

Similarly to what had already been determined in Cerveteri, in fact, if on the one hand this methodology seemed appropriate to show the intensity and extent of archaeological deposits, on the other hand it was not able to locate the structures punctually, unless they clearly discerned portions emerging from the surface.

In the clayey soil of Tarquinia, where the ground has been for a long time subjected to agricultural work, the interpretation of aerial images did not seem suitable to provide definitive results, if not accompanied by further stratigraphic analyses or geophysical investigations.

Coming back to the processing of the three-dimensional data, it was necessary to use algorithms that were not too selective and automatic in discarding the points not belonging to the ground. Due to the morphological and dimensional characteristics of the archaeological structures it was necessary to pay attention to this elaboration phase in order to not confuse the points of possible structures with background noise information and thus automatically delete them (*Crutchley and Crow, 2009; De Laet et al., 2009; Kraus and Pfiefer, 1998*).

Therefore, it was necessary to maintain all the trends and all the discontinuities of the terrain that were analysed and to interpret them on a case by case basis, excluding large structures that did not present problems of comprehension.

The working method used consequently the direct exploration of the point cloud and the aerial photographic data. Considering the presence of the infesting vegetation in some points of the plateau, the application of the procedure in Tarquinia allowed to conduct for the first time in Italy a specific research on the potentialities of that technology in similar conditions.

In order to obtain more information on the profiles of the terrain and the demonstration of the presence of archaeological remains hidden by the dense vegetation, an example could be represented by the northern area of the plateau where an additional flight was necessary. The obtained average density was about 10 points per square metre for the flat area of the "Pianoro della Civita", increasing along the northern perimeter strip where the presence of the walls was expected. In this case a density of about 25 points per square metre has been reached, value that is not always homogeneous due to the physical-natural limit constituted by the presence of Mediterranean low, medium and high vegetation, particularly close to the ground points and sometimes difficult to distinguish from the background noise. For this reason, it was tried the recovery of the largest number of information along the outer layers of the plateau in order to improve, as much as possible, the details of the DTM/DSM and consequently make them more defined in view of their subsequent interpretation (*Devereux et al., 2005; Doneus and Briese, 2011; Zaksek and Pfiefer, 2006*).

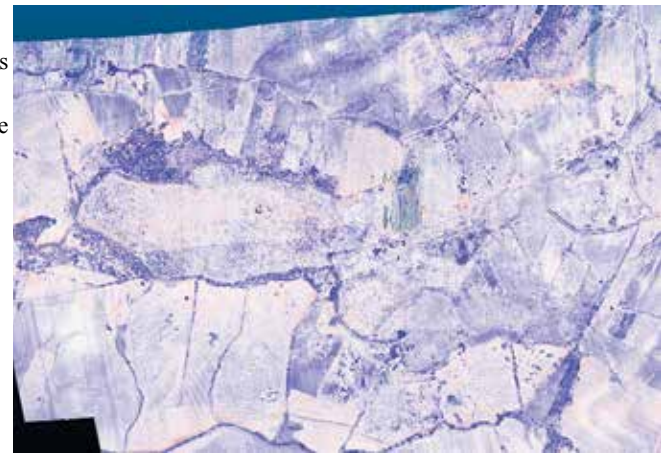

Figure 4. Representation of the intensity all over the plateau

The elaborations were also based on analytical functions of the surfaces, for example: shading or hill-shading[3] which have allowed to increase the shading effect in order to highlight the discontinuities; functions that allow to emphasize the altimetry to bring out the changes in altitude and better understand the course of the terrain; representations aimed at highlighting concavity and convexity of terrain and structures, using the Sky View Factor parameter[4]. Subsequent elaborations have taken into account the frequency and the number of returns of the pulses allowing to distinguish the different macro-categories (figure 4) that compose the cloud, thus allowing to exclude small, medium and high vegetation and to identify more clearly parts of the wall circuit and some archaeological structures (figure 5).

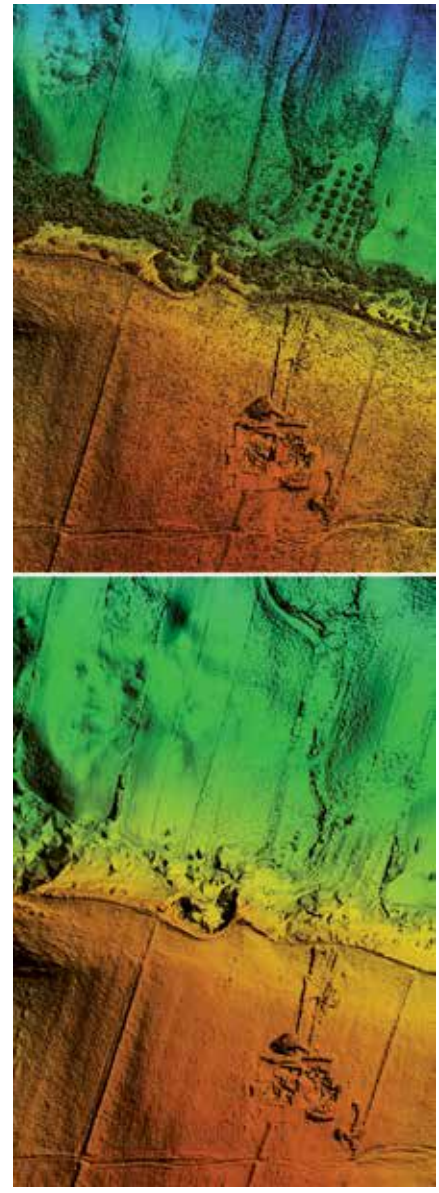

Figure 5. Details taken from the digital three-dimensional model with and without the vegetation

Considering the presence of the infesting vegetation in some points of the plateau, the application of the procedure in Tarquinia allowed to conduct for the first time in Italy a specific research on the potentialities of that technology in similar conditions

Above all, the insertion of an artificial lighting source within the three-dimensional model made it possible to better identify the discontinuities of the terrain, highlighting the contours even for the smallest changes of elevation. This process, together with the differentiation by macro-category of the points, has made easier a first identification of the areas and structures of possible interest from an archaeological point of view.

Through these different processes it was possible to obtain suitable explorations of the cloud, to determine the peculiar characteristics of the Civita Plateau and of the marks of continuity and to make the terrain clearly understandable, highlighting its morphology and the shapes it assumed (figures 6-8), returning the digital altimetric trend for an area of about 90 hectares.

This allowed to overcome the objective limit of the vegetation and to clearly identify signs and characteristics also thanks to dedicated tools, such as the sections (figure 9), able to show the morphology of the ground and its structures intercepted by the section plane.

In fact, the possibility of cutting the point cloud or the three-dimensional model representing the trend of the terrain profile has made it possible to associate and verify data that have been uncertain until now. The sections have been also used to recognize small variations in height (15-20 centimetres) in specific areas that very often have been traced to structures present under a thin layer of earth (*Marzullo and Piazzi 2017*).

All these tools, representations and elaborations have been frequently used in combination in order to have a cross-checking. Subsequently these data were verified through on-site surveys, with acquisition of their positioning through GNSS instrumentation.

Main results

These analyses, together with what emerged from the interpretation of the cartographies and the archaeological research (*Marzullo 2018, pp. 21-48*), made it possible to evaluate and verify the remains, contributing to the creation of thematic maps of the Tarquinian ancient wall circuit (*Marzullo 2018, pp. 79-93*) (figure 10).

The comparative study of signs related to each cartographic threshold, carried out by inserting data into a Geographic Information System, highlighted the elements that constitute

Figure 6. Perspective view of the wireframe DTM

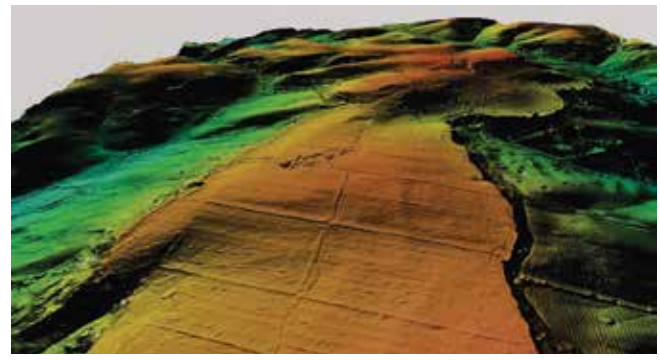

Figure 7. Perspective view of the Civita Plateau 3D model with the LiDAR texture

Figure 8. Perspective view of the Civita Plateau 3D model with the orthoimage texture

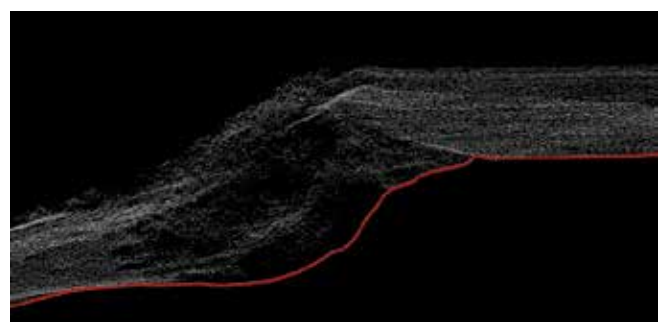

Figure 9. Section of the West slope with evidence of the city wall

the palimpsest of the "Pianoro della Civita", which can be both ancient and modern. In this regard, the systematic analysis of the historical documentation and of the thematic representations from the Renaissance to nowadays made it possible to understand which of these elements were ancient, while at the same time extending the basis of available information (*Marzullo 2018, pp. 21-48*).

The LiDAR data processing produced the most updated, accurate and comprehensive cartographic basis of the plateau. Thanks to its versatility, to the capability to isolate the different materials that compose the surfaces, to the possibility to exclude the vegetation, to measure the height and extension of the geomorphological evidence, and to observe all cartographic representation shaped according to the morphology of the territory, it was possible to rectify accurately all the cartographic information collected.

One of the most significant results is the assessment of structures and sites including several almost unknown remains.

If the location and orientation of the remains could be generically indicated at the areal level, since they were only testified by archival documents such as sketches or excavation reports, the elaboration of the LIDAR data allowed a greater deepening.

Observing the morphological trend of the terrain in relation to the altimetry and examining the discontinuities, it emerged with immediate clarity the extraordinary correspondence between what was indicated in the documentation and the relative portion of the model with what is currently on the site.

Thus, evaluating the archival data in relation to the metrically reliable geometries of the three-dimensional elaborations, it was possible to place with extreme precision not only limited portions, but whole areas.

If, on the one hand, this is a remarkable achievement itself because it had been impossible to observe so much information

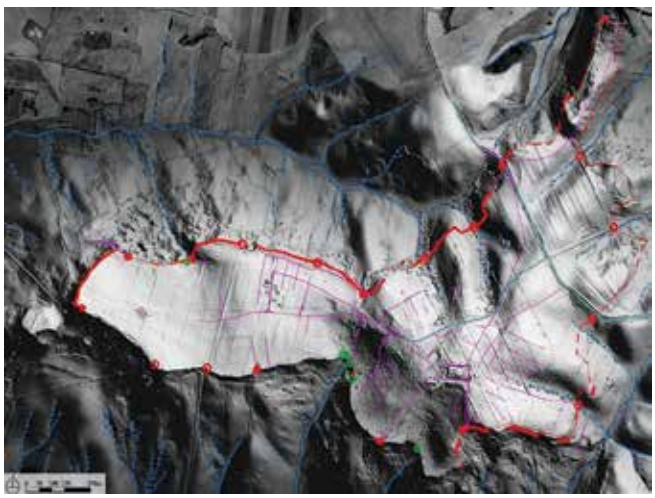

Figure 10. Thematic map of the walls, accesses and roads of the ancient Tarquinia on grayscale LiDAR DTM (*Marzullo 2018, tav. 45*)

The LiDAR data processing produced the most updated, accurate and comprehensive cartographic basis of the plateau. Thanks to its versatility, to the capability to isolate the different materials that compose the surfaces, to the possibility to exclude the vegetation, to measure the height and extension of the geomorphological evidence, and to observe all cartographic representation shaped according to the morphology of the territory, it was possible to rectify accurately all the cartographic information collected

together in a single topographic view before, on the other hand, this is just the starting point for further researches.

One of these concerns an implementation of this open system, which now makes it possible to recover a set of fundamental information, such as the geophysical prospections carried out by the Fondazione Lerici between the 1960s and 1980s. The output of the prospections was not processed in a synthesis embracing the whole data. The past analyses were focused exclusively about road system, highlighting the anomalies in theory related to road alignments (*Cavagnaro Vanoni, 1989*).

The particular value of such achievements lies in the scope of the work, which is nowadays hard to replicate due to the exceptionality of the conditions of the plateau at that time, not yet polluted by waste and metal objects. The issues that have prevented experts from the use of prospections concern the amount of data, the difficulty of interpretation, and mainly their topographic positioning. In this regard, first of all, the Lerici system was set according to the magnetic North, which does not correspond to the geographic North. In addition, each square of the primary grid on the map corresponds to a predetermined linear length and does not consider the changes of the profiles of the terrain. This means that the Lerici's cornerstone mesh does not match to the corresponding physical limits of the same area on the maps. So, to recover the data, the alignment and positioning of the topographical mesh on the ground were needed, moulding it according to the current levels of the terrain.

This is disadvantaged by the impossibility to recognize the topographical references used at those times to place the grid. Without such data, the only elements on which we can now rely are the immutable signs still identifiable in the territory, such as structures, and visible in the Lerici output.

The result we achieved is to newly anchor the geophysical information to the territory and numerous terms of reliable comparison for data analysis, essential tools to face the reconstruction of the urban dimensions of Tarquinia.

In this context, the above-mentioned integrated system of tools developed at interdisciplinary and multidisciplinary level provide a set of services for joining different existing data sources through the definition of a semantic network of relationships among landscapes, stratigraphic layers, structures and artefacts. Therefore, it allows to switch from a territorial scale to the scale of the structures and thereby facilitating the comparison between different series of evidence within the same site.

The set of cartographic, archival information and the recovery of data that couldn't be considered in their wholeness up until now have allowed us to obtain an exhaustive cognitive framework, both from a strictly archaeological and topographic point of view. All this information, currently systematized and easily accessible through a database, is an invaluable resource also as regards as the management of the current territory of the "Pianoro della Civita di Tarquinia". In fact, these data permits the design of plans, the drafting of guidelines for the preservation of the cultural landscape and of archaeological remains and allows a full involvement of the institutions operating on this territory through the creation of a common table with the aim of protection, conservation and enhancement of these areas. This system could be implemented and updated by different figures to store information, to keep track of the actions performed on the archaeological area, to evaluate the achieved results, to plan and to set the objectives regarding the next steps.

Endnotes

[1] Project coordinated at national level by G. Bartoloni and under the responsibility of G. Bagnasco Gianni for the section of Tarquinia MIUR – PRIN 2008-2012, Marzullo 2018

[2] *The publication containing the archaeological interpretations and results on all the archaeological remains of the "Pianoro della Civita di Tarquinia" is currently in preparation, Marzullo 2018, pp. 18-19.*

[3] Available in G.I.S. software such as ArcGIS or GlobalMapper.

[4] in SAGA G.I.S. open source software.

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New regulatory procedures for non-geostationary satellites

The 38th ITU World Radiocommunication Conference (WRC-19) has adopted a new innovative milestone-based regulatory approach for the deployment of non-geostationary satellite orbit (NGSO) satellites in specific bands and services.

The agreement reached at WRC-19 establishes regulatory procedures for the deployment of non-geostationary satellites, including mega-constellations in low-Earth orbit (LEO). The milestone-based approach will provide a regulatory mechanism to help ensure that ITU's Master International Frequency Register reasonably reflects the actual deployment of such NGSO satellite systems in certain frequency bands and services. In defining more flexible timelines and objective criteria, this approach also seeks to strike a balance between the prevention of spectrum warehousing, the proper functioning of coordination mechanisms, and the operational requirements related to the deployment of NGSO systems.

While satellites in geostationary orbit are aligned with the earth's rotation at an elevation of 36,000 km, NGSO satellites move across the sky during their orbit around the earth, in medium Earth-orbit 8,000 – 20,000 km above the earth and in low-Earth orbit at elevations between 400 and 2000 km.

With the availability of launch vehicles capable of supporting multiple satellite launches, mega-constellations consisting of hundreds or thousands of spacecraft are becoming a popular solution for global telecommunications, including to remote rural areas and isolated communities, providing low-latency broadband coverage (owing to their proximity to the earth's surface), remote sensing, space and upper atmosphere research, meteorology, astronomy, technology demonstration and education.

Filings for frequency assignments to NGSO satellite systems composed of hundreds and thousands of satellites have been received by ITU since 2011, in particular in frequency bands allocated to the fixed-satellite service or the mobile-satellite service.

Under the newly adopted regulatory approach these systems will be required to deploy 10 per cent of their constellations within two years from the end of the current period for bringing into use, 50 per cent within five years, and complete the deployment within seven years. *www.itu.int*

In Coordinates

10 years before...

mycoordinates.org/vol-5-issue-12-December-09

Practical multivariate statisticalmultipath detection methods

Lawrence Lau
Research Fellow Department of Civil, Environmental and Geomatic Engineering
University College London

A practical cocktail multiple outlier detection algorithm, called CMOD, is proposed to tackle the undetected outlier problem in classical multiple outlier detection method (MOD) when phase multipath errors in two or more frequencies of a satellite are in-phase. Tests with static test datasets showed that using CMOD with GPS or Galileo three-frequency data may not improve positioning accuracy when compared with MOD results. The author believes that this is due to the fact that there is insufficient redundancy to take advantage of the multiple outlier detection process used in CMOD.

"The consensus attained during the evolution of NSDI is a demonstrator of its relevance to the society"

Says Maj Gen (Dr) R Siva Kumar, CEO, NSDI while explaining the status of NSDI in India

What do you think is a realistic timeline for the NSDI to be implemented before it loses its relevance?

NSDI, today, is relevant and functional. NSDI should not for the time being, be seen as a data repository. It is in effect a combination of technologies policies and standards. The consensus attained during the process of evolution of NSDI is a demonstrator of its relevance to the society.

Sustainable Land Governance

Prof Stig Enemark
FIG President Aalborg University, Denmark

Land administration activities are, not just about technical or administrative processes. The activities are basically political and reflect the accepted social concepts concerning people, rights, and land objects with regard to land tenure, land markets, land taxation, land-use control, land development, and environmental management. Land administration systems therefore need high-level political support and recognition.

GPS equipment accuracy testing

It is essential that all GPS equipment be tested not only initially but periodically also

N K Agrawal

The Northern Territory – Digital survey and cadastral innovators

The processes identified in this paper can relate to any jurisdiction in the world that is looking to digitally manage and upgrade cadastral data

Ian Harper
Geodata Australia

The Northern Territory (NT) has been able to introduce innovative digital survey and cadastral management for Land Administration. GNSS became the obvious alternative to historical traversing in remote areas and the NT recognised early that a survey accurate coordinated digital database was the way of the future.

Since the mid 1990s the NT used applications that stored the original survey plan measurements to create objects (lots/parcels) that could be joined together and adjusted to build a survey database that would be the cadastral layer in developing GIS for land administration. The process adheres to rules of topology and connectivity to ensure the veracity of the digital process.

The survey accurate database SPICAD created from survey plans and coordinated survey control is incrementally replacing the Digitised Cadastral DataBase (DCDB) as the authoritative cadastral database. SPICAD is now used to spatially analyse new surveys and then that new survey data is used in spatial upgrading a local area of SPICAD.

From the beginning local surveyors were engaged by the project for back capture of plans and the survey of control for the co-ordination of land parcels. This inclusion process engendered ownership and allowed a smoother implementation of other technical and administrative changes. Importantly, they came to understand that this was a different approach to managing their survey data, and it set the agenda for their role and responsibilities in digitising the cadastre.

In July 2016, DIPL (NT Government, Department of Infrastructure, Planning and Logistics – Land Information Group) mandated all survey plan lodgements to be completely digital but with a mixture of digital images, a file of machine readable content of certain parts of the plan for a degree of automation and an examination report generated by the surveyor.

The NT also has the capacity for land boundaries to be delimited or defined by coordinates through Legislation enacted in 2004. The Surveyor-General has discretion to declare these areas when they are satisfied that the SPICAD model is of suitable precision to represent the surveyed boundaries or a property is suitably defined by SPICAD. Three (3) "pilot" areas have been declared to date.

Unit (strata) Plans and their 3D components are now being captured in SPICAD.

This Paper follows the digitisation processes and outcomes from the beginning to recent times.

The Department of Infrastructure, Lands and Planning (DIPL) has all but completed the back capture of survey plans into SPICAD which facilitates dynamic 2D digital cadastral modelling. The process to replace the Digitised Cadastral DataBase (DCDB) mapping database with the survey database created from survey plans and coordinated survey control is under way

Introduction

The Northern Territory (NT) covers over 1.3 million sq. kms and is sparsely populated with approximately 250,000 people mainly in several urban areas with approximately 85,000 land parcels. Pastoral Leases can cover large expanses and in the past these boundaries (up to 80km) were traversed by survey parties but now GNSS surveys can do in 1 day what may have taken weeks or months in the past.

In the mid-1990s the NT Government were engaging with the implementation of the Association of Consulting Surveyors (ACS) survey coordinate geometry software developed by Michael Elfick and Mike Fletcher. Development work on the GeoCadastre survey database application by Elfick and Fletcher had been under way for several years. DIPL recognised the benefits of GNSS and a digital survey database over 20 years ago and looked at how to take advantage of these new technologies.

The varied expertise and background experience of Elfick and Fletcher generate a powerful synergy in moving from a manual hard copy land administration system to a digital one. Dr Michael Elfick is a Registered Surveyor in New South Wales with experience in private industry, as a senior technical advisor to the NSW Lands Department & a University academic in surveying. Mike Fletcher is a software engineering systems developer with considerable experience in large corporate digital systems.

Michael and Mike began development of a 'survey coordinate geometry package' for PDP-11 systems for ACS in the early 1980's, which was then adapted for PC's in 1990. Development of the Parcel Fabric Survey Database Application **GeoCadastre** began in 1990 in conjunction with the Hunter Water Board (Utility) in NSW and then with the Northern Territory since the late 1990's.

This was the beginning of the NT becoming survey and cadastral innovators with the guidance and applications of Elfick and Fletcher that use survey processes to manage survey data in a GIS object based environment.

Elfick and Fletcher continued development of the process for generating coordinate based cadastral systems from measurement based "Metes and Bounds" information with projects in NSW, Queensland, the Philippines, New Zealand and the USA. From 2004 Michael and Mike worked with the ESRI development team to incorporate the GeoCadastre cadastral management engine into the ESRI GIS environment. This was licensed to ESRI as the Parcel Editor tool in the ESRI Enterprise system used by all level of Government and Utilities worldwide. ESRI adopted the GeoCadastre (GC) structured text file for the management of cadastral boundary information in the Cadastral Editor XML (CEXML) interchange format. It was important to maintain the survey integrity of the process in that GIS environment even though the level of rigour in data verification and analysis was not usual GIS practice.

GeoCadastre provides a local survey solution to fit survey plans together into a seamless database for ongoing upgrading with survey and spatial data. That process and data structure is scalable into the ESRI Parcel Fabric GeoDatabase to manage a dynamic strategic or State Land Administration system. For the Northern Territory Elfick and Fletcher developed an application to store the cadastral data in a standard SQL database or other suitable databases and can be accessed via web applications.

In spite of the NT being a statistically small jurisdiction with limited budgets, it showed initiative to progress digitisation at a time when others were unsure how to progress.

The geocadastre parcel fabric – A digital survey database solution

In the Torrens Title System, government maintains a register of land titles with a comprehensive record of ownership and the "RRRs" - Restrictions, Rights and Responsibilities (FIG, 2005) related to that land. That register includes a spatial representation generally supplied by a survey plan of a deemed standard that is referenced by the title register.

In the Torrens System, Government generally provides a guarantee of title (indefeasibility) but does not guarantee the exact dimensions or spatial extents based on the fact that older survey plan dimensions may vary slightly from the accurate distance between monuments. Spatially it is based on the premise of "monument over measurement" which dictates any monument or survey mark placed by the original surveyor determines the location of a boundary, irrespective of any measurements on a survey plan defining a Title.

GeoCadastre is based on the process that Licensed/Registered Surveyors would follow in their computations using the field measurements and notations shown on survey plans that legally represent the spatial extents of land titles in Torrens or similar survey plan based systems.

In a desktop database solution, plan parcels were joined together in a seamless parcel fabric survey database and then a Least Squares Adjustment (LSA) would use survey intuition to get the most accurate outcome based on the information available. This survey database exists in a coordinated database where Fletcher's system management expertise provided considerable value.

Any point in a digital database is defined by coordinates and any object in a mapping database is defined by a collection of points. Survey plans only define the relationship between points and adjoining objects so there has never been a wider location context until the advent of the database. The GeoCadastre Parcel Fabric connects those two sets of data.

The Elfick/Fletcher process looks to the survey plan as a means to feed the available survey measurements into the database and then uses tools to validate the quality of that data and adjusts it to the most informed location.

Michael Elfick comments "In a measurement based title system it is important to view coordinates as simply being derived information, not the base reference material itself".

Working with survey dimensions as attributes of all parcels increases the capacity to manage and analyse cadastral data by using a Least Squares Adjustment (LSA). Adjoining parcels defined by surveys from different eras can share the same node points and provide redundancies to the LSA. This provides a more rigorous adjustment outcome than a coordinate based solution as well as a tool to analyse a dataset for errors in data entry or recorded on survey plans.

The GeoCadastre text file holds the measurement and other database intelligence. This format was adopted early and the NT has retained that transfer structure even though other States have adopted the Australia wide Intergovernmental Committee on Survey and Mapping (ICSM) LandXML ePlan standard structure. The ICSM LandXML file structure is limited to one 'survey' or plan, whereas the GeoCadastre text file can represent one or many plans in an adjusted survey database. The GC file also has some extra cadastral functionality that includes 'Line Points' that allow a line of many segments to remain a straight line in the adjustment as indicated by the survey plan. See Diagram 1 below.

Implementing digitisation in the Northern Territory

The NT began by looking for a better way to manage the pastoral lease areas, but it realised that the GeoCadastre process was applicable to the whole territory. The problem was approached from a survey point of view - that is to honour the data and capture the survey information from the plans and hold it in a logical way.

The design of the system unfolded by simply following what actually existed. That is, plans contain parcels, parcels are made up from lines, lines have a point at each end, some points coincide with a control point; and each object (Plan, Parcel, line, point and control point) has a number of data types. For example a point has X, Y, Z etc.

Larger Pastoral Leases were initially defined by (curved) parallels of latitude but traverses undertaken to mark the extents of these leases on the ground (up to 60 years ago) were a series of straight lines between the pegs placed. Under the auspices of Torrens Title the pegs/monuments placed by those surveys now defined the boundary. That allowed the boundary survey traverses to be back captured and create the survey database. (See Diagram 2)

From the 1990s the NT manually entered and stored the original survey plan measurements to create objects (lots/parcels) that could be joined together and adjusted to build a survey database that would generate the cadastral layer in developing GIS for land administration. The process adhered to the rules of topology and connectivity to ensure the veracity of the digital process.

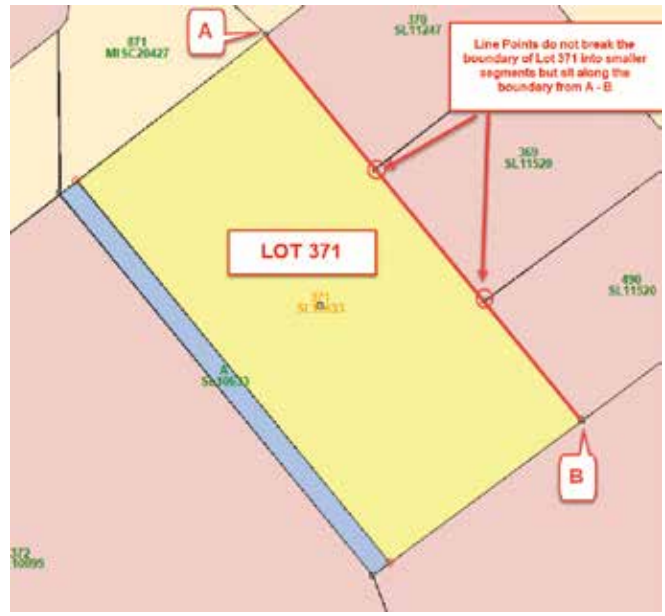

Diagram 1: Line Points

Diagram 2: Pastoral Leases in remote areas that have been back captured

NORTHERN TERRITORY - LICENSED SURVEYORS ACT 2004

PART VI – PRACTICE OF LAND BOUNDARY SURVEYING

46A. Coordinated survey areas

(1) The Surveyor-General may declare an area of land in the Territory to be a coordinated survey area.

(2) A declaration under subsection (1) is to be notified in the *Gazette* and takes effect on the date specified in the notice.

(3) A survey within a coordinated survey area is to be in accordance with an approved methodology to delimit land boundaries by geodetic coordinates or with another approved system of delimitation.

Figure 2: Coordinated Survey Areas Legislation

The back-capture was undertaken by in-house survey staff and outsourced locally. Local surveyors were also engaged by the project for survey coordination of control points.

An early outcome of the implementation was recognition that coordinates could be used as prima facie evidence to determine the location of a boundary. Legislation enacted in 2004 was not complicated so the Surveyor-General could determine suitability of areas without needing to consider excessive conditions in the Legislation. (See Diagram 3) This recognised the future capacity of GNSS and the survey database (SPICAD) to accurately define land under the Torrens System.

The Surveyor-General has discretion to declare these areas when they are satisfied that the SPICAD model is of suitable precision to represent the surveyed boundaries or a property is suitably defined by SPICAD. Three (3) "pilot" areas have been declared to date .As of July 2016, DIPL has mandated all survey plan lodgements to be completely digital but with a mixture of formats that is each "Fit-For-Purpose". Whilst the "Fit-For-Purpose Land Administration" publication (Enemark FIG, 2014) was focussed on developing countries, a flexible and pragmatic approach is equally applicable to developed countries.

The process requires surveyors to lodge:

1. a digital image of their new survey plan as they have prepared it in the past
2. a GeoCadastre text file of specific content. That content relates to parcel dimensions and other measurements that can benefit the spatial upgrading of SPICAD and statutory jurisdictional content needed for transactions.
3. a Northern Territory Plan Examination Report generated by GeoCadastre verifying the text file data content.
4. New geodetic data in various digital formats including:
   - Location diagrams
   - Observation data
   - Coordinate listing
   - Other relevant reports

The NT digital cadastral content may be reduced but retains all data relative to a rigorous solution. However it is scalable if more rigour or cadastral intelligence is required in the future.

After the plan and data is Registered and new titles are issued, the GC text file is used for updating the cadastral survey database. A 'packet' of the parcels surrounding the new title is extracted from SPICAD as a joined survey database. The new GC text file including survey control coordinates is joined to the packet and adjusted. This spatially upgrades the packet database but the outer extents are held fixed to return seamlessly to SPICAD. The subdivided parcel remains in the survey database with an 'historical' parcel designation. Historical parcels are not visible as part of a current cadastre but are always accessible.

As the original survey measurements are stored in SPICAD, this survey database packet can be used for spatial examination in GeoCadastre. Comparisons

of new survey measurements and existing survey measurements can be made or there are strategic options to compare new and old spatial database locations with relative precision reporting.

Surveys completed since 1980 are of the highest precision and are generally spatially enabled so the capacity exists to move to greater digital processes with SPICAD underpinning the processes supported by the Coordinated Survey Areas Legislation outlined above.

The current status

The Department of Infrastructure, Lands and Planning (DIPL) has all but completed the back capture of survey plans into SPICAD which facilitates dynamic 2D digital cadastral modelling. The process to replace the Digitised Cadastral DataBase (DCDB) mapping database with the survey database created from survey plans and coordinated survey control is under way.

Comments from the Director Survey, DIPL (Rob Sarib) on the current status note that: *the Department has seen efficiency gains (less red tape) in the processing of survey plans and the subsequent issue of a title, and also greater transparency with respect to the roles and functions of surveyors in the public / private sector.*

It has also been an integral part of the pathway in the electronic (digital) land development cycle – that is from an application to develop a parcel to the issuing of tenure. For the NT it has been an incremental process to fully digitise the cadastral information cycle; although it has taken some years, rapid technological and system developments in the geospatial and survey arena has provided more flexible and Fit-For-Purpose options.

The challenges that remain include:

- *Surveyors having the appropriate skillsets / capabilities for the future*
- *Legal, policy and institutional hurdles – land survey statutory requirements, standards & practices, guidelines with respect to – what is the legal medium / form defining the cadastre, digitising, rendering information, auditing etc*
- *Technical :*
  - *back capture and digitisation of survey data (units and other interests – "RRRs")*
  - *reviewing and updating the cadastral information model for 3d / 4d and a modernised digital cadastral system*
  - *visualisation of the cadastre*
  - *upgrading to a survey accurate spatial cadastre (cm)*
- *Unification of jurisdictions on matters associated with Cadastre 2034 – national approaches versus local*
- *Completing the replacement of the DCDB geometry with SPICAD geometry*

The development of the NT cadastral system has been driven by surveyors over the last 100 years. Now land

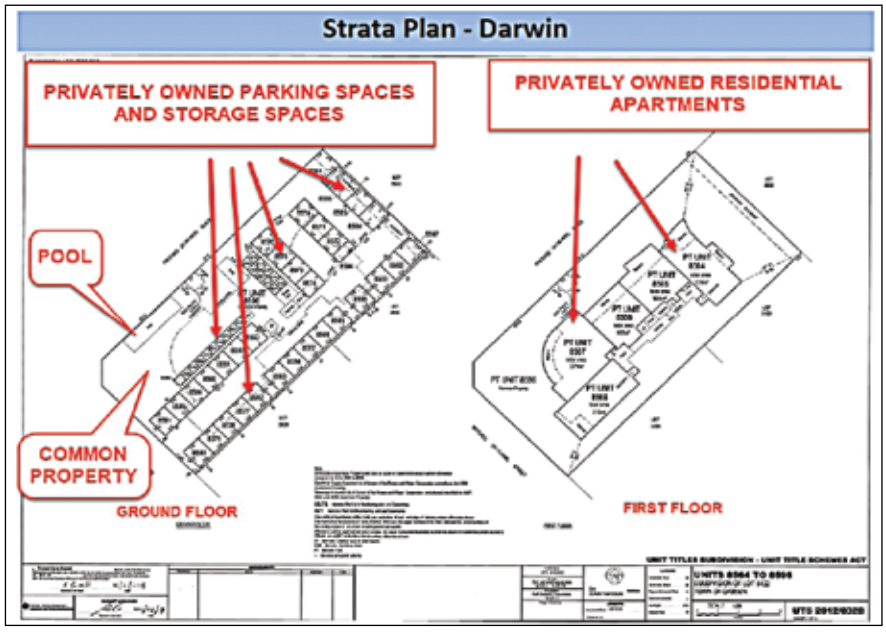

Diagram 3: Strata Plan showing individual floor plans. Every level is represented on the plan even if they are exactly the same floor plan.

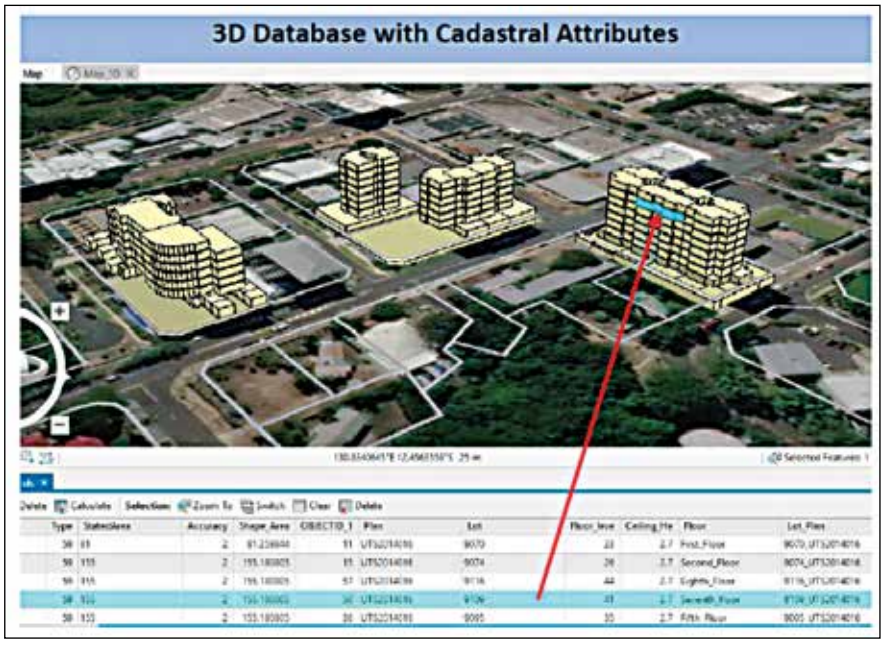

Diagram 4: 2D & 3D attributes assigned to parcels allows interactive 3D modelling

administration and management has to make sure that all legal and other entities are correctly represented in the database. Many existing mapping polygons must be reworked as they differ from survey data and the complexity lies in the detail.

One historical issue being dealt with by DIPL is that spatial management of land (the survey plan) and the tenure (ownership details) is managed by different departments and each has a unique identifier (UI). These need to be linked by another unique identifier (the LAISKEY). By comparison some other states use a UI defined by a Lot/Plan configuration which identifies both the survey and legal entities.

A further challenge is representing land tenure or an interest (RRR) which is located within OR is over the parent parcel that has another form of tenure or interest. The tenure status of this parcel of land is sometimes referred as "secondary tenure" or an "admin parcel" as it is NOT excised from the parent or underlying parcel. This land tenure could also be registered or NOT registered with the Land Titles Office.

In the short term, the greatest benefit will be for DIPL, but it will benefit private sector surveyors as they start to understand the counter intuitive object based process and the value of the data available. Where they intend to do a cadastral survey they can download an area of the survey database that would have all available survey plans joined together and adjusted to available coordinated control. It will be in a machine readable text file, so it will be readily accessible to new applications in the future and it would be the most accurate representation of the real world cadastre. This is one of the major objectives of DIPL in the future electronic land development cycle.

The model coordinates would assist the surveyor in quickly finding monuments or survey marks relative to their survey objective. That would either confirm the spatial integrity of the existing database or where boundaries differ, they can be presented as an updated digital file and rendered diagram to DIPL from their working dataset.

> The foundation of the future NT cadastral database will still be built on the information captured from the original survey plans but smarter applications will be able to enhance the outcomes and that smarter data will be able to be utilised by other applications

Converse to that is the capacity of the survey database to assist surveyors in finding problems in the field or on survey plans. Where things don't fit in the field the surveyor can use variations of GNSS control in the adjustment to identify quickly where the problem or problems in the existing survey data may be.

Local surveyors are aware of the initiatives of DIPL but as they are being implemented in the immediate future they are still learning some of the detail of the processes and how they will benefit them in their field work, their computations and digital outcomes. DIPL will facilitate that knowledge transfer.

3D cadastre in the Northern Territory

3D cadastre in Australia is mostly spatially defined by the regulations of Strata Title Acts in each state. The Strata Title Legislation that allows people to own the freehold title of an apartment was first enacted in NSW in 1961 and the basic Regulations have not changed significantly since that time. Across Australia there are in the order of 300,000 Strata schemes housing over 3 million people.

Strata plans have limited measurement or height data as the ownership extents are defined by the faces (or centres) of structural walls or columns and the upper and lower levels (or centres) of structural floors. Measurements were not required as an owner or others could immediately determine exactly the extent of ownership. Structural components of buildings and shared access areas are deemed Common Property and are managed by a representative group of unit owners. Services supplying water, sewer, electricity, drainage etc were deemed to be covered by Rights, Restrictions or Responsibilities, irrespective of the fact that their location may be uncertain.

The Strata Title Legislation could be deemed Fit-For-Purpose as it is a basic but elegant solution for a complex ownership arrangement but spatial data from existing strata plans to populate 3D digital databases is not readily available. BIM modelling is quoted as the future source of good digital data but BIM data is not available for existing Strata Plans or the majority of 3D cadastral entities currently being constructed or into the near future.

In the NT, capture of basic components for 3D cadastre visualisation is now considered in the plan registration process and those 3D attributes are stored in the survey database for future 3D modelling. DIPL will determine the structure of the intelligent digital data supplied by the surveyor at the time of Strata Plan registration. This data collection and management will allow the automation of 3D modelling.

The flexibility of the GC text file allows extra attribute fields to be incorporated so the digital data supplied by the surveyor contains the required 2D and 3D intelligence. That 3D intelligence can nominate every individual unit as an object in the database so units on top of each other will be co-linear but 3D modelling applications will provide the visualisation capacity.

The real challenge to all States is integrating the 300,000 Strata Schemes that have no 3D spatial attribution into the digital environment. See Diagram 3 below.

The strength of the NT processes are that all types of spatial data (survey traverses, GNSS, imagery location, crowd sourcing, etc) can be used for location upgrading with the spatial integrity of the data taken into consideration to give greater security of title into the future. With the applications available, states should be rapidly looking at digitisation implementations to capture and retain the integrity of good data moving forward

The digitisation process is not difficult for existing Strata plans if the spatial precision requirements are not set too high and the economics of a Fit-For-Purpose outcome are adopted. Diagram 4 below shows the capacity of the ESRI ArcGIS Pro application for dynamic 3D modelling with basic 2D and 3D attributes provided. If the data is accessible any similar visualisation application can be utilised.

The future

The foundation of the future NT cadastral database will still be built on the information captured from the original survey plans but smarter applications will be able to enhance the outcomes and that smarter data will be able to be utilised by other applications.

The current capacity to capture parcel 3D attributes will flow through to capturing parcel 4D attributes that will feed the dynamic land administration foundation that will be responsive to higher precision and accessibility.

Surveyors are uncertain how Torrens Title land can be defined by a coordinated database in the same way it has been done since 1863. In the edict 'monument over measurement' coordinates become the new monuments as they define a specific point on the ground. If the surveyor is satisfied that he or she can prove that a coordinate does not accurately represent the original corner, they can put their evidence to the Titles Office and if the evidence is accepted then the coordinates of that point in the database can be amended to a more accurate representation. This follows the same process in the existing system where the surveyor would register a plan of redefinition as the spatial reference for a title if they disagree with the current spatial representation shown on a plan.

This highlights how critical the 4th dimension attributes are in the system for the future as any surveyor would be required to check that any boundary survey they are undertaking reflects the current coordinates of the title. This also considers any geodetic adjustments that improve the spatial quality of the coordinates or datum shifts like the Geocentric Datum of Australia (GDA) 2020 shift of approximately 1.8m in Australia to match the continental plate drift with GNSS datum.

Concluding remarks

The processes identified in this paper can relate to any jurisdiction in the world that is looking to digitally manage and upgrade cadastral data. The NT cadastre is measurement based (bearing and distances) but the processes implemented by the NT are equally applicable to a coordinate based cadastre.

The strength of the NT processes are that all types of spatial data (survey traverses, GNSS, imagery location, crowd sourcing, etc) can be used for location upgrading with the spatial integrity of the data taken into consideration to give greater security of title into the future. With the applications available, states should be rapidly looking at digitisation implementations to capture and retain the integrity of good data moving forward while considering how historical legal records are brought into the system.

NT took a leap of faith in the 1990s in the digitisation implementation. With limited finances and resources the NT did not begin the process by going down the classic path of completing business strategies and setting up complex Data Models, etc. With the guidance of Elfick and Fletcher the Northern Territory considered what survey plan data was most relevant to the digital environment and began development and implementation.

The NT is now benefitting from that foundation as the 4th Industrial Revolution introduces technological infrastructure for automation of processes and transactions.

In their own way the NT are survey and cadastral innovators as they manage the transition from the measurement based title system of the past to a position based title system of the future (Elfick 2010).

Acknowledgements

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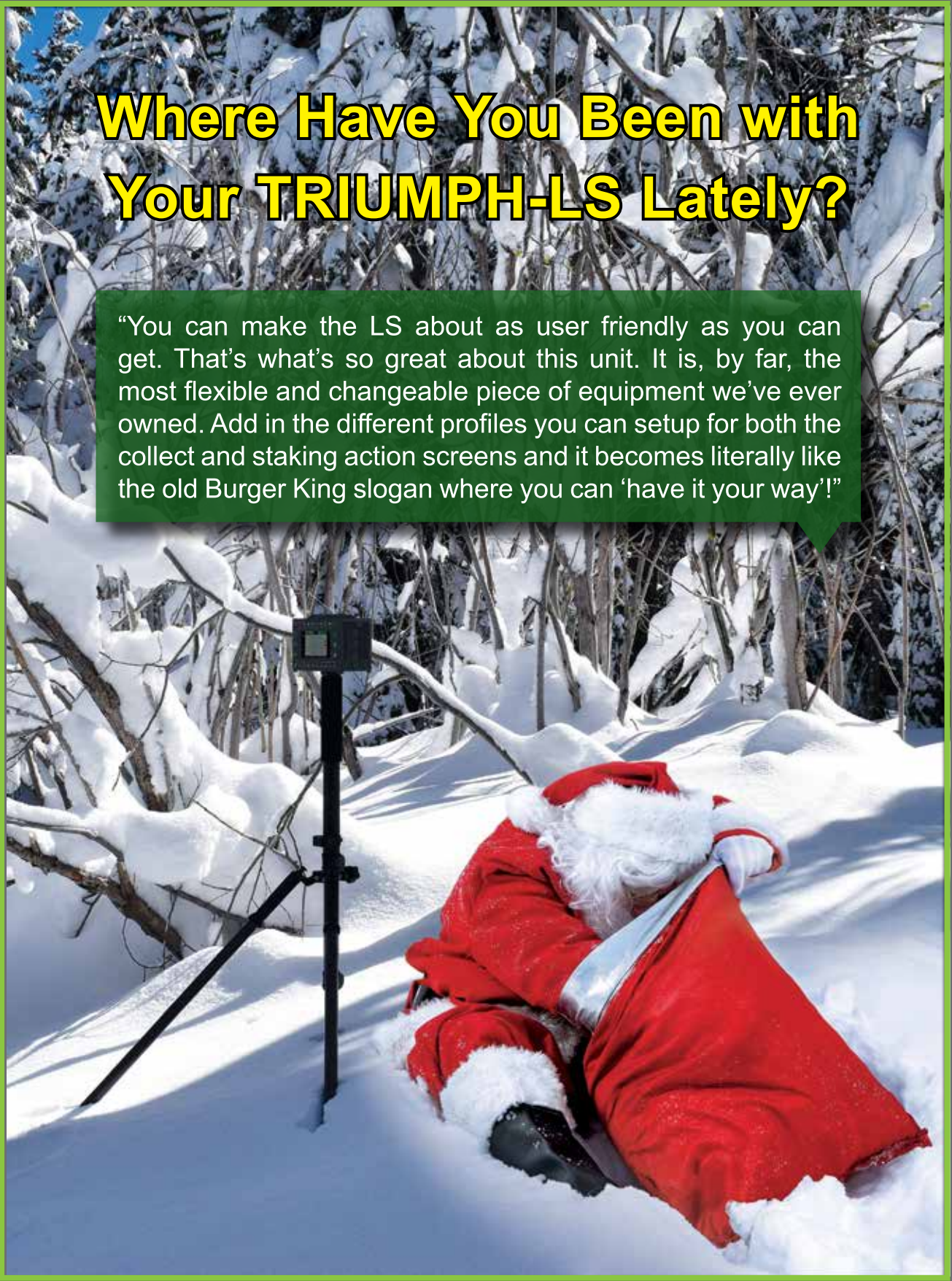
Robert Monteath - Registered Surveyor / Licensed Strata and Community Manager, Newcastle, NSW.

The paper was presented at 15th South East Asian Survey Congress (SEASC2019) Darwin, Australia, 15-18 August 2019.



JAVAD

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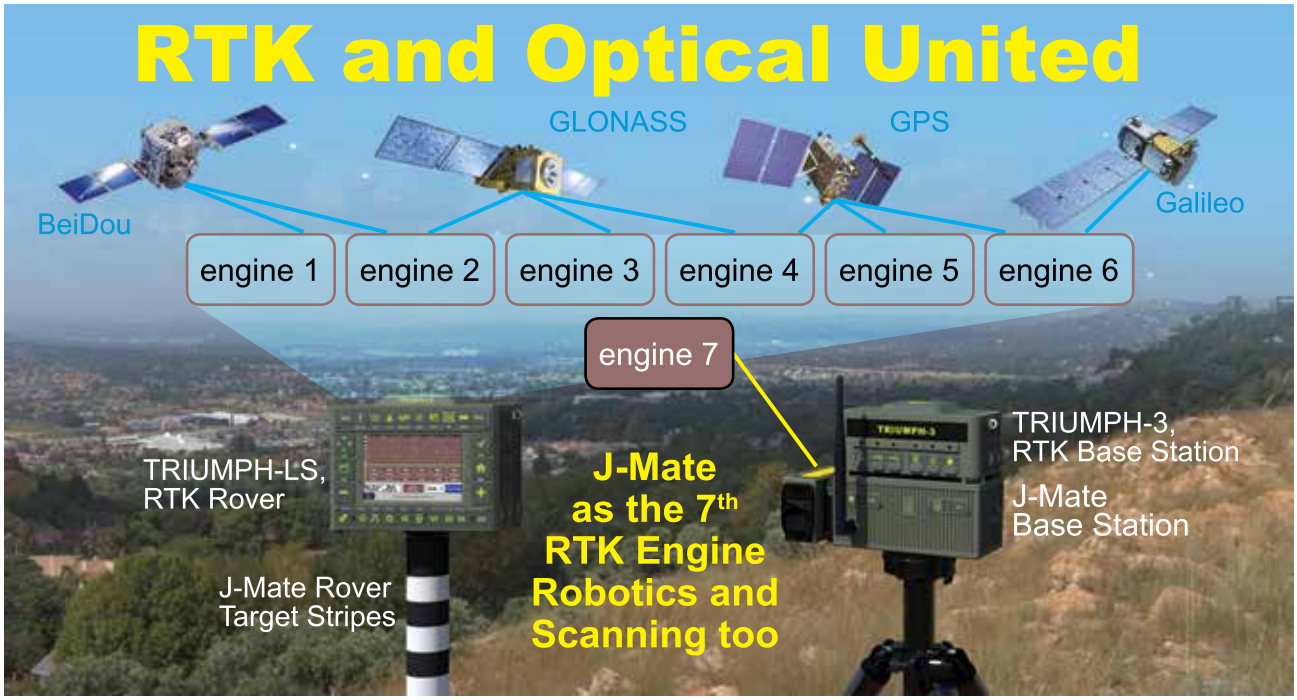
Front

Stephen Drake
TRIUMPH-LS user and J-Mate Volunteer.

"I don't know if I'd still be in business if it weren't for Javad"



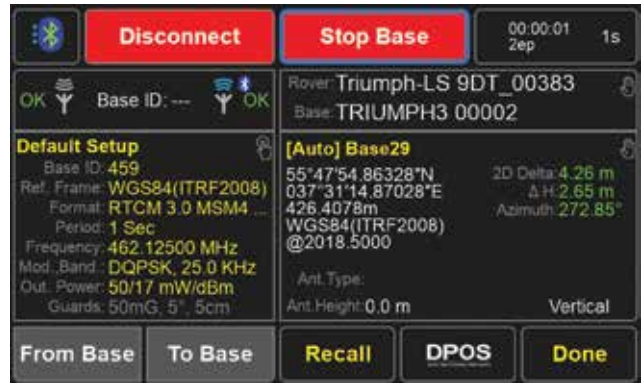
Your Own Complete RTK & Optical

Setup TRIUMPH-3 on top of J-Mate. Set up TRIUMPH-LS on top of the Zebra rod.

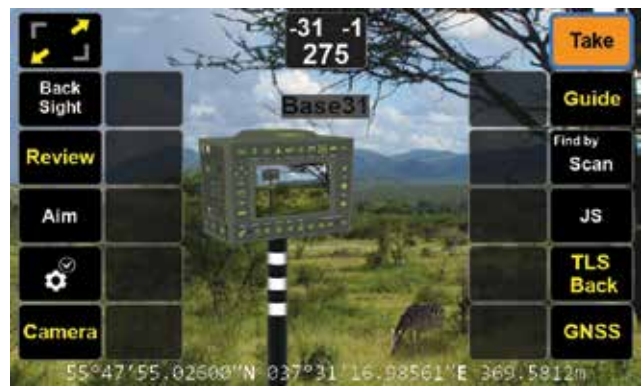
TRIUMPH-3 is the RTK base station and TRIUMPH-LS the RTK rover. J-Mate is the optical base station and the Zebra rod is the optical rover.

Now RTK and optical solutions are available simultaneously and can verify each other's solutions. They also can cover each other, when one is not available.

RTK has six engines. We treat the J-Mate solution as the seventh engine of the system.



The system is self-sufficient for all jobs. No need to pay RTN service providers for RTK base stations and no need to pay communication service providers. The communications are done via integrated and included Bluetooth, UHF, and Wi-Fi embedded in the system.



Another major advantage is that because your own RTK base station is not far from your rover, RTK solutions will be provided much faster and more reliably.

We added the "Aim" option for stake-out. In this mode J-Mate points to the selected stake point and you follow the laser to reach the intended point. This is in addition to the robotic mode which J-Mate follows your Zebra pole.

At TRIUMPH-LS = 2.13 kg (4.40 lb), TRIUMPH-3 = 1.26 Kg (2.20lb), and J-Mate = 2.17 kg (4.41 lb), the total package of 5.6 kg (11.02 lb), weighs less than one conventional optical total station alone.

J-Mate does have complete geodetically encoded scanning (3 points per second) and robotic features too.

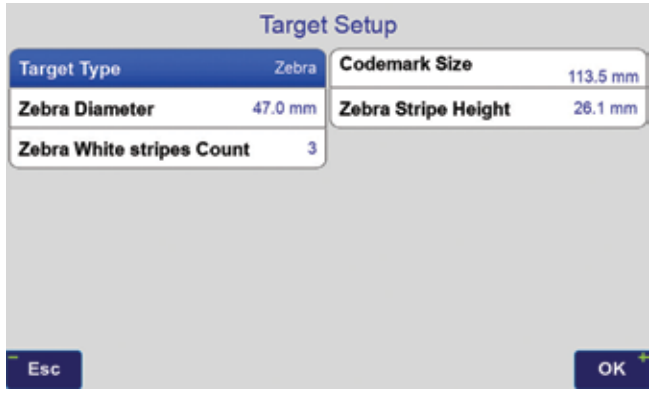
J-Field, the Embedded Controller

J-Field is the embedded application program of TRIUMPH-LS. It has the following unique features for each point surveyed:

- Six parallel RTK engines to maximize solution availability.
- Automatic Engines Resets, verification and validation strategy.
- Several graphical and numerical confidence reports and documentation.
- Voice-to-text conversion for hands free operation and documentation.
- Lift & Tilt and automatic shots for hands free operation.
- Visual Stakeout (Virtual Reality).
- "DPOS it" or "Reverse Shift it" features. The most advanced RTK verification.
- Photogrammetry and angle measurements with embedded cameras.
- Automatic or manual photo documentation.
- Automatic screen shots documentation.
- Audio files for documentation.
- Automatic tilt correction.
- Scanner feature.
- Find objects by their shape, by laser or optical.
- Comprehensive HTML and PDF reports.
- Comprehensive codes, tags and drawing tools.
- Status of all GNSS signals and their quality.
- Over 3,000 Coordinate Systems.
- Automatic and free software update via Internet.

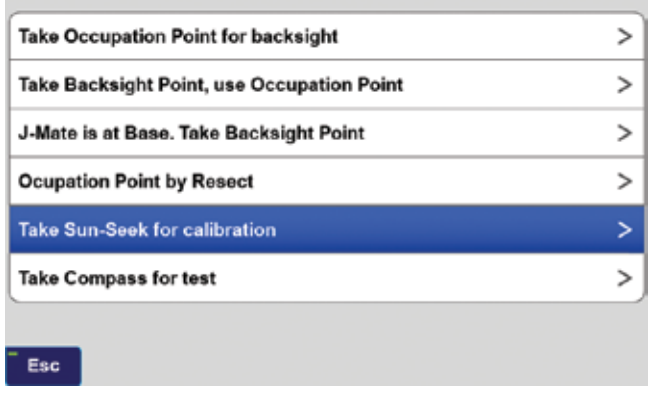
Take Backsight with a Single Shot

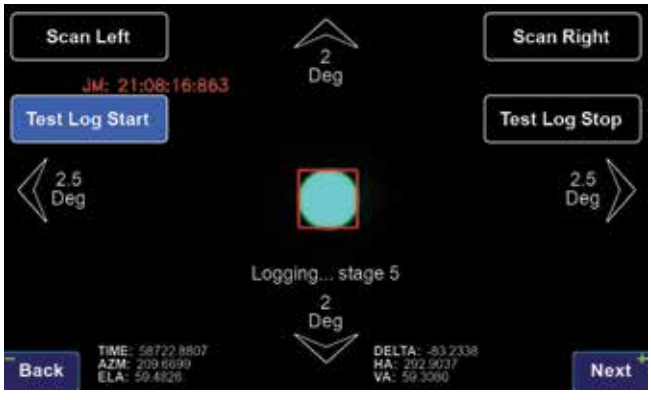
To calibrate the J-Mate, take few seconds of RTK at the Backsight point, and click "Backsight" button. There is no need to locate Occupation Point and the Backsight point, because Occupation point is the RTK Base station and one point is enough to determine the azimuth to calibrate the J-Mate angular encoders.

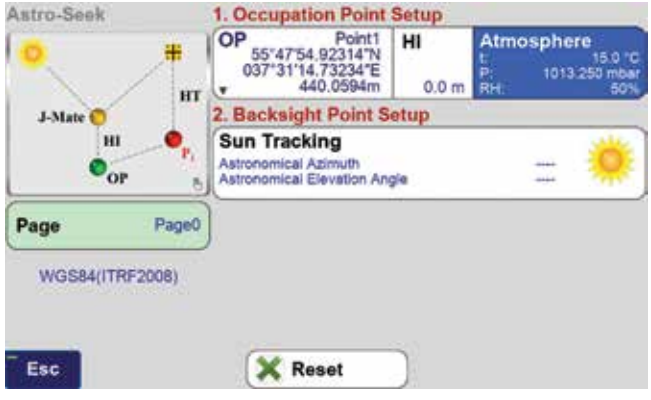


Backsight with Auto SunSeek

Click a button and after a few seconds Backsight will be calibrated with the Sun AUTOMATICALLY. Don't forget the Sun filter.







See details at www.javad.com

Light Weight, Low Cost

Costs ½ , Weighs ½ and works much better than conventional total stations and RTK systems.

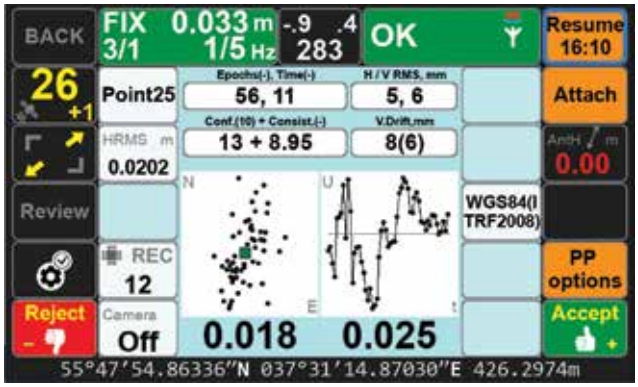
Complete RTK Base & Rover.
Complete controller and software.
Complete optical system.
Free updates.
Robotic & Scanner...
...all under $40K

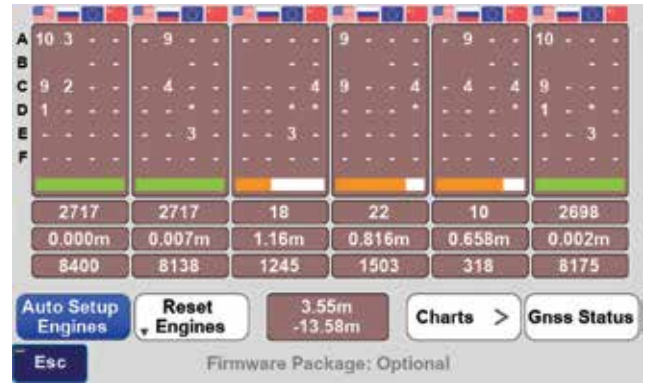
And it all fits in a small carrying bag.

Six RTK Engines Auto VERIFY

Smart assignment of satellite signals to different engines.

This vigorous, automated approach to verifying the fixed ambiguities determined by TRIUMPH-LS gives the user confidence in his results and saves considerable time compared to the methods required to obtain minimal confidence in the fixed ambiguity solutions of other RTK rovers and data collectors on the market today. The methods required by other systems are not nearly so automated, often requiring the user to manually reset the single engine of his rover, storing another point representing the original point and then manually comparing the two by inverse, all to achieve a single check on the accuracy of the fixed ambiguities. Acquiring more confidence requires manually storing and manually evaluating more points. Conversely, J-Field automatically performs this test, resetting the multiple engines, multiple times (as defined by user), provides an instant graphic display of the test results, and produces one single point upon completion.





Adam Plumley, PLS

Locating fence posts...

If you notice the LS center is on the inside face of the post. That is where I will be placing the wire. I staked out each point where a metal tpost will be driven between the larger wooden posts. I will cut the wooden posts to height later. For now I had to climb up on the roof of the buggy to shoot them. I've done about 500 ft of tposts so far and they line up great. Much better work flow than the old school way of tying Mason twine to the posts and using that for line and pulling tape or flipping tposts (if you know what I mean). I've flipped a few in my time.

FR

TRIUMPH-3

The new TRIUMPH-3 receiver inherits the best features of our famous TRIUMPH-1M.

Based on our new third generation TRIUMPH chip enclosed in a rugged magnesium alloy housing.

The TRIUMPH-3 receiver can operate as a portable base station for Real-time Kinematic (RTK) applications or as a receiver for post-processing, and as a scientific station collecting information for individual studies, such as ionosphere monitoring and the like.

It includes options for all of the software and hardware features required to perform a wide variety of tasks.

- UHF/Spread Spectrum Radio
- 4G/LTE module
- Wi-Fi 5 GHz and 2.4 GHz (802.11 a, b, g, n, d, e, i)
- Dual-mode Bluetooth and Bluetooth LE
- Full-duplex 10BASE-T/100Base-TX Ethernet port
- High Speed USB 2.0 Host (480 Mbps)
- High Speed USB 2.0 Device (480 Mbps)
- High Capacity microSD Card (microSDHC) up to 128GB Class 10;
- “Lift & Tilt”
- J-Mobile interface

Ideal as a base station

Global experiences with public private partnerships for land registry services: A critical review

The purpose of this paper is to provide an overview of experiences globally with LRS PPPs and privatization proposals. Readers may recall that we published the first part of the three parts of the paper in the last issue where emphasis was on understanding privatization and Public Private Partnerships. Here we present the second part of the paper. In this section, author shares some of the global experiences from Canada, United Kingdom and Malaysia

Dr. Keith Clifford Bell
RFD, FIEAust, FISV, F.ASCE, LS, CPEng, NER
The World Bank Office
Bangkok, Thailand

PART B – Global experience

Case Studies

This report presents ten case studies on LRS ASD approaches – 6 where PPP has been fully adopted; two outright rejections (one of which also considered full privatization); and two which have adopted alternative approaches. Any review should be objective and hype-free. Apples should be compared with apples, and where it is a matter of comparing apples with oranges, there is a need for explicit clarifications. The respective case studies endeavor to consider the following:

- The political, economic and fiscal situations of jurisdictions at the time that ASD was first considered
- The capacity of the land registries to deliver services
- Requirements for investment in technology to modernize service delivery
- Due diligence undertaken
- The deal
- Risks
- Governance
- Consultation with stakeholders – professions, business and the public.

Notably, almost all of the cases reviewed in this report, are jurisdictions which use the Torrens title system.[29] The exceptions being Ontario and UK. Most Canadian provinces use the Torrens system. The Australian and New Zealand cases are Torrens. Also, the two cases from Asia, viz. Malaysia and Philippines, are Torrens.

Ontario Province, Canada

Challenges faced by Ontario 1980s-90s

What drove Ontario went down the LRS PPP path is quite a compelling account of developing innovative solutions in troubled economic times. Ontario's circumstances were anything but the scenarios of NSW, SA and now Victoria - strong economic performance, low interest rates, low inflation and well-capacitated and resourced modern land registries. The initial Ontario decision wasn't a political expedient to realize a quick cash windfall from a recycled asset. In sum, the Ontario Land Registries were struggling to deliver services and modernize (automate) and this came at a time when the country plunged into a severe recession.

Former Deputy Minister Daniels, responsible for establishing the Ontario LRS PPP, provides a bleak but

sobering, first-hand assessment of land registry offices, back in the 1980s:

"Imagine having to queue in tents outside a government office to fill out documents. That is what used to occur at land registry offices across Ontario. Government had no space inside for them inside and did not have enough staff to cope with the volume This was happening during a real estate boom in mid-1980s, the land registry system was a very archaic and fragmented organization. It had 67 offices across the province containing. land records of some 3.8 million parcels of land and 200 million paper records.

Registration and search volumes were steadily rising and land values increasing at the time.

Customers were required to close their land deal in person and on paper in their own limited jurisdiction. On the operational front, the government had a number of pressing challenges. The sheer volume of the paper-based land registration system was becoming unmanageable while, at the same time, constructing a good chain of title in the registry system was difficult since land records were not parcelized.

In the late 1980s, after receiving reports from the Law Reform Commission and Law Society of Upper Canada plus completion of a successful pilot exercise, the Ontario Government passed legislation to automate the land registrationsystem.

The Land Registry Reform Act of [1984] subsequently gave legal authority to an electronic registry record and work began on POLARIS – the Province of Ontario Land Registration Information System.

POLARIS is comprised two related databases – a real-time title database containing title information that replaces paper documentation; and, a map database that is a graphical index of individual properties which is updated after information is recorded in the title database.

In 1987 land registry officials realized the system was designed to modernize services behind the counter not with needs of the customer in mind. It was also designed without the awareness that the internet could change the customer interface. When the public service leaders realized they could have a system that would provide customers real time and online services. To upgrade to this new service would cost an additional 150 million dollars, would require 1200 additional staff and take 12 years complete. Given the state of the economy and the tight pressure on public spending, it was clear that this level of investment was untenable"[30]

Daniels' comments on the Ontario economy are very important, as it was probably the major influence on the government's decision to adopt the PPP. Ontario's economic and fiscal circumstances were bleak, as indeed were other provinces at that time:

- By 1990, the persistent inflation of the 1970s and 1980s had pushed the consumer price index (CPI) to a level nearly four times as high as in 1970.
- During that whole inflationary period, many Canadians sought to protect themselves from the effects of inflation through indexed wage contracts and by investing in the housing market. Others saw an opportunity to benefit from high inflation by speculating in real estate or other assets. Since many of these transactions had been financed by borrowing, debt had risen to high levels.
- When the Bank of Canada's anti-inflationary policy actions in the late 1980s finally convinced Canadians that inflation would be brought under control, the inflationary excesses that had built up contributed to a severe recession in 1990–91.
- Canada's other major economic problem in the early 1990s was large budget deficits—federal and provincial.
- By 1994, the Canadian dollar came under strong downward pressure, and interest rates rose sharply (in excess of 13 percent) across all maturities as investors demanded even larger risk premiums.
- Canadian governments (federal and provincial) responded "forcefully and effectively" in the mid-1990s to the need to cut fiscal deficits and slow down the accumulation of public sector debt. The overall government sector moved from a total deficit of close to C$45 billion or 6 per cent of gross domestic product (GDP) in 1995, to a balanced position in 1997 and 1998, and to surpluses thereafter. Moreover, net public debt as a ratio of GDP fell from close to 104 per cent in the fiscal year 1995-96 to an estimated 80 per cent in 1999-2000.[31]

In preparing this paper, the author communicated with the former NSW Registrar-General, Kevin Nettle, who specifically commented on how challenged Ontario was in the early 1990s, which he observed during his visit to advise on titles automation, drawing on the advanced status in NSW.[32]

Ontario's decision for the PPP

The Ontario Cabinet decided to explore a partnership with the private sector after positively reviewing the approach taken by the Province of Quebec in the James Bay Hydro-electricity[33] construction project, where as an alternative to direct contracting, a strategic alliance was established between the government and the private sector contributing equity and both providing staff resources.

Prior to engaging in negotiations with the private sector, Ontario established a committee of Assistant Deputy Ministers (one of who was Arthur Daniels) to review and assess what a land information system should look like. This group included a range of key ministries: Transportation, Natural Resources and Finance. The team developed a Request for Information to determine whether there was any interest from the private sector in collaborating to develop a land information system across Ontario. Seventy-five companies of varying sizes attended the first meeting. The government considered that there were too many companies so they were asked to form consortiums. They merged into two large partnerships that included banks, surveyors, lawyers, and investment firms, with two companies submitting competitive bids. What followed was almost two

years of negotiations to determine which would be the most effective partner:

"*Normally, things in the private sector move a little quicker so it was important to explain to the private sector partners the need for government to carry out its due diligence. It was a very thorough process of negotiating and trying to get the best deal*.

Patience was needed because Teranet was not going to make an investment return within the first ten years. The investment was initially focused on building a new system: hundreds of millions of dollars into imaging, conversion and Research and Development. As the company automated the processes it received the profits from the electronic services; and this acted as a compelling incentive for sustainingprogress.

Creating the partnership that established Teranet was a challenging proposition. Commitment and support had to be obtained from a number of powerful stakeholders including the Law Society of Upper Canada.

Following public tender and an arm's length audited selection process, the partnership was struck. The result – the private sector's spirit of innovation and entrepreneurship blended wonderfully with the public sector's aura of stability and accountability.

In this newly formed partnership, Teranet was responsible for building automated LAS [Land Administration System] *and providing electronic search, registration and certification capabilities for the Province's land registry system. The new system has virtually replaced (99.9%) the outdated paper-based land registration system and converted from Registry lands to Land Titles using guaranteed ownership."*[34]

Thus, Teranet was established in 1991 as a partnership between the Province of Ontario and the private sector, with the specific goal to automate the province's cumbersome, paper-based land administration system and run its operations.

Ontario sells it interest in Teranet

In 2003, the Ontario government sold its 50 per cent stake in Teranet, the province's electronic land registry service, for C$370 million. The sale has created considerable controversy. The sale of government's stake, effectively valued Teranet at C$740 million. The controversy arises because Teranet was operating with profit margin of 62 per cent - sales of C$190 million and a profit of C$118 million. Analysts have assessed that a more realistic estimate of Teranet's total value would have been closer to C$2 billion, not C$740 million. This was subsequently raised by the enquiring media as being a fire-sale price to the detriment of the public purse. However, what drove the sale of the government's stake in Teranet was Premier Eves, who after only 18 months as premier was facing an election and claimed that the province did not have a budget deficit, and it was the sale of its stake in Teranet that was filling the hole. Eves lost the election, in October 2003.[35, 36] Furthermore, as raised later in this case study, the huge cost overruns required a very significant injection of extra funding, far in excess of the C$370 million received and the initial investments by government. That Teranet was also far behind schedule is further cause for concern.

Borealis acquires Teranet

In November 2008, Borealis Acquisition Corp. announced its takeover bid for Teranet. Borealis is infrastructure investment arm of the Ontario Municipal Employees Retirement System (OMERS). The total acquisition figure was around C$1.6 billion.[37]

Lease extended to 2067

In November 2010, Ontario signed a 50-year contract extension until 2067 with Teranet's owner, Borealis Infrastructure, for an upfront payment of C$1 billion.[38] This was ahead of schedule, as the original agreement ran to the end of 2017. From 2017, under the new agreement, Teranet will pay annual royalties of C$50 million a year. So, in addition ot the annual cash flow benefits to the province, the upfront payment also saves the province up to C$50 million a year in debt repayment charges. This would seem to be a sensible business decision taken by government, with the primary driver for the early extension being reduction in provincial debt. However, was it the best deal for the government? The period of the lease would make any recovery by the government all but impossible in the event of contract failure.

Fee setting and transparency concerns raised

In Ontario, the Electronic Land Registration Services Act, 2010 (ELRSA) received Royal Assent from the May 18, 2010. The law created the position of Electronic Land Registration Services Commissioner to oversee and regulate the financial and operating relationship among the government, Teranet and third party service providers. Under this law:

- The ELRS Commissioner's records are exempt from public scrutiny under the Freedom of Information (FOI) and Protection of Privacy Act.
- The law gives the government a free hand to allow third parties to charge fees in addition to the prescribed government fees.

The exemption of the Commissioner's records from FOI impacts transparency.[39]

It is widely reported that most fees have now increased by an average of 350 percent. At the time ELRSA received Royal Assent, Teranet surcharges for title searching started at C$10. This is now widely reported as now being C$28. In Ontario, Teranet imposes a C$10 service charge to register documents, in addition to the government fee of C$60. In comparison with other provinces such as British Columbia, the search fee starts at C$1.50.

There have been impacts on the land transfer tax in Ontario, and in particular Toronto, the provincial capital. Effective from April 1, 2016, Toronto imposed an administration fee of C$75 plus HST (harmonized sales tax) – total C$84.75 - to cover the cost of collecting the municipal land transfer tax on the registration of all

The Ontario LRS PPP experience with Teranet continues to be cited as a successful example of using private finance to modernize an archaic government service at a time when the government lacked funds in a tight fiscal environment. Teranet modernized the Ontario LRS and has continued developments with digital mapping, electronic search and secure collaboration, e-signature and e- registration and certification

titles transfers. Teranet itself charges the C$75 fee, so that is on top of this. As it has been described, it is a tax on a tax.[40] In preparing this report, the results of complaints to the provincial Ombudsman concerning Teranet were not found.

Real estate and money laundering concerns

Fraud and corruption has emerged as a significant issue across Canada's real estate sector. Buyers, sellers, realtors, developers, lawyers, mortgage brokers and banks have been implicated in various fraud and corruption cases. Money laundering, lying about income and occupation, fake bids, value falsification, title fraud and falsely claiming as owner-occupied are common real estate frauds in Canada. In 2012, Equifax[41] uncovered C$400 million of mortgage fraud in Canada, which experts suspect represents only a fraction of the cheating taking place in the country's real estate market. It has been reported some Canadian banks allow wealthy Asian investors to skirt Chinese law by helping them bring in large amounts of money, which is then often used to buy real estate. Canada is reported to be an attractive destination for Russian oligarchs. The Panama Papers leak of documents from the law offices of Mossack Fonseca[42] brought to light a rather high level of referrals by Canadian banks to the Panamanian offshore specialist.[43]

As Canada is increasingly sought as a tax haven, and also for anonymity, the most attractive lure to foreigners is the Ontario limited partnership (LP), which is a unique tax structure is marketed globally by dozens of online firms promising quick and easy anonymity and shelter from taxation. Ontario's corporate and land registries allow corporate concealment, where owners of companies and property can hide behind company names established by their lawyers and accountants. Vancouver in British Columbia and Toronto the capital of Ontario are the two key destinations. A recent study by Transparency International Canada found it impossible to determine the identity of nearly half the owners of the most expensive Vancouver homes bought or sold over the last few years. Their names are hidden by numbered companies, private trusts, figurehead directors and impenetrable corporate structures.[44]

This paper has specifically raised this growing concern in Canada for consideration in the Australian context were access to land registry information by Federal and State police may be compromised by private sector operation of land registries, as has been reported in Canada.

Author's remarks

The Ontario LRS PPP experience with Teranet continues to be cited as a successful example of using private finance to modernize an archaic government service at a time when the government lacked funds in a tight fiscal environment. Teranet modernized the Ontario LRS and has continued developments with digital mapping, electronic search and secure collaboration, e-signature and e- registration and certification.

The Ontario government's own reform commission cites the success of the PPP:

"Teranet's agreement with the Ontario government is an example of a public-private partnership in public service delivery that modernized the way customers conduct electronic transactions in real property, title and writ searches, and registrations. Since the introduction of electronic registration in 1999, over 15.3 million documents have been registered electronically. Additional private-sector partnerships that improve public service delivery and quality need to be sought and attained.[45]

Princeton University also published a very positive report on the Ontario LRS PPP experience.[46]

On the other hand, the early failures of the Teranet IT automation and Ontario having to invest further funding, gets little attention. Given the PPP commenced in 1992, and it was not until 1999 that automation commenced, there would appear to be issues that have not been reported. Nonetheless, over the long-term the automation can be judged to be a technical success. However, the "technical success" of Teranet, came at a huge cost overrun, and ran well past its anticipated completion date. The Ontario Legislative Assembly's Standing Committee on Public Accounts reported the findings of the Provincial Auditor:

"In 1991, the Polaris project had an original cost estimate of $275 million and an anticipated 1999 completion date. Then, in April 1999, Teranet provided the ministry with an estimate of over $700 million to complete the project and a project completion date of 2010. Then, according to a consultant hired by the ministry, due to significant uncertainties in the assumptions used by Teranet, the project could cost over $1 billion. Consequently, the ministry's risk, costs and benefits with respect to the project have changed considerably."[47]

Thus, reporting of the Teranet experience in Ontario is a mixed bag.

Manitoba

In 2012, the provincial government of Manitoba government announced that it would be "selling" The Property Registry (Manitoba Land Titles and Personal Property Registry) to Ontario-based Teranet, a private firm.[48] The Property Registry then generated around C$11 million per annum in each of 2010 and 2011. It was a time when there was significant fiscal restraint in government and Manitoba was ranked as having the worst performance in governance of all provinces. The Property Registry required investment in technical systems development for automation, which it was unable to finance out of public funds. So, there was legitimate rationale for engaging a private sector partner. It is noteworthy that the 2013 Manitoba provincial budget committed to "sell off" C$83 million in government assets. The asset sales were a key part of the fiscal plan to keep the province's deficit to C$460 million for the fiscal year. In addition, the government was to cut program spending by C$128 million.[49]

The government advised of the following key benefits of the deal with Teranet:

- An upfront lease payment of C$75 million would be paid to the government;
- Teranet would invest C$35.5 million in systems development;
- There would be estimated annual royalty payments of C$11 million in 2013, increasing to C$24 million at the end of the 30-year licensing agreement;
- Employees of the existing Property Registry would be transferred reducing the size of government by more than 100;
- Teranet would not lay-off employees and will protect employee benefits.

Did the government get a good deal? There doesn't seem to be available any analysis of the real return over the lease period compared with the retaining the operation under government. Furthermore, there seems to be no economic assessment of the net social benefits.

In terms of risk mitigation, the government advised of the following:

- The Government would maintain the authority to set rates charged by Teranet for services;
- All existing Property Registry offices would remain open;
- Data such as land survey and property titles, would always be owned by the Province and protected by privacy legislation.

These are similar for most LRS PPPs.

The Canadian Center for Policy Alternatives (CCPA) subsequently raised some serious concerns about the lease to Teranet, which have gone unanswered by the government:

"When tax payers build a valuable data base and a private corporation reaps the benefits by controlling access to that asset so it can expand its product base into non-controlled, proprietary products, we see why a private corporation would find this deal attractive. But why would an NDP [New Democratic Party] government, committed to a strong public sector, hand this asset over?

Will the amount paid in royalties (which to start at least, are no more that the revenues already transferred to the province) adequately compensate Manitobans for their loss of control over this public asset?

When all is said and done, what will the impact be on quality of service?

Details of the Property Registry sale notwithstanding, privatization of this asset in itself may not make a big difference in our day-to-day lives. But it does beg bigger questions: why, if protection of Manitoba Hydro [the government-owned provincial electric power and natural gas utility] was paramount in the NDP's re-election platform, is this government willing to let our Property Registry go so easily, without even consulting the public? [Presumably, Manitoba Hydro had a strong and influential union base that had powerful political influence.]

Is the concept of public assets for public good not the same with this smaller agency?

Given the potential profit-making capacity this public resource has, is Teranet paying enough?

Could the public sector not develop this resource, rather than handing it over to the private sector?"

Nova Scotia

Nova Scotia, up until 2015, had operated highly-decentralized land registries down to county level. Following a government decision to reduce costs, the province decided to close thirteen Land Registry offices, cut some staff and re-deploy other staff and consolidate to five registries in more central locations. The decision was expected to save the province around C$1.8 million per annum. The rationale for cost cutting and reduction in staff was also a reflection of the way doing land registry business had changed. Seventy per cent of transactions were being conducted online, while twenty-five percent were mailed or couriered. Thus, only five per cent of the land transactions were completed in person at the county Land Registry offices. There used to be an office in every county. Closures began the end of June 2016 and are expected to be completed by the end of 2017. Thus, it was inevitable to restructure registry offices in Nova Scotia.[50]

Nova Scotia also looked at the overall organizational, technical and financial aspects of its registry operations and in doing so looked at both privatization and a PPP. The government's review extended beyond the land registry and also covered two other registries, viz. motor vehicles and joint stocks. The province invested C$825,000 to undertake its review. In April 2016, after it had completed the seventeen-month long review was completed, the government reached the decision to not pursue privatization or PPP for its registries. As such, this represented a major diversion from the huge PPP investor sector of Canada with decades of experience, and much of it quite successful.

The review which especially looked at overall revenue expected to be generated, initial payment and annual returns - represented only a marginal gain for

the Nova Scotia government considered the representations of both opponents and proponents. It undertook the necessary due diligence, which included an independent assessment of the business case, and reached the decision to reject moving to either privatize or a PPP

the provinces. Up until 2016, the land registries collectively generated around C$105 million net revenue per annum. It is significant to note that this is net revenue, after all operating accounting for all costs.

"*We have decided an alternate service delivery approach with a private sector partner is not the right approach. It is not the best option … a government-led approach offers certainty."*[51]

But there were other factors that may have influenced the decision, which included:

- Very active opposition and lobbying by the private sectors, including land surveyors.[52]
- Protests by the 320 staff of the registries
- Strong public sector union lobbying, especially in the media.

Furthermore, the provincial government is Liberal, which is at the center of the political party spectrum in Canada, tends to be more public sector oriented.

Nova Scotia land surveyors' opposition was especially vocal, and drew attention to the Ontario and Manitoba experiences with Teranet, especially the tripling of land registry fees and reduced information access.[53]

The provincial government also was well aware of the magnitude of the investments required, especially in IT to upgrade the registries:

- The joint stocks registry, with around 175,000 transactions per year, required C$4 to 5 million in upgrades.
- The land registry, with around 200,000 transactions a year, required C$3 to 4 million to in upgrades; it does 200,000 transactions annually.
- The registry of motor vehicles, with around two million transactions per year, required s C$25 million in upgrades.

There was reported to have been very strong private investor interest expressed to take on the leasing of the registries under a PPP. Five joint ventures consortiums, all considered to be highly competent were interested. Notably, these included Teranet, which has decades long contracts to run registries for the provinces of Ontario and Manitoba as well as Jamaica in the Caribbean.

The private sector, also lobbied hard in favor of leasing. The media reported that the Premier's 2013 campaign manager, Chris MacInnes, was hired by Teranet to lobby the Nova Scotia government on "government procurement" and "privatization and outsourcing." [54]

In sum, the Nova Scotia government considered the representations of both opponents and proponents. It undertook the necessary due diligence, which included an independent assessment of the business case, and reached the decision to reject moving to either privatize or a PPP.

United Kingdom

The UK has twice looked at either full privatization or partnering with the private sector for the operation of HM Land Registry, in 2014-15 and again 2015-16.

There are three separate Land Registry organizations in the UK:

- HM Land Registry covering England and Wales under the national UK Government
- The Land Registry Service of Scotland - Registers of Scotland (RoS) is the non-ministerial department of the Scottish Government responsible for compiling and maintaining records relating to property and other legal documents.
- The Land and Property Services (LPS), is an agency of the Department of Finance of the Northern Ireland Executive. The agency, created in 2008, includes the Ordnance Survey of Northern Ireland (the OSNI).

However, it is only HM Land Registry that directly comes under authority of the national government, and it was only this land registry that was the subject of an alternative service delivery model.

First attempt: 2014-15

In January 2014, the Government issued a public consultation on its proposal to create a service delivery company to carry out the day-to-day process of land registration. The government saw the opportunity to realize a £1bn-plus upfront payment with an expected on-going revenue stream. It is very clear that the government was looking alternatives including: (i) wholly Government-owned company; (ii) privately; or (iii) PPP approach. The adoption of any option would have been to regulatory control from the Office of the Chief Land Registrar, which would remain part of the UK government.

This proposal generated considerable controversy in the media and was opposed by Land Registry staff. There was also opposition to the plans from legal professionals and other users of Land Registry services. In July 2014, the Government announced that, having considered the results of the consultation, whilst it continued to consider that there were considerable benefits to a service delivery company, it felt that further consideration was necessary and therefore would not be proceeding with any changes. It is also notable that the State Secretary for Business, Vince Cable, vetoed the privatization during the coalition because he believed that would:

"…it would not have raised much money. The only rationale behind the proposed sell-off was dogma. I am glad the minister has seen sense."[55]

It is important to note that as there was a general election to be faced in 2015, the decision to drop, was driven by the looming election and fear of a public backlash. In 2015, the Conservatives won outright victory, enabling the Cameron government to govern alone, but with a slim working majority of just 12 seats.

Notably under the first Cameron term, it was the Chancellor of the Exchequer, George Osborne that pursued austerity policies aimed at reducing the national debt, including privatization and PPPs. Arguably the inclusion of the Land Registry in such considerations was sensible government fiscal policy management and working through a process of extensive consultations with all stakeholders all very reasonable and good governance.

Second attempt: 2015-16

After the Conservatives won the 2015 general election, Prime Minister Cameron reappointed Osborne as Chancellor in his second government and gave Osborne the additional title of First Secretary of State. Within months of being returned to government, in November 2015, Chancellor Osborne re-opened consideration of "privatizing" the Land Registry. The government looked at further proposals for operation of the Land Registry and conducted extensive public consultations over a two-month period, March 24 to May 26, 2016.

The governments public consultations were led by the Department for Business Innovation & Skills (BIS) - "Consultation on Moving Land Registry Operations to The Private Sector ". The public-sector union (FDA) was especially critical of the proposals and its published response is most explicit, especially in terms of risks:

- Risk of creating a structure which contains fundamental flaws and is not fit for purpose
- Risk inherent in using a contractual model to achieve stated ends
- Risk of indemnity liability falling on the state and the indemnity scheme not being properly administered
- Risk to data held, and its availability, and risk of fraud
- Risk to the government's immediate and wider economic objectives.[56]

The FDA raised concern that the government was not looking at alternative approaches, but was more concerned about fast-tracking:

"It is clear that a decision has already been taken about a preferred model and so the whole notion of 'consultation' appears somewhat illusory."[57]

FDA was incorrect regarding its claim that the BIS did not present alternatives, when indeed it presented three:

- Option 1 variant – operating concession
- Option 1 variant – mutual Joint Venture
- Option 2 - Full privatization with independent economic regulation.

However, the government was certainly limiting options and the BIS document most definitely proposes fast-tracking.[58]

Comment by the highly regarded "The Economist" magazine, in November 2015, advised of the need to look at the big picture and the real return, not just the upfront payment received:

"Privatization is no panacea for profligate governments. Selling assets is a one-off that provides only brief respite for those addicted to overspending (though, once sold, assets – from ports to companies – tend to generate far more business). It also must be weighed against the lost revenue from well-managed state companies. Selling when markets are depressed is generally a bad idea."[59]

Following the 2016 Brexit referendum of June 23, 2016, and the subsequent resignation of PM Cameron in July 2016, Osborne was sacked by newly appointed Prime Minister Theresa May and replaced by Phillip Hammond. May had a mutually adversarial relationship with Osborne. In the 2016 Autumn Statement[60], Chancellor Philip Hammond put an end to speculation about the future of the Land Registry:

"Following consultation the government has decided that HM Land Registry should focus on becoming a more digital data-driven registration business, and to do this will remain in the public sector. Modernization will maximize the value of HM Land Registry to the economy, and should be completed without a need for significant Exchequer investment."

Former Chancellor Osborne had such strong ownership of the government's privatization agendas, that his removal was an opportunity to remove his brand from everything he had pursued. Notably the actual future model for the Land Registry operation - privatization or PPP – had never been decided, before his sacking.

The UK media widely reported the decision by the government as the "shelving of privatization" for the second time. A Land Registry deal was part of an overall package of "government sell-offs to raise £5bn. Notably the Land Registry "sale" was to be included in the Neighborhood Planning and Infrastructure Bill, which was enacted in April 2017. [61] It was also described as "quietly postponing".[62]

It is fair to speculate, that we have not seen the end to the UK Land Registry saga, given the media labelling it is "shelved for now". The election outcome of June 2017 for the May Government, which saw it lose its absolute majority and establish a coalition, has certainly put an end to any Land Registry changes for at least the short term.

Opposition to changing the status of HM Land Registry

The UK government's own watchdog, the Competition & Markets Authority (CMA) advised that the privatization would give a private organization monopoly over commercially valuable data and would reduce access especially to conveyancers. The private partner would inhibit private search companies and other private users access to ordering platforms and other systems to check on property locations and other parcel information important for sellers and buyers. CMA warned that it could make it harder and costlier to

In sum, the UK bowed to public pressure to not pursue privatization or PPP for the Land Registry on two occasions, and if it not been for Brexit leading to the resignation of PM Cameron, the Chancellor Osborne agenda for asset sales, full privatization or PPP, would almost certainly have come to fruition

access information, leading to a lack of transparency over property ownership.[63, 64]

Public consultations were undertaken by the government for each of the two attempts. The first attempt's consultations in 2014, through BIS, resulted with an overwhelmingly by 91 percent rejection by respondents who didn't agree that privatizing the organization would result in a more efficient Land Registry. On top of that, 89 percent said they would not be comfortable with the private sector processing land registration information.[65] The second attempt's consultation in 2016, again through BIS, drew similar high levels of rejection.

Public Petition – There is reported to have been two public petitions, one for each of the government's attempts. The government's first attempt attracted a petition signed by more than 250,000 people.[66] For the second attempt around 318,000 people signed. Given the combined populations of England and Wales are around 56 million, it could be argued that these petitions were not significant evidence of public opposition.

"We Own It" Campaign - We Own It is a civil society organization which campaigns for public services, which are publicly owned, accountable and "run for people, not profit". The organization secured strong support from the Labour party. It was highly successfully in combatting Chancellor Osborne. Every form of privatization he raised they battled over publicly, using both the media and social media to great effect.[67] The defeat of privatization of the UK Land Registry was celebrated as a major victory by We Own It. The organization's website provides an excellent summary of its efforts which include a detailed report[68] jointly prepared with the New Economics Foundation (NEF) covering a number of agencies that the government planned to either privatize or seek private partners to finance.[69]
It is significant that NEF's research determined that the UK government would expect to receive negative financial returns after twenty-five years of private sector operation. The analysis seems the recommended methodology from the UK Treasury's "Green Book" which uses the Social Time Preference Rate (STPR) to determine present values.

Government Consultation - The government's own consultations for the first attempt on transferring the operations of the Land Registry to a private company in 2014, resulted with an overwhelmingly by 91% rejection by respondents who didn't agree that privatizing the organization would result in a more efficient Land Registry. On top of that, 89% said they would not be comfortable with the private sector processing land registration information.[70] The second ate

John Manthorpe – The highly respected former Chief Land Registrar (1990-96), has been a very public expert figure, opposing changes to the registry, especially raising the risks:

"The registry's independence from commercial or specialized interests is essential to the trust and reliance placed on its activities. It would not be possible for actual or perceived impartiality to be maintained, or public confidence sustained, if a private company were to assume responsibility for the maintenance of a public register." [71]

Conclusions on UK experiences

In sum, the UK bowed to public pressure to not pursue privatization or PPP for the Land Registry on two occasions, and if it not been for Brexit leading to the resignation of PM Cameron, the Chancellor Osborne agenda for asset sales, full privatization or PPP, would almost certainly have come to fruition. Osborne's motivation was entirely fiscally driven, given the impact of the 2008 economic crisis, that the UK sought to recover from through major economic restructuring. The government certainly heard the noise of public opposition to "privatization" of the Land Registry, the first time around. However, the second time around it was well placed to ignore, as a Cameron government didn't have to go to the polls until 2019. Brexit brought a change to all of that, and Cameron departed, Osborne was replaced and PM May's call for an early election pushed her into a minority government. The government's own consultative processes through BIS, left much to be desired and the concerns raised by the major union, the government's own CMA and ICO are compelling. Arguably the merits of any of the proposed approaches were lost in the processes followed.

Malaysia

Malaysia uses the Torrens land registration system. It has long experience in PPP across many sectors and services, commencing with establishing the legal basis for private participation in infrastructure (PPI) in 1981. PPP commenced around 2005. Malaysia has a special PPP unit under the PM's office and the current guidelines came out in 2009. Overall, the guidelines are quite robust.[72]

Malaysian PPP experience has been mixed, with the water sector being especially problematic. The LRS PPP, called e-Tanah[73] (Electronic Land), was established in 2006. The government's rationale for this PPP was that IT could solve both corruption and incompetence of government service delivery. However, e-Tanah failed and this was well-reported in the Malaysian media and also by the Malaysian Bar Association.[74]

The primary reason for inclusion of the Malaysian e-Tanah PPP in this report is that it failed. e-Tanah land administration system, costed at around RM66 million (A$20 million) was meant to be fully operational by 2007. The system was implemented in Penang as a pilot project and the computerized system was supposed to replace all manual documentation and paperwork in relations to the work processes of the state Lands and Mines Department. The Auditor-General's Report for 2011 reported on the faults in the system, in which out of nine modules in the system, only four were fully operational while the other five were not operational and does not cater to the needs of the department. Despite the implementation of the computerized system, key processes were required to be done manually because five key modules were not operational in the system. The five modules covered the processes for land development, enforcement and auction, land disposal and land acquisition.

The initial probe was undertaken by the Penang Public Accounts Committee (PAC) has kicked off the official enquiry.[75] Ironically, the government continued to promote the success of the failed e-Tanah system in professional fora, despite the PPP being cancelled and work mainly reverting to manual.[76] What is significant in this case is the PPP was to provide the IT infrastructure to support the land registry system rather than undertake full land registration operations. Furthermore, the system was still at its Penang pilot site and had not rolled out nationally. For those reasons, Malaysia controlled the failure of this PPP. However, solving the problem became a ten-year ordeal. Although the e-Tanah system was reported as failed back in 2007,[77] the Auditor-General's report was only delivered in 2011, as mentioned above.

In June 2017, Malaysia announced it was back into a new e-Tanah, and it launched "e-Tanah Go-Live" system. The new system is again under a PPP concession. The government has maintained its objective to conduct land administration digitally. This is considered by the government as being a key requirement to increase the country's capacity to attract international business investment. E-Tanah is the land administration and management system operated electronically using the concept of 'Single Point of Contact'. The PPP follows the Build, Operate and Maintain (BOM) mode and the private concessionaire, Puncak Tegap, was appointed by the Ministry of Natural Resources and Environment to build and maintain the system for 14 years (two years to build the system, 12 years of maintenance), depending on the date the system started operating in each state. The system is intended to integrate the operations across government land administration agencies, such as the Malaysian Survey and Mapping Department, the Malaysian Centre for Geospatial Data Infrastructure and the Director-General of Federal Department of Land and Mines.

Malaysia's motivation for the e-Tanah PPP would seem to be sound. It has had a troubled implementation history and government has rightfully stepped back in and made extensive enquiries into the causes of failure, with the Auditor-General also engaged. The recently re-launched new e-Tanah PPP, has again sought private sector investment to develop and operate the system. It is clear that government was not scared off by the initial failure, and was determined to follow the same PPP path, to enable private sector financing to invest in new technology and deliver services. Only time will tell as to whether the decision to pursue the PPP for a second time was the right one.

Endnotes

29 Torrens was first adopted in 1861 for the then colony of Vancouver Island which is now part of British Columbia. British Columbia continues to use a modified version of Torrens. Since 1885, Ontario uses a system based on the English Transfer of Land Act (1875) which has many similarities with Torrens. New Brunswick and Nova Scotia converted from a Deeds registration system to a Torrens title system in the 2000s. Torrens was implemented from 1886 in what was then the Northwest Territories and has continued to be used by the three Prairie provinces (Alberta, Saskatchewan and Manitoba) into which the southern part of the Northwest Territories was divided. The only provinces in Canada which do not have Torrens titles include Newfoundland and Labrador, Prince Edward Island, and Quebec, which is a civil rather than common law jurisdiction. https://en.wikipedia.org/wiki/Torrens_title

30. Daniels, A., (2017). pp. 32-33.

31 Remarks by Gordon Thiessen, Former Governor of the Bank of Canada (1994-2001), January 22, 2001.

32 Private email from Kevin Nettle to the author, June 28, 2017.

33 The James Bay Project is the construction by state-owned utility Hydro-Québec of a series of hydroelectric power stations on the La Grande River in northwestern Quebec, and the diversion of neighboring rivers into the La Grande watershed.

34 Daniels, A., (2017). pp. 32-33.

35 https://beta.theglobeandmail.com/technology/reclusive-investor-gets-last-laugh-as-queens-park-bungles-teranet/article1117805/?ref=http://www.theglobeandmail.com&

36 Premier Eves has moved into a new line of business in 2015 as chairman of Timeless Herbal Care, a Jamaican medical marijuana company with ties in Canada and Israel. [Every serious study needs something light-hearted!]

37 https://www.theglobeandmail.com/report-on-business/borealis-wins-teranet-with-discounted-bid/article1065829/

38 http://www.torontosun.com/news/canada/2010/11/18/16210171.html https://news.ontario.ca/mof/en/2010/11/modernizing-

ontarios-electronic-land-registration-system.html

[39] http://www.canadalandshow.com/how-fees-public-records-block-journalism-and-hide-corruption/

[40] http://www.canadalandshow.com/how-fees-public-records-block-journalism-and-hide-corruption/

[41] Equifax is a North American consumer credit reporting, considered one of the three largest American credit agencies along with Experian and TransUnion.

[42] Mossack Fonseca & Co. is a Panamanian law firm and corporate service provider, which is the world's fourth biggest provider of offshore financial services.

[43] http://projects.thestar.com/panama-papers/lessons-for-canada/

[44] ibid

[45] Commission on the Reform of Ontario's Public Services, (2012), p.389 http://www.msdsb.net/images/ADMIN/correspondence/2012/Commission%20on%20the%20Reform%20of%20Ontarios%20Public%20Services.pdf

[46] Gainer, M., (2017), January 2017, Princeton. https://successfulsocieties.princeton.edu/sites/successfulsocieties/files/Canada%20Case%20Study%20With%20Logo%20JRG_1_30_2017.pdf

[47] Standing Committee on Public Accounts, (2001) Special Report of the Provincial Auditor.

[48] CCPA, February 28, 2013. https://www.policyalternatives.ca/publications/commentary/fast-facts-first-ripple-then-wave

[49] http://www.cbc.ca/news/canada/manitoba/manitoba-sells-property-registry-to-private-firm-1.1147970

[50] http://www.cbc.ca/news/canada/nova-scotia/13-land-registry-offices-closing-across-nova-scotia-1.3027275

[51] Statement by Nova Scotia Service Minister Mark Furey. http://www.cbc.ca/news/canada/nova-scotia/registries-privatize-government-private-sector-service-nova-scotia-1.3540782.

[52] http://www.cbc.ca/news/canada/nova-scotia/ns-land-registry-1.3223444

[53] http://legalblogs.findlaw.ca/legal-life/how-will-move-to-privatize-land-registry-affect-ns-homebuyers-467/

[54] http://www.cbc.ca/news/canada/nova-scotia/ns-land-registry-1.3223444

[55] https://www.ft.com/content/e2ec0140-74dd-11e6-bf48-b372cdb1043a

[56] FDA, May 2016.

[57] Ibid, para 111, p.42.

[58] Options p.33-34; fastrack p.36.

[59] The Economist, "The $9 Trillion Sale", Jan 11, 2015. https://www.economist.com/news/leaders/21593453-governments-should-launch-new-wave-privatisations-time-centred-property-9

[60] 2016 Autumn Statement, November 23 2016. https://www.gov.uk/government/publications/autumn-statement-2016-documents

[61] Financial Times, UK shelves privatization of Land Registry, Sep 7, 2016 https://www.ft.com/content/e2ec0140-74dd-11e6-bf48-b372cdb1043a

[62] https://www.ft.com/content/e2ec0140-74dd-11e6-bf48-b372cdb1043a

[63] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/524817/cma-response-to-BIS-land-registry-consultation.pdf

[64] https://www.theguardian.com/business/2016/may/23/cma-objects-land-registry-privatisation

[65] https://www.theguardian.com/housing-network/2016/apr/04/privatising-land-registry-misguided-wrong

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[67] https://weownit.org.uk/about/about-us

[68] McCann and Macfarlane, (2016), "Future profits vs short term cash: what's at stake in the great British Sell-off". https://weownit.org.uk/sites/default/files/attachments/Future%20profits%20vs%20short%20term%20cash%20-%20What%27s%20at%20stake%20in%20the%20Great%20British%20sell%20off.pdf

[69] Ibid. p.18 and STRP is explained in footnote #44 on p.42.

[70] https://www.theguardian.com/housing-network/2016/apr/04/privatising-land-registry-misguided-wrong

[71] ibid

[72] Malaysian Guidelines for PPP. http://www.ukas.gov.my/c/document_library/get_file?uuid=02f1ea81-8075-4387-8b69-ebb2120292f1&groupId=15223

[73] "tanah" is the Bahasa word for land

[74] http://www.themalaymailonline.com/malaysia/article/penang-pac-investigates-faulty-e-tanah-system

[75] http://www.themalaymailonline.com/malaysia/article/penang-pac-investigates-faulty-e-tanah-system#Cdmry20tPuy8jgsT.97

[76] https://geospatialworldforum.org/2012/gwf_PDF/Haji%20Abdul%20Kader.pdf

[77] http://www.malaysianbar.org.my/bar_news/berita_badan_peguam/e_tanah_system_lets_many_down.html

To be concluded in next issue.

Integration of mapping technology into elections systems

National States Geographic Information Council (NSGIC) has been awarded $300,000 by the bipartisan Democracy Fund Voice organization for the second phase of NSGIC's Geo-Enabled Elections project. This continues a national effort by state government geospatial information officers and coordinators to work with other state agencies, local elections officials and state elections offices, national GIS and elections organizations, and federal partners to identify opportunities to leverage this powerful technology to strengthen elections management and citizen engagement.

The Geo-Enabled Elections project was launched in October 2017 and will now continue for an additional two years. The project aims to help strengthen electoral systems by supporting states in the adoption of GIS. Concretely, this means encouraging state governments to replace non-spatial 'address file' systems with election precinct and voter data in a GIS format, leveraging that format's inherent visual and analytical advantages.

With its second phase, the project turns to focus on working hands-on with up to ten more states through the pilot program, developing a curriculum for elections officials on foundations of GIS in elections, increasing awareness of the benefits of geo-enabling elections systems among elections stakeholders, and developing policy guidance and advocacy tools to support integration of GIS in elections. *elections.nsgic.org*

Cemetery mapping & management tool launched

T-MAPY has launched an international version of its Cemetery Management Module. Designed to assist with the complex task of cemetery administration, Assetino Cemetery applies proven geospatial asset management technology allowing operators and visitors to identify and locate the final resting place of an individual, manage capacity and maintenance of a facility and aid with ancestry studies. From simple searches of burial records to automated management of contracts and fees, Assetino Cemetery is available as an online solution complete with integrated smart mapping. *www.tmapy.com*

Focus on infrastructure engineering for digital cities by Bentley Systems

Bentley Systems has presented its new *digital cities* initiatives, applying digital twins for more efficient city and regional operations and for more connected and resilient infrastructure. Digital twins converge assets' 4D-surveyed and engineering representations to enable new collaborative digital workflows to serving planners and engineers in public works, utilities, property management and development, and city stakeholders. Digital twin cloud services provide an intuitive and immersive 4D environment converging *digital context* and *digital components* with *digital chronology* for "evergreen" infrastructure digital twins over asset lifecycles. For infrastructure professionals, BIM and GIS are effectively advanced through 4D digital twins.

Mapping disease outbreaks in urban settings using mobile phone data

Researchers from EPFL and MIT have shown that human mobility is a major factor in the spread of vector-borne diseases such as malaria and dengue even over short intra-city distances. In a paper published in *Scientific Reports*, the team compares different mobility models and concludes that having access to mobile phone location data can prove crucial in understanding disease transmission dynamics -- and, ultimately, in stopping an outbreak from evolving into an epidemic. Yet, according to the researchers, this kind of information is hard to come by. They recommend bringing in new legislation to fill a legal void and enable scientists, NGOs and political decision-makers to access people's phone location data for public health purposes.

The authors studied the interplay between human mobility and the 2013 and 2014 dengue outbreaks in Singapore. They found that even low levels of mobility can cause the epidemic to spread, underscoring the need for an effective spatial distribution model.

Dengue is a viral disease carried by the Aedes aegypti mosquito. It occurs in the tropics and subtropics, and is particularly prevalent in rural areas and poor urban communities.

The researchers demonstrated that the mobile phone data and census models were effective at predicting the spatial distribution of dengue cases in Singapore, and that such data could be obtained without infringing on people's privacy. Their findings invite further discussion about the merits and drawbacks of using mobile phone data to model disease outbreaks, as well as other potential applications. *www.sciencedaily.com*

Esri India inaugurates GIS data management centre in Panchkula

Esri India has announced the launch of its latest Global Delivery Centre for GIS data management in Panchkula. This centre will provide GIS data management services to global customers in sectors like power, telecom and government, Esri India President Agendra Kumar told reporters here *www.esri.in*

Differential privacy & the 2020 USA census

The U.S. Census Bureau has changed the way it ensures privacy for the 2020 Census. The new method is called Differential Privacy (DP). To help people assess some of the implications and unintended consequences of Differential Privacy, Caliper is providing several interactive maps for public inspection.

The first map, created with Maptitude shows the change in population for every Congressional district after applying Differential Privacy to the current congressional district boundaries. The map illustrates that the current 116th Congressional District populations would have been different in many instances, with possible implications for service provision, allocation of funds, and political representation*. *caliper.com*

Cadasta Foundation launches new global land rights challenge fund

Cadasta Foundation has launched its new Global Land Rights Challenge Fund to help partners better leverage Cadasta's innovative tools and services to document land and resource rights worldwide.

The Land Rights Challenge Fund will feature multiple grant programs through 2021, each designed to advance land rights and tenure security for vulnerable populations around the world.

All grants will enable the use of Cadasta's tools, including mobile applications for data collection and web applications for data management and analysis. Grantees will also have access to Cadasta's high-quality imagery, data layers, dashboards, and analytical tools for monitoring, advocating, storytelling, and reporting. Cadasta's platform and tools are built on open standards and access, and are supported by Esri ArcGIS technology. *https://cadasta.org*

Carlson introduces new surveying system

Carlson Software just released its new Void Scanner+ (VS+), a fully wireless surveying system designed to be used for underground surveying. The system is an upgraded model of Carlson's standard Void Scanner.

Engineered to scan in extreme environments, the ruggedised VS+ system is designed to be deployed into potentially hazardous locations, allowing operators to map underground cavities safely.

The information collected by the VS+ can be viewed in real-time and can provide mine site managers the information needed to optimise production, review extraction, backfill operations, and monitor problems with ore loss and dilution. It can also be used for ore pass monitoring, mine design management, underground blast planning, drive surveys, and pre and post underground evacuation planning.

SPARC – SBAS simulation platform for authentication reliable concepts

The European Commission is exploring the possibility of improving the security of the SBAS service. SBAS data is currently trusted by end users, even if the navigation data (and signals) are not protected. The objective of the SPARC project is to identify a viable solution to authenticate the SBAS messages, when broadcast by the GEO satellites, possibly providing authentication also for the GNSS constellations augmented by SBAS. SPARC is a procurement launched by EC under the H2020 Framework Programme and it is technically managed by GSA.

Satellite based augmentation systems (SBAS) have been conceived to support safety of life operations in aviation by broadcasting GNSS differential corrections and integrity information. They are used mostly during precision approach. SBAS systems are regional systems, such as EGNOS in Europe and WAAS in the United States, among others. The increasing amount of radio frequency interference (RFI) and cyber-attacks to navigation systems is an emerging trend that can threaten receiver operation. The signal broadcast by the SBAS service can be subject to falsification. Since SBAS data is trusted by the user, erroneous data would affect the computation of the navigation solution, in a manner that is not detectable by the traditional techniques available for GNSS. This creates a risk for any SBAS user, including civil aviation and safety-critical applications. Authentication techniques can mitigate some of these threats. The purpose of the SPARC project is to identify a viable solution to authenticate SBAS data, when broadcast by the GEO satellites, possibly providing authentication also for the GNSS core constellations.

Project approach

The project includes three iterations of the design with the following steps:

1. The analysis of the external requirements. The purpose of this analysis is to consider the information available from the different organizations and stakeholders defining the aviation operational needs and developing SBAS standards. This is a fundamental step to identify a solution meeting the operational needs and current status of the standardization process.
2. The analysis of the technical drivers. This activity aims at identifying which technical requirement drives the design of the authentication technique; these technical requirements must be compatible with the current state of the SBAS technologies, the SBAS standardization process and the aviation community requirements.
3. The definition of the authentication techniques. The consortium will design and test techniques for the authentication of the SBAS messages and possibly also GNSS navigation data and will determine their impact on the SBAS availability or continuity performance. The broadcast of authentication data is done through the SBAS satellite communication channels. The project will explore the transmission of the authentication data exploiting existing data channel and also new data channels.

The project includes the development of a Simulation Environment capable of generating the whole SBAS and GNSS navigation chain (including GPS and Galileo constellations). The Simulation Environment allows to test each authentication solution to assess the impact on the SBAS services. It can work faster that real time or real time modes to provide statistically meaningful results from synthetic and real data for the metrics of interest.

Chinese bolster navigation system with dual Beidou launch

China recently launched a new pair of navigation satellites - Beidou-3M21 (Beidou-50) and Beidou-3M22 (Beidou-51) from the Xichang Satellite Launch Center, Sichuan province. The satellites are using a bus that features a phased array antenna for navigation signals and a laser retroreflector, with a launch mass 1,014 kg. Spacecraft dimensions are noted to be 2.25 by 1.0 by 1.22 meters. Usually, the satellites reside in a 21,500 – 21,400 km nominal orbit at 55.5 degrees.

The satellites are equipped with lightweight hydrogen maser clocks, which will serve as a more stable precision frequency reference to make the satellite navigation system work more accurately. This was the sixth launch dedicated to the replenishment of the Beidou Navigation Satellite System in 2019. *www.nasaspaceflight.com*

Russia to launch glass sphere into space

Russia plans to launch into orbit a spherical glass satellite for measuring Earth's gravity field by the end of December. The BLITS-M retroreflector satellite will be launched together with three Gonets-M communications satellites using the Rokot carrier rocket, scheduled to take off from the Plesetsk Cosmodrome on December 25.

The BLITS-M satellite is an improved version of the Russian BLITS (Ball Lens In The Space) satellite. It is a glass sphere designed to obtain satellite laser ranging (SLR) data related to geophysics, geodynamics, and relativity. It will also be used to increase the accuracy of the Russian GLONASS navigation system, calibrate various radio systems in orbit and help determine Earth's rotation parameters and the precise characteristics of our planet's gravitational field.

Russia launched the first BLITS (Ball Lens In The Space) retroreflector nanosatellite into orbit in 2009. The satellite, which consisted of two outer hemispheres made of glass and an inner glass ball lens, collided with one of the fragments of the Chinese Fengyun-1C meteorological satellite on January 2013. *https://sputniknews.com*

China promotes greater use of BeiDou GNSS in Central Asia

The Chinese government has started an initiative to promote greater use of its BeiDou GNSS in Central Asian countries for applications such as precision farming, transportation, and disaster relief and management. Agreements between China and Central Asian countries were signed at the China-Central Asia Cooperation Forum held in Nanning, China, on 20 October 2019. The agreements bolster research and application development of BeiDou GNSS throughout the region. *https://spacewatch.global*

Russia to launch about 30 new-generation satellites

Russia is planning to launch about 30 GLONASS-K2 satellites to overhaul its aging GLONASS navigation satellite constellation. Over the past five years, Russia has been launching no more than two navigation satellites annually. At the same time, the majority of the GLONASS satellites in orbit operate beyond the warranty period. As a result, the GLONASS network experienced multiple malfunctions in 2019 when only 21 devices remained operational, while a total of 24 global satellites were needed to ensure global signal coverage. The GLONASS navigation grouping currently consists of 27 satellites, including 23 operational, two in maintenance, one spare and one in flight test phase. *www.urdupoint.com*

PSLV-C47 successfully launches Cartosat-3

On 27th November 2019, India's Polar Satellite Launch Vehicle, in its forty ninth flight (PSLV-C47), successfully launched Cartosat-3 along with 13 Nanosatellites of USA from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota.

PSLV-C47 lifted-off at 0928 Hrs (IST) from the Second Launch Pad. After 17 minutes and 38 seconds, Cartosat-3 was successfully injected into a sun synchronous orbit of 509 km. Subsequently, 13 nanosatellites were injected into their intended orbits. After separation, solar arrays of Cartosat-3 were deployed automatically and the ISRO Telemetry Tracking and Command Network at Bengaluru assumed control of the satellite. In the coming days, the satellite will be brought to its final operational configuration.

"Cartosat-3 is the most complex and advanced earth observation satellite built by ISRO." Indian Space Research Organisaton Chairman, Dr Sivan said. The mission life of the Cartosat-3 is 5 years. It will address the increased user's demands for large scale urban planning, rural resource and infrastructure development, coastal land use and land cover, etc. *www.isro.gov.*

Japan announces open sharing of radar satellite data

Ms. Sasaki, Parliamentary Vice-Minister of Education, Culture, Sports, Science and Technology of Japan recently announced that the Japan Aerospace Exploration Agency (JAXA) would be providing open access to information and data from a suite of their radar satellites. This data is key, particularly in the tropics, where cloud cover hinders optical sensor observation. In addition, radar satellites provide data for historical time series for various decision-making purposes. Since the 1990's, Japan has published long-term archived data from other Earth observation satellites, such as GCOM-W observing Water Cycle, GCOM-C observing atmosphere, terrestrial and ocean, and GPM observing precipitation. This data is essential for the GEO community and beyond, and contributes to broad range of societal benefits. *www.earthobservations.org*

Smart agriculture solution by Sony

Sony Electronics Inc. has announced a Version 2.0 software update for its Smart Agriculture Solution aimed at providing agricultural customers with new AI-based imaging capabilities. These new features, based on industry feedback, provide expanded functionality and are planned for rollout in March 2020. Additionally, Sony Electronics, which currently offers its Smart Agriculture Solution in the United States, expects to begin offering the solution in Australia starting next month.

ESA declares success at ministerial meeting

The European Space Agency's member states agreed to provide nearly 12.5 billion euros ($13.8 billion) for the next three years, giving the agency nearly all that it requested.

According to ESA Director General Jan Woerner, the allocations were sufficient to fund all of the programs it requested, an improvement over the previous ministerial in 2016 when ESA failed to win funding for an asteroid mission. "There was not a single program which we had to stop, as last time," he said. By contrast, Earth observation programs received more than requested, with 2.54 billion euros versus a request of 2.39 billion. That includes a 29% oversubscription for ESA's contributions to the European Union's Copernicus program.

The funding will allow ESA to move ahead on various initiatives, ranging from continued utilization of the International Space Station to participation with NASA in a Mars sample return initiative to lunar exploration. That includes 300 million euros to start work on two modules for the NASA-led lunar Gateway, a refueling and telecommunications module called European System Providing Refueling, Infrastructure and Telecommunications (ESPRIT) and a habitation module to be developed in cooperation with Japan. *https://spacenews.com*

6 remote-sensing satellites successfully launched by China

China sent six new remote-sensing satellite into planned orbit: one from the Jiuquan Satellite Launch Center in northwest China's Gansu Province and the other five from the Taiyuan Satellite Launch Center in north China's Shanxi Province.

The Jilin-1 Gaofen 02A, which belongs to the Jilin-1 satellite family, was launched by Kuaizhou-1A, a carrier rocket. And then, the five Ningxia-1 satellites were launched by a Long March-6 carrier rocket. The Jilin-1 Gaofen 02A satellite is a new optical remote-sensing satellite independently developed by Chang Guang Satellite Technology Co Ltd, featuring high resolution, wide width and high-speed data transmission. *www.shine.cn*

Velodyne Lidar introduces Alpha Prime lidar sensor

Alpha Prime, the next generation lidar sensor utilizing Velodyne's patented surround view technology to deliver the combined highest performance specifications for the autonomous mobility industry in one sensor. The sensor is an unmatched solution in perception, field-of-view and range for autonomous markets including transportation, trucking and robotics. *www.velodynelidar.com*

New USGS LiDAR base specification released

Geological Survey National Geospatial Program (NGP) has released a new version of the USGS LiDAR Base Specification (LBS) that defines deliverables for nationally consistent LiDAR data acquisitions. Some notable changes include:

- Defining the project area as the LiDAR acquisition project boundary plus a 100-meter buffer.
- Applying the specification to the extent of the defined project area.
- Updating and clarifying point

classification requirements.
- Changing the Digital Elevation Model (DEM) delivery format to require GeoTIFF.
- Requiring the null value in a DEM to be a value of '-999999.'

This update of the LiDAR Base Specification better aligns the specification with the LiDAR data workflow in the USGS NGP, streamlines the data publishing workflow, clarifies language, and addresses Federal requirements to use non-proprietary data formats. *www.usgs.gov*

Ouster introduces new low-cost LiDAR sensor

Ouster Inc has introduced the OS1-32, an affordable 32-channel lidar sensor. It is designed to accelerate the development and deployment of perception systems by offering Ouster's high-resolution digital lidar technology at an attainable price point for researchers, roboticists, and commercial applications. *https://ouster.com*

Hyperspectral remote-sensing center in Europe

Headwall BVBA, Belgium and geo-konzept of Germany announced the formation of a Center for Hyperspectral Remote Sensing Europe (CHRSE).

The Headwall CHRSE will be located at geo-konzept's headquarters in Adelschlag, Germany. The new center will support the implementation and utilization of hyperspectral imaging technology combined with other sensor technology such as LiDAR and high-precision GPS focusing on agriculture, mining, environmental monitoring and infrastructure inspection applications.

The facility features large areas for unmanned drone flights and certified unmanned aerial vehicle (UAV) pilots available to test and demonstrate hyperspectral imaging technology in application-specific environments and to train the next generation of UAV operators. *www.headwallphotonics.com*

ITU devising 'Driving Test' for the AI 'Drivers'

A new ITU Focus Group on 'AI for autonomous and assisted driving' will work towards the establishment of international standards to monitor and assess the performance of the AI 'Drivers' steering automated vehicles. The group is open to all interested parties. Building public trust in automated vehicles will be the prerequisite to their success in reducing the 1.3 million deaths on our roads each year. The Focus Group's primary objective is to validate that the driving behaviour of automated vehicles presents evidence to justify this public trust.

The motivations for the project were first elaborated at the third edition of the AI for Good Global Summit in Geneva, 28-31 May 2019, where discussions led by ADA highlighted the public expectation that AI Drivers should be held to the same legal standards as human drivers.The original Turing Test is a test of a machine's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human. The proposed Turing Test for the road could become the basis for an International Driving Permit for AI. The right hold to this permit would be assessed continuously, based on the AI Driver's behavioural performance on the road. *www.itu.int*

HERE joins 5G automotive association

HERE Technologies has announced its membership of the 5G Automotive Association (5GAA), a global, cross-industry organization of automotive, technology and telecommunications companies working together to develop end-to-end solutions for future mobility and transportation services.

The 5GAA helps to define and develop the next generation of connected mobility and automated vehicle solutions. Established in September 2016, it unites an ever-growing member base currently at 134 members, including eight founding companies: AUDI AG, BMW Group, Daimler AG, Ericsson, Huawei, Intel, Nokia and Qualcomm Incorporated.

The 5GAA supports the idea that 5G will be best able to carry out critical communications for safer driving, support enhanced V2X (vehicle-to-everything) communications and connected mobility solutions. *www.here.com*

Volvo Buses demonstrates electric autonomous solution for bus depot

Volvo Buses shows the significant potential of buses in depot. The live demonstration, one of the world's first for a 12 m electric and autonomous bus at a bus depot, represents an important milestone in Volvo Buses' autonomous journey towards safer, cleaner and more efficient public transport. The demonstration, held together with bus operator Keolis, took place at Keolis' bus depot just outside of Gothenburg, Sweden. During the demonstration, the fully-electric 12 m autonomous bus successfully drove itself between the parking bay and several workstations including cleaning, servicing and electric charging, before parking itself in the correct bay – all while carrying passengers.

Volvo Buses is at the forefront of the development of autonomous buses. In ten years, an additional one billion people will most likely be living on the planet, most of whom will live in cities. This will create even greater demands on public transport, infrastructure and urban planning, which in turn needs to be managed in an even more sustainable and efficient way. *www.volvobuses.com*

Phunware releases enhancements to LBS sample code

Phunware, Inc. a fully-integrated enterprise cloud platform for mobile that provides products, solutions, data and services for brands worldwide, has announced the expansion of its Location Based Services sample code to enable more use cases developers can implement in applications using Phunware's Location and Mapping Software Development Kits (SDKs).

The enhancements also come with designed user interfaces that eliminate the need for developers to build and design custom interfaces. These user experiences provide standard user interfaces that follow iOS and Android best practices and are already familiar to end users. *www.phunware.com*

Department of justice announces update to policy on use of UAS

The Justice Department in the USA has announced the publication of its updated Policy on the Use of Unmanned Aircraft Systems. In light of advancements in unmanned aircraft system (UAS) technology, and lessons learned from the Federal Bureau of Investigation's limited use of UAS, the Policy enables the Department of Justice's law enforcement components to safely and responsibly employ UAS technology within a framework designed to provide accountability and protect privacy and civil liberties.

The Policy permits the use of UAS only in connection with properly authorized investigations and activities. It also requires compliance with the Constitution and all applicable laws and regulations, including regulations issued by the Federal Aviation Administration. Department of Justice components anticipate using UAS to support crime scene response and investigation, search and rescue, and site security, among other authorized uses. In order to ensure accountability and airspace safety, the Department requires UAS operations to be approved at an appropriate level and conducted by personnel who meet Department-wide training standards. Importantly, the new policy also requires components to evaluate UAS acquisitions for cybersecurity risks, guarding against potential threats to the supply chain and DOJ's networks.

The Policy reflects the Department's strong commitment to the protection of privacy and civil liberties, mandating annual privacy reviews of UAS programs and assessments of new UAS technology from a privacy perspective. It also places limits on data retention, generally requiring privacy sensitive data to be deleted within 180 days, unless certain exceptions are met.

In addition to utilizing UAS as a law enforcement tool, the Department takes seriously the threat posed by unlawful and unsafe uses of UAS. The Department has trained federal prosecutors and agents across the country on the criminal and civil enforcement tools available to counter the misuse of UAS, such as the use of drones to smuggle contraband into prisons or violate restricted airspace. *www.justice.gov*

FAA announces LAANC expansion to major airports, adds new providers

The Federal Aviation Administration (FAA) has announced two important expansions of the Low Altitude Authorization and Capability (LAANC), which automates the application and approval process for drone operators to obtain airspace authorizations.

Four airports – Baltimore/Washington International Thurgood Marshall Airport, Dulles International Airport, William P. Hobby Airport in Houston and Newark Liberty International Airport – joined the list of approximately 400 air traffic facilities covering about 600 airports where LAANC is available. LAANC, a collaboration between the FAA and the Unmanned Aircraft Systems(UAS) industry that directly supports the safe integration of UAS into the nation's airspace, expedites the time it takes for drone pilots to receive authorizations to fly under 400 feet in controlled airspace. The service is accessible to all pilots who operate under the FAA's small drone rule.

senseFly enterprise partnerships with Trimble and Microsoft

senseFly has announced new strategic partnerships. The organisations include Trimble and Microsoft and demonstrate the capability and suitability of senseFly's fixed-wing drones and drone sensors for precision agriculture.

senseFly's distribution agreement with Trimble, as part of its Trimble Select list of preferred partners, will see senseFly products distributed via the Trimble Agriculture network, giving agriculture professionals across North America and Europe direct access to senseFly products. It also announced partnership with Microsoft Azure FarmBeats, which is an agriculture initiative that seeks to sustainably increase global food production by 70% by 2050. Azure FarmBeats combines IoT sensors, UAVs and more, to collect and analyse large amounts of agriculture data. The data is then used to develop new artificial intelligence and machine learning algorithms to provide actionable insights to farmers. *www.senseFly.com*

UK Civil Aviation Authority launches platform to recover lost drones

The UK Civil Aviation Authority (CAA) has launched Drones Reunited, a platform set up to help recover the thousands of drones lost in the UK each year. It will help drone users recover their missing machines – a serious problem for flyers, as new research reveals that over a quarter of drone owners (26%) have lost a drone.The study found that drones are most at risk of being lost due to flight malfunctions – with more than half (51%) of misplaced drones going missing due to battery loss, poor signal, or a technology failure. And in a quarter of cases it's down to pilot error. *www.caa.co.uk*

Trimble launches UAS1 high-precision GNSS board

Trimble has introduced a compact, high-precision GNSS board designed for unmanned aerial systems (UAS): the Trimble UAS1. The board's simple connectivity and configuration allow UAS system integrators to easily add satellite-based positioning using rugged connectors and Trimble's software interface, with the ability to upgrade capabilities later.

The UAS1 incorporates Trimble Maxwell technology with advances in high-precision GNSS positioning. The GNSS engine with 336 channels is capable of tracking L1/L2 frequencies from the GPS, GLONASS, Galileo and BeiDou constellations for robust centimeter-level, real-time kinematic (RTK) positioning. The board has a Remote Network Driver Interface Specification (RNDIS) that enables manufacturers to access the web user interface with the USB connector.

XAG's project Vesper delivery drone

Since July 2019, Airbus and XAG teams have combined efforts to develop a

Minimal Viable Product (MVP) service to start testing deliveries. This MVP is built on top of the P30 platform, XAG's award-winning plant protection drone. The objective of the trial is to validate a highly automated delivery flight from the vendor to the destination and back, across precisely pre-selected pathways. Joining the extensive experience of XAG in designing, manufacturing, and operating small drones at scale – tens of thousands of drone flights every day – to Airbus' expertise in design, engineering, assembly, and certification of aircraft of various form factors, this trial will create feedback cycles to learn and iterate on a drone cargo service in China.

In this trial, a select group of customers in Guangzhou, can order their favorite food from a nearby noodle shop through the Drone Cargo WeChat application. The fresh food is prepared and then the cooked dish, carefully placed into an insulated box, is itself loaded into the waiting drone on a custom locker. The noodle shop being only 1.6 kilometers away, the flight to the first destination locker takes just under five minutes. The customer receives a notification on their phone about the approaching drone and directions to the nearest locker. The drone lands at a safe height, separated from people, and the customer retrieves their food. *www.xa.com*

Frequentis and A1 make drone flights safer

Frequentis and A1 Telekom Austria develop system to expose drone violations to public safety authorities as electronic identification rules are phased in Drones provide an innovative and cost-effective way to deliver services but the potential for misuse or danger to other airspace users is cause for concern. Rules for compulsory registration and electronic identification are about to be phased in, in Europe, to ensure safe integration and the potential for intervention. Frequentis has partnered with A1 Telekom Austria to create a powerful application for this purpose.

Compulsory drone registration and electronic identification will be phased in from 2020. Mobile cellular networks can provide a lot of benefits to the future management of drones. Besides the registration and identification of drones and their owners, they can also track and steer the drone during its flight – even beyond visual line of sight (BVLOS). Mobile network technology is powerful for reliable, high-speed and real time transfer of any kind of drone sensor data (payload data). *www.frequentis.com*

Microdrones' three new UAVs

Microdrones is releasing three new Integrated UAV Systems based on the heavy lifting power, resilience and efficiency of the Microdrones md4-3000 aircraft: the mdMapper3000DuoG VHR, the mdMapper3000DuoG, and the mdMapper3000 PPK. The company has also updated the mdTector1000CH4 LR with a Pergam Laser Methane Falcon sensor for detecting Methane (CH4) and methane-containing gases.

Drone delivers laboratory supplies in 43-mile ocean-crossing test

In a test to improve delivery of health services between communities in the U.S. Virgin Islands (USVI) and its public health laboratory, the USVI Department of Health, Association of Public Health Laboratories (APHL) and other collaborators made a successful 43-mile open-ocean drone crossing last week between St. Croix and St. Thomas.

The flight carried simulation vials and other health supplies in a temperature-controlled compartment. While drones have been trialed internationally in the past, this test marks a critical milestone for domestic use of drones in public health. *aphl.org*

FLIR introduces StormCaster payload family

FLIR Systems, Inc. has announced the FLIR StormCaster™ family of Unmanned Aerial System (UAS) payloads for its SkyRanger® R70 and R80D SkyRaider® airframes. The new line launches with two multi-sensor products –StormCaster-T, which delivers continuous zoom and longwave infrared (LWIR) imaging; and StormCaster-L, which provides ultra-low-light imaging, tracking, and mapping. *www.flir.com*

Leonardo invests in world's first solar-powered drone

Leonardo is accelerating the progress of technology and innovation in autonomous flight by investing in Skydweller Aero Inc., a US/Spanish start-up specializing in large-scale solar-powered unmanned air systems. The initiative will result in the development and deployment of the Skydweller drone, the world's first fully-electric unmanned aircraft capable of carrying large payloads with unlimited range and ultra-persistent endurance.

Skydweller combines potentially unlimited persistence and range with the flexibility of an aircraft. It will operate from existing airbases around the world, deploy thousands of miles away to areas of high need, and remain overhead for orders of magnitude longer than current aircraft. This revolutionary platform will be used for purposes ranging from land and maritime surveillance to monitoring the environment and infrastructure, from industrial geo-information services to telecommunications and precision navigation. During emergencies and disaster-recovery situations, the system can be rapidly deployed from distant locations to provide backup communications and direct support to first responders.

The Skydweller project builds on a proven and mature aircraft that successfully circumnavigated the globe in 2016. The first phase focuses on converting the aircraft from a manned platform into an Optionally-Piloted Vehicle (OPV) by integrating advanced autonomy algorithms and vehicle management systems. The second step of the project will culminate in the first production aircraft, designed solely for unmanned operations and hardened against a range of environmental conditions. Autonomous flights of the OPV are projected for 2020 and the first production model of the unmanned version of the aircraft is expected in 2021. *www.leonardocompany.com*

Racelogic announce new indoor positioning system

Racelogic is launching a brand-new Indoor Positioning System, called VIPS, which is an advanced system for measuring real-time 3D position to an accuracy of ±2cm in areas where GPS is not available, making it an ideal tool for construction applications both indoors and in urban areas.
The system has been designed for any application that requires accurate measurement and recording of 3D positioning and enables GPS based technologies to operate in GPS denied environments.

Discussions are already underway with construction partners to implement VIPS for applications including Indoor/Outdoor Surveys, Snagging, AR, Machine Control, Crane Safety, Depth Measurement and Automated Guided Vehicles. However, the flexibility of VIPS and the option for bespoke adaptation means there are no limits to the potential applications of this cutting-edge technology. VIPS consists of Fixed Ultra-Wideband (UWB) beacons which are placed around the perimeter of the operation area (e.g. floor plan of building or construction site), in known positions which have been manually surveyed using a handheld laser, Total Station or, if time is of the essence, a self-survey can also be performed. The beacons are completely stand-alone and can be battery-powered, making the deployment very rapid.

A fixed or hand-held receiver continuously communicates with the beacons and triangulates its position. This data is combined with the measurements from a highly accurate inertial measurement system, providing a real-time 3D position to within 2cm. The data can be viewed live on a Racelogic VBOX Touch and coordinate locations can be saved to an SD card so that they can be efficiently revisited at a later time. *http://racelogic.co.uk*

Trimble, Hilti and Boston dynamics partnership

Trimble Hilti and Boston Dynamics have announced a collaboration to explore the integration of Trimble's and Hilti's construction management software solutions, GNSS technology and reality capture devices with Boston Dynamics' Spot Robot platform.The companies will collaborate to develop a "proof-of-concept" solution. *www.bostondynamics.com*

Trimble clarity

Trimble® Clarity is available as a stand-alone web application that simplifies the visualization and navigation of 3D data. It enables geospatial professionals to view, use and share 3D point cloud data, models and meshes with engineers, architects, city planners and other project stakeholders via a web browser, which can be viewed on desktop and mobile devices. *https://clarity.trimble.com.*

Advanced RTK engine delivers increased accuracy

Trimble® R12 GNSS receiver is a high-performance GNSS surveying solution powered by an all new Real Time Kinematic (RTK) and Trimble RTX® positioning engine. It features ground-breaking Trimble ProPoint TMGNSS technology that empowers land surveyors to quickly measure more points in more places than ever before. The ProPoint GNSS technology allows for flexible signal management, which helps mitigate the effects of signal degradation and provides a GNSS constellation-agnostic operation. *https://trimble.com*

Verified Photomontages for UNESCO world heritage sites achieves best accuracy

Verified photomontage is an important planning tool to envision how proposed surrounding development plans would affect UNESCO World heritage sites. Verified photomontage demands the best accuracy for the best visualization to determine what a development may look like to a person standing at the photographic viewpoint. For MS Environmental (MSE), selected to provide verified photomontage for multiple UNESCO World Heritage sites, including in the UK Royal Botanical Gardens at Kew and the City of Bath, the Spectra Geospatial SP80 GNSS receiver has emerged as the receiver of choice to achieve the highest quality visualization.

At the UNESCO World Heritage City of Bath, the Bath and North East Somerset Council commissioned MSE to produce technical photography from strategic views around the World Heritage City to show how development proposals would affect strategic views across the city.

The SP80 tracks and process all available GNSS signals, to provide the most reliable measurements and the highest possible accuracies in challenging environments. It also offers the best communications and connectivity capabilities available today including SMS and email alerts and anti-theft protection. *www.spectrageospatial.com*

Leica Geosystems announces Leica Zeno mobile

Leica Zeno Mobile data collection app now integrates HxGN SmartNet post-processing service and Esri's Geospatial Cloud. The new functionalities allow workforces with limited surveying knowledge to optimise data accuracy and precision in the field and office and enable a seamless data flow to Esri's GIS products. Thanks to HxGN SmartNet, Zeno delivers high accuracy RTK positioning. In areas without internet connection, Zeno Mobile's new automatic post processing service allows users not to have to worry whether they have a mobile internet connection or not. *https://leica-geosystems.com*

Leica Geosystems, autodesk collaboration

Leica Geosystems has announced a new collaboration with Autodesk, integrating the Leica iCON iCT30 construction layout tool and Leica Viva TS13 and TS16, and Leica Nova TS60 and TM50 total stations with the Autodesk BIM 360 Layout App. In this latest collaboration, users are experiencing quicker and more productive time by connecting layout tool and total stations directly to the BIM 360 Layout app, now also

available in Android, for immediate use on the site. *leica-geosystems.com*

Second generation dual-frequency GNSS by Broadcom

Broadcom has introduced second generation dual-frequency GNSS solution - the BCM4776. These new chips will be capable of using the new BeiDou-3 constellation's B2a signals, which is the Chinese name for L5. This means that the second generation dual-frequency GNSS will be able to track 30 new L5 signals (60 percent more) with a significant impact on accuracy. And the benefit? End users will experience much higher reliability of the submeter accuracy that is inherent to dual-frequency L1-L5. *www.broadcom.com*

Phantom™ and Vega™ positioning and heading OEM boards

Hemisphere GNSS has introduced its all-new Phantom™ and Vega™ positioning and heading OEM boards powered by next-generation Lyra™ II digital ASIC, Aquila™ wideband RF ASIC, and Cygnus™ interference mitigation technology platforms for the global agriculture market. It offer flexible and scalable accuracy and reliability for a wide array of demanding precision agriculture applications.

It improve performance and track over 800 channels for position-only (Phantom series boards) and over 1,100 channels for position and heading (Vega series boards). This new ASIC technology provides access to every modern and planned GNSS constellation and signal, including GPS, GLONASS, Galileo, BeiDou, QZSS, IRNSS, SBAS, and Hemisphere's Atlas® L-band correction service. Signal support and tracking for L5, AltBOC and BS-ACEBOC, BeiDou phase 2 and 3, and QZSS/L6 (L6-D and L6-E) are also available. *www.hgnss.com*

NovAtel SMART7 antenna

NovAtel's SMART7 Antenna combines a NovAtel OEM7 receiver with a VEXXIS high precision antenna in a durable and waterproof enclosure. The SMART7's ability to track multiple GNSS signals allows for better satellite availability under variable terrain and environmental conditions. TerraStar Correction Services and GLIDE provide flexible positioning options to meet application-specific needs for accuracy and pass-to-pass performance. The SMART7 is optionally available with NovAtel's tightly-coupled GNSS+Inertial Navigation System (INS) SPAN technology that is optimized for the unique dynamics commonly experienced in demanding applications like precision agriculture and machine control. *www.Novatel.com*

AgilLOC antenna element combats GNSS jamming at sea

ST Engineering has developed AgilLOC Antenna Element Compact (AEC), which provides GNSS protection against three simultaneous jamming/interference sources with its adaptive nulling algorithm for the maritime sector, ensuring continuous GNSS protection to connected systems. It was designed for easy integration with new or existing legacy systems that required uninterrupted GNSS reception. .

ADVA introduces multi-band GNSS receiver

ADVA has launched a modular multi-band GNSS receiver for ePRTC and PRTC-B synchronization, bringing new levels of precision timing to 5G networks. The new solution is engineered to overcome ionospheric delay variation that causes timing inaccuracy, enabling communication service providers (CSPs) and enterprises to deliver nanosecond precision.

Quectel announces dual-band high-precision positioning module

Quectel Wireless Solutions Co., Ltd. has announced that Quectel LC79D. The LC79D is an L1/L5 high precision GNSS module that offers a cost and performance level vastly superior to L1 GNSS solutions on the market today. Based on Broadcom's BCM47755, the solution offers simultaneous support for L1 and L5 bands for GPS, Galileo and QZSS satellites, L1 band for GLONASS and BeiDou satellites as well as L5 band for IRNSS. *www.quectel.com*

Regulus cyber wins CES 2020 innovation award

Regulus Cyber has won the CES 2020 Innovation Award for their breakthrough software-based cybersecurity defense against GNSS spoofing. The Regulus Pyramid GNSS solution was named an honoree in the product category of cyber security and person privacy. The software-based cybersecurity solution is designed to protect GNSS against highly dangerous spoofing attacks. The Regulus Pyramid GNSS is a stand-alone software solution that uses a sophisticated, proprietary algorithms to detect GNSS spoofing and defend any GNSS receiver, device, or chipset against it. *www.regulus.com.*

CHC navigation introduces LT700H GNSS RTK tablet

CHC Navigation has launched its LT700H RTK Android tablet, designed to increase efficiency and productivity of the mobile field workforce in applications requiring centimeter-to-decimeter positioning accuracy.

Portable, rugged and versatile, the LT700H enables precision GIS data collection, forensic mapping, construction site layout, environmental surveys, landscaping and earthmoving jobs.

Powered by 184-channel high-performance GPS, GLONASS, Galileo and BeiDou module and a superior tracking GNSS helical antenna, the LT700H provides position availability in demanding environments. Its integrated 4G modem ensures seamless communication from field-to-office and robust connectivity to GNSS real-time kinematic (RTK) networks corrections.

RIEGL strengthens construction and surveying market presence

RIEGL announced the expansion of its terrestrial LiDAR presence in North America with the introduction of its new distribution partner, SITECH South. Operating out of their office in Smyrna, Georgia, SITECH South is a reseller of precision technology for civil engineering and construction.

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January 2020

International Workshop on Advanced Spatial Analytics and Deep Learning for Geospatial Applications
20 - 31 January
Bengaluru, India
www.workshop.csag.res.in

Precise Time and Time Interval Meeting (PTTI)
21 - 24 January
San Diego, USA
www.ion.org

March 2020

Munich Satellite Navigation Summit
16 - 18 March
Munich, Germany
www.munich-satellite-navigation-summit.org

10th International Conference and Exhibition on Geospatial & Remote Sensing (IGRSM 2020)
17 -18 March
Kuala Lumpur, Malaysia
http://igrsm.org/igrsm2020

Geo Connect Asia 2020
18 - 19 March
Singapore
www.geoconnectasia.com

April 2020

United Nations/Mongolia Workshop on the Applications of GNSS
13 - 17 April
Ulaanbaatar, Mongolia
www.unoosa.org

SpaceTimeAI 2020
20 - 22 April
London, UK
www.ucl.ac.uk/civil-environmental-geomatic-engineering/

May 2020

China Satellite Navigation Conference
May 2020
Chengdu, China
www.beidou.org

XPONENTIAL 2020
4 - 7 May
Boston, USA
www.xponential.org

GISTAM 2020
7-9 May
Prague, Czech Republic
www.gistam.org

FIG Working Week 2020
10 -14 May
Amsterdam, the Netherlands
www.fig.net

European Navigation Conference 2020
11-14 May
Dresden, Germany
www.dgon.de

GeoBusiness 2020
20 - 21 May
London, UK
www.geobusinessshow.com

ICCM 2020: International Conference on Cartography and Mapping
21 - 22 May
London, UK
https://waset.org

June2020

International Conference on Localization and GNSS (ICL-GNSS 2020)
2 - 4 June
Tampere University, Finland
https://events.tuni.fi/icl-gnss2020/

XXIVth ISPRS Congress
14 - 20 June 2020
Nice, France
www.isprs2020-nice.com

The 8th International Conference on Cartography and GIS (ICCGIS)
15 - 20 June
Nessebar, Bulgaria
https://iccgis2020.cartography-gis.com

July 2020

GI Forum
7 - 10 July
Salzburg, Austria
www.gi-forum.org

Esri User Conference
13 - 17 July
San Diego, USA
www.esri.com

September 2020

ION GNSS+ 2020
21 - 25, September
St. Louis, Missouri, USA
www.ion.org

October 2020

INTERGEO 2020
13 – 15 October
Berlin, Germany
www.intergeo.de

November 2020

Trimble Dimensions 2020
2 - 4 November
Nashville, USA
www.trimbledimensions.com

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