RNI: DELENG/2005/15153
Publication: 15th of every month
Posting: 19th/20th of every month at NDPSO

No: DL(E)-01/5079/17-19
Licensed to post without pre-payment U(E) 28/2017-19
Rs.150

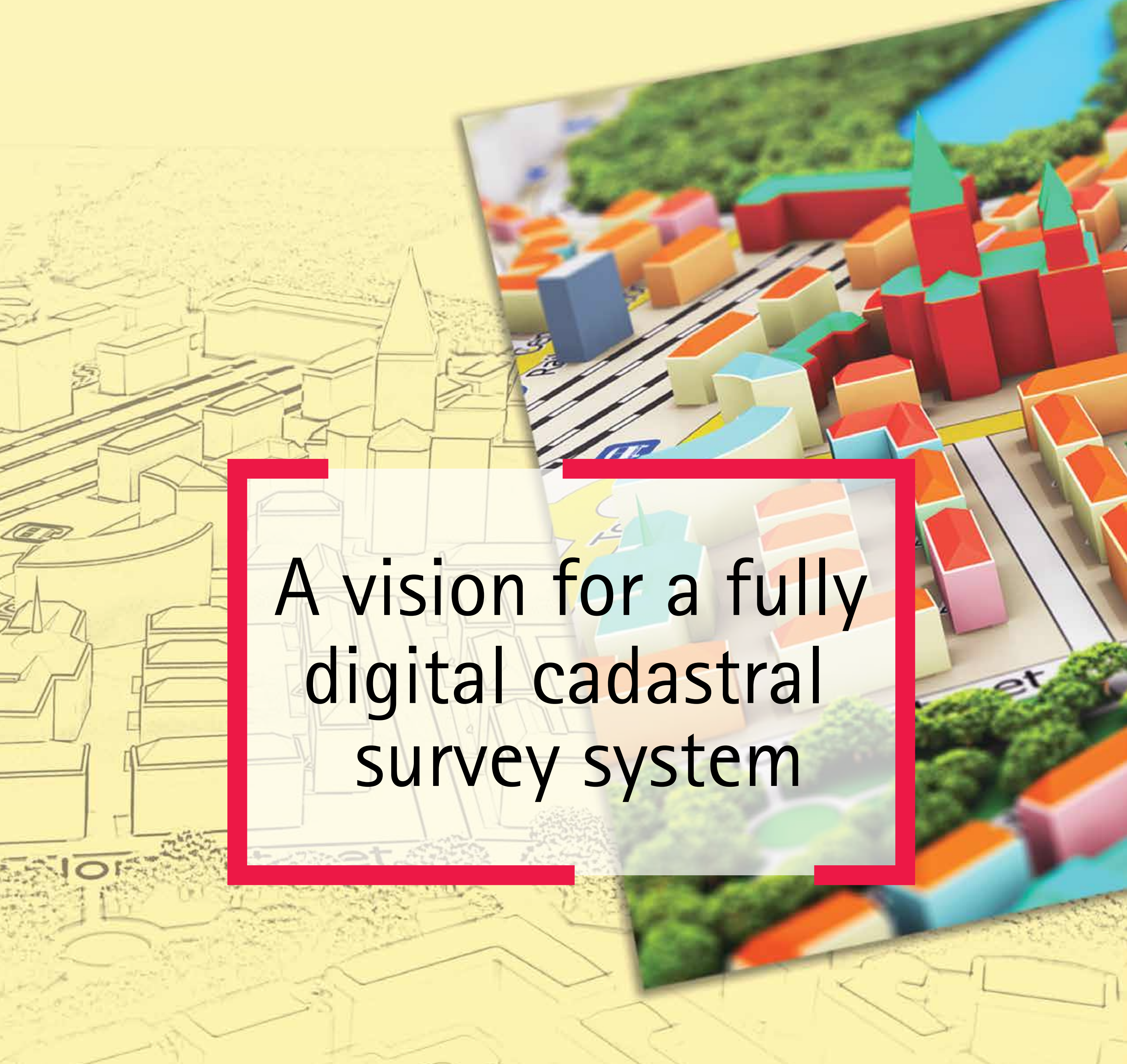
ISSN 0973-2136

www.mycoordinates.org

# Coordinates

Volume XIV, Issue 10, October 2018

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



## A vision for a fully digital cadastral survey system

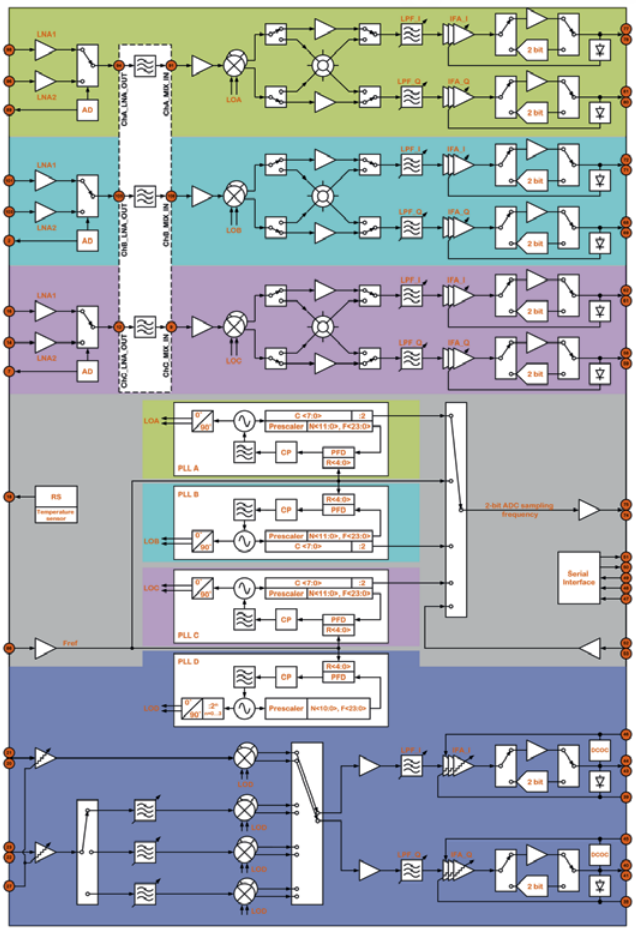
## Tracking cities from the sky with Artificial Intelligence

NTLab
www.ntlab.com


# NT1066 NEW

## Multi-Channel GNSS RF Front-End IC

*Precision is going to be*
*simpler, cheaper, faster …*



NT1066 is a multi-channel GNSS RF Front-End chip for professional navigation market: geodesy, driverless cars, drones, transport tracking and similar applications.

Product features:

- simultaneous reception of NavIC/GPS/GLONASS/Galileo/BeiDou/QZSS signals;
- frequency bands: **S**/L1/L2/L3/**L5**/E1/E5/E6/B1/B2/B3:
  - channels "A", "B" and "C" are designed with single conversion low-IF architecture, individually programmable and intended to receive L1, E1, B1, E6, B3, L2, L3, B2, **L5**, E5 in various combinations;
  - channel "D" is dedicated to operate on **S** band of NavIC or L2, L3, **L5** bands of other GNSS and has zero-IF architecture;
- it is possible to eliminate effectively ionospheric distortion utilizing large signal base of NavIC between **L5** and **S** bands;
- full programmability of each of 4 channels (signal bandwidth, downconversion sideband, AGC options, analog/2-bit digitized output, etc.);
- simple and easy-to-use register map for chip configuration.

NT1066 is produced using 0.18µm SiGe BiCMOS technology and it is already in mass production.

नाविक के सभी बैंडों के लिए उपयुक्त

**applicable to all bands of navic!**

FRANKFURT 2018 INTERGEO
16 – 18 OCTOBER GLOBAL HUB OF THE GEOSPATIAL COMMUNITY

**Visit us at booth 12.0E.110**


# In this issue

Coordinates Volume 14, Issue 10, October 2018

## Articles



## Columns



**This issue has been made possible by the support and good wishes of the following individuals and companies**
Anselm Haanen, Avik Bhattacharya, Billy CH Hau, Ka Wai Hui Karena, Man Sing Wong, Marco Lisi, Miles Ware, Sawaid Abbas, Shaunak De and Trent Gulliver and; Absolute Precision, Effigis, EOS Positioning, Geomax, Hemisphere GNSS, Javad, Labsat, Leica, Linertec, NTLab, Pentax, Riegl, SBG System and many others

**Mailing Address**
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.
**Phones** +91 11 42153861, 98102 33422, 98107 24567

**Email**
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
[subscriptions] iwant@mycoordinates.org
**Web** www.mycoordinates.org



**Annual subscription** (12 issues)
[India] Rs.1,800 [Overseas] US$100

**Printed and published** by Sanjay Malaviya on behalf of Coordinates Media Pvt Ltd
**Published** at A 002 Mansara Apartments, Vasundhara Enclave, Delhi 110096, India.
**Printed** at Thomson Press (India) Ltd, Mathura Road, Faridabad, India

**Editor** Bal Krishna
**Owner** Coordinates Media Pvt Ltd (CMPL)

**This issue of Coordinates is of 52 pages, including cover.**

# UAV policy impetus

Finally, one can fly drones in India

Legally after December 1, 2018

After taking permission

And observing certain regulatory provisions,

As per the policy regulations

From the Office of Director General of Civil Aviation

Released in the last week of August.

UAVs get a push from the top echelon of the government

Which is also evident

When it constituted a 13-member task force on drones

Headed by minister of state for civil aviation.

The task force is expected to come up with a road map for drone operations.

The transition in the approach of the government

From reluctance to caution to facilitation

Is a welcome step not only for the users

But for the manufacturers as well.

**Bal Krishna, Editor**
**bal@mycoordinates.org**

record • replay • simulate


# LabSat 3 WIDEBAND

**The most powerful LabSat yet, the new LabSat 3 WIDEBAND captures and replays more GNSS signals at a much higher resolution than before.**

Small, battery powered and with a removable solid state disk, **LabSat 3 WIDEBAND** allows you to quickly gather detailed, real world satellite data and replay these signals on your bench.

With three channels, a bandwidth of up to 56MHz and 6 bit sampling, **LabSat 3 WIDEBAND** can handle almost any combination of constellation and signal that exists today, with plenty of spare capacity for future planned signals.

**LabSat 3 WIDEBAND** can record and replay the following signals:

- GPS: L1 / L2 / L5
- GLONASS: L1 / L2 / L3
- BeiDou: B1 / B2 / B3
- QZSS: L1 / L2 / L5
- Galileo: E1 / E1a / E5a / E5b / E6
- SBAS: WAAS, EGNOS , GAGAN, MSAS, SDCM
- IRNSS

www.labsat.co.uk

# High positioning accuracy and precise time transfer with PPP GNSS receivers

These recent developments in the "race" for higher positioning accuracy prove that there is no single technology capable of providing a reliable and continuous solution in all environments, so the need for integration and fusion

**Dr. ing. Marco Lisi**
European Space Agency – ESTEC
Noordwijk, The Netherlands

In the last few months we have been witnessing a remarkable (and, to some extent, surprising) increase of interest for GNSS high accuracy positioning, involving both systems and receivers.

In particular, this growing demand for increased positioning accuracy is evident for mass-market applications, in areas such as:

- IoT tracking devices;
- Wearable tracking devices;
- Automotive;
- UAV's;
- Robotic vehicles.

Several GNSS augmentation methods have been developed over the years, aiming at improving the navigation system performance not only in terms of positioning accuracy, but also in terms of reliability, availability and sometime integrity.


## Satellite based augmentation systems

One first family of augmentation systems is based on the principle of "Differential GNSS". This method consists in using reference receivers, positioned in fixed, well-located positions, known as "base" stations, to derive correction errors that apply with a good degree of approximation to all user receivers located nearby.

Well known and already fully operational are the so-called Satellite-Based Augmentation Systems (SBAS), such as the American Wide Area Augmentation System (WAAS) and the European Geostationary Overlay Service (EGNOS) (figure 1).

These systems provide a wide-area or regional augmentation of existing GNSS (e.g. GPS) through the broadcasting of additional satellite messages to users.

The augmentation messages are derived after processing information collected by dedicated stations and then sent to one or more satellites (usually geostationary) for broadcast to the end users. The augmentation messages can also be broadcasted to users via Internet. This is the case of the EGNOS Data Access Service (EDAS), a terrestrial commercial service offering ground-based access to EGNOS data through the Internet on controlled access basis. Geared to users requiring enhanced performance for professional use, EDAS provides users with the same data broadcast by the EGNOS satellites (EGNOS Message) in near real-time (figure 2).

## Real –Time Kinematic (RTK) and Precise Point Positioning (PPP)

Presently, GNSS correction services to achieve very high positioning (centimetre-level) accuracy are already offered to professional users. They are based on two main technologies: Real-Time Kinematic (RTK) and Precise Point Positioning (PPP).

The RTK technology is a differential GNSS technique based on the use of code and carrier phase measurements from the satellites of the GNSS constellation and on corrections provided wirelessly to a user receiver by a local reference ground station, at a well-known location (figure 3).

Using carrier-phase measurements, together with ionospheric and tropospheric error corrections, allows reaching centimetre-level accuracies.

The drawback is that for carrier-phase measurements, phase ambiguity has to be solved, a process requiring non-negligible convergence times.

Atmospheric (ionospheric and tropospheric) corrections require a reference station (the "base station") not too far away from the user (the "rover'), with baselines not longer than about 15 kilometers (usually between 10 and 20 km).

Besides atmospheric corrections, the base station helps reducing errors from such sources as satellite clock and ephemeris.

With PPP, satellite clock and orbit corrections (significantly more precise than those available in the broadcast navigation message), generated from a network of global reference stations and calculated through sophisticated algorithms by a centralized processing facility, are delivered to the end users via satellite or over the Internet (figure 4).

It is worth noting that, as compared to RTK, PPP does not provide atmospheric effects corrections. On the other hand, PPP does not require a local base station and offers a worldwide service.

Combining the precise orbit and clock corrections with a dual-frequency GNSS receiver (thus removing the first order ionospheric errors), PPP is able to provide position solutions with accuracy at centimeter level.

As compared to RTK, PPP offers a worldwide service and, being based on a global network of reference stations, guarantees a highly redundant and robust infrastructure (while RTK is totally dependent on the availability of the local base station). One drawback of PPP is that the processing algorithms generating orbit and clock corrections require rather long convergence times to achieve maximum performance, although real-time or quasi real-time PPP systems are being developed.

Summarizing, both RTK and PPP technologies are able to provide positioning accuracies in the order of few centimeters, with reasonable convergence times, while single-frequency pseudorange-based positioning using navigation message data provides meter-level accuracy at best.

## System-level high accuracy services

As already mentioned, technologies for very accurate positioning, such as RTK and PPP, have been adopted so far mostly by professional users, not targeting mass-market applications such as, e.g., smartphones.

Something is changing, as far as system-level solutions are concerned.

In Japan, the GPS-based, regional Quasi-Zenith Satellite System (QZSS) is already planning to provide centimetre-level positioning and navigation services over the Japanese territory. The system is based on more than one thousand reference stations to constantly correct satellite errors. The corrected data is then compressed for real-time transmission back to the constellation of three satellites for broadcasting to user receivers.

In Europe, a fairly radical and strategic decision was taken in March 2018, with the Implementing Decision by the European Commission redefining the scope of the Galileo Commercial Service.

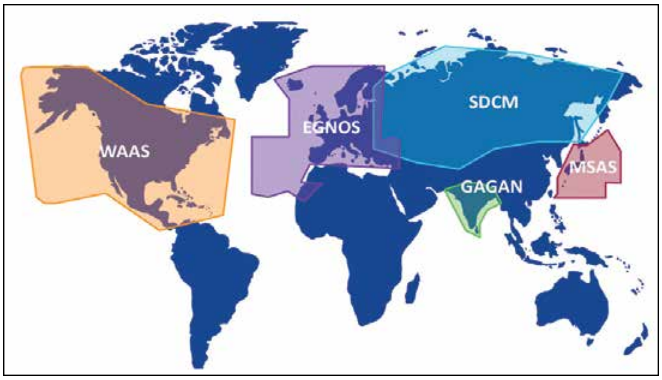



**Figure 1: Satellite Based Augmentation Systems around the world**

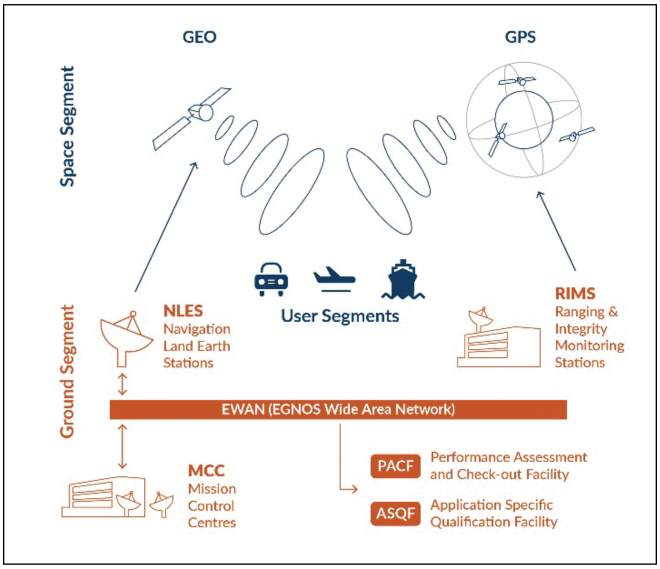



**Figure 2: EGNOS System Architecture**

It is worth noting, at this point, that the PPP technique was proven to be not only able to provide centimeter-level positioning accuracy, but also to be a very effective tool for remote time and frequency synchronization of atomic timescales and oscillators.

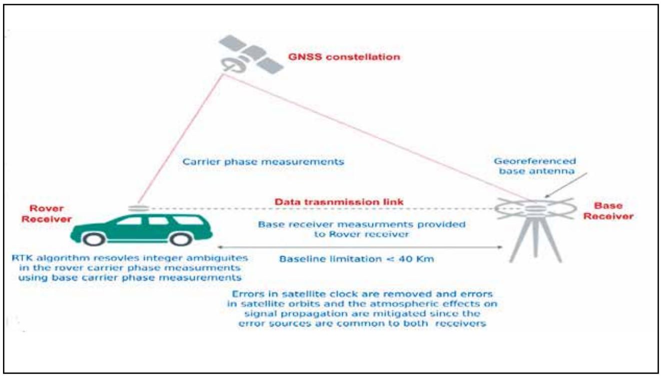



**Figure 3: Real-Time Kinematic Concept**

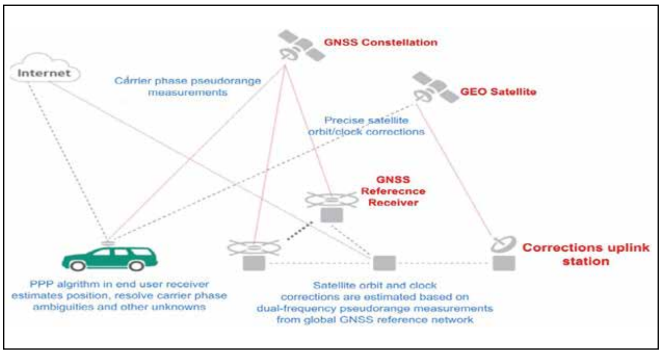



**Figure 4: Precise Point Positioning Concept**

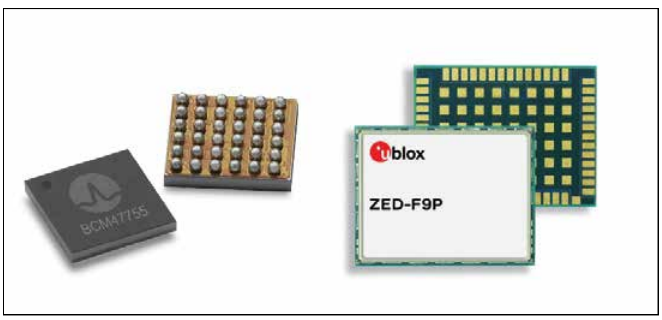



**Figure 5: Broadcom and U-blox Multi-Constellation, Dual-frequency Receivers**

The EC decision, recognizing the increasing demand for higher positioning accuracy by fast expanding sectors, such as autonomous vehicles, robotics and drones, introduced a "free-access" High Accuracy Service (HAS) on $E_6$ signal, allowing users "to obtain a positioning error of less than two decimetres in nominal conditions of use". The convergence time of this new service should be , on the other hand, in the order of about five minutes, thus making it attractive for mass-market applications, including smartphones, but not in direct competition with "external" services such as RTK and PPP.

The approach of offering the High Accuracy Service (HAS) to all interested users on a free of charge basis, with content and format of data publicly and openly available on a global scale, was deemed to increase the public benefit delivered by Galileo. It was also estimated that it will contribute to position Galileo in the market as the first GNSS system offering high accuracy services on a free of charge basis. On the other hand, since departing from the scheme originally foreseen by Implementing Decision (EU) 2017/2243 of 8 February 2017, the new Implementing Decision was taken after consultation with all potential stakeholders.

The practical implementation of the EC decision is being studied jointly by the European GNSS Agency and ESA, leading to industrial developments in 2019.

## Multi-Constellation, Dual-Frequency GNSS Receivers for mass-Market Applications

A little revolution is also taking place in the world of GNSS receivers and chipsets manufacturers: four major companies (Broadcom, Intel, STMicroelectronics and U-blox) decided to make commercially available for mass market applications dual-frequency receivers, offering position accuracies down to 30 centimeters (figure 5). Several flagship smartphones are planning to integrate them in 2018.

The technical specifications and technological solutions adopted vary slightly among the four manufacturers, but they all start from recognizing the same market requirements:

- Smartphones, IoT, wearable and other mobile devices;
- Commercial unmanned vehicle applications (drones, heavy trucks, UAVs);
- Applications in "hostile" urban environments;
- Assisted and autonomous driving;
- Automotive safety compliance (ISO 26262, ASIL);
- Built-in integrity checking;
- Built-in jamming and spoofing detection capabilities;
- Sensor data fusion.

In particular, the lane-level navigation accuracy on highways (to allow Lane-Departure Warning, LDW) seems to be a very important requirement for car manufacturers.

All receivers of new generation, apart from some technical differences, are essentially based on the same architecture: multi-constellation, dual-frequency, high power efficiency, low cost.

The dual-frequency capability ($L_1/E_1$ and $L_5/E_5$) makes them able to better cope with reflections off buildings in urban environments: multipath correction, detection of reflected signals, ionospheric errors correction, resolution of phase ambiguity (in case carrier-phase measurements are performed) are all made possible.

It is worth noting that dual-frequency operation starts being attractive because as from 2018 there are enough $L_5/E_5$ satellites in orbit (about 30, including Galileo, GPS-3 and QZSS).

## Advanced processing software for autonomous driving

Autonomous and connected vehicles are positioning themselves among the most disruptive mass-market technologies of the future. Despite some unfortunate accidents and a rather different approach to standardization and regulation, the deployment of autonomous vehicles will soon become a reality on US and European road networks.

Autonomous vehicles can take over activities traditionally performed by the driver, thanks to their ability to sense the environment, navigate and communicate with other vehicles and road infrastructure when combined with connected vehicle solutions. Widespread adoption of autonomous driving can reduce traffic accidents, reduce fuel consumption and improve traffic flow, as well as improve driver comfort.

The adoption of autonomous driving is probably going to happen much faster than everyone thinks, following adoption curves closer to those typical for digital technologies, rather than to those typical for transportation systems.

In other words, while cars took decades to be widely adopted, autonomous driving will have a worldwide spread in just a few years.

Many believe that autonomous driving will probably be the single largest societal change after the Internet. One thing is for sure: autonomous driving will destroy the traditional concept of the car as a personal good to be owned, moving to the paradigm of "transportation as a service".

For some years now big corporations such as Waymo (Waymo is an autonomous car development company and subsidiary of Google's parent company, Alphabet Inc.), Uber, Tesla, GM and many others, from Mazda to Maserati, have been testing their driverless cars (figure 6).

While all of them consider standard-precision GNSS as an indispensable component of their automated vehicle sensor suite, they still view it as a secondary sensor, not accurate or reliable enough for positioning the vehicle within the lane.

In order to achieve the level of positioning required for the safe operation of autonomous vehicles, an intimate fusion of on-board sensors, computer 3D modelling and GNSS technologies is needed.

One well known problem is that ground vehicles often operate under sky-obstructed areas, where GNSS signals can be altered or blocked by buildings and trees. In these cases, GNSS receivers can become wildly inaccurate, just when they would be most needed, i.e. in densely populated and highly built-up urban areas (where incidentally most of the users are located).

**Figure 6: Google Prototype Driverless Car**

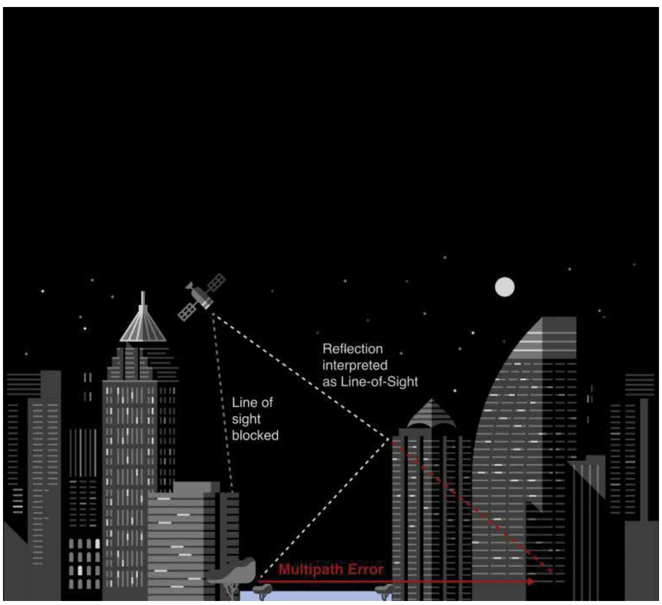



**Figure 7: Uber Simplified Merging of Satellite SNRs and 3D Maps**

Multi-constellation and dual-frequency are partially solving the problem. To further overcome this challenge, companies like Google and Uber are developing software applications to substantially improves location accuracy in urban environments utilizing 3D maps together with fairly sophisticated ray-tracing, probabilistic computations on GNSS raw data available from the on-board user receiver (figure 7).

## An accurate, simple and cost effective time synchronization approach

It is worth noting, at this point, that the PPP technique was proven to be not only able to provide centimeter-level positioning accuracy, but also to be a very effective tool for remote time and frequency synchronization of atomic timescales and oscillators.

The PPP technique, as applied to time transfer, can be seen as a "One Way" time transfer approach. Experimental campaigns have demonstrated that this alternative synchronization technique offer high-level performance, comparable with state-of-the-art methods, such as "Two-Way Satellite and Frequency Transfer" (TWSTFT). As compared to TWSTFT, a "One Way" technique based on the Galileo HAS would be simple and low cost. Moreover, given the recent development of GNSS chip sets for high accuracy in mass-market applications, it can be expected in the near future a generation of multi-constellation, dual-frequency receivers, able to take advantage of the Galileo High Accuracy Service.

The availability of low cost, high performance receivers for time and frequency synchronization purposes could be an enabling factor for the development of the future 5G network infrastructure. As a matter of fact, the nodes of the 5G network will require synchronization accuracies between 5 and 20 nanosecond, almost one order of magnitude better than what presently achievable with a GNSS receiver (unless "Common View" techniques are used).

The multi-constellation, dual-frequency, HAS-enabled receivers could become the basis for affordable Primary Reference Time Clocks (PRTCs), possibly in combination with miniaturized atomic clocks, to provide high accuracy time and phase synchronization signals traceable to the UTC time standard, with good holdover performance for resiliency.

## Conclusion

These recent developments in the "race" for higher positioning accuracy prove on one side that there is no single technology capable of providing a reliable and continuous solution in all environments, so the need for integration and fusion; on the other hand, that high accuracy navigation is part of a much larger technological revolution, triggered by 5G, IoT, unmanned vehicles, vehicle-to-everything (V2X), augmented reality.


EOS
Positioning Systems
ARROW SERIES™
High Accuracy Field Mobility
Submeter with GAGAN, 1cm with RTK
SafeRTK™ for poor cell coverage areas
GPS/Glonass/Galileo/BeiDou, L1/L2/L5
4cm real-time accuracy anywhere in the world
WWW.EOS-GNSS.COM
Made in Canada

# Hemisphere's key applications are focused on providing world-class RTK positioning performance

Says Miles Ware, Director of Marketing, Hemisphere GNSS in an interview with Coordinates magazine

**For the benefit of our readers please take us briefly through the journey of Hemisphere GNSS and role of its principal owner Unistrong.**

Hemisphere GNSS, Inc. (Hemisphere), headquartered in Scottsdale, AZ, USA with offices located around the globe, began life in January 2013, when Beijing UniStrong Science & Technology Co., Ltd. acquired the precision products business, and related GNSS technology and intellectual property, from Hemisphere GPS, Inc. Until then, Hemisphere GPS had been a company with primarily three areas of focus: precision guidance and control for agricultural operations; high-precision positioning and guidance for the professional and commercial marine market; and embedded OEM precision GNSS technology. For obvious reasons, these areas were complementary for many years as Hemisphere GPS pioneered precise location, optimized for agricultural operations, as well as its Crescent®, Eclipse™, and Vector™ technology platforms with chips and software designed from the ground up for these purposes.

At the time of purchase, both UniStrong and Hemisphere were placing a big bet with big stakes—the goal was to form a new GNSS powerhouse and enter the global market as a company controlling all aspects of precision and satellite-based location, from engineering talent and intellectual property to chip production and finished product manufacturing. This was audacious; in a sector dominated by a handful of firms.

The convergence of the newly formed Hemisphere and UniStrong resulted in Hemisphere having the ability to offer its proven GNSS technology to a truly global audience and control the entire innovation and delivery mechanism. UniStrong already having a dominant presence as a top-tier manufacturer of rugged tablets and mobile devices gave the new organization a mature

**The convergence of the newly formed Hemisphere and UniStrong resulted in Hemisphere having the ability to offer its proven GNSS technology to a truly global audience and control the entire innovation and delivery mechanism**


manufacturing and supply chain to manufacture and distribute Hemisphere-based products and technology to the world. UniStrong, established in 1994, was already a major GNSS firm in China. Though not an innovator in this sector, the eight-branch firm, with more than 1,000 employees and two-world class manufacturing facilities, was noted for high-end handhelds with GPS, GLONASS, and BeiDou capabilities, used for navigation and high-accuracy surveying.

Although for many organizations these accomplishments would have been enough for any company to declare mission accomplished, however Hemisphere and UniStrong were just getting started. The first mandate from the new corporate leadership team was for Hemisphere to introduce a new and completely redesigned world-class RTK positioning engine to rival the performance and features of industry leaders. Based on this objective and with the financial strength and investment of UniStrong, Hemisphere sought out and assembled top engineering talent in the geospatial positioning sector and quickly made extraordinary advancements in their RTK positioning technology.

**Armed with its new arsenal of RTK positioning technology Hemisphere was now positioned to step into the arena with a new focus and strategy to truly be a major force in the positioning industry**

## Hemisphere GNSS is a leader in high-performance satellite positioning with a strong technology foundation and a relentless focus on innovation. Would you like to elaborate on this further?

Hemisphere's engineering team, started from the ground up to develop GNSS engines, boards, and software based on the best new thinking in GNSS. A senior director of engineering said, "At the beginning, we sat down in front of a blank screen and had to start with the basics, from writing math libraries, linear algebra, filters, to basic GNSS data management, everything from scratch. There is not a single line of code that was not reviewed or improved as part of this new project; we left no stone unturned."

This new research and development initiative bore fruit with extraordinary rapidity. Within three years of Hemisphere's formation, two new groundbreaking GNSS solutions had been brought to market, the Athena™ GNSS RTK engine and the Atlas® GNSS global correction service, delivering correction signals via L-band satellites at scalable accuracies ranging from sub-meter to sub-decimeter levels.

Armed with its new arsenal of RTK positioning technology Hemisphere was now positioned to step into the arena with a new focus and strategy to truly be a major force in the positioning industry.

## What are the key application areas where Hemishphere GNSS has unique products and solutions to offer?

Hemisphere's key applications are focused on providing world-class RTK positioning performance to the land survey, machine control and precision agriculture markets through both guidance and steering solutions, and marine positioning and heading solutions for navigation and hydrographic surveying solutions.

Hemisphere offers solutions to the land survey market through its own brand and also through several OEM brands such as Carlson Software and Stonex branded products. Hemisphere's OEM partners take advantage of the world-class RTK performance of the Athena GNSS RTK engine and Hemisphere's design and manufacturing capabilities offer exceptional products to their customers at a very competitive and disruptive price point.

Hemisphere has renewed its focus in the machine control market with its GradeMetrix™ OEM machine control toolkit. Hemisphere has combined its proven positioning and heading technology along with its new GradeMetrix software platform to offer machine manufacturers a fully scalable software platform for guidance and control applications for dozers, excavators, motor graders, and skid


steers. The GradeMetrix toolkit allows OEM machine manufacturers to offer their customers with the machine control solutions and applications that they have identified as key to their customer base to ensure they experience the efficiency and ease of use that many in the mature machine control market have come to expect in a modern GNSS machine control offering.

**Hemisphere offers solutions to the land survey market through its own brand and also through several OEM brands such as Carlson Software and Stonex branded products**

Hemisphere continues to grow its presence in the marine market with its line of Vector products that offer fully scalable multi-frequency, multi-GNSS solutions for the marine navigation and hydrographic survey markets. Hemisphere also offers access to its Athena RTK performance and Atlas GNSS global correction service in all of its new products positioned for the marine market. The Vector product line offers position and heading solutions for the leisure, professional, and commercial marine markets. Hemisphere's Vector solutions are made in various platform sizes ranging from the 13 cm V104 providing 1-degree accuracy; the 50 cm V500 providing 0.3-degree accuracy; and the V1000 for large-scale solutions which supports antenna separations up to 20 meters and provides users with 0.01-degree accuracies. All of Hemisphere's Vector solutions incorporate IMU and gyro technology to allow the products to continue to provide specified accuracy performance when used in challenging environments or when GNSS satellite visibility is compromised or unavailable.

### Recently, Hemisphere GNSS acquired Outback Guidance Business from AgJunction, Inc. What value does it bring to overall portfolio of Hemishphere GNSS business?

Hemisphere recently renewed its commitment and efforts in the precision agriculture market with the recently acquired Outback Guidance (Outback) product line and distribution channel, based out of Hiawatha, KS, USA and Winnipeg, MB, Canada. Outback has been a proven brand in the precision agriculture space leveraging Hemisphere's RTK solutions to provide superior machine guidance and steering to various agriculture applications including, but not limited to, steering, implement control, section control, and data management. Hemisphere sees a tremendous opportunity to elevate the Outback brand to new heights with its new RTK engine and solutions that offer access to its Atlas GNSS global correction service. The continued global expansion of Outback products and solutions to emerging regions of the world that will benefit from having value based affordable solutions that make agriculture applications efficient and productive for a greater variety of large and mid-size tractors and machines is very exciting.

# A vision for a fully digital cadastral survey system

The value of cadastral survey data is rapidly increasing in line with the movement into the digital age. To truly realise its value, it will be necessary to detach completely from paper-based approaches associated with the past


**Anselm Haanen**
Deputy Surveyor-General, Land Information New Zealand

**Trent Gulliver**
Senior Cadastral Survey Advisor, Land Information New Zealand


The world is going digital. Advancements in technology and an evolving society are coupling to mean it is fast becoming the norm to provide and consume information digitally. Local and central governments are reacting to this by developing policies, systems and infrastructure that are 'digital by design' and 'digital by default' (Corydon, Ganesan & Lundqvist, 2016). Examples include New Zealand's capital city, Wellington, which has developed the strategy, Wellington Towards 2040: Smart Capital (Wellington City Council, 2011), and Singapore is well down the track to become a 'Smart Nation' (Smart Nation and Digital Government Office, 2018).

Cadastral survey systems define the boundaries of property rights and in countries like New Zealand are crucial to economic success. Making the cadastral survey system digital helps drive efficient economic activity and is a key enabler of the initiatives being pursued by governments. The cadastre also provides a critical base layer that is used in Geographic Information Systems and more ubiquitous technologies. It also enables the integration of property-related services that are administered by local and central governments. The importance of cadastral survey systems emphasises a wider need for such systems to be truly and fully digital.

This paper explores a vision for a fully digital cadastral survey system in New Zealand. A particular focus of the paper is to discuss how the existing system, despite being highly digital, incorporates paper-based approaches that are a testament to past practice. It is these approaches that stand in the way of a fully digital system that supports processes of automation, enhanced data quality and data re-use.

## Current digitisation of the survey process

Since the establishment of the cadastral survey and title systems in the 1800s, New Zealand surveyors have prepared survey plans to formally record the location and extents of property rights, restrictions and responsibilities in the cadastre. Since 2000, with the introduction of the automated survey and titles system 'Landonline', most of the survey process have been progressively digitised and use digital data – in the field, in the office, and for the cadastre itself.

With reference to Figure 1, a cadastral survey begins with a surveyor remotely searching the cadastre for records that relate to the area of interest (e.g., where existing parcels are to be subdivided). The surveyor uploads information that is relevant to their job, such as ownership records (e.g., titles) and historic survey plans. In addition to any image-based records, survey data is extracted and imported into the surveyor's preferred survey software. The surveyor adds new data from their field survey along with any other data derived from ground-truthed architectural or engineering drawings. The required data for the finalised survey is then exported to a LandXML file *(http://www.landxml.org)*.

The surveyor then logs into a restricted area in Landonline and imports the LandXML file (see Figure 2) and invokes a series of in-built tests that validate the dataset against various regulatory requirements. They also use tailored software within Landonline to generate diagrams of the survey and parcels that ultimately become the plans of the survey (see Figure 3). The surveyor adds supporting documents, such as a survey report and any supporting graphics, certifies the package, and submits the 'cadastral survey dataset' to the national cadastral survey system.

Currently 3D surveys, such as those for multilevel, multiple ownership 'Unit Title Developments' are only represented in plan image format – without structured data. Surveyors create these plans using their own software and import them into Landonline as TIFF images.

Once the survey dataset successfully passes a final validation process, it is approved and then integrated into the authoritative cadastre. This includes generating accurate coordinates for all the points in terms of the survey control network, and updating the parcel map to show the new parcels (see Figure 4). The resultant information is then made freely available for reuse by all users.

## Problems and opportunities

### Data Duplicated on Plans

The current Landonline system, which was initially built nearly 20 years ago, was designed to support 'automation' through the capture, validation and storage in the cadastre of digital survey data. Surveyors and users, however, insisted that the equivalent of traditional 'plans' were still needed (LINZ, 1998).

The system was, therefore, built to enable this and has resulted in the information shown on the plans duplicating that held as data in the dataset. In today's digital world such duplication is considered inefficient and results in unnecessary compliance costs for the surveyor and ultimately the property developer.

Under the current New Zealand survey regulations, both the data and the plans are legally authoritative and, therefore, have to be correct (Surveyor-General, 2010). The Surveyor-General is currently considering whether to change the regulations

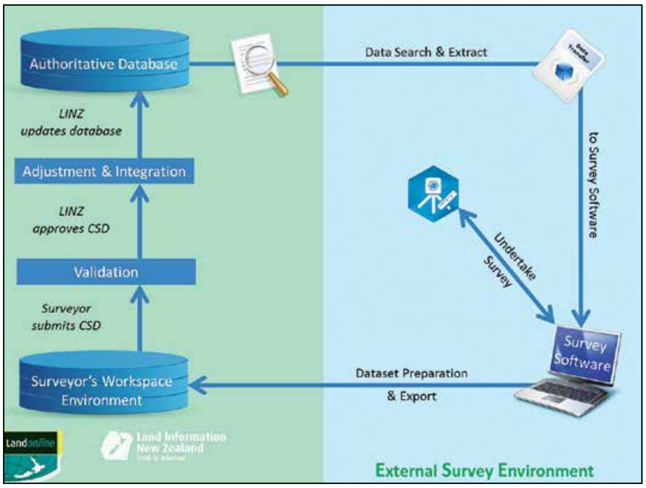



**Figure 1. Cycle of Cadastral Survey Data using Landonline**

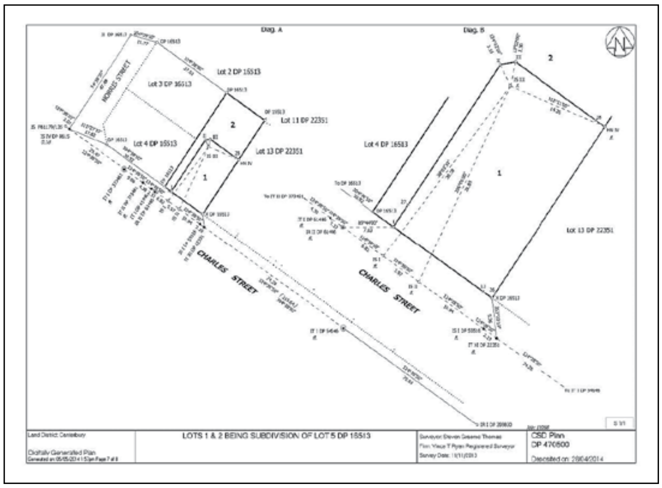



**Figure 3. Landonline 'plan' image based on captured data**

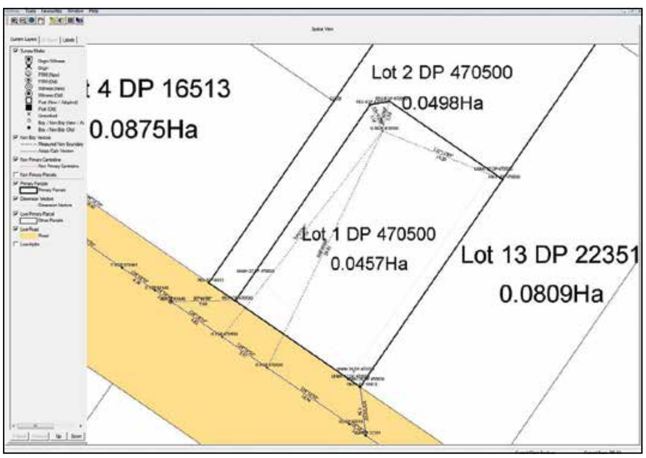



**Figure 2. Landonline spatial view of captured survey data based on LandXML file**

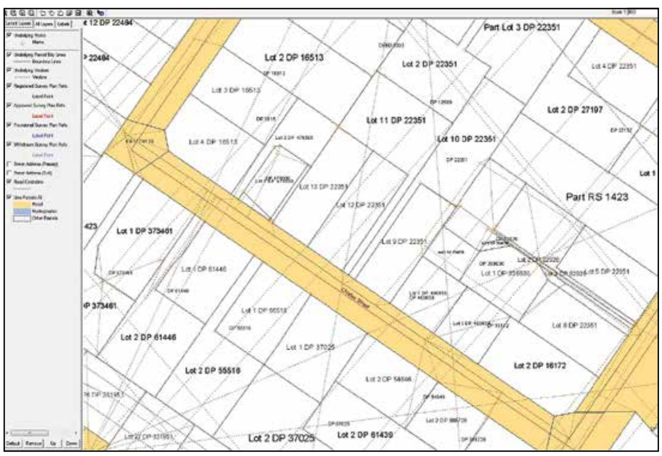



**Figure 4. Landonline spatial view of the integrated digital cadastre**

that specify the content of a cadastral survey dataset so that they need not include plans. The Cadastral Survey Act 2002 already allows for legislative references to 'survey plans' to be synonymous with 'cadastral survey datasets'. There would be no need, therefore, to change the parent legislation.

In order to avoid this duplication, the primary question is how to ensure that users can visualise the survey dataset without the effort and cost of generating a plan. This is covered in the section below.

### Datasets of 3D Surveys

At the time that Landonline was being developed the tools to manage 3D data in the cadastre were not readily available. Consequently the digital versions of paper plans continue to be used for most 3D surveys today – they are not represented in the form of data. Those plans are difficult to create and (with increasing development scale and complexity) can be notoriously difficult to interpret. They consist of multiple plan ('bird's-eye') views, sections, and elevations that have to be combined in the user's head, or reproduced as perspective or 3D depictions, to envision the actual structure and boundaries. This is exacerbated where the boundaries are neither horizontal or vertical (such as slope or curved boundary surfaces).

A 3D digital dataset of these surveys would enable them to be readily rendered, visualised and interrogated, as well as being tested for 3D gaps and overlaps. The technology is now readily available and the potential benefits are significant (see below).

While the step required to move from plan to data is greater for 3D than for other types of survey (as '2D' surveys are already digitally enabled), that step is not as significant with today's technological capabilities.

### Benefits of digitisation of the Cadastral Survey Process

Putting aside the issue of plans for the moment, making the cadastral survey process fully digital provides significant benefits that can be categorised under the process headings of capture, validation, integration, and reuse:

#### Capture

The practice of surveying is already fully digitally enabled. Existing digital data from the cadastre is able to be uploaded into survey office applications and field equipment (see ① in Figure 5), and all new measurements, including from GNSS, are captured digitally. The digital transfer of this data to other applications, particularly survey calculation software, helps avoid errors and ensure the integrity of the survey data.

#### Validation

Having a digital representation of the survey enables validation tests (e.g., business rules) to be run that help ensure the quality of the dataset. Mathematical, topological, and spatial tests can be applied to the data, including by comparing it to existing data, such as an underlying survey already held in the cadastre. Provision of a 'Validation Service' (via an API – Application Programming Interface) that is accessible from both survey software and to cadastral survey system validation staff would provide efficiency (avoiding duplication of tests) and help ensure quality by detecting errors early in the cycle (see ② in Figure 5).

#### Integration

Once the survey dataset has been quality assured, it can be safely recorded in the authoritative cadastre. This can be a simple record of each independent survey. However as each parcel boundary is also the boundary of the neighbouring parcel, and the boundaries of that parcel are also common with its neighbours, each survey can be integrated into the cadastral survey network as if the whole country were covered by a single continuous survey network (see ③ in Figure 5).

#### Re-use

Digital data, including the map of the cadastral survey network, is then available for reuse by surveyors, other land and property professionals, and the many other known and emerging users of cadastral data.

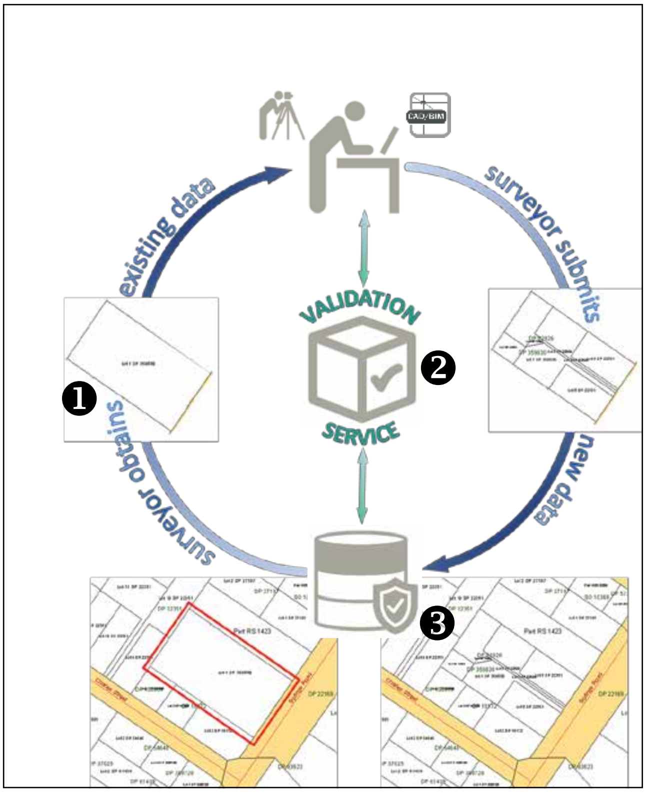



**Figure 5. The cycle of digital cadastral survey data. Adapted from Gulliver, Haanen & Goodin (2017)**

## Visualising a dataset without a plan

The previous section has made the case for representing a survey in the form of a structured, digital survey dataset, rather than a static plan image. For most users, including many surveyors, this will be a major challenge as it would break a long-established traditional means of recording the outcome of a survey. The current digital versions of plans are primarily intended to be printable and readable in that form – persisting with the traditional concept that people need something in paper form. Yet we know that virtually all users of the cadastre already undertake their operations in the digital world every day and that a plethora of technologies provide much better ways of presenting and interacting with information – including spatial.For example, surveyors need to be able to see both the overview of the entire survey, as well as the specific detail at, say, a boundary. On plans this is typically achieved through the use of individual diagrams. It is precisely this capability that is inherently available in digital tools for viewing (and printing) digital spatial data.

### Bridging the Visualisation Gap

Users of a cadastral survey dataset need to be able to see its data in graphical form. Conveyancers and title registrars in particular currently prefer, at least in terms of the authors' experience in New Zealand, to have formal documents that provide a persistent record of the parcels and boundaries defined on the survey. These are typically attached to titles and may be recorded in the register.

A number of methods and tools can be used to visualise the data in survey datasets. These include:

- Automatic rendering of a dataset as an image file (e.g., the New South Wales service *(http://www.nswlrs.com.au/__data/assets/pdf_file/0003/214869/User_Guide_for_Land_XML.pdf)* that renders a LandXML file for all but complex surveys as a TIFF file).
- On-the-fly' display in web-based clients from a suitable service platform (typically also works for 3D). Some of these are now consumer-grade products that are freely available on the web or as apps on mobile devices.
- Survey software, GIS, CAD, etc.
- PDF reading software that enables spatial viewing of interactive PDFs. These are easily generated from survey and spatial software. These 'persistent' files are readily viewed and printed from free and readily available readers which also provide surprisingly powerful tools to spatially interact with the data (illustrated in particular by 3D PDFs *(https://helpx.adobe.com/acrobat/using/displaying-3d-models-pdfs.html)* (see Figure 6)).

A significant advantage of many of these approaches is that they allow subsets of the data to be displayed or used for specific purposes – compared to the use of a universal plan which is expected to serve all purposes. This includes the ability to display the cadastral survey data with other data such as base maps, aerial photography, or utility mapping. Exposing well-constructed data

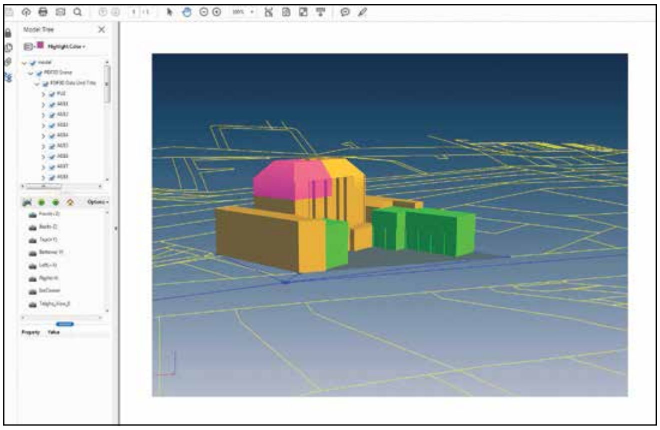


**Figure 6. Interactive 3D PDF of a Unit Title Development integrated into the digital cadastre**

offers the ability to filter, view and render the data and integrate it with other data in forms tailored to meet a user's specific needs.

## Conclusion

The value of cadastral survey data is rapidly increasing in line with the movement into the digital age. To truly realise its value, it will be necessary to detach completely from paper-based approaches associated with the past. It will only be then that the efficiencies and effectiveness of a fully digital cadastral survey system will be realised to the benefit of all.

## References


Cadastral Survey Act 2002. New Zealand Government.

Corydon, B., Ganesan, V., & Lundqvist, M. (2016). Digital by default: A guide to transforming government. *New York: McKinsey & Company*.

Gulliver, T., Haanen, A., & Goodin, M. (2017). A 3D Digital Cadastre for New Zealand and the International Opportunity. *ISPRS International Journal of Geo-Information*, *6*(11), 375.

LINZ (1998). Landonline design and build documentation – LINZ internal. New Zealand Government.

Smart Nation and Digital Government Office (2018). Smart Nation Singapore. Singapore Government.

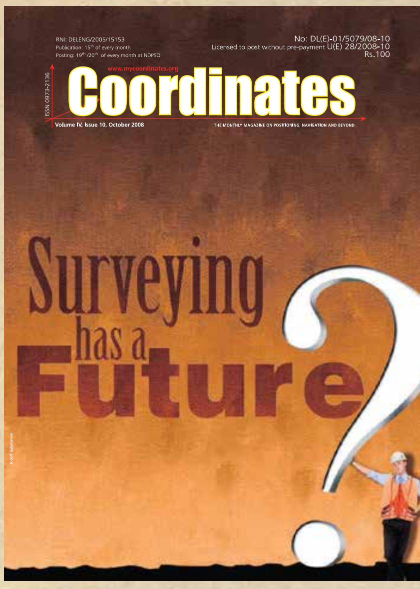
Surveyor-General (2010). Rules for Cadastral Survey 2010. New Zealand Government.

Wellington City Council (2011). Wellington Towards 2040: Smart Capital. Wellington City Council.


*The paper was presented at FIG Congress 2018, Instanbul, Turkey, May 6-11,2018.*

# In Coordinates

## 10 years before...




mycoordinates.org/vol-4-issue-10-October-08/

### Users should gain from our services

**Simon Kwok**
Chair, Geomatics Faculty, Royal Institution of Chartered Surveyors Hong Kong

We should take up the opportunity to serve our clients and the society, and by doing our work well, we should make ourselves known and be understood. More importantly, we should help the users to gain value from using our services.

### Technology has grown but not the profession

**Prof P Misra,**
Consultant, Land Information Technologies, India

Surveying is a service oriented profession, by making maps we do service to the society. The more you serve the society, the more the profession will be known. In a country like India, there is a huge requirement of professionals in the domain of surveying.

### In the face of global demand of surveyors, will we find sufficient graduates?

**John Hannah**
Professor, School of Surveying University of Otago Dunedin, New Zealand

The real question is not, "Does the surveying profession have a future", but rather, "In the face of the global demand for surveyors, where will we find sufficient graduates?."

### The production and supply of GI has moved from national agencies to private organisations

**Dr William Patrick (Paddy)**
Prendergast, Department of Spatial Information Sciences, Dublin Institute of Technology, Ireland

Educational reform for surveyors is vital to deal with ever increasing variety, complexity and use of geographic information and to have the skills to offer quality professional service at local and international levels.

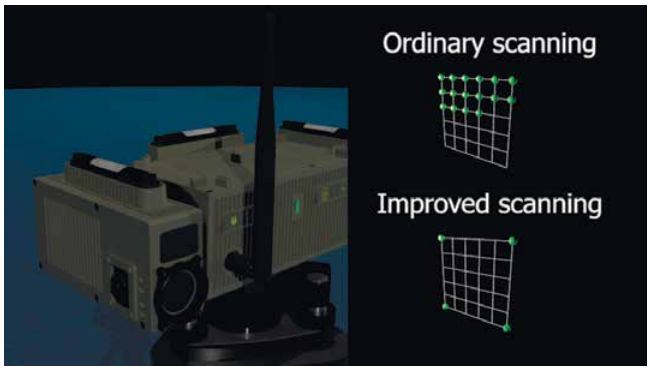
# Introducing J-Mate

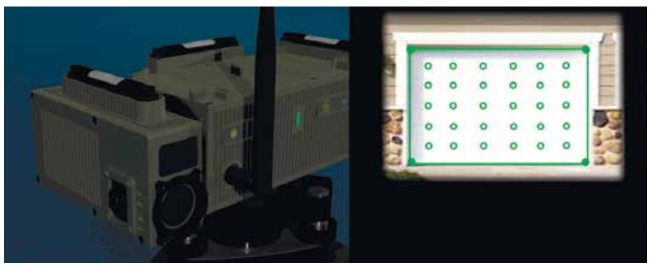

## Smart laser scanner

J-Mate is also a camera-aided, smart laser scanner. The camera identifies redundant points that do not need to be scanned, but instead can be copied or interpolated from other readings without loss of information. That is, if the camera identifies a completely uniform flat area, it only scans the four corners of that area and interpolates in between. This feature can increase the effective speed of the scanner to much higher than its native 10-points-per-second speed.

The scanning feature can also be used to find items like wires and poles and “closest-in-view” items and shoot them automatically.

We have a “**Total GNSS**” with a “**Robotic Total Station**” and a “**Smart Laser Scanner**”. We call it our **“Total Solution”** and it can be operated by one person to perform jobs.



And all components fit in this small carrying case.

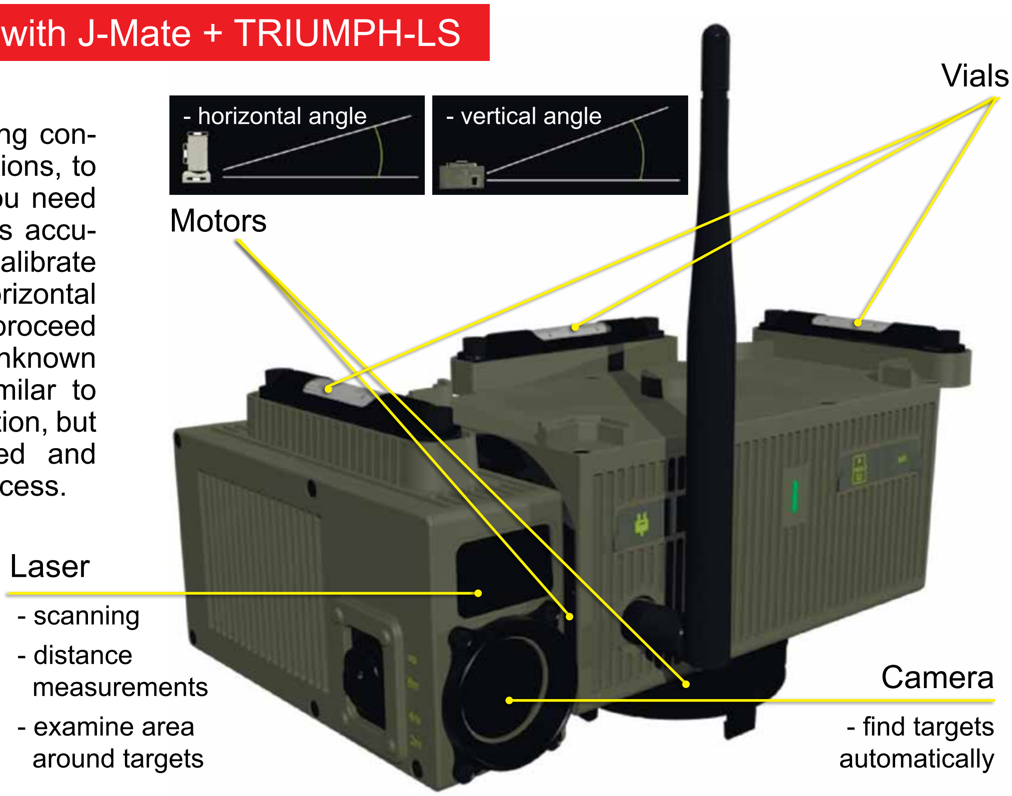
Why follow a workflow designed for yesterday's equipment?

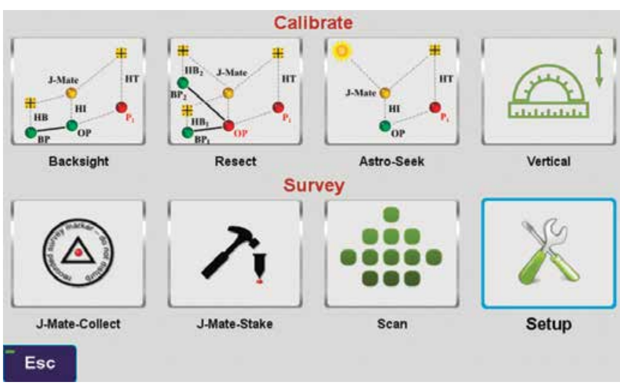
# This is J-Mate


J-Mate features a **camera** that can also find targets automatically, and a **laser module** for accurate distance measurements. It scans and examines the area around the intended target to ensure reliable identification. Two **precision encoders** measure vertical and horizontal angles to the target. Three **precision vials** allow a visual check on levelness of the instrument.

## Take control with J-Mate + TRIUMPH-LS

Similar to using conventional total stations, to use the J-Mate you need first to establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.




With J-Mate you can establish your occupied position via three different ways: 1) Backsight; 2) Resection; or 3) our new Astro-Seek (more of that later).

When you click the Setup icon of the J-Mate screen you get access to parameters that tunes J-Mate to your desire.

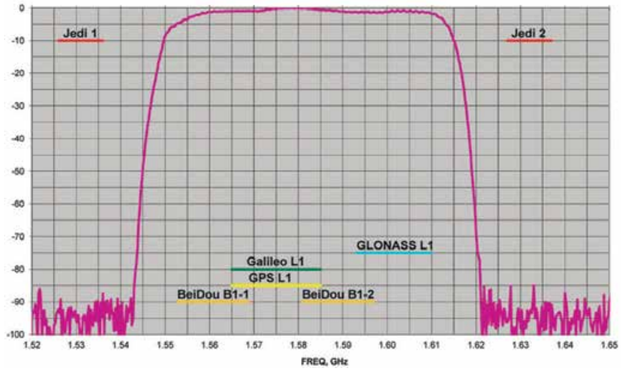
After the J-Mate is calibrated, you can proceed with your work as normal via the Collect or Stake icon.

**LIVE video at www.javad.com**

These are ways that we defend against jammers and spoofers and inform users of details.

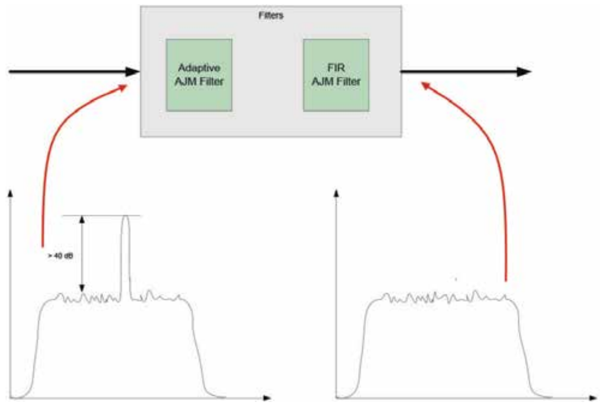
# J-Shield Filter
## and Near Band Interference

J-Shield is a robust filter in our antennas that blocks out-of-band interference. In particular signals that are near the GNSS bands like the LightSquared signals. The graph on the right shows the protection characteristics of our J-Shield filters. It has a sharp 10dB/KHz skirt which provides up to 100 dB of protection. It makes the precious near band spectrums available for other usages and protects GNSS bands now and in the future.

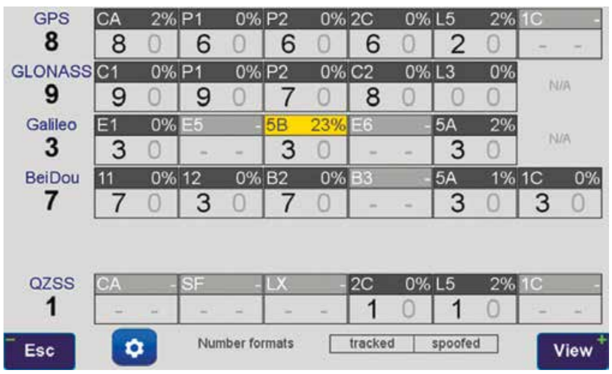



# FIR (Digital Filter)
## and In-Band Interference

Our In-Band protection digital filter protects against in-band interference like harmonics of TV and radio stations when you get close to them, or against illegitimate in-band transmissions. Our in-band interference protection is based on the 16 adaptive 80th-order filters. AJM-filters can be combined in pairs for complex signal processing. This filter can simultaneously suppress several interference signals.

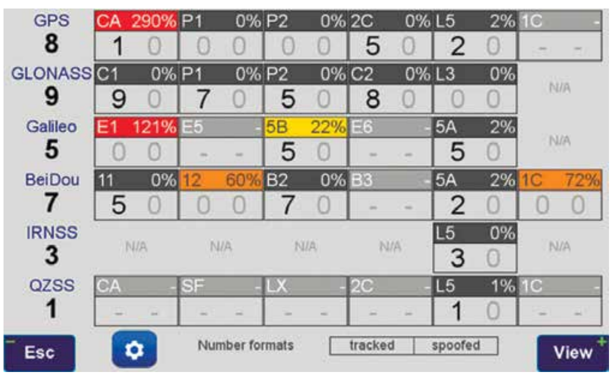



The 16 FIR AJM-filters can be combined in any number in chain. Each filter is a 255 order FIR-filter. It can be used to suppress the stationary interference signal in programmable (in compare with adaptive AJM-filter) area or for spectrum shaping. To have more suppressing areas or more aggressive suppressing one can combine FIR_AJM serial.

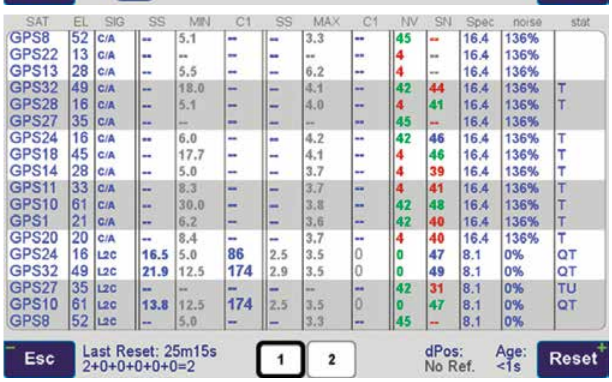



# In-Band noise
## Measurement

This figure-of-merit number shows the level of interference as percentage of noise above the normal condition. The first row of the first screenshot shows the condition in a clean environment. 8 GPS satellites were visible (according to the almanac). 8 C/A, 6 P1, 6 P2, 6 L2c and 2 L5 GPS signals were tracked. The noise level is 2% on C/A and L5, and 0% on P1,P2,and L2C. The screenshot below that, shows 290% noise in GPS C/A and %121 on Galileo E1. Only one of 8 GPS C/A code and none of 5 Galileo E1 signals were tracked. ▶




This typical screenshot shows details of each signal. In the last column (T) indicates the signal was tracked by the main channels, (Q) by the Fast Acquisition Channels and (U) signal was used in position calculations. The SN color coded column shows the signal-to-noise ratio of tracked signals. Blue is perfect, green is 3 dB down, and red is 6 or more dB down. Percentage numbers show the percentage of interference above the normal level. We explain other columns later. ▶

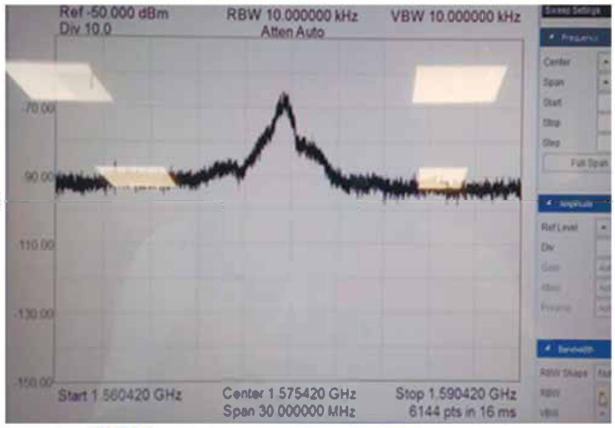



No jammer can escape our figure-of-merit test.

# Spectrum Shape

We have a very powerful spectrum analyzer within our GNSS TRIUMPH chip. Each spectrum shows the power and the shape of the interfering signals and jammers. This is more powerful and more efficient than  having a $30,000 commercial spectrum analyzer to evaluate the environment. The screenshot on the right shows the shape of the GPS L1 band spectrum when the band is not jammed. The GPS C/A code peak at the 2-MHz center of the L1 band is visible. ▶
The height of the spectrum is 11.2 dB.

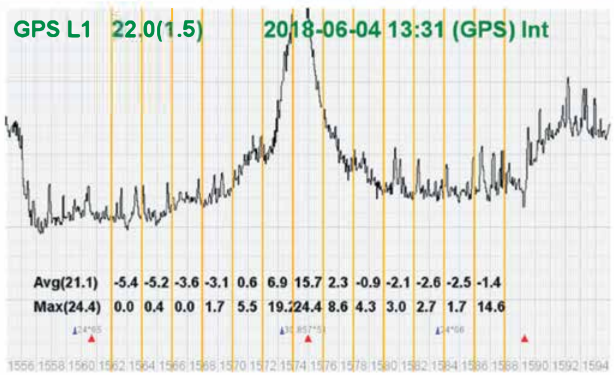

This is an example of GPS L1 spectrum with a commercial $30,000 spectrum analyzer. ▶




Our integrated spectrum analyzer has the advantage that it monitors the spectrum inside the chip where it matters. It has effective bandwidth of 1 KHz.

Our embedded spectrum analyzer also has the advantage that it can be programmed to automatically record the spectrum (and other information) periodically or according to the set conditions, and monitor the environment continuously.

This is the spectrum example of a GPS L1 band when it is jammed. There is a huge peak in the center where the C/A code is. The number on the bottom left is the height of the peak. ▶




The height of the spectrum is 21.1 dB, which compared to the calm 11.2 dB, indicates about 10dB of jammer.

Although we label the bands as three GPS and 3 GLONASS bands, but they represent all bands of all GNSS signals, because bands are shared by all GNSS signals.

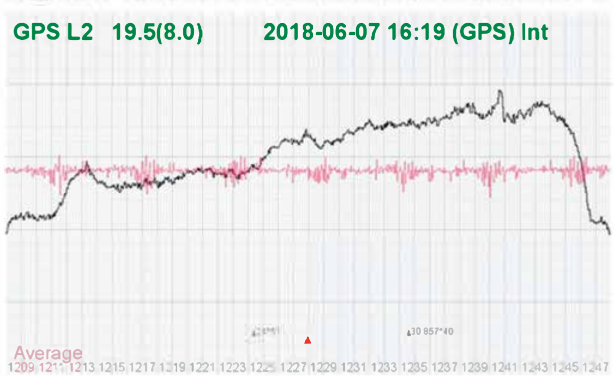
# AGC
## Automatic Gain Control

In addition to the spectrum, we also keep record of Automatic Gain Control which is another indicator of external signals. ▶


The AGC monitors the environment and adjusts the gain to keep the voltage at a certain level. The change in AGC is an indicator of interference existence.

The narrow orange line in the middle of the band in this screenshot shows a quiet AGC.

AGC in this screenshot shows there are activities in this band which our AGC was able to defend against it. ▶




We believe it could be harmonics of GSM cellular phone near our site.

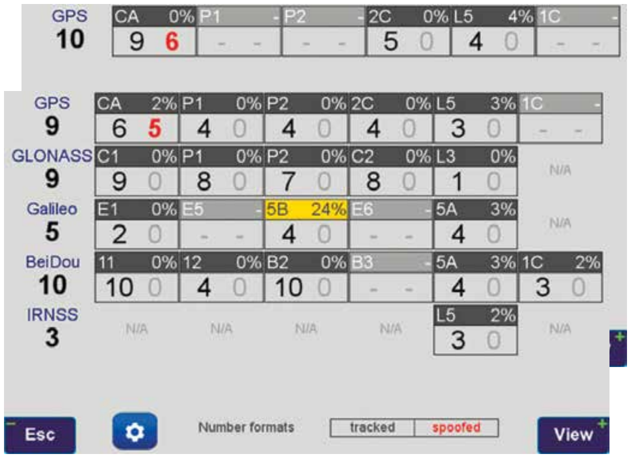
Our AGC mitigates the effect of such interference completely.

# Spoofers & 2 Peaks

Spoofers are quite different from jammers. They don’t disturb the environment and the spectrum shape. They broadcast a GNSS-like signal to fool the GNSS receivers to calculate wrong positions.

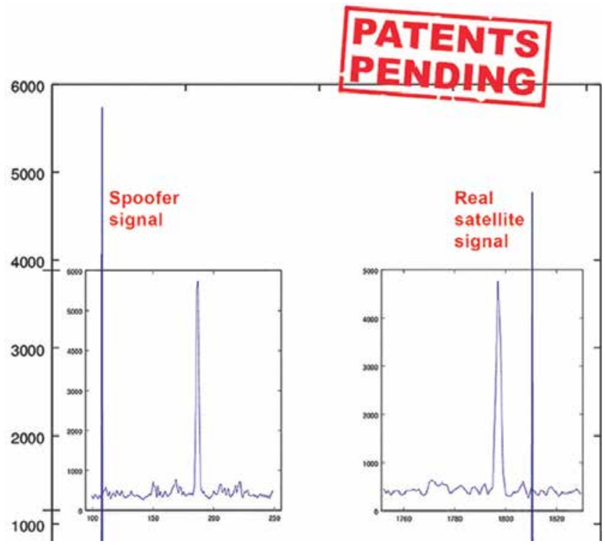
In the top screenshot 10 GPS satellites were visible (according to the Almanac). 6 of the 9 GPS satellites that we tracked were spoofed, as indicated by the red number, while the noise level was 0% in the GPS C/A band.

In the second screenshot, 5 of the 6 GPS C/A signals were spoofed while the noise in the band was only 2%.

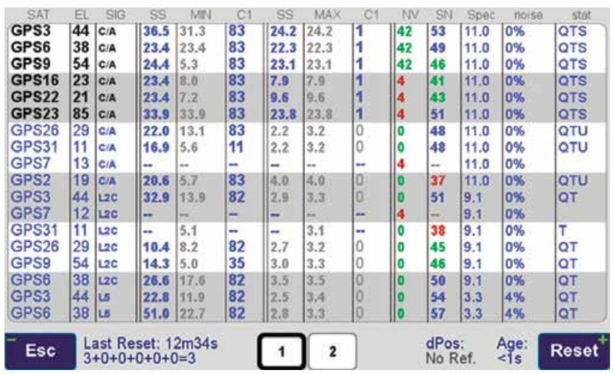



We detect spoofers by digital signal processing. With 864 channels and about 130,000 Quick Acquisition Channels in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofer signals. Figure on the right is an example of two peaks. We isolate and ignore the wrong peak.



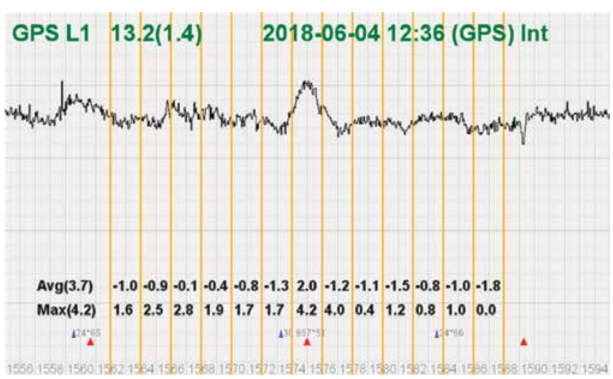

The screenshot on the right shows details of each signal. The first six lines in this screenshot show the spoofed signals that we detected as soon as they appeared (numbers “1” in those line). The two section columns represents the characteristics of each peak. Second SS column show if the second peak is a consistent signal.



| SAT | EL | SIG | SS | MIN | C1 | SS | MAX | C1 | NV | SN | Spec | noise | stat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GPS3 | 44 | C/A | 36.5 | 31.3 | 83 | 24.2 | 24.2 | 1 | 42 | 53 | 11.0 | 0% | QTS |
| GPS6 | 38 | C/A | 23.4 | 23.4 | 83 | 22.3 | 22.3 | 1 | 42 | 49 | 11.0 | 0% | QTS |
| GPS9 | 54 | C/A | 24.4 | 5.3 | 83 | 23.1 | 23.1 | 1 | 42 | 46 | 11.0 | 0% | QTS |
| GPS16 | 23 | C/A | 23.4 | 8.0 | 83 | 7.9 | 7.9 | 1 | 4 | 41 | 11.0 | 0% | QTS |
| GPS22 | 21 | C/A | 23.4 | 7.2 | 83 | 9.6 | 9.6 | 1 | 4 | 43 | 11.0 | 0% | QTS |
| GPS23 | 85 | C/A | 33.9 | 33.9 | 83 | 23.8 | 23.8 | 1 | 4 | 51 | 11.0 | 0% | QTS |
| GPS26 | 29 | C/A | 22.0 | 13.1 | 83 | 2.2 | 3.2 | 0 | 0 | 48 | 11.0 | 0% | QTU |
| GPS31 | 11 | C/A | 16.9 | 5.6 | 11 | 2.2 | 3.2 | 0 | 0 | 48 | 11.0 | 0% | QTU |
| GPS7 | 13 | C/A | -- | -- | -- | -- | -- | -- | 4 | -- | 11.0 | 0% | |
| GPS2 | 19 | C/A | 20.6 | 5.7 | 83 | 4.0 | 4.0 | 0 | 0 | 37 | 11.0 | 0% | QTU |
| GPS3 | 44 | L2C | 32.9 | 13.9 | 82 | 2.9 | 3.3 | 0 | 0 | 51 | 9.1 | 0% | QT |
| GPS7 | 12 | L2C | -- | -- | -- | -- | -- | -- | 4 | -- | 9.1 | 0% | |
| GPS31 | 11 | L2C | -- | 5.1 | -- | -- | 3.1 | -- | 0 | 38 | 9.1 | 0% | T |
| GPS26 | 29 | L2C | 10.4 | 8.2 | 82 | 2.7 | 3.2 | 0 | 0 | 45 | 9.1 | 0% | QT |
| GPS9 | 54 | L2C | 14.3 | 5.0 | 35 | 3.0 | 3.3 | 0 | 0 | 46 | 9.1 | 0% | QT |
| GPS6 | 38 | L2C | 26.6 | 17.6 | 82 | 3.5 | 3.5 | 0 | 0 | 50 | 9.1 | 0% | QT |
| GPS3 | 44 | L5 | 22.8 | 11.9 | 82 | 2.5 | 3.4 | 0 | 0 | 54 | 3.3 | 4% | QT |
| GPS6 | 38 | L5 | 51.0 | 22.7 | 82 | 2.8 | 3.3 | 0 | 0 | 57 | 3.3 | 4% | QT |



While six satellites were spoofed, there was no indication on the noise level (0%) and no indication on the spectrum shape and level as shown on the screenshot on the right below the chart.




If the spoofer strategy is to cover the real satellite signal and then put the fake signal on top of it to produce only one peak, we notice that by more that 200% of noise level that it has to introduce.

We reject infected signals and then among all the available GPS, GLONASS, Galileo, BeiDou, IRNSS and QZSS multiple signals we use the healthy ones.

Usually there are over 100 signals available at any given time, and we need only four good signals to compute position. In rare cases that all signals are affected, we inform the user and guide them to use compass and altimeter to get out of the Jammed area.

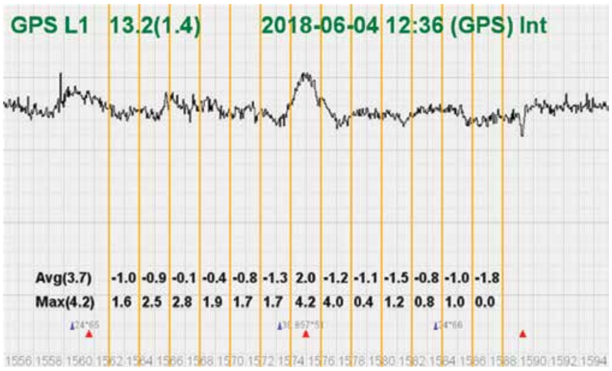
There is absolutely no way that we can be spoofed without our knowledge. We will immediately recognize and take corrective action.

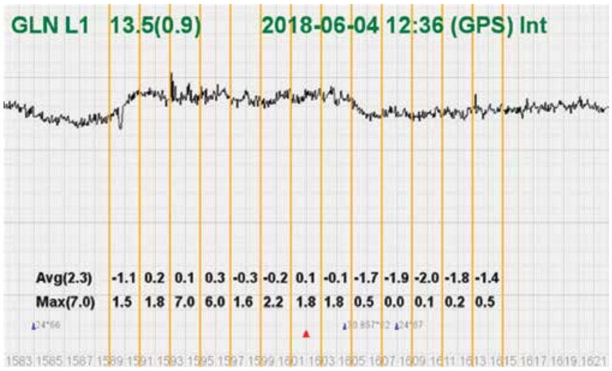
**Jamming and Spoofing protection option is available in all of our products and OEM Boards.**

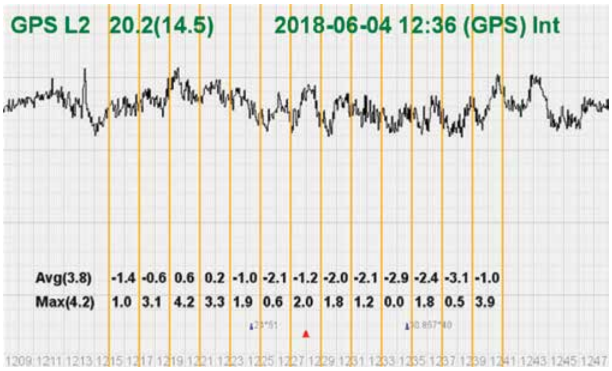
## And Examples of when the world is peaceful.

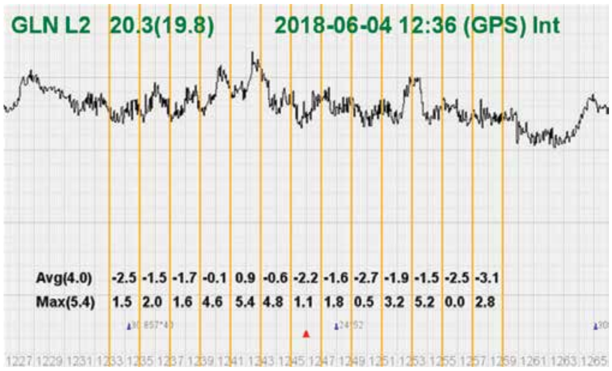
Jamming and Spoofing protection option is available in all of our products and OEM Boards.

### All screenshots are from our TRIUMPH-LS Receiver.

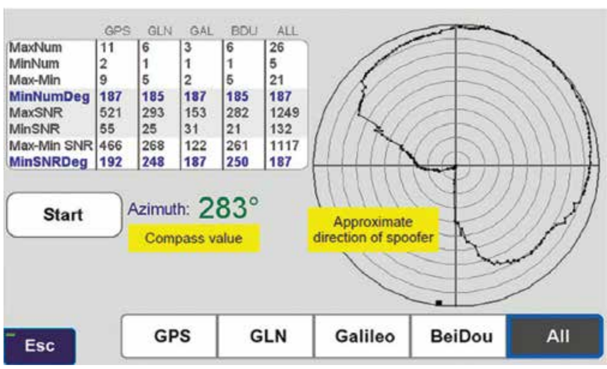





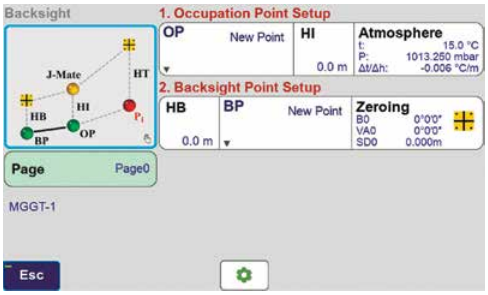

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

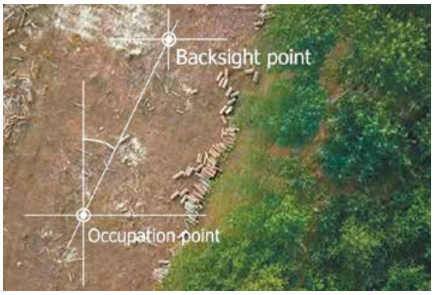
After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure below.



## Backsight icon

If GNSS signals are available at the job site, click the J-Mate Backsight icon.

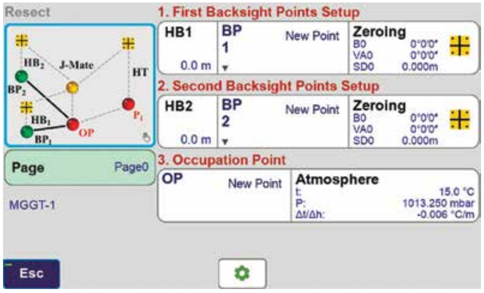


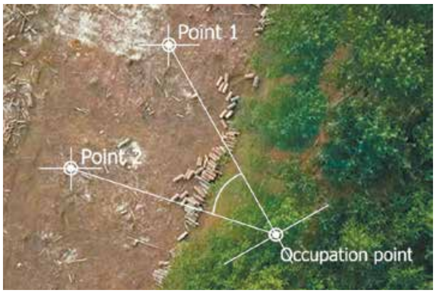




This screen appears which guides you to determine the accurate positions of the Occupation Point and the Backsight Point, to establish an azimuth and calibrate the J-Mate angular encoders.

## Resect icon

If GNSS signals are not available at the Occupation Point, click the "J-Mate-Resect" icon

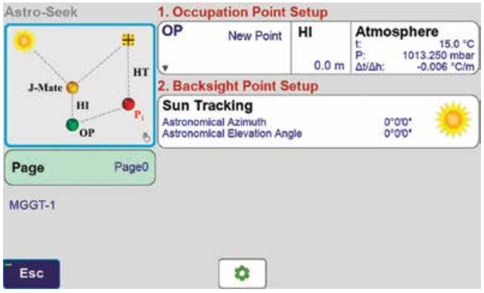



Shoot two or more known points to establish an accurate position and calibrate the encoders. Then continue to shoot the unknown points.

## Astro-Seek icon

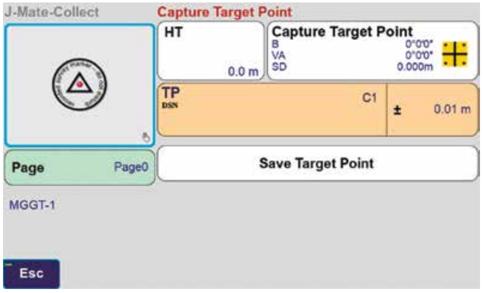
**And now our new feature!**




We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun or other astronomical objects-Seeking feature.

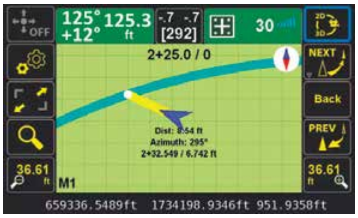
## J-Mate-Collect

After calibration is performed, click the J-Mate-Collect icon to shoot the unknown points.




## J-Mate-Stake

Click the J-Mate-Stake icon to use for stakeout.




The functions and features of the J-Mate stakeout are very similar to our conventional GNSS stakeout: RTK solutions guide you to the stake points. But with the J-Mate the camera follows the "+" sign that you carry and then the encoders and laser measurements (shown on screenshots) provide guidance to the stakeout features. This is similar to Visual Stakeout and other useful and innovative features of our TRIUMPH-LS GNSS RTK stakeout.

# Linux Operating System

## Now Available for the TRIUMPH-LS

Javad GNSS has enhanced and improved the capabilities and performance of the TRIUMPH-LS by creating a customized Linux operating system to replace the existing Windows CE operating system of the TRIUMPH-LS. Some of the noticeable benefits of this Linux Yocto Project operating system include:

- **Decreased startup and boot time**
- **Improved stability and general performance**
- **Improved WiFi, Bluetooth and cellular modem connectivity**
- **Improved database speed**
- **SSH connections for advanced remote support**
- **Improved camera performance**

Like always, this software update and all software and firmware updates are free to all owners of a TRIUMPH-LS and can easily be installed. The installation process of software and firmware updates only requires an internet connection to the receiver. More information can be found about this and other exciting topics on the Javad GNSS Support Forum at **http://support.javad.com**.

# A Large-scale Monitoring System of Tree Tilt Angle through Integrating Smart Sensing Technology and GIS

A GIS-based platform of long-term monitoring the tilting angles of trees will be launched to identify potential tree root hazards

**Dr Man Sing WONG**
Associate Professor, Department of Land Surveying and Geo-informatics, The Hong Kong Polytechnic University, Hong Kong SAR, China

**Dr Billy C.H. HAU**
Principal Lecturer, School of Biological Sciences, The University of Hong Kong, Hong Kong SAR, China

**Ka Wai HUI Karena**
Project Manager of the Jockey Club Smart City Tree Management Project, Department of Land Surveying and Geo-informatics, The Hong Kong Polytechnic University, Hong Kong SAR, China

**Dr Sawaid ABBAS**
Postdoctoral Fellow, Department of Land Surveying and Geo-informatics, The Hong Kong Polytechnic University, Hong Kong SAR, China

Urban forests refer to the sum of all urban trees, shrubs and lawns and pervious soils in urban areas (Escobedo et al., 2011). Unlike trees growing in natural forests, urban trees are more prone to failure due to insufficient growing space, poor soil and bad or lack of maintenance. On the other hand, the increasing frequency of rainstorms and typhoons due to global climate change is another important threat to urban trees. Some tree species are more vulnerable to extreme weather and may be more affected (Johnston, 2009). Over the past decades, Hong Kong had experienced extreme weather conditions such as 4.2 days of extreme rainfall and an annual maximum 3-day rainfall of 367 mm (Hong Kong Observatory, 2018). These rainfall conditions would increase to 5.0 days and 476 mm respectively between 2051 and 2060 under the high greenhouse gas emission scenario (Hong Kong Observatory, 2018).

Urban forests, especially urban trees, provide important ecosystem services to city inhabitants. Urban trees play an important role in air pollution removal (Jim and Chen, 2008; Nowak et al., 2006); carbon sequestration (McHale et al., 2007); mitigation of heat island effect (Scholz et al., 2018); urban flood prevention (Cariñanos et al., 2018); water quality improvement (Nagabhatla et al., 2018); aesthetic enhancement (Price, 2003); biodiversity enhancement (Endreny, 2018) and conservation (Snep et al., 2011). With the ever-increasing urbanisation worldwide, the planning and management of urban forests and trees have become a key adaptation and mitigation measure of global climate change (Cariñanos et al., 2018).

Trees behave as a vibrant system. A tree's anchorage is its ability to hold soil firmly with its roots to support the tree trunk and foliage. Weak anchorage can be reflected by the tilting of a tree, which in serious cases pose the hazard of falling. The weaving interaction between wind and trees is dynamic and depends on the degree of wind loading and natural frequency of trees i.e. the inherent vibrating frequency of tree (Moore et al., 2005). Wind force on tree canopy generates a turning momentum at the tree base. Such a turning momentum is resisted by the root system which determines the anchorage strength of a tree, and it can be considered as a function of the rotational angle of the structural root zone. If the root system i.e. anchorage strength is not strong enough to sustain the turning momentum, then the tree will tilt or even be uprooted and fall (Moore and Maguire, 2005). As such, measuring and monitoring urban trees' root stability could help to predict more accurately tree fall risk and ensure public safety.

Many studies have been conducted to measure tree displacement via a wide spectrum of quantifiable tools, which includes accelerometers, displacement transducers, prism-based systems, tilt sensors or inclinometers, strain sensors and video-based techniques (James et al., 2013). These instruments help measure the rotational angle, tree displacement or tilting

**Figure 1: A prototype sensor has been installed on lower tree trunk to measure the displacement angles and the collected data will send to our Spatial Big Database for data analysis**

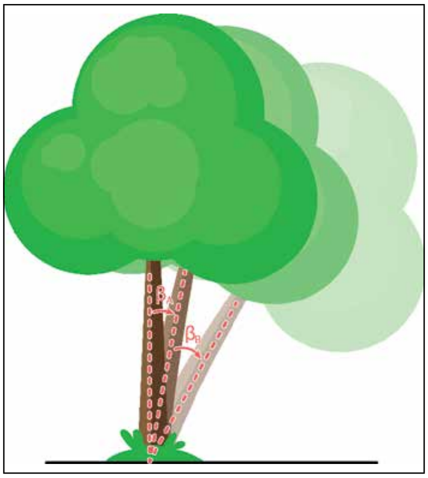


**Figure 2: Conceptual framework of the change of tree tilting angle, with $\beta_A$, at its threshold level, and $\beta_B$ where the tilting angle exceeds the threshold that the tree may likely to collapse or fall without advance notification to the tree assessor**

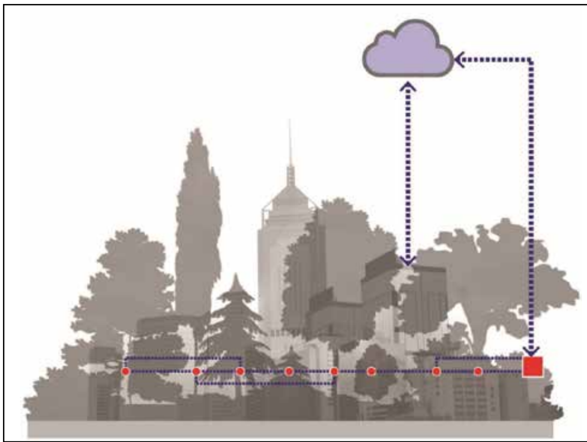


**Figure 3: Comprehensive tree risk assessment in the consideration of different types of spatial data and information such as the temporal tree tilt angle measurement data, tree attributes, spatial attributes as well as other ancillary data sets**

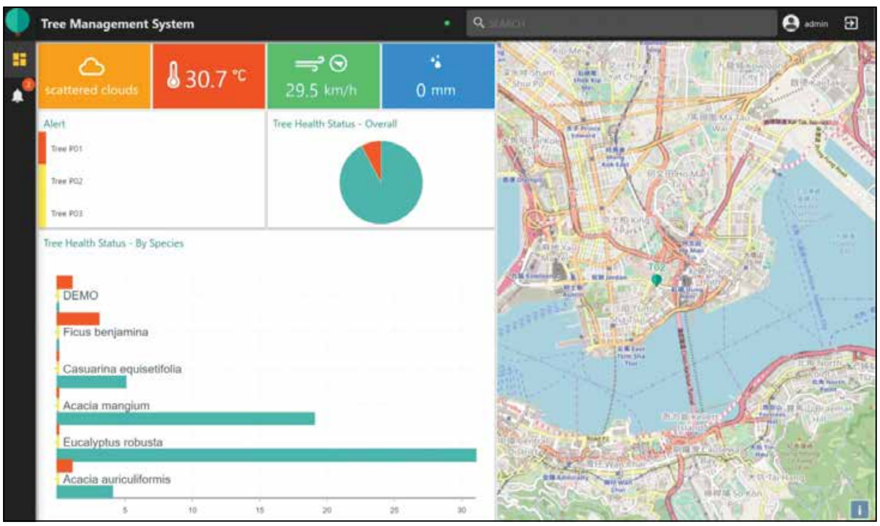



**Figure 4: A visualization of the dashboard model will be developed based on the GIS-platform to monitor the changing conditions of tilt angle and the environmental factors**

angle due to the overturning momentum of a tree. Whilst the use of the accelerometer for measuring tree tilt is not new, the increased capability of tilt accuracy, sampling frequency and battery life of measuring root-plate tilting angle has been enhanced and improved with the aid of state-of-the art technologies. The sensor can measure the mechanical response of the tree to wind force, recording the tilting values at near ground level and provides an insightful strength of root anchorage (TreeSensors, 2018). It is also important to study the failure pattern of different tree species on their root responses towards adverse weather conditions. In addition, monitoring root plates rotation on a regular basis would enable an early warning system in tree management to reduce the risk of damage caused by root failure.

In this study, we are developing an integrated tree tilting monitoring system based on Smart Sensing Technology (SST) – the technology of monitoring environmental changes with the use of remote sensors and techniques through the application of the Geographic Information Systems (GIS). Commenced in February 2018, the 3-year pilot Project is supported by The Hong Kong Jockey Club Charities Trust with a funding of $32.28 million. With tailor-made sensors installed on the lower trunk of approximately 400 selected urban trees in two pilot sites with high traffic and pedestrian flow: Kowloon East and Wan Chai, it aims to monitor their tilting angles over time using SST. The trees from 9 vulnerable species at risk of tree failure with different tree forms are selected for monitoring, e.g. *Bauhinia variegata, Delonix regia, Senna siamea, Aleurites moluccana.*

Taking various environmental factors into consideration, a threshold will be determined by the project team to measure the root-plate movement. If a sensor shows that the tilting angle of a tree exceeds the threshold, the system will alert the project team to conduct a visit and verify the data and calibrate the system. When deemed necessary, the relevant tree management team will be informed to conduct detailed investigations in a timely manner. In the second phase, SST sensors will be installed at over 8,000 trees across the entire city in Hong Kong. The Project will also collect data from the sensors and will develop a system via a GIS-based platform.

## Big Data Analytics

Results from thresholds and testing will be fed for Big Data Analytics for constructing a Spatial Big Database with interface of alert notification. This early monitoring system can help identify and mitigate tree failure efficiently and effectively by closely monitoring the alert thresholds observed from the selected trees in testing. A systematic early alert system with user interface will be developed as an analytical tool to evaluate the received tree movement data or threshold database in real time. The system can also be compatible with GIS platform for visualization and pinpointing the potential "follow-up" trees in testing. A compatible Android and iOS-platform will also be developed for effective management of urban tree species which are potentially vulnerable to climate change.

GIS-based mapping and management tools have shown promise for effective maintenance and management of trees (Miller, 1997). Tree risk assessment analysis is also a pre-requisite for sustainable urban ecology. Analysis of the spatial distribution and properties of urban trees, site characteristics, and surrounding biotic and abiotic micro-environments, can help determine risk factors of urban trees.

There are various ways to estimate the extent of risk associated with urban trees. Since the tree risk assessment is comprehensive, requiring the use of different types of spatial data and information such as the temporal tree tilt angle measurement data, tree attributes (e.g., tree species, DBH, height, canopy shape, tree crown size, tree health status, and phenological stages), spatial attributes (e.g., proximities to highways, residential and commercial areas, topography, population density and buildings data) as well as other ancillary data sets (e.g., traffic, meteorological data and soil characteristics), as part of its assessment process. The GIS, a valuable tool, compared to conventional data processing systems, provides a means of handling and managing IoT and displays in the form of thematic maps (Marble et al., 1984; Foote and Lynch, 1996). In this project, a GIS-platform with a set of data analytic functions will be developed and useful for managing Spatial Big Data.

Aiming at sustaining a longer tree life by enhancing the efficiency of tree management, it is a Hong Kong's large-scale urban tree project using a quantifiable method to aid on conventional visual tree inspection method, supplementing information for the current industry practice. The GIS-based tree management system will provide an additional tool for the tree management team to provide scientific observations for monitoring changing conditions on tilt angles, which will facilitate tree monitoring in a massive scale based on their geographical locations of an individual tree. Findings from this study will also facilitate policy decisions to enhance tree management system in Hong Kong as well as other highly urbanized tropical cities.

It is important to study the tree tilt pattern of these common tree species and preserve these trees especially under the threat of climate change

## Conclusion

A GIS-based platform of long-term monitoring the tilting angles of trees will be launched to identify potential tree root hazards. It is important to study the tree tilt pattern of these common tree species and preserve these trees especially under the threat of climate change. Trees can be monitored on a regular basis to observe tree tilting. As the adverse weather is predicted to be more frequent, large-scale monitoring system becomes an urgent need. The system will trigger a notification message from the SST sensor if a tree is tilted exceeding a threshold angle. In a nutshell, the monitoring system will be a spatially explicit GIS-based early notification framework of measuring and monitoring tree movement to transform uncontrollable forces of nature into timely manageable challenges in Hong Kong's urban areas.

## Acknowledgement

The project team wishes to acknowledge The Hong Kong Jockey Club Charities Trust, funding us to commence this Project for the enhancement of the tree monitoring system in Hong Kong.

## References

Cariñanos, P., Calaza, P., Hiemstra, J., Pearlmutter, D. & Vilhar, U. (2018). The role of urban and peri-urban forests in reducing risks and managing disasters. Unasylva, 69, 53-58.

Endreny, T.A. (2018). Strategically growing the urban forest will improve our world. Nature Communication s, 9, 1160, 1-3.

Escobedo, F.J., Kroeger, T & Wagner, J.E. (2011). Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. Environmental Pollution, 159, 2078-2087.

Foote, K. E., & Lynch, M. (1996). Geographic Information Systems as an Integrating Technology: Context, Concepts and Definition, TX: University of Texas.

Foster, D.R., Boose, E.R. (1995). Hurricane disturbance regimes in temperate and tropical forest ecosystems, in: Grace, J., Coutts, M.P. (Eds.), Wind and Trees. Cambridge University Press, Cambridge, pp. 305–339. doi:DOI: 10.1017/CBO9780511600425.019

Hong Kong Observatory (2018). Retrieved September 14, 2018, from URL: http://www.hko.gov.hk/climate_change/proj_hk_rainfall_e.html

James, K., Hallam, C., & Spencer, C. (2013). Measuring tilt of tree structural root zones under static and wind loading. Agricultural and forest meteorology, 168, 160-167.

James, K. R., Haritos, N., & Ades, P. K. (2006). Mechanical stability of trees under dynamic loads. American journal of Botany, 93(10), 1522-1530.

Jim, C.Y. & Chen, W.Y. (2008). Assessing the ecosystem service of air pollutant removal by urban trees in Guangzhou (China). Journal of Environmental Management, 88, 665-676.

Johnston, M. (2009). Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and practitioners. Canadian Council of Forest Ministers.

Marble, D. F., Calkins, H. W., & Peuquet, D. J. (1984). Basic readings in geographic information systems. Williamsville, NY: SPAD systems.

McHale, M.R., McPherson, E.G. & Burke, I.C. (2007). The potential of urban tree plantings to be cost effective in carbon credit markets. Urban Forestry and Urban Greening, 6, 49-60.

Miller, R. W. (1997). Urban Forestry: Planning and Managing Urban Greenspaces (2nd. ed). NJ: Prentice Hall. (pp. 105-130).

Moore, J. R., Gardiner, B. A., Blackburn, G. R., Brickman, A., & Maguire, D. A. (2005). An inexpensive instrument to measure the dynamic response of standing trees to wind loading. Agricultural and forest meteorology, 132(1-2), 78-83.

Moore, J. R., & Maguire, D. A. (2005). Natural sway frequencies and damping ratios of trees: influence of crown structure. Trees, 19(4), 363-373.

Nagabhatla, N., Springgay, E. & Dudley, N. (2018). Forests as nature-based solutions for ensuring urban water security. Unasylva, 69, 43-52.

Nowak, D.J., Crane, D.E. & Stevens, J.C. (2006). Air pollution removal by urban trees and shrubs in the United States. Urban Forestry and Urban Greening, 4, 115-123.

Price, C. (2003). Quantifying the aesthetic benefits of urban forestry. Urban Forestry and Urban Greening, 1(3), 123-133.

Putz, F. E., Coley, P. D., Lu, K., Montalvo, A., & Aiello, A. (1983). Uprooting and snapping of trees: structural determinants and ecological consequences. Canadian Journal of Forest Research, 13(5), 1011-1020.

Schaetzl, R. J., Johnson, D. L., Burns, S. F., & Small, T. W. (1989). Tree uprooting: review of terminology, process, and environmental implications. Canadian Journal of Forest Research, 19(1), 1-11.

Scholz, T., Hof, A. & Schmitt, T. (2018). Cooling effects and regulating ecosystem services provided by urban trees—novel analysis approaches using urban tree cadastre data. Sustainability, 10, 712, 2-18.

Snep, R.P.H., WallisDeVries M.F. & Opdam P. (2011). Conservation where people work: a role for business districts and industrial areas in enhancing endangered butterfly populations? Landscape and Urban Planning, 103, 94-101.

TreeSensors (2018). Retreived September 14, 2018, from URL: http://www.treesensor.com/Sensors.aspx

# Tracking cities from the sky with Artificial Intelligence

Artificial intelligence presented itself as an interesting direction that could potentially help overcome the challenges of automating a complex problem


**Dr Shaunak De**
Remote Sensing and Deep Learning Specialist
Research Fellow, Indian Institute of Technology Bombay, Powai, India

**Dr Avik Bhattacharya**
Associate Professor
Centre of Studies in Resources, Engineering (CSRE)
Indian Institute of Technology Bombay
Powai, India


## Cameras that fly blind

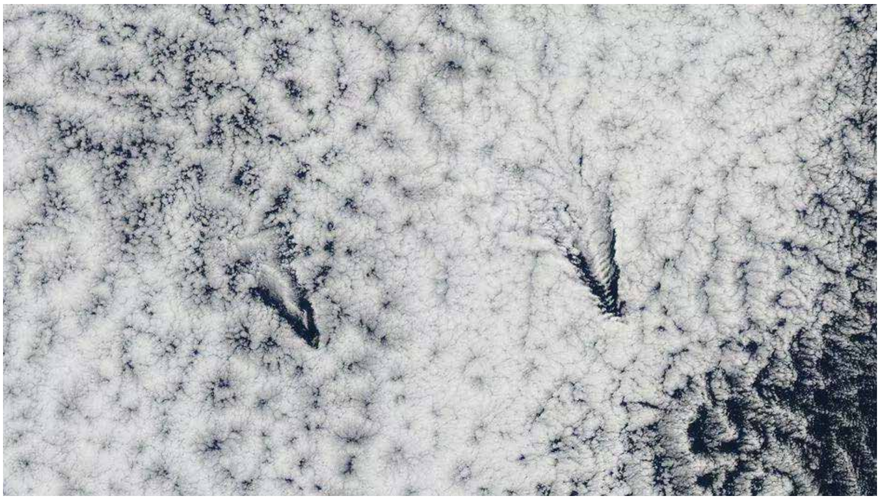
The UN estimates that more than 55% of the world's population - that is, over 4.07 billion people - currently lives in urban areas. This proportion is rapidly growing, especially in developing nations, and is projected to reach 68% by 2050. Urban living offers several distribution and economic efficiencies. It often represents an increased access to resources, manufactured goods, services, and infrastructure which attracts migrants seeking an increased quality of life for themselves and their families. With such a large, concentrated human population, it is critical to track the growth of urban centers and check their ability to access resources, their vulnerability, and the connectivity needs of the people living there. Additionally, in case of unforeseen events like natural disasters, it becomes critical to map affected areas for disaster relief and mitigation efforts.

The distribution efficiency of cities is based on a simple principle: a piece of infrastructure has limited geographical reach. There is only a certain distance people will be willing to travel to benefit from the services offered by that infrastructure. Thus it is advantageous to encourage high density settlement so that fewer pieces of infrastructure need to be built. Unfortunately, the downside of high density living is that there are increased challenges in essential resource distribution like water, electricity, and sewage services. It can also be more difficult to control the spread of disease, prevent crime, and provide timely emergency response. This necessitates advanced and thorough planning and preparedness by the governing bodies of these areas. Unfortunately, urban growth in several parts of the world happens unplanned, and often in the economically disadvantaged sections of society that have sometimes been forced by circumstances to make this migration. These populations are more vulnerable to economic and natural hardships. Thus is it critical that growth in urban areas be continually monitored by means of surveys and updated maps. Not only can this help drive policy and governance decisions, but current mapping data is crucial for any kind of disaster response.

Manually mapping and surveying can be a prohibitively expensive endeavor. With the advent of space-based imagery, remote sensing has become the backbone of map generation and a crucial input for any decision support systems in use by local governing bodies. The most common type of space-based imagery is produced by optical imaging sensors.

These sensors are not unlike the digital cameras most of us are familiar with. They essentially take a photograph of the land surface as they fly past in their orbits several hundred kilometers above ground. Optical imaging satellites have become ubiquitous for mapping and monitoring the Earth's surface; however, their operations are easily impeded by inclement weather. This becomes a matter of concern for tropical countries, like India, where the monsoon season lasts up to 5 months, during which the probability of obtaining a cloud-free image is quite low. Thus it can be very difficult to use these sensors for operational urban monitoring. Given that the fastest growing populations reside in cities in these tropical regions, this is a serious impediment.

This issue is amplified in case of a natural calamity like a hurricane where the ongoing weather phenomenon makes optical imaging futile. While it is crucial to obtain up to the minute information about the affected populations in a situation like a heavy rain induced flood, because these sensors can not image though the clouds, imagery can only be obtained after the rains have subsided and the clouds have cleared. This is often too late and leaves the disaster response infrastructure stressed. If flooding could be monitored as it happens, warnings and instructions could be issued at a much more granular level. An example would be issuing the instruction of evacuation only to low lying areas, or areas immediately at risk, while avoiding spreading panic in areas currently deemed safe. This can prevent critical transport routes from becoming unnecessarily crowded. Additionally, disaster mitigation teams can better allocate their resources to the most critical areas - optimally serving the area.



**A view of the Juan Fernandez Islands cutting through the clouds. Optical sensors are of little use in heavy cloud cover. (NASA/Aqua Satellite)**

## Let there be electromagnetic waves

Over the years, several radar imaging satellites have been launched by government agencies and private entities for disaster response and monitoring, especially in the monsoon seasons. Radar satellites are active sensors, which carry their own source of illumination. They operate by pulsing a target area of the ground with electromagnetic energy, followed by coherent reception of the reflected pulse from the target. As they pass in their orbits, they are able to look at the ground target from several different observation angles, and later coherently sum the pulses from the target. This correlation of several observations is called synthetic aperture processing, and leads to improvement in resolution of the image. By increasing how long the target is observed as the sensor passes, or the dwell time, a more detailed image can be created independent of the size of antenna or sensing wavelength. This makes radar sensors incredibly flexible. Radio waves can easily pass through clouds and other atmospheric impediments like aerosols. Thus, radar satellites can image through clouds. Additionally, since they carry their own source of illumination, they can operate at night, making them highly versatile and apt for disaster response and geo-intelligence surveillance.

While radar images can be ideal for imaging and monitoring urban areas in high resolution, in-inhibited by the monsoon seasons, they do have a downside: radar images can be very difficult to interpret. Unlike optical sensors, which passively image an area directly under them, radar sensors involve pulsing energy at a target, and this must be done at a slant angle to avoid confusing echoes from equidistant points under the sensor. This configuration leads to several challenging geometric artifacts in the images. Tall buildings and mountains appear to "fold over" as echos from elevated surfaces and the base return at the same time. In addition, as the waves travel through the air, they interact with each other constructively and destructively leading to a speckled effect in the final imagery. This speckle is characteristic of all coherent imaging media, like ultrasound, and can make algorithmic interpretation of these images challenging.

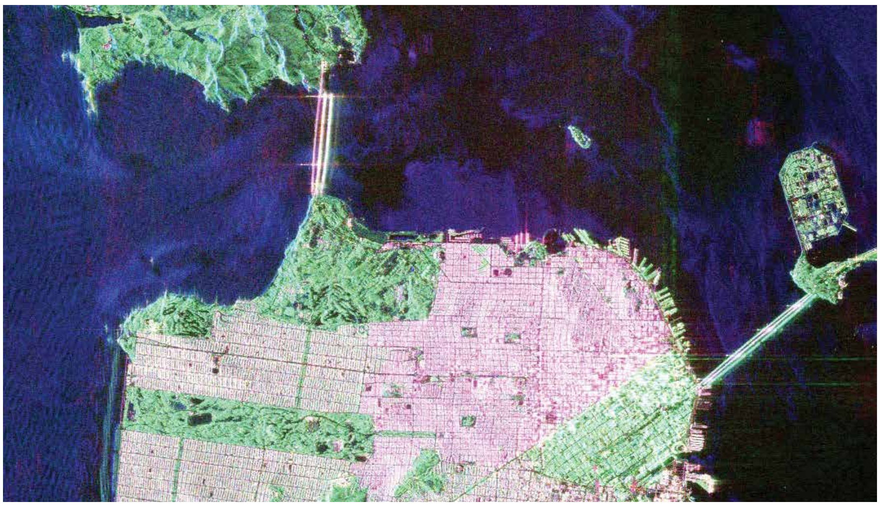
The difficulty of interpretation is compounded for advanced imaging modalities like polarimetric radars. In this mode, the radar transmits alternate pulses with closely controlled polarization configurations, and receives each coherently. While this allows much more detailed characterization of the target, it also exponentially increased the difficulty of interpretation. For instance, an urban building can be expected to return a strong echo in vertical polarizations. But if you have a situation with closely spaced buildings, the vertical and horizontal returns may interfere to form a helical return. Of note here is that several polarimetric radar constellations in current orbit like Sentinel-1 and the soon to be launched NISAR sensor represent significant public investment and are funded by government agencies. The imagery is freely distributed and plentiful, and being able to fully exploit the information captured by these systems is in the taxpayer's best interest.

## Clever but slow humans

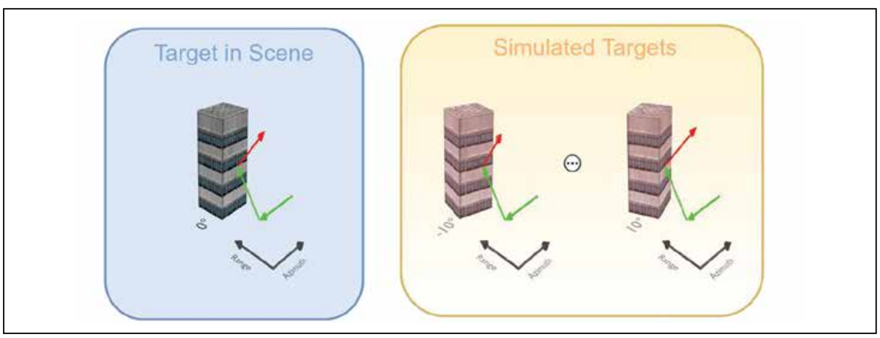
Often, a highly skilled trained professional is needed who is intimately familiar with radar scattering physics to exploit the information available from these sensors. This is especially true for urban areas, which are challenging to identify because of their complex shapes which lead to multiple scattering, and sometimes to the radar pulse being reflected away from the sensor. Manual interpretation is limited to the by the capacity of the individual expert to parse data, and hiring more experts can be prohibitively expensive. Besides, it's difficult to maintain mapping quality and timeline assurances when manual processes are used for production without additional steps and efforts. Both for the sake of quality and cost, it’s desirable to automate urban mapping.

However, due to the unique challenges of radar images, it is difficult to apply traditional image processing and computer vision algorithms to radar data. Even simplistic edge detection and filtering algorithms are unable to produce satisfactory output because of the challenging image artifacts. Artificial intelligence presented itself as an interesting direction that could potentially help overcome the challenges of automating a complex problem. Several recent advances and successes of the fledgling field recently prompted researchers Dr. Shaunak De and Dr. Avik Bhattacharya at the Indian Institute of Technology Bombay to explore a solution to radar analysis using the technology.

First was the problem of even finding urban areas. Due to the complex nature of radar scattering, even something relatively simple like finding all built-up structures can be a daunting task. The first breakthrough came in this direction when the researchers identified that at scale of the sensing wavelength, architectural details of the buildings crease to matter, and the radar is more or less only sensitive to the coarse shape of the building. While this idea, at its core is relatively simple, it holds the key simplification which enables us to teach a computer algorithm the physics of radar scattering. An interesting side-note, the inspiration behind this idea comes from a computer city management simulation game called SimCity. The researchers noticed that while scrolling though the rendered city areas in the game, they were able identify different urban neighborhoods faster if they ignored the details in the renders and instead focuses on overall building and neighborhood geometry. If it helps our own cognitive systems, it’s only logical that it would help an artificial one.



A polarimetric image of San Francisco acquired by the ALOS-2 sensor. Here the highly urban Mission district has been completely misidentified as vegetation due to the complex radar scattering in urban structures. Also notice the artifacts caused by bright scatter from bridges, ships and tall buildings. (JAXA/ALOS-2)




By simulating the electromagnetic scattering of several urban targets, the researchers were able to teach the algorithm to generalize the physics of radar scattering, thus improving its performance.

## Teaching a computer physics

To implement this idea, they created several million 3-D simulations of radar scattering in common urban area structures like a cluster of houses, or a pair of skyscrapers. These models were also rotated about the radar line of sight to simulate the effect of a change in orbits or sensing geometry. Real scattering targets from different urban radar acquisitions were also selected as training data. They then trained a deep learning algorithm to learn the associations between the building geometry and the radar scattering.

Deep learning is a technology that aims to simulate the functions of clusters of biological neurons and aims to be able to learn concepts similar to how our own cognitive systems grow, train and learn over time.  It learns much like a child does, through guided training, trial and error, rewards for “good” or correct results, and punishments for contrary ones.

In essence, the algorithm was taught the basic principles of radar scattering, just like a human expert would be trained. This allowed it to the algorithm to generalize the nature of radar targets in urban areas much better and be able to respond to targets that it had never seen in its training by inferring from scattering physics. The algorithm has been demonstrated to outperform state of the art techniques and has human-like target identification accuracy. Although the training is a time-consuming process, once the model is created it can be applied to a large number of radar images in seconds. Thus it is possible to now efficiently, cheaply and accurately map urban targets in large swaths of polarimetric radar data.

One advantage of Neuro-similar algorithms like deep learning are that although they are computationally intensive to train, they are incredibly efficient to test. This means that while teaching the algorithm takes a long time and considerable computational resources, the algorithm is able to perform the taught task fairly quickly, much like actual human workers. The advantage to this is while it can take a bit of tweaking and work by an expert data-scientist to train, in operation the method is extremely fast and stable. In addition a lot of the computation can be favorably performed on consumer graphics processing hardware that are commonly used to play video games, alleviating any expensive hardware requirements to make this system operational.

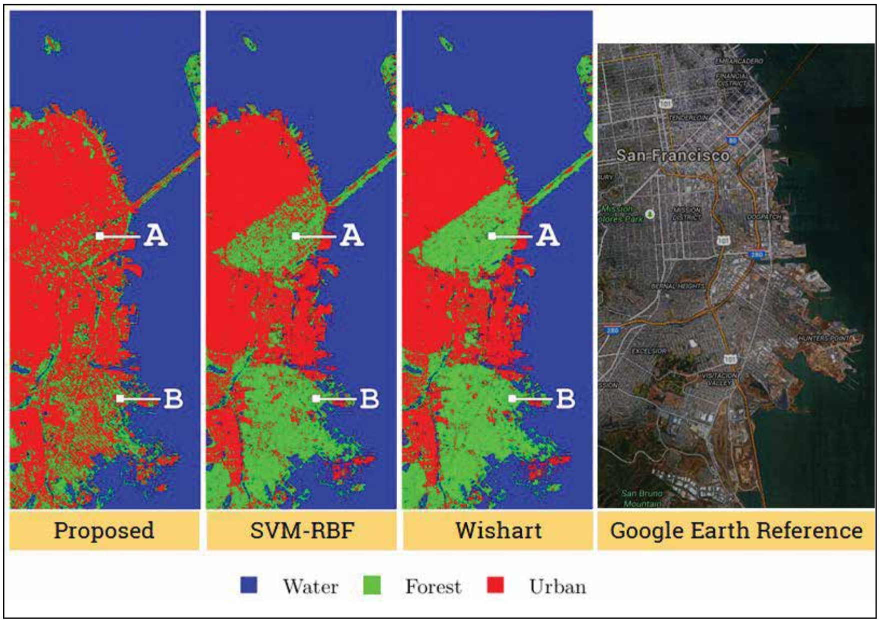
## Sentinels in the sky

Such an algorithm can be tasked with monitoring the terabytes of information being received from orbiting radar satellites and can automatically generate maps of urban areas, monitor urban sprawl, temporary and unorganized settlement, illegal encroaching. This can in-turn help urban planners meet the needs of these populations and distribute resources fairly and efficiently. Perhaps the most compelling use case for this technology is in case of natural calamities like hurricanes, where you want to quickly generate change maps of urban areas so the destruction of property can be monitored and disaster relief efforts can be correctly directed. In this case, an optical image is completely impeded by the weather system, and radar data coupled with this automated algorithm to generate urban and urban change maps can be lifesaving. The technology has application in military surveillance. Due to the ability of the radar to image at night, the algorithm can automatically detect bunkers and encampments constructed by insurgents in the cover of the night, helping plan a course of action security forces.

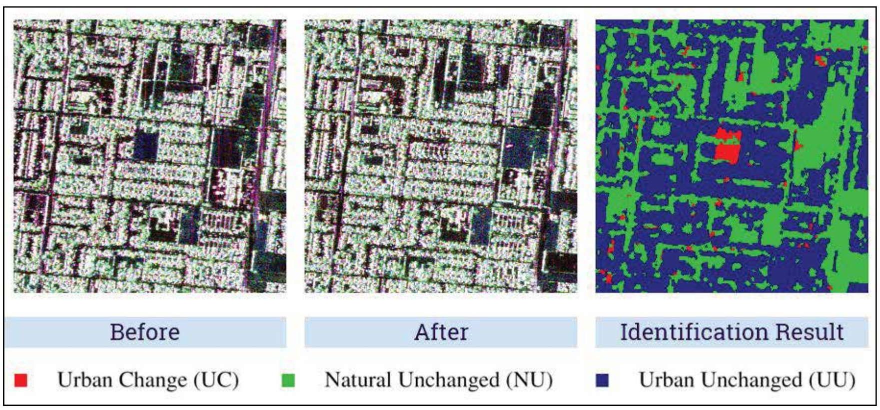
> Due to the unique challenges of radar images, it is difficult to apply traditional image processing and computer vision algorithms to radar data

Once routine maps of cities are created, several multi temporal studies such as change detection and monitoring can be done. These can be important inputs for several economic monitoring projects and indices. In fact with a slight modification to the current algorithm, automated changed urban area maps can be generated as well. Instead of teaching the algorithm to only identify between urban and non-urban areas, it can be presented examples in pairs. Some, in which no significant change has occurred between the areas in the pairs, and some in which construction or destruction has occurred. Again by learning the differences in scattering mechanisms this time the algorithm can be used to quickly mark changed urban areas in pairs of images – making it valuable for long term city monitoring, as well as disaster recovery efforts where significant damage has occurred in urban areas.

In the future this approach can be extended to several other applications like crop identification and snow-cover monitoring. More applications will allow better understanding of dynamic systems on earth independent of the weather systems in the atmosphere and will fully exploit the potential of the electronic sentinels keeping a watch over us from space.




**The proposed deep learning algorithm is able to outperform state-of-art techniques and isolate the urban areas (marked red) with human like accuracy.**




**With a slight modification, the algorithm can be used to identify changes in urban areas. Here it is used to check for long term urban change over Los Angeles, CA**

# UAV policy in India

Office of the Director General of Civil Aviation, Government of India came out with the requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS) on August 27, 2018. Here are the excerpts

## Categories of RPA

Civil RPA is categorized in accordance with Maximum All-Up-Weight (including payload) as indicated below:

i. Nano : Less than or equal to 250 grams.
ii. Micro : Greater than 250 grams and less than or equal to 2 kg
iii. Small : Greater than 2 kg and less than or equal to 25 kg
iv. Medium : Greater than 25 kg and less than or equal to 150 kg
v. Large : Greater than 150 kg

## Applicability

This Civil Aviation Requirement (CAR) is applicable to Civil Remotely Piloted Aircraft Systems, which are Remotely Piloted from a Remote Pilot Station.

## Application process

For RPA imported to India:

Any entity intending to import RPAS in India shall obtain Equipment Type Approval (ETA) from WPC Wing, Department of Telecommunication for operating in de-licensed frequency band(s). Such approval shall be valid for a particular make and model. The applicant, other than Nano category, shall apply to DGCA for import clearance.

For RPA locally purchased in India:

The applicant shall ensure that locally purchased RPAS shall have ETA from WPC Wing, DoT operating in de-licensed frequency band(s). Such approval shall be valid for a particular make and model.

## Requirements for issue of unique identification number (UIN)

Civil RPA shall require Unique Identification Number (UIN) from DGCA. UIN will be granted where the RPAS is wholly owned either:

a. By a citizen of India; or
b. By the Central Government or any State Government or any company or corporation owned or controlled by either of the said Governments; or
c. By a company or a body corporate provided that:
    i. it is registered and has its principal place of business within India;
    ii. its chairman and at least two-thirds of its directors are citizens of India; and,
    iii. its substantial ownership and effective control is vested in Indian nationals; or
d. By a company or corporation registered elsewhere than in India, provided that such company or corporation has leased the RPAS to any organization mentioned in Para 6.1(b) or (c) above.

### Exemption from UIN

RPA in Nano category intended to fly upto 50 feet (15 m) AGL in uncontrolled airspace/ enclosed premises for commercial / recreational / R&D purposes are exempted from obtaining UIN.

RPAs owned / operated by NTRO, ARC and Central Intelligence Agencies are also exempted from obtaining UIN.

## Requirements for issue of Unmanned Aircraft Operator Permit (UAOP)

Civil RPA operators other than those mentioned in following para shall require UAOP from DGCA.

Following entities will not require UAOP:

a. Nano RPA operating below 50 feet (15 m) AGL in uncontrolled airspace / enclosed premises.
b. Micro RPA operating below 200 feet (60 m) AGL in uncontrolled

airspace / enclosed premises. However, the user shall intimate to local police office 24 hours prior to conduct of actual operations.

c. RPA owned and operated by the agencies as indicated in Para 6.5 of this CAR. However, the agency shall intimate local police office and concerned ATS Units prior to conduct of actual operations.

## Security/ Safety Requirements

The operator shall be responsible for the safe custody, security and access control of the RPAS. In case of loss of RPA, the operator shall report immediately to the local police office, BCAS and DGCA.

The operator of all RPA except Nano RPA shall be responsible for notifying any incident/ accident involving RPA to the Director of Air Safety, DGCA

## Remote Pilot Training Requirements

Remote pilot shall have attained 18 years of age, having passed 10th exam in English, and undergone ground/ practical training.

The ground training shall be obtained at any DGCA approved Flying Training Organization (FTO), and include the following theory subjects:

a. Basic Radio Telephony (RT) techniques including knowledge of radio frequencies.
b. Flight Planning and ATC procedures.
c. Regulations specific to area of operations.
d. Basic knowledge of principles of flight and aerodynamics for fixed wing, rotary wing, and hybrid aircraft.
e. Airspace Structure and Airspace Restrictions with knowledge of No Drone Zones
f. Basic Aviation Meteorology.

## RPAS maintenance requirements

Maintenance and repair of RPAS shall be carried out in accordance with the manufacturer's approved procedures, as applicable. Maintenance of the ground control equipment shall be carried out in accordance with the manufacturer's recommended inspection and overhaul interval, as applicable. The remote pilot/ user shall not fly the RPA unless he/ she is reasonably satisfied that all the control systems of RPA including the radio and Command & Control link are in working condition before the flight. The UAOP holder shall maintain records of each RPA flight and make such records available to the DGCA on demand.

## Equipment requirements

All RPA (except for Nano category intending to operate up to 50 ft (15 m) AGL in uncontrolled airspace/ enclosed premises),shall be equipped with the following serviceable components/ equipment:

a. GNSS for horizontal and vertical position fixing
b. Autonomous Flight Termination System or Return Home (RH) option
c. Flashing anti-collision strobe lights
d. RFID and GSM SIM Card/ NPNT compliant for APP based real time tracking
e. Fire resistant identification plate inscribed with UIN
f. Flight controller with flight data logging capability

In addition to the equipment required under above mentioned para, all RPA (except Nano and Micro category operating in uncontrolled airspace) intending to operate in controlled airspace up to 400 feet (120 m) AGL shall be equipped with the following additional equipment/capabilities:

a. SSR transponder (Mode 'C' or 'S') or ADS-B OUT equipment
b. Barometric equipment with capability for remote sub-scale setting
c. Geo-fencing capability
d. Detect and Avoid capability

Remote pilot shall be equipped with communication facilities to establish two way communication with the concerned ATS unit.

The tracking system of the RPA shall be self-powered and tamper/ spoofing proof to ensure data relay even in the event of RPA accident.

Indian Air Force shall monitor RPA movements in the country in coordination with Airports Authority of India.

## Operating requirements

The policy lists out the operating requirements. Some of them are mentioned below:

The RPA operator shall prepare Standard Operating Procedures (SOP), which shall contain following procedures according to the provisions contained in relevant sections of (Aeronautical Information Publication) AIP-India:

a. Take-off/landing
b. Collision avoidance
c. Noise abatement
d. Flight plan filing
e. Local airspace restriction
f. Right-of-way
g. Communications
h. RPA emergency including loss of C2 link
i. Safe recovery of RPA through controlled airspace in case RPA system failure precludes the ability to remain outside controlled airspace, etc.

Irrespective of weight category, all RPA operations shall be restricted to day only, within Visual Line of Sight (VLOS), subject to conditions given in in the following para.

RPA operations except those in enclosed premises, shall be conducted only when the following meteorological conditions exist:

a. During daylight (between sunrise and sunset).
b. In Visual Meteorological Conditions (VMC) with a minimum ground visibility of 5 km and cloud ceiling not less than 1500 feet (450 m).

c. Surface winds of not more than 10 knots or as specified by the manufacturer. d) No precipitation (rain, hail or snow) or thunderstorm activities, or exceeding those specified by the manufacturer.

The operator [except Nano intending to operate up to 50 ft (15 m) AGL in uncontrolled airspace/ enclosed premises] shall obtain permission before undertaking flight through 'Digital Sky Platform'.

## Operating restrictions

Some of the operating restrictions are as mentioned below:

No RPA shall be flown:

a. Within a distance of 5 km from the perimeter of airports at Mumbai, Delhi, Chennai, Kolkata, Bengaluru and Hyderabad;
b. Within a distance of 3 km from the perimeter of any civil, private or defence airports, other than those mentioned in Para 13.1(a);
c. Above the Obstacle Limitation Surfaces (OLS) or PANS-OPS surfaces, whichever is lower, of an operational aerodrome, specified in Ministry of Civil Aviation (Height Restrictions for Safeguarding of Aircraft Operations) Rules, 2015 notified through Gazette of India notification GSR751(E) as amended from time to time;
d. Within permanent or temporary Prohibited, Restricted and Danger Areas including TRA, and TSA, as notified in AIP;
e. Within 25km from international border which includes Line of Control (LoC), Line of Actual Control (LAC) and Actual Ground Position Line (AGPL);
f. Beyond 500 m (horizontal) into sea from coast line provided the location of ground station is on fixed platform over land;
g. Within 3 km from perimeter of military installations/ facilities/ where military activities/ exercises are being carried out unless clearance is obtained from the local military installation/facility;
h. Within 5 km radius from Vijay Chowk in Delhi. However, this is subject to any additional conditions/ restrictions imposed by local law enforcement agencies/ authorities in view of the security.
i. Within 2 km from perimeter of strategic locations/ vital installations notified by Ministry of Home Affairs unless clearance is obtained from MHA;
j. Within 3 km from radius of State Secretariat Complex in State Capitals;
k. From a mobile platform such as a moving vehicle, ship or aircraft;
l. Over eco-sensitive zones around National Parks and Wildlife Sanctuaries notified by Ministry of Environment, Forests and Climate Change without prior permission.

The detailed policy can be seen at *http://dgca.nic.in/cars/D3X-X1.pdf*

### UK radar satellite NovaSAR-1 successfully launched

The radar imaging satellite NovaSAR-1, carrying an Airbus S-band synthetic aperture radar (SAR) built in Portsmouth, has been launched successfully on a PSLV launcher from India. The spacecraft was built under the leadership of Surrey Satellite Technology Limited, an Airbus subsidiary.

The innovative small satellite will be used to monitor the Earth day and night.  SAR instruments can see through clouds to enable uninterrupted imaging of the Earth below, which is key when monitoring changes of features on the ground. NovaSAR-1 is the first SAR spacecraft to be manufactured entirely in the UK and is a technology demonstration mission designed to test the capabilities of a new low cost S-Band SAR platform. The satellite is owned by SSTL.

### MDA Signs Multi-million-dollar SAR Information Contract

MDA, a Maxar Technologies company has signed a multi-million-dollar contract with the South African National Space Agency (SANSA) for a one-year maritime surveillance programme that includes the delivery of synthetic aperture radar (SAR) data products from the RADARSAT-2 satellite, using MDA's global network of ground receiving stations. The contract includes two additional option years.

As part of the Presidential programme Operation Phakisa, SANSA has been tasked to acquire SAR imagery with the aim of enhancing the monitoring and protection of South Africa's coastal regions and oceans.  Initiatives under this programme are considered crucial in accelerating the delivery of South Africa's development priorities.

### European Space Imaging awarded £ 20 million maritime contract

European Space Imaging has been awarded its third major contract for the provision of very high-resolution optical satellite data to the European Maritime Safety Agency (EMSA). EMSA includes optical satellite images as part of its maritime surveillance services to the European Commission and Member States to support a number of functions in the maritime domain. *www.euspaceimaging.com*

### India using remote-sensing tech developed by NASA

An advanced remote-sensing technology developed by US space agency NASA to map minerals on the moon and Mars is being used in India for the first time to prospect for gold, diamonds, platinum and rare earth elements.

Rare earth metals are a group of 17 elements with many similar properties and are often found together in geologic deposits. They're in high demand across the world because of their use in high technology devices such as smart phones, digital cameras, computer hard disks, fluorescent and LED lights and computer monitors, among others.

"In its pursuit for minerals, the GSI is going to use ultra-modern remote sensing technology to find lead, zinc, copper, gold, diamond and platinum, among others. This will be used for the first time in India," Dinesh Gupta, director general, Geological Survey of India (GSI).

Called Advanced Visible Infra-Red Imaging Spectrometer-Next Generation (AVIRIS-NG), the sensor-based technology that will now be used in India has been proved effective for mapping surface mineralogy on earth, the moon and Mars. The AVIRIS-NG sensor was mounted on an ISRO aircraft to get hyperspectral images of 14 mineralised blocks across India, including in Jhagadia in Gujarat, Udaipur in Rajasthan, Chhatarpur in Madhya Pradesh and Kuhi-Khobna in Maharashtra, among others.

GSI signed a MoU with the National Remote Sensing Centre (NRSC), a wing of the Indian Space Research Organization (ISRO), on September 5, to analyse data to trace the minerals from the hyperspectral images taken by ISRO in three phases – October to November 2015, January to February 2016, and April to May 2018. *www.hindustantimes.com*

### Australian Space Agency signs a statement of strategic intent with Airbus

The Australian Space Agency has signed a statement of strategic intent with European manufacturing giant Airbus Defence and Space SAS. The Minister for Industry, Science and Technology Karen Andrews welcomed the signing, the first by Australia's new agency with an industry partner, sending a strong signal for further investment opportunities.

### Quanergy announces availability of new solid state LiDAR sensor

Quanergy Systems has announced the availability of its S3-2 solid state LiDAR sensor. It features Quanergy's proprietary QORTEX™ object profiling software directly embedded within the sensor, resulting in the industry's first all-in-one sensing solution. Quanergy views solid state LiDAR technology as essential to the future of smart sensing and perception. The S3-2's lack of moving or vibrating parts enables it to perform with the highest level of reliability, longevity, and cost efficiency while requiring less power.

### Raytheon strengthens tie up with HawkEye 360

Information and Services business is collaborating with commercial small satellite company, HawkEye 360 Inc., as part of its ongoing focus to provide innovative commercial technologies and more precise data to the government sector.

The alliance includes a strategic investment in HawkEye 360 and provides Raytheon with a unique level of access to data, enhancing the company's analytics services for government customers. HawkEye 360 is pioneering the use of low-flying, small satellites to collect radio frequencies for use in next-generation geospatial services. HawkEye 360 will launch its Pathfinder cluster of three small satellites at the end of 2018, with additional clusters planned until the full constellation is in orbit by 2020.

## BSNL launches satellite phone services

Bharat Sanchar Nigam Limited, India's only authorised service provider for satellite phone services, launched the Global Satellite Phone Service (GSPS).

For fishermen, it is a revolutionary communication gadget that would come in handy as they practice multiday deep-sea stay fishing. Satellite-based mobile phone service provides voice call and SMS facility using satellite communication without any mobile network or any signal from a mobile tower and keeps the user connected in the remotest corner through direct linkage with the satellite. A SIM card having unique mobile number is allotted for this service and will cover the entire country, including exclusive economic zones. *www.thehindu.com*

## Japan plans self-driving cabs for the 2020 Tokyo Olympics

ZMP, a developer of autonomous driving technology, and the taxi company Hinomaru Kotsu, began road tests with a minivan in Tokyo. In their latest trial, a minivan equipped with sensors made four round-trips a day on a busy 5.3 kilometres stretch of road between the Otemachi and Roppongi districts.

The experiment has captured the imagination of Tokyo residents and 1,500 people have applied to be passengers. *www.forbes.com*

## GSA publishes its second GNSS User Technology Report

The second edition of the European GNSS Agency's (GSA) GNSS User Technology Report has been published, providing an exhaustive review of all the latest GNSS trends and developments. It is a sister publication to the GSA's GNSS Market Report, is published every two years and takes an in-depth look at the latest state-of-the-art GNSS receiver technology, along with providing expert analysis on the trends that will shape the global GNSS landscape in the coming years

## USAF Announces selection of GPS III follow-on contract

The U.S. Air Force announced selection of Lockheed Martin for a fixed-price-type production contract for 22 GPS III Follow-On satellites with a total estimated contract value up to $7.2 billion.

The Air Force operates a total of 77 satellites vital to US national security that provide communications, command and control, missile warning, nuclear detonation detection, weather and GPS for the world.

The Air Force's acquisition strategy for this solicitation achieved a balance between mission success, meeting operational needs, opportunities for technology insertion, lowering costs and introducing competition for National Security Space missions. *www.af.mil*

## Orbital cluster Glonass now has 23 operational satellites

Russia's space satellite Glonass-M number 754 has been withdrawn from the orbital group, which now consists of 23 operational satellites, as follows from information available on the website of the information and analysis center of temporal, coordinate and navigation support.

According to earlier reports, global coverage will require 24 operational GLONASS satellites, including 18 covering the territory of Russia. Thirteen of the 26 satellites in the cluster are beyond the warranty date.

Satellite number 754 was withdrawn from operation for maintenance. It was launched on March 24, 2014 and commissioned on April 14, 2014. Its guaranteed service life is seven years.

Earlier it was announced that Glonass-M space satellite number 756 joined the orbital cluster on August 29. Launched on June 17, it is to replace Glonass-M number 734.

Satellite number 734 has been suspended for maintenance. Last April it went out of order and it took nearly one month to restore the satellite to normal operation.

It was announced that with the commissioning of satellite number 756 satellite number 734 will be transferred to the orbital reserve. Glonass-M number 734 was put in orbit in December 2009 and commissioned in January 2010.

At the moment the GLONASS group consists of 26 satellites, including 23 operational ones (number 701 is undergoing flight tests). *http://tass.com*

## ESA awards Galileo ground control upgrade to GMV

ESA has awarded a new work order for the Galileo Control Segment — that part of the Galileo system responsible for the monitoring and control of all the satellites in orbit — to GMV Aerospace and Defence, Spain.

The Galileo Control Segment has been designed to allow the automatic execution of routine operations. It also includes elements supporting flight dynamics analyses, constellation operations short-term planning as well as operations preparation.

This work includes upgrading the system architecture to manage a constellation of up to 41 Galileo satellites, updating obsolescent elements in the current system, improving operability linked to the provision of services and the addition of a new, second TT&C station to be based in Kourou, French Guiana.

## British companies, academics excluded from EU Galileo space project

British companies and academics will be excluded from the future development of the European Union's Galileo space project if the country leaves the bloc without a deal in March 2019. The UK government said in the notice that companies currently involved in Galileo may face difficulties completing their existing contracts and should contact authorities to try to ensure they can comply with the conditions of their contracts.*www.reuters.com*

## Iran plans to unveil new navigation system soon

According to the Chairman of the Board & CEO of Iran Airports and Air Navigation Company (IAC), Iran plans to unveil a new navigation system in the near future.

Several Iranian knowledge-based firms and academic centers are working together to unveil a new navigation system.

Iran is located in a geopolitically important region, between Europe and Asia Pacific, and has the potential to be one of the most important aviation hubs in the world.

Iran has 54 airports and 80 percent of air traffic activities are concentrated in eight major airports. *https://en.trend.az/iran/society/2949379.html*

## Danish Tech firm launches robot system for construction sites

Construction sites could soon include mini manufacturing units where robots custom-make building components at the push of a button – at least that's if Danish tech firm Odico has its way.

The robotic system, currently a functional prototype, would be shipped to projects inside a standard shipping container then use locally sourced materials to custom-fabricate a range of products, including formwork, insulation, reinforcement or tiles.

Factory-On-The-Fly is based on Odico's signature robotic manufacturing system, which is able to quickly produce formwork molds for concrete with complex double-curved geometries. Two robots dynamically bend a flexible heated blade, while a third robot moves a block of EPS foam through it. *www.bimplus.co.uk*

## Driving geospatial innovation in Singapore and the UK

Managing Director of Ordnance Survey (OS) International, Peter Hedlund, and Singapore Land Authority (SLA) Director of Geospatial and Data, Mr Ng Siau Yong signed an MOU which will see both organisations intensify focus on the promotion and use of geospatial information to support smart services and solutions which aim to benefit citizens, communities, business and government.

Building on the current, longstanding and strong relationship between OS and SLA, the MOU will support both parties in exploring new collaborations. For example, the OS and SLA aim to jointly hold events between OS' Geovation and SLA's GeoWorks, Singapore's new geospatial industry centre for start-ups, companies and interested communities in both the UK and Singapore.  Another key focus of the MOU is the co-development of a proposal for autonomous vehicles, exploring data capture, data processing and standards.*www.os.uk*

## Karnal, India to get GIS-enabled revenue record maps

With the aim of having GIS-enabled revenue record maps of the district, a team of the Survey of India (SoI) has started mapping the land record with the help of a drone. As per the authorities, Karnal has been chosen for a pilot project.

As a pilot project, the SoI is preparing details online and GIS-enabled revenue maps of a few villages and urban areas of Karnal as a technology demonstrator. The technology will involve drone camera and the drone will be operated by experts of the SoI. The drone would capture the whole area from a height of around 50 metres so that each object was visible easily. The details of non-revenue record land (lal dora) and agricultural land would be covered under this mapping, he added. *www.tribuneindia.com*

## Global Mapper v.20 now available

Blue Marble Geographics has announced the immediate availability of Global Mapper version 20. It includes numerous new tools, functional upgrades, and performance improvements across all areas of the application. Among the significant enhancements are a new tool for creating a point cloud from a 3D model, a new free-flight mode for navigating the 3D View, expanded support for tablet and touch screen computers, numerous new Map Layout options, and a new eyedropper tool for selecting a specific color in a raster layer.

## senseFly launches eBee X Drone

senseFly has launched the eBee X. The eBee X, part of the Parrot Business Solutions portfolio, is designed to boost the quality, efficiency and safety of an operator's geospatial data collection. It offers a camera to suit every job, the accuracy and coverage capabilities to meet the requirements of even the most demanding projects, and is durable enough to work virtually every site.

It includes a range of revolutionary new camera options to suit every mapping job—from land surveying and topographic mapping to urban planning, crop mapping, thermal mapping, environmental monitoring and many more.

## Genesis, an industrial IoT platform for drone based surveillance

Asteria Aerospace, India has launched GenesisTM, an industrial IoT network platform for drones. It is a secure enterprise software platform to enable organizations to effectively use and manage fleets of drones in surveillance & security operations.

Genesis allows authenticated users to login from any device, anywhere, and view video, images, sensor and telemetry data from multiple drones in real-time. Moreover, the data from the drones is automatically stored and managed on the platform for search and analysis. Genesis makes it possible for a police force to have several drones deployed over a city for event security and the live video feed from all the drones to be broadcast to a central command center. *www.asteria.co.in*

## DroneTracker 3.5 offers protection against drone swarms

Dedrone has released DroneTracker 3.5, the drone detection industry's response to understanding airspace activity and ensuring that protected sites are aware of all drone activity overhead, whether it be a single or orchestrated drone incursion.

Drone swarms, or more than three drones in a single area, have been demonstrated in action in modern military settings for surveillance and delivery. Pilots who operate more than one drone at a time can expand their reach and impact to an area, whether to support disaster response and recovery, drop contraband at a correctional facility, distract law enforcement from their operations, or threaten the security of a military base.

No airspace is immune to drone threats. DroneTracker ensure its customers can protect their assets against the growing threat of unauthorized drones in their airspace. *www.dedrone.com*

## SimActive enables South Korean government's first drone mapping project

SimActive has enabled the first government UAV mapping project in South Korea. Asia Aero Survey (AAS), a SimActive regional partner, used Correlator3D for the public survey delivered to the Korean National Geographic Information Institute (NGII) and the Korean Association of Spatial Information, Surveying & Mapping (KASM). While such projects were previously conducted using manned aircraft, a drone was preferred due to the difficulty in accessing the area of interest through traditional aerial and ground surveying methods. *www.simactive.com*

## Ainstein announces new airborne and ground-based drone detection radar sensors

Ainstein, a leader in intelligent radar sensing solutions, has announced two new products in its Ultra Long Range UAV radar series; the Ultra Long Range Airborne (ULAB-D1) and Ultra Long Range Ground-Based (ULGB-D1) radars, capable of precise detection more than 1,000 meters away.

As drone adoption increases, Ainstein's new ultra long range UAV radar systems address the need for highly precise and cost-effective tools to minimize disaster risks and keep assets and classified information safe. For high-security facilities, such as government buildings and airports, or critical infrastructures, such as water treatment facilities and mass transit systems, the need for drone detection is especially high.

## Walmart looks at Blockchain for automated delivery drones

Walmart's recent patent endeavors have demonstrated how the retail giant is making a foray into blockchain technology and also focusing on autonomous delivery drones.

The patent application details a system by which "autonomous electronic devices" communicate with each other wirelessly and pass transported objects to each other after an identification process.

Drones would depend on a database of delivery information stored on whichever blockchain the company is operating.

For identifying each other, robots could use a variety means to transmit signals from one to the other, including RFID codes, QR codes or ultrasound, the patent filing says.

As per the filing, the use of automated technology is envisioned as a way to reduce the times at which elements of the delivery process have to be "trusted." Indeed, Walmart argues that the fact that consumers would have to trust the delivery of their goods to flying machines "raises challenges related to security" and requires a reliable system of identification for the drones. *www.cips.org*

## PrecisionHawk acquires HAZON and InspecTools

PrecisionHawk, Inc., recently announced acquisition of both HAZON, Inc. and InspecTools Inc. These businesses specialize in the delivery of inspection services and technology for the energy industry and bring demonstrated domain expertise to enable tighter integration between the collection and the analysis of drone data. *Precisionhawk.com*

## New version of labsat satgen V3 of GNSS simulation software

An updated version of SatGen v3 is now available to download. Along with a number of optimisations and fixes, this is a major update to the capabilities of the software as it now allows for the simulation of new satellite signals such as L2, L2C, and L5 – making the use of SatGen with the LabSat 3 Wideband significantly more powerful.

This latest version also allows for the creation of complex (multi-frequency, multi-constellation) scenarios, enabling development and test of dual frequency GNSS receivers in a highly dependable and repeatable manner.

With L2C likely to be fully operational within the next two to three years once twenty-four satellites are transmitting the signal (currently at nineteen), the emergence of dual frequency devices is set to rapidly accelerate. Taking advantage of the robust simulation capacity of LabSat 3 Wideband hardware in conjunction with SatGen V3 software will give a competitive edge to those manufacturers leading the way in dual frequency design.

SatGen can now be used to create a single scenario containing all the upper and lower L Band signals for GPS, GLONASS, and BeiDou, and will take advantage of the LabSat 3 Wideband's ability to read RF data at up to 80 MB/s.

## Utraq: India's own GPS module launched

India-based semiconductor distribution company has launched country's first ever 'desi' GPS module. Ramakrishna Electro Component Pvt Ltd announced a new kind of Vehicle Tracking System, under 'Utraq' brand that will run on Indian Satellites.

Utraq launched two models L100 and L110. These are GPS receivers Modules based on IRNSS supported by GAGAN/NaviC signals, designed using L5 and S bands. It is owned by Ramakrishna Electro Component & manufactured by Shanghai Mobiletek. This module is IRNSS compliant for VTS application. IRNSS is Govt of India initiative under ISRO. IRNSS User Receiver module is integrated with front-end chipset and embedded high performance ARM9 processor from leading chipset manufacturer. It has internal S RAM, UART, USB, CAN and 10 Bit ADCs. *www.bgr.in*

## Teledyne Significantly Increases Bottom-tracking Range

Teledyne RD Instruments (TRDI) has released a new proprietary Extended Range Tracking (XRT) option which, according to the company, is capable of extending the bottom-tracking range of its Pathfinder and Pioneer doppler velocity logs (DVL) by 60%. This latest development allows users to attain bottom lock faster and more efficiently than ever before, further increasing user control and confidence during subsea missions. Extensive in-house and customer testing has proven this extended range in a wide array of conditions and terrains and has in fact exceeded design expectations.

## CGG Conducts Rich-azimuth Multi-client Survey North-west of Shetland

CGG has commenced acquisition of a high-density, rich-azimuth, towed-streamer multi-client survey in the UK West Shetland Basin. The 3,600-square-kilometre survey has received strong industry support and has been designed in collaboration with major international oil companies. It focuses on delivering high-resolution seismic data in a prospective but underexplored area north-west of the Shetland Isles over the northern part of the Rona Ridge. A fast-track PreSDM dataset will be available in Q1 2019.

The innovative acquisition geometry is designed to image multiple targets from shallow Tertiary and Cretaceous plays to complex fractured Devono-Carboniferous reservoirs by undershooting the volcanic intrusions and shallow unconformities present in the area. Two vessels, the Oceanic Vega and the Geo Caribbean, are being deployed. Each vessel operates triple sources using simultaneous source technology.

## Satcom Direct and Iridium Partner to deliver Iridium CertusSMTerminals

Iridium Communications Inc. has announced that Satcom Direct, Inc. (SD) is the newest Value Added Manufacturer (VAM) and service provider for Iridium Certus aviation products. SD will be designing and manufacturing new terminals for compatibility with the Iridium Certus service, while also providing the service direct to the business aviation community. SD's mission is to synchronize the aircraft with flight operations. Iridium Certus will integrate with existing SD hardware and software, including the already popular SDR® Series and SD Hub Series of cabin routers, as well as the SD Pro® platform, to provide customers with features and capabilities like real-time data analytics, cyber security, account management and more. *www.iridium.com*

## Rugged LNA for RF and microwave applications like GPS introduced by NuWaves

NuWaves Engineering in Middletown, Ohio have introduced the HILNA GPS C034 ruggedized, high-performance low-noise amplifier (LNA) for GPS systems that an LNA that will work in harsh environments like launch applications.

The HILNA GPS C034 is a broadband low-noise amplifier designed to achieve high gain while maintaining low noise and a high third order intercept point, and is specifically targeted for the L1 (1575.43 MHz) and L2 (1227.6 MHz) GPS signals.

This ruggedized high-performance module delivers 32 dB of gain across the frequency range of 1200 MHz to 1600 MHz with an OIP3 of +30 dBm and less than 1 dB of noise figure. *www.nuwaves.com*

## Rx Networks announces assistance GNSS data tailored for IoT devices

Rx Networks Inc. has announced an update of its location.io platform to provide GNSS assistance data to enable better positioning in IoT devices. It has updated its location.io HTTP interface to provide Real-Time GNSS ephemeris data with a reduced payload, a smaller Predicted GNSS ephemeris client while maintaining full featured accuracy. The location.io HTTP interface is now leaner and requires fewer requests and less data. www.rxnetworks.com

### Integrated Navigation Systems by Polynesian Exploration Inc.

Polynesian Exploration Inc. has introduced PolyNav 2000P, a high accuracy navigation solution for emerging applications such as autonomous driving and UAVs. It is designed to fully utilize the advantages of both GNSS and INS to provide centimeter level position and velocity accuracy with dual frequency Real Time Kinematic (RTK) technology, with simultaneously accurate attitude information (roll, pitch and heading). The system is ultra-stable in terms of short time satellite signal outages and capable of providing highly accurate heading information no matter whether the system is static or moving. *www.polyexplore.com*

### GPS L5 and Galileo E5 simulation capabilities to the R&S SMW200A GNSS simulator

The Rohde & Schwarz R&S SMW200A GNSS simulator is the ideal tool for efficient test and characterization of multi-constellation and multi-frequency GNSS receivers. With its recently added simulation capabilities for GPS L5 and Galileo E5, the R&S SMW200A makes it easy to generate complex and highly realistic test scenarios with up to 144 channels in the GNSS frequency bands L1, L2 and L5. In addition to GPS (L1/L2/L5), GLONASS (L1/L2), Galileo (E1/E5) and BeiDou (L1/L2), the R&S SMW200A also supports signal generation for QZSS and SBAS on L1. The available channels can be routed to up to four RF outputs, so that even multi-antenna systems can be tested. Apart from its new GNSS simulation capabilities, the R&S SMW200A remains the first and only vector signal generator that can generate complex coexistence and interference scenarios with multiple interferers. GNSS signals, noise and all interference signals are generated directly in the instrument. Additional signal sources for external generation of interference signals are not required, resulting in small, compact and simple test setups. *www.rohde-schwarz.com*

### Spirent, Fraunhofer and LZE partnership

Spirent Communications plc has announced a partnership with Fraunhofer IIS and LZE GmbH that will ensure continuity of supply of Spirent's leading Galileo Public Regulated Service (PRS) Radio Frequency Constellation Simulator (RFCS) product extension after the UK leaves the European Union. The new partnership will see sales and order processing hosted by LZE GmbH of Erlangen, Germany, with Munich-based Fraunhofer IIS taking on responsibility for the future development, fulfilment and support of Galileo PRS in the Spirent GSS9000 GNSS test solution. Fraunhofer will become the sole owner of the SimPRS software/firmware, which will no longer be accessible to Spirent after the UK leaves the EU. *www.spirent.com*

### GNSS Module Exploits Teseo III Chip

STMicroelectronics' Teseo-LIV3F module integrates essential features to speed application development and includes up to 16 Mb of flash memory for firmware updating or data logging without a backup battery. The module enables engineering teams without extensive in-house RF expertise to leverage Teseo III advantages in creating new products in the industrial and consumer market segments like vehicle trackers, drones, anti-theft devices, pet locators, and systems for services such as fleet-management, tolling, vehicle sharing, or public transportation.

### NovAtel launches Smart7 GNSS Antenna Series

NovAtel has launched its new SMART7 family of SMART antennas, adding SPAN technology, GNSS, Wi-Fi and Internet Protocol (IP) connectivity, tracking performance and TerraStar-C PRO corrections to the availability, accuracy, and reliability used by major equipment manufacturers for demanding applications like precision agriculture and machine control.

The SMART7-S includes NovAtel's tightly-coupled GNSS+Inertial Navigation System (INS) SPAN technology, the most advanced GNSS+INS integration in the market. SPAN provides accurate attitude information that can simplify the development of vehicle guidance systems and bridge GNSS signal outages.

For easier connection to mobile devices and cellular gateways, the SMART7-W includes Wi-Fi and an integrated NTRIP client, and the SMART7-I model also incorporates Ethernet. A new advanced ISOBUS-compatible CAN interface also supports NovAtel logs, commands and firmware upgrades.

### DT Research's newest tablet provides scientific-grade GNSS

DT Research has launched the DT372AP-TR rugged real-time kinematic (RTK) tablet, a lightweight military-grade tablet that offers RTK to enhance the precision of position data derived from satellite-based positioning systems.

The tablet enables 3D point cloud creation with centimeter-level accuracy to meet the high standards required for scientific-grade evidence in court, the company said.

A dual-frequency GNSS module is built into the tablet, which uses real-time reference points within 1- to 2-centimeter accuracy to position 3D point clouds created from aerial photogrammetry, using GPS, GLONASS and Galileo satellites.

### New BlueSky GNSS Firewall from Microsemi

The new BlueSky™ GNSS Firewall from Microsemi Corporation, a wholly owned subsidiary of Microchip Technology Inc. enables critical infrastructure providers to harden the security of their operations from GPS threats and deliver a more reliable and secure service. The security-hardened system provides protection against GPS threats such as jamming, spoofing and complete outage. It also supports a range of precision timing technologies, including atomic clocks, to enable continuous operation when GPS may be completely denied for extended periods. *www.microsemi.com*

## Antenova is shipping its ultra-small GNSS active antenna module with LNA and SAW

Antenova Ltd, manufacturer of antennas and RF antenna modules for connected devices and the Internet of Things, is now shipping its latest module for tiny positioning devices – the RADIONOVA M20047-1. This is an active antenna module for GNSS applications in the 1559-1609 MHz satellite bands using GPS, GLONASS, GALILEO or BeiDou.

The M20047-1 antenna module comprises an SMD antenna with built-in active components: an LNA filter and SAW to boost antenna performance – so designers will not need to add these – all contained in a compact FR4 part with low power consumption, measuring just 7.0mm x 7.0mm x 0.9mm, and weighing less than 2g.

The on-board LNA and filter act to boost the signal to the GNSS processor in environments where there is a restricted view of the sky or where line-of-sight to the horizon is difficult. *www.antenova.com*

## Airsight Australia choose advanced navigation for NextCore

Airsight Australia started in 2012 as one of the first entrants to the UAV operations market and swiftly developed a reputation for providing high quality and safe UAV operations for industrial asset inspection and surveying. The NextCore system really differentiates itself by using cost-effective hardware to increase data quality in the post-processing system. This is made possible by the highly accurate Advanced Navigation Spatial Dual which allows a lower-spec laser unit to be used, considerably reducing costs.

## Trimble adds Galileo and BeiDou to its VRS Now Service in North America

Trimble announced that Galileo and BeiDou observation data is now included with Trimble VRS Now™ subscriptions in North America. Powered by the Trimble Pivot™ Platform GNSS Real-Time Network software, Trimble VRS Now in North America fully supports GPS, GLONASS, QZSS and now, Galileo and BeiDou satellite systems. The addition of the Galileo and BeiDou constellations allow users to make use of more satellites, enabling more robust performance when working in harsh GNSS environments such as in urban canyons and under canopy. *www.trimble.com*

## Trimble enhances its TruETA Solution

Trimble has announced the introduction of enhancements to its TruETA solution for improved route planning. While the estimated time of arrivals (ETAs) are not new to the trucking industry, the application adds a new dynamic to the solution—driver intent.

Most TMS systems allow for visibility of a route's speed limits, traffic delays and weather factors, among other things. But, along with the enhancements to the solution, Trimble is offering two additional add-on modules for one of the most accurate ETAs—Driver Trip Planning and Out-of-Route/Out-of-Corridor.

## Hexagon completes acquisition of AutonomouStuff

Hexagon's Positioning Intelligence division has welcomed AutonomouStuff following the completion of the acquisition as announced by Hexagon AB. AutonomouStuff being part of Hexagon PI will boost collaboration between the organizations to provide superior solutions for autonomous vehicle development.

Hexagon PI has been an important technology provider to AutonomouStuff for several years, and the two organizations have worked closely together to serve common customers and collaborate on important industry events. As the division grows, AutonomouStuff will continue to function as an independent brand within Hexagon PI.

## Leica Geosystems selects Getac's ZX70 tablet

Getac has announced that Leica Geosystems has selected its fully rugged ZX70 Android tablet as hardware of choice for the new Leica Zeno GG04 plus Tablet Solution. The new partnership will allow Leica Geosystems to bring comprehensive geospatial data collection capabilities to its customers in all terrains and weather conditions such as utilities, public services, transportation and construction.

## BeiDou AltBoc Signal is Being Tracked by JAVAD

New phase 3 satellites of Chinese BeiDou satellite system have several new signals. ICD for B1C and B2A signals are available, while for the other signal(call it B2B) is not. JAVAD was able to track the signal that is on 1207140000 MHz frequency on BeiDou's satellites #32,33,34. Now we see that this signal is available on all recently launched BeiDou phase 3 satellites and we track it successfully.

This B2B signal plus B2A signal together form altBoc(10,15) signal on 1191795000 MHz (call it BaltBoc). Assuming, that BOC parameters of this signal are similar to Galileo's, Javad managed to track it. Tracking of B2B and BaltBoc signal will be available on most of its receivers with 3.7.4 firmware or higher, which should be released by Mid October 2018.

# SUBSCRIPTION FORM

YES! I want my Coordinates

I would like to subscribe for (tick one)

☐ 1 year — 12 issues — Rs.1800/US$100
☐ 2 years — 24 issues — Rs.3000/US$170
☐ 3 years — 36 issues — Rs.4300/US$240

SUPER saver

First name ..........................................

Last name ..........................................

Designation ..........................................

Organization ..........................................

Address ..........................................

..........................................

City ................... Pincode ...................

State ................... Country ...................

Phone ..........................................

Fax ..........................................

Email ..........................................

I enclose cheque no. ..........................................

drawn on ..........................................

date ................... towards subscription

charges for Coordinates magazine

in favour of **'Coordinates Media Pvt. Ltd.'**

Sign ................... Date ...................

Mail this form with payment to:

Coordinates
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.

If you'd like an invoice before sending your payment, you may either send us this completed subscription form or send us a request for an invoice at iwant@mycoordinates.org



## MARK YOUR CALENDAR

### November 2018

**Trimble Dimensions 2018**
5 - 7 November
Las Vegas, USA
www.trimbledimensions.com

**CHINTERGEO2018**
7 - 9 November
Chengdu, Sichuan Province
PR China
www.chintergeo.com

**International Navigation Conference 2018**
12 - 15 November
Bristol, UK
www.rin.org.uk

**ITSNT 2018**
13 - 16 November
Toulouse, France
www.itsnt.fr

**Commercial UAV Show**
14 - 15 November 2018
London, UK
www.terrapinn.com/exhibition/the-commercial-uav-show/

**United Nations World Geospatial Information Congress**
19 - 21 November
Deqing, China
www.unwgic2018.org

**ISPRS V Symposium**
20 – 23 November
Dehradun, India
http://isprstc5india2018.org

**International Symposium on GNSS (ISGNSS 2018)**
21 - 23 November
Bali, Indonesia
www.isgnss2018.com

**The Pacific GIS and Remote Sensing User Conference**
26 - 30 November 2018
SUVA, Fiji
www.picgisrs.org

**The 16th IAIN World Congress 2018**
28 November – 1 December
Chiba, Japan
https://iain2018.org

**BeiDou Satellite Navigation Application Expo & Smart City Expo**
30 November - 02 December
Nanjing, PR China
www.tleer.cn/enbdsexpo

### January 2019

**International LiDAR Mapping Forum (ILMF)**
28 - 30 January
Denver, United States
www.lidarmap.org

### March 2019

**2019 URSI Asia Pacific Radio Science Conference**
9 - 15 March
New Delhi, India
www.aprasc2019.com

**Munich Satellite Navigation Summit**
25 - 27 March
Munich, Germany
www.munich-satellite-navigation-summit.org

**Land and Poverty Conference 2019**
25 - 29 March
Washington, DC, USA
www.worldbank.org

### April 2019

**European Navigation Conference 2019**
9 - 12 April
Warsaw, Poland
http://enc2019.eu

**FIG Working Week 2019**
22 - 26 April
Hanoi, Vietnam
www.fig.net/fig2019

**AUVSI Xponential 2019**
29 April - 2 May
Chicago, United States
www.auvsi.org/events/xponential/auvsi-xponential-2019

### June 2019

**HxGN LIVE 2019**
11 - 14 June
Las Vegas, USA
https://hxgnlive.com/2019

**TransNav 2019**
12 - 14 June
Gdynia, Poland
http://transnav.am.gdynia.pl

### July 2019

**Esri User Conference**
8 - 12 July
San Diego, California
www.esri.com

### August 2019

**The South-East Asia Survey Congress(SEASC) 2019**
15 - 19 August
Darwin, Australia
https://sssi.org.au

### September 2019

**ION GNSS+2019**
16 - 20 September
Miami, Florida, USA
www.ion.org


Focusing on true performance!
PENTAX
D-600
Precise Aerial Imaging System
6 Rotor Multicopter with Autopilot
PENTAX
R-1500N & R-2800N
Reflectorless Total Stations
Total surveying solutions
W-1500N & W-2800
Windows CE Total Stations
Truly integrated systems
G6 Ti | Ni
GNSS Receivers
Precision Satellite Surveying with wireless communications
S-3180V
Scanning System
3D laser measurement system