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Coordinates

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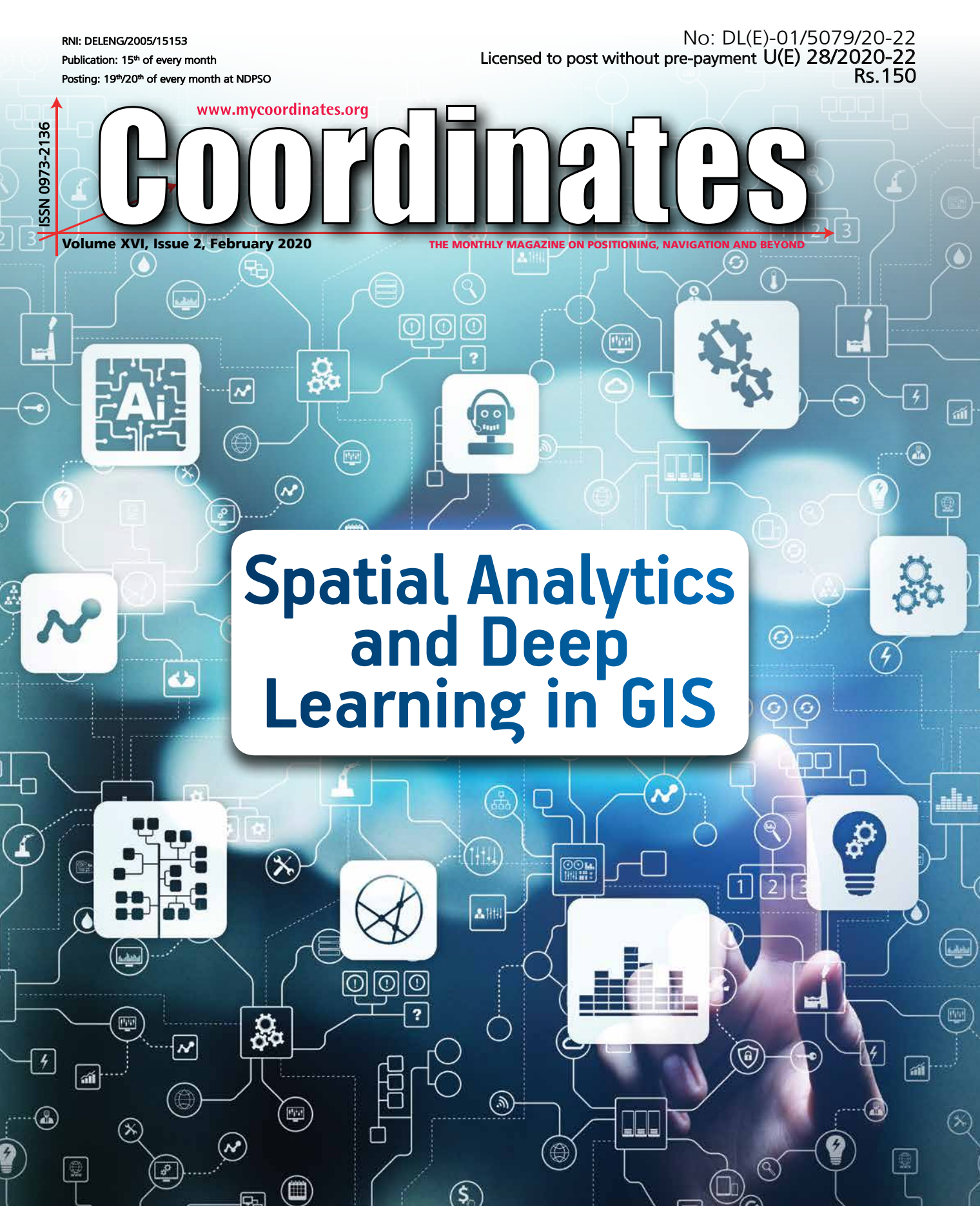

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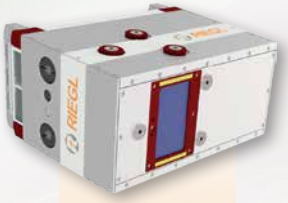

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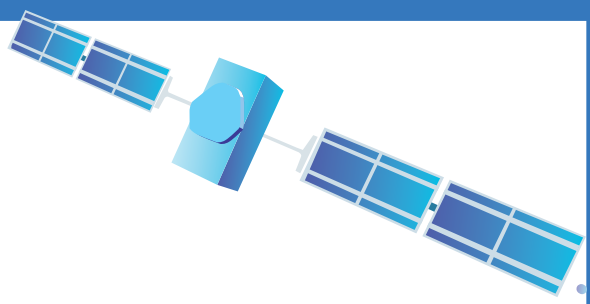

GNSS

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In this issue

Coordinates Volume 16, Issue 2, February 2020

Articles

Columns

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Quarantined

As the official figure of deaths

Due to novel corona virus (Covid-19) surges to over 1,100,

The situation is frightening.

When thousands of the victims are being quarantined and treated,

The challenge is to trace the many, who might have been infected,

And how to curtail its further spread.

The World Health Organization recognizes the threat

As grave and global.

The world grapples to figure out ways to deal with the situation

Which is not only medically challenging

But also emotionally and socially traumatic.

The likely devastating fallouts on economy

Are yet to be assessed.

The virus is a threat to the humankind.

It also has put on test

The humanity per se.

Bal Krishna, Editor
bal@mycoordinates.org

Geographic Coverage Expands as Imaging Technology Matures

Vexcel Imaging will continue to develop advanced hardware and software for the benefit of its commercial customers and for VDP with a focus on optimizing efficiency and quality.

By Alexander Wiechert, Vexcel Imaging GmbH

Remote sensing relies on hardware, software and workflow processes to deliver consistent and useful imaging products for a broad range of applications. When the industry was in its infancy, a great deal of attention was focused on improving the hardware to collect a much higher quality of data. Now we must fine-tune the software and workflow processes to fully leverage the tremendous amount of data that is being generated. After a hectic period marked by significant advances in collection and processing capabilities, we have reached a more stable point with development cycles becoming longer and incremental benefits to the customer.

Hardware First

Hardware became the first "battleground" as industry leaders continued to experiment with different approaches. Eventually imaging technology made the revolutionary leap from analog to digital, which resulted in significant performance improvements and created many new opportunities.

Now that a digital format is accepted as the most effective technology for mapping, the aerial imaging industry is focusing on more subtle evolutionary hardware changes. We are making modifications that increase efficiency and enable improved quality. For example, with faster frame rates and new camera electronics, airplanes can fly at higher speeds and collect data with a greater forward overlap, which leads to better image quality and more efficiency.

To continue delivering improvements to our customers, Vexcel Imaging is developing a completely new camera design. We are changing everything — lenses, sensors, electronics, storage, and housing. This 4th generation UltraCam camera is based on the latest CMOS sensors instead of CCD, which boosts efficiency to the next level. The newest CMOS technology, for example, supports an increased pixel count in the imagery and provides radiometric advantages and better image dynamics without the downsides present in previous generations of CMOS.

The entire suite of UltraCam cameras will benefit from the new design, with the expected efficiency gain to be between 15–40%, depending on the camera model. The updated UltraCam Osprey will be released first, in spring 2020, with a wider nadir footprint and an almost doubled oblique collection capability. Next in line for release is the UltraCam Condor, scheduled in 2021, which will also offer a significantly larger footprint and faster frame rate. A new version of the UltraCam Eagle will follow at a later stage.

UltraCam Osprey Mark 3 Premium. The next generation UltraCam Osprey model will be released later this year.

Handling the Data

Since imaging hardware has achieved such high performance levels, next the industry has to focus on software development and workflow processing. The volume of data collected by advanced aerial and satellite imaging resources has increased exponentially, so software products must handle larger

data streams. Workflow processes are being streamlined to handle the increased volume of data. As a result, the industry continues innovating by adding automation and updated workflows to keep pace with the hardware and to meet the demand for faster turnaround of end products and analysis.

Vexcel Imaging is committed to investing in further development of UltraMap, our photogrammetric post-processing software that provides highly automated processing capabilities. We just launched Version 4.5 in November 2019, featuring real Oblique AT, and 5.0 is on the horizon, which will add a rich feature set to further improve efficiency and 3D capabilities. Vexcel has learned many lessons while processing our own huge datasets and that experience goes into UltraMap to benefit our commercial customers.

International Flying Programs

Another factor driving improvements in hardware, software and workflows is the creation of large flying programs that focus on high-resolution mapping of entire countries on a regular revisit schedule. Several flying programs started by global companies are applying the lessons learned from decades of hardware manufacturing and software development to improve their own collection and processing efforts and make up-to-date imagery available to meet the growing demand for high-resolution maps.

The Vexcel Data Program (VDP) is a cloud-based imagery service, founded in 2018 with the insurance industry as an anchor customer. Vexcel's exclusive partner, the Geospatial Intelligence Center (GIC), was initiated by the National Insurance Crime Bureau (NICB) that represents over 1,000 insurers in the US. The consortium of insurers shares the GIC program costs in return for access to current aerial imagery before and after natural disasters. Insurers benefit from the expedited process where agents can review imagery to assess damage instead of traveling to the site and deliver value to their customers with more accurate claim evaluations and faster payments.

VDP has a two-pronged approach to data collection. "Blue sky" refers to the scheduled collection of priority areas to complete large-area datasets. Initially the plan called for annual coverage of the entire US and several European countries at 20 cm GSD, with major metro areas collected at a higher resolution of 7.5 cm GSD. More recently survey-grade (metric/calibrated) oblique data to facilitate 3D modeling of buildings is also being collected.

The second category is "gray sky" collections, which take place in disaster areas, immediately after floods, fires, hurricanes, earthquakes, etc. Vexcel's highly automated processing capability makes images accessible online within 24 hours after data collection to all government agencies and other emergency personnel. This access is provided through GIC/NICB and has substantially improved the situational awareness of organizations trying to deliver services in devastated areas.

Philadelphia, PA, USA. Blue sky imagery captured for the Vexcel Data Program.

Demand for imagery is increasing around the world. The geographic priorities of Vexcel's global partners are influencing the selection of overseas targets. In 2020, with the UltraCam Condor collecting nadir imagery, geographic coverage will grow in Europe and potentially areas in the Asia Pacific region. The UltraCam Osprey is also collecting high resolution urban oblique imagery of major areas in the United States, and the program is expanding to Australia, New Zealand and other Asian locations.

Large flying programs are the way of the future as they allow up-to-date imagery of entire countries to be available at lower cost. Vexcel Imaging will continue to develop advanced hardware and software for the benefit of its commercial customers and for VDP with a focus on optimizing efficiency and quality.

Emerging PNT and GNSS technology trends

Creating resilient, wireless connected systems

John Fischer
Leading industry authority in PNT and GNSS technologies, and serves as the VP of Advanced R&D for Orolia, the world leader in Resilient PNT

As Coordinates readers, you appreciate the value of knowing where you are and what time it is, along with the best route to your destination. Whether you're on your way to an important business meeting at an office you've never visited, or you need to find the safest route through dangerous environments, you need reliable, continuous Positioning, Timing and Navigation (PNT) data.

No matter how sophisticated our technology environment becomes and how much further we evolve into a more digital and mobile world, we should be mindful that for many of our most essential tasks, it all comes down to the availability of essential resources like PNT data and GPS/GNSS signals. When we look at emerging technology trends, these common denominators are having a greater impact on industry's ability to deliver reliable new technologies that are immune to emerging threats.

Most of us use PNT data every day without even thinking about it. We check our route options for morning traffic and, on hectic days, we might need to find the nearest gas station or a coffee shop with a drive-through along the way. On a personal level, getting the wrong PNT data could mean that you run out of gas, get lost or wind up in a dangerous area. For critical infrastructure and defense programs, it can bring far worse consequences. Add to that the fact that rogue actors are getting more sophisticated in spoofing and jamming, and the risk of PNT data disruption and loss grow exponentially.

Next to PNT data, one of the most important tools for the latest technology innovations is access to GPS/GNSS signals. After all, most PNT data is delivered through these signals and we use GNSS signals for so many critical needs. We rely on having a signal wherever we go, and we aren't particularly opinionated about it as long as it works and we can get things done. Like turning on a light switch, we hardly ever think about it but we expect it to be immediately available 24/7.

Why will emerging technology continue to rely on PNT and GNSS?

Wireless connections are becoming required as the minimum starting point for any new technology. If we no longer need wired connections because our wireless connections are seamless, new technology can transcend geographic, environmental and other barrier limits that exist today.

Data speed and capacity are also essential. Transmission rates must continue to get faster to keep up with our requirements for instant results. Newer technologies often involve much larger file and data packet sizes, so data capacity also has to keep expanding in line with increasing demand.

What will these next-gen technology

> As PNT industry leaders, we need to establish, continuously improve, and adapt our technology with features that guarantee PNT data integrity in every environment. By the way, it's not just PNT data that we need to protect. We also need to ensure continuous access to resilient GNSS signals to transmit the data that PNT-reliant systems need in order to operate

features do for us? With failsafe wireless connections, lightning fast data speeds and extensive data capacity, we can enable connected systems, wireless networks and hive technology to converge our resources into a collective "brain" and manage everything at once. When we no longer have to build tethered data connections, we can achieve exponentially superior automatic systems that are not only efficient, but operate harmoniously with infinite inputs.

What do these technology trends mean for the PNT industry?

As PNT industry leaders, we need to establish, continuously improve, and adapt our technology with features that guarantee PNT data integrity in every environment. By the way, it's not just PNT data that we need to protect. We also need to ensure continuous access to resilient GNSS signals to transmit the data that PNT-reliant systems need in order to operate. Our contributions to emerging technologies can provide the assurance of PNT data integrity and GNSS signal access as building blocks for tomorrow's wireless connected systems.

We also need to respond to the growing demand for multiple data inputs by providing data hub and integration technologies to facilitate connected systems. By converging data points from multiple sources, we can enable higher order data analysis and processing for more intelligent, informed digital decision-making based on countless data points.

Critical systems require extensive testing, that will increasingly require sophisticated simulation to assess real world performance for missions that cannot afford to fail.

It's also important to realize that a single upgrade won't be enough. Continuous system testing through simulation, developing new solutions to defeat new threats, and Interference Detection and Mitigation (IDM) technologies are needed to close the loop and maintain system integrity over time

Looking ahead

Weighing the risks and benefits of emerging technology trends, it's better to embrace new technologies and the benefits they offer, rather than clinging to archaic ideas. New technologies are being developed faster than ever, and as PNT leaders we need to offer access to these features right away, not years from now. Bolt-on and retrofit PNT and GNSS solutions are available now that can not only future-proof existing systems, but also protect them from the latest threats.

With new digital technology, we can solve problems and increase efficiency in ways that would take decades or more for humans to do on their own. At the same time, we shouldn't rely too much on machines to make our decisions. It's important to maintain human in the loop technology so that we can make a human decision based on better facts.

The need for wireless, global, continuous and unimpeded data and communications signals will continue to grow. For PNT reliant systems, the data and signals are essential, and our role as industry experts to protect them is more critical than ever.

Critical systems require extensive testing, that will increasingly require sophisticated simulation to assess real world performance for missions that cannot afford to fail. For consumer technologies, simulation helps ensure that we can rely on our personal devices and trust them to perform as promised.

While testing, simulation and Resilient PNT technologies can keep us online, we also need to know when our data has been compromised. Today's adversaries are developing more sophisticated GNSS jamming and spoofing methods, and they can be so subtle that you'd never know they were there.

While resilient technologies and testing through simulation can provide confidence that your system will overcome certain known threats, there are always new threats that we can't test for today. As a result, alerting systems that can detect and inform you when you're under attack are fundamental for critical systems.

The PNT kit of the future will need to ensure continuous, reliable PNT data and access to GNSS signals, while protecting against emerging threats. It also needs to provide high data transfer capacity and hub technology to integrate data from multiple remote sources. These needs are immediate, and bolt-on solutions can provide the fastest route to a system upgrade.

It's also important to realize that a single upgrade won't be enough. Continuous system testing through simulation, developing new solutions to defeat new threats, and Interference Detection and Mitigation (IDM) technologies are needed to close the loop and maintain system integrity over time.

With these emerging technologies to look forward to, it's an exciting time for our industry, global businesses and consumers. With Resilient PNT and GNSS systems, along with better data integration and processing, we can trust this new technology to tell us the truth and keep us safe, while enabling us to reach for the stars and understand our world in ways that we've never been able to do before.

Challenges for 3D mapping

From controlling project timeframes and cost consumption, to sustainability and overcrowding, SLAM (Simultaneous Localization And Mapping) technology has become a powerhouse for progression in developing economies

Graham Hunter
GEOSLAM Founder

Although awareness of SLAM (Simultaneous Localization And Mapping) technology is at a very nascent state in some countries such as India, mapping technology itself has been particularly influential in the decision-making process and management of various built environments. From controlling project timeframes and cost consumption, to sustainability and overcrowding, this technology has become a powerhouse for progression in developing economies.

Mapping a challenging landscape

Among other factors, the biggest hurdle for leaders of developing economies is to complete projects within promised deadlines and budgets. While this is a frequent obstacle for most countries around the world, the implications of under-budgeting and forecasting an unachievable timeline in a developing economy could be significantly detrimental, wasting materials, labour and, in some cases, bringing projects to a complete halt. As India's government seeks to improve its population's standard of living, the country is undergoing enormous infrastructure development works in order to meet the demand of the rising population. The scale of the country means it also has the second largest railway network in the world, and the government is working to electrify the entire network in order to bring the benefits of the latest technological innovations to the economy.

the biggest hurdle for leaders of developing economies is to complete projects within promised deadlines and budgets. While this is a frequent obstacle for most countries around the world, the implications of under-budgeting and forecasting an unachievable timeline in a developing economy could be significantly detrimental, wasting materials, labour and, in some cases, bringing projects to a complete halt

Implementing these changes however is a challenge in itself, because of the country's diverse and challenging physical geography, which spans 3,287km2 across a broad range of terrains. Much of the country's existing infrastructure including bridges and roads, which were built during the nineteenth century, are no longer fit for purpose.

Overcoming skills shortages

India Today recently reported that over 80 per cent of Indian engineers are unemployable, citing a lack of new-age technology skills and an absence of fundamental training. It also stated that only three per cent of engineers have skills and knowledge in areas that are booming, including AI, machine learning, data science and mobile development.

Combatting these skills shortages, GeoSLAM's method of data collection can be performed by anyone, from inexperienced junior staff to senior construction workers through its easy-to-use mapping solution. Individuals do not require any additional skills to operate the devices, enabling the project to continue with no hold ups.

Pushing a 'mega city' to its limits

The overcrowded city of Mumbai for

example, which houses roughly 22 million people, is the fourth most populated city in the world, coined India's largest 'mega city'. Pushed to its limits through poor city planning, its residents are suffering at cramped railway stations, office buildings and roadsides. The situation became so bad, that in 2013 the state minister for housing backed calls for another new city to be constructed 50 miles away in Uran, to spread the load.

Several versatile devices capable of being used as a handheld device as well as being mounted onto a vehicle and an UAV, will enable city planners to access a clear, aerial view of the ground beneath, providing an indication of severely overcrowded areas of a city or locations of interest for future infrastructure, in order to avoid future mismanagement.

To tackle the housing crisis, GeoSLAM teams visited India in 2016 to help support the redevelopment of slum housing, as part of the Prime Minister Housing Scheme (Pradhan Mantri Aawas Yojna PMAY).

The scheme, which aimed to build 20 million low-cost homes by 2022, involved demolishing collapsing slums and setting out plans to create new homes, which were better fit for purpose.

Managing the built environment

Unlike the UK, bridges in India are not inspected every year and so many problems with infrastructure go unnoticed. Mounted onto an UAV or simple backpack solution, the Horizon for example can map the current state, movement and predicted decline of a structure, as well as rapidly demonstrating where improvements are needed to ensure stability.

We're also working with more other Asian countries like Singapore and Malaysia, as they drive to become 'smart', and, like India, tackle the increasing number of people moving to 'mega cities' in search of a better way of life. Mega cities need to be mapped out, managed and maintained carefully in order to properly cater to the masses.

what we're doing is democratising to the world the ability to have 3D information at your fingertips. This data is no longer in the domain of surveyors or companies selling expensive high-end equipment - it's there for anyone to access. The real challenge though, is how to interpret and manage that data

Costa Rica, a country, which has recently witnessed steady economic growth, has also turned to the latest technology to assist with rising population rates and the increase in deforestation. Monitoring systems have been used by city planners and non-governmental organisations to map areas of the country's built environment to locate where people have built illegal properties, and as a way to monitor sustainable forest management.

This technology will enable governments and city planners to enforce planning models into cities, ensuring dangerous situations such as these don't occur again. This might include mapping areas for potential development of businesses and apartments; reducing the rate of deforestation and organising new networks for a streamlined transport system and installing fibre-optic cables so that everyone is fully connected.

UAVs flying high

From delivering life-saving medicine, to mapping and monitoring sites for refugee camps, UAVs have huge potential for helping developing economies.

Although their benefits are proven, their reputation for causing disruption in the air precedes them. However in my opinion, the effect of drone-captured data and a drone's ability to deliver drugs to remote or hard-to-access areas, far outweigh any concerns that people may have. If restrictions on drone technology were relaxed, then perhaps more countries and citizens across the world would experience the benefits that come with these systems.

Democratising 3D information

I would predict that we are going to see more rapid data capture. We live in a '3D plus' society that historically has proven hard to capture.

For us, what we're doing is democratising to the world the ability to have 3D information at your fingertips. This data is no longer in the domain of surveyors or companies selling expensive high-end equipment - it's there for anyone to access. The real challenge though, is how to interpret and manage that data.

With the demand for capturing data on the rise, more devices are entering the market with a focus on accessibility and ease-of-use. As more data is created, the need for managing that information and providing useful insights quicker, will be on the increase.

Data is also being shared more frequently too, from construction sites to head offices across the world, putting more emphasis on the importance of managing results so that that data can be interpreted in a meaningful way.

New workflow software's are being developed that will be able to manage the vast amounts of data that will be generated, then to automate the processing and communication of that data. It will also be a platform for data to be backed up and stored in the right place, so that it can be accessed from anywhere in the world.

Application of GIS and remote sensing in urban planning

Initiatives of Ministry of Housing and Urban Affairs, Government of India

Mohd.Monis Khan
Town & Country Planner, Head, Urban and Regional Information System (URIS) Division, Town & Country Planning Organisation, Ministry of Housing and Urban Affairs Govt. of India, New Delhi, India

The Ministry of Housing and Urban Affairs (MoHUA) is engaged in the development and promotion of State-of-Art Technologies such as Geographic Informat ion System and Remote Sensing, Aerial Photography etc. since 1990's. The Ministry has handled several projects and schemes such as Urban Mapping Scheme, National Urban Information System, Sub-Scheme of formulation of GIS based Master Plan for 500 AMRUT cities.

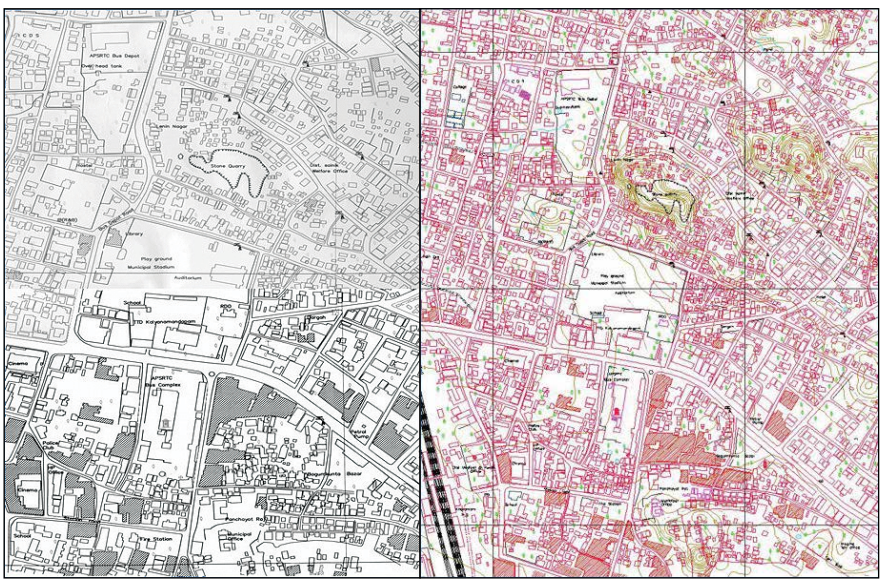
Urban Mapping Scheme

The Ministry has launched a pilot scheme for preparing large-scale urban maps using aerial photography for 53 towns in order to meet the requirement of base maps for towns and cities, was taken up during the Eighth Five Year Plan. The budget allocation for the Scheme was 20.39 Crores. The project envisaged development of technical capabilities of the town planning organisations at Central and State level so as to enable updating of the maps in a revision cycle.

In the first phase, 25 towns from six States were selected on priority basis for coverage under this scheme and in the Second phase 28 towns from 19 State were taken. The work of aerial photography and mapping was assigned to NRSC for all 53 towns. All the maps generated under the Scheme have been sent to respective State Town Planning Departments for their use.

National Urban Information System

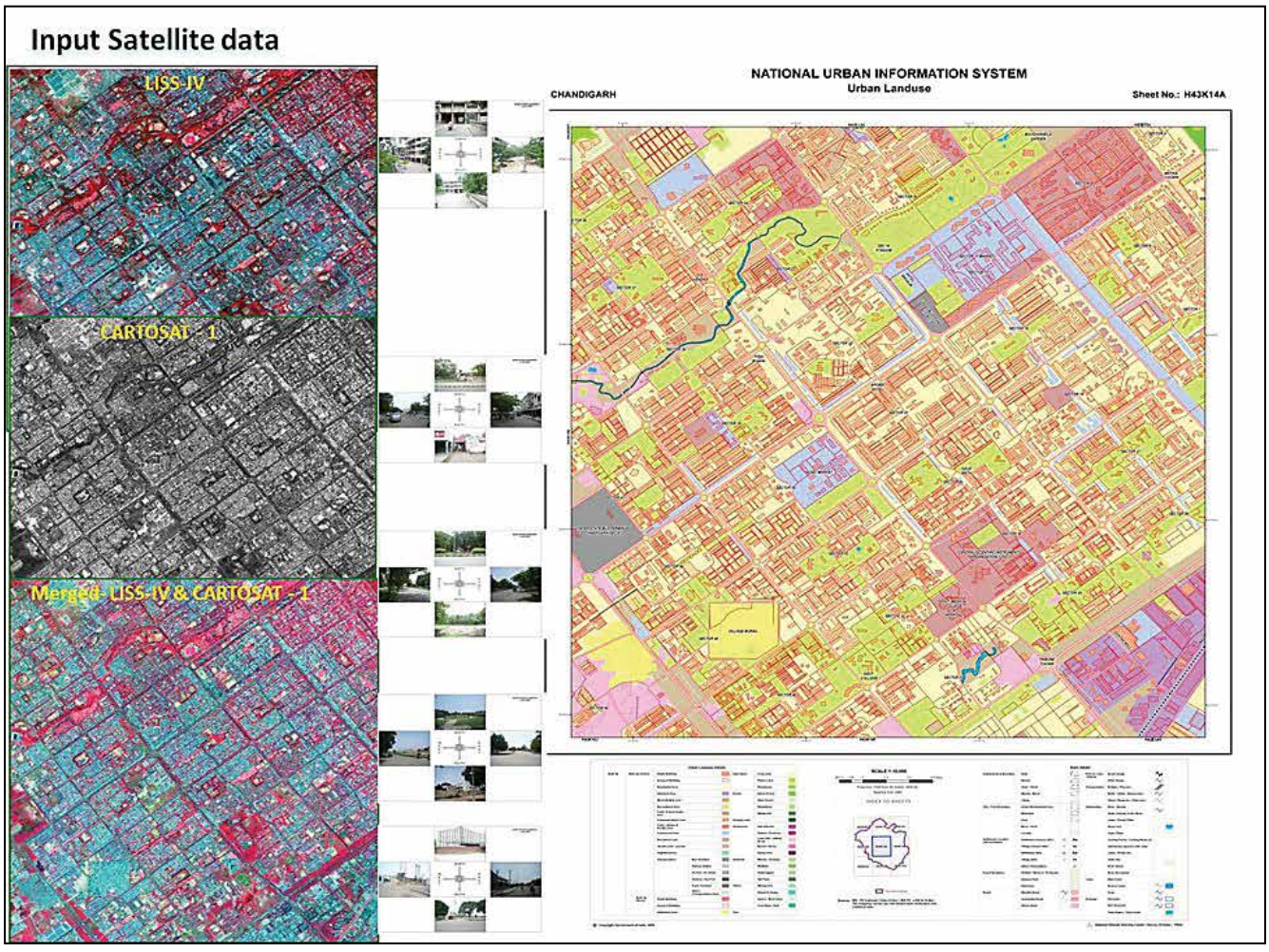
The Ministry has launched National Urban Information System (NUIS) Scheme in March, 2006 to develop GIS databases for 152 towns/ cities in two scales i.e., 1:10,000 and 1:2000. Apart from spatial data, the Scheme had other components i.e. National Urban Data Bank and Indicators (NUDBI), Capacity Building, HW/SW and Application Development. The total outlay of the scheme was Rs. 66.28 Crores of which 75% was borne by the Central Govt. and the remaining 25% by the State. The work of spatial data was undertaken by the Survey of India, Dehradun. The spatial and attribute databases thus generated were used for preparation of Master/ Development plans, town planning schemes etc. serves as decision support for e-governance purposes. The scheme is has been successfully completed in 31st March, 2018.



Line Map and digital map generated under Urban Mapping Scheme

Sub-Scheme on formulation of GIS-based Master Plans for AMRUT Cities

Formulation of GIS-based Master



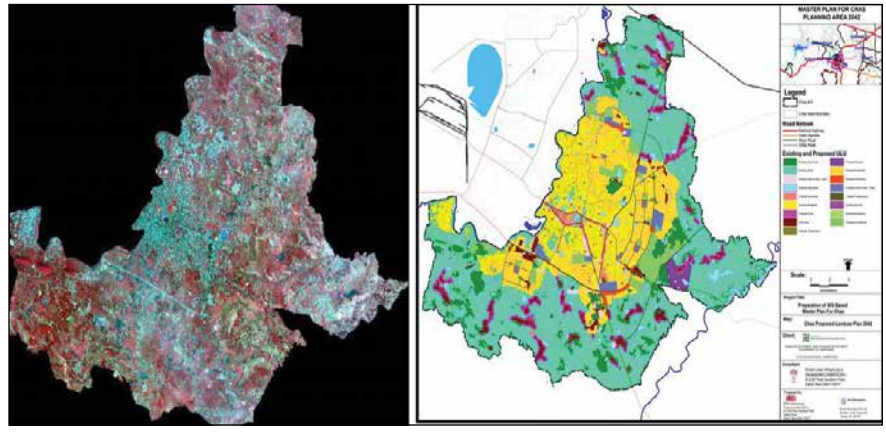
Maps generated under NUIS Scheme

Plans for 500 AMRUT Cities is one of the important reforms under the AMRUT Mission. It has three major components i.e. Geo-database Creation, GIS based Master Plan Formulation and Capacity Building. As on date 34.

States/UT with 456 towns are covered under the Sub-Scheme. The total budget allocation for the Sub-Scheme is Rs.515 Crores and sum of Rs. 97.31 Crores has been released to States.

An MoU has been signed between National Remote Sensing Centre (NRSC), Department of Space and Ministry for Geo-database creation, but State Governments can opt NRSC or private consultancies for Geo-database creation

Accordingly, 21 States/UTs (242 towns/ Cities) are with NRSC and 13 States/ UTs are creating Geo-database with



Draft GIS based Master Plan formulated under AMRUT GIS Sub Scheme

State Resources/ consultants. NRSC has established well equipped GIS Lab facility with 150 systems at their Jeedimetla Campus in Hyderabad and about 300 man hour works is being done daily to accomplish the task of Geo-database creation under the Sub-Scheme.

Under the Sub-Scheme, as on date 226 cities have prepared the Draft base Maps, 24 cities have prepared and submitted the Draft Master Plans and 1297 officials from various State Governments have been trained in 43 training programmes under Capacity Building.

Identifying GNSS market in Indonesia before and the future

This paper will highlight the GNSS market in Indonesia before and the future. We found that within ten to fifteen years the GNSS market in Indonesia will be the biggest around South East Asia and probably in Asia Pacific

Heri Andreas
Geodesy Research Division, Faculty of Earth Science and Technology, Institute of Technology Bandung, Indonesia

Sandy Noveriansyah
Universitas Komputer (UNIKOM), Indonesia

Global Navigation Satellite System (GNSS) is one of the best finding of the twenty century world technologies. It is satellite base positioning and timing system. A millimeter accuracy of 4D positions can be provided by this GNSS system, allowed us to measure the geodynamic with millimeter per year signal only, measure small deformation and even the change of pole of earth rotation. Not to mention the GNSS for navigation and transportation system, it helps a lot in such traffic management, tracking, controlling, etc. GNSS market has contributed huge amount of dollars in world's economy. Japan and America are two country of among others for biggest GNSS market so far. As for Indonesia, it is only part of 4% of Asia market in the early 2000. With such similar characteristic between Indonesia and Japan, especially relating to fast growing nation and the ring of fire, in this case market of GNSS in the future can be promising in Indonesia. This paper will highlight the GNSS market in Indonesia before and the future. We found that within ten to fifteen years the GNSS market in Indonesia will be the biggest around South East Asia and probably in Asia Pacific.

Introduction

The revolution in world scale positioning has begun as the satellite technology invented in the beginning of year 70. Global Navigation Satellite System (GNSS) has been played as remarkable tool for positioning and mapping with high accuracy can be achieved in the easiest

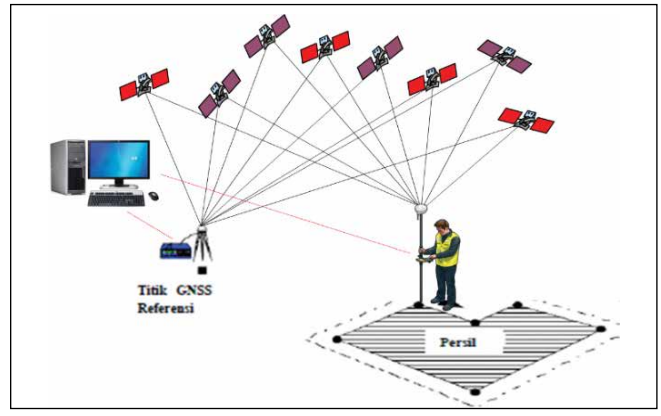


Fig. 1. Illustration of positioning using GNSS technology.

Source GPS World

Fig.2. Illustration of multiuse of GNSS (GPS and GLONASS) in variety of fields.

way (Seeber [1], Abidin [2-3], Leick [4], Hofmann et. al. [5]). In everywhere and in anytime worldwide when signals from the satellites received by the receivers, in these cases the position in 3D or even 4D can be determined precisely (figure 1) and even with precision in the order of millimeter. Not to mention, the position can be also precisely determined "real-time" in the order of few centimeter by Real Time Kinematik (RTK) Method. The GNSS become a revolution in positioning on the 20th century.

Global Positioning System (GPS) and Globalnaya navigatsionnaya sputnikovaya sistema (GLONASS) are GNSS product by US and Russia. For more than two decade they give all kind of services on positioning and timing. In the case of positioning they allowed us to measure the geodynamic with millimeter per year signal only, measure small deformation and even the change of pole of earth rotation. Not to mentioned their positioning services for survey and mapping and geodetic engineering. In the context of navigation, they helps a lot in such traffic management, tracking, controlling, etc. Figure 2 shows many multiuse of GNSS GPS GLONASS in variety of fields.

In the recent years, the GNSS is expanding when the BEIDOU or COMPAS has been launched by the China, the GALIEO by European Union, QZSS (Quasi Zenith Satellite System) by the Japan, etc. So, today it is not only GPS and GLONASS who existed and give services in positioning and timing, we have more. The additional satellite system is theoretically adding the value to others GNSS System since more satellite can be observed. Also with combination of geostationary and original prograde satellite of 12 hour period, the positioning will be more robust.

With such remarkable services in positioning and timing, GNSS market has contributed huge amount of dollars in world's economy. Japan and America are two country of among others for biggest GNSS market so far. As for Indonesia, it is only part of 4% of Asia market in the early 2000 (DOC [6]). With such similar characteristic between Indonesia and Japan, especially relating to fast growing nation and the ring of fire, in this case market of GNSS in the future can be promising in Indonesia. This paper will highlight the GNSS market in Indonesia before and the future.

World GNSS market

With such tremendous contribution to the world in context of application of positioning and timing (e.g. Navigation, transportation, survey and mapping etc. as mentioned) the GNSS market has given huge amount of dollar in world's economy like previously mentioned. The value of the world GNSS technology business in 2002 reached $ 9 billion with an annual increase of around $ 1 billion. This means that currently the value of the GNSS technology business is estimated linearly in more than $24 billion. On the other hand an estimation of $ 96 billion is given by GNSS market for present years (GPS World [7]). Global GNSS GPS receiver market by geography shows America and Asia Pacific (but mostly Japan) are the biggest market until today. It is 31.02% and 42.11%. Meanwhile 26.87% credit for Europe and Middle East (Businesswire.com [8]).

In 2016, the GPS receiver market in Asia Pacific (APAC) was valued at $1.52 billion. In the same year the GPS receiver market in Europe and Middle East (EMEA) is growing at a CAGR of 10.25%. The GPS Receiver market in Americas is expected to reach $2.26 billion by 2021 (Businesswire.com [8]).

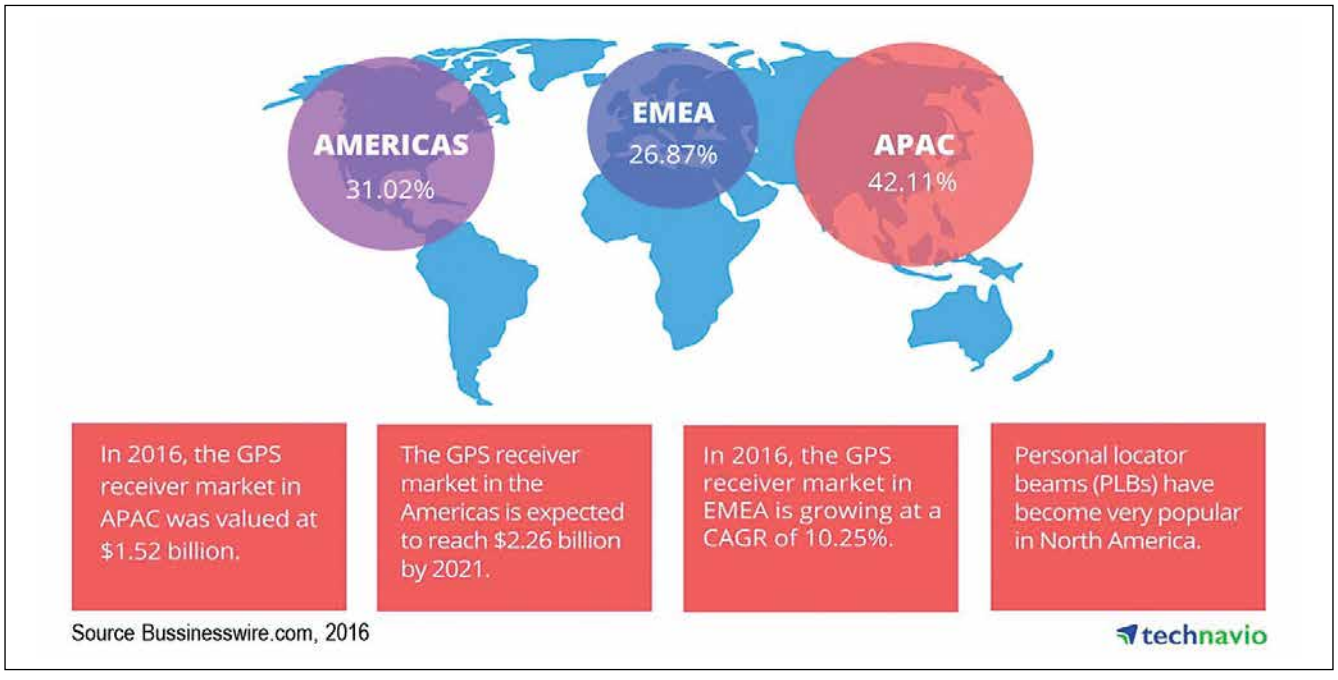


Fig.3. Map of world transaction on GNSS GPS Receiver by 2016. APAC own 42.11%, EMEA own 26.87% and AMERICAS own 31.02%. The future prediction conclude APAC will be the biggest market in the world [8]

Do not forget that we just talking about GPS receivers only. As explained above, In the recent years, the GNSS is expanding when the BEIDOU or COMPAS has been launched by the China, the GALIEO by European Union, QZSS (Quasi Zenith Satellite System) by the Japan, etc. Market of receiver is even more huge. Production of Receiver with has BEIDOU channel is growing rapidly. Previously we only familiar with TRIMBLE, LEICA, ASTECH, MAGELLAND and TOPCON, but now we have various brand like SOUTH, HI-TARGET, CHC, NAVCOM, COMNAV, STONEX, HEMISPHERE, UNISTRONG, etc.

Low cost GNSS receiver is also growing quite rapidly, and not to mentioned the handy type like Garmin, Magelland,

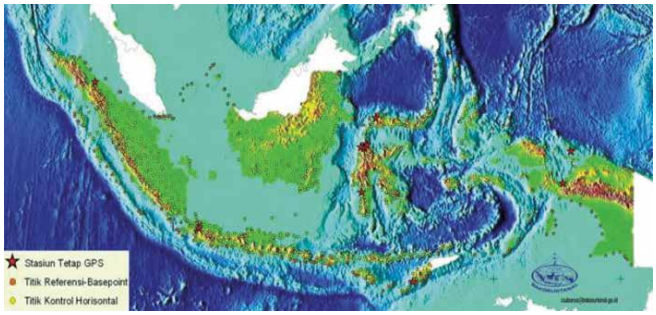


Fig.4. Distribution of benchmark belong to primary and secondary Indonesia Network Frame for survei and mapping (BIG [12])

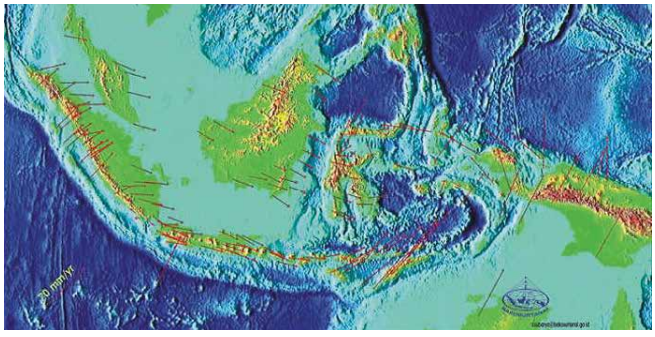


Fig.5. Tectonic motion of Indonesia regions derived from GNSS GPS measurements. The movement indicated by vector displacement (BIG [12])

Fig.6. Activities of GPS measurement in the field to support survey and mapping and others.

etc. If we included this segment into economic value, in this case more billions dollar should be added.

China market and economic value of GNSS is still underestimated by calculation. It should be very huge in sales as well as the economic value. GNSS factories are growing rapidly in China. With such big country, the china market of GNSS in their own country will be the same or even bigger than Japan market. We mentioned again that Japan own 44% of world market in the early 2000. GNSS from China is now enter Africa and South America. We can easily found SOUTH Receiver, CHC, HI-TARGET in those continent and sub-continent.

GNSS market in Indonesia

GNSS market in Indonesia is still relatively small. Fields that are using GNSS technology such as navigation and LBS, transportation, survey and mapping and geodynamic study. Indonesia has only 200-300 CGNSS (Continous GNSS) while Japan has more than 1600. First GNSS receiver come to Indonesia was in 1989 and growing market started since 1994. Slowly but sure the market is growing toward positive direction. Roughly note the vendors have sold for more than 5000 geodetic type receiver so far (Geoprima Solution [9], Wisesa Berkah Bumi [10], and Asaba [11]). This is good news for the market.

First let's talk in detail the beginning the receiver come to Indonesia. It was demo in 1989. After demo the Government realize that GNSS is right tool to help problems of positioning in Indonesia. In 1994 a National Program creating Network Frame for Survey and Mapping executed with GPS. All Benchmark belong to primary and secondary of Network Frame measured by the geodetic type dual frequency receiver. Figure 4 show distribution of Benchmark.

After benchmark being established, another big project being established and indeed even earlier and that is high scale mapping. We used photogrammetry and remote sensing surveys beside conventional tachymetry survey. In order to accomplish the project, help from GPS is crucial. The ground control point for Photogrammetric and High Resolution Satellite Image Data comes from GPS measurements. Fix points of tachymetry is also comes from GPS. In this moment, purchasing of GPS receiver was quite remarkable. Figure 6 shows activities of GPS measurements in the fields.

Since Indonesia is very active tectonically, therefore GPS measurement for geodynamic and deformation is demanding and it started after 2004 Tsunami Earthquake in Aceh. The Government install CGNSS in many places. Approximately we have 200-300 CGNSS. The receiver put it on the stable benchmark. There are also CGNSS on tide gauge stations, on Buoy, etc. Figure 5 shows tectonic motion of Indonesia. This information is very much useful for earthquake and tsunami mitigation program and also for definition of semi dynamic datum. Today Indonesia has

SRGI 2013 semi dynamic datum, replace DGN95 static datum.

Another market of GNSS is on navigation and LBS using GPS handheld receiver, Integration of GPS with GIS (Geographic Information System) and also with the Smart City. Today the Smart Phone also capable on observing GPS satellite. Now we have many applications that is based on positioning and navigation and or LBS such as Google Map, WAZE, GOJEK, GRAB, UBER, etc. Other LBS (Location Base Services) is also available. Off course those all things adding the value of GNSS economy. Below is table 1 summarize the GNSS market in Indonesia until today.

Table 1. Summary of GNSS market in Indonesia until today

High precision positioning	Geodynamic and deformation monitoring, disaster mitigation, early warning
Survey and Mapping	Survey Network, Ground Control Point, Fix Points, etc.
Navigation and LBS	Tracking System, Google Map, WAZE, GOJEK, GRAB, etc.
Maritime	Batimetry, vessel navigation, etc.
Aviation	Flight Navigation, UAV positioning, etc.
Others	Military, GPS time transfer, agriculture, sport, recreation, etc.

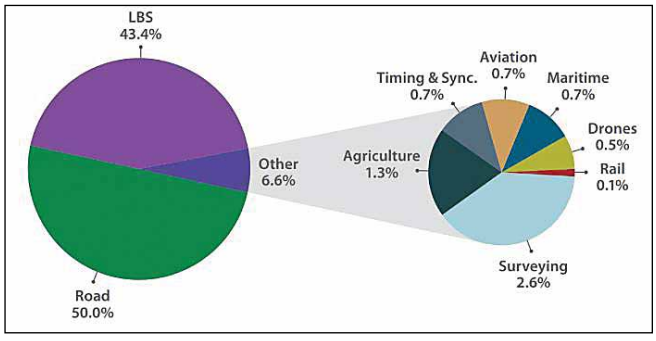


Fig.7. Trend of future GNSS application in the world [12]

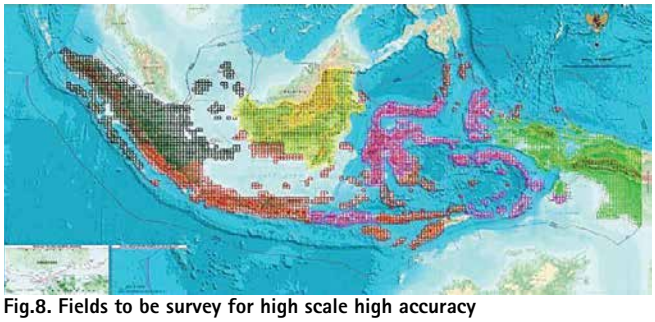


Fig.8. Fields to be survey for high scale high accuracy map in Indonesia including villages.

Fig.9. Indonesia is accelerating in development. Huge infrastructure is being developed.

Future GNSS in Indonesia

Trend of future GNSS applications in the world as well as in Indonesia can be seen in figure 7 below (gsa.europe.eu [13]). Indonesia becomes one of the fastest growing nations and quicker adaptation to the world's changing. The economic value of GNSS in the market will be tremendous. GNSS is expected to service many more fields in the future than today. The trend will be to LBS, Road and others (Surveying, Drones, Maritime, Aviation, Timing and Synchronization and Agriculture). The highest trend will be LBS. For countries with such disaster like Indonesia, the GNSS application for monitoring and disaster mitigation will also be future trend to accelerate.

With such similar characteristic between Indonesia and Japan, especially related to fast growing nation and the ring of fire, Indonesia will be one of the biggest market around South East Asia and even in Asia Pacific. Indeed the future prediction conclude APAC will be the biggest market in the world while Indonesia is belong to APAC. In another word Indonesia is also belong to the potential market for some reasons.

Indonesia is spatially bigger than Japan. If Indonesia applies GNSS in many fields, it is not impossible to defeat Japan and other countries. As noted earlier, Indonesia is still a 4.7% market share in South East Asia. This means that if Japan has reached 44%, then the deviation value is still very large as an opportunity.

The mandate of the Geospatial Information Act No. 4 of 2011 has opened up opportunities for surveys and mapping to high accuracy, which requires GNSS technology. The Indonesia Geospatial Agency (BIG) as a trustee institution must produce 1: 1000 maps of the entire territory of Indonesia, including the mapping of 80,000 villages (figure 8).

Disaster-laden Indonesia needs GNSS technology for disaster monitoring and mitigation. Indonesia is full of earthquakes, tsunamis, landslides, floods, etc. GNSS technology can be used as a module in modeling disaster phenomena, which in turn becomes an input for disaster mitigation models. Estimation of CGNSS for geodynamic study to be installed in Indonesia is 6000 (base on figuring 1600 at Japan). Not to mentioned for natural deformation purpose.

If we talking man made deformation (e.g. deformation on buildings, bridges, road, railways, platform oil and gas, DAM, etc.), prospect of GNSS to monitor man made deformation is very bright. Huge infrastructures is being developed today in

all over Indonesia (figure 9). Today only few programs have been set up to monitor some bridges, platform oil and gas and DAM. Probably no program yet on monitoring building, road and railways. So, we can imagine the prospect in the future.

Indonesia is one of the biggest archipelago country in the world. Located in the equator regions Indonesia is rich for natural resources such as forest (figure 10), fishing ground, farmland, mining, etc. Managing all resources need position as one basic parameters. So, we can imagine another prospect in the future for GNSS in Indonesia. One finest example in the future is precise farming. The others are delineation of forest boundary, calculate size of mining area, etc.

Land parcel in Indonesia consist of about 140 millions unit. Until today only 50 million is well define (e.g. certified). The rest we still need measurements. For about couple years ago, the RTK multi GNSS plays an important role in measuring land parcel in Indonesia. This RTK can speed up the measurement (Andreas [14]). Base on record from vendors (Geoprima Solution [9], Wisesa Berkah Bumi [10], and Asaba [11]), GNSS receiver selling reached more than 2000 unit in order to support land parcel measurements. In the future they estimate there will be more millions to sell. Land parcel certification expected to finish by 2025.

As for fleet managements system, navigation, tracking and controlling system, figure 11 show future of them in the

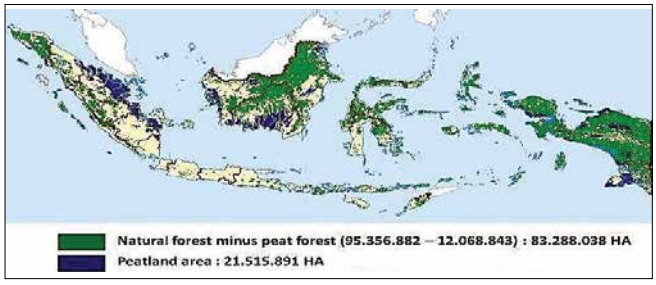


Fig.10. Map of forest (natural and peatland) in Indonesia

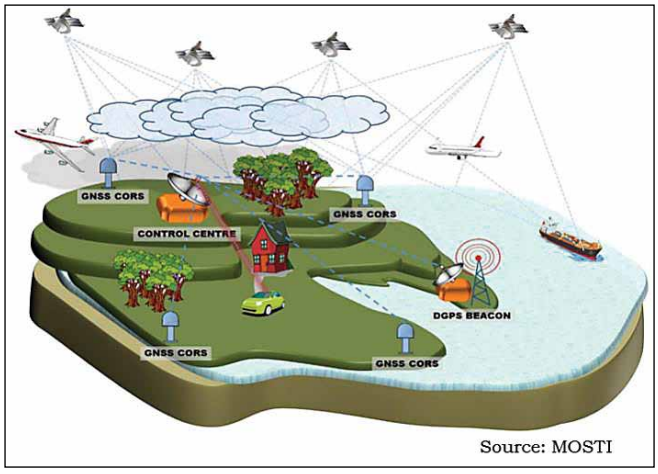


Fig.11. GNSS infrastructures for fleet management system, navigation, controlling and LSB system.

world. Indonesia has the same future figure. As mentioned earlier in Indonesia now we have many applications that is based on positioning, navigation and LBS such as Google Map, WAZE, GOJEK, GRAB, UBER, etc.

Based on research on literature, interviewed and questionary the Goverment, the Experts, Academia, the Vendors, the variety of users, we found that within ten to fifteen years the GNSS market in Indonesia will be the biggest around South East Asia and probably in Asia Pacific. Below is table 2 summarizing the future GNSS market in Indonesia.

Table 2. Summary of GNSS future market in Indonesia

High precision positioning	Geodynamic and deformation monitoring, Infrastructure monitoring, disaster mitigation, early warning
Survey and Mapping	Survey Network, Ground Control Point, Fix Points, etc.
Navigation and LBS	Tracking, Fleet Management System, Google Map, WAZE, GOJEK, GRAB, etc.
Maritime	Batimetry, vessel navigation, surveillance, etc.
Aviation	Flight Navigation
Agriculture	Precise farming, Forrest management, etc.
Others	Military, GPS time transfer, agriculture, sport, recreation, etc.

Closing remarks

In everywhere and in anytime worldwide when signals from the GNSS satellites received by the receivers, in these cases the position in 3D or even 4D can be determined precisely and even with precision in the order of millimeter. Not to mention, the position can be also precisely determined "real-time" in the order of few centimeter by Real Time Kinematik (RTK) Method. The GNSS become a revolution in positioning on the 20th century.

For more than two decade the GNSS give all kind of services on positioning and time. In the case of positioning they allowed us to measure the geodynamic with millimeter per year signal only, measure small deformation and even the change of pole of earth rotation. Not to mentioned their positioning services for survey and mapping and geodetic engineering. In the context of navigation, they helps a lot in such traffic management, tracking, controlling, etc.

With such tremendous contribution to the world in context of application of positioning and timing, the GNSS market has given huge amount of dollar in world's economy. Global GNSS GPS receiver market by geography shows America and Asia Pacific (but mostly Japan) are the biggest market until today. It is 31.02% and 42.11%. Meanwhile 26.87% credit for Europe and Middle East. China market and economic value of GNSS in this country is still underestimated by calculation. It should be very huge in sales and in the economic value. GNSS factories are growing rapidly in China. With such big country, the china market of

GNSS in their own country will be the same or even bigger than Japan market.

GNSS market in Indonesia is still relatively small as for today, nevertheless slowly but sure the market is growing toward positive direction. Based on research on literature, interviewed and questioner, we found that within ten to fifteen years the GNSS market in Indonesia will be the biggest around South East Asia and even in Asia Pacific.

Acknowledgements

Many thanks to students and surveyors who help us in distributing the questioner. Thanks also to people (expert, Academia, Government and bussinessman) who willing to interviewed.

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The paper was presented at ISGNSS 2018 E3S Web of Conferences 94, 03010 (2019)

In Coordinates

10 years before...

mycoordinates.org/vol-6-issue-2-February-10

Defining civil PNT requirements

To support the expanding demands for PNT services into the future, civil PNT requirements need to be identified. Civil agencies and departments can do this by supporting a standardized set of terms for PNT services, and state their needs without regard to how they will be implemented. This method worked well for the US military in developing and fielding GPS, and it will work well for civil departments and agencies in fostering the next generation of PNT services in years to come. The efforts being made by the United States to define PNT requirements can be adopted by other countries as well to support a universal statement of civil PNT requirements.

John W Lavrakas
President, Advanced Research Corporation, Newport, Oregon, USA

Fuzzy strong tracking unscented Kalman filter

An alternative state estimation technique called the fuzzy strong tracking unscented Kalman filter has good potential as the GPS/INS navigation state estimation technique

Dah-Jing Jwo
Professor and Chairman Department of Communications, Navigation and Control Engineering National Taiwan Ocean University

Fong-Chi Chung
Department of Communications, Navigation and Control Engineering National Taiwan Ocean University

Shih-Yao Lai
Universal Microelectronics, Co., Ltd.

GNSS support to Canine search and rescue

osmografo® is an innovative technological aid for search and rescue teams using rescue dogs. It does not substitute but provides added value to expert rescuers in their operation and decision making process. The system is fit to user requirements, not just technical, but operationally. Particular fit to dog characteristics with a safe detachable collar of right size and weight.

José Caro
Head of GNSS Advanced Systems Division (GMV)

Manuel Prieto
GNSS Engineer at GMV, Madrid

MISSION 2020

India needs the Land Titling project 'yesterday'! not tomorrow or day after. We need to make a good beginning through a Steering Committee, as mentioned, who will identify the main 'pillars' and the 'milestones' of the project. This is a mega-project which is expected to bring major change. Therefore all the principles of management of change will be applicable to this project also.

The project should be evolved in such a way that is not only 'right' but is 'acceptable' to all, especially rural people. A brand new project always generates need for training, research, standards and reference. Letthese be started on a sound footing. The research action can even be started now, ahead of titling project. The State Departments of Land Surveys have all the knowledge and wisdom. These must be utilized. There is no of a fresh technology.

Prof P Misra
Consultant, Land Information Technologies

Where Have You Been with Your TRIUMPH-LS Lately?

Survey statistics

Averaging		Horizontal Percentiles		Vertical Percentiles	
Points	147	100%	0.023ft	100%	0.050ft
Distance	0.007ft	99%	0.020ft	99%	0.030ft
HRMS	0.005ft	95%	0.015ft	95%	0.025ft
VRMS	0.007ft	90%	0.012ft	90%	0.023ft
GPS	7.6	85%	0.010ft	85%	0.019ft
GLNS	6.1	80%	0.009ft	80%	0.016ft
Per Point	1534.01 sec	75%	0.008ft	75%	0.015ft
		68%	0.008ft	68%	0.013ft
		50%	0.006ft	50%	0.010ft

John Evers

"Awesome Precision"

"All shots are comprised of 7 engine resets for phase 1, 180 seconds phase two, no validation. open sky T3 base and LS rover.

85% within 0.01' horizontal, and 0.02' vertical.

I have never seen anything like this when using my T2 base."

Darren Clemons

"big ole tree"

"5'+ across white oak - the LS is within about 2" of being flush with the trunk - got a fully validated, verified shot and a check within about 8 minutes...."

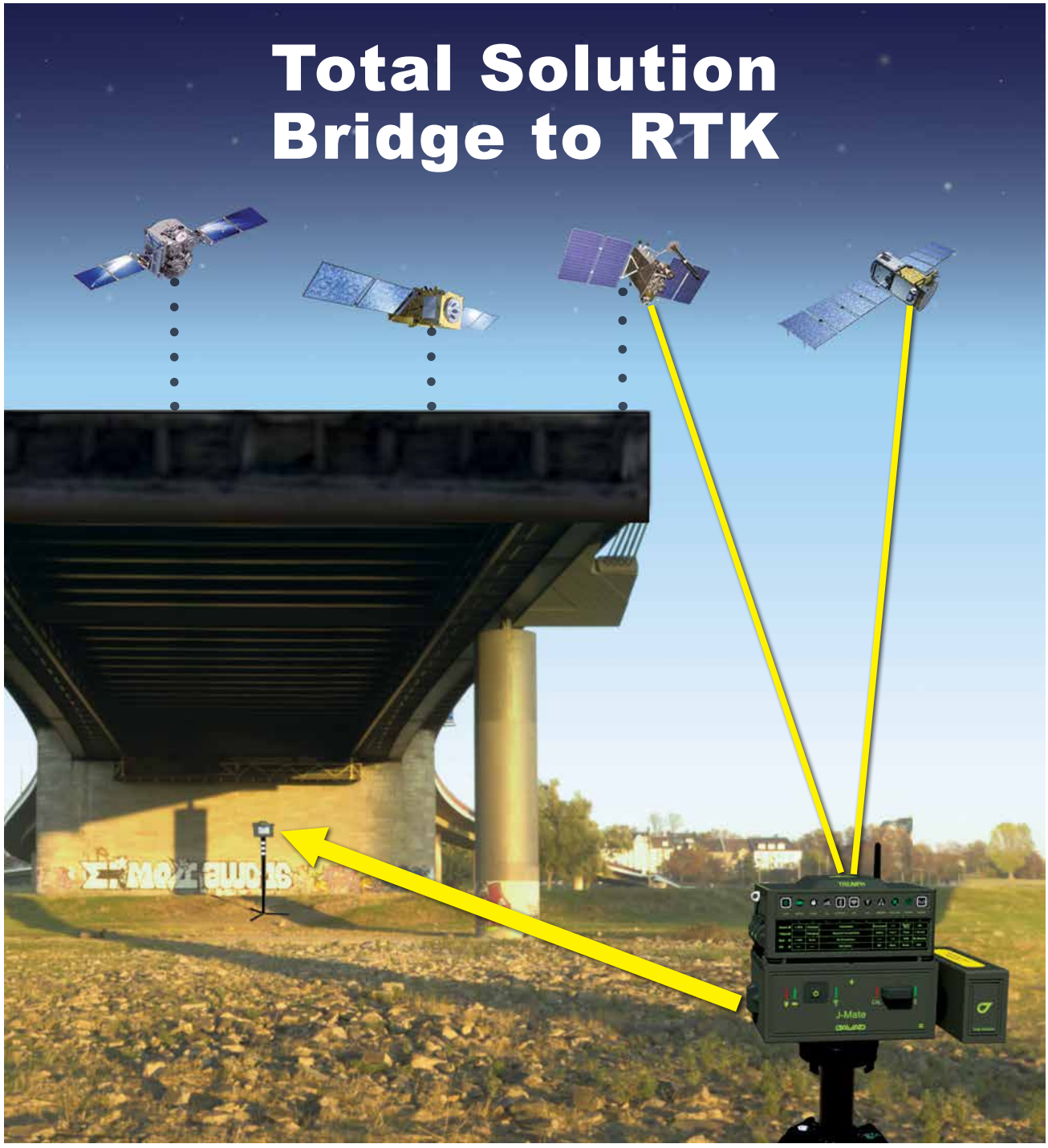
The new **TLS2TLS** and more features see inside **>>**

Front

JAVAD

www.javad.com

Total Solution
Bridge to RTK

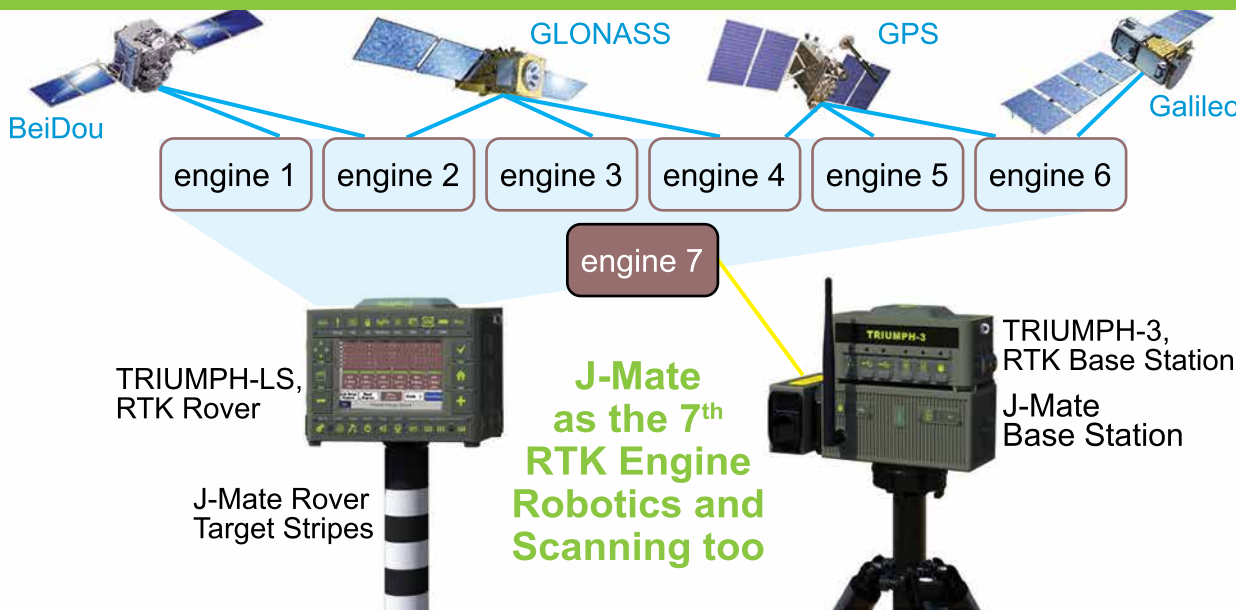


J-Mate is a bridge between RTK and areas that GNSS signal is not available.

- **Direct up to 300 feet**
- **Remote (Robotic) up to 150 feet**

FL

RTK and Optical United



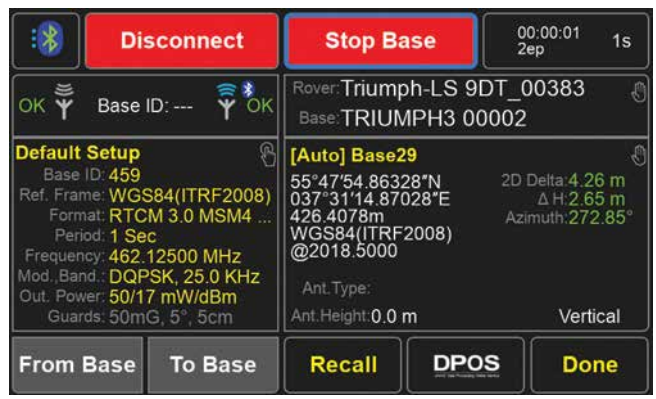
Your Own Complete RTK & Optical

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

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

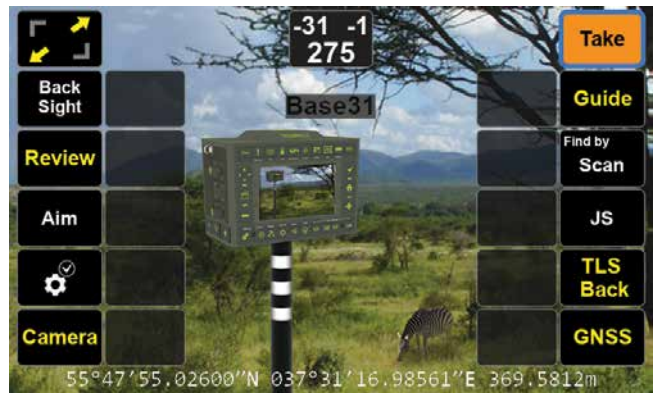
Now RTK and optical solutions are available simultaneously and can verify each other's solutions. They also can cover each other, when one is not available.

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



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

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



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

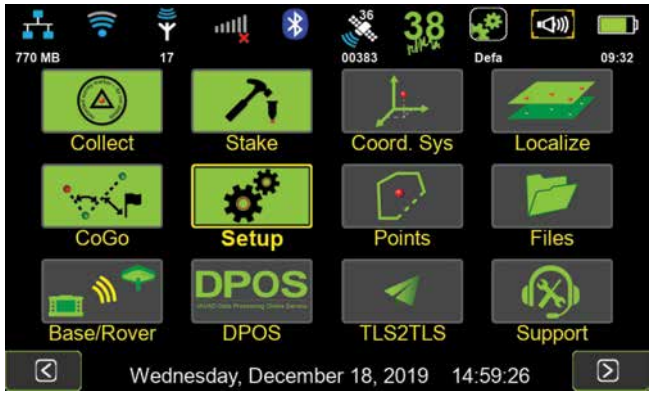
At TRIUMPH-LS = 2.13 kg (4.40 lb), TRIUMPH-3 = 1.26 Kg (2.20lb), and J-Mate = 2.17 kg (4.41 lb), the total package of 5.6 kg (11.02 lb), weighs less than one conventional optical total station alone.

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

J-Field, the Embedded Controller

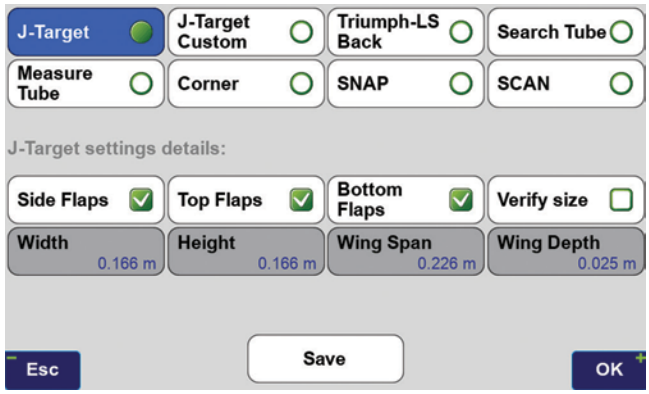
J-Field is the embedded application program of TRIUMPH-LS. It has the following unique features for each point surveyed:

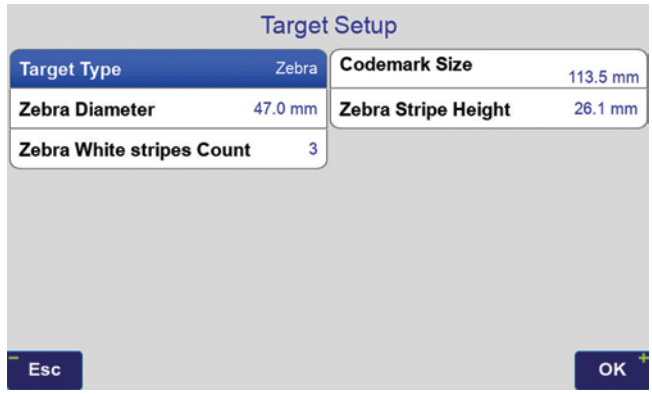
- Six parallel RTK engines to maximize solution availability.
- Automatic Engines Resets, verification and validation strategy.
- Several graphical and numerical confidence reports and documentation.
- Voice-to-text conversion for hands free operation and documentation.
- Lift & Tilt and automatic shots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



Take Backsight with a Single Shot

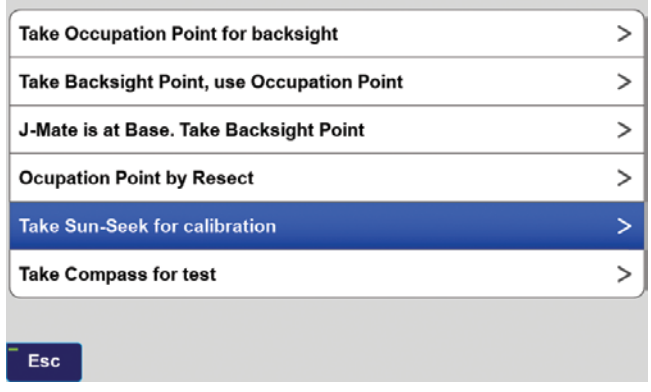
To calibrate the J-Mate, take few seconds of RTK at the Backsight point, and click "Backsight" button. There is no need to locate Occupation Point and the Backsight point, because Occupation point is the RTK Base station and one point is enough to determine the azimuth to calibrate the J-Mate angular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

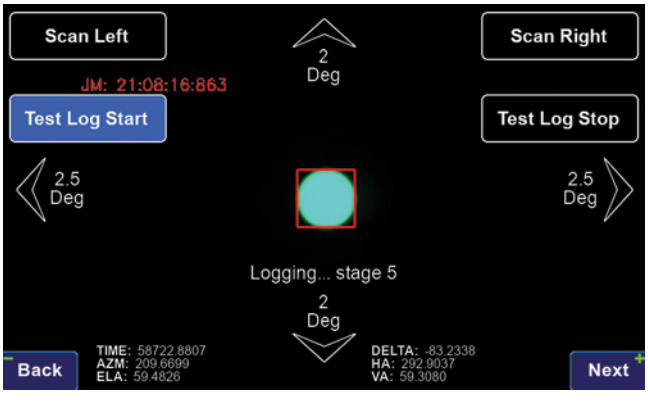


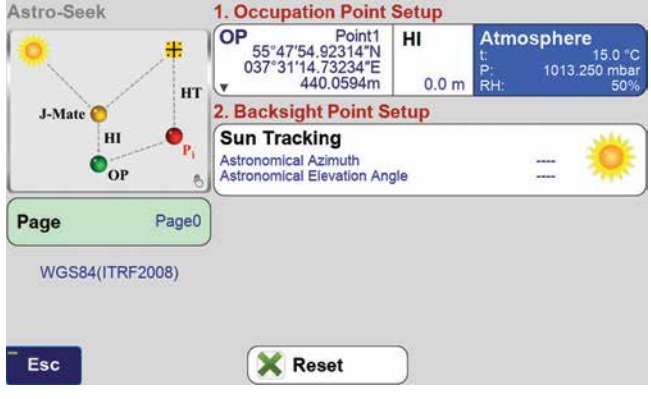


Backsight with Auto SunSeek

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







See details at www.javad.com

Light Weight, Low Cost

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

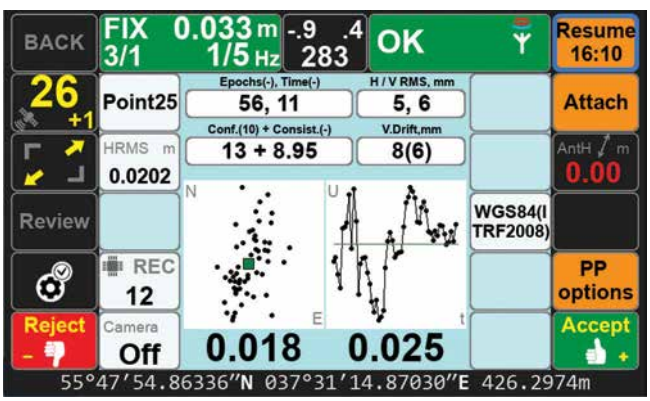
Complete RTK Base & Rover.
Complete controller and software.
Complete optical system.
Free updates.
Robotic & Scanner...
...all under $40K

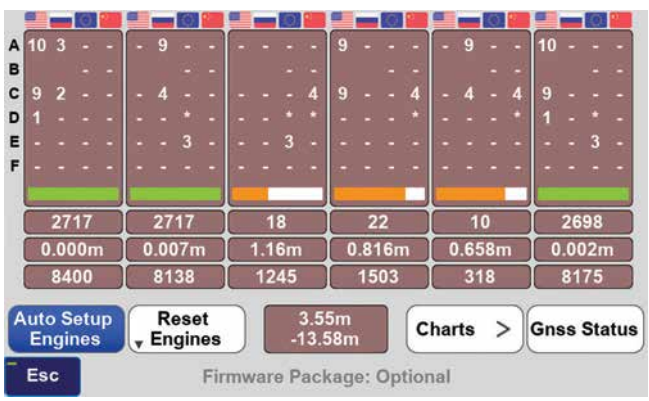
And it all fits in a small carrying bag.

Six RTK Engines Auto VERIFY

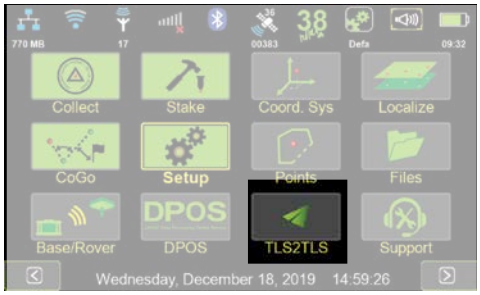
Smart assignment of satellite signals to different engines.

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

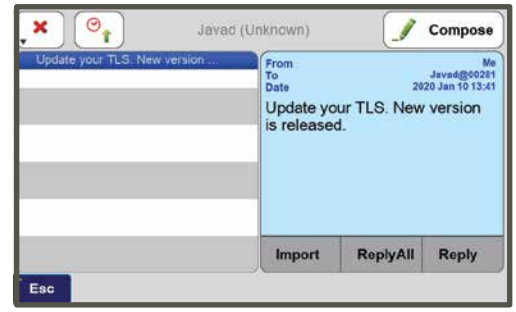


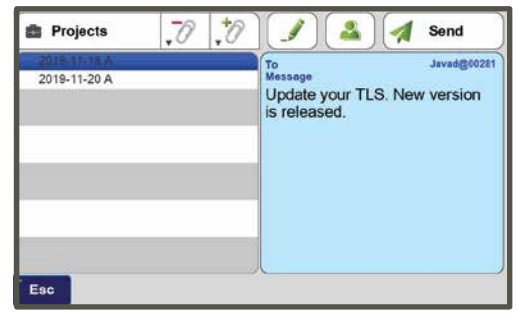


TLS2TLS



You can send and receive text messages and files from and to other TRIUMPH-LS units. In the Main screen click TLS2TLS and then in the “Compose” screen, click and enter names and serial numbers of the TRIUMPH-LS units that you want to communicate with. You can attach Projects, Screenshots, Images, Audio, GNSS RAW files to your text messages and send to the selected TRIUMPH-LS units.





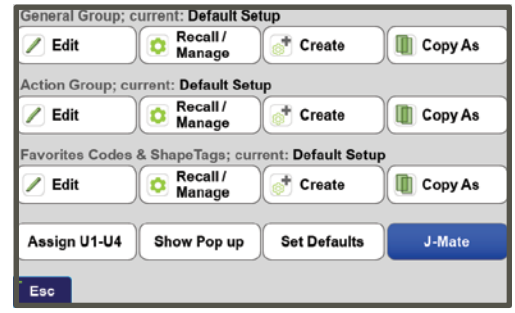
The received messages are shown in the first screen. You can “Import” the attached files, if any, to your local unit. Click “Reply” to reply to a message.

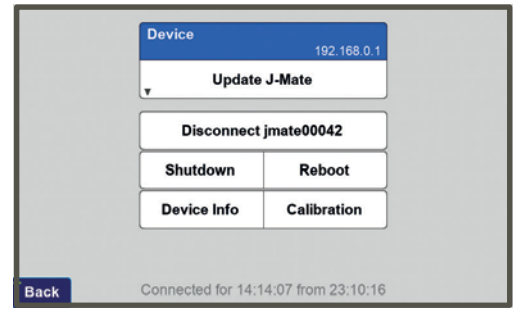
You can reply to received messages by clicking the “Reply” (only to sender) or “ReplyAll” (to all recipients) buttons.

You may receive “Public” messages from JAVAD GNSS team. You do not to reply to them.

Connecting the TRIUMPH-LS to the J-Mate

Let’s set the record straight: J-Mate is not a total-station. J-Mate and TRIUMPH-LS together make the “Total Solution” which is a combination of GNSS, RTK, camera, angle encoders and laser range measurements that together do, conveniently and cost-effectively, a lot more than a total station. For long distances, you use GNSS and for short distances (maximum of 300 feet in Direct mode and 100 feet in Remote/Robotic mode), you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges from zero to infinity.





TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate.

Click the Setup icon on the TRIUMPH-LS Home screen and click “J-Mate” to connect to J-Mate.

The J-Mate SSID will be in JMatexxxxx format, where xxxxx is your J-Mate’s serial number. After Wi-Fi connection is established, click the “Collect” or “Stake” icons according to your job.

As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate.

TRIUMPH-3

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

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

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

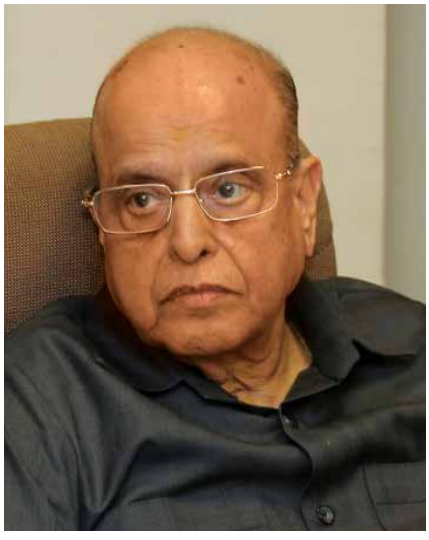
It includes options for all of the software and hardware features required to perform a wide variety of tasks.

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

Ideal as a base station

Spatial analytics and deep learning in GIS

The future will be of Spatial Analytics - based on principles of Data Science, Artificial Intelligence and Deep Learning. Spatial data is voluminously available for human activity – triggered by the Big Data and cloud technology



Dr K Kasturirangan
Former Chairman,
Indian Space Research
Organization (ISRO), India

Today, information is key to the success of a citizen, society, governments and humanity as a whole. Our government's vision is to bring a new paradigm for governance and development with emphasis on participatory approach from communities and citizens; enable a scientific mapping of the resources, examine needs and aspirations of citizen beneficiaries and society; support sustainable development and spatial planning; assist quick and reliable monitoring of plan implementation and status of development; enable transparent systems for inclusivity of society and support real-time mapping of feed-back and redressal systems. Spatial Analytics can play an important role and support many aspects of national economic development and governance process.

Geospatial technology has made spectacular advances over the past half a century since the early 1970s when the computerisation of maps using primitive manual coding and card-punching gave rise to "store and print maps" at will. At the same time, the satellite images from ERTS (Landsat) gave details and perspectives of every part of the Earth as never seen before. India's tryst with remote sensing also started in early 1970s as a unique way of building applications by involving user departments – called the Joint Experiments Programme (JEP) which creating a rich experience of applications and user service orientation. Way back in 1980s, we started the GIS activities and initiated the concept of Natural Resources Information System (NRIS) – a spatial system demonstrating support for decision-making process through many pilot-projects, particularly focussing on natural resources as well as planning and development . Over the years, India has developed successful activities in Imaging (series of IRS satellites, aerial platforms), Mapping (topographic and thematic), positioning and surveying and GIS (databases and applications) – both in government and commercial domain. GIS technology is widely used and a good knowledge-base has been created over the years. In fact, India has been at the forefront at some unique systems – the National Natural Resources Management System (NNRMS); the NRIS and Integrated Mission on Sustainable Development (IMSD); the National Spatial Data Infrastructure (NSDI); National Urban Information System (NUIS); Bhuvan and more recently National GIS – these were all unique India-centric systems that would have brought scientific decision-making and benefits to governance and citizens in a significant way. While these systems definition were successful, I see that the systems implementation has been not that successful and we have a lot of catching up to do now. However, GIS based initiatives (or projects) of the various departments of the Government; efforts at modernization of land records; various City-GISs; GIS initiatives of the states

> Some of the initiatives have certainly been successful to prove GIS application potentials in a "project mode" but GIS is yet to get a "service orientation" and get assimilated to become a part of the work-process of governance, planning and nation-building in a significant manner

(of particular mention is the wonderful work done by Karnataka for a Karnataka-GIS which was spearheaded by KJA); GIS technology in private sector services and research activities in universities have helped bring good and operational examples of applications of GIS.

In spite of fairly wide usage of GIS as a technology, the full potential of GIS has not been exploited for decision-support by planners, stake holders for governance-process, decision-makers and also bring direct benefit to citizens and many others. Some of the initiatives have certainly been successful to prove GIS application potentials in a "project mode" but GIS is yet to get a "service orientation" and get assimilated to become a part of the work-process of governance, planning and nation-building in a significant manner. There is also a gap in technology development levels – we need to maintain a high-level of national capability in this important technology area and also leverage to be in the fore-front of GIS technology at the international arena. These two important aspects are at the background of many recent endeavours and discussion – we need a forward plan of action for Spatial Technology and Applications.

In 1970s, the birth of GIS was with simple data models and a monolithic computer software, performing a wide range of functions that included capture, storage, and analysis of spatial data. Over the subsequent decades into the 1990s, the set of software functions in a GIS proliferated, as did the underlying data models become complex, in the interests of supporting new data, new applications and becoming decision-oriented on mainframes to minicomputers, and ultimately to the desktop and now to handheld devices. In the 1990s, two very significant changes to this early vision of GIS set the goals for Spatial Data Infrastructures – large volumes of maps, images and spatial data had become digitalised by then; first global coverage of satellite images were available digitally and the satellite based Global Positioning System (GPS) had greatly reduced the cost of measuring location and location mapping. Yet another development was that a large number of research had been generated and large workforce and industries, apart from government and academia, were engaged in the GIS eco-system across the world. The need to share the digitalised spatial data across user communities triggered the vision of a National Spatial Data Infrastructures. World-over large initiatives were taken up in various nations to organise SDI and National GIS systems. India too embarked on a vision to organise a NSDI in 2002 to bring a collective effort at aligning the geospatial community and various demonstrations of NSDI were taken up.

The next few years will see massive transformation, in society as a whole but also in geospatial technology. S-Insights will be the ultimate goal – but with due regard to openness, access, and engagement, the geospatial infrastructure of the future will integrate information, processes, and workflows, and capture sufficient information to support replicability across the world

The birth of the www and internet in the 1990s boosted the "sharing" vision and also eased the technologies that were required for sharing the spatial data and in generating and storing them on the web. The commercial aspects of spatial data became a possibility and the world saw many a g-marketplace emerge for commercial spatial data availability. By the time of the 2000s the SDI vision had been over-whelmed by GIS on the Web and now GIS on the cloud. Very quickly the world saw Google Earth, Digital Earth initiatives took a great boost and was available to every citizen.

In the 2000s, we see another major change – giving a twist to the SDI vision to the vision of GIS Systems of System. Creating spatial data, maps, images – which hitherto were time-consuming and costly suddenly transformed to one of rapid process and also cost effective – thus, various technologies and sensors captured location and vast amounts of data got collected very easily across the Earth – data collection which soon made a citizen a "sensor" through on always-connected device, the mobile phone. So today it is easy to create maps of phenomena such as road congestion that are valid only for a few minutes and available free to the user through mapping apps on a mobile device. Sensors in the environment are now able to create an abundance of time-dependent geospatial data, making time an important element of today's vision of geospatial technology. Similarly, contemporary technology such as GPS,

BIM (building information management), structure-from-motion, platform- mounted LiDAR, and ground-penetrating radar have made it possible to acquire three-dimensional representations of geographic features. Today, the basic element of spatial data is no more x,y but <x,y,z,t,a> where x, y-a define the traditional coordinate and z are the height/depth reference in three- dimensional space, t is time, and a is an attribute of that location in space-time. Today, this is how spatial data is characterised – giving rise to the next vision of GIS – Big Data GIS – what I call as GIS Systems of Systems. I must tell all of you that the first of concept of such a GIS Systems of Systems was defined in India – National GIS which was a comprehensive definition of India's leadership in the global arena of GIS. The National GIS initiative, driven by Dr Shailesh Nayak and Dr Mukund Rao, was a result of exhaustive consultation and discussions within Government, industry and academia and in 2012 the final plan of action was defined. We have not made much progress from that definition stage – and many of us are realising that in

2020 we need to go back to drawing-boards and define of vision ahead again.

Where does one see the GIS technology and applications go from here? It is entirely reasonable, therefore, that the geospatial community should chart a path that can help and give India a stable direction. Where are we going with this technology, and how can it address the challenges that we currently face, and will face in the coming years? With the past experience of past 40-50 years, tremendous possibilities are there that can change the way India will deal with spatial technologies and applications – it becoming just one "bit" of data and applications in the complex Big Data Systems of System exploding on the internet.

Today, geospatial technology extends into virtually all areas of human activity helping to solve problems and make decisions, predict outcomes, and discover and explain how the Earth's environmental and social systems work and is reaching each and every citizen on this Earth. The fusing of spatial data with other data allows its users to get "insights," by using maps, images and statistics to reveal what would otherwise not be visible, appreciated, understood and experienced by one and all. Government agencies, private sector, academia, and non-profit organisations use GIS in many aspects of their businesses and activities. Individual citizens encounter GIS in mapping and wayfinding apps, and in apps that provide information that is customized to the user's location. Just like a human nervous system collects signals from many parts of the body and transmits them to the brain, where they can be processed and combined, leading eventually to actions, we now have a spatial nervous system of the Earth – characterising how the planet is sensed, how the resulting data are transmitted and to whom, how the various signals are conflated and stored, and how the costs of all of this are met.

The future will be of Spatial Analytics - based on principles of Data Science, Artificial Intelligence and Deep Learning. Spatial data is voluminously available for human activity – triggered by the Big Data and cloud technology. Data Analytics is key to obtain Insights and what I see for the future is that Spatial Insights will drive the vision for all of us for using more spatial data, maps, images and in real-time and arrive at key answers to questions that citizens, society, government, industries, researchers may have for their contributions for the betterment of humanity and our Earth. So S-Insights or Spatial-Insights would be the way of development of this technology further. The next few years will see massive transformation, in society as a whole but also in geospatial technology. S-Insights will be the ultimate goal – but with due regard to openness, access, and engagement, the geospatial infrastructure of the future will integrate information, processes, and workflows, and capture sufficient information to support replicability across the world. It will develop on power of technology that is anticipated in the 4I revolution – keeping the conflation, resampling, upscaling, and fusion of S-Insights to bring benefit to one and all.

Data science is emerging as a major element of knowledge and profession and is core to make sense of the vast collections of big data systems. Data science is a set of fundamental principles that can easily support and guide the extraction of insights from data. In processing data for new insights, mathematics, statistics, logic and reasoning, modelling, deep learning and artificial intelligence etc will be an important capability. For data to be processed, engineering the data itself will become so important – already Data Engineering is becoming a new paradigm for preparing the vast data so that it becomes amenable to the analysis process easily and repeatedly. Outputs would be as simple as answering statements; visualisation data products; a easy to understand GIS dashboard or any product that supports achieving a more informed decision. Spatial Analysts will drive the Big Data of GIS and make it easily amenable to Deep Learning processes where the vast data itself will provide triggers to further analysis. For example, the vast collections of IRS satellite images can itself provide the spectral signature libraries to automatically classify and segment the newer images and detect changes over time – this autonomous classification algorithm can be easily derived from the existing images that are available from 1987 onwards. Similarly, the census data collection from 1950 onwards can itself provide predictive logic and models of how Indian demography can trend for next 10/20/50 years – thereby learning trend algorithms from the census data holdings. Or say, daily traffic data in a city can itself provide autonomous road-load indicators across every hour in a city and model traffic-loads on a daily basis. There can be numerous examples by which large GIS data collections can be the self-learning crucibles and be "answers" to questions that various problems that emerge in society. In fact, GIS databases are naturally characterised for Deep Learnings and artificial intelligence models because they are a structured, referenced collection of time-stamped pixels, vectors, rasters, data points making them so easy for Dl and AI models. Spatial Analytics is very important and India needs to build its capabilities and capacities in this area for the future.

GIS databases are naturally characterised for Deep Learnings and artificial intelligence models because they are a structured, referenced collection of time-stamped pixels, vectors, rasters, data points making them so easy for Dl and AI models

This article is based on Dr K Kasturirangan's inaugural address at International Workshop Advanced Spatial Analytics and Deep Learning for Geospatial Applications held during January 20 – 31, 2020 in Bengaluru, India

Maps by the citizens, of the citizens and for the citizens

An idea mooted at International Workshop on Advanced Spatial Analytics and Deep Learning for Geospatial Applications held during January 20 – 31, 2020 in Bengaluru, India

"India has been at the forefront at some unique systems like NRDMS, NRIS, NSDI, National GIS, etc." said Dr K Kasturirangan, Former Chairman ISRO. He, however, lamented that though these systems definitions were successful but the implementation has not been successful.

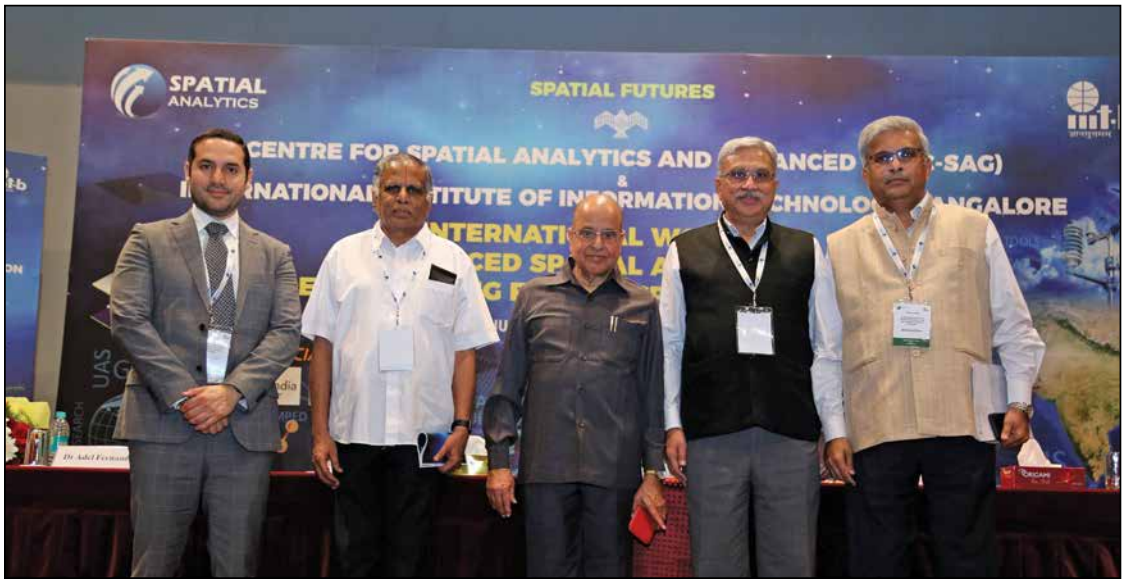
What Dr Rangan said was true but as the time has changed and so has the technological ambience around which the spatial technologies function. Some of these changes and challenges were addressed at International Workshop Advanced Spatial Analytics and Deep Learning for Geospatial Applications held during January 20 – 31, 2020 in Bengaluru, India organized by Centre for Spatial Analytics and Advanced GIS (C-SAG), Bengaluru and International Institute of Information Technology, Bengaluru (IIIT-B).

"This is the first of its kind workshop in India which has provided perspective and concepts of Data Science, Data Analytics - particularly Spatial Analytics, Artificial Intelligence, Machine Learning, Modelling – all centered around spatial data and geospatial applications. Specific applications and governance issues were addressed in the Workshop that has brought tremendous awareness of using Analytics and Deep Learning tools in GIS," says Dr Mukund Rao, Chief Executive, C-SAG.

And as the workshop progressed, it ventured to explore the section where 'spatial' and 'analytics' overlap and interact.

When Geodata is Big data

The workshop provided a snapshot of the status of geospatial data generation, usages and many of the applications as it brought together the faculties of many of the leading organizations. Dr Mukund Rao gave a comprehension of how the technology, and application of Spatial Analytics has emerged at the forefront and will push GIS to insightful limits in future – especially becoming citizen-centric in all its crowning-development. Dr Vishnu Chandra, Deputy Director General, National Informatics Centre shared a very interesting experience related to *Swacch Bharat Abhiyan* where people share the location of newly built toilets and pictures of their status. These information are validated later. Dr Shailesh Nayak, Director, NIAS ran through the complex phenomenon of earth system, its components like ocean and atmosphere and their interactions. He said that it is important to understand this relationship so that we can see the connection between the Indian monsoon and drought in Australia. He also elaborated on the role of Data Analytics and Modelling in weather forecasting. Dr PLN Raju, Director, North East Space Application Centre (NESAC) shared the role of NESAC and shared details of some of the projects being undertaking by his centre. Arvind Kumar, Head Bhuvan Content Generation Division, National Remote Sensing Centre spoke in detail about Bhuvan and how it is handling, managing, storing and also making accessible big data like satellite imageries. Dr P S Acharya, CEO NSDI shared learnings from SDI applications and Dr Debapriya



Dr Adel Bolbol Fernandez, Prof S Sadagopan, Dr K Kasturirangan, Dr Shailesh Nayak and Dr Mukund Rao at the Inaugural of the Workshop.

Dutta, Head NRDMS, Department of Science and Technology discussed the spatial dimensions of spatial analytics.

Citizen Series Maps (CSM)

Lt Gen Girish Kumar, Surveyor General of India explained the mandate and activities of the Survey of India (SOI). He also spoke about Defence SeriesMaps (DSM) and Open Series Maps (OSM while discussing the issues of data availability and accessibility. He shared one interesting initiative of the SOI - SAHYOG App which facilitates the participation of citizens in map making processes. Taking the cue Dr Mukund Rao suggested why can't the SOI engages with citizens of the country and involve them in designing, developing and managing a new series of maps - Citizen Series Maps (CSM) – Maps by the citizens, of the citizens and for the citizens.

Evolving Analytics

"Gone are the days when we had paper maps which were not easy to rectify and update," said Prof S Sadgopan, Director IIIT-B while emphasizing the need of a professional body that can bring cartographers and GIS together. He said that the time has changed. Now children see maps on phones. While elaborating on the interface between spatial and analytics, he said that though we have been talking about artificial intelligence since long but it is now being nurtured with the availability of data. What is required now is to develop applications that can benefit people.

"AI has evolved over time," said Prof V Kamakoti, IIT Madras. "There was a time when Garry Kasparov played chess with computer but now it is proposed if he can play chess with a robot, - a significantly more complex proposition," he added.

Dr Mukesh Mohania, Professor, IIIT Delhi explained the applications of Machine Learning and Big data analytics and Professor Uttam Kumar, IIIT-B underlined the importance of Data Science in Applications.

Prof NL Sarda, Retd Professor, IIT Bombay discussed some of the issues related to Data Analytics and Applications. He shared some of his experiences in banking segment and other areas. He emphasized while technologists do have the capabilities in data analytics, the domain expertise is important where applications are envisaged.

Embracing the challenge

There was a clear message from the industry that it is aware of the challenges ahead is prepared to deal with it. Dr Ujaval Gandhi, Google Earth explained how Google Earth Engine, a cloud-based platform enables large-scale processing of satellite imagery to detect changes, map trends, and quantify differences on the Earth's surface. Prof Praphul Chandra, Founder and Chief Scientist, KoineArth explored the intersection of Big Data, Blockchain and Machine Learning. He said that the blockchain adds the layers of trust when we process big data with Machine Learning. Dr Adel Bolbol Fenandez, Global Business Lead, Esri Middle East told how industry is repositioning itself to new challenges. Now the focus is multidisciplinary research and server-based solutions are encouraged. Vijay Kumar, Esri India elaborated on Advanced Data Analytics in ArcGIS and Dr Shailesh Desphpande, TCS came out with a study on how to leverage spatial and spectral mixture of urban objects for landuse classification. Vijay Khanna, Amazon Web Service discussed Cloud Configurations and Applications. Kasi Viswanadham Ponnapalli of IIC Academy detailed on processing aerial images in LiDAR and Shrikrishna Shastry, SkyMap Global elanorated on Geo Intellugence from Image Processing.

GeoAI – The way forward

Professor Michael Goodchild, University of California Santa Barbara, USA spoke about the future of GIS and spatial analytics. He said that at present it is an interplay of four disciplines viz. Information System, Geographic Information, Artificial Intelligence and Data. He emphasized on the need to think on how to make GIS better using AI. He said GeoAI – an interdisciplinary field of geography and AI could be the way forward.

The data issues

Data being generated is huge. Dr Rao painted the massive Datasphere – something that will blow up soon to different management systems. Millions of bytes are added every moment and many of these data have positional significance. Data Science, Machine Learning, Algorithms all have a role to play along with geospatial technologies. However, many questions were raised. What are these data, where they are generated, how to use them and for what they can be used, where they can be stored, how to archive? Are all data useful? What to do with them once they are used? How they can be discarded? How secure are the data? What if they are hacked? Misused? etc.

Prof V Kamakoti, IIT Madras was of the opinion that data storage is not an issue. Data can be stored in cloud. Even ML may help to find out which data are useful and which are not. However, the problem lies in their retrieval. As data formats keep evolving, it will be difficult retrieve them. Along with, data security is a major concern. Many of us are not even aware where the data related to us are stored and how they are used. We need to learn to live in this era of clouds but which cloud is trustworthy. Trust is not a term that can be defined mathematically.

Prof V Sridhar, IIIT-B alerted that Cyber Crime is a reality and data are being breached. Despite all the precautions and backups, possibility of hacking cannot be ruled out. These concerns were also shared by Ms Vinutha BN and Narendra N of Wipro.

It appears that Spatial Analytics and Deep Learning are set to be at the driving seat for Geospatial applications. Spatial on it own may not go beyond a point; it will be Analytics that will provide the needed acceleration.

"India should have a new series of maps – Citizen Series Maps"

says Dr Mukund Kadursrinivas Rao, Chief Executive, NIAS Centre for Spatial Analytics and Advanced GIS (C-SAG), National Institute of Advanced Studies (NIAS), India

Dr Mukund Kadursrinivas Rao

What is the relevance and importance of this workshop?

Today, geospatial technology extends into virtually all areas of human activity helping to solve different problems, make better decisions, predict outcomes, and discover and explain how the Earth's environmental and social systems work – efforts are on to see that the technology benefit reaches each and every citizen on this Earth.

In India, GIS based initiatives (or projects) have been undertaken in various departments of the Government; various initiatives in the states; unique GIS applications in private sector and research activities in universities – these have helped to bring good and operational examples of applications of GIS in India. However, in spite of fairly wide usage of GIS as a technology, the full potential of GIS has not been exploited in India as GIS is yet to be embedded into work-flows and practices of Governance and citizen systems – which is very critical so that governance-process and decision-making can bring direct benefit of GIS actions to citizens and developmental activities. While GIS data availability was major challenge in the past, it is no more an issue. Today, spatial data is generated in multitude of ways – through satellite measurements and imaging; through sensors on Unmanned Aerial Systems or aircrafts; embedded precise positioning using specialized hand-held devices; underground utilities data collection systems; indoor positions and mapping; mobile systems and Wi-Fi systems based on positions of transmitters; radio-frequency identification (RFID) using networks of fixed detectors/readers; laser imaging matched to 3D geometry and many, many more methods. In fact, world-over society is generating, referencing, archiving and using vast amount of such "integrated" data sets. Datasets are now "time-stamped" - making them amenable to easy change detection and time-analysis. As a result, now we have good quality, real-time access and easy affordability to GIS layered data across the world (and also in India) - particularly, private-sector initiatives of MapMyIndia, Here, Google Earth, ESRI etc are changing the outlook for access and use of spatial and locational data.

India does not still have a profound capability in Spatial Analytics – we still are into basic database and visualisation regimes of what I call "bottom of pyramid of GIS". We need to maintain a high-level of national capability in this important technology area of GIS and also leverage to be in the fore-front of GIS technology at the international arena.

One of the goals of C-SAG is also to further the knowledge and capabilities in Spatial Analytics. With 2 years of massive data collected, analysed, experimented upon in Agri-GIS and the understanding the importance of Analytics, it was timely to share the knowledge of Spatial Analytics that we and others in the world have with a wider cross section of experts in India and bring focus on this important technology and applications area. To that extent, this Workshop has served an important purpose of C-SAG – this is the first of its kind workshop on SA and DL in India.

I am happy to inform your readers that C-SAG successfully conducted the International Workshop on Advanced Spatial Analytics and Deep Learning for Geospatial Applications during Jan 20-31, 2020. A total of 51 candidates from government, industry, academia and NGOs participated in the 10-day workshop. The Workshop was inaugurated by Dr K Kasturirangan and proficiency certificates were awarded to participants by Mr S Ramadorai on Jan 30, 2020.

At the Workshop, you mentioned to Surveyor General about a new series of maps for India – CSM? Can you elaborate your vision on this?

India has 2 series maps – DSM – Defence Series Maps and OSM – Open Series Maps. Both these maps are under the aegis of SOI and various policies govern its use and applications. Of course, DSM is not available to non-military users; OSM has its own difficulties of updating, datedness, digital amenability, easy accessibility and "controlled restrictions" etc. As a result, a citizen can never even dream of being able to use these DSM and OSM even in his life-time. Many a times I have felt we have kept these maps (and satellite images

too) "locked" and citizens has no way of envisioning his country except through "foreign maps and images" (Google, Bing and so on). The small efforts that Indian industries have done (like MapMyIndia) have their own terms for availability and accessibility. Thus, I have always felt that citizens may really not know their country and maps are being denied to them – policy issues are also not helping this problem.

I have always questioned "What does a citizen look for in maps" and in my views, a citizen looks for basic information of administrative boundaries, simple terrain features, water bodies, important city and rural information, transportation features, cultural features, tourism features, governance features and some more (actually in my count a list of about 50 features can be the core minimum a citizen would need and most would be points, some line and some polygonal features). In C-SAG we have done a study and determined that these 50 to 60 features can be easily obtained from public satellite images, Positioning surveys of crowd-sourcing and basic cultural and administrative features from SOI. Further, today younger citizens are well-versed with mapping and imaging technology and can easily populate lots of features from primary and secondary sources – which when vetted and verified can become excellent content for maps for citizens. One will recall that this method and technology of citizen making maps and managing them have been proven already. Thus, I felt that India should have a new series of maps – Citizen Series Maps (CSM) which can be a unique project managed by SOI, with a Citizen Council driving the design, development, management and utilisation solely by and for citizens of India. The CSM can ultimately become an a new series maps that any citizen can access and utilise with authentic boundaries and vetted/verified features which can be updated suing public-domain satellite images instantly to bring authorativeness to CSM. I am sure that there will be many start-ups and corporates, citizen groups and NGOs, universities and students and even government officers that will be most happy to contribute to CSM. In fact, advanced Deep Learning and AI tools can be used for effective vetting and building the CSM – which I feel can be easily developed in 1 or 2 years for the whole country.

In the Workshop, I personally proposed and discussed the idea of CSM with Surveyor General of India on Jan 24, 2020 and he readily agreed with the idea – the 50 and odd participants also endorsed the idea and echoed that CSM is worthy to take up as a national citizen movement. I also feel that the Government will also like the idea as it has an extremely pro-citizen development paradigm – thus, I requested Surveyor General to discuss with Government for a fast-track project on this. C-SAG has been asked to submit a idea-note on CSM and we are soon submitting the same.

What interface you see between Advanced Data Analytics and Geospatial Applications?

Data plays a critical role in bringing logical decision-making, intelligence and wisdom in society – and citizens are one block of users of various types of data. Today, the world generates about 30-35 Zettabytes (1ZB is 1 Trillion GB) of data annually and this is expected to grow to ~170-200 Zettabytes by 2025. Worldover, thousands of experts are working on ways to deal with this data explosion. Most of these data have location tags and thus we are to deal with voluminous and ever-growing data. Managing the Datasphere is becoming as important as managing the climate/environment, managing economy and managing the social and cultural fabric of society. Development of the Geographic Information System (GIS) industry is due to the incorporation of new and upcoming technologies like Data Analytics, 3D, Augmented Reality (AR), and Virtual Reality (VR) in GIS systems. Artificial Intelligence (AI), automation, cloud, Internet of Things (IoT), and miniaturization of sensors are expected to be the catalysts driving the development.

As a result, world is developing robust analytics capability and customised "solutions" – that too in a Big Data model, on cloud processing and deep learning algorithms. Spatial Analytics (SA) is becoming increasingly important as it helps determine intrinsic geographic patterns – patterns of commonality, optimality, suitability, predictability etc and adopts advanced modelling and heuristics of data science and self-learning principles. SA processes definitions of "where"; metrics of distances/area/shape/proximity/nearness etc; relationships between data by similarity; siting and locating analysis; spatial econometrics; aviation analytics; Spatial Decision Support Systems (SDSS) and simulations using interpolation methods. GIS Augmented Reality provide reality street views; In-Building Mapping where laser and mapping instruments on robots develop indoor maps and data. All of these characters of SA are oriented to "find patterns"; "newer meanings" in data.

It is important that organisations in India apply many of the newer Data Science concepts and tools for spatial data – like R, Python, Tensor, Tableau – using which one can build focussed applications of structured and un-structured data fusion and mashups in GIS. They can power many a new and innovative applications – reaching the last-in-mile, like our farmer in Agri-GIS.

What are the future elements you see of geospatial technologies vis-a-vis technologies like AI, ML, Big Data, etc?

There are 6 areas that the future is charting out in the broad Datasphere. One, Data Management – where big data concepts are defining capabilities to create, manage and access large increasing volumes of spatial data autonomously and build Systems of System across the globe with advanced data access/verification/certification/security at the core as Blockchain technology systems; Sensor Metrics – where Internet of Things (IoT) is slowly bringing an exponential expansion of sensors or measurement systems – all of which geo-tagged, including the ubiquity of drones, satellite-based imaging and under-the-ground mapping, which is making geographic data

more readily timely, available and relevant for decisions and analytic processes on any place on Earth; Cloud - the rise of distributed computing and the Cloud is leading led to increasingly flexible GIS systems that can quickly scale both data storage capacity and processing power to answer questions that were previously insurmountable; Crowd Sourcing - with the ubiquity of smartphones and tablets and increasing mobility, citizens and mute equipment are becoming data sources with ease and clarity that is helping creating a quickly shared common GIS view in the decision process; Spatial Analytics tools where the trend is towards adopting modern concepts of data science and sophisticated spatial analytics capabilities across geographic AND other data/ information that can reveal newer patterns, trends, and relationships in ways that hitherto has not been possible AND finally, Deep Learning – where advancements in machine learning and artificial intelligence have greatly accelerated analysis of even massive volumes of imagery and geographic data fused with financial, environmental, banking, citizenry, disaster and emergency, natural resources, land, water and many other information.

There have been many initiatives in India like NSDI, National GIS but somehow they could not materialise in way they were envisaged? What could be the reasons?

I have written about this in the past – to me there are 3 important issues. One, is the lack of easy accessibility (whatever data is available is also not easily accessible to users) to most current and granular geospatial data for the country. Data generation must get out of government agencies and must become a private enterprise and become a commodity of easy trading/exchange and commerce. As a nation, our present ability to generate advanced, automated and systematic geospatial data is very limited and is constricted – just imagine, we still do not have large scale base maps for the whole country; we don't have Indian sub-metre current satellite images for the whole country; high-granular DEM is still not available easily and obtaining UAS based imaging-at-will is even now a "no no". Other nations have made tremendous progress on the generation of systematic geospatial data - we have constricted our own abilities. Two, the map/image/spatial data policies are even now "restrictive" and not-so-easy procedures that frustrate a user who wants to use geospatial data – imagine that IRS images cannot be ordered online while world-over satellite images are online the very day of acquisition; even now we do not have 2019 updated digital OSM for India (which can be easily done); all public-funded data really is not available on National Portal – in all these and many other areas other nations have progressed far ahead with use of advanced technology and better policy management. I feel we have just "churned and churned" over the past years to in-effect. As a result, I feel that, we have not been pragmatic in building the best of eco-system for Geospatial technology – neither did we create technical excellence in geospatial technology; we have not built best of societal and national applications that benefit governance of society; we did not encourage and build a home-grown geospatial industry system and nor have we boosted advanced research in our universities. In fact, once again we seem to have missed the "bus"!! But the nation moves on – development happens and prosperity and economic growth is happening – sometimes I feel is geospatial technology and applications really that important – I am convinced but the nation seems not yet (like say, mobile technology; railway technology; aviation sector). Maybe we need renewed collective efforts once again!!

When I look back, national systems like NNRMS-NRIS and NRDMS laid the initial ground-break and showed the potential of RS and GIS in enthusiastic demonstrative projects; NSDI attempted to bring along a platform of data generators for easy data exchange and availability of geospatial data – NSDI has just become a small government office now; National GIS aimed to build a seamless, national-level geospatial data and DSS platform but seems to have got trapped in "governmental squabbles" and never took off; newer avatars come up and make some drive ahead – of course, in each of these endeavours we have made some small progress (in some bits) but as a national enterprise in RS and GIS we are left far behind and that is the reason we do not have a national excelling eco-system of government-industry-academia-society in Geospatial sector. On other hand, nations like USA, Europe, Australia, China and others have done considerably, if not remarkably, well and are quite advanced. The best thing for India now would be to turn to the geospatial technology/data/ services offerings from these advancing nations and develop robust application system and then, if possible, leap-frog far ahead in next 10-20 years!!

What is way forward for geospatial technologies especially in India?

In my tryst with RS and GIS of past 40 years, I do feel that some of the government agencies could have distinguished themselves much better in the "national spirit" as far as geospatial technology is concerned – with their turf-wars and squabbles they did not help boost or grow an integrated working together in this "integrating field of GIS". Private sector have "sold products and hours" and faded away when the jingle went off. Academia could never peak to excelling advanced research and just made a knowledgeable work-force. To each his own seems to have been the motto – and therefore each has done some bit but the "whole system" has never emerged.

In today's parlance, I think a "nationalistic spirit" is even more essential in geospatial technology where the larger national good must be the driver to develop a progressive eco-system that promotes technical merit/excellence and helps develops a goof and progressive eco-system. The ME must step-back and make for the WE – that will be good for geospatial technology. Ultimately what will count is HAS THE NATION (WHICH MEANS ITS CITIZENS) BENFITTED?? We must work for this now.

Blue Marble Geographics announces partnership with COPTRZ

Blue Marble Geographics® has announced its first official partnership with a UK GIS-focused company — COPTRZ, UK Commercial Drone Experts. Providing comprehensive support to businesses interested in using drones, COPTRZ will now include Blue Marble's GIS software and point cloud processing software Global Mapper® and the LiDAR Module® to its portfolio of surveying solutions.

Esri partners with OSI

Esri has announced its partnership with Open Systems International, Inc. (OSI). Their joint customers in the electric, gas, and water utility industries will now be able to leverage both Esri's ArcGIS Utility Network Management as part of their GIS and OSI's monarch operational technology (OT) platform. OSI has extensive experience in leveraging Esri GIS network models as an input to OSI's real-time OT solutions built on the monarch platform. *www.esri.com*

Hasse receives N.J. conservation award for vast online mapping project

Rowan University Professor of Geography John Hasse and a team of researchers have compiled a massive trove of New Jersey land use data and moved it all online for easy access, a project that will benefit students, journalists, municipal officials, developers and residents for decades to come. The project spawned numerous research offshoots including the New Jersey Conservation Blueprint to help guide development in the state and to preserve valuable and often sensitive parcels for future generations.

Hasse described NJ MAP as an interactive atlas, a 21st Century resource that makes finding detailed ecological and environmental information easy, and puts it literally in the palm of one's hand, be it from a laptop, a desktop computer or a smartphone. He said the NJ MAP program and side projects such as the Conservation Blueprint not only help illustrate the state in an unprecedented way but also are helping to save resources, financial as well as physical.

NOAA, Ocean Infinity to advance ocean exploration and mapping

NOAA's Office of Ocean Exploration Office of Ocean Exploration and Research and Ocean Infinity have announced a new agreement to develop deep-water autonomous technologies that can gather ultra-high-resolution ocean information.

The four-year Cooperative Research and Development Agreement (CRADA) between NOAA and Ocean Infinity will also focus on advancing telepresence or the transmission of ocean information in real time to public and academic audiences as well as new data-collection and processing methods to increase the value and relevance of deep-ocean data. *www.workboat.com*

Cloud-based geospatial data refinery and modeling platform

Descartes Labs has announced the availability of the Descartes Labs Platform, the industry's first-ever cloud-based geospatial analytics platform. It provides enterprises with a real-time geospatial data catalog and flexible modeling environment – all in one complete package.

This modeling tool enables forecasting capabilities across industries, including agriculture, energy, sustainability, mining, shipping, financial services, and insurance, to facilitate everything from agricultural monitoring to mineral exploration. *DescartesLabs.com*

Renoworks enters into agreement with EagleView

Renoworks Software Inc. has announced the integration of aerial measurement data from EagleView into the Renoworks FastTrack Platform. The agreement allows Renoworks to integrate EagleView's patented measurements with Renoworks FastTrack, the all-in-one 3D modeling, visualization, and measurement solution for the construction and remodeling industry, enabling Renoworks to broaden its customer base and provide additional solutions to multiple industry stakeholders, including manufacturers, dealers, contractors, and retailers, in both residential and commercial construction projects. *www.renoworks.com*

The Netherlands DGeo subscribes to Maxar's SecureWatch platform

Maxar Technologies has announced the Defence Geographic Agency (DGeo) of The Netherlands Ministry of Defence signed a multi-million dollar, multi-year subscription to SecureWatch, the company's cloud-based geospatial intelligence (GEOINT) platform.

DGeo will leverage SecureWatch to enrich its geospatial foundation data holdings and derivative product portfolio that aid critical decision-making within The Netherlands Ministry of Defence (MoD). Through SecureWatch, DGeo will have access to Maxar's 110-petabyte, high-resolution satellite imagery library, daily imagery collections, Vivid and Metro imagery mosaics, FirstLook service and synthetic aperture radar data from MDA's RADARSAT-2 satellite. *www.maxar.com*

Public grants fund to accelerate Blockchain development

Nervos Network has announced a public grants fund to fuel ecosystem growth and development for its permission less layer one blockchain—the Nervos Common Knowledge Base (CKB). To provide participating individuals, teams, and projects with the resources necessary to develop and deploy new solutions on the network, Nervos is committing $30 million USD in grants to be awarded across multiple project categories ranging from infrastructure development to decentralized applications.

As an open source public blockchain, Nervos is striving for a completely decentralized ecosystem. The new grants fund will allow Nervos to promote blockchain innovation and facilitate collaboration across the wider developer community. Through the grants program, blockchain teams and projects will be able to make significant contributions toward building out the infrastructure of Nervos Network and help further expand the ecosystem. *www.nervos.org*

Iridium Cloud Connect goes live

Iridium Communications Inc. has announced that Iridium CloudConnect, the first and only satellite cloud-based solution offering truly global coverage for Internet of Things (IoT) applications, is now actively serving customers. This new service combines Iridium® IoT capabilities with Amazon Web Services (AWS) IoT and cloud services extending customers' IoT reach to the more than 80 percent of the Earth that lacks terrestrial coverage.

The service makes it easier to do business by translating between industry-standard cloud protocols and Iridium's Short Burst Data® service. This allows virtually any IoT device connected through the Iridium network to speak natively with AWS IoT services as well as other value-added elements available in AWS Marketplace.

Iridium's IoT services continue to experience strong subscriber growth. Commercial IoT data subscribers grew 25% from the third quarter of 2018 through the third quarter of 2019, to 767,000 customers. *www.iridium.com*

Indoor mapping platform selected for patient wayfinding

Inpixon has announced its indoor mapping solution has been selected by a leading mental healthcare facility in North America. Utilizing its indoor mapping platform, Jibestream, the solution is expected to allow patients to effectively search for and navigate to specific locations, such as reception areas, doctor and therapist offices, and testing areas and clinics, within the hospital's multi-building complex.

The U.S. healthcare market loses approximately $150 billion per year from missed medical appointments, due in part to the difficulty some patients face navigating complex buildings. The indoor mapping and location platform is designed to empower users to create map-enabled solutions that enable patients to easily locate and navigate to destinations within the hospital complex, in turn, reducing missed or late appointments, as well as enhancing the patient experience. This user plans to implement the Inpixon mapping and location platform within its app-based solution in a manner that will, in addition to the benefits outlined above, also address regulations and requirements for those with disabilities by providing patients a filter to navigate a path that is handicap accessible. *www.inpixon.com*

Phiar launches AI-powered AR navigation app

Phiar, a Palo Alto-based startup that is using artificial intelligence and augmented reality to enhance vehicular navigation, is finally making its long-awaited AR driving app available for the first time — albeit in a limited fashion. The company recently announced the start of a private beta program for iPhone users, and plans to expand the program to Android devices later in 2020.

Phiar notes that the app automatically picks visible AR overlays by looking at the road, lighting, weather, and objects present in the live video, drawing pathways using either lines or higher contrast patterns that will be more visible as you drive. It also uses AI for lane segmentation, semantic segmentation, and 3D localization, allowing the app to determine and draw a proper navigational route through multi-lane streets. The user can then just follow the suggested path, as well as seeing floating icons that indicate points of interest and traffic signals. One key to these tricks is on-device edge AI processing rather than reliance on cloud servers. *https://venturebeat.com*

RealityEngines.AI autonomous AI service

RealityEngines.AI, a San Francisco-based AI and machine learning research startup, is coming out of stealth and launching the world's first completely autonomous cloud AI service to address common enterprise use-cases. The cloud AI service automatically creates, deploys and maintains deep learning systems in production. The engine handles setting up data pipelines, scheduled retraining of models from new data, provisioning high availability online model serving from raw data using a feature store service, and providing explanations for the model's predictions. The service is the first of its kind and helps organizations with little to no machine learning expertise plug and play state-of-the-art AI into their existing applications and business processes effortlessly. http://realityengines.ai

Using artificial intelligence to enrich digital maps

Researchers at the Massachusetts Institute of Technology (MIT) and Qatar Computing Research Institute have developed an artificial intelligence model that uses satellite imagery to tag road features in digital maps.

The RoadTagger model combines a convolutional neural network (CNN) and a graph neural network (GNN) to automatically predict the number of lanes and road types hidden by obstructions.

The CNN digests raw satellite imagery while the GNN segments the road into 20-meter tiles or graph nodes linked by lines; the CNN extracts road features and shares that data with its immediate neighbors. *http://news.mit.edu*

HERE's new HD GNSS enables sub-meter positioning for mass market

HERE Technologies has introduced its High Definition GNSS (HD GNSS) positioning, a cloud-based solution that enables mass-market devices to achieve sub-meter accuracy across the globe.

HD GNSS enables new user experiences with lane-level navigation, augmented and virtual reality. It combines precise point positioning (PPP) and real-time kinematic (RTK) positioning methods, allowing for fast convergence time, high availability and global coverage.

It also supports off-the-shelf mobile devices and internet of things (IoT) trackers equipped with dual frequency chipsets such as the Broadcom BCM47765 and BCM47755. More mass-market devices and vehicles are being equipped with dual-frequency GNSS receivers. With the

HD GNSS service, the receivers enable high-precision positioning, HERE said, a capability that was cost and geographically prohibitive less than two years ago.

TomTom Traffic Index

TomTom has released the results of the TomTom Traffic Index, a report detailing the traffic situation in 416 cities in 57 countries. Bengaluru in India takes the top spot this year with drivers in the southern Indian city expecting to spend an average of 71% extra travel time stuck in traffic. Next in the global rankings are Philippine capital, Manila (71%); Bogota in Colombia (68%); last year's most congested city, Mumbai (65%); and Pune (59%), also in India; making up the top five most congested cities in the world.

Greater Moscow1 takes the lead in Europe (59%) with Istanbul (55%) coming a close second. Kyiv (53%), Bucharest (52%), and Saint Petersburg (49%) make up the rest of the top five. Paris (39%), Rome (38%) and London (38%) ranked in at 14th, 15th and 17th respectively.

In the US, the top five most congested cities are Los Angeles (42%), New York (37%), San Francisco (36%), San Jose (33%) and Seattle (31%). *www.tomtom.com*

Telangana, India launches AI projects

The Telangana government, India has begun several initiatives on artificial intelligence (AI) and information technology (IT), including signing of memoranda of understanding with technology companies and launching pilot projects on AI. The state government has also declared 2020 as the 'Year of AI'.

The state government now also aims to transform public service delivery and governance with the help of deep technology. The state has identified eight emerging technologies, including AI, blockchain, cloud, Internet of Things, and robotics, in its push for the use of technology. The Telangana government has also formulated policy frameworks for blockchain, drones, cybersecurity and e-waste, among other things.

However, experts had their misgivings. "The implementation of AI in policing and sharing data of AI development with the private sector is a concern as there is no data protection law. The state government needs to inform people if their data is being shared even between departments, as the fundamental right to privacy guarantees that no one can use my data without my permission," said Srinivas Kodali, an independent reseacher based in Hyderabad who works on data and governance.

This concern was shared by some citizens. "It is definitely a matter of concern, because data on us can be used in a wrong manner, especially by private players. The state government needs to actually tell us before they do anything with the data they have collected." *www.livemint.com*

Hitachi Automotive Systems and TomTom collaboration

Hitachi Automotive Systems Americas, Inc. and TomTom, the location technology specialist, have announced that they are collaborating on a proof of concept for the development of a new real-time hazard service for navigation and Advanced Driver Assistance Systems (ADAS).

Through the collaboration, the companies will combine technological strengths to deliver real-time updates on the location of road hazards, detected by Hitachi Automotive Systems' vehicle sensors, ECU (Engine Control Unit) and on-board DNN (Deep Neural Network), to navigation and ADAS applications running TomTom's connected services.

Hitachi will use its in-car sensor and edge processor technology to detect potholes and road debris, process that information, and send it to its cloud. This information is transferred to TomTom's cloud-based fusion engine – TomTom Traffic. TomTom would then deliver the hazard information to all navigation and ADAS applications running TomTom's connected services in the same manner it delivers its traffic data, helping drivers make better decisions that save time, reduce stress and create safer roads. *www.tomtom.com*

First test of vehicle equipped with smart LiDAR sensor

RoboSense has announced the world's first public road test of a vehicle equipped with a Smart LiDAR Sensor. The RS-LiDAR-M1 Smart LiDAR is the world's first MEMS Smart LiDAR Sensor to incorporate sensor hardware, AI perception algorithms, and IC chipsets, transforming conventional LiDAR sensors from an information collector to a complete data analysis and comprehension system, providing essential information for autonomous vehicle decision-making faster than ever before. *www.robosense.ai*

Trimble to acquire Kuebix

Trimble has announced acquisition of privately held Kuebix, a leading transportation management system (TMS) provider and creator of North America's largest connected shipping community. This acquisition will enable Trimble to bring together its network of private fleet and commercial carrier customers, which collectively represent more than 1.3 million commercial trucks in North America, with Kuebix's extensive community of more than 21,000 shipping companies, creating a powerful new platform for planning, execution and freight demand-capacity matching.

Patent for automated indoor map generation capabilities

InnerSpace, an IoT-based indoor location intelligence platform for Smart Buildings, has been awarded a patent by the US Patent Office for its approach to generating maps for indoor navigation. The patent (#10458798B2) titled "Method for Sensing Interior Spaces to Auto-Generate a Navigational Map" protects the company's unique approach leveraging LiDAR to create maps of indoor spaces. It uses WiFi networks and/or its proprietary sensors to measure how people and things behave within an indoor space. The company makes it easy for clients in Food & Beverage Retail, Public Safety and Security, Workplace Experience, and Real Estate Operations to turn any building Smart. *Innerspace.io*

ISRO's NavIC will support Qualcomm

Qualcomm has released three new chipsets that will come with support for India's NavIC satellites -- developed by ISRO.

Support for NavIC will be seen on Qualcomm's latest Snapdragon 720G, 662 and 460. These are budget to mid-tier performing chipsets that will be seen on upcoming budget-friendly smartphones. *www.indiatimes.com*

Galileo now replying to SOS messages worldwide

For three decades the Cospas–Sarsat system has used relays on satellites such as Europe's MSG and MetOp to pick up distress calls from ships and aircraft.

As well as providing global navigation services, Europe's Galileo satellite constellation is contributing to saving more than 2000 lives annually by relaying SOS messages to first responders. And from now on the satellites will reply to these messages, assuring people in danger that help is on the way.

This ESA-design "return link" system, unique to Galileo, was declared operational recently. The delivery time for the return link acknowledgment messages from initial emergency beacon activation is expected to be a couple of minutes in the majority of cases, up to 30 minutes maximum, depending primarily on the time it takes to detect and locate the alert.

All but the first two out of 26 Galileo satellites carry a Cospas-Sarsat search and rescue package. At only 8 kg in mass, these life-saving payloads consume just 3% of onboard power, with their receive-transmit repeater housed next to the main navigation antenna.

Galileo's Search and Rescue service is Europe's contribution to Cospas-Sarsat, operated by the European Global Navigation Satellite System Agency, GSA, and designed and developed at ESA. As the overall Galileo system architect and design authority, ESA has been responsible for the interface between the core Galileo infrastructure to the Return Link Service Provider facility, procured by the European Commission and operated by French space agency CNES.

The Cospas-Sarsat satellite repeaters are supplemented by a trio of ground stations at the corners of Europe, known as Medium-Earth Orbit Local User Terminals (MEOLUTs), based in Norway›s Spitsbergen Islands, Cyprus and Spain›s Canary Islands and coordinated from a control center in Toulouse, France. This trio is soon to become a quartet, with a fourth station on France›s La Reunion Island in the Indian Ocean under development.

The satellites relay distress messages to these MEOLUTs, which then relay them to local search and rescue authorities. The service's return link message capability was developed as an inherent part of the Galileo system. *https://phys.org*

Russia to modify its tracking station in Angola

The Russian Lower Parliament endorsed Russian-Angolan cooperation on space research and peaceful use of outer space, signed in April 2019 during President Joao Lourenco's official visit to Moscow amidst plans by Roscomos to leverage the capacities of its station in Angola for data reception from Russian satellites.

The agreement includes the conditions for the exchange of information and the customs regime for special goods as well as allows the development of joint activities of both countries in the fields of space research and astrophysical research, materials science, space medicine and biology; communications, manned flights and training, as well as satellite navigation, including the deployment of GLONASS radio stations in Angola. *https://africanews.space*

EU reserves four Ariane 6 rockets for Galileo navigation satellites

The European Commission has "pre-booked" four launches using Europe's next-generation Ariane 6 rocket. Arianespace's first Ariane 6 mission will launch 30 small broadband satellites for startup OneWeb during the fourth quarter of 2020.

The European Commission in 2017 ordered two Ariane 62 launches for Galileo — two satellites at a time — with launches then slated for 2020 and 2021. The first of those launches slipped to 2021 due to a disagreement between ArianeGroup, Ariane 6's manufacturer, and the European Space Agency, that delayed the start of serial production until last April. *https://spacenews.com*

Be ready if you lose GNSS signal, Airbus advises pilots

As operators report an increasing number of GNSS signal losses related to radio frequency interference, Airbus is reminding pilots of the consequences and required action in the cockpit.

Various reasons may explain the loss of GPS signal. It can cause the loss of some navigation and surveillance functions. Built-in redundancies maintain position computation capability.

The power of the GPS signal "is comparable to the power emitted by a 60-watt light bulb located more than 20,000 km [12,000 mi.] away from the surface of the earth; this means the signal could easily be disturbed by any ground source located near an aircraft and emitting in the GPS L1 frequency," Airbus experts in operations, navigation and security say in a company publication focusing on safety.

The source can be a personal jammer activated in the vicinity of an airport, a protection system around a sensitive site or military activity in a conflict zone. A GPS repeater in a hangar, used for aircraft maintenance, can cause interference with actual GPS signals, the experts note. GPS spoofing and anti-drone measures have not created any problem yet, but Airbus monitors such threats.

Interference can cause the loss of GNSS position and timing. In that instance, the Flight Management System (FMS) will revert to the onboard inertial reference system (IRS) and ground-based navigation aids, such as DME and VOR (distance measuring equipment and VHF omnidirectional range). "A loss of GNSS

inputs does not lead to a map shift or an erroneous position computation by the FMS. In the case of a loss of GPS signal, the FMS switches from the mixed GPS/IRS position to an IRS-DME/DME position or IRS-VOR/DME or pure IRS, in order of priority," the experts explain. The loss of signal was temporary in most of the reports Airbus received. Nevertheless, there is a list of a dozen systems and functions that can be affected.

The capability for required navigation performance (RNP) operations can be lost. The predictive functions of the terrain awareness and warning system (TAWS) can disappear. The runway overrun protection (ROPS) system may no longer work ADS-B Out can be lost, too. If this happens in an area where such automated position reporting is required, pilots should notify air traffic control. *https://aviationweek.com*

Use of the EU's space assets under scrutiny of auditors

The EU currently has three space programmes: Copernicus, which provides data from earth observation satellites; Galileo, a global satellite navigation and positioning system; and EGNOS, a European regional satellite-based augmentation system used to improve the performance of global navigation satellite systems. Up to the end of 2020, total EU expenditure for the deployment of infrastructure and the operation of satellites and ground stations will amount to some €19 billion. A further €15.5 billion has been proposed by the Commission for the 2021-2027 period.

The auditors have published an Audit Preview on the EU's space assets and their use. Audit Previews provide information on an ongoing audit task. They are designed as a source of information for those interested in the policy or programmes being audited.

The audit will assess specifically whether the Commission is promoting effectively the services provided by the EU's main space programmes. In particular, the auditors will examine whether:

- The Commission has decided on a robust strategy regarding the use of services and data from the EU's flagship space programmes;
- the regulatory framework in place facilitates service and data uptake;
- the Commission's activities have actually succeeded in boosting the uptake of services and data, and;
- the Commission has set up a proper monitoring system for this purpose.

Currently, the EU has three flagship space programmes:

- Copernicus: the world's largest earth observation programme. Operational since 2014, it currently has seven satellites in orbit. Copernicus aims to provide accurate information for use in the environment, agriculture, climate, security and maritime surveillance fields.
- EGNOS: the European Geostationary Navigation Overlay Service. Since 2009, this system has been supplementing the Global Positioning System (GPS) by reporting on the accuracy of its data and sending corrections for aviation, maritime and land-based navigational use.
- Galileo: Europe's global navigation satellite system (GNSS). Launched in 1999, the programme has currently 26 satellites in orbit. Galileo aims to provide very precise navigation services.

The audit report is expected to be published towards the end of 2020. *www.eureporter.co*

CubeSat in Galileo receiver

CubeSats are nanosatellites based on standardised 10 cm-sized units. Originally devised for educational uses, they are nowadays being put to commercial and technology testing uses. The Swiss Astrocast company is assembling a constellation based on 3-unit CubeSats to serve the emerging internet of things (IoT).

Vigilant for new initiatives that foster innovation in the field of navigation, ESA navigation researchers supported Switzerland's ETH Zurich technical university to fly a navigation payload — composed of four low-cost multi-constellation mass-market satnav receiver modules plus two antennas — aboard a test CubeSat.

This opportunity, funded through ESA's European GNSS Evolution programme, was conceived together with ESA's Galileo Science Advisory Committee, a group of scientists advising ESA on scientific matters related to Galileo and fostering its scientific exploitation.

This first AstroCast CubeSat was launched in December 2018, and the first results confirming the use of Galileo satellites for positioning were reported at the recent Galileo Science Colloquium in Zurich, typically demonstrating orbital positioning precision down to less than 5 m.

ESA's Galileo Navigation Science Office and GNSS Evolution are looking into extending this pioneering experience to perform more CubeSat-based experiments in space to test ideas for evolutions of European satnav systems and scientific experiments with Galileo, in partnership with universities and research institutions.

Spire Global shares early data from GNSS Reflectometry satellites

Spire Global shared early data from new GNSS Reflectometry cubesats at the American Meteorological Society conference. With its existing fleet of more than 80 cubesats, it gathers GNSS radio occultation weather data in addition to tracking ships and airplanes. The European Space Agency's Pioneer program, which supports demonstration of new technologies, systems and services, helped fund Spire's GNSS Reflectometry program.

Spire's first two GNSS Reflectometry cubesats are technology demonstrators. It is developing two more GNSS Reflectometry cubesats to launch later this year. With the second pair of GNSS Reflectometry cubesats, Spire plans to offer sustained monitoring of soil moisture and ocean winds. The data will have important applications for weather forecasting, agriculture, drought monitoring and flood prediction, Masters said. *https://spacenews.com*

Agreement on data utilization of EOS with FAO

Japan Aerospace Exploration Agency has agreed to collaborate with Food and Agriculture Organization of the United Nations (FAO) on data utilization of Earth Observation Satellites(EOS), and Imai Ryoichi, JAXA Vice President and Daniel Gustafson, FAO's Deputy Director-General for Programmes have signed the Memorandum of Understanding at JAXA Tsukuba Space Center on January 23, 2020.

Leveraging this cooperation, JAXA and FAO will be monitoring forests and mangroves around the world by JAXA's satellites with L-band Synthetic Aperture Radar (SAR).

Only JAXA has observed forest using L-band radar (SAR) technology from 1992. Observation data of global forests that JAXA has been accumulating for over 25 years will be provided to the System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL) that is FAO's toolkit for monitoring forest and land-use. Additionally, this cooperation supports JAXA to improve the accuracy of its satellite data. *http://global.jaxa.jp*

Slow light to speed up LiDAR sensors development

A team from Yokohama National University in Japan believes they have developed a method to obtain such a sensor by taking advantage of slow light, an unexpected move in a field where speed is often valued above other variables.

Light detection and ranging also called LiDAR sensors can map the distance between distant objects and more using laser light. In modern LiDAR sensors, many of the systems are composed of a laser source; a photodetector, which converts light into current; and an optical beam steering device, which directs the light into the proper location.

"Currently existing optical beam steering devices all use some kind of mechanics, such as rotary mirrors," said Toshihiko Baba, paper author and professor in the Department of Electrical and Computer Engineering at Yokohama National University. "This makes the device large and heavy, with limited overall speed and a high cost. It all becomes unstable, particularly in mobile devices, hampering the wide range of applications."

In recent years, according to Baba, more engineers have turned toward optical phased arrays, which direct the optical beam without mechanical parts. But, Baba warned, such an approach can become complicated due to the sheer number of optical antennae required, as well as the time and precision needed to calibrate each piece.

"In our study, we employed another approach - what we call 'slow light,'" Baba said.

Baba and his team used a special waveguide "photonic crystal," aimed through a silicon-etched medium. Light is slowed down and emitted to the free space when forced to interact with the photonic crystal. The researchers engaged a prism lens to then direct the beam in the desired direction.

"The non-mechanical steering is thought to be crucial for LiDAR sensors," Baba said.

The resulting method and device are small-sized, free of moving mechanics, setting the stage for a solid-state LiDAR. Such a device is considered smaller, cheaper to make and more resilient, especially in mobile applications such as autonomous vehicles. *www.spacedaily.com*

ESA and Airbus sign contract

The Bartolomeo platform from Airbus gives new opportunities for research on the International Space Station (ISS). The European Space Agency ESA has now firmly booked a payload slot for a Norwegian instrument to monitor plasma density in the Earth's atmosphere.

The Bartolomeo platform - named after Christopher Columbus' younger brother - is currently in the final stage of launch preparation at Airbus in Bremen and is scheduled for launch to the ISS in March 2020. Bartolomeo is developed on a commercial basis by Airbus using its own investment funds and will be operated in cooperation with ESA.

The platform can accommodate up to 12 different experiment modules, supplying them with power and providing data transmission to Earth. It is suitable for many different experiments. Due to the unique position of the platform with a direct view of Earth from 400 kilometres, Earth observation including trace gas measurements or CO2 monitoring of the atmosphere are possible, with data useful for climate protection or for use by private data service providers.

The Multi-Needle Langmuir Probe (m-NLP) is an instrument from the University of Oslo and the Norwegian company Eidsvoll Electronics to measure ionospheric plasma densities. With its relatively low orbit, the ISS passes near the peak plasma density of the ionosphere. The m-NLP is currently the only instrument in the world capable of resolving ionospheric plasma density variations at spatial scales below one metre. It will gather valuable data from the equatorial and mid-latitude ionosphere, enabling study of the dynamic processes in this region in unprecedented detail. The Langmuir Probe will map plasma characteristics around the globe. *www.airbus.com* Shoreline mapping contract for Quantum Spatial

NV5 Global, Inc. a provider of professional and technical engineering and consulting solutions, has announced that Quantum Spatial, Inc. ("Quantum Spatial"), an NV5 company, has been selected as prime contractor under the National Oceanic and Atmospheric Administration's (NOAA) Shoreline Mapping contract. The $18.8 million contract to perform shoreline mapping services includes the collection and processing of topographic and bathymetric LiDAR data and aerial imagery and covers the North Carolina Coast, the Florida Panhandle, Guam, and portions of the Commonwealth of the Northern Mariana Islands. *www.NV5.com*

KazUAV supports World Bank's school infrastructure risk assessment initiative

KazUAV, a group company of Japan-based Terra Drone Corporation, has been supporting the World Bank in its initiative to build sustainable school infrastructure in the Republic of Kyrgyzstan. As part of the General-Purpose Simulation Program (GPSS) under the Global Facility for Disaster Reduction and Recovery (GFDRR) grant-funding mechanism of the World Bank, KazUAV has surveyed and mapped Kyrgyz schools for a pilot project. A highly-detailed database of the educational infrastructure facilities – consisting of geographic coordinates, aerial imagery, orthophotomaps, and 3D models of the school buildings – has been created to help the World Bank make better decisions for improving the safety and functional conditions of schools in Kyrgyzstan. *www.terra-drone.net*

The Leica Aibot AX20 promises high precision

Leica Geosystems positions Aibot AX20 as "a complete UAV solution for land surveying, civil engineering and construction." Its biggest advantage is that its photogrammetry is "high resolution, high precision—it's possible to achieve better than one centimeter accuracy, depending on how accurate your ground points are and how high you fly." Maximum area coverage is 150 acres per flight, but project coverage more typically runs 25 acres, in line with Aibot's surveying and construction missions. The result is highly accurate information through 50 percent fewer photos covering the same sample area, at lower cost, using fewer staff.

Correlator3D™ version 8.4 by SimActive

SimActive Inc. has released Correlator3D™ version 8.4 with significant accelerations. The new version leads to speeds that are multiple times faster compared to previous releases. It allows a dynamic allocation of hardware resources, reducing potential bottlenecks from PC components. For example, solid states drives (SSD) are used more efficiently by the software, as well as additional CPU cores and extra RAM. *www.simactive.com*

DJI introduces the Zenmuse XT S

DJI has introduced a new thermal imaging camera, the Zenmuse XT S, for DJI's Matrice 200 Series drones. The camera features an infrared thermal imaging sensor with high thermal sensitivity and resolutions for clear and detailed thermal imagery. It enables firefighters, police officers, inspectors and more to gather intel beyond the capabilities of visual data, and act on them quickly to save money, time and lives. *www.dji.com*

Team up by Pierce Aerospace and DRONEDEK

Indiana drone startups Pierce Aerospace and DRONEDEK LLC have teamed to advance commercial drone delivery.

The collaboration unites Pierce Aerospace's Remote Identification expertise and technologies and DRONEDEK's patent portfolio in last-mile logistics, including a drone mailbox system. The teams' combined systems provide the infrastructure that enables scalably of authenticated package delivery to government, commercial, institutional, and residential locations throughout the world. *www.dronedek.com*

New drone solutions by Blue innovation and Kyocera

Blue innovation Co., Ltd. and Kyocera Corporation have announced that the companies reached an agreement to jointly develop a new drone solutions.

By flying multiple drones with mobile relay station functions in areas where mobile phone signals do not reach, such as disaster sites, the "moving communication relay station system" enables reliable mobile phone communication as if under normal circumstances. By combining technologies from both the companies, it will develop a moving drone-enabled communication relay station. *https://global.kyocera.com*

UPS and Henry Schein sign agreement

UPS and Henry Schein, Inc. has announced an agreement to explore and test a variety of drone delivery use cases. The use cases would examine unmanned aerial vehicles within business-to-business operating models.

The initiative to explore drone deliveries will begin in 2020 and will focus on testing the transport of essential healthcare products by UPS to customers of Henry Schein, a provider of healthcare solutions to office-based dental and medical practitioners. *www.nasdaq.com*
Hyundai Motor and Uber partnership

Hyundai Motor Company and Uber have announced a new partnership to develop Uber Air Taxis for a future aerial ride share network and unveiled a new full-scale aircraft concept). Hyundai is the first automotive company to join the Uber Elevate initiative, bringing automotive-scale manufacturing capability and a track record of mass-producing electric vehicles. The air vehicle concept Hyundai released recently was created in part through Uber's open design process, a NASA-inspired approach that jump-starts innovation by publicly releasing vehicle design concepts so any company can use them to innovate their air taxi models and engineering technologies.

Draganfly releases new payloads

Draganfly Inc. has announced three new specialized payload offerings, which are intended to expand agricultural research and environmental monitoring using drones.

It has developed these new payload options in collaboration with research experts in agricultural and water resources fields. These new camera packages, are intended to increase efficiency and improve the spatial and spectral quality of actionable data collected. *www.draganfly.com*

Vexcel Imaging to acquire Image Resources from Verisk

Vexcel Imaging, a leader in aerial imagery data, large-format aerial cameras, and photogrammetry software, signed a definitive agreement on 21st Jan 2020, to acquire the imagery sourcing group from Verisk's Geomni business. The acquisition will combine Geomni's imagery surveying and content-related teams and assets into Vexcel. Verisk, a leading data analytics provider, will be a minority owner in Vexcel with full access to all aerial imagery libraries.

The combination of Geomni's fleet of fixed-wing aircraft and aerial operations, mapping business, and oblique aerial image library together with Vexcel's sensor business and data program will create the world's leading geospatial data library.

Geomni's analytics team and assets will remain part of Verisk and continue to focus on world-class advanced analytics. The team will work closely with Vexcel on a strategic road map and joint projects. *www.vexcel-imaging.com*

Visualization platform for accurate digital representation of real world

Hexagon has announced the introduction of HxDR, a new cloud-based, digital-reality visualization platform. It creates accurate digital representations of the real world through the seamless combination of reality capture data from airborne, ground and mobile sensors. Users can then leverage the complete, accurate and precise replicas to visualize and share their 3D design projects and models within a real-world context.

For the first time, airborne imagery and laser scans, indoor and outdoor terrestrial scan data and mobile mapping data can be seamlessly combined using HxDR. .

Hexagon and University of Arizona introduce Mining 4.E curriculum

Hexagon's Mining division and the University of Arizona have announced the launch of Mining 4.E, an online course designed to broaden the understanding of modern mining and its associated technologies.

Developed in partnership, Mining 4.E will cover the complete mining cycle, from discovery to reclamation, as well as the innovation and technology spurring improvements at each step. Participants will learn about the overriding importance of safety in all aspects of mining and the radical changes in mining. *Hexagon.com*

Mesa® 3 Rugged Tablet Running Android™

Juniper Systems, Inc. has released the Mesa 3 Rugged Tablet running on the Android™ operating system. It is the next evolution in rugged handheld computing and data collection for all Android-based application needs.

Offering performance increases across the board, the Mesa 3 is backed by Juniper Systems' world-class support and durability promise. Running on Android 9.0, the Mesa 3 will grant users access to the Google Play Store providing the data collecting, mapping, and productivity applications users require to be successful. *www.junipersys.com*

GMV to install control system for Space Norway's two Arctic-deployed satellites

GMV has signed a contract with Northrop Grumman for development and supply of the Satellite Operations Center for Space Norway HEOSAT's ASBM-1 and ASBM-2 satellites.

Space Norway HEOSAT, a subsidiary of the government owned Space Norway, is a Norwegian company set up to run the Arctic Satellite Broadband Mission (ASBM). ASBM-1 and ASBM-2, built by Northrop Grumman on the GeoStar3 platform, make up the core of ASBM, a satellite system designed to work in highly elliptical orbits (HEO) to ensure broadband connectivity at latitudes beyond the reach of geostationary satellites. Geostationary satellites are capable of providing coverage from the equator, whereas ASBM satellites will be using their unique orbit to provide coverage in the Arctic, from 65 degrees Northwards, providing broadband for civil and military users in the Arctic.

Miniaturized rubidium atomic clock improves performance

Microchip Technology Inc. has announced the industry's highest performance atomic clock for its size and power - MAC-SA5X. The new device also delivers a wider thermal range, critical performance improvements and other enhancements over previously available technology.

It is a miniaturized rubidium atomic clock that produces a stable time and frequency reference that maintains a high degree of synchronization to a reference clock, such as a GNSS-derived signal. Its combination of low monthly drift rate, short-term stability and stability during temperature changes allow the device to maintain precise frequency and timing requirements during extended periods of holdover during GNSS outages or for applications where large rack-mount clocks are not possible. Operating over a wider temperature range of -40 to +75 Celsius, the MAC-SA5X was designed to quickly achieve atomic stability performance by taking less time to lock compared to some of the existing clock technology available in the market. *www.magnetprgroup.com*

Integration of robots into construction site

Trimble, Hilti and Boston Dynamics have announced a collaboration to explore the integration of Trimble's and Hilti's construction management software solutions, GNSS technology and reality capture devices with Boston Dynamics' Spot Robot platform. The objective behind the partnership is to explore the use of autonomous robots, equipped with Trimble and Hilti survey instruments, in the construction industry.

Autonomous robots can play a significant role in construction, specifically in production and quality control workflows by enabling automation of routine and tedious tasks, reducing workload and improving safety. The companies will

collaborate to develop a "proof-of-concept" solution. Equipped with Trimble's and Hilti's reality capture devices as its payload and directly communicating with a cloud-based construction management application, the Boston Dynamics Spot Robot will be able to provide consistent output, deliver improved efficiency on repeatable tasks and enable up-to-date as-built data analysis. *www.trimble.com*

Scan2K Terrestrial Scanner by Carlson

Carlson Software recently released its Scan2K Laser Scanner, a versatile, fast, easy-to-use solution for the creation of accurate 3D survey data up to a range of "2K" (2,000) meters.

Built with surveyors in mind, the Scan2K is at home in the field with its weather-proof housing, user-friendly sunlight-visible touch screen interface with simple, menu-driven operations for quickly collectng and georeferencing point cloud data. With an integrated high-resolution camera, inclinometers, a compass, and an L1 GNSS receiver, it can be deployed in many environments and orientations, including mobile operations. Carlson's partner on the Scan2K project is Teledyne Optech, a world leader in 3D survey systems. *www.carlsonsw.com*

AVL adds Rohde & Schwarz GNSS stimulation to vehicle test environment

GNSS signals are of major importance for positioning and tracking, orientation and safety-related information, such as congestion, in road traffic. A collaboration between AVL and Rohde & Schwarz, two of the world's leading providers of measuring and automotive testing systems, now permits the reproduction of realistic GNSS reception conditions for testbed vehicle testing. As a result, users can reliably test all aspects of GNSS-based vehicle positioning – a core functionality of autonomous vehicles.

AVL DRIVINGCUBE™ enables the reproducible testing of driver assistance systems and driving features for self-driving vehicles using a real vehicle within a virtual environment in a variety of different traffic situations. For that purpose, test drives are performed with a real, ready-to-drive vehicle on a chassis dynamometer or powertrain testbed.

The range of environment simulations carried out with AVL DRIVINGCUBE™ can now be extended to include GNSS signals, bringing simulation closer to reality than ever before. The vehicle's GNSS receiver (e.g. GPS) is stimulated realistically using GNSS signals generated on the testbed.

For generating GNSS signals, Rohde & Schwarz GNSS stimulators are used (R&S®SMBV100B or R&S®SMW200A), which allow the generation of signals for all of the available satellite navigation systems (GPS, Glonass, Galileo, BeiDou, QZSS, SBAS) across all frequency bandwidths (L1, L2, L5). *rohde-schwarz.com*

New L-band receiver enables cm-level positioning for the mass market

U-blox has released a cost-effective approach to bringing centimetre-level accuracy to GNSS receivers. Its new NEO-D9S GNSS correction data receiver module receives GNSS correction data from correction service providers broadcast on the L-band (at 1525–1559MHz). A host processor is then able to decrypt this correction data and present it to a high precision GNSS receiver, merging corrections directly with readings from the satellite constellations to facilitate much more accurate position readings than those provided by GNSS signals alone.

The module is a correction-only receiver, based on the company's latest 9th generation (D9) platform. *www.electropages.com*

Qualcomm's Snapdragon chipsets

Qualcomm's Snapdragon chipsets power millions of Android smartphones and tablets. The Snapdragon 865 features major upgrades in key areas like the central processing unit, digital signal processor, image sensor processor, and modem. It offers up to 25 percent improved CPU performance and more than 25 percent graphics performance boost over its predecessor. The 865's external X55 5G modem-RF system is compatible with 5G technologies.

BAE Systems to get Collins GPS and Raytheon ATR businesses

BAE systems has reached definitive agreements for the proposed acquisitions of Collins Aerospace's military GPS business and Raytheon's Airborne Tactical Radios (ATR) business.

Mediatek Helio G70 mid-range SOC officially announced

Chinese chip maker – MediaTek – has announced the launch of a new SoC the MediaTek Helio G70. It uses an 8-core 64-bit design, with four Cortex A75 large cores clocked at 2GHz plus four Cortex A55 small cores running at 1.7GHz. MediaTek did not reveal which manufacturing process is being used but we can safely assume it's the same as the G90T, thus the older 12nm. *www.gizchina.com/*

Broadcom's second-generation dual-frequency GNSS

Broadcom introduced in 2017 the first mass-market implementation of dual frequency: BCM4775. This chip makes use not only of the classic L1 frequency broadcast by every satellite, but also of the more advanced L5 signal broadcast by a subset of the satellites.

The use of this enhanced L5 signal improves the accuracy of GNSS in an urban scenario, as it mitigates the main source of error: the reflections in the nearby buildings, also known as multipath. Given the unabated need for better precision and accuracy, Broadcom has introduced its second-generation dual-frequency GNSS solution — the BCM4776.
The new chip is capable of using the new BeiDou-3 constellation's B2a signals (the Chinese indicator for L5). It will be able to track 30 new L5 signals (60 percent more) with a significant impact on accuracy. End users will experience much higher reliability of the submeter accuracy inherent to dual-frequency L1-L5.

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www.geoweek.com

HxGN LIVE India
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https://hxgnliveindia.com

April 2020

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

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

May 2020

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

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

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

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

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

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

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

June2020

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

AEC Next Technology Expo + Conference
June 3-5, Chicago
www.aecnext.com

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

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

July 2020

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

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

September 2020

Commercial UAV Expo Americas
September 15-17, Las Vegas,
www.expouav.com

7th International Conference on Geomatics and Geospatial Technology (GGT) 2020
21-24 September 2020
Royale Chulan, Kuala Lumpur, Malaysia.
http://ggt2020.uitm.edu

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

October 2020

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

AARSE2020
26-30 October
Kigali, Rwanda
https://aarse2020.org

November 2020

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

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