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THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

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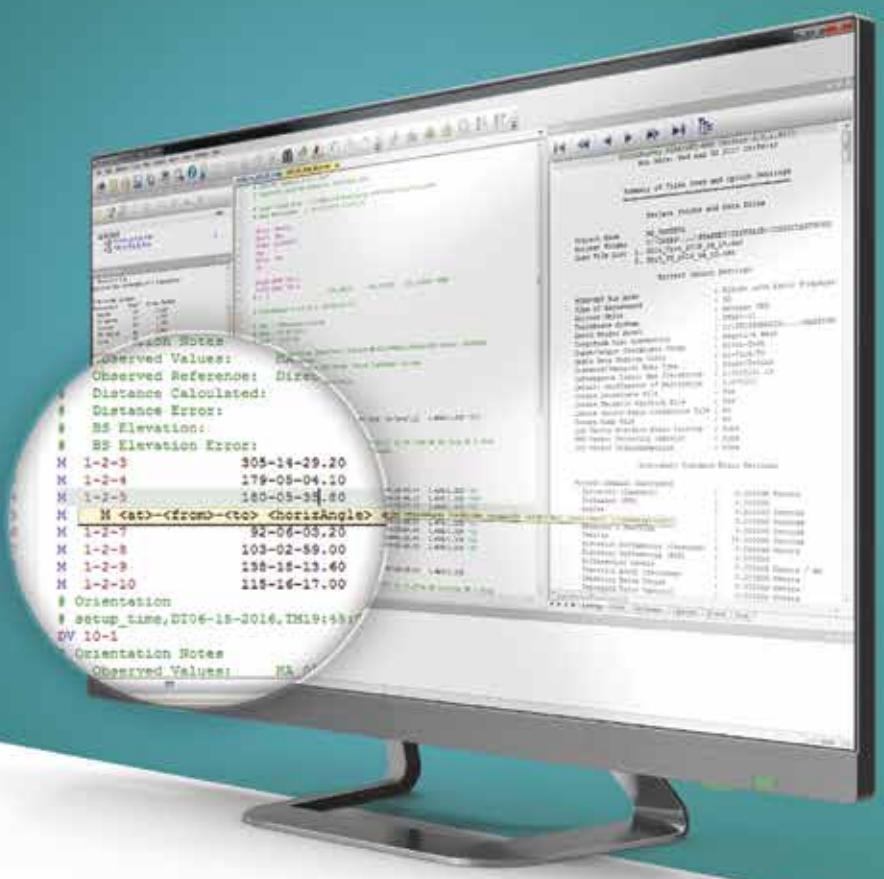

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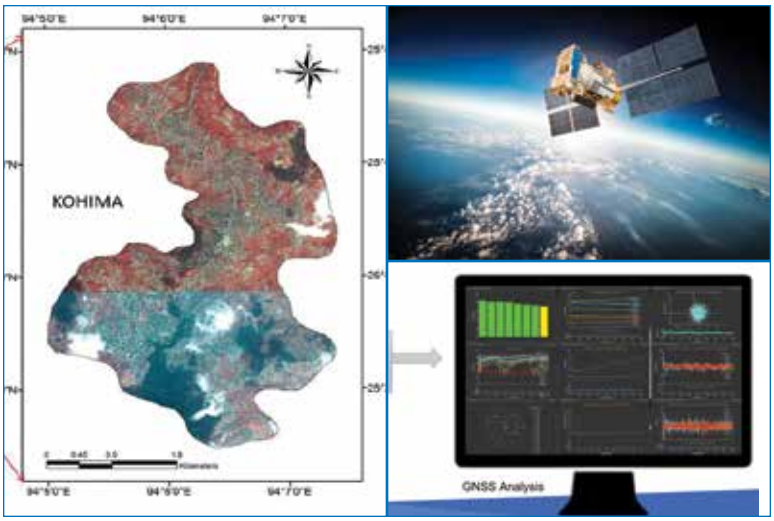

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Gone in smog

If you don't breathe,

You die.

But if you breathe in Delhi,

You may still die.

Air is poisonous.

Visionaries visionless,

Government clueless,

Millions helpless.

Come November,

It is smog all around.

Delhi needs a breather,

To be safe and sound.

Bal Krishna, Editor
bal@mycoordinates.org

Resilient PNT: Is it?

Experts share their views on vulnerability, impacts and possibilities

Cyber-attacks on PNT Systems–Disturbing evolutions

Guy Buesnel
PNT Security Technologist, Spirent Communications, Paignton, Devon, UK

GNSS signals are very weak when received on the surface of the Earth and that makes them susceptible to a particular set of vulnerabilities – for example, Radio Frequency Interference (RFI), signal spoofing and atmospheric events (scintillation or solar weather). There is a lot of publicity associated with the spread of GPS jamming events around the world – often these events are associated with low cost GPS jammers that are purchased to prevent tracking, whereas GPS spoofing has often been regarded as an exotic, unrealistic attack scenario that would be too expensive and complicated to become a real-world threat

GPS anomalies in the Black Sea

Recent events have shown that spoofing needs to be considered as much, if not more, of a threat as interference.

There has (rightly) been a lot of discussion on the recent events that took place in the Black Sea - the US Maritime Administration issued an advisory notice in September containing details on the reported disruption.

GPS Spoofing affects smart phones at a major GNSS conference

The threat posed by GPS spoofing was brought home to delegates at IONs GNSS+ 2017 conference vividly by an incident that took place in the exhibition hall. RF radiation from a piece of GPS test equipment leaked into the hall near a stand, spoofed the date/time and location of numerous cell phones of people who were within range of the signals and rendered some of them inoperable. A number of delegates were unable to recover their phones and were forced to seek further technical help. Whilst the cause of this incident was purely accidental, it highlights the importance of avoiding the generation of spurious over-the-air radio frequency signals and demonstrates the ease with which consumer devices "accepted" the fake GPS signals as authentic – to the detriment of other sensors. Though it is certainly true that in an enclosed, covered exhibition hall, the leaked GPS signals were the only signals available to GPS devices, other sensors should have provided indications that the data being provided by the GPS sensor was conflicting.

This incident took place at a conference where many satellite navigation professionals were present, so the rogue signal was located, isolated and shut-down relatively quickly. Under other circumstances – like a malicious attack indoors – the consequences could be much worse.

Other verified instances of GPS spoofing

There have been some well documented instances of GPS spoofing in the real world that occurred before events in the Black Sea. In October 2016, reports started to surface from Russia that GPS users in the vicinity of the Kremlin found that their devices suddenly showed them to be located almost 20 miles away at Vnukovo airport. There

were also reports that GPS users near the centre of St. Petersburg suddenly found that their devices were indicating a location close to Pulkovo airport.

http://www.breakingnews.ie/world/kremlin-system-blocking-gps-in-central-moscow-760454.html

https://themoscowtimes.com/news/drivers-in-st-petersburg-report-gps-problems-in-city-center-56653

It is speculated that the incidents in the Black Sea, Moscow and St Petersburg are the implementation of a system to prevent drone overflights of sensitive area – but there is no way to confirm this. If these anomalies were caused by some sort of system designed to deter or disrupt drone flights, it is clear that they have caused a significant amount of collateral impact. The events at ION GNSS+ 2017 acted as vivid corroboration that the impact of replica GNSS signals on innocent users can be significant and widespread.

Spoofing GPS Time

In a paper at DEFCON 25 in August, a presentation by ZX Security showed how easy it is to build a low-cost GPS spoofer and use it to generate fake GPS signals in order to time-spoof an NTP server. The cost of the components that ZX Security used was less than $500, and the process of building the spoofer was described as "a party trick; simple and cheap." The paper went on to demonstrate how a successful spoofing of time to the NTP server could result in the misuse of Time-based One Time Passwords (TOTP) by a hacker. The paper highlighted the particular vulnerabilities of NTP for this type of time spoofing hack and also showed how it could be exploited to generate an incorrect transaction log.

The low cost of building equipment to hack GPS

It is now possible to build a very capable GNSS spoofer based on an SDR for less than $500. Most of the software code needed to programme the SDR to act as a GNSS transmitter is readily available on the internet, making it easy to produce a system capable of disrupting drone flights or to manipulate the operation of cell phones indoors.

Whilst it might be theoretically possible for a determined individual hacker to cause some disruption with a low cost device, the sheer scale of disruption experienced in Russia and the Black Sea region suggests that well organised, well-resourced organisations are much more likely to have been behind these instances of GPS disruption.

Fake GPS signals can cause unpredictable behaviour

Re-transmission of GNSS signals or broadcast of replica or "fake" GNSS signals over the air often causes receivers or systems to become "confused" and start behaving unexpectedly, even if they are not spoofed. Sometimes the affected receiver will not recover when the source of the replica signals is removed – necessitating a hard reset of the affected receiver or system. This accords with many of the symptoms experienced by the delegates at the ION GNSS+ conference who were unlucky enough to have had their personal cell phones affected by the signal leak.

GPS jamming is still a significant risk

There is also a great deal of evidence that GPS jamming or interference can degrade the performance of GPS receivers to the point where misleading information is reported by a device. In a well-reported 2010 trial in the UK's North Sea (the STAVOG project), it was found that receivers affected by GPS interference can report false positional data without generating any warnings or cautions to the user. However, no incorrect signals were generated during the STAVOG project – it was focused on understanding the impacts of GPS jamming on bridge navigation systems.

It is now possible to build a very capable GNSS spoofer based on an SDR for less than $500

The need for risk assessment

Developing and testing spoofing detection and mitigation in GNSS receivers should now become a much higher priority for the industry.

It certainly highlights how important it is to test equipment and systems to understand how they are likely to behave when subject to the re-broadcasting or faking of GPS signals. so that steps can be taken to mitigate. These tests can be extremely difficult to conduct in the real world – the military often conduct such tests on remote test ranges to ensure that civilian users could not be affected. For commercial users, it can be highly problematic to obtain the permissions and sponsorship to carry out testing on a military range. But it is now possible to conduct detailed simulations of jamming and spoofing affects, which allow the effects to be evaluated without needing to generate an over-the-air signal.

The importance of openness in reporting observed vulnerabilities

The reports of GPS disruption in the Black Sea led to a Maritime Alert message by MARAD. This alert message should result in raised awareness of the potential impact of this sort of event in the GPS user community. It demonstrates the benefits of openness in the commercial sector when it comes to reporting GNSS vulnerabilities. Raised awareness of the potential vulnerabilities of GNSS, the need to always "trust but verify" the data it provides, benefits everybody in the whole GNSS value chain—from users to system integrators and developers to manufacturers.

Financial impact of the vulnerabilities of GNSS

Andy Proctor MA, FRIN
Innovation Lead, Satellite Navigation and PNT
UK Delegate to the European Space Agency Board of Navigation
Innovate, UK

There has been a great deal written in this publication about the vulnerabilities of satellites, particularly when providing signals used for Position Navigation and Timing (PNT) applications. The nature of these vulnerabilities has been studied in great detail over many years; receivers, integrated systems, atmospheric effects, multipath, and sources of interference. The impact of 3 or more constellations on being able to provide robust space-based PNT capabilities is also being studied by researchers and industry, with results showing that Global Navigation Satellite Systems (GNSS) are an essential part of our lives, now and in the future; an invisible utility. There is though a price to pay for this invisible utility, and this article will talk about the scale of the economic scale of our dependency.

The extent of our dependency on GNSS is once again becoming a topic of interest to policy makers, politicians and those charged with the protection of the systems we rely on day-to-day. Policy makers understand that times and technology change, and when the UK government (via the Innovation Agency, InnovateUK and the UK Space Agency) started to look again at our dependencies some 3 years ago, it was clear that that a knowledge refresh and addition of new work was needed. Some of that work is still ongoing but one aspect that had never been studied in the UK before was the *financial impact* of the vulnerabilities of GNSS and our dependency upon it.

A study, jointly commissioned by InnovateUK, the UK Space Agency and the Royal Institute of Navigation set out to answer the question of how much would the UK be impacted financially by a loss of GNSS. We imagined a number of scenarios where loss of GNSS can have impact, the causes of loss and methodology of how to study this. When study budgets were considered, we set out a scenario that presented a reasonable worst case scenario rather than lots of perhaps more complex events. We also wanted to look at aspects such as the benefit that GNSS brings to the UK and what about the public money invested – has it been a valuable investment, delivering sufficient return to justify continued funding?

The scenario chosen was a 5-day total immediate loss of GNSS, but also that systems and backups function as designed. The 5-day value was chosen as it fit a number of criteria; from the recommendations from the Royal Academy of Engineering Report into GNSS Vulnerabilities from 2011, to align with a number of scenarios in the UK National Risk Assessment and to present a reasonable worst case.

Thus our objectives for the study were set:

- Identify the industrial sectors are supported by GNSS in the UK?
- Quantify the economic benefit to those sectors of using GNSS?
- Estimate the economic impact to the UK of the loss of GNSS?
- Identify mitigation techniques are there and their cost?
- Assess the impact of UK public funding in the GNSS domain

The contract was managed by a steering board comprising of InnovateUK, UK Space Agency, Satellite Applications Catapult, The Knowledge Transfer Network, the RIN and the Government Office for Science (GO-Science). This brought alignment to GO-Science work on GNSS dependency, the ability to reach out to UK GNSS communities, understanding the economic factors in markets and to facilitate introductions where appropriate. Defence applications were not addressed during the study, to enable it to be published freely.

The methodology of the study was to first perform some secondary research then conduct a number of one to one interviews with stakeholders identified during discussions. These took around 3 months to complete and the quality of the results was greatly enhanced by the willingness of all those who participated to be open and frank with the London Economics (LE) team. The more observant reader will have seen them at the INC16 conference in Glasgow. In the order of 35 people were interviewed from across many areas where GNSS is used in the UK.

In order to understand the benefits and impacts LE designed a logic model to ensure a consistency of approach over each area of work, this is shown in figure 1.

For each case analysed the broad group, application, use and role of GNSS (including any resilience measures) was identified, then a clear understanding of the benefits and socio-economic impacts. These were monetised if possible and the understanding of the impact of the loss was broken down application-by-application, which were also monetised where possible. This logic model has proven a useful methodology to put structure around this type of analysis.

What then did the study find? We found that the answer to the exam question was £5.2bn of financial impact for a 5-day loss of GNSS. This comprised of £1.7bn in lost GVA and £3.5bn in lost utility benefits. The biggest sector impacted, somewhat unsurprisingly, was the road sector with 37% of this value being taken from the road sector, the majority is in lost utility benefits due to loss of time by the effects on congestion as GNSS-dependent drivers lose the ability to

optimise their route, spending more time navigating and going back on wrong turns. Together with other effects that consider the impact of slower moving GNSS-dependent drivers on the entire road network (i.e. on all drivers), the impact is large. The fact that smartphones are fast becoming the dominant in vehicle device and some of those can use alternate technologies such as Wi-Fi and Cell-ID was taken into account.

The next largest sector to have a financial impact was the emergency services and justice sector. This comprised mainly of the monetisation of the delays and losses due to public service answering points not having the location of emergency calls and the associated increase in time per call, loss of the fleet management benefits enjoyed by police, ambulance and fire services would also be lost. This would increase the response time and result in significant, detrimental impacts.

The maritime transport infrastructure in the UK would be the next largest sector impacted by this 5-day loss. These impacts range from nuisance/ inconvenience brought about by buoys that are no longer synchronised (making navigating a large vessel in narrow shipping lanes more challenging), to severely detrimental effects from the loss of accurate measures of speed and consequent unavailability of accurate time of arrival at ports. The loss of navigation, speed information and AIS would also most likely cause vessels to slow down, reducing the likelihood that they make the designated timeslot. The impact of loss of GNSS would be particularly high in adverse weather conditions with reduced visibility as vessels would need to reduce speed to ensure they remain in shipping lanes and do not run aground.

The study estimates the various impacts on the automotive manufacturing processes and these can be translated through economic models for the other sectors.

The same sectors also show the greatest benefits of using GNSS, unsurprisingly the road sector shows the greatest economic benefit from the use of GNSS.

All of these assessments should be considered *a minimum* as it was not possible to monetise all of the benefits and GNSS loss impacts and therefore the study makes clear the impacts in practice would be greater.

Several mitigation strategies are discussed in study. The most applicable mitigation strategies for the largest number of applications are eLoran and Satelles Time and Location (STL). These high-availability services could mitigate many of the detriments in the maritime sector, and while the accuracy is insufficient

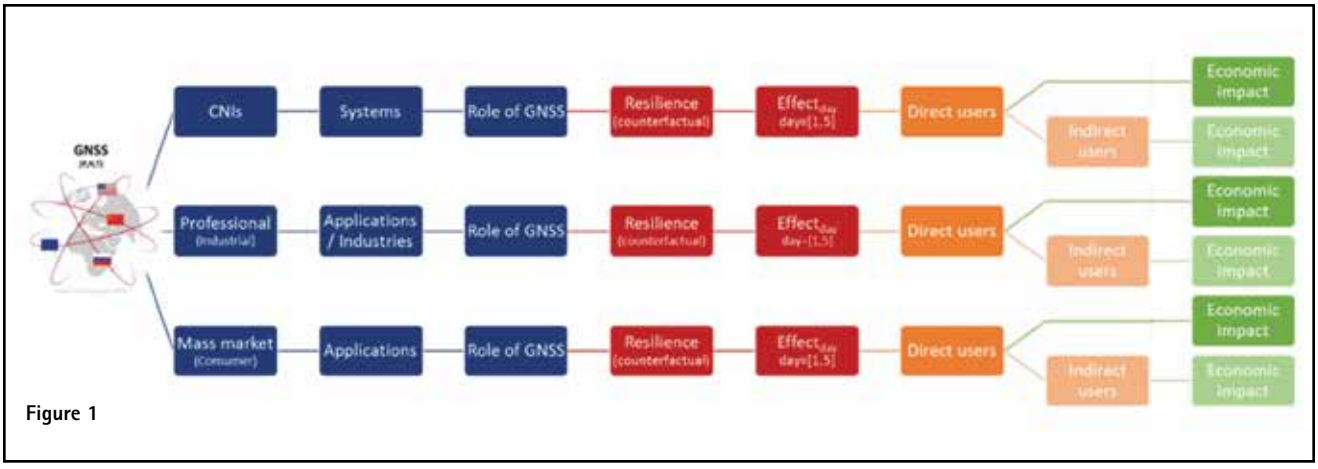
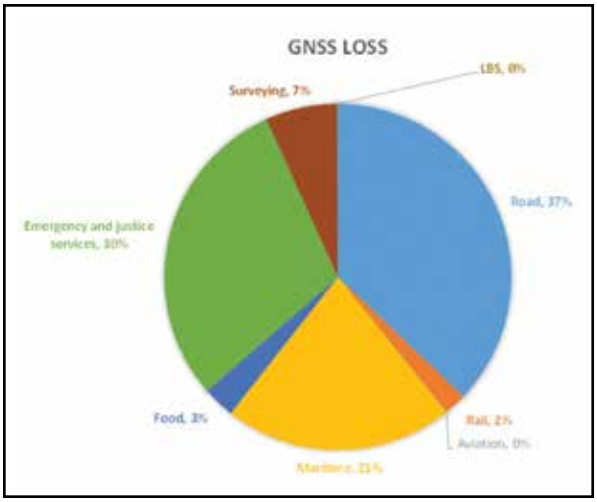
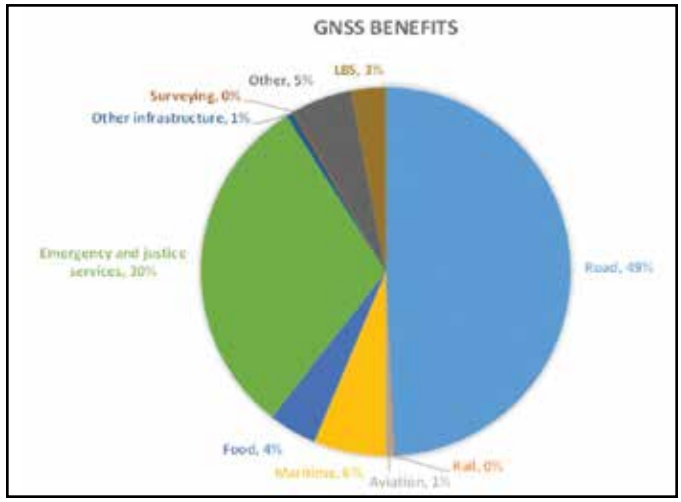


Figure 1





for container stacking and autonomous cranes, the ability to schedule port operations and reduce downtime would help to keep ports open. Omnisense SP500 and Locata may be preferred for localised applications that require high levels of accuracy (e.g. surveying and agriculture). Timing applications were found to be mostly resilient to a five-day outage of GNSS, but could implement eLoran, STL, Locata or freely-available Network Time Protocol (NTP) servers as a source of timing for low accuracy applications. If higher accuracy is required, Precision Time Protocols (PTP) or time-over fibre networks, like NPL-time, are two alternatives.

The public funding aspects in the study could almost be considered a study within a study as it analysed the rationale for public investment, identified the investments made so far, the schemes and what the target of the public investment has been plus compared this against the counterfactual of no public funding.

The reports concludes that there are strong benefits for society, estimated to be between £4 and £5 per £1 of public investment in GNSS. In order to capture these benefits, the UK has made a €1,474m investment in GNSS since 2000. Most of this investment (94%) has occurred through EU channels but €95m has been in the development of new GNSS applications that generate revenue for UK companies, productivity benefits for end-users, and environmental benefits for society. The UK also recently announced a further €30m investment through the European Space Agency Navigation (ESA) Innovation and Support Programme, the majority targeted directly at UK companies to provide help with research and development funding.

In conclusion, a very wide range of economic sectors in the UK rely on GNSS for their daily activities. All critical national infrastructures rely on GNSS to a greater or lesser extent. Communications, emergency services, finance, Government and transport were identified as heavy users of GNSS with the global availability and consistency playing a key role for some. Those critical infrastructures that rely on GNSS have developed over decades to a current situation in which GNSS is an integral source of timing and positioning information, where systems are defined on the basis that GNSS is available.

For professional activities in the UK, GNSS is a primary input for transport (road, air, maritime, and rail) workers, farmers, surveyors and lawyers. Sectors generating 11.3% of UK GDP have been identified as reliant on GNSS to greater or lesser extent, and the primacy of GNSS inputs in critical infrastructures means that a wide range of sectors is underpinned by GNSS.

Outside of professional activities (or in the household sector), GNSS is used for navigation and information gathering for all types of transport (leisure, commuting), and underpins insurance telematics that rewards safe drivers.

This report is the first report to qualify the economic impact to the UK of the loss of GNSS and has been widely shared across government and those sectors impacted the most. The fact that no single mitigation will resolve the issues identified is clear but the extent of properly implemented mitigations could reduce the £5.2bn by as much as 4/5th's in ideal conditions. We recognise that the study could not address every scenario and some additional areas for study are identified.

What next for this work? The study has been a key input to the Government Office for Science and Cabinet Office Blackett report into the UK functional dependence upon GNSS, and has been used to identify innovations and become a specific area of interest for the current InnovateUK funding round (at time of writing). This means the government has acted directly from the report. The report has also been discussed by the US Government, ESA and the European Commission.

How to be more effective ...

John Pottle
Director of the Royal Institute of Navigation, UK.

Good news: Positioning, Navigation and Timing (PNT) systems and applications are getting easier to use with better functionality and performance. However, at the same time "success" in a PNT system is more complex, and certainly more difficult to quantify, than ever before.

To illustrate this, I would like to start relatively recently with the GPS receiver developer at the turn of the century. In those days, success was getting a stable fix and reporting the position as Latitude and Longitude. Perhaps an LCD display was now being driven rather than LED's of the past. The display interface offered new levels of flexibility with options to render the position in different formats including, for the lucky few, as cross hairs on a line-drawn map outline. Measuring success by these accomplishments seems rather basic and simplistic in comparison to what can be achieved today.

This is clear if we take that same developer, or the next generation of developer perhaps, today. Pick a growing area such as connected autonomous vehicles (CAV); or a mobile device such as a smartphone; or a drone; or even a robotic logistics facility. Let's look at the PNT aspects from the developer's perspective.

Position

Each application example above has in common the necessity of a degree of accuracy in position information, often both absolute and relative position. Sometimes the position is indoors in a so-called 'GNSS-denied environment',

unable to pick up the all-too-weak satellite navigation signals. Often the position needs to be reported very accurately, particularly relative position where collisions need to be avoided, or an accurate landing is required for example. To achieve this, satellite navigation alone is nowadays rarely enough. The days of autonomous GPS are going, going, gone, indeed often gone already. Today's systems usually take signals from multiple satellite constellations together with a rich cocktail of sensors (see Figure 1), and integrate these together in a sensor fusion engine to provide blended position information. Sophisticated techniques are now routinely used to tune the sensor fusion algorithms for accuracy. For example, most modern smartphones switch sensor fusion algorithms depending on the context. The context is automatically detected using the inertial sensors, sometimes other sensors as well, in the phone. In simple terms, when your device has detected it is in your hand it's using a different positioning calculation to when it's in your car to when it's in your pocket.

Navigation

Until around the turn of the century navigation was normally achieved through plotting positions to enable a route to be followed. But then came more processing power and data storage. This in turn enabled mass-market routing algorithms. Render those on an electronic map or chart and show current and predicted positions and you have the basis of today's electronic navigation systems. But our imaginary developer has a lot more than that to deal with today – crowd sourced data points, device accuracy that may regularly be more accurate than the underlying map information, assessing the integrity, or trust, in the position information to name but three. At a recent RIN conference, Jeremy Morley, chief geospatial scientist of Ordnance Survey updated us that a connected autonomous vehicle will generate 1 Petabyte (1,000,000,000,000,000 bytes) of information per year from its various sensors and communications interfaces. That's roughly equivalent to the data storage of 15,000 contemporary smartphones. Of course much of this is filtered and/or dumped rather than stored … yet something else for our developer to deal with.

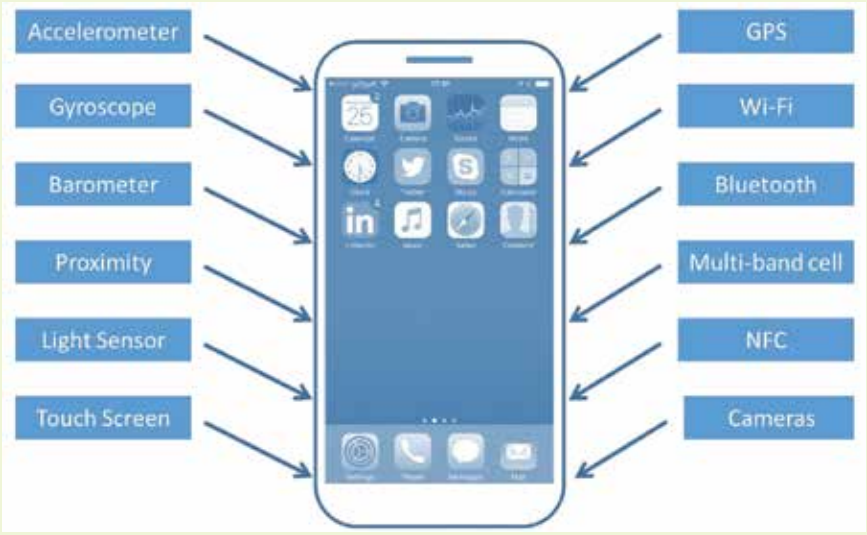


Figure 1: Typical smart device sensors used for positioning and context sensing

Figure 2: Natural plus intentional and unintentional manmade sources of GNSS vulnerability (credit: Spirent)

Timing

This brings us neatly to timing and, more specifically, the precise time that is needed to enable the world's synchronised and time-stamped communications. GPS offers free access to very precise time. It's very reliable and works very effectively. However, as is well understood by PNT experts these days, undue reliance has been placed on a satellite navigation system that has inherent vulnerabilities. The likelihood of disruption may be relatively low but if the impact is high to very high then the risk overall is also high. So our developer also has to contend with natural vulnerabilities as well as manmade, be they malicious or unintentional (see Figure 2). The risks need to be identified, assessed, categorised and mitigated in a way that is appropriate for the specific application.

In conclusion, from this brief review of only a couple of example PNT-centric systems and applications, it's readily apparent that our developer's life is very complicated. So much so, in fact, that the most successful organisations proactively engage across disciplines and across organisations spanning industry, academia, users and government.

"GNSS has a big role to play in Indian economy"

Dr Jayanta Kumar Ray, Vice President - GNSS and Aerospace Electronics, Accord Software & Systems Pvt Ltd India shares his thoughts on issues and possibilities of GNSS in India

Your vision is "Innovative Information Technology Solutions for a better world". Explain how your products and solutions are aligned with the vision statement.

Accord has been striving to create innovative technology solutions that benefit our customers in particular and the nation at large over the past two and a half decades. By virtue of steady and continuous investments in research and development into Global Navigation Satellite System (GNSS) and allied fields, Accord has provided out-of-the-box techniques and methods to solve the customer needs in many critical applications including automotive, defence, and aerospace. Some of our key customers such as Research Centre Imarat (RCI-DRDO) and Indian Space Research Organization (ISRO) always encouraged us to create Indigenously Designed Developed and Manufactured (IDDM) GNSS receivers that motivated us to build innovative solutions.

We believe Accord played a key role in our country achieving self-reliance in navigation area in aerospace and defence. Our vision was truly rewarded when we received DRDO Technology Absorption Award from the Honorable Prime Minister of India Sri Narendra Modi for the indigenous design, development and production of Advanced High Dynamics GPS+GLONASS+GAGAN Receivers.

Accord has been one of the leaders in developing SBAS receivers. How has been its penetration among users so far?

Accord built the first GPS-SBAS receiver in 2005 and got it certified by the Federal Aviation Administration (FAA) of the United States for airworthiness in 2007. Since then, Accord has created nearly half-a-dozen variants of the GPS-SBAS receiver and got them certified by the FAA. These safety-critical and life-critical GNSS receivers guarantee to have better than one-in-ten-million failure rate.

Accord's GPS-SBAS receivers are used in thousands of general aviation aircraft, experimental aircraft, UAVs, drones etc. in the USA, UK, Australia, Italy, Germany, Israel and other countries. Some of the aircraft models where our GPS-SBAS receivers are used are Beechcraft, Cessna, Dornier, Pilatus, Piper and Bell Helicopter. This is one Indian product which has gone truly global.

In India, our FAA certified GPS-SBAS receivers were used in GAGAN signal-in-space validation. Variants of the GPS-SBAS receivers, including GPS-SBAS-GLONASS and IRNSS-GPS-SBAS-GLONASS receivers are used in many critical applications in India including automotive, helicopter, aircraft, UAVs, ships, smart bombs and many other platforms for navigation and guidance.

What has been the best "time to first fix" by Accord GNSS receivers?

The 'time-to-first-fix' of Accord's GNSS receivers are amongst the best in the world. Accord's GNSS receivers are benchmarked with the best in class GNSS receivers in the world in terms of cold start time, warm start time, hot start time, signal reacquisition time in open sky, low signal and obstructed view conditions and found to be at par.

How ready Accord is, for handling Dual frequency multi-channel capability?

Accord not only has the capability of dual frequency multi-channel GNSS receiver, but, we already have ready solution of dual frequency, multi-constellation, multi-channel GNSS receiver. Accord developed IRNSS dual frequency Reference receiver for ISRO in 2013 even before the IRNSS satellites were launched. Today, Accord has multi-constellation GNSS receivers covering GPS L1, L2,

Someone must come out with IRNSS chipset solution soon, which could bring down the cost to own IRNSS receiver. A mandate from the Government recommending use of IRNSS in critical applications could make IRNSS popular in India.

L5, GAGAN L1, GLONASS L1, L2, Galileo E1, E5a, E5b, IRNSS L5, S, BeiDou B1, B2 constellation receivers.

How do you see the growth potential of GAGAN in India?

GAGAN provides integrity information in addition to the corrections to the satellites measurements. GNSS receivers employ information from GAGAN to enhance the integrity and reliability of the position solution and compute the error protection limits, suitable for aviation applications. Further, GAGAN enhances the accuracy and availability of GPS solution. Position information with high degree of reliability and accuracy from GPS-GAGAN is also very useful for safety applications including aerospace, railways, mining, precision farming, precise timing and automotive applications. Additionally, the text messaging services from GAGAN could be very effectively used for disaster management.

What is your opinion to explore the potential synergy between IRNSS and GAGAN?

IRNSS and GAGAN have very different objectives. While, IRNSS provides an independent means of position computation using Indian satellite navigation system, GAGAN is used to improve the reliability and accuracy of the computed position using US GPS. IRNSS by virtue of its dual frequency satellite signals at L5 and S, allows the receiver to have ionospheric-free measurements. On the contrary, GAGAN satellite signal provides estimates of the ionospheric errors to single frequency GPS receivers. It is conceivable that IRNSS and GAGAN satellites send corrections to measurements that would benefit the single frequency GPS-GAGAN and GPS-IRNSS receivers.

Do you think that India is ready to use IRNSS as we use GNSS in our daily life?

Today, GPS is used in all walks of life and has become integral part of our day-to-day life. For example, it is extensively used for route guidance, fleet operations, asset tracking etc. It is expected that in the coming days many of these operations will be carried out using IRNSS, in addition to GPS. However, this could happen only when inclusion of IRNSS does not drive the cost of the system substantially. That means someone must come out with IRNSS chipset solution soon, which could bring down the cost to own IRNSS receiver. A mandate from the Government recommending use of IRNSS in critical applications could make IRNSS popular in India.

What are key challenges faced by companies like Accord to develop technologies pertaining to GNSS for India and overseas?

Accord has been developing GNSS receiver solutions for Indian and overseas customers for more than two decades. Accord's receiver solutions are used in space, military aerospace, civilian aircraft, automotive, hand-held, timing and varieties of applications. The major challenges faced by companies like Accord are a) most often the selection of a receiver by the end-user is governed by the cost alone and not by its feature, indigenousness, technical support and after-sale service b) some of the tax structures are not favorable to indigenous product development c) Quantities required in India are small compared to the world market, therefore, it is difficult to make big investment for Indian market only and d) very few educational institutes teach GPS technology and therefore there is always a shortage of trained manpower to work in the development of GNSS receiver,

How do you see the private sector contribution in technology research and role in growth of GNSS technology based market in India?

GNSS technology is of strategic importance to the country and has a big role to play in the economy of the country as well. The investment made by US in GPS enabled a trillion-dollar economy spanning multiple sectors such as Aviation, Automobiles, logistics, Timing, Security and Mobile navigation. While companies like Accord is focusing on research in the core GNSS area, there are several players developing application based on them. Fleet tracking and Asset Tracking are the two critical applications areas which can deeply impact the everyday life of all Indians in the years to come.

What initiatives should be taken by private sector in engaging with educational institutions for improving GNSS technology research?

First we need to create awareness of the huge opportunity offered by Navigation to all the students. The kind of applications one can make using this technology is only limited by one's imagination only. Towards this Private sector companies like us should conduct workshops in colleges and offer products at a discount to the student community. We also need to sponsor good students for higher studies in the area of navigation or provide internship opportunities at our workplace.

What according to you, are the technology and applications trends going to emerge in near future?

Some of the possible technology / application trends that may emerge in the near future are:

- We might increasingly see prevalence of multi constellation GNSS solutions
- Indoor and under water and underground positioning on demand may become a reality which would be available to all
- GNSS in watches with lowest power consumption would become the norm
- Navigation will increasingly become linked to security leading to the formation of new vertical for growth.

BIM is the New GIS

Building Information Modelling presents itself as a new opportunity for the surveying and spatial industry and education

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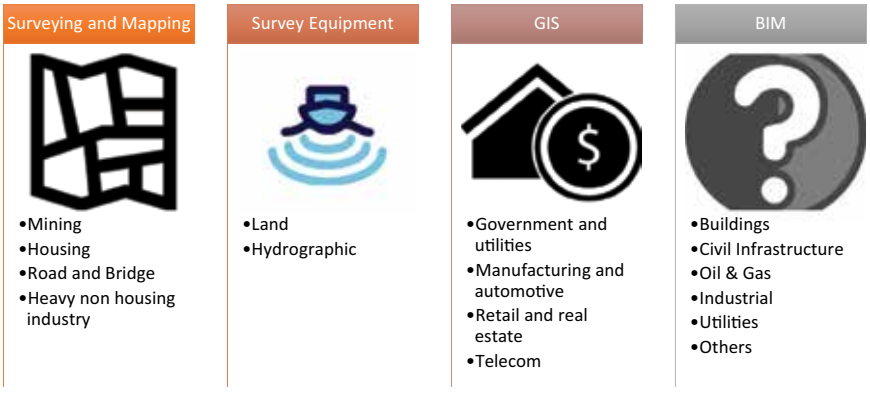
- BIM is the new GIS for the Surveying and Spatial Industry.
- Industry needs to focus more on what it can offer to other industries with BIM rather than only preparing BIM.
- Some action items that we have to take as an industry like revising content and focus of surveying and spatial education.

Data collection will not grow much

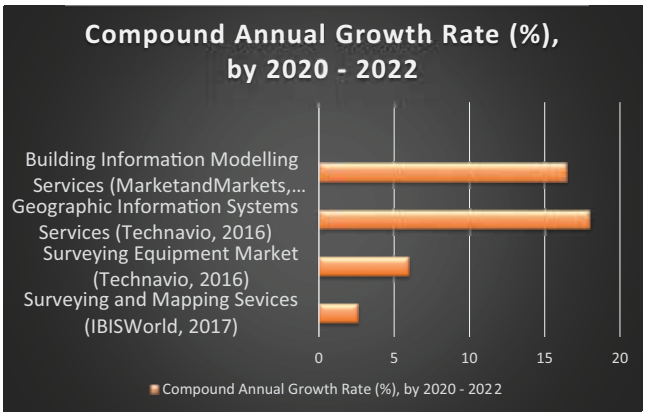
In general, our industry offers surveying and mapping services, survey equipment and GIS services. More recently it also provides BIM services. In the surveying and mapping, our industry offers data collection services, and at a higher level, it provides services related to the interpretation of the data like what degree of accuracy is required to achieve a specific goal, how property rights and restrictions should be designed, so the occupants have the best living experiences. We offer the surveying and mapping service to the mining, housing, infrastructure and heavy industries. Survey equipment is about technologies we use for data collection. There are two classes of data collection equipment, collecting data about land, and collecting data about water bodies, seas, oceans. GIS is about spatial data analytic and is offered to government, automotive, retail and telecom industries. We play a role in GIS, but the information technology sector is also active. The prominent example is Google. AEC offers BIM, and we are a small player regarding the share of the economy in the AEC. BIM services are offered to the building, infrastructure, oil and gas, utility industries. In the surveying and mapping, 40 percent of the service is cadastral surveying driven by land development.

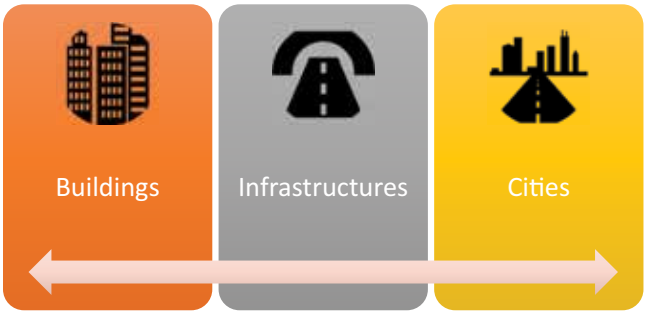


The hydrographic survey equipment sector is significantly larger than the land survey equipment sector and is driven by international trade. The retail and real estate industries account for 30 percent of GIS-driven by the consumer market.

Now, if we look at the growth rate of each of these industries, there is one clear message, and that is spatial data collection will grow very slowly. Land surveying equipment also has been affected by the availability of low-cost devices that can collect spatial data; low-cost drones now are used to update road network, traffic data and even in developing nations where the information gap is for cadastral surveying. The cost of collecting data will be increasing declined. What is fast growing is that what we can do with the data. Using GIS, we can predicate how fires spread, we can model how transport network behaves, etc. BIM will be no different to surveying and mapping if we only focus on the preparing building information. But we go beyond building information; we can discover a continuum of opportunities.

The continuum means that that if we plant the seed correctly, we can harvest it for a long time. A BIM includes spatial information of built environment; our industry is expert in spatial data. BIM is about collaborative and common data environments (CDE); we have expertise in spatial data management through SDI, we have standards for common spatial data environment and BIM data is no different. We have a longstanding expertise in generalising large-scale spatial data to create a small-scale map; the same principle applies to BIM. We can generalise BIM to create city models. One single building brings all these opportunities, creating BIM, creating CDE, maintaining the BIM data and converting it to city models.





BIM is full of opportunities

Nowadays, multi-storey and complex developments often include residential buildings, office buildings, and shopping facilities. Today's developments create mix uses of land and space where a piece of land is turned to a complex with multiple owners and use with various levels of entitlements and liabilities.

Despite these complexities, we still subdivide such buildings very similar to what we do with the broad acre land. One would argue that we have hacked the land subdivision process and have taken the same approach to create stratified ownership. This approach cannot be sustainable for future. In these complex developments, determining whether the ownership of an apartment extends between faces of two walls, the median of the walls or exteriors faces of the walls can be a cognitive challenge for its owner. Ascertaining if owners are individually or collectively responsible for facades, services, shafts or cables can be a cognitive challenge for building operators.

BIM presents itself as an opportunity to be a source data for strata plans or building subdivisions. The way buildings are currently managed can be significantly improved by replacing 2D plans that challenge the cognitive capacity of building managers by BIM models that include the spatial extent of ownership information.

BIM provides the opportunity to bridge the long-standing gaps we have had in our cadastral databases in term of underground utilities. With BIM being able to accommodate essential services associated with an infrastructure, we now have a chance to integrate utility databases and cadastres together.

Site topography is an important part of a BIM. BIM can be used to upgrade our cadastres that have been essentially a flat representation of the real world. Depth limitations in individual title plans can be integrated, so it helps with the major infrastructure projects.

BIM provides opportunities to evolve our GIS technologies that are focused primarily on outdoor environments into technologies that can be used for indoors spatial analysis. For example, BIM, with the help of spatial analytics that our industry is expert in, can be used as a decision support system in emergency situations. For example, we can help transform traditional emergency practices of complex buildings.

Numerous and diverse technologies push cities towards 3D spatial information infrastructures to manage human, natural and physical systems. Spatial industry can benefit from BIM in enabling urban planning workflows using 3D data. BIM can be used as a source data for development approval processes including visualising and processing 3D spatial data when used in urban planning processes.

Surveying and spatial industry and education to take leadership in BIM

Analysing the value chain of the AEC and how BIM adds value to it, we can see there are three benefits in using BIM: increased data integration, information sharing, and complete digital information about buildings. Besides our expertise in collecting building information, we are experts in integrating, sharing and managing spatial information. This is an opportunity to play a bigger role in AEC. To develop business opportunities, we need to highlight and define what we can do through advocating BIM.

There are now numerous guidelines for dealing with BIM in AEC at the international and jurisdictional levels. For example, in Australia NATSPEC a national not-for-profit organisation has developed National BIM Guide which is a reference document that defines roles and responsibilities, collaboration procedures, approved software, modelling requirements, digital deliverables and documentation standards for projects in general.

However, guidelines for using BIM in surveying and spatial industry is missing. Private companies such as Plowman Craven provide BIM specification for the survey of buildings. There are also some initiatives by Open Geospatial Consortium and buildingSmart International that acknowledge GIS and BIM integration issues and work towards addressing them. We need much more comprehensive and widely accepted guidelines yet.

Finally, and perhaps more importantly, we need to rethink the geospatial engineering curriculum and upskilling the profession. There is an urgent need to update our training and education, so BIM is integrated and highlighted. BIM requires further attention in the spatial and surveying education.

Rising expectations -public institutions facing a new reality in a digital era

Public institutions face new expectations every day, as citizens, companies and elected representatives expect them to improve their services and streamline processes by adopting new technologies.

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Public institutions face new expectations every day, as citizens, companies and elected representatives expect them to improve their services and streamline processes by adopting new technologies. While the development of new technologies makes improvements possible, institutions may struggle to keep their innovation level in pace with the speed of rising expectations.

The purpose of this paper is to present two examples of how information and communication technology (ICT) are changing the conditions for public institutions due to growing expectations from citizens. In the long run these expectations, and whether the institutions manage to meet these expectations, should have great significance for both their ability to serve their purpose and in extent, the legitimacy of the institutions basically.

One could argue that new technology changes the relationship and the balance of power between citizens and government fundamentally. ICTs can dramatically improve the possibilities of citizens to influence public institutions, both directly (through e.g. improved transparency and means for action) and indirectly (through the pressure stemming from growing expectations).

The context chosen for the following examples is the land administration and surveying field of Sweden. Nevertheless, several observations made should be relevant also for public institutions in other contexts as well, in Sweden and internationally.

With land administration, I refer to public processes to identify and record the land and the ownership of the same (property). In most countries with a functioning and transparent system of land ownership and well-working real estate markets, public institutions has a significant role both through legal and organizational arrangements. A well-developed land title registry system is essential to a smooth functioning market economy, as it makes it possible to acquire, own and dispose of immovable property. In addition to the security of land ownership, a land title registry also enables property to be mortgaged, allowing for investment and economic growth. By extension, the security held in real property is a pillar of the whole credit system and in extension the modern market economy. The importance of these institutions was shown by Hernando de Soto (2000) in the book *The Mystery of Capital: Why Capitalism Triumphs in the West and fails everywhere else.*

In addition to new ICT giving rise to rising expectations of citizens, organizational theories like New Public Management (NPM) may also have contributed to a view of the citizen-state relationship regarding the citizen as a "customer" and the state as a "supplier" of public services. It is reasonable to assume that technology and ideology may have combined effects on the expectations mentioned. In this paper though, I

intend to focus on effects and policy implications of technological progress.

Background

E-government is a concept that aims to capture and describe how information and communications technology (ICT) change the conditions for how public institutions function. The World Bank has defined e-government as follows:

"E-Government" refers to the use by government agencies of information technologies [...] that have the ability to transform relations with citizens, businesses, and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions. [...]"

Within the broad concept of e-government a variety of sub-categories exist, such as e-democracy, e-service provisioning, e-management and e-governance to name a few. Categories can differ and concepts can be filled with different meanings, all depending on context.

In many contexts, the emphasis in the discussion is the opportunities that ICT provides for public institutions to improve their existing service provision to citizens, or to streamline existing processes. This is of course an important part of e-government, but equally or even more interesting is how technology is fundamentally transforming the public sector and how technology changes the relationship between the citizen and the state. My claim is that new technology allows for rising expectations of citizens, and that these expectations can be a powerful force for change in the role of government.

Reddick (2014) examined what factors determine citizens' choice of communication channels when communicating with public institutions. Digital communication channels (defined as websites and email contacts) are of great importance when the purpose of the contact is primarily devoted to information seeking, while traditional contact channels (phone, personal visits and regular mail) continues to play a major role when the user has a specific issue to deal with. Thus traditional and digital channels complement each other and it is important for an institution to understand the differences in order to deliver a good service and thus respond to citizens' expectations.

The role of social media was not examined by Reddick, but can be expected to be of significant importance for the topic of this paper. We have yet to see how social media will transform public institutions in the long term.

Furthermore, Van Ryzin (2004) attempted to measure how citizens' expectations affect their actual experiences of the quality of public services, by applying an *expectancy disconfirmation theory* developed by Oliver. The model is primarily developed for and used to measure customer satisfaction in the private services sector. It is based on first trying to quantify a customer's initial expectation of a service and then to estimate what impact expectations has on the final experience when the service is delivered. The difference between the expectations and the perceived performance is called a *disconfirmation gap* and can be either positive or negative, which basically means that the experience can either exceed expectations or fail to meet them.

Van Ryzin shows than the initial expectations can have even bigger impact on the final satisfaction level of the user, than the actual perceived performance level of the service provided. Although the conclusion at first can appear somewhat surprising, it is not difficult to recognize that emotional affects such as disappointment, or the feeling of pleasant surprise, can linger long.

The studies mentioned above points at the importance of understanding what effects the use and design of e-services can have. For public institutions in the digital age, it should be of great importance to first convey what you do in a good way, and thus produce the right expectations, and then also to live up to these expectations in an equally good way. An illustration of this challenge follows in the examples below.

Examples

To illustrate how ICT can change the conditions for public institutions due to growing expectations, here are two examples drawn from the land management and surveying field of Sweden. The most important institution in this context is the Lantmäteriet, the Swedish mapping, cadastral and land registration authority, although the issues raised below is essentially the same for the municipal cadastral authorities.

The diary page of property formation procedures

Permanent ownership of land in Sweden complies with the ownership of one or more properties. The boundaries of properties make up a grid that covers the entire surface area of Sweden, that is – a full covering land cadastre. Changes in the division into property units are achieved through a property formation procedure (a förrättning), a process that is regulated in the Real Property Formation Act (FBL) and the Real Property Formation Proclamation (FBK). A property formation procedure must be applied for by a qualified stakeholder, and the procedure is accomplished by a public cadastral authority (a municipal such in major cities, otherwise by Lantmäteriet, the Swedish mapping, cadastral and land registration authority).

FBL stipulates that at least two documents are produced in the property formation procedure. The first document is the protocol (FBL 4 ch. 16 §) where the property formation order amongst others and the motives for these orders are noted. The second document is

the diary page (FBK § 13), where it is noted when the procedure was applied for, what actions are taken, what documents are filed or produced as well as the date for the final orders.

According to the author of this paper, the diary page had for a long time been used sparingly. That is, until a few years ago, generally very few things was noted at all in the diary. At best, the diary page could for some procedures serve as a table of contents to the cadastral dossier, but apart from that the diary page seldom held much information.

An illustration of this is that the diary page up until recently often was omitted in the copy of the dossier, which after the procedure was sent to stakeholders. This was common practice in Lantmäteriet as well as in many municipal cadastral authorities, probably because the officials thought the document was of limited interest for anyone outside the authority.

In 2013 Lantmäteriet launched an e-service called Mina fastighetstjänster, "My real property services". The service gives a property owner access to an overview of their own properties as well as direct insight into ongoing property formation procedures affecting these properties.

The service retrieves information directly from the processing system of the authority and presents this information in an easily understandable way for the user. The diary page has come to have a prominent role as it is presented as a case summary for the user of the service. As the diary page of the service is updated in real time, it gives the property owner the opportunity to "supervise" how processing proceeds.

The importance of this new insight can hardly be overestimated. From the perspective of power between citizens and government, my opinion is that the citizen's influence is strengthened considerably, especially since the "information advantage" of the authority is reduced. In addition to insight, the information also enables the property owner to challenge the authority during the process in a completely new way.

An anecdote from a procedure meeting in 2015 may serve to illustrate the new role of the diary page. The authority had a time before the meeting received a written request from a stakeholder and made a note in the diary page. The note could be interpreted as if the authority found the request reasonable. The final assessment however, is made in the announcement of the formal order. At the meeting the cadastral surveyor (responsible for the process) informed the participants what request had been made and took a rather cautious position towards the request. The cadastral surveyor was then immediately questioned by a participant who said he had looked into *Mina fastighetstjänster* and asked why the official had changed her mind. The surveyor however managed to calm the wrought-up participant, reassuring him that no final position had yet been taken on the issue.

The anecdote illustrates how the diary page, which has been compulsory in the procedure for at least 45 years (since FBL came into effect, before that counterparts of today's diary page existed in the then applicable legislation), has come to have a new importance almost overnight. What was previously regarded as an internal concern of the authority has now become a means of transparency for stakeholders. The balance of power between citizens and government have changed, and as a result new expectations rise, in a mutually and continually reinforcing process.

The phenomenon described above does not necessarily concern only the institution involved, since expectations of citizens can spread into other fields of government as well. A post on the microblog Twitter can serve to illustrate this final argument (posted by AndersRamang, 2015-06-26 17:10, my translation):

The service @lantmateriet provides which give online access to documents / diary is great. When will we see the equivalent of @Domstolsverket (the Swedish courts)?

Property boundaries on the website hitta.se

The example above illustrates how one small component of a public process, a up-hitherto almost unused diary page, with the help of ICT can transform into a vital instrument for the citizen as a key stakeholder.

Example number two has some similarities with the first one when it comes to forming expectations, but in contrast to the former example, this is about a development that has taken place gradually over a very long time. Henman (2010) argue that e-government, even if the concept is novel, describes a phenomenon that is not at all new. Rather, the development of digital technology followed hand in hand with the development of society and the public institutions ever since the invention of computer technology in the 1950s. To go to the beginning of example number two, we need to back even another hundred years, to a time of great land reforms in Sweden.

Before industrialization, when people lived of the earth, the tradition in Sweden was for most landowning families to pass on their holdings in equal parts to each son of the next generation. The properties where usually split in a way so that each heir got their share of every single parcel of land, with the consequence that the properties with time became more and more shattered. With collective farming within the village, that was not necessarily a problem. But with improved larger-scale agricultural techniques, a decreasing mortality and a growing population, this meant that for each generation it became increasingly difficult to feed of a family from an ever shrinking portion of land.

Around the 1700s ideas began to spread in some circles about land reform to increase agricultural productivity. Reforms such as *solskifte* and *storskifte* was carried out in some parts of the country, in order to create more coherent agricultural units. But it was not until the mid-1800s, with a crying need which expressed itself in starvation and migration, and a functioning central government with the means to carry out reforms that the conditions were in place to enter the era of *laga skifte*. This reform came to reshape almost the whole of Sweden, improving

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Surveying techniques underwent a tremendous development during the last century. With global navigation systems it is possible without much effort to measure objects and areas with centimeter precision that previously required weeks of work efforts. This of course led to rising expectations on cadastral authorities to provide efficient public service with high quality.

conditions for agricultural productivity by redistribution of land to create viable property units, while at the same time shattering villages through relocations of farms from the former village centers.

During this period, which lasted roughly from the mid-1800s to the early 1900s, the country was pretty much in detail measured village by village. Land was classed and redistributed and maps of the land was produced with an accuracy that is still impressive. The maps from *laga skifte* is a cultural treasure of rank and are still often the starting point even today when a cadastral surveyor is about to investigate who is the owner of a certain part of land.

An economic map is a map that shows land use and ownership of properties. The first public economic maps in Sweden was made available during the late part of this land reform era, as the information was now available in the necessary quantity and quality.

These maps were pretty much a patchwork of the village maps produced in the land reform procedure *(laga skiftes-kartor)*. These individual pieces, which often had been produced with great accuracy, was tweaked together to fit a scale that did not allow for much details. Especially not when it comes to property borders, since most effort and detail was given to land use, infrastructure and such.

During the late 1900s the national land title registry database was established, using at the time modern database techniques. As new technology was developed the analogue economic maps was digitalized and came to form a part of the registry in the 1990s. As this work was labor intensive and the main purpose of the digital maps was basic guidance, the techniques used to produce them further reduced accuracy in its details. Since then the quality of the map has been gradually improved, as new data is added when property formation procedures are undertaken, but the quality of the information still varies greatly.

This is not necessarily a problem, since according to Swedish land code it is primarily the physical boundary marks on the ground that determines property borders. But if you are unaware of the variations in data quality, the risk of misinterpreting information in the digital maps is obvious when you consider that one millimeter in an analogue map of scale 1:10000 equals 10 meters in reality.

In 2014 the company Hitta.se, which provides a catalogue service of phone numbers and addresses, launched a new online service called *Find your property border.* The service is available on www.hitta.se/kartan and presents property borders collected from the national land registry map against the backdrop of an areal photo (more accurately an orthophoto). As the service is free and does not present any obvious reservations concerning quality, it has become popular among property owners wanting information about their or their neighbors' property boundaries.

Not surprisingly, it is common to see in the maps property boundaries that appear to go for example straight through buildings or in the middle of a street. When the user turns to the source of the data with their concerns, which is the cadastral authority, they usually expect to get a quick and precise answer about the location of the property border. They do not in general expect to hear that the position of the property border in the national land title registry map can differ up to tens of meters compared to reality. When cadastral authorities are to live up to the soaring expectations of citizens in a situation like this, they clearly have the cards stacked against them.

The example shows a development that has taken place over a very long time, where data from the authorities "suddenly" becomes available through digital channels. In this case the data is produced by the cadastral authorities, but the information is bought and provided to citizens by a private company. Expectations of what capacities cadastral authorities hold are formed in a process beyond the control of the authority, in a way which bears some resemblance with the Twitter-post in the previous example.

Discussion

The purpose of this paper was to present some examples of how ICT are changing the conditions for public institutions, as they allow expectations from citizens to rise constantly as a result of technological innovation. Lacking better alternatives, the term e-government has been called the 24 hour government in Swedish, capturing the essence of expectations in a digital era.

e-government is a phenomenon that changes the relationship between the citizen and the state and questions of ITC hold real political implications when the role of public institutions are redefined. Van Ryzin (2004) showed that initial expectations are of great importance when citizens are to assess the quality of public services. Authorities must manage to live up to these expectations in order to be perceived as well-functioning and legitimate.

Digital technology provides citizens with new opportunities to exercise their rights. A sensational example from 2014 was the municipality of Kalmar in Sweden who, after receiving critique from a public citizen ombudsman, had to hire a civil servant whose only job would be to answer a single person who day after day requested large amounts of documents electronically, in accordance with the constitutional right of public transparency. Even though the example is extreme, it resembles my first example above where existing legislation combined with new technological tools can be of great importance for the abilities and opportunities of citizens, in their dealings with government. New means of transparency makes it possible to supervise public processes, and also challenge authorities in new ways.

Within land surveying, technological innovations has always been an integral part of the development. Surveying techniques underwent a tremendous development during the last century. With global navigation systems it is possible without much effort to measure objects and areas with centimeter precision that previously required weeks of work efforts. This of course led to rising expectations on cadastral authorities to provide efficient public service with high quality. My second example shows how new applications using existing data reshapes expectations beyond the control of the original producer of the data. Public institutions must keep up with the development if they do not want to be perceived as outdated or even obsolete.

Parallel to the technical side of land surveying, an interesting question is whether we are facing an equally formidable revolution in other fields of surveying and land administration as digital innovation progress steadily in decision making processes. In this context, it is difficult to ignore the discussion that emerged recently on the automation of jobs and how it is possible for computers to perform more and more tasks that previously required human intervention. Within certain fields of government, such as for example tax and social security, automated decision making is well established.

It is reasonable to believe that digitalization will transform most parts of government and land administration should be no exception. Digital technology brings great opportunities, and both citizens and elected representatives will expect that public institutions make use of them to deliver the best public services possible. For the authorities, it is only to equip themselves to face this challenge.

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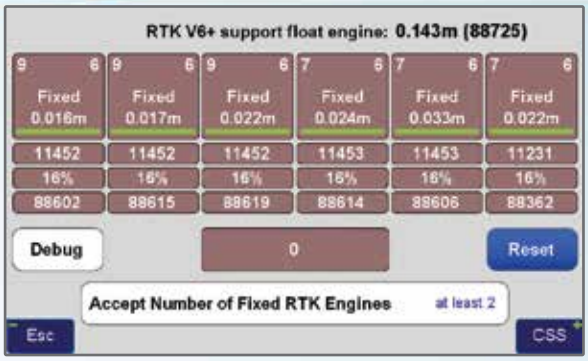
The paper was presented at FIG Working Week 2017, Helsinki, Finland, May 29 – June 2 2017

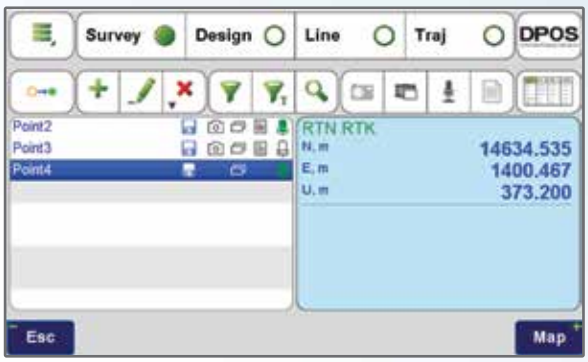
INTERGEO 2017 –"Bringing worlds together"

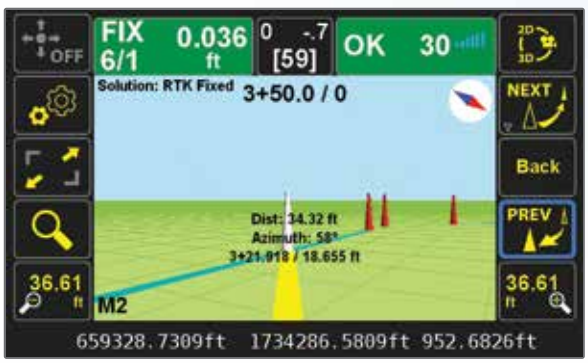
After three incredibly successful days in Berlin, INTERGEO 2017 has drawn to a close. The trade fair and conference have been carried on the crest of the unstoppable wave that is digitalisation. Displaying a truly impressive spirit of innovation, INTERGEO confirmed its position as the world's most important communications and networking forum for geo-IT. "We are going to ride this wave. Stopping it is not an option." That was the declaration made by Prof. Hansjörg Kutterer, President of INTERGEO's host the DVW, when he spoke about the mammoth challenge that digitalisation poses for the entire geo-IT sector. The momentum that is driving digitalisation forward is constantly growing and INTERGEO reflects the current market dynamic, thus sending out a clear signal in this environment. After three days of showcasing products and solutions, disseminating information and promoting lively interaction at the conference and in forums, the event has drawn to a close with top marks. Some 580 exhibitors from 37 countries and more than 1,400 conference delegates can attest to the outstanding success, which has seen INTERGEO reaffirm its position as the leading international trade fair for geodesy, geoinformation and land management. Berlin also provided the bonus it promised as a major capital city – for the first time, the trade fair and conference attracted more than 18,000 visitors from over 100 countries. Innovation brought to life at the trade fair and conference The product and solutions portfolios of the exhibitors at INTERGEO covered the entire process chain from data capture and analysis through to the presentation and visualisation of results. The range on offer from manufacturers and service providers this year stretched further than ever. Just about everything was covered, from products and solutions relating to GNSS surveying, 3D modelling, GIS and Europe's COPERNICUS Earth observation program to the practical presentation of information based on virtual and augmented reality technologies. Ron Bisio, Vice President Geospatial at Trimble, neatly summed up the feelings of many other exhibitors: "That was possibly the most vibrant INTERGEO we have ever exhibited at. It went like a dream for us. We met partners and customers from all other the world." Dr. Jürgen Dold, President of Hexagon Geosystems, was similarly positive: "From my point of view, the event was extremely successful, and not just because we were able to exhibit a whole host of innovations to our customers and friends, but because of all the inspirational discussions we had about digitalisation with other companies and public sector bodies."Digitalisation was also a recurrent theme at the conference and in the trade fair forums, too. Focal points of the wide-ranging programme of presentations and numerous interactive discussion formats included the digital city, Building Information Modelling (BIM), Geospatial 4.0 and Open Government. All change – occupations, BIM and smart citiesThe three days at INTERGEO highlighted the breakneck pace of the digital transformation. Occupations themselves are changing, as the geodesists of yesterday become the geodata managers of tomorrow. There is an ever-increasing demand for "all-rounders" who can bring geodetic expertise, IT know-how and management skills to the table. This varied skill set will be essential for Building Information Modelling (BIM), the digital process applied to the planning, construction and operation of buildings and infrastructure. This particular hot topic played an even bigger role in INTERGEO, particularly because geodata lies at the very heart of this still relatively new method, which is designed to boost efficiency in the construction sector. The digitalisation of entire cities and the creation of digital twins for urban areas are two other areas where geoinformation takes centre stage. In his keynote speech on "Digital Networking – the Basis for the City of the Future", Prof. Manfred Hauswirth, Director of Fraunhofer FOKUS, claimed that geodata is some of the most important data worldwide. At SMART CITY SOLUTIONS, INTERGEO showcased an extended range of solutions for the intelligent city of tomorrow. Representing her young company LocLab Consulting at the "Innovations Made in Germany" joint stand was BIM expert Dr. Ilka May. She spoke about the next stage in innovation, which was in evidence at this year's INTERGEO. "Besides increasingly high-tech data capture solutions, we are witnessing the emergence of interactive solutions that take planning and building to the next level."INTERAERIAL SOLUTIONS – Europe's biggest civil drone showA total of 158 exhibitors, 84 presentations in two forums and more than 30 take-offs and landings in Europe's largest flight zone made interaerial SOLUTIONS at INTERGEO the meeting point for the international UAV sector. The enormous range on show underscored the event's importance as Europe's leading commercial and civil drone show. Presented for the first time this year, the DRONE PIONEER AWARD, which recognises sustainable solutions using drones, went to the ECOSwat project. This project documents climate change to provide conclusive evidence. A special prize sponsored by the Joschka Fischer Company was also presented to the ELEPHANT SURVIVAL ORGANISATION. Winner of the startup sessions was Project Airteam from Berlin, which offers drone services for a range of applications, including infrastructure inspection. Digitalisation – the headline topic is here to stay. And that goes for 2018 in Frankfurt, tooAs DVW President Professor Kutterer pointed out, it is still not possible to say how far digitalisation will take us. However, he stressed the importance of finding the right direction to ensure everyone is prepared for when the Internet of Things (IoT) and artificial intelligence methodologies bring added dimensions of digitalisation to the fore. "The overwhelmingly positive response from visitors to the trade fair and conference shows that we picked the right issues to focus on. We are evidently headed in the right direction,"said Kutterer. *www.intergeo.de*

TRIUMPH-LS and J-Field

Hands free operation







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

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

J-Tip
J-Pod
J-Pack
J-Field
J-Shield

Front

Here is an interesting shot. I wanted to shoot the rebar, on the ground. But, post was in the way. I drove a 16d nail, with it's head cut off, (leatherman did that) and used a plumb bob to get it just right. Then, took the LS off the pole, and there is a small hole in the "handle" which I placed over the headless nail. It sat and shot it, while I did other things.
As you can see, by the tree, and shade, this is not a shot for just any GPS.

Nate

SW Arkansas, USA, Planet Earth

As for the performance, you can't beat it. However, I want to put out a kudos to the support team from Javad. My LS had a hiccup a couple weeks back. John Evers worked tirelessly into the evening trying to fix it. When it came time to send it in for repair, Michael Glutting sent me his personal LS to keep me going for the few days until the rental unit arrived. THANKS. I don't think you would see that kind of service from any vendor any where.

Bob Farley

J-Tip

Integrated Magnetic Locator

$850

No need to carry heavy magnetic locators any more. The J-Tip magnetic sensor replaces the tip on the bottom of your rover rod/monopod. Its advanced magnetic sensor send 100 Hz magnetic values to the TRIUMPH-LS via Bluetooth. TRIUMPH-LS scans the field and plots the 2D, 3D and time view of magnetic characteristics. It also shows the shapes and the centres of the objects under the ground and guides you to it.

PATENTS PENDING

J-Tip advantages:

• J-Tip does not have “null” points around the peak and will not produce false alarms.

• J-Tip is fully automatic for all levels of magnets. There is even no “Gain” button to adjust.

• J-Tip senses the mag values in all directions. You don’t need to orient it differently in different searches.

• J-Tip gives a 2D and 3D view of the field condition when you have RTK and will guide you to the object. You can actually see the shape of buried object.

• J-Tip, In Time View, shows positive and negative mag values of the last 100 seconds and the Min and the Max since Start.

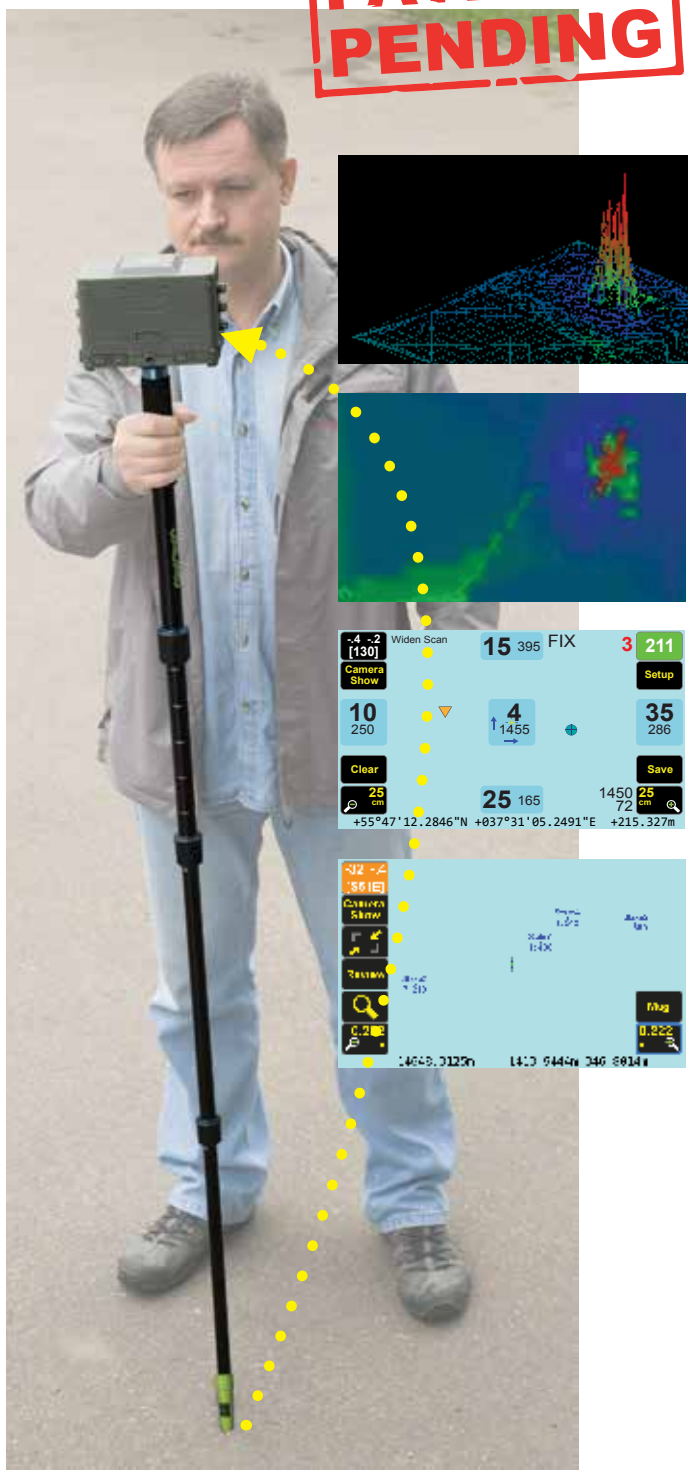
• J-Tip shows the instantaneous magnetic vector in horizontal and vertical directions.

• J-Tip works as a remote control for the TRIUMPH-LS

• J-Tip weighs 120 grams and replaces the standard pole tip. In balance, it weighs almost nothing.

• The built in camera of the TRIUMPH-LS documents the evidence after digging.

• And... you don’t need to carry another bulky device.



J-Pod $850

A rugged Transformer-Pod

J-Pack $290

Convenient survey bag

Javad.....Bravo!!!!

The J-Pack is nicest bag I have ever seen for surveying. I especially like the pocket in the back and all of the places to tie down equipment and stuff.

Adam Plumley, PLS

Landing Pads

J-Pod Inside bag.

Monopod >>> to + Bipod >>> to + Tripod… On demand.

J-Field

Application program of TRIUMPH-LS

Who moved my base?

It is well known that having your own base station near your job site provides you with faster, more accurate, more reliable and less expensive solutions. If you don't know the accurate position of your base, our DPOS service will find it. Read details in the following pages.

After you start your base, If during your survey somehow your base is moved, all your rover points will be inaccurate to the amount of the base movement. But...

...But! Don't Worry, Be Happy:

We will let you know instantly during your survey if your base has moved. We use:

1. Inclinometer which shows the tilt value.
2. Accelerometer which shows motion and shocks.
3. We calculate displacement. This value is accurate to 2 cm.

By the way, a must read book for adult professionals

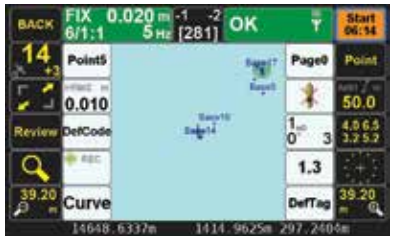
1) Set the displacement threshold here. "Off" means ignore displacement. Our default is 5 cm.

2) Click the "Start Base". it will change to "Stop base."
RTK corrections as well as motion values will be transmitted to the rover.
Maximum values of the motion parameters will be kept at all time.

3) Maximum values of the three sensors can be shown in a white box in the action screen. Top left is the acceleration in milliG, bottom left is tilt and bottom right is displacement in centimeter.

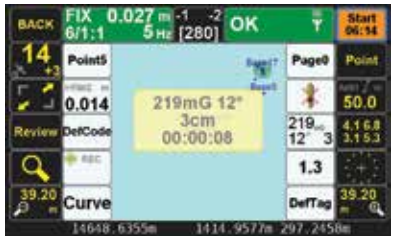
4) If any of the threshold values exceeds, a pop up will alert you and shows the maximum value of the sensors since you started the base. The bottom number is time since the threshold(s) exceeded.

5) To setup for base movement alert, go to base rover setup screen and click on the left side of the screen.



6) You can set up threshold limits for accelerometer, inclinometer (tilt) and displacement values to create alert when these thresholds are exceeded.

7) Set Acceleration limit here. The units are in milliG (mG). G is acceleration in free fall. "Off" means ignore this sensor. Our default is 5 mG

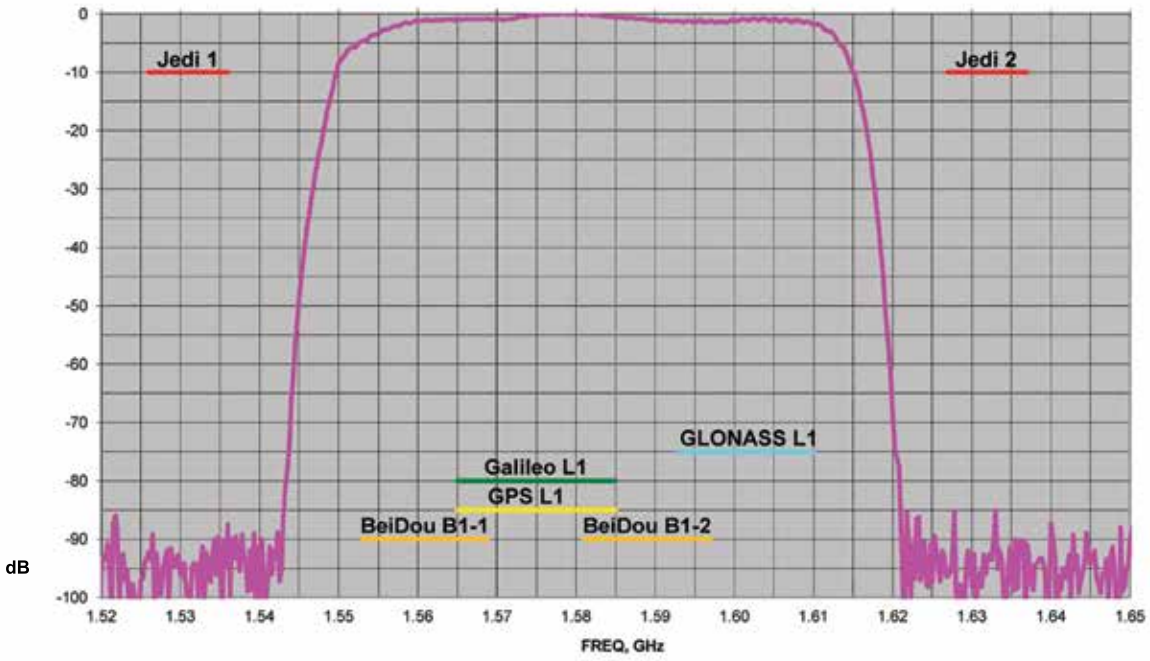


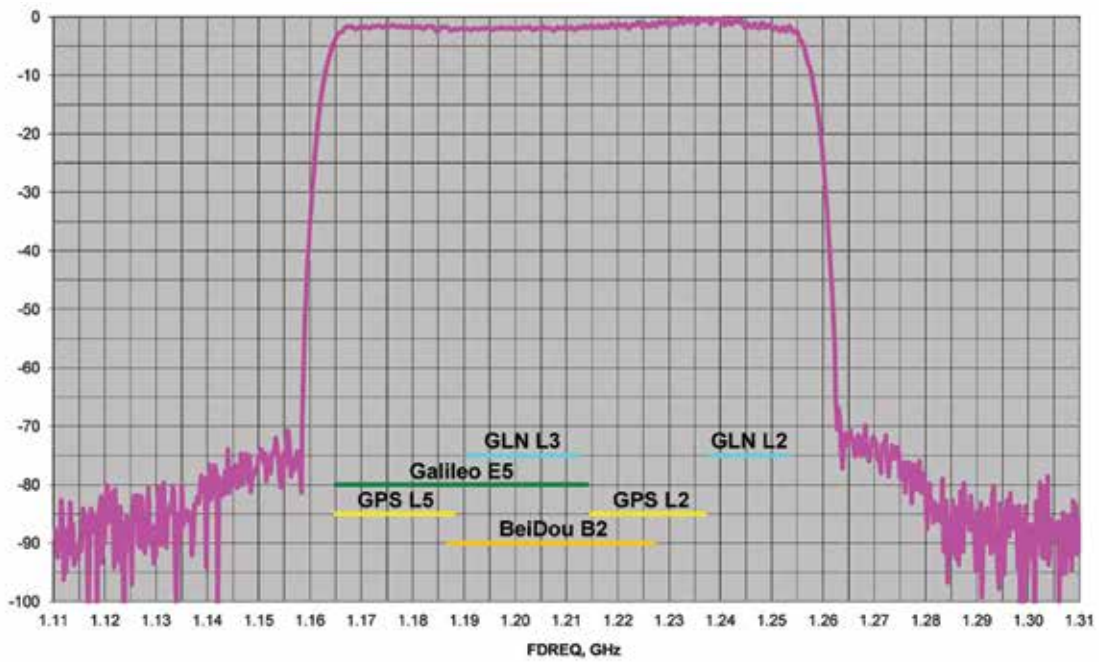
8) Set the tilt threshold here. Units are in degree. "Off" means ignore tilt.
Our default is 5 degrees.

J-Shield

In case the **Jedi** returns

$450





J-Shield of TRIUMPH-LS
protecting all GNSS Bands.

I am on a job now with 143 iron pins found so far. The J-Tip has been awesome for me.

I was out with another local surveyor on this same job last Saturday, and he carried his classic Schoenstedt. There were signals that his detector did not really give a definite reading on, that the J-Tip did. There was also a railroad spike 6 inch deep in the road that the J-Tip missed, and his Schoenstedt did find. When I put the J-Tip over his spot, I only had a 1.8 positive reading, which did drop back to zero when I moved away. When the spike was exposed, the J-Tip reading was 11 while in contact with the spike.

I am also getting good at judging depths before we dig in the road. I am usually within an inch.

John Evers

I needed it, the LS and the J-tip found it. Another game changer from Javad.

David M. Simolo

TRIUMPH-1M

$8,990

864 channel chip, equipped with the internal 4G/ LTE/3G card, easy accessible microSD and microSIM cards, includes “Lift & Tilt” technology.

TRIUMPH-2

L1 $1,990

L1/L2 $3,490

with RTK $4,990

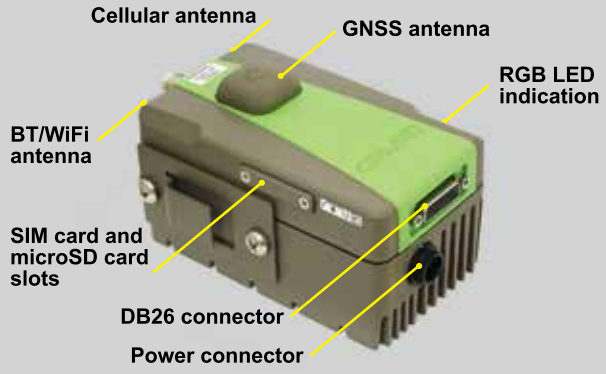
Total 216 channels: all-in-view (GPS L1/L2, GLONASS L1/L2, SBAS L1) integrated receiver.

The one and the only Digital Radio Transceiver in the world!

Unique adaptive digital signal processing, which has benefits: the full UHF frequency range and all channel bandwidths worldwide • the best sensitivity, dynamic range, and the highest radio link data throughput • embedded interference scanner and analyzer • compatibility with another protocols. Cable free Bluetooth connectivity with GNSS receivers and Internet RTN/VRS access via embedded LAN, Wi-Fi, and 3.5G

*Power, data cables and antenna are included.

And all this with competitive prices!



JLINK LTE*

$1,499

Connects all types of devices via UHF, WiFi, Bluetooth, and 4G/LTE for reliable IP communication in the field.

HPT401BT*

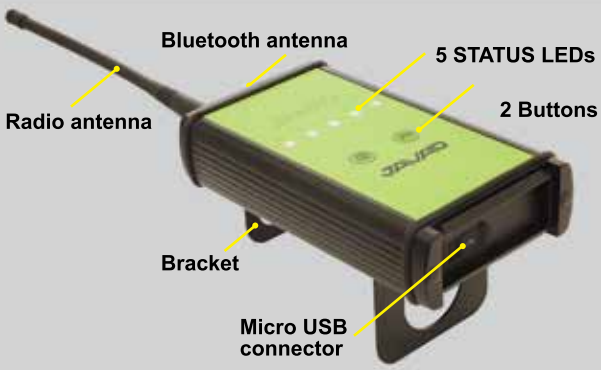
$2,010

1 W UHF transceiver with internal battery. Suitable for TRIUMPH-2 Base or as repeater.

HPT435BT*

High power (up to 35 W) UHF transceiver. Suitable for TRIUMPH-1M/ TRIUMPH2 Base or as repeater.

$2,710



JRADIO*

$1,190

Tri-band UHF receiver with Bluetooth, USB, and internal battery. Suitable for TRIUMPH-2 Rover.

3D deformation analysis using GNSS data

A case study of Penggaron bridge of Semarang-Ungaran toll road section. The results of this study show that there are deformation on eight Penggaron Bridge observation points. The strain has the same pattern with horizontal and vertical movement patterns of the observation points

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Penggaron bridge is located in Semarang-Ungaran toll road, 20th kilometer in Susukan region, East Ungaran, Semarang. According to PT. Transmarga Central Java, The bridge is relatively new and actively used since 2010, but the bridge is visually deformed as indicated by small cracks in some pillars of the bridge.

Trisnawati (2015) states that the influences from nature are suspected to be the main effect of movements and cracks that occured on the bridge. Some pillars are planted in unstable ground that allow the pillars continuously deformed to the maximum limit of the bridge's strength, that will reduce the estimated age of the bridge. During the year of 2013 to 2016, there are some studies about deformation that is occurred in Penggaron Bridge. The results showed that there was a movement in the monitoring points installed around the Penggaron Bridge. Deformation occurs in Penggaron Bridge almost has the same trend movement, according to Utomo (2013). This theory is also supported by Waluyo's research (2016). He states that the direction of deformation occurs in Penggaron Bridge has a trend movement toward southwest at all points of observation.

The movement analysis and strain model occured at the observation points around the bridge makes it easier in a bid to cope with the risk of a disaster that happen on the Penggaron Bridge. Geometric analysis method using Modified Least Square (MLS) at the observation point is expected to identify the movement in the observed area. The using of Finite Element (FE) analysis is expected to get the strain values and its model that occur at Penggaron Bridge. Nine stations of ina-CORS BIG observation around the research location are used as a benchmark by considering the network precision.

Research methodology

This research using observational data observation of GNSS deformation monitoring points in Penggaron Bridge in epoch 2015 to 2016. This data consists of the observation data in July 2015, August 2015, September 2015, April 2016, and May 2016. Data observation of nine Ina-CORS BIG around Central

Point	Velocity			Standard Deviation (cm/year)		Direction
	V_N (cm/year)	V_E (cm/year)	V_R (cm/year)	σV_N (cm/year)	σV_E (cm/year)	
CP01	-0,182	0,998	1,014	1,294	2,044	100°20'6,72"
CP02	0,278	1,175	1.207	0,527	0,672	76°41'19,8"
PGR1	-0,052	0,179	0,186	0,906	1,222	106°11'55,3"
PGR2	-0,024	0,375	0,375	0,501	0,631	93°39'42,9"
TP01	-1,047	2,388	2,607	0,643	0,850	113°40'28,9"
TP02	-1,281	1,473	1,952	0,873	1,251	131°00'43,2"
TP03	-2,040	2,571	3,282	0,542	0,735	128°25'50,8"
TP04	-3,406	5,150	6,174	0,656	0,863	123°28'44,4"

Table 1. Horizontal Velocity

Point	Velocity of Vertical Movement (U) (cm/year)	Standard Deviation (cm/year)
CP01	-7,141	8,589
CP02	0,065	1,495
PGR1	-0,472	5,296
PGR2	-0,272	2,379
TP01	-7,323	3,568
TP02	-7,340	2,259
TP03	-8,932	2,832
TP04	-13,202	3,834

Table 2. Vertical Velocity

Java and Yogyakarta, and 12 IGS station, precise ephemeris, broadcast ephemeris, h-files global, ionosphere correction, meteorology correction according to doy GNSS observations of the Bridge.

GNSS Data Quality Checks

The quality data of RINEX GNSS checked by TEQC. In conducting the qualification to the data, there are some data quality parameters, namely 1) Moving average MP1 and moving average MP2 less than 0.5 m. 2) The value of IOD slips less than 100. 3) The values IOD or MP slips less than 100. 4) The Data which were removed from the overall data amount is relatively small (Lestari, 2006).

Data Processing Using GAMIT/GLOBK

The observation data processing with GAMIT/GLOBK. The results of GAMIT processing are then evaluated by the value postfit nrms and fract. The results of GAMIT match the requirements, if the processing fract value <10 and postfit nrms value <0.25. The computation of velocity vector movement using GLOBK is performed in the entire observation times of the bridge deformation. The calculation is done automatically by inserting the script of velocity computation. After this processing, and then it should be done for plotting velocity vector movement.

Deformation Computation and Analysis

Computation and analysis are done in some observation scenarios. The analysis of the computation is done with congruency and observation point movement test. The coordinates data and its standard deviation that are used in this analysis, are the observation point coordinates and its standard deviation in the toposentric coordinates system which is from the GAMIT/ GLOBK data processing result.

Determine and Test of 3D Strain Parameters

The strain parameters test were determined by Matlab software. The determination of strain parameter are used the coordinates of the observation point between 2015 and 2016 from GLOBK result. The obtained strain parameter is then calculated for its extension and compression values, as well as the angle of the strain for the visualization in the area of my research.

Results and analysis

The results of deformation geometric analysis

The test results demonstrate the value of the network congruency test is the whole scenario calculation is more than 1,962. it means the value of the network congruency test is rejected. It shows that the observation network is change and not congruent in the first and second epoch on the entire processing scenario. The test results show that the value of the movement point test all the observation points is more than 1,740. It means the value of the movement point test rejected This result indicates that all the point have displacement in all coordinates components.

The Results of Velocity Computation

Table 1. shows the horizontal movement velocity and its standard deviation of the observation point

Based on Table 1, N component (VN) has velocity values ranging from -0,024 to 3,406 cm/year. All of the observation points have movement horizontally toward the southeast. Figure 1 shows the results of plotting the horizontal velocity movement of the observation point on Penggaron Bridge.

Figure 1 shows that all of the observation points have movement horizontally toward the southeast. In addition, the horizontal displacement processing with GLOBK is also produces vertical movement. Table 2 shows the value of vertical movement and its standard deviation.

Based on Table.2. it shows that, the vertical movement velocity of the observation point have a range 0,065 cm/year to -13,202 cm/year.

Figure 2 shows the visualisation that the bridge observation points have a vertical movement tend to go down to the surface.

The results from velocity plotting the movement observation points have the same trend towards the movement of the CORS BIG Semarang station.

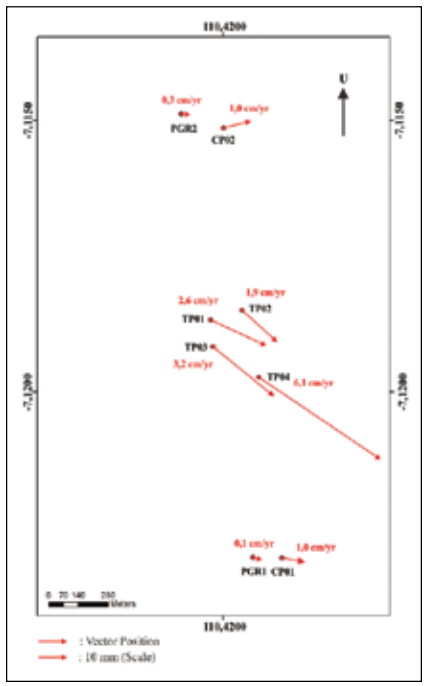

Figure 1. Plotting of velocity and direction of the horizontal deformation using GMT software

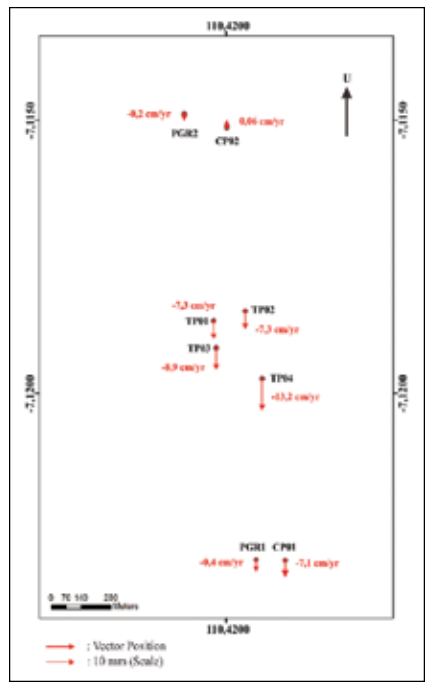

Figure 2. Plotting of velocity and direction of the vertical deformation using GMT software

Figure 1 shows the direction movement of the bridge observation point and the movement of CORS station.

Based on Figure 3, it shows the eight observation points of Penggaron Bridge have the same relative direction, compare to the movement of CORS CSEM station. It is because of the Penggaron Bridge location has a geological conditions similar to CORS CSEM station. Geological conditions which is vulnerable to the ground motion is a condition that potentially be the demage of Semarang's toll Solo part Semarang-Ungaran km 5+600 to km 8+500 (Trisnawati, 2015)

The Results of Strain Parameter Test

The objectives of this scenarios are to get the value of the strain that are occured from the beginning to the end of the observation. The calculation of this test is done by forming network scenarios to determine the value of strain that occurs at each observations. In this research, the scenarios for strain computation are divided into six network observations. Figure 4 shows the visualization of the results normal strain.

Based on Figure 4, the computation results show the normal and shear strain value with the range from 10^{-3} fraction to 10^{-5}, with a value of translation between 0,014 m to 0,084, and with the value of rotation between $4{,}69 \times 10^{-5}$ to $3{,}38 \times 10^{-3}$ rad. The computation of extension and compression of six scenarios network, have rotation that are ranged from 10^{-3} to 10^{-5} toward the northeast and southeast. While Figure 5 shows the visualization of extension and compression of the six observations network.

Based on the Figure 5 above, it shows that all tests are accepted in all network. It means, the results of similarity test are accepted on the entire networks. While the results of congruency test is in the other way around. It shows that the tests are rejected in all network.

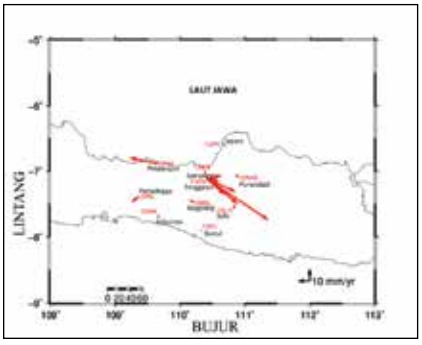

Figure 3. Velocity and Direction movement of Observation Points

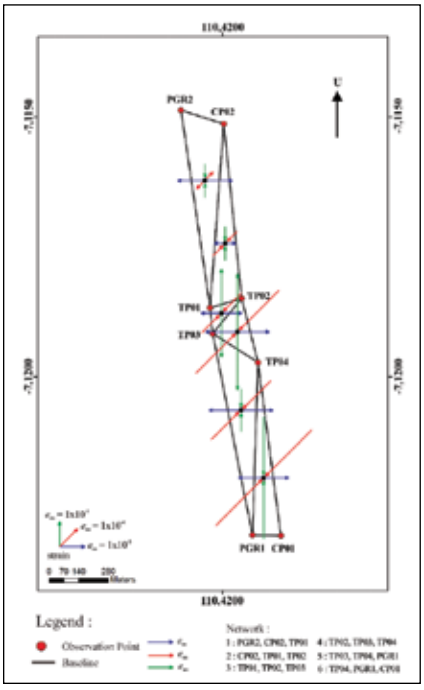

Figure 4. The 3D visualization of normal strain

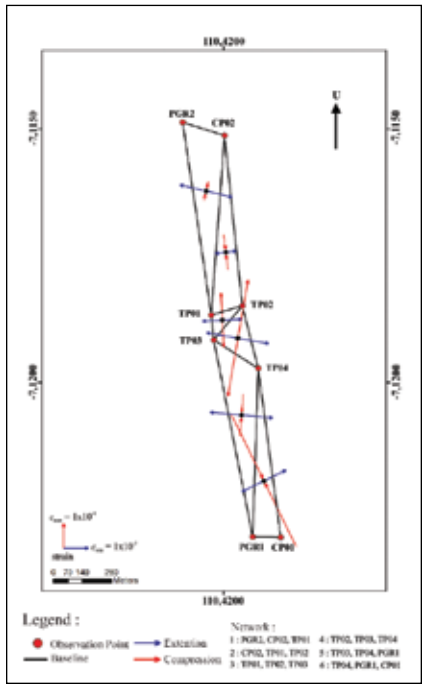

Figure 5. Visualization of extension and compression

Acknowledgements

This research was supported/partially supported by PT. Geotronix Pratama Indonesia. T. Aris Sunantyo, Nurrohmat Widjajanti who provided insight and expertise that greatly assisted the research.

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Evaluation of landslide hazard of Kohima, India

The present study is an attempt to generate a landslide hazard zonation map of Kohima through quantitative method in GIS environment. Kohima, the capital of Nagaland is located the Inner Fold Belt which is geologically unstable

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Landslide comprises almost all the varieties of mass movements on slopes, rock falls, topples and debris flow that involve little or no sliding (Varnes and IAEG, 1984). Landslides are considered as a major natural geologic hazard occurring throughout the World. Landslide triggers instability to the land which disrupts the water pipe lines, road linkages, buildings as well as loss of human lives. Landslides are inevitable and quite common in tectonically active mountain chain where they annually recur during monsoonal events (Aier et al., 2012). Landslides are also increasing due to development activities because of increasing population, urbanisation, and infrastructural development. Identification and zonation of areas prone to landslide has therefore, become crucial to prevent and safeguard physical properties and human lives. Zonation of the land applies to division of the land surface into areas and the ranking of these areas according to degree of actual or potential hazard from landslides or other mass movements on slopes (Varnes and IAEG, 1984).

Identification of area susceptible to landslide is crucial since urbanisation is increasing with time. The spatial information related to the causative factor for landslide can be derived from remote sensing and geographical information system (GIS) techniques. GIS a powerful tool for integrating different data type has made some significant development especially in spatial data analysis (Rawat et al., 2015). High resolution satellite images (Quick Bird 2 and World View 2) have been used to delineate the areas affected by landslide and has been processed in

Classification Method	Class	Area (Pixel)	Landslide area (Pixel)	R Index (%)
Equal Interval	Low	12368	15	0.65
	Moderate	74741	459	3.31
	High	39352	852	11.66
	Very High	12274	1924	84.39
Quantile	Low	33230	146	4.62
	Moderate	36184	188	5.47
	High	35357	338	10.06
	Very High	33964	2578	79.85
Geometrical Interval	Low	44083	178	2.79
	Moderate	43026	296	4.76
	High	32473	530	11.29
	Very High	19153	2246	81.15
Natural Break	Low	36581	150	2.67
	Moderate	43637	269	4.01
	High	41630	686	10.72
	Very High	16887	2145	82.61

Table 1: Comparison of the information obtained from landslide hazard map crossed with landslide distribution.

GIS environment to bring out the hazard map. Landslide hazard map divides the landslide prone hilly terrain into different zones according to the relative degree of susceptibility to landslide (Marrapu and Jakka, 2014). LHZ provides information on the susceptibility of the terrain to slope failures and can be used for the estimation of the loss of soil due to slope failures, new construction sites and road alignment, for prevention, evacuation and mitigation processes (Talib and Napiah, 2000). LHZ techniques are classed into direct and indirect methods. Direct method involves the geomorphologist experience and terrain condition knowledge which directly determines the landslide susceptibility. In indirect method, statistical models or deterministic models are used to predict landslide prone areas based on information obtained from interrelationship between landslide conditioning factors and landslide distribution (Van Westen et al., 2003). Kohima, the capital of Nagaland located in the North-eastern part of India is situated in a tectonically active zone. The region comprises the intermediate hills of the Inner fold belt lying north of the Kohima Synclinorium and east of the belt of Schuppen and Patkai Synclinorium (Aier et al., 2012). Geologically unstable along with torrential rainfall in monsoon season has a huge impact on the distribution of landslides in Nagaland particularly, Kohima.

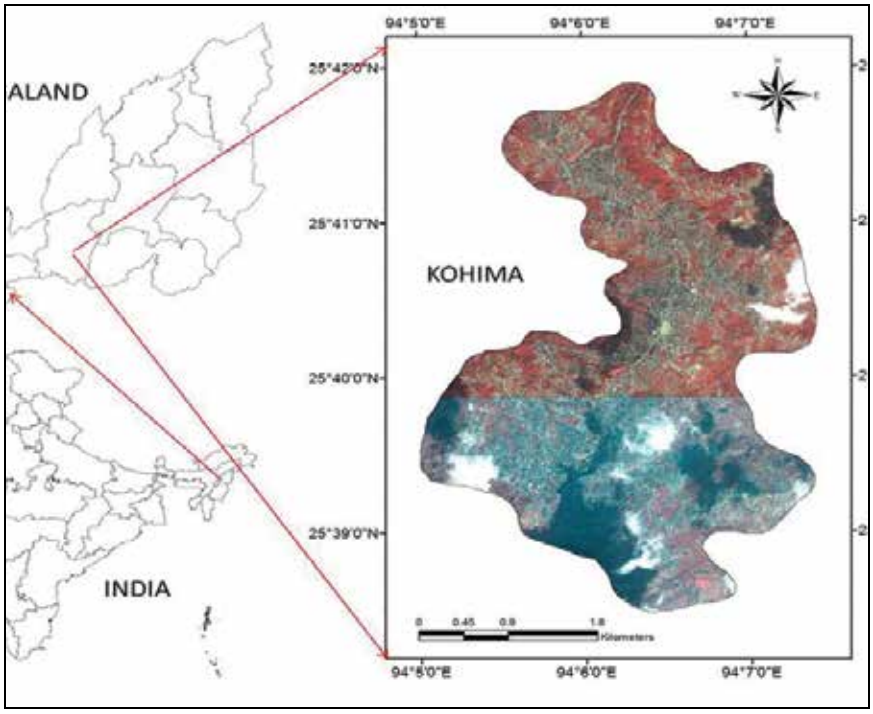

Figure 1: Location map of the study area though Quick Bird 2 image in FCC.

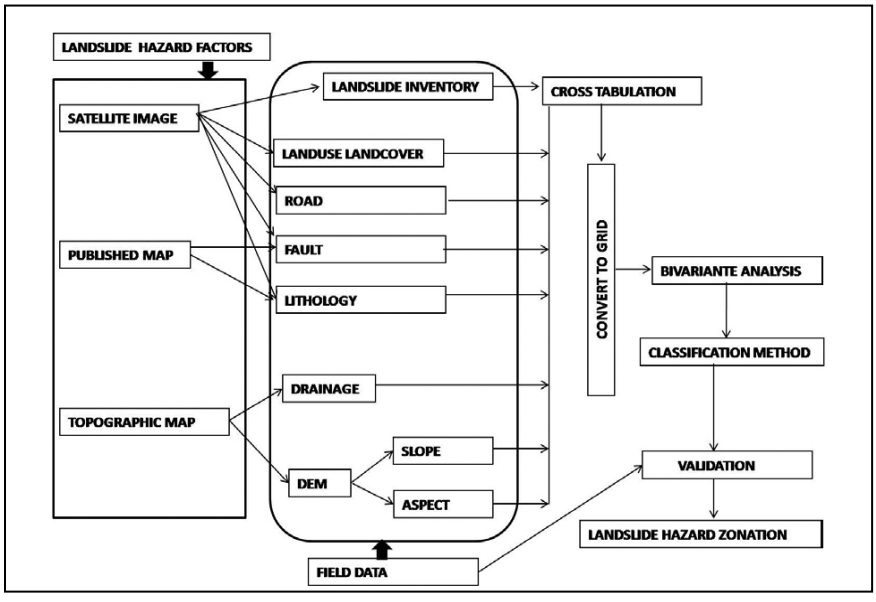

Figure 2: Methodology used for deciphering the Landslide hazard zonation map.

Study Area

The study area- Kohima, capital of Nagaland is situated on the Inner Fold Belt characterised by Disang and Barail group of rocks, north of the Kohima Synclinorium (Srivastava and Pandey, 2011). The geographical extent of the study area lies between 94˚05'04'' E and 94˚07'23''E latitudes and 25˚38'28''N and 25˚39'24''N longitudes respectively covering an area of 14.03 km^2 (Figure1). The study area consists of 19 town wards and the peripheral areas of the ward.

Kohima is located at an elevation between 800 to 1500 m above mean sea level. Annual temperature is moderate ranging from 5˚C in winter to 30˚C in the summer. In 2015, Kohima experiences annual rainfall about 1521.3 mm with 149 numbers of rainy days, precipitation is maximum in the month of June to August where maximum rainfall was observed in august with monthly rainfall of 374.1 mm.in 2015. Tectonically, it is unstable as it forms part of the Eastern Himalayas and also it lies in the seismic zone V which is liable to seismic intensity IX (Khatsu and Van Westen, 2004).

The process of urbanisation is progressing rapidly where population has increased from 77,030 in 2001 to 99,039 in 2011 according to Census report 2011. The population density of the study area is 7059 persons per km^2 displaying a high density populated area (Figure 5(a)). The geographical growth of Kohima is increasing vertically as well as horizontally. The limitation

of available land for constructing buildings has compelled the citizens to expand vertically despite the fact that it is geologically unstable.

Database and methodology

The main objective was to generate a landslide hazard zonation map. Thematic layers was generated from high resolution images for landuse landcover, road, landslide and also for fault and lithology, topographical maps was used for generating drainage layer and DEM to create aspect and slope maps, published maps were consulted for fault mapping and lithology mapping. The method chosen for delineating the landslide hazard zonation was based on statistical analysis viz- Information value method (IVM). The steps followed in the methodology are shown (Figure 2). The various thematic layers was generated in GIS based platform and crossed with landslide layer to generate cross tabulated weighted layers. The crossed layers were combined and classified by various classification methods. The classified methods used were natural break, quantile, equal interval and geometrical interval. The classified maps were crossed examined and validated using relative landslide density (R). The best classified method was considered for generating the landslide hazard map.

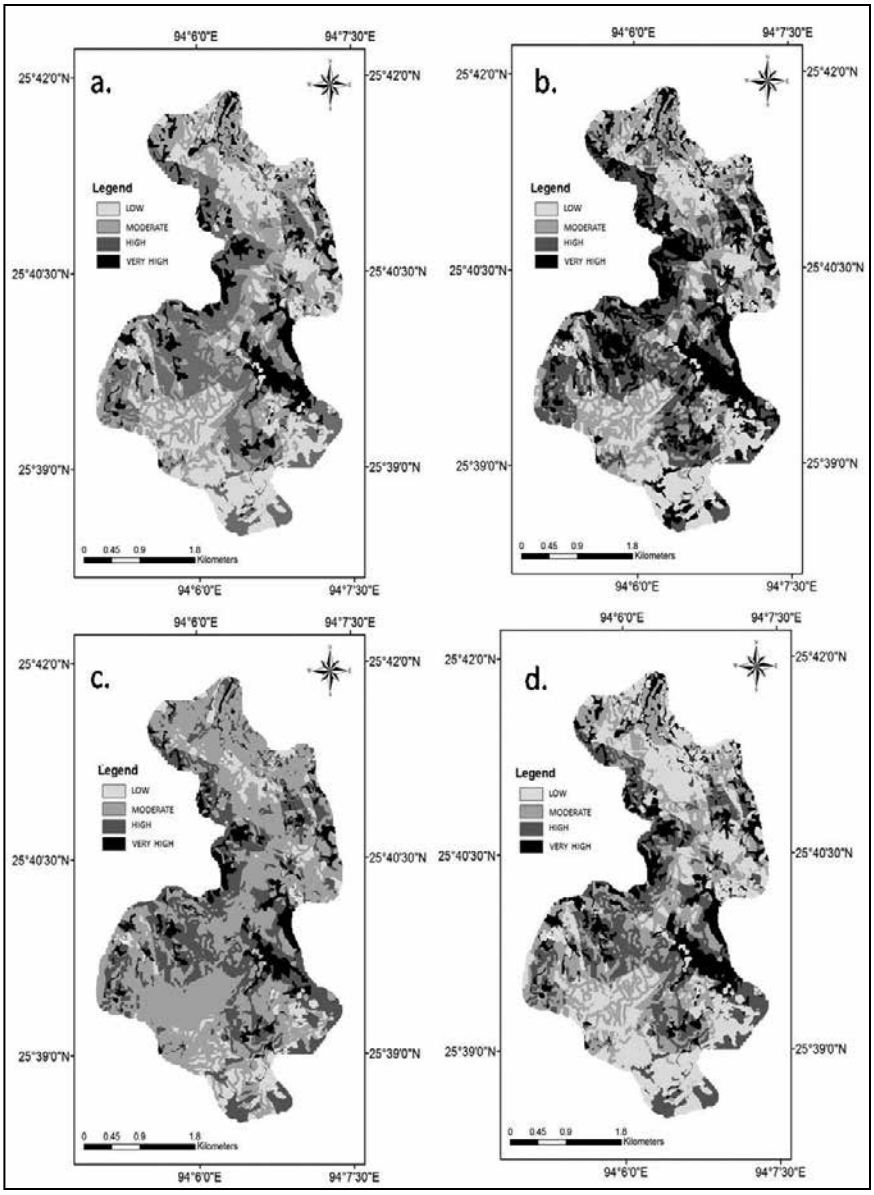

Figure 3: Landslide hazard zonation map based on the four classification method; a). Natural break; b). Quantile; c). Equal Interval; d). Geometrical Interval.

Bivariate statistical analysis

Data driven approach (statistical approach) has gain much popularity in the recent years because of its better subjectivity and more reproducible results. Statistical analysis is divided into two groups- bivariante and multi-variante statistical analysis respectively (Pardeshi et al., 2013). The main concept of bivariante is to determine the relationship between spatial landslide distribution and landslide controlling factors (Guzetti et al., 1999). Information value method is an important bivariante statistical method used in LHZ mapping. Potentiality of landslide hazard is based on the various causative factors and the relationship between them which triggers the slope instability (Sarkar et al., 2013). One of the simple and effective data driven statistical analysis for landslide study is IVM.

Information value method

IVM developed by Yin and Yan (1998) is used to calculate the weight for each class of factor layer by ratioing-landslide density of each class to the landslide density of the total area. Equation of IVM is as follows;

$$IVM = ln\frac{Npix(si)/Npix(Ni)}{\Sigma Npix(s)/\Sigma Npix(N)} \quad \ldots (1)$$

Where,

Si = number of pixels with landslide in the class,

Ni = number of pixel in each class,

S= number of landslide pixels and

N = total number of pixels.

Relative landslide density (R)

R index is an indication for goodness of fit and is derived from the ratio of percentage of total landslide area in

each class to total area in the class, expressed as shown in equation 2;

$$R = \left[\frac{ni/Ni}{\sum(ni/Ni)}\right] \times 100 \quad \ldots (2)$$

Where,

ni = number of landslide in class i,

Ni= total area occupied in class i.

R index calculated from the study area is shown in Table 1. The index shows an increase in the number of landslides with each landslide classes as it progresses in all the classification methods. Equal interval has the highest index with 84.39% in very high class and the lowest index with 0.65% in low class. Quantile has the highest index in very high class with 79.85% and low class with 4.62%. Geometrical interval has very high class with an index of 81.15% and in low class with an index of 2.79%. Natural break has an index of 82.61% in very high class and in low class an index of 2.67% was obtained.

Result and discussions

The hazard map generated from IVM was divided into various class based on mathematical method for data classification method based on GIS platform. The landslide map derived from IVM crossed with landslide distribution using different classification methods to generate their respective R index is shown in Table 1. The results of the four classification methods (natural break, equal interval, quantile and geometrical interval methods) used for deciphering landslide information is shown in Figure 3.

Figure 4 shows the percentage statistics of area in each class derived from the classification method. Equal interval has high value (59.2%) for very high susceptibility class but very low value for low susceptible class (0.46%) in landslide area which is not proportional, hence, it cannot be considered for LHZ. Quantile has high value (79.32%) in very high landslide class but the values are similar in proportion in total area, hence, it cannot be considered. Geometrical interval has high slide value (69.11%) in very high susceptible class and low value (5.48) in low susceptible class. The slide area in high and very high landslide classes in the geometrical interval is 85.42%. The value of R index in Geometrical interval increases as the landslide susceptibility class increases. Natural break has high value 66%) in very high landslide susceptible class and low value (4.62%) in low susceptible class.

The slide area in high and very high classes in Natural break is 87.11%. The value of R index also increases as the landslide susceptibility class increase. Highest R index is shown by equal interval (84.39%). However, for considering classification methods, since the classification is based on landslide distribution, landslide information is more important. Both geometrical interval and natural interval are in proportion with the landslide susceptibility distribution. Natural break, however, has more R Index value (82.61%) in very high landslide susceptible class and higher value in high and very high classes in slide percentage area as compared to geometrical interval. It is therefore, considered for generating the landslide hazard zonation (Figure 6).

After cross validation of the classification methods with R index, the final landslide hazard map was prepared and categorized into low, moderate, high and very high hazard zones (Figure 6). The zone categorized into very high zone is highly unstable because of steep topography, where landslide is frequent during the monsoon season. The zone also occurs near tectonically weak zone and fault areas which cause landslide annually (Figure 5 (c) and 5 (d)). The zone is prevalent in the central western and central eastern part of the study area. It constitutes about an area of 1.68 km^2 forming 12% of the study area. High hazard zone is observed around the periphery of very high hazard zone. This zones are characterised by steep slopes

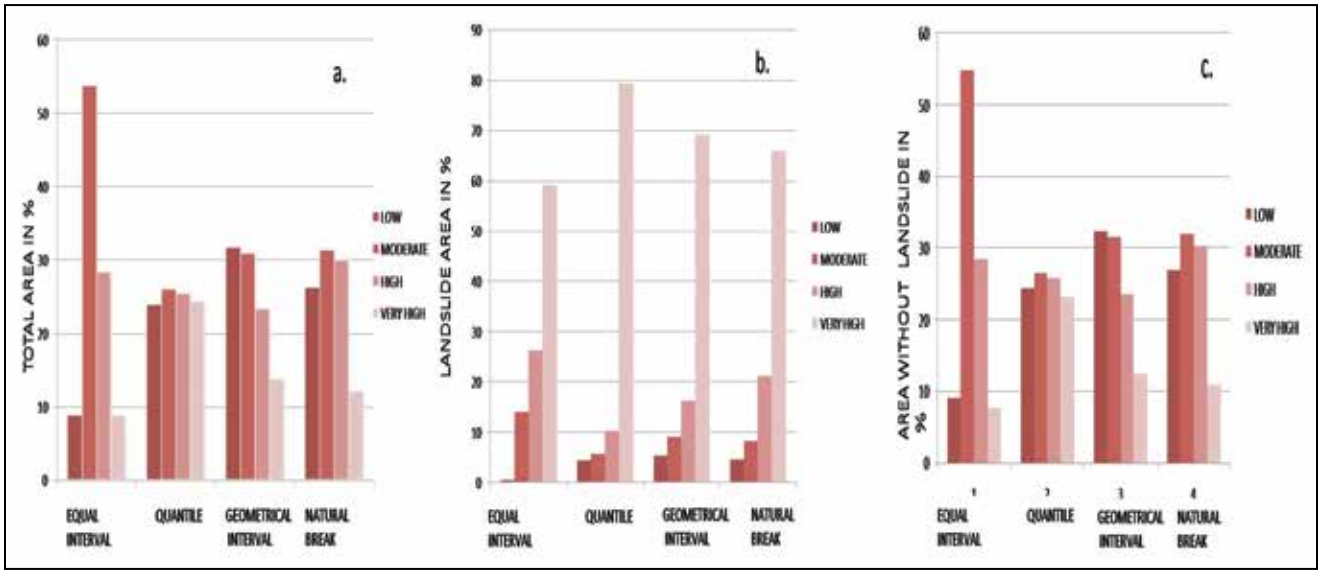

Figure 4: Percentage of area for each class derived by classification method; a). Total area. b). Landslide area. c). Without landslide.

Figure 5: a). Portion of the study area– note the closely constructed heavy concrete construction on unstable slope. b). Affected buildings in Ward no.1 of the study area. c). Landslide with an approximate length of 150 m in Ward no. 6. d). Landslide at Asian Highway (AH) 1 in Ward no. 18.

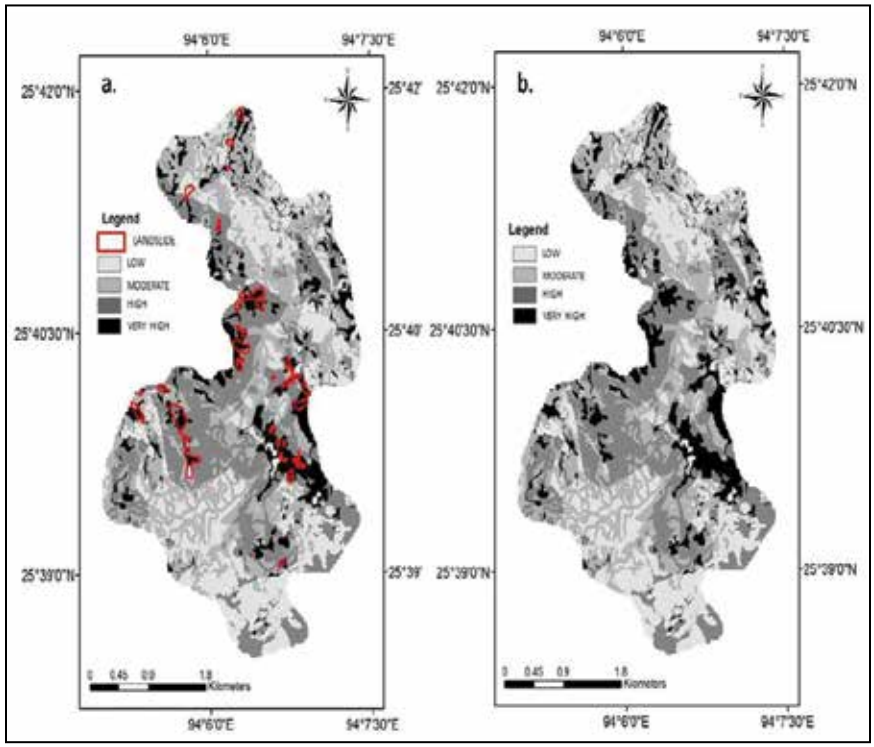

Figure 6: Landslide Hazard Zonation map (LHZ) of Kohima town ranging from very high hazard zone to low hazard zone, shows landslides overlaid on the LHZ map; b) shows the LHZ of the study area.

which when disturbed can be susceptible to landslide. This zone occupies 30% constituting 4.21 km^2 of the study area. Precaution if not taken to check house construction, construction of retention walls can trigger landslide after heavy rainfall in high hazard zone. Moderate hazard zone is observed in the vegetated area and areas away from the drainage. The zone constitutes 32% with an area of 4.49 km^2 in the study area. Low hazard zone is observed in areas where the slope is gentle observed in northern part of the study area or in well vegetated area observed towards the southern part of the study area which is located near the Reserve forest in Kohima. The low hazard zone forms 26% which is about 3.65 km^2 of the study area.

Slow creeping movement is observed in Ward 1 of the study area (Figure 5(b)). This particular area falls under Disang shales which is geologically a weak formation. The soil gets easily absorbed by rainfall causing more subsidence and creeping movement. The weak geological structural settings, heavy rainfall along with vehicular movement has caused landslide in Ward 18 (Figure 5(d)). This particular stretch of road is constantly paralysed owing to landslide almost every year. The area falls under very high hazard zone where the landslide is caused mainly due to geological structural failure as fault line passes though this area (Aier et al., 2011). The unfavourable geological settings coupled with heavy rainfall caused landslide in the study area. One of such landslide is shown in figure 5(c) which is in an army cantonment near the helipad. The steep slope along with little vegetation cover has exposed the land to slides and erosion.

Conclusion

The geologic formation in the study area is very weak been made up of crumpled and weathered shale's (composed of Disang shales). Barail sandstone formation passes through a thin stretch of the study area towards the south western part of the study area which falls under low hazard zone. The occurrence of landslide

is further triggered with anthropogenic activities particularly by building constructions which are built without any regulations. The scarcity of land has pressured the citizens to vertically expand their construction, further aggravating the danger of a catastrophic event in case of a seismic activity.

Landslides are diverse and their type varies from region to region with certain specific conditions. Hence, determination of landslide hazard zone is difficult depending on various attribute parameters as well as the type of model used. In this study, the statistical model used was Information value method for demarcating the landslide hazard zone. The application of high resolution image has increased the efficiency of the study. The generation of the thematic data's using high resolution data has improved in better delineating the features. The use of various classification method and R index technique has improved the output by removing the insignificant variants.

The technique used in the study will however vary since the conditions will differ. The landslide hazard map was into four zone- low, moderate, high and very high landslide hazard zones respectively. The very high hazard zones was located mainly in the weak geologically settings. These zones should be avoided as they are unsuitable due to weak geologically unstable area and slope failure occurs in these places once it is triggered by rainfall. Anthropogenic activities should therefore be discouraged in this zone. Various scheme like afforestation and construction of retaining wall should be undertaken to minimise the slope failures. Since, the area being on very high hazard zone mismanagement will not only disrupt but also affect the other safer zone since the study area falls under high tectonic active area.

The use of R index and field evidence validates the hazard zonation map and makes the map correlate with the actual ground condition. The landslide hazard zonation map will help the planners to utilise and manage the area in the best suitable manner. The areas susceptible to landslide should be avoided and care must be taken to avoid this areas. If at all the land has to be utilised it should be properly supervised and care should be taken to prevent slides. The quality of the landslide hazard map can be further improved by incorporating more causative factors. Any change in the present landscape caused by human activities may change the landslide hazard zonation map. The map should be periodically updated to keep in line with the existing landscape scenario.

The use of R index and field evidence validates the hazard zonation map and makes the map correlate with the actual ground condition. The landslide hazard zonation map will help the planners to utilise and manage the area in the best suitable manner.

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GNSS Analysis Tools from Google

The primary intent of these tools is to enable device manufacturers to see in detail how well the GNSS receivers are working in each particular device design

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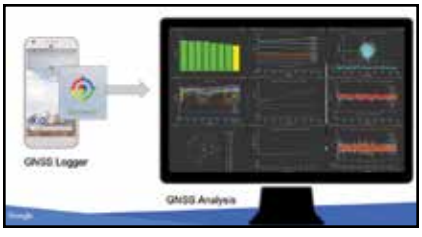
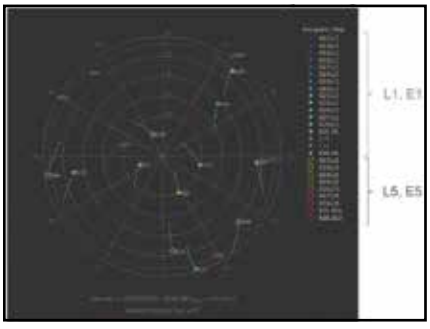
Last year in Android Nougat, we introduced APIs for retrieving Global Navigation Satellite System (GNSS) Raw measurements from Android devices. Last month, we publicly released GNSS Analysis Tools to process and analyze these measurements.

Android powers over 2 billion devices, and Android phones are made by many different manufacturers. The primary intent of these tools is to enable device manufacturers to see in detail how well the GNSS receivers are working in each particular device design, and thus improve the design and GNSS performance in their devices. However, with the tools publicly available, there is also significant value to the research and app developer community.





How to use the tool?

The GNSS Analysis Tool is a desktop application that takes in raw the GNSS Measurements logged from your Android device as input.

This desktop application provides interactive plots, organized into three columns showing the behavior of the RF, Clock, and Measurements. This data allows you to see the behavior of the GNSS receiver in great detail, including receiver clock offset and drift to the order of 1 nanosecond and 1 ppb and measurement errors on a satellite-by-satellite basis. This allows you to do sophisticated analysis at a level that, until now, was almost inaccessible to anyone but the chip manufacturers themselves.

The tools support multi-constellation (GPS, GLONASS, Galileo, BeiDou and QZSS) and multi-frequency. The image below shows the satellite locations for L1, L5, E1 and E5 signals tracked by a dual frequency chip. The tools provide an interactive control screen from which you can manipulate the plots, shown below. From this control screen, you can change the background color, enable the Menu Bars for printing or saving, and select specific satellites for the plots.

Receiver test report

The tools also provide automatic test reports of receivers. Click "Make Report" to automatically create the test report. The report evaluates the API implementation, Received Signal, Clock behavior, and Measurement accuracy. In each case it will report PASS or FAIL based on the performance against known good benchmarks. This test report is primarily meant for the device manufacturers to use as they iterate on the design and implementation of a new device. A sample report is shown below.

Our goal with providing these Analysis Tools is to empower device manufacturers, researchers, and developers with data and knowledge to make Android even better for our customers. You can visit the GNSS Measurement site to learn more and download this application. *https://android-developers.googleblog.com*

CASA tightens drone rules ahead of review

Australia's Civil Aviation Safety Authority (CASA) has introduced tighter rules on recreational drone flight ahead of a full review of drone regulation. It cites community concern as the prompt for the new restrictions, and a rising number of incidents being reported.

The new regulations enforce a maximum ceiling of 400 feet (just under 123 metres) on recreational drones, and craft must remain more than 30 metres from people not involved in controlling the drone, and only one person may fly a recreational drone at one time. All drones – recreational and non-recreational – must now be kept away from areas where fire, police or other emergency operations are underway unless there is approval from the person in charge of the emergency operation. Drones weighing over 100 grams now cannot be flown within 5.5 kilometres of a controlled aerodrome — the major aerodromes in capitals and regional centres — or non-controlled aerodromes, if it is clear that aircraft are operating at these sites. Controlled aerodromes can be easily identified by whether a control tower is present at the facility, or on Airservice Australia's map. *www.spatialsource.com.*

CLASS: European project integrates, tracks and manages drones in the airspace

Drone technology is on the rise and the number of drones in the air is increasing at a rapid pace. These vehicles are often hard to detect since they literally fly below the radar. The chances of conflicts between drones and manned air traffic (or between drones themselves) pose safety concerns and require technology solutions.

CLASS or CLear Air Situation for uaS, is a project funded as part SESAR 2020, the programme for air traffic management modernization, and within the framework of Horizon 2020. It aims to combine existing technologies to build the core functions need for safe and secure drone traffic management. It also aims to validate technologies required for the surveillance of UAS traffic.

Functionalities to be researched include real-time tracking and the display of both cooperative and non-cooperative drones. The project will validate the drone detection and tracking technologies during live demonstrations, and publish and share its results with the relevant stakeholders, including the drone users and the air traffic management community.

Conclusions and recommendations for follow up will be largely disseminated to enable drones to safely operate on large scale for the benefit of the growing drone business. The CLASS project is spearheaded by Airbus Defense and Space. International partners Aveillant, ENAC, NTNU and Unifly join forces to research and evaluate the ground-based technologies' potential to monitor and separate drone traffic in a real-time unmanned aerial system traffic management system (UTMS). *www.sesar.eu, www.sesarju.eu*

Phase One Ind and Lufthansa Aerial services sign co-op agreement

Phase One Industrial and Lufthansa Aerial Services have signed an agreement to explore collaborative development and deployment of UAVs for a range of specialized industrial surveying and inspection projects. Under terms of the agreement, both are testing and evaluating scenarios for UAV-based aerial equipment featuring Phase One Industrial aerial cameras. *www.industrial.phaseone.com*

US president announces innovative drone integration pilot program

President Donald J. Trump directed U.S. Secretary of Transportation Elaine L. Chao recently to launch an initiative to safely test and validate advanced operations for drones in partnership with state and local governments in select jurisdictions. The Unmanned Aircraft Systems (UAS) Integration Pilot Program implements a directive signed by President and the results will be used to accelerate the safe integration of UAS into the national airspace and to realize the benefits of unmanned technology in our economy.

The program will help tackle the most significant challenges in integrating drones into the national airspace while reducing risks to public safety and security. The program is designed to provide regulatory certainty and stability to local governments and communities, UAS owners and operators who are accepted into the program. In less than a decade, the potential economic benefit of integrated unmanned aerial systems into the nation's airspace is estimated to equal up to $82 billion. *www.transportation.gov*

Velodyne LiDAR partnership with YellowScan

Velodyne LiDAR Inc. has announced that it is partnering with YellowScan to integrate its VLP-16 Puck and VLP-16 Puck LITE LiDAR sensors into YellowScan's Surveyor for a turn-key and reliable LiDAR system for demanding UAV applications. *www.velodynelidar.com*

Remote sensing for cosmic dust and other celestial bodies

In a paper published in EPJ Plus, Stefano Bagnulo from Armagh Observatory and Planetarium in Northern Ireland, UK, and colleagues review the state-of-the-art in polarimetry for studying the small bodies in our solar system. Combined with other observational techniques, such as thermal radiometry and visible photometry, polarimetry may be used as a remote sensing technique to measure asteroids' size, to reveal the composition and size variation of dust in comets or of aerosols in planetary atmospheres, to study the surface structure of asteroids, or even to detect extra-terrestrial biomarkers.

So how does polarimetry work? The way light is polarised depends on the nature of the scattering surface, and the measured polarisation changes when the object is observed from different angles. Imagine that radiation hits an electron on a surface. That electron begins oscillating, and becomes more inclined to move in a direction parallel to the surface than to penetrate it. Therefore, the reflected light presents an excess of photons oscillating in the direction parallel to the surface, making the reflected light polarised. In this way, measuring polarisation can yield pertinent information on objects in the solar system. By combining it with other techniques, scientists can make important advances in the physical characterisation of these small bodies. *www.eurekalert.org*

India maps 185 districts through RS for horticulture

The Union ministry of agriculture, India has mapped 185 districts under a project using remote sensing technology to identify areas best suited for seven different fruits and vegetables across the country, agriculture minister Radha Mohan Singh said.

The first report, for eight states in the North East, will be ready in December and will be given to the state governments in January, Singh told reporters after a presentation on the project known as CHAMAN or Coordinated Horticulture Assessment and Management using geoinformatics. w*ww.hindustantimes.com*

SpaceX launches Taiwan's first home-built satellite

SpaceX has launched the first satellite designed and built entirely in Taiwan, a spacecraft that aims to boost disaster forecasts and mapping, environmental observation and space research. The satellite, called FORMOSAT-5, weighs nearly 1,000 pounds (450 kilograms) is designed to operate for five years, and will orbit the Earth once every 100 minutes. Its predecessor, FORMOSAT-2, was decommissioned last year after 12 years, a lifespan in which it mapped a series of major disasters in parts of Asia and Africa. *https://phys.org*

China launches remote sensing satellite for Venezuela

China has launched Venezuela's second remote sensing satellite, five years after helping the South American nation with its first satellite. The VRSS-2 satellite was launched from the Jiuquan Satellite Launch Centre in the Gobi desert using a Long March 2D carrier rocket. It is the third satellite to be jointly launched by China and Venezuela. *www.newindianexpress.com*

Pakistan's first optical remote sensing satellite to be launched in 2018

Pakistan's first optical remote sensing satellite PRSS-1 would be launched in 2018, the Pakistan Space and Upper Atmosphere Research Commission (Suparco) announced. *www.geo.tv*

ISRO to establish a research facility in Guwahati

The Indian Space Research Organization (ISRO) will establish research facility in Guwahati, the largest city in the North East Indian state of Assam. The research facility will explore the possibility of using geospatial technology, including data generated through GPS, GIS and satellite remote sensing for fast paced development of Assam.

New calibration capabilities in HIPS and SIPS 10.4

Teledyne CARIS has released HIPS and SIPSTM 10.4. This version introduces the first commercial release of CIDCO's Automatic Boresight Calibration tool, providing a systematic approach to calibration as an alternative to the traditional, manual patch test.

It is designed to simplify both survey planning and post-processing for calibration requirements, requiring fewer survey lines in the field and providing a repeatable, robust calculation of the boresight angles between the IMU and sonar in post-processing in just a few clicks. *www.teledynecaris.com*

Carlson Survey 2018 OEM released

The recently released Carlson Survey 2018 OEM comes with the AutoCAD® 2018 OEM engine built-in. In this latest OEM version, Carlson Survey users gain the ability to directly read and write the current AutoCAD DWG-drawing file format.

In the LotNetwork routines of Carlson Survey 2018, users now have the ability to setup multiple building footprints with their individual dimensions and setback requirements and designate the order of placement priority. Each lot is then automatically drawn with the building footprint as designated. There are also new options to leave empty lots and to draw driveways. *www.carlsonsw.com*

NEW RIEGL VQ-780i mapping sensor

The new RIEGL VQ-780i is a high performance, rugged, lightweight, and compact airborne mapping sensor. This versatile system is designed for high efficient data acquisition at low, mid, and high altitudes, covering a variety of different airborne laser scanning applications from high density to ultra wide area mapping.

High speed rotating mirror design ensures reliability, and uniform point distribution across its entire wide field of view and at all flying altitudes. Based on RIEGL's proven Waveform-LiDAR technology, the system provides clutter-free point clouds with high accuracy, excellent vertical target resolution, calibrated reflectance readings, and pulse shape deviation for unsurpassed information content on each single measurement.

The system is complemented with RIEGL's advanced acquisition and data processing software suite that utilizes parallel computing (GPU) for fast data processing. The scanner is designed to work with the latest Inertial Navigation (IMU) Systems, flight management systems, and camera options.

Europe's largest terminal installs positioning technology

The MSC PSA European Terminal (MPET) in Antwerp, Belgium, has found a new positioning technology that will integrate with its legacy system and control an annual throughput capacity of 9 million TEUs once its expansion is completed.

MPET's new field-proven technology from Airobot, a company that creates systems to stop collisions and aid navigation and positioning, will use multipath mitigation to combat the many GNSS reflections caused by all the metal containers. It is providing a SC-PSA-GNSS unit (pictured below) that uses an integrated AsteRx-m GNSS receiver from Septentrio NV. It also combines satellites from the American GPS and Russian GLONASS systems to provide a solution close to the quay cranes. *www.porttechnology.org*

Kongsberg develops integrated DP reference solution

Kongsberg has combined satellite positioning and inertial technology to create an integrated reference solution for dynamic positioning applications. Its DPS i2 and DPS i4 use signals from GNSS's - GPS and Glonass, and fuses with information from inertial sensors.

DPS i2 and DPS i4 use a motion gyro compass and motion reference unit to provide additional information to the GNSS data. DPS i2 utilises GPS and Glonass, while DPS i4 uses Galileo and Beidou GNSS systems in addition. *www.marinemec.com*

Orolia introduces VersaPNT for battlefield Navigation

Orolia, through its Spectracom brand, has announced the availability of its latest technology innovation, VersaPNT™. It provides virtually failsafe battlefield navigation, even in GPS-denied environments, to protect critical networks with Assured PNT technology. This new, ground, air or sea vehicle-mounted solution is ideal for military environments, with a ruggedized, compact, low power and lightweight form factor. *www.orolia.com*

KVH augments battle-proven inertial tactical navigation solution

KVH Industries, Inc. has announced that its TACNAV® 3D inertial navigation system is now available with KVH's exclusive TACNAV Moving Map Display (MMD). The MMD offers real-time moving map technology with an easy-to-read, easy-to-use graphical navigation capability.

Soldiers who once relied on grid reference alone now have the benefit of viewing a visual map on a 10-inch diagonal, high bright color display viewable in all lighting conditions. They can create, store, and activate waypoints and routes from the touchscreen, which helps increase situational awareness. The TACNAV MMD displays position, heading, speed, cross track error, distance, and bearing to waypoint, and is capable of presenting navigation information in multiple languages, enhancing joint multinational operations. *www.kvh.com/tacnav*

Hexagon announces to acquire Luciad

Hexagon AB has announced to acquire Luciad, a Belgium-based software company specializing in the visualization and analysis of real-time geospatial information. Luciad's visualization technologies support live connections to dynamic sensor feeds

in a 3D environment. The result is a 5D digital reality – real-time, rapid fusion of multi-source content and the ability to perform analytics on-the-fly.

Trimble launches GFX-750 display system for agriculture applications

Trimble has introduced the Trimble GFX-750 display system for agriculture applications. The display system comes with the easy-to-install, roof-mounted NAV-900 guidance controller featuring Trimble's most advanced multi-constellation GNSS receiver. The satellite coverage provides farmers with more robust signal availability which means more active working time, especially in mountainous terrain.

The high-resolution 10.1-inch display is an ideal system for a farmer with a mixed fleet and it can work with tractors from most manufacturers. The display is ISOBUS-compatible, a universal communication protocol that Müller-Elektronik, a Trimble Company, was a key contributor in developing.

Airborne LiDAR production now fully integrated with Leica HxMap workflow

Leica Geosystems, industry leader for reality capture and measurement technology, have released LiDAR data processing capability in the Leica RealCity solution package. It has partnered with international asset integrity and geo-intelligence solutions provider, Fugro, to begin acquiring and processing data over multiple cities and coastal regions across the US. Using CityMapper, Fugro conducted aerial surveys over some of North America's most densely populated urban centres, in support of their geospatial mapping services. As the world's first hybrid airborne sensor combining oblique and nadir imaging as well as a LiDAR system into one instrument, the CityMapper enables significant time and cost savings by flying once to collect both imagery and LiDAR data. All collected LiDAR and imaging data can be processed in the one unified workflow solution, Leica HxMap.

"Global trend towards 3D mapping solutions is driving stronger demand"

says Alexander Wiechert, CEO of Vexcel Imaging in an interview with Coordinates..

What is unique about Ultracam Panther?

The UltraCam Panther is a versatile, portable Mobile Mapping System. It carries complementary sensors to capture full-spherical imagery and video, dense 3D LiDAR point clouds and precise geopositioning information in both indoor and outdoor environments.

The UltraCam Panther's panoramic head, the systems centerpiece, holds 26 cameras to capture very high-resolution still imagery or video with a 360-degree field of view.

A multi-beam rotating LiDAR sensor simultaneously collects precise 3D data and a GPS/INS system, combined with a visual odometry sensor offers a custom-built software solution that delivers uninterrupted accurate trajectory data even in challenging environments where no GNSS signals are present.

How do you think Ultracam Panther would complement other range of products/ solutions from the house of Vexcel Imaging?

The UltraCam Panther is the ideal complement to the aerial UltraCam product family. Vexcel Imaging offers a comprehensive digital aerial camera portfolio that provides a wide range of imaging capabilities from wide-area mapping to nadir and oblique camera systems. On the terrestrial side, the UltraCam Panther can be complemented with the car-based mapping system, UltraCam Mustang.

That means, the UltraCam product family lets customers capture the world from all angles: from an aerial, street- and ground-level and an indoor perspective!

What is the cost benefit of using an Ultracam Panther?

The UltraCam Panther offers outstanding flexibility for mapping and virtual reality applications and can be used in a variety of environments. One key factor is also the modular concept of the portable system. Thanks to this modular design, the system can be flexibly adapted to the user's needs and allows an individual compilation of the components depending on requirements and budget (low-cost to high-end). Users decide for themselves which configurations and elements they need for their jobs. Depending on whether it is for indoor or outdoor photography, elements such as the LiDAR or an orientation module can be integrated.

How do you see growth prospect of 3D mapping solutions in different fields of application?

The global trend towards 3D mapping solutions is driving stronger demand. This requires rich visualization and highly-accurate geospatial data for e.g. urban planning.

There is also a growing need for accurate terrestrial data for augmented reality and mixed reality applications, both indoors and outdoors. Vexcel Imaging has a history of creating products that address such needs.

Mobile data, fixed broadband and pay–TV to drive Malaysian telecom market to 2021

Steady growth in the consumption of mobile data, fixed broadband, VoIP and pay-TV services is set to help Malaysia's telecom market remain viable through to 2021, according to GlobalData, a leading data and analytics company.

According to the company's latest report, the sector, which has struggled since 2014, is expected to recover from 2019 onwards returning a flat performance of +0.01% growth through 2021 with estimated sales of $8.4bn, the same figure it posted in 2016. The Malaysian telecom services market suffered a revenue decline of 8.1% in 2016, mainly due to a weak economy, a price war on broadband services and a general decline in voice revenue. Revenues were further reduced as operators competed with each other to offer cheaper plans to counter weak consumer spending. Mobile services revenue is set for a flat compound annual growth rate (CAGR) of 0.8% until 2021, due to the huge erosion in mobile voice revenues caused by user migration from voice telephony to OTT-calling applications together with free calling offered by operators as part of bundle deals.

Cooperation between TomTom and ZENRIN

Navigation technology company, TomTom and Japanese mapping company, ZENRIN, recently announced their intention to collaborate on traffic services. The agreement pairs both the companies to deliver a powerful combination of services for the future of driving in Japan.

TomTom Traffic offers up-to-date information on road conditions such as traffic jams, roadworks and accidents. ZENRIN produce Japan's most detailed, accurate and richly attributed digital maps which can be used for navigation, geocoding, routing driver assistance, visualization and search, thereby allowing users to make smarter mobility decisions. *www.businesswire.com*

HERE partners with Mitsubishi for driver–less car program

HERE has signed with Mitsubishi Electric as its partner in it's the bid to pioneer the autonomous car. The companies will initially focus on ADAS (advanced driver assistance systems) such as cruise control, as those are technologies that are easily available right now. Eventually, advancements in current driver assistance features will pave the way for the fully autonomous vehicles of the future, for both HERE and Mitsubishi.

Apart from the features related to the familiar cruise control, HERE and Mitsubishi will also support smart lane-level guidance for vehicles based on real-time information about traffic conditions and incidents.

Panasonic to launch its autonomous driving system in 2022

Panasonic's autonomous driving system is expected to be launched in 2022. This move will help the Japanese company bridge its gap with rival suppliers in a fiercely competitive market. Panasonic, the exclusive battery cell supplier for Tesla Inc's mass-market Model 3, has been revamping itself as a provider of advanced auto parts to escape the price competition of smartphones and other lower-margin consumer products.

The new autonomous driving system will enable autonomous driving at low- and medium-speed ranges including self-valet parking, Panasonic said.

Centre for Spatial Analytics and Advanced GIS in Bengaluru

Under the aegis of NIAS Council of Management (COM) and with support from Tata Trusts, Centre for Spatial Analytics and Advanced GIS (C-SAG) has been established in Bengaluru. This Centre will work in the field of Spatial Analytics and advanced GIS to develop Intellectual Property (IP) and GIS knowledge that will build deep and advanced capability in India in the GIS area.

Mr S Ramadorai, Chairman of NIAS Council of Management, said "Spatial Analytics is important for a variety of citizen, governance, commercial and research purposes – there is a need for greater understanding in the management and analytics of spatial data. There is no institution in this country that is working in this knowledge area and understanding the fundamentals, technological, social and economic aspects of GIS knowledge. Even as many GIS applications have been taken up, the Spatial Analytics is still in a nascent stage. In the vision of JRD, furthering advanced studies, is the goal of NIAS – that is what we propose to do through C-SAG and build knowledge capability." In conjunction with Bill and Melinda Gates Foundation, the Tata Trusts is supporting Centre for Spatial Analytics and Advanced GIS (C- SAG), established under NIAS, for "empowering" farmers with timely advisories from real- time satellite images, GIS processing, beneficiary-level data analytics using advanced Spatial Analytics and Artificial Intelligence capabilities. One of the initial focus of C-SAG is to quickly develop an Agri-GIS engine in 3 districts of S Orissa, alongwith Tata Trusts and Orissa Agricultural University. The Agri-GIS will support Smallholder Farmers – considering the natural, social and economic aspects of farmer beneficiaries. C-SAG is developing advanced modelling, automated software and analytical capabilities for Unmanned Aerial Systems (UAS), City-GIS modelling, Health GIS, Spatial Econometrics, Big data analysis, Social Analytics and many other areas. *www.csag.res.in*

New Cross-Platform BIM and geospatial collaboration software by 3D Repo

3D Repo has turned to the latest gaming technology to enhance its cloud-based BIM collaboration software with quick and easy multi-platform access to 3D BIM models and data. Utilising a new rendering engine, based on the popular Unity gaming platform, improves 3D Repo's memory footprint and unifies the BIM solution across the desktop, web and even Virtual Reality (VR) devices, so all new features are simultaneously accessible across all platforms.

The new version of this open source BIM collaboration platform generates dynamic resources – or 'knowledge packages' – from a remote repository. The 3D Repo viewer easily visualises 3D revisions from the cloud without any previous knowledge of the assets, all in real-time. The use of the Unity game engine also improves the memory footprint of the 3D Repo solution as, once the data is loaded into the GPU memory, the main CPU memory is freed and available to power other applications required by the user. *http://3drepo.org*

EarthSense partnership maps city clean air cycle routes

A project combining Ordnance Survey (OS) geospatial data with real-time air quality data from EarthSense Systems is set to highlight clean cycle routes in Britain's cities.

Using a network of fixed and static air pollution sensors, EarthSense is producing city-wide visualisations of air quality. Combined with OS's open dataset of greenspaces, the EarthSense air quality models highlight areas of higher air pollution, often along busy roads, and allow users to identify cleaner air routes, such as through parks or along canal paths. Air pollution is the world's largest single environmental health risk, according to the World Health Organisation, with 80 percent of the world's population living in cities that exceed its standards for pollution. Air pollution in the UK has been described as a 'public health emergency' and levels of nitrogen dioxide (NO_2), emitted mostly by diesel vehicles, have been above legal limits in almost 90% of urban areas since 2010.

A recent survey has shown that, in the last few years, the number of people who cycle at least once a week has increased by more than 100,000, with more than two million adults regularly cycling. Using data from a city wide network of sensors, including the EarthSense state-of-the-art Zephyr sensor, EarthSense captures real time air quality measurements. Combined with other inputs, including satellite observations, weather conditions and traffic emission data in its MappAir modelling solution, EarthSense can deliver data for forecasting, master planning and identifying cleaner cycle routes. *www.earthsense.co.uk*

Singapore sets aside $4.5M for solar forecasting

Singapore is setting aside S$6.2 million (US$4.57 million) to develop capabilities in predicting solar energy output as well as setting up sandboxes to facilitate testing of new products in electricity and gas.

The Energy Market Authority (EMA) said the S$6.2 million would go towards a research grant that had been awarded to a consortium, which would be led by the National University of Singapore (NUS). This group of partners would tap various techniques in weather prediction, remote sensing, machine learning, and grid modelling, with the aim to improve the accuracy of solar photovoltaic (PV), or solar energy.

The four-year initiative would tap solar-related data generated from sensors installed on the rooftops of buildings as well as weather data from another network of sensors deployed islandwide by Meteorological Service Singapore (MSS).

The consortium comprised NUS, Solar Energy Research Institute of Singapore at NUS, Centre for Remote Imaging, Sensing and Processing at NUS, A*STAR's Experimental Power Grid Centre (EPGC), and Singapore-MIT Alliance for

Research and Technology's Centre for Environmental Sensing and Modelling (CENSAM). *http://www.zdnet.com*

Filling in the soil moisture mapping gaps

Soil moisture influences many decisions by landowners and property managers. Determining the moisture level of precise locations is a daunting task, due, in part, to the many factors that can cause fluctuations.

"Soil moisture conditions at two places just 30 feet apart can be almost completely uncorrelated," said Tyson Ochsner, associate professor in Oklahoma State University's Department of Plant and Soil Sciences. "Differences in soil texture, vegetation types, weather conditions and many other factors cause soil moisture conditions to vary tremendously." To help alleviate some of the unknowns and missing information about soil moisture, Ochsner and a team of researchers are working to develop a more complete monitoring system across the state. The National Science Foundation project is designed to create statewide high-resolution soil moisture maps to improve drought monitoring, wildfire forecasting and hydrologic modeling.

Until this project, measurements from the Oklahoma Mesonet provided soil moisture information, but only for approximately 120 monitoring stations across the state. However, Ochsner's research team was able to enhance soil moisture estimates to provide statewide coverage by incorporating information from digital soil maps and radar-based precipitation data from the National Weather Service. To fill in the gaps, the team used a special mobile instrument called a cosmic-ray neutron rover. "The rover detects soil moisture within about 650 feet of the instrument and up to 2 feet deep in the soil and it can continuously measure from a moving vehicle," said Geano Dong, Ph.D. student working under Ochsner. "The data from the rover will help us determine the primary factors causing spatial variability in soil moisture around and between the Oklahoma Mesonet point measurement locations. We will incorporate that understanding into models that will allow us to make high resolution soil moisture maps for the whole state." *http://www.hpj.com*

Geospatial technology to support national mission for clean ganga

Union minister of state for Water Resources, River Development and Ganga Rejuvenation Satyapal Singh has asked the officials of National Mission for Clean Ganga (NMCG) to make optimal use of latest geospatial technologies to rejuvenate the river. He reaffirmed that geospatial and crowd-sourcing technologies like Bhuvan Ganga app must be used effectively to evoke a mass movement and as many people as possible should be involved in the clean Ganga movement. *www.gisresources.com*

Cisco helps Vijayawada create India's longest smart street

Cisco's technology and solutions for smart cities have been implemented in India like elsewhere in the world and are helping offer better citizen services, foster innovation and generate more jobs. Cisco's Bengaluru campus is designed as a campus-as-a-city for thousands of its employees to work and is spectacular showcase of what the digitization of a country means for the future of work, education, healthcare and the digital delivery of citizen services.

The Govt. of Andhra Pradesh, working alongside Cisco, has created India's longest Smart Street… "The Golden Mile" In Vijayawada. The 3kms stretch has several smart services integrated to make the citizen's life easier. With 35 Wi-Fi access points, providing speeds of upto 2 Mbps, close to1500 people can access Internet along the Golden Mile Stretch. 240 smart lights ensure an energy efficient lighting experience.

Advanced motion sensors and software application controlled by The Cisco City Digital Platform help adjust luminosity and ensure efficiency.

With the Golden Mile Project setting the tone for similar projects in Andhra Pradesh and the country, Vijayawada is fast-being recognized as the Global city of the future. *https://gblogs.cisco.com*

Esri India, IIEST-Shibpur to launch CoGE in Eastern India

To impart GIS skills to graduates and working professionals through a set of comprehensive education programs in India, the Indian Institute of Engineering Science and Technology (IIEST)-Shibpur and Esri India announced the launch of a Centre of Geospatial Excellence (CoGE) in the eastern region. The CoGE will launch various short and long-term programs that will be co-designed with senior faculty members from IIEST and domain experts from Esri India.

GeoSLAM, Bentley Systems form ties

GeoSLAM and Bentley Systems announced a partnership to enable the simple and fast production of hybrid reality models in any environment.

Through a combination of using the GeoSLAM ZEB-REVO mobile mapping system and ZEB-CAM, and the latest version of Bentley's ContextCapture software, it is now possible to produce high resolution textured reality meshes of indoor scenes, complex infrastructure and other challenging environments faster than ever before.

Delhi cops to use Google Maps to decongest roads

Google will come to the aid of road managers in Delhi, with traffic police all set to use Google Maps to monitor traffic situations on arterial roads. The cops will employ the traffic maps, which give real-time vehicular situations, determine the congestion on roads. If any stretch is seen to be badly affected, a screenshot of the map will be sent on a Whatsapp group to the traffic inspector, ACP and DCP concerned for corrective actions. The brass will be kept in the loop to ensure prompt response to the screenshot posts. *https://timesofindia.indiatimes.com*

First contract between ESSP and KARI

ESSP has recently signed a framework Contract with KARI (Republic of Korea Aerospace Research Institute) to support them on the set-up of the future Korean Service Provider for KASS, the Korea Augmentation Satellite System similar to the European EGNOS. The signature was sealed last October 25th at the Toulouse Cité de l'Espace, between ESSP CEO Thierry Racaud and KARI Executive Director of SBAS, Dr. Gi Wook Nam. KASS system will be based on EGNOS (European Geostationary Navigation Overlay System) system fundamentals. EGNOS has been successfully operated by ESSP since 2011.

KASS is a project strongly supported by the European Commission, the European GNSS Agency (GSA), the European Space Agency, the EASA (European Aviation Safety Agency) and CNES (French Space Agency). The Republic of Korea will initially be using KASS to provide aeronautical applications services, including Safety- of -Life services so that it can be used during different flight phases, especially precision approaches and landings. It will eventually extend these services to other applications, including maritime, road or rail.

Professor terry moore receives kepler award

The Institute of Navigation's (ION) Satellite Division presented Professor Terry Moore with its Johannes Kepler Award September 29, 2017 at the ION GNSS+ Conference (Portland, Oregon) for his outstanding contributions to the development of satellite navigation through a sustained and distinguished professional career devoted to research and teaching.

Professor Terry Moore has over 30 years of research experience in surveying, positioning and navigation technologies, and is a consultant and advisor to European and UK government organizations and industry. He has taken a leading role in national and European initiatives aimed at integrating academic research and teaching activities in GNSS and interacting closely with industry. Prof. Moore is credited with extensive work on the introduction and implementation of WGS 84 as the standard reference systems for air and marine navigation, as well as the development of standard software tools for coordinate transformations and map projections used extensively through the aviation industry. n.

The Johannes Kepler Award recognizes and honors an individual for sustained and significant contributions to the development of satellite navigation. It is the highest honor bestowed by the ION's Satellite Division.

Prolific earth gravity satellites end science mission

After more than 15 productive years in orbit, the U.S./German GRACE (Gravity Recovery and Climate Experiment) satellite mission has ended science operations. During their mission, the twin GRACE satellites have provided unprecedented insights into how our planet is changing by tracking the continuous movement of liquid water, ice and the solid Earth.

GRACE made science measurements by precisely measuring the distance between its twin satellites, GRACE-1 and GRACE-2, which required that both spacecraft and their instruments be fully functional. Following an age-related battery issue on GRACE-2 in September, it became apparent by mid-October that GRACE-2's remaining battery capacity would not be sufficient to operate its science instruments and telemetry transmitter. Consequently, the decision was made to decommission the GRACE-2 satellite and end GRACE's science mission.

GRACE, a mission led by Principal Investigator Byron Tapley at the University of Texas at Austin, launched in March 2002 on a planned five-year mission to precisely map our planet's ever-changing gravity field. It has revealed how water, ice and solid Earth mass move on or near Earth's surface due to Earth's changing seasons, weather and climate processes, earthquakes and even human activities, such as from the depletion of large aquifers. It did thisby sensing minute changes in the gravitational pull caused by local changes in Earth's mass, which are due mostly to changes in how water is constantly being redistributed around our planet.

GRACE used a microwave ranging system to measure the change in distance between the twin satellites to within a fraction of the diameter of a human hair over 137 miles (220 kilometers). The ranging data were combined with GPS tracking for timing, star trackers for attitude information, and an accelerometer to account for non-gravitational effects, such as atmospheric drag and solar radiation. From these data, scientists calculated the planet's gravity field monthly and monitored its changes over time.

GRACE established that measuring the redistribution of mass around Earth is an essential observation for understanding the Earth system. GRACE's monthly maps of regional gravity variations have given scientists new insights into Earth system processes. Among its innovations, GRACE has monitored the loss of ice mass from Earth's ice sheets, improved understanding of the processes responsible for sea level rise and ocean circulation, provided insights into where global groundwater resources may be shrinking or growing and where dry soils are contributing to drought, and monitored changes in the solid Earth. Users in more than 100 countries routinely download GRACE data for analyses. *www.jpl.nasa.gov*

JNTU, India opens GNSS laboratory in collaboration with Hexagon

The Jawaharlal Nehru Technological University-Hyderabad (JNTU-H) and Hexagon Capability Centre India (HCCI) have established a GNSS laboratory at the Centre for Spatial Information Technology, JNTU-H, Hyderabad, of Telangana state.

The lab is equipped with NovAtel GNSS receivers, antenna, systems, cables and other hardware components. The equipment enables reception, processing, analysis and development of navigational data and applications to augment curriculum for JNTU-H students for research and education. The

establishment of the GNSS lab will also provide an opportunity to the students, scholars and faculty members to carry out research in satellite-based navigation and to develop advanced applications. HCCI will provide internship to the students with financial support and job opportunities. This provision will not only be for CSIT students, but also for students with geo-informatics background from other constituent units of JNTU-H.

Russia increases Glonass orbital grouping to 24 satellites

Russia has started using the Glonass-M No. 52 navigation satellite produced by the Reshetnev Information Satellite Systems Company pursuant to its designation, the press office of State Space Corporation Roscosmos reported on Tuesday.

"With the launch of the Glonass-M No. 52 satellite into operation, the Glonass orbital grouping has again been increased to its standard number of 24 space vehicles," the Roscosmos press office said.

The Glonass-M No. 52 satellite orbited on September 22, 2017, has been accepted for operation following the results of checks into its functioning in flight conditions. It will be used instead of a satellite that had worked in the orbital grouping 1.5 times longer than the guaranteed service life. *http://tass.com*

Germany aims to modernize airspace, navigation infrastructure by 2029

DFS Deutsche Flugsicherung GmbH has launched a comprehensive innovation program for the optimization and modernization of airspace and navigation infrastructure in Germany, according to DFS. The program aims to enable the transition from ground-based to modern surface navigation. By 2029, DFS said the flight procedures at more than 60 German airfields would be gradually transitioned to area navigation procedures involving satellite navigation. This, DFS said, takes account of the increasing demands on the transport capacity in the airspace.

The introduction of surface navigation is based on parameters set by ICAO in 2012 and the announcement by the EU Commission on the implementation of these navigation procedures for European airspace, DFS said.

The organization has already begun planning for the introduction of the area navigation system in anticipation of the EU requirement.To achieve the transition by 2029, DFS said some 2,800 arrival and departure procedures have to be newly designed, and an adjustment of the airspace structure must be completed. The German airspace is divided into seven clusters, which contain airports that are in close proximity to one another and have dependencies, DFS said. It hopes to implement the changes in clusters based on air traffic safety requirements.

The transition is set to start after an extensive inspection process in the Elbe/Weser cluster at the end of 2020 in northern Germany, according to DFS. *www.aviationtoday.com*

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December 2017

ICG 2017
2 - 7 December
Kyoto, Japan
http://www.unoosa.org

International Symposium on GNSS (ISGNSS 2017)
10-13 December
Hong Kong
www.lsgi.polyu.edu.hk

Esri India User Conference
13-14 December
Delhi, India
www.esriindia.com/events/2017/uc

January 2018

14th International Conference on LBS
15 - 17 January
Zurich, Switzerland
http://lbs18.ethz.ch

February 2018

18th Annual International LiDAR Mapping Forum
5 - 7 February
Denver, USA
www.lidarmap.org

GMA: Geodesy, Mine Survey and Aerial Topography
15 – 16 February
Moscow Novotel Center, Russia
http://www.con-fig.com/?lang=eng

March 2018

Munich Satellite Navigation Summit
5 - 7 March
Munich Germany
www.munich-satellite-navigation-summit.org

EUROGEO 2018
15 - 17 March
Cologne, Germany
www.eurogeography.eu

Gi4DM 2018
18 - 21 March
Istanbul Technical University, Turkey
gi4dm2018.org

April 2018

The 7th Digital Earth Summit 2018
17 – 19 April
El Jadida, Morocco
http://www.desummit2018.org/

9th IGRSM International Conference and Exhibition on Geospatial & Remote Sensing (IGRSM 2018
24-25 April 2018
Kuala Lumpur, Malaysia
https://igrsmconf18.wixsite.com/igrsm2018

May 2018

Geoscience-2018
2-4 May
Rome, Italy
http://geoscience.madridge.com/index.php

FIG Congress 2018
6 - 11 May
Istanbul, Turkey
www.fig.net/fig2018/

The European Navigation Conference 2018
14 - 17 May
Gothenburg, Sweden
www.enc2018.eu

GEO Business 2018
22 - 23 May
London, UK
http://geobusinessshow.com

June 2018

HxGN LIVE 2018
12-15 June
as Vegas, USA
http://hxgnlive.com

7th International Conference on Cartography & GIS and Seminar on Early Warning and Disaster Management
18-23 June
Sozopol, Bulgaria
www.iccgis2018.cartography-gis.com

July 2018

GI Forum 2018
3 - 6 July
Salzburg, Austria
www.gi-forum.org

Esri International User Conference 2018
9 - 13 July
San Diego, USA
www.esri.com/events

September 2018

Inter Drone 2018
5 - 7 September
Las Vegas, USA
www.interdrone.com

ION GNSS+ 2018
24 - 28 September
Miami, USA
www.ion.org

October 2018

Intergeo 2018
17 - 18 October
Frankfurt, Germany
www.intergeo.de

December 2018

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

KCS TraceME - LoRa™ - Sigfox

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The portable platform is simultaneously capturing georeferenced spherical imagery and video, precision LiDAR 3D data and highly accurate geopositioning information.

Versatility

Combined with its unmatched video capability and very high resolution imagery, the UltraCam Panther defines a new class of 3D capture systems.